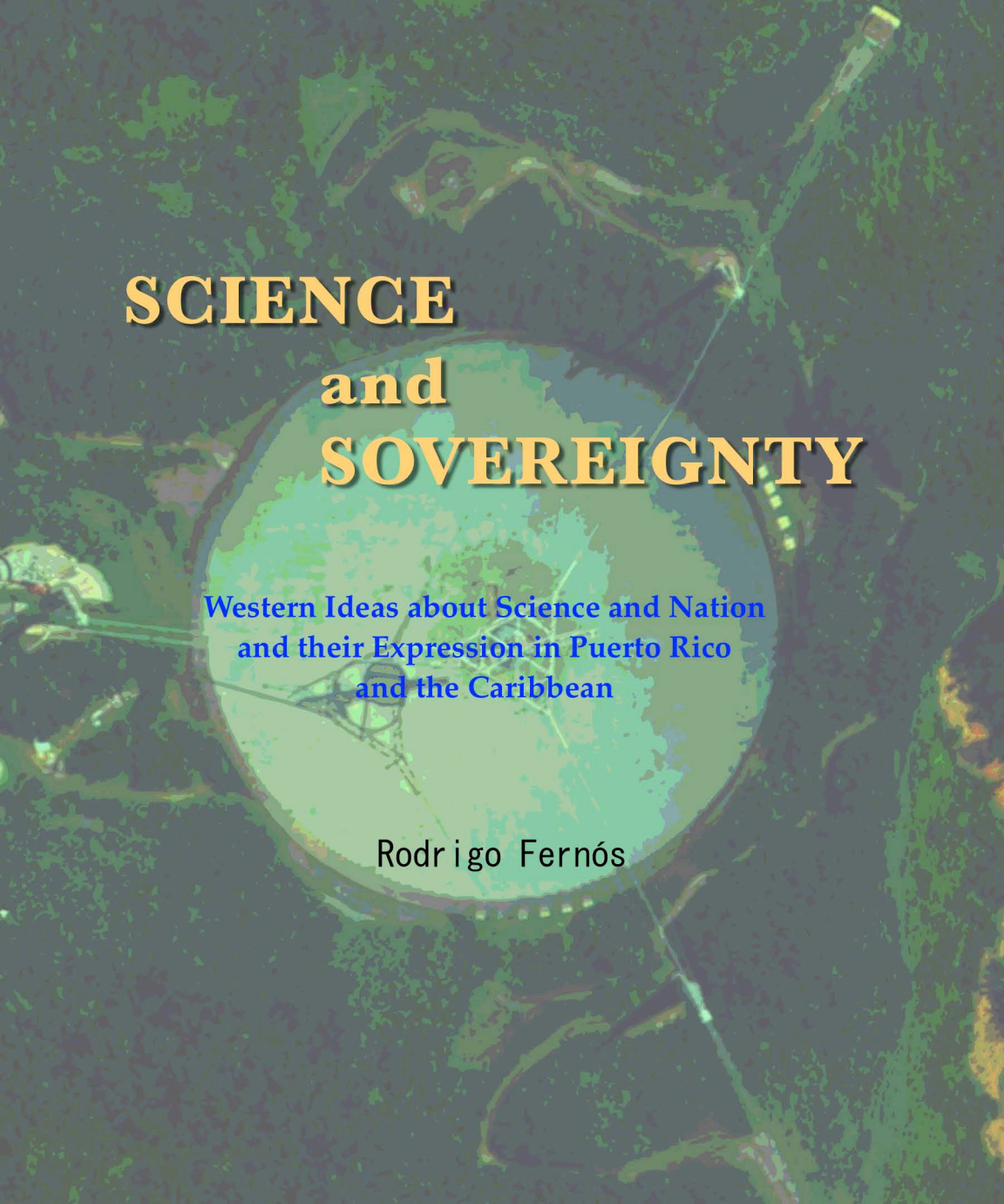
SCIENCE
and
SOVEREIGNTY
Western Ideas about Science and Nation
and their Expression in Puerto Rico
and the Caribbean
Rodrigo Fernós

Science and Sovereignty:
Western Ideas about Science and Nation and their Expression in Puerto Rico and the Caribbean

by

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Front image: Satellite photo of Arecibo Observatory, courtesy of Google Earth, December 10, 2020, HTML: https://earth.google.com/web/@18.34413126,-66.75273603,240.99092054a,1068.27761957d,35y,-0h,0t,0r

Dedicated to the future leaders of Puerto Rico

Table of Contents

Table of Contents 4
Table of Illustrations 5
Acknowledgements 6
Introduction 7
Hispanic Science in the Colonial Greater Antilles 15
Tapia's Lament 16
The Black Legend in 1900 21
The Incessant Intrusion of Politics 29
Interlude: The Paradoxes of Science 36
The Impact of Science on Political Theory 50
The Scientific Revolution in Sixty Seconds 51
Hobbes 58
Locke 68
Montesquieu 77
Bounded Liberty 88
Interlude: Murderous Sun 90
The Impact of Science on Political Action 95
Franklin 96
Jefferson 114
The French Revolution 133
Shifting Tides 158
Interlude: Fashionable nonsense 160
Scientific Rebels 167
Lavoisider, War Hero 168
Linnaeus 172
Latin American Independence Movements 182
Acosta 187
Baldorioty 202
Finland 211
Moral Onus 221
Interlude: A Plea for a Puerto Rican History of Science 225
Davids versus Goliaths 233
On the noxiousness of avarice 234
The Pointilist Empire 243

Justice Louis D. Brandeis, Cowboy.....250
The Sociobiological Roots of Avarice.....261
John Dewey and the new Goliaths 267
Interlude: The Arecibo Observatory.....281
Small State Science 295
The dynamics of the Small State.....296
Science Policy for Small States.....317
Interlude: On the benefits of democracy for the would-be tyrant 325
Conclusion 330
Epilogue.....335
Bibliography.....343
Index 362

Table of Illustrations

Graphic 1: Network dynamics 302
Graphic 2: Power law growth curve.....303
Graphic 3: Jipp's Law and Puerto Rico (1978).....308
Graphic 4: Patents in the Caribbean (1975-2011).....311
Graphic 5: Science in Latin America (1991-1997) 312

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-RF
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Introduction

The first principle of republicanism is that the lex majoris partis is the fundamental law of every society of individuals of equal rights; to consider the will of the society enounced by the majority of a single vote as sacred as if unanimous is the first of all lessons in importance, yet the last which is thoroughly learnt. This law, once disregarded, no other remains but that of force, which ends necessarily in military despotism...and I wish the understanding of our Southern brethren may be sufficiently enlarged and firm to see that their fate depends on it's sacred observance.

-Thomas Jefferson

On May 4, 1898, Dr. Agustin Stahl, a German doctor and naturalist who became known for his ambitious natural history of Puerto Rico, took the ferry as he did on a regular basis between Cataño and San Juan—a slow 20 minute boat ride that was then the most expedient route between Bayamon and San Juan. Though born in Puerto Rico, Stahl received his higher education in Germany, where he obtained a medical degree as well; while considering himself a Puerto Rican, there can be no doubt that his intellectual training was of the highest European caliber.

A man sat down next to him on the ferry, and politely inquired his thoughts on the arrest of the Cuban General Macedo—to which Stahl responded that, though in disaccord with the military leader's goals, Macedo needed to be shown respect for the enormous courage he had shown in the field of battle. Such is what enemies owed to one another. Stahl was immediately arrested by the representative of the reactionary conservative party of the *Partido Incondicional*, whereupon he was exiled to the Dominican Republic. Stahl was fortunate in that the arrival of the Hispanic American War ten days after his arrest led to his restored freedom. His return to his hometown of

Bayamon, however, would unfortunately result in frustrated and unrecognized efforts toward the scientific development of the island.

Ramón Baldorioty de Castro and other leading intellectual men of science in Puerto Rico during the latter half of the nineteenth century, would suffer similar iniquities in that scientific activity was neither recognized nor valued in the Hispanic island nor by its Spanish colonial governors. When the autonomist leader Baldorioty attempted to establish a "*filotécnica"* school, based on Darwinian evolutionary principles, the island's only newspaper, *La Gazeta*, published a humiliating frontpiece article criticizing the enterprise, in the apparent attempt to shame him before the entire island. It was claimed that Baldorioty did not have the necessary credentials—an arbitrary claim given that Baldorioty, along with his close friend Jose Julian Acosta, had received the highest scientific training there was to be had in Europe. Baldorioty but a few years earlier had been the person in charge of reviewing prospective candidates and issuing their teaching certificates.

These arbitrary obstacles blocking the men of science of nineteenth century Puerto Rico, referred to locally as "*proceres,"* would occur time and time again, revealing the threat posed by open scientific inquiry to the Spanish monarchy and its medieval representatives in the island's government. Though a supporter of closer ties to Spain, Acosta would also be arrested after the 1868 *Grito de Lares*, with the charge of having promoted the failed insurrection; this arrest would lead to his famous essay, *"Horas en prisión*". Acosta had sought the end of slavery in the island, as had Ramón Emeterio Betances whom had been exiled on more than five occasions throughout his life, living a substantive portion of it in France. Betances, more than his other scientific peers, formally sought the independence of the island, well aware of the arbitrary frivolity with which Spanish authorities and its representatives had continually treated it during his lifetime. Tragically, Betances's love of the island meant that he would live the majority of his life outside of it.

When we look at the abusive colonial treatment of the most sophisticated Puerto Rican scientists of the nineteenth scientists, it is hard not to notice a relationship between science and sovereignty—be it whether the latter term is defined either as nationalism or democracy. All *proceres* studied sciences of some sort in Europe. Betances and Stahl became physicians, one studying in France while the other in Germany. Baldorioty and Acosta studied in Spain, but traveled to France, England, and Germany during their university years. The relationship is implicitly verbalized by Alejandro Tapia y Rivera in his autobiographical *Mis Memorias*; Tapia, now known as the father of the Puerto Rican theatre, had also studied the sciences in Spain.

The principal purpose of this book is to explore this interaction, specifically seeking to understand whether the development of science in Puerto Rico during the nineteenth century led to the search for sovereignty, and whether this relationship also existed in the twentieth after the island formally entered the sphere of interests of the United States. What is the relationship between science and soverignty, generally speaking? Do they inherently clash or do they mutually coexist in different spaces without influencing one another?

We may note the sometime conflict between science and politics. Science is based on open ended discussion among equals, based on reason and evidence. Tyranny, on the other hand, is literally its praxical opposite, being inherently arbitrary and blind to reason given the dynamics of concentrated power. The tyrant, by definition, cannot know all—and hence will manifest arbitrary decision-making at some point or other. A good example is that of Joseph Stalin. His ignorant support of Trofrim Lysenko destroyed the revolutionary new science of genetics in Russia. Countless murders and persecutions led to a famine of some 32 million deaths, including that of Nikolia Vavilov—a leader in the field who had been his former employer. If we accept the inherent contradiction between science and certain political forms as tyranny, might we also presume that the development of science will tend to push arbitrary tyrannies

towards their demise. This book might be regarded as a sequel to my *Biology and Ethics* (2018), seeking to expand and refine ideas first explored in that volume.

Before we begin, it would be prudent to briefly present the definitions of our concepts. “Sovereignty” in this book will be used rather broadly, incorporating within is use both “democracy” as well as what is normally regarded as “sovereignty”, alluding to its association with “nationalism”. Democracy itself means popular sovereignty. Rebelling against king to abolish monarchy or the rule of one man is not too different from a nation rebelling against an empire for its independence in that both rebellious populations seek to control their own destinies and rights with regards to decisions about the prevailing social order, values, and so forth. Both terms, democracy and nationality, appeal to the same general principle of governance by popular consensus.

This political principle can be illustrated by the many institutions in which it is not found. Colonial relations are not governance by consensus, as neither are military institutions nor prison systems where its members have very little say, if any, with regard to their manner of living. Non-democratic institutions are characterized precisely because their members are typically subjected to the will of another. It constitutes both a loss of agency, and the subjection to potential abuse between a stronger power and a lesser one, most obvious examples of which would be slavery and pedophilia.

A broad typology of cases will be used in this inquiry. We will first explore the ideological use of science or natural philosophy as a means of repression, a good case being that of the Aztecs, whom used their ideas about the cosmos as a justification for colonization. Although clearly its case cannot be regarded as modern science, we must ask how often its example has been repeated throughout history. The use of atomic bomb testing which affected the destiny of countless Pacific island societies, some of which were completely relocated, is an example of the use value of science or scientific praxis, our second topology. Within it, we will look at the actual practices of

science, not as we would like to see them rather but as they have actually occurred. Medical repression in Puerto Rico as was the case of Albizu Campos, do constitute extreme cases which by their very nature tend to stand out.

Thirdly, we will analyze the use of science in political theory. The rise of science as represented by a long 150 year long history contributed to political theory. Thomas Hobbes is good example in that his interpretation of the natural world and politics were placed under same rubric, making only minor distinctions between them. During the 1950s, the rise of scientific naturalism in American political though, with its emphasis on scientific objectivity, led to the elimination of traditional values from political analysis, substituting these with structural components as pluralism or the absence of ideology which greatly contextualized the formation of Puerto Rico's commonwealth or *Estado Libre Asociado* during the early 1950s.

Finally, we will look at reflections by political thinkers on the actual relationship between the two, science and sovereignty, during the twentieth century. There have been a great variety of positions, as those of Robert K. Merton, Timothy Ferris, and Jessica Wang. Unnamable others have unfortunately been unduly influenced by corporate pressure. We will look at the development of democratic theory in its own reflections with regard to its direct relationship to science, of which there is no consensus—likely due to the complexity of the topic.

It goes without saying, however, that both science and sovereignty have been key worldwide values of the twentieth century, thus lending to an inherent interest in their own right. How have these two prominent fields of human activity in the Western world interacted with one another? If there is a link between science and democracy, should we then expect that an increase in the scientific development of a nation will inevitably lead to its independence, as in the case of Puerto Rico, or will it also positively lead to the strengthening and prevalence of a democratic culture?

As always, we have to postulate a few disclaimers.

Sovereignty is caused by many factors, and one cannot simply claim that science will be solely responsible for its emergence, as if it were sovereignty's only cause. Political status is the result of a wide body of complex relationships that cannot be carelessly reduced to a single factor simply because it is more cognitively manageable. In some instances economic dynamics have played a predominant role, specifically the unfulfilled expectation of benefits sparked rebellions in more instances than one would care to imagine. There are countless cases of the phenomenon in Latin America.

We have to also note that science is not a static entity, as neither is democracy for that matter, and in both there is a constant push and pull over their identity and nature. While modern science was born roughly in 1687 with the publication of Newton's *Principia*, it has undergone a continual series of modifications during the nineteenth and twentieth centuries which have resulted in the formation of what is known as "big science." "Little science" and "big science" are very different beasts, with radically different dynamics. The popular conception of science is typically that of little science, the most well known examples being the cases of Newton or Einstein: single geniuses which revolutionized our understanding of nature. Big science, by contrast, is dominated by complex corporate, technological, bureaucratic structures within the framework of capitalism, leading to a drastic alteration of its fundamental character.

That big science is not characterized by the free exchange of ideas should be continually kept in mind throughout the book.

Democracy and sovereignty are similarly not static entities as well, either with regard to political structure or the virtues essential for its continuance, as in the case of the United States. During the North American colonial era, virtue referred to actions and decisions by autonomous actors who were economically independent, selling their own products and services in the small scale market, harking at Rousseau's notion of virtue in his idealized depiction of the noble savage. As for Rousseau and the U.S. Founding Fathers, virtue was not a

characteristic of dependent individuals, whom included slaves the poor white, whose votes could be regularly purchased during prerevolutionary France.

However, as the definition of democracy shifted during the nineteenth century, so did notion of virtue upon which it had been founded during the creation of the United States. Women during the nineteenth century became the new gatekeepers to democracy, serving to preserve the virtue necessary for its continuation. This view became widely held and diffused throughout Latin America, as can be noted in the writings of Acosta and others as Valentin Letelier of Chile. Hostos dedicated an entire treatise to the subject, *Educación científica de la mujer*. While the notion of nation and sovereignty emerges with Hobbes, it does not become common until the rise of the modern era.

Again, we might query, presuming there is a causal link between science and democracy, what its implications are for Puerto Rico. As it has advanced in science over the decades and centuries, can we identify an increase in these tensions between the two, both in the historical record or in today's renewed conflicts? If Puerto Rico were to become a scientific society, which today it is far from being, would it then become more democratic and less authoritarian? More importantly, if there are limitations to Puerto Rico's scientific growth, what implications would it hold for its political culture; would it also inhibit its democratic mentality?

A realistic appraisal of Puerto Rico's scientific glass ceiling would help us avoid the blind error committed by scientists as Baldorioty and Stahl whose consequent results came at a tremendous personal cost. Nearly all *proceres* jumped before looking, presuming that Puerto Rico could have a metropolitan culture akin to that which they experienced during their long European stay. The clash between the normative presumption of universal scientific values versus the reality of an autocratic political environment led, in some instances, to their very deaths.

In the end, we might ask that eternal question: does democracy precede science or does it follow it? Is there a mutual interdependence between the two?

There is final disclaimer to be made. The state of these academic topics, be it of the history of science in Puerto Rico or of the relationship between science and democracy, are in their infancy, and hence constitute an innovative theme we hope others diligently and rigorously pursue. Only in the last twenty years, for example, has the topic on the impact of science on politics been seriously breached. Newton was so idealized as an exemplar of rationality, such that any critical social analysis was not only precluded from debate, but actively attacked when it was brought forth, as was the case of Margaret Jacobs and her innovative analysis of Newtonianism in England.

Similarly, it has to be remarked that the history of science is, as of yet, is not an established profession in Puerto Rico, but its courses have not been incorporated into the university curriculum. While the field could have been institutionalized by the 1970s, the history of science has been routinely sidestepped. Why this should be so is perhaps indicative of the nature of the topic we are about to embark.

There is no doubt, however, that the inclusion of the history of science into the history of Puerto Rico will place the island in an entirely new light from that which it is usually seen.

Part I

Hispanic Science in the Colonial Greater Antilles

Chapter 1

Tapia's Lament

Alejandro Tapia y Rivera was born in 1826, the result of a union between a humble Spanish soldier and a Creole mother. Unfortunately his father leaves for Spain when Tapia was but four years old due to an illness. When Tapia turned seven years old, the family goes to visit the father, he becomes enamored with the theatre. Though he did not necessarily understand was being said, he found it to be a source of joy and much needed humor. Due to Spain's political instability, however, they quickly return to Puerto Rico and in his autobiography he ponders what life might have been like had he remained in Europe. As a boy in a monarchical nation suffering the pangs of democracy, Tapia went around shouting "constitution or death" without truly understanding its meaning, which must have terrorized mother and almost leads her to a nervous breakdown.

As a boy, Tapia studied at the renown school of Afro-Puerto Rican Rafael Cordero in Old San Juan, whose egalitarian principles were remarkable. Because Cordero charged parents only what they could afford, this enabled sons from wealthy families, as Jose Julian Acosta, and those from humble backgrounds, as Roman Baldorioty de Castro, to obtain a high quality education, while at the same time providing a forum for their mutual intercourse, broadening the experiences of both respective students.

There can be no doubt that Cordero was a perceptive teacher. Cordero observed that Tapia loved to be outdoors, as he tended to play in the courtyard by a tree; being also fidgety, he could not stand the stone-like decorum required for his classes. Tapia, as his life would continually attest, detested standing still. As a result, Cordero would reward Tapia's attention by allowing him to go outside as often as he could. From thereon, Tapia

referred to the sky in Old San Juan as "*el cielo de Rafael Cordero*" or Cordero's blue sky.

These events occurred in early nineteenth century Puerto Rico, where Old San Juan was not the congested nightmare that it has become today. Hard as it might be to imagine, the colonial capital was filled with courtyards, farms, trees, and abundant vegetation. Its annual *Fiestas de San Juan* originated with the routine arrival of the *situado* from Mexico. The generous funds were themselves a byproduct of the silver and gold mined in the New World, whose embarkations took a much needed rest on their way from New Spain to old Spain, becoming the principal source of income for much of the island. The shouts of "¡V*elas velas!*" would mark its arrival and a city-wide festivity would be held—at the cost of countless indigenous lives in New Spain.

At the age of 22, Tapia wrote a play, *Roberto d'Evreux*, which would forever alter his life. Dramatizing a story about a Queen's love affair, its description of royal jealousy humanized her too much for the tast of the crown. Tapia was forced into exile by Governor Pezuela. As Stahl and Baldorioty later, Tapia appears to have presumed that he was living in eighteenth century France, forgetting that could not express his humorous tales as he would have liked. Tapia was in constant conflict with leading governmental authorities, and his creative imagination resulted in their renaming, referring to its governors as "the antichrist" or, in Jose Laureano Sanz's case, "Attila the Hun". As Sanz would be Puerto Rico's colonial governor on two occasions, there had been plenty of evidence regarding his arbitrary and repressive use of colonial power.

Upon his arrival to Spain, Tapia meets up with his old school friends. Because Tapia had actually been close friends with Acosta's elder brother, Eduardo Eugenio, the two hit it off. It should be noted that, by this time, Acosta's family fortunes had drastically declined, which would impact the education of his other brothers. Although his younger brother, Juan Euclides, was very bright, the family was unable to pay for his education in Europe as had been the case of Jose Julian. He instead studied in

the island and became a pharmacist. One of the principal problems caused by the absence of higher educational institutions in Puerto Rico was that the costs of such education were prohibitively high, in that islanders were forced to pay for travel, stay, living costs in Spain that such an education required.

In spite of their busy and hectic schedules, Acosta and Baldorioty were very accommodating, encouraging Tapia to takes science classes at the University of Madrid. During these years, Baldorioty initiates the *Sociedad Recolectora*, consisting of a group of Puerto Rican students studying in Europe. Its purpose was the gathering of historical records in Spanish archives pertaining to Puerto Rico but which had been unavailable in the island and its local historians. Although Baldorioty is the most active in the endeavor, many other young scholars participated, whom themselves would also go on to play important roles in the island's political history, included Betances and Ruiz Belvis. Tapia even suggests that had the two revolutionaries been more patient, the *Grito de Lares* of 1868 might have been successful. When Tapia returns to Puerto Rico, he publishes the enormous four volume compilation, *Biblioteca Histórica de Puerto Rico*. It should not be overlooked that, in practice, Puerto Rico lacked direct access to formal historical documentation in spite of its existence—a pattern that has continued to this day.[1]

Although autobiographical, *Mis Memorias* eloquently describes many of the key problems afflicting Puerto Rican society during the nineteenth century, principally of which was the lack of education. These included the absence of high schools and universities, the arbitrary political rule by quasi-monarchcal figures as General Prim, whom instructed that no news from Spain be published in the island's newspaper. Gen.

[1] Scholars as Jorge Rodriguez Beruff brought back military documentation from the U.S. National Archives in Washington D.C. Today this is fortunately a rapidly decreasing problem given the role of the internet and the rise of digital online archives as PARES (Spain) or the National Archives (U.S.).

Pezuela is known to have made a distinction of political domains; while the Queen ruled Spain, he ruled Puerto Rico; "*la reina allá, yo acá*."

Tapia, in short, describes the arbitrary governance which inevitably arose from such colonial structures, and in this aspect, the relatively large amount of influential British literature that is mentioned in his memoirs is surprising. It goes without saying that there was some access to alternative forms of knowledge and information, in that there existed public libraries as well as private collections, the latter which were particularly important to the diffusion of prohibited works which were secretly lent between individuals.

Spain had denied Puerto Rico the ability to open a port, which paved way for importance of St. Thomas in the colonial Caribbean as a key trading post where many goods could be obtained and clandestinely transferred to the island, as books written by British Protestant authors or revolutionary books of the French Enlightenment,. Such authors included Arnat, de Condillac, Montaigne, Voltaire, Descartes, and Renan—all of whom were key Enlightenment figures. Other prohibited authors and works cited by Tapia included Shakespeare's *Hamlet*, and *MacBeth*; and Romantic writers as Sir Walter Scott and Lord Byron. In fact, we might characterize much of Tapia's outlook as an eclectic combination of authors from disparate tendencies that usually would not be mixed, a trait particularly prominent of the Jesuit Order whom for so long had controlled education in Latin America and the Caribbean.

Tapia's memoirs clearly reveals that he is well aware of the experience of progress, in particular the role of technological change which we take for granted all too often today. Tapia mentions an ice-making machine brought from St. Thomas, particularly pleasant in a tropical climate as Puerto Rico. He also observes the telegraph and railroad in Europe. Intercontinental submarine telegraphs allowed for instantaneous global messaging, even if costly at the time, and British steamships for agile transatlantic travel. It had taken Tapia two months to sail from Puerto Rico to Spain. Tapia also mentions that critical tool

for any playwright, the printing press, which had only arrived in 1804, without which the Scientific Revolution would not have occurred. Scientific journals as the *Philosophical Transactions* were regularly being printed in England as early as the seventeenth century, making these surprisingly legible to a modern reader. Even at the dawn of the twentieth century, handwriting was still being used for governmental communications and general government record-keeping in the island. Tapia also alludes to the transition from whale fat to kerosene for lighting, the latter which was much more readily available and did not require the mass slaughter of whales.

Unfortunately, there is little mention of science in his *Mis Memoiras*. Tapia openly admits that he is not a scientist, though he clearly recognized its importance, likely due to his European experiences. As a result, it is particularly striking to observe his apparent awareness of the history of science. Tapia mentions Arab contributions to Western science and the chemical element oxygen, both of which might have been gained in his classes with Padre Rufo at the *Seminario Conciliar*.

Although not a scientist, Tapia was able to verbalize the historical difficulties of scientific and technological activity in the island like no other—and hence his importance to our analysis.

Chapter 2

The Black Legend in 1900

Most people find it difficult to conceive how utterly backward Spain was in 1900, a historical gap generally due to a lack of the history of science in the Hispanic world—which still today is not taught in Puerto Rico nor can one find it as a regular part of the university curriculum. Puerto Rico in this sense shockingly finds itself in the same position as Mexico during the 1970s, so aptly captured by Elias Trabulse in his 1984 book, *El círculo roto*. This backwardness is particularly acute when one contrasts the state of science in Spain to that of other major European powers as France or Germany. Entire scientific fields had been invented by this time, while Spain was still languishing in the errant gasps of medieval philosophy.

The most obvious examples of this contrast are perhaps the invention of modern chemistry by Lavoisier during the eighteenth century, or the creation of organic chemistry by entire divisions of chemist armies during the second half of the nineteenth century in Germany. Germany's enormous economic growth during a second industrial revolution was led by companies as Bayer and BASF, now recognized more for their aspirins and magnetic disks than for their dyes.

Geology was the forbidden child of that eternal clash between France and England, one side calling for radical cataclysm as the case of Cuvier, and the other insisting on uniform gradual change as that of Hutton. Comte de Buffon, a mathematician, used molten metal to calculate the cooling rate of the Earth, thus expanding its age by hundreds of thousands of years, rather than the 6,000 years claimed in the Bible. Were man to have used the Bible as a scientific document, the solar system would have never been identified as most of its planets are never mentioned in its pages.

Cuvier for his part identified the ages of the Earth using rock formations of a Parisian quarry, further expanding the age of the Earth by a much larger range, on the scale of millions of years. It was clear to him that fossils represented ancient forms of life that no longer existed; his excellence in this study made him one of the first paleontologists. In most of Europe, the notion that the Earth had been created in six days held no sway, but one had to be careful telling that to a Spaniard who was still living in the medieval world of St. Augustine and St. Aquinas. The contrast was equally great when compared to the United States, founded by scientists as Benjamin Franklin and Thomas Jefferson, who would imbue in its foundation a scientific culture into its very constitution and political culture.

At the time of the Hispanic American War, Iberia in 1900 had a combined illiteracy rate of 65%; Portugal at 74% and Spain at 56%. By contrast, England had already instituted a national education system, having reduced this figure to only 3% more than half a century before (1730). Spanish Prime Minister Olivares had long ago been well aware of Spain's increasing backwardness, concerned about the state of its engineering methods when compared to those of England. The application of science to technology by James Watt ultimately led to the creation of the steam engine, the motor of England's Industrial Revolution and global dominance.

In the biology of 1850, physiology was being invented by both French and German scientists, who were unraveling how the human body actually worked using all the available scientific tools and fields they had available. In Spain, on the other hand, the use of the microscope was still being debated in the halls of academia at this time, sarcastically noted by Santiago Ramon y Cajal, a 1906 Nobel winner in neurology and notable Spanish exception to the norm.

In the field of physics of 1900 the quantum revolution was already starting to appear. Germany, again, was leading the way, and its "physics boys" ushered a 30 year revolution that would upturn Newtonian physics. While the rest of Europe was already superseding the important discoveries of the seventeenth

century Scientific Revolution, Spain had university professors still debating its merits and insisting on teaching a medieval physics based on the scholasticism of St. Thomas Aquinas, whom had written more than six centuries before. While Napoleon's cruel invasion of Spain at the beginning of the nineteenth century upturned all notions of democratic reciprocity, it had been grounded on the sad truth of her pathetic scientific backwardness.

During much of the Colonial period, education had been under control of religious bodies. In spite of their diversity, schools were still essentially religious, hence profoundly influenced the nature of this education. The most important of these were the Jesuits, whom had taken a hold of educational institutions in both Spain and Latin America. A religious body which emerged as a result of the war with Protestantism during the Counter Reformation, the Jesuits established the *Ratio Studorium* (1580-1599), serving as the basis of their education policy for two centuries.

It stipulated that the principal purpose of education was to create priests for the Catholic Church. This policy also dictated that only one subject would be taught per year, relegating mathematics to the last year of the educational system. Because, in the vast majority of cases, parents removed their children out of *colegios* before that point, mathematics instruction was relatively rare in the population. While it is to be noted that Christopher Clavius, a Jesuit mathematician in the Colegio Romano, tried to push for the more prominent teaching of math in the educational system, he was unsuccessful.[2]

The inevitable byproduct of this educational system, was that Spain and her colonies would be lacking one of they key foundations of all sciences. Modern science is based on four fundamental traits: empiricism, experimentalism, mathematics, and mechanism. As this tendency had been true for more than two centuries, the French were acutely aware of Spain's intellectual decadence by the eighteenth century. At the time,

[2] Clavius, had previously backed Galileo Galilei, recognizing his ample talents in natural philosophy.

Pierre Simon Laplace was already making substantive contribution to Newtonian physics.

It might be asked, if France and Italy were also Catholic nations, why did they participate in the Scientific Revolution whereas Spain did not?

This is a complicated question beyond the purview of this book. That being said, although religion was a factor of the scientific development of Catholic countries, it was not only one. As the case of Galileo amply demonstrates, there were entire geographical regions within what would later become Italy that prohibited the entry of Jesuits or their domination of educational institutions. A strong stance against the educational hegemony of the Catholic Church in Italy would be seen in Venice and elsewhere.

The *Dictionary of Scientific Biography,* a compendium of some 16 volumes comprehensively listing the principal figures of the history of science, include at most five Hispanic scientists in its volumes. That half of these were from Spanish America, such as Ruiz y Pavón of Peru, implies that a history of science written without Spanish contributions would have only negligible distortions in its account.

These historical realities have led to intense debates by Spanish historians and Latin American scholars which are now referred to as the "*polémica de la ciencia española*", and are closely tied to notions of the "black legend" arising out of the accounts written of the New World by Bartolomé de las Casas. While the two, the *polémica* and the *leyenda negra* are similar, they have to be distinguished in that they allude to two distinct phenomena: one the brutality towards Indians (black legend), and the other the lack of scientific contributions in the Western world (*polémica*).

In 1782, the attack was first made by Nicholas Masson de Morvilliers in the French *Encyclopedie* while writing about geography. Morvilliers asked an apparently simple question, "What has Spain contributed to science?" to which he provides an equally simple answer: "Nothing." At issue in part was the is

the definition of science. This did not include the repetition of mindless calculations, but rather to substantive innovations in our understanding of the world. The creation of new knowledge as such meant that the notion of "novelty" was an important indicator of intellectual progress and of science itself. As Francis Bacon first insightfully observed, the important innovations as the compass or the printing press showed that the members of his generation had sailed beyond the pillars of Hercules, the intellectual boundaries set by the Ancient Greeks.

Morvilliers, perhaps unknowingly, created of one of the most contentious academic debates in the field of history, implicitly alluding to the inclusion, or lack thereof, of the Iberian peninsula within the ambit of the Western World. Is Spain a cultural part of Europe? Today the *polémica* has almost become its own academic field given the enormous repercussions of its conclusions, and whose combatants have included leading Spanish intellectuals and literary luminaries as Mendez y Pelayo, Unamuno, and Ortega y Gassett. The debate touched on many issues of national identity, prestige, and status.

One should not overlook the role of imperial rivalries between major colonial superpowers. Spain during the early Colonial period had been the strongest of all European powers—akin to the military might of the United States after World War II. In spite of its gradual decline during the next four centuries, which occurred alongside the rise of secondary powers as England or the Netherlands, Queen Elizabeth during her British golden age sought to make sure never to provoke the suspicion or ire of Spain as England was then not equipped to directly confront her superior military rival. The role of rhetoric in these subaltern dynamics had distinctive cultural and, geopolitical advantages too obvious to ignore, however.

It might be asked, nonetheless, how did Spain respond to the emerging Scientific Revolution? Unfortunately, Iberia did not respond that well.

One of the first to react was Augustinian friar Diego Pedro de Zúñiga, offering what was mainly a theological argument rather than a scientific one per se. As the Bible did not

state that the Earth does not move, the Copernican heliocentric view was not contrary to Catholic doctrine. Personally, however, because he simply could not conceive how the Earth could be moving, Zúñiga argued for its impossibility. By 1616, it was decreed that Copernican heliocentrism was prohibited in Spain. Any Jesuits contemplating the idea had to stop publicly discussing it, and they were forced to formally recant all traces of heliocentrism, resulting in a backward return to Thomistic natural philosophy at the dawn of modern science. The administrative decree forced a return to the medieval Aristotelism, in which Satan in hell occupied a central place in its worldview.

This is not to say that mathematics or other scientific techniques were not used in Spain, as they were a regular part of the navigation and engineering necessary for the colonization of the New World, which in turn required a more advanced geography. The adventures of Alonso Ramirez, a Puerto Rican sailor who spent life at sea during the colonial period are particularly relevant.

Ramirez narrated his adventures to the Mexican scientist-priest, Carlos Sigüenza y Góngora, who in turn published his account. After abandoning his family and home as a teenager, Ramirez is eventually captured by pirates, leading to his misadventures throughout the globe. At one point, he was left adrift with a traitorous group. The small boat with Ramirez's abandoned crewmen quickly became lost at sea because nobody knew mathematics or astronomy—a common problem to mutinies by ignorant seamen who could not calculate their position at sea. Fortunately for Ramirez, he knew enough to be able to estimate that they were close to New Spain, where he eventually landed and met the Jesuit scientist.

The Spanish monarchy had created a whole host of institutions for the administration of empire, as the *Casa de Contratación*. While there was ample use of the sciences of astronomy, geography and mathematics in such institutions, these have to be distinguished from genuine intellectual innovations. It also has to be pointed out as well that while there were biological studies of New World animals, their accounts were often highly

questionable, and led to a great deal of skepticism over their scientific value by members of the the British Royal Society. In spite of the countless Spanish explorers to the New World, none resulted in a Darwinian revolution; their biological theoretical contributions were of a rather limited nature.

Spain actively repressed technological innovation and scientific activity in Puerto Rico given its bad habit of destroying such institutions when they emerged, a phenomenon well described by Tapia in his *Memorias*. There are various cases throughout the colonial period of how utterly cruel the Spanish government was in its mistreatment of the colonies.

While the creation of *ferias*, might have been used for the active promotion of science by the Spanish colonial state—as these were meant to stimulate recognition, invention, and personal success—the Spanish state noxiously used such fairs to detect and identify prosperous taxpayers, thus turning them into counterproductive measures for the ends they were in principle designed to serve. Similarly, while the creation of the *Academia de Bellas Letras* was supposed to become a forum for the freedom of expression, and hence for the development of literature and the arts; the entity was instead used to identify the enemies of the state. In other words, instead of stimulating the creative arts, its halls were turned into a trap for those whom would become subject to political persecution.

The Spanish state sent Acosta and Baldorioty to Europe to become teachers for a projected secondary school in Puerto Rico but would shortly upturn the project. The erratic and inconsistent policies of the government as the most horrific lesson Acosta and Baldorioty would receive upon finishing their scientific training in Europe. If that was not bad enough, the Spanish colonial state in Puerto Rico also began taxing the very same private organization dedicated to developing the insular economy by identifing new exportable goods, the *Sociedad Económica Amigos del País*, for the exclusive benefit of the governor's hunting expeditions.

The list of these outrageous abuses is endless, but also mark the countless attempts by Creoles in colonial Puerto Rico

to create educational bodies which today are taken for granted—as those by the *Grito de Lares* leader Ruiz Belvis in Mayagüez. Nearly all such efforts were pathetically blocked by the colonial Spanish authorities, infuriating Tapia and many others as these inevitably impacted the socioeconomic well being of island.

Spain, in short, had the bad habit of frivolously distorting the purposes and aims of important public institutions so necessary for the economic and scientific prosperity of the island—a tendency which unfortunately is still all too commonly found in today's local insular institutions.

With the pervasiveness of *caciquismo* culture, minor monarchies existed everywhere in the island. The notion of a political decision by consensus is as foreign today as it was some two hundred years ago. Tragically, these abuses still routinely occur in the island and are, irrespective of gender, race or religion; there are countless horror stories of perversely corrupted social bodies. From a Small Business Bureau that is used to steal innovative business ideas, to the utter lack of confidentiality by the police to whom crimes are reported or by the very lawyers sworn to protect the confidentiality of their claimants. The arbitrary confiscation of property is nearly as pervasive today as it had been during the Spanish colonial period—if a bit more well concealed. There is an active tendency to undermine of the state from within, and the notion that Puerto Rico is a place of law and orders is a false mantle used to hide the abundant institutional abuses which occur within the confines of its beautiful beaches.

So erratic and unpredictable is the arbitrary behavior of its institutions, that it is simply hard to tell, and much less predict, when an institution can be trusted to comply with it mission—leading to the countless list of silent frustrations, and tragic injustices by those who reside within it.

Chapter 3

The Incessant Intrusion of Politics

It is unfortunate not only that the history of science has received so little attention in Puerto Rico, but also the study of its relationship to politics has been marked by relatively unsophisticated conceptual structure—regardless of how innovative such studies might have seemed at the time.

In Juan Bonnet Jr.'s introductory essay to *Ciencia y Política*, we find diverse meanings to science and politics, which are also reflects throughout its essays. Bonnet Jr. views politics as a nuisance, which has come to plague and distort its nascent scientific development. For him, the battles over political status, be it statehood (PNP party), ELA (PPD party) or independence (PIP party), are a waste of time, money, and effort.

His principal aims are two. The first is that of science policy, identifying the best means to develop science in the island. It goes without saying that Bonnet Jr. recognizes the value of science; in his ambition to further its development, he becomes dissatisfied with current state of affairs as much more work needs to be done than that which had occurred.

Secondly, Bonnet Jr. aims to control the extremes of science and technology, specifically their environmental impact—a concern that generally still holds true to this day. As a nuclear engineer, Bonnet Jr. was well aware of the enormous and potentially misused power of science, and was acutely sensitive to environmental issues given that his father had been an agronomist at the Agriculture Department of Puerto Rico. "*La contaminación ambiental*," was a common phrase in during the Puerto Rico of the 1970s.

In spite of his noble goals, however, Bonnet Jr. lacks a broader and nuanced historical sensitivity, as he views these entities—science and democracy—as "ready made", and by implication presumes them to have a given set of fixed traits, showing little awareness of how the two might have changed and interacted in the past. It goes without saying that Bonnet Jr. was not a historian, and the book's title should have more appropriately included the term "science policy" to more accurately reveal its thematic content. He also fails to consider how the history of science of Puerto Rico might itself be an indicator of poor scientific level and democratic culture as well. While Bonnet Jr. was undoubtedly a scientists interested in the history of science, he lacked the historian's mentality and cultural nuance—something which is not meant not to underestimate the significance of his contributions to the field in the island.[3]

Another author in the same edited work, Juan Fernández, also shows similar biases. His essay attempts to provide a brief overview of science policy by contrasting two prominent writers, one from the United States, William Brode, and the other from Latin America, Amilcar Herrera. This is an innovative approach by the scientist-administrator given that Puerto Rico lies in the political and cultural intersection of both regions, respectively speaking. Fernández does not hide his prominent concerns with scientific dependency, akin to the dependency theory of Celso Furtado, which was so influential at the time. For Furtado, poor nations were poor because they exported raw primary materials, while rich nations were rich because they exported finished industrial goods, leading to an inherent and continual imbalance of payments between the two. For Puerto Rico and Latin America to progress, the relationship needed to be inverted.

Fernandez, perhaps unknowingly, captures the historical continuities so aptly described by Tapia in his *Memorias*, and

[3] During the 1980s, Bonnet Jr. had been fairly active as a historian of science, publishing various works in the history of science and directing a master's thesis.

describes in some detail the number of problems inherent to the scientific activity of the island. There was a clear undervaluation of scientific activity in actual policy implementation and practice, even while science was hypocritically adulated in public. For example, governmental agencies lacked laboratories, forcing these to send their samples abroad, which naturally caused many delays. He, as Bonnet Jr., noted the general lack of valuation of science by politicians, and noticed the limited role scientists played in governmental affairs. The former Dean of the University of Puerto Rico at Rio Piedras identified a couple of aspects which will help clarify what we want to explore in this book.

In contrast to Bonnet Jr. and Fernanez, we are seeking to understand how science affects politics in broad terms, looking at the arrow of causality going in one direction principally: did the open culture of debate so characteristic of scientific practice impact the emergence of democratic politics? We might also ask whether science is inherently political or whether it is value-neutral. "Science" and "politics" can lend themselves to a great variety of meanings, thus we have to make sure we are referring to the same phenomenon. While our main focus is not that which is covered by Bonnet Jr. and Fernandez, though it certainly will play a part. It is rather shocking to observe the same persistent complaints more than a century apart between Taipa and the two scholars regarding the lack of scientific development in the island—which, in turn, has historiographical implications for the writing of the writing of the history of science in the island.

How does one write a history of science without heroes? After all, the history of science is, by definition, the history of success as that of Galileo, Newton, and Darwin. How do we overcome these cognitive gaps that both reveal a realistic image of the historical events, while a the same time present a coherent and inspiring view of the scientific enterprise?

Fernandez's and Bonnet Jr.'s claims are at first somewhat shocking and strange given the heavy U.S. involvement in the science of the island, specifically its relatively high amount of investment in the island's science. Puerto Rico's scientific

funding level, on average, is far higher than those of other Latin American countries as a result of this relationship, and in this sense is more similar to Panama, another U.S. beneficiary, than to the Dominican Republic or Haiti. There are numerous scientific institutions and bodies that exist in Puerto Rico, the most famous being the Arecibo Observatory of 1963, having appeared in various Hollywood movies as "Contact", based on a novel by Carl Sagan, or in James Bond action films as "Live or Let Die". As the important *Instituto de Neurobiología* of 1967 shows, it certainly is not the only one.

But, what do the claims by Bonnet Jr. and Fernández mean? Should the scientific institutions already present in Puerto Rico not be considered a part of Puerto Rican science? In this, the notion of an "enclave" which emerges from the study of corporate activity in Latin America is particularly useful. While an enclave might be associated with the particular nations or geographical region it finds itself in, it is not inherently a part of that place, not altogether much different form the definition of Puerto Rico as that found in the *Insular Cases*. Enclaves constitute a physical part of the region, but do not form part of its cultural, economic, or social infrastructure.

Fernández alludes to many of the same problems observed in Tapia's memoirs, specifically the instability of Puerto Rico's scientific institutions. Throughout the Spanish colonial period, educational, and by definition scientific, institutions came and went, as the *Colegio Central* where Acosta and Baldorioty were expected to teach upon their return. Fernández similarly mentions at least three such bodies that have as quickly disappeared as they were formed: 1) the *Consejo Adjunto de Ciencia y Tecnología*, created via an executive order 4939 in 1987 2) TROPICO or the *Desarrollo Tecnológico de Recursos Tropicales de Puerto Rico*, formed in 1988 with a $2M subvention, and the 3) *Corporación para la Transformación Tecnológica* with a $3M piggybank in 1988.

A common pattern that repeats itself throughout the twentieth century. Institutions come and go in the blink of the

eye, with the passing and ending of each governmental administration. When the *Departamento de Agricultura* was dismantled, its huge library, which well could have become an important source of historical material, was also swept under the rug. Routinely, each administration creates policies and bodies which are destroyed by the following administration, resulting in an enormous waste of funding. This dynamic, in turn, reflects in Lipsetian inherent tension between groups in weak democracies, whom mutually see each other in the light of fanaticism.

The substantial amount of institutional instability is rather common throughout the Caribbean. Agencies are as quickly formed, as they are quickly dissolved—a situation markedly different to that of U.S. based scientific institutions as the NSF or the NIH. Sailing the instability of political maelstroms is perhaps an impossible task that only the strongest or the richest can endure.

The history of science in Puerto Rico as a field itself is an indicator of the island's lack of scientific development. No history of science program exists in the island, a fact which is particularly striking in light of the 55 or so that exist in the United States.[4] This is the case, in spite of the fact that as early as the 1960s, there were individuals trained in the field as is the case of Isabel Becerra de Weirich whose high quality master's thesis on agricultural research stations is highly recommended for those wishing to embark on the field. Becerra never seems to have become a history professor, even though she did become part of administration, and hence left no intellectual legacy in the island.[5]

As with the island's scientific activity, the few works that exist in the history of science of Puerto Rico share a common

[4] Were we to look worldwide, the number of departments and faculty members would be shockingly far higher.

[5] It was a pleasant surprise to discover her work, as it was shocking to consider its implications. Her thesis can be found at the *Colección Puertorriqueña* of the University of Puerto Rico, Rio Piedras campus.

trait in their instability over time. There arise figures erratically but no consistent and coordinated effort in this regard can be found. No programs or schools are built, no broad-ranging theory is formulated. The interpretations that appear resemble the fossils of the geological record, which show wide gaps between its appearances. There is hence a "layering effect" that is particularly distinctive in the local historiography.

Juan Bonnet Jr. was part of this process during the 1970s and 1980s. Bonnet did guide a history of science masters thesis written by Victor de León Díaz in 1979, which although a useful quick overview, cannot be considered a history of science per se. Former colleagues of his personally revealed that Bonnet Jr. had series of periodic *tertulias*, a book club of sorts, to discuss important works in the history of science. It is clear that, as with Acosta and Baldorioty, the sources of information in the field have historically been rather limited in Puerto Rico.

In the pre-internet era, where the principal source of new works was the local bookstore, there existed few bookstores. Tekes in Plaza las Americas principally sold fiction and religious books, and although Bell Book & Candle in Condado was a far better bookstore, its limited range of topics and lack of parking hindered its use. This might explain why the arrival of Borders to Puerto Rico between 2000 and 2011 became such a success. Its two level store presented a rather broad ranging and comprehensive set of literary wonders which were a joy to discover. The sales rate was so high, that Borders executives flew to the island concerned about the possibility of a massive fraud scheme; yet its high volume sales simply provided an invaluable service which is taken for granted in the United States today.

The earliest historian of Puerto Rican science I have come across is Jose Julian Acosta. Acosta made it a point to publish during the nineteenth century scientific and historical works of the island that were not available in it, amongst these the famous civil and natural history by Iñigo Abbad y Lasierra. While Abbad y Lasierra published his work in 1788, Acosta would make it publicly known nearly a century later, in 1866. Few, if any, science works in the island were available, and hence why the

labor of groups as the *Sociedad Recolectora* were of such cultural and intellectual significance to the island. It goes without saying that we need to emphasis Spain's poor scientific record, both within Spain and throughout her colonies.

We might ask the following question. If Spain was so very backward, could Puerto Rico have actually have come to scientifically supersede her had Acosta and Baldorioty been allowed to influence the island's scientific development and political destiny? Did Spain regularly use violence in the island simply out of the fear of being scientifically eclipsed by Puerto Rico, as Hong Kong superseded China during the first half of the twentieth century?[6]

Let us consider a hypothetically alternate scenario. If Spain had not actively repressed local institutions in Puerto Rico; would the island have developed as quickly was implicitly supposed by Tapia? We should, after all, be critical in accepting Tapia's own presumptions without question. More importantly, if Puerto Rico had developed scientifically during the second half of the nineteenth century, what implications would this have had for the development of a local democratic culture?

[6] Hong Kong, after all, had been a British colony, hence its political culture was characterized by far more liberal values, democracy and freedom of expression, than those found in China.

Interlude: The Paradoxes of Science

Fukuyama's *End of History* (1992) presents an ambitious amount of evidence demonstrating the rise of democratic liberalism during the twentieth century. This global phenomena was pervasive and is reflected in a number of other sources as well. As Ferris also shows, between 1950 to 2009 the number of democracies grew from 22 to 89, roughly half of total of the world's nations. Poor nations tend to sink away from it, and an economic boundary has been observed at $6,000 GDP, or what might be loosely referred to as the tipping point of democratic governance.[7] Forty of the worlds largest cities are liberal-democratic and eighteen of the twenty largest economies are also liberal democracies—demonstrating their greater propensity towards economic success.

These trends help contextualize Spain's rather backward political stances during the late colonial era, and it might be suggested that Spain was going against the "ends of history" in its clash with Tapia, Baldorioty and other leading *proceres* of nineteenth century Puerto Rico. By this century, the general political ideal towards which to all societies should strive for had been established, and Spain was, in effect, rejecting recognized and well established ideal political forms, imperfect as they might be. These new ideal forms consisted of political and economic autonomy, and were characterized by a relatively limited role for the modern state, allowing for greater individual freedom within it.

Spain's imposition of conservative monarchical power, so eloquently described by Tapia, was arbitrary, erratic and unjust in

[7] Above this figure, democracies are relatively stable.

character, which grossly limited Puerto Rico's economic and cultural development. Specifically, colonial monarchism limited the growth of science, and created political monsters (military governors) whom with their enormous power were like speed boats: fast to move, but equally fast to crash. Democracy, in this regard, was more like a slow leaky tugboat; one's feet were always wet and it was slow to get about, but one always safely arrived to port precisely because of its inherent internal conflicts.

The rise of science during the colonial period was of such a marked character, that even the Queen of Spain, seeking to improve her global status, tried to rewrite the facts of Spanish history. Books were produced with the intention of showing to the world Spain's "hidden" scientific activity, and of Isabel's own allegedly avid support of the sciences—whilst completely ignoring the historically persistent ideological clashes against scientific activity which were so well documented by Tapia. Spain's first scientific publications in natural history had been written over three centuries prior to Tapia's own works. The monarchical propagandists showed the existence of naturalists as Oviedo, Acosta, Hernandez, as if to reveal to the world the existence of Spanish colonial science which had not been previously recognized before—a formal reaction to the "*polemica"* which grossly distorted the meaning and culture of science for political ends.

Spain's isolationist policy during the colonial era, which feared foreign encroachment into its New World territories, provide more than enough evidence against such a claim. Just as corporations today, the scientific knowledge was produced in Spain was only for internal use rather than public consumption. There was a general ban precisely on those publications which would have been the most significant, as natural histories or the cartographies of the region. This policy went directly against the "communalist" spirit of science; as Merton so eloquently stated, science is about sharing. If you do not publish, it does not count in the world of science. Hence, however, grand and important these publications might have been, their repression by the

Spanish state can never be legitimately used for claims as to colonial national scientific prowess by Spain, being anathema to the character of scientific inquiry itself.

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Although Robert K. Merton first looked at the links between science and political forms, arguing for a loose relationship between the two, it is David Thomson whose 1955 article "Scientific Thought and Revolutionary Movements" made the most forceful argument relating the two.

He looks at the distinct phases between various revolutions and their association with sciences, including that of enlightened despotism, Republicanism, the French Revolution, Liberal Democracy, and Marxism, to elucidate the particular character of its influence. For example, during the Enlightenment it was presumed that reason would lead to universal conclusions, and in this sense, the principal obstacle to sound social orders had been the lack of universal education, wherein individuals had not been able to develop their faculty of reasoning. Both Lavoisier and Condorcet, early supporters of the French Revolution, pushed for the universal development of a science-based education.

Condorcet's role is particularly important. An important scientist making contributions at by the age of 25, he worked with Alexis Clairaut, the latter whom was seen in time as "next Newton" for his brilliant mathematical mind. Condorcet developed the notion of social statistics, correctly believing it would help provide effective governance, and the discovery of his work stimulated a lost Auguste Comte into his prodigious intellectual output. When French Revolution exploded, Condorcet had been secretary of the *Academie des Sciences*, to whom most French scientists did not belong due to its extremely exclusive nature. His wife ran a salon, wherein he interacted with Adam Smith, and the two figures would play an important role in the application of science to society, then called "moral philosophy" rather than its modern term "social science." While awaiting the guillotine in 1793, dying the following year, Comte

wrote a piece on the philosophy of history which would greatly influence the young Comte to create a "positive" understanding of historical development.

Thomson emphasizes that the formation of liberal democracies was based on the presumption of universality of rationality, hence the profound hatred of parties and groups with special privileges, distinct from rest of society. Examples of these privileged groups included medieval guilds and the Catholic Church. The Founding Father's hatred of political parties was well known. In his farewell address, George Washington dismisses them. Jefferson once noted that he would rather go to hell than join a political party.

In light of the current "postmodern era" and its relativistic truths, it might be asked whether the destruction of enlightenment rationality implies that we should not only abandon democracy, but universal human rights as well. We may similarly ask whether current social groups, of both liberal and conservative ideologies, are seeking distinct rights which do not extend to members of other groups, and in this manner reject Jeffersonian claims regarding the universal applicability of the law for all members of society. It goes without saying that such distinctive claims are highly problematic, seeking "exclusion" zones from obligations which also seek to void the notion of "universal human rights". As previously shown in *Biology and Ethics*, the rejection of the existence of truth goes hand in hand with a problematic ethical and moral relativism, and which suggest that, as Thomson argues, the rise of science is both cause and effect of democracy and republicanism in its wider sense of the term.

There are, however, problems with Thomson's argument, specifically in his use of the term "revolution", given that it is unclear whether he is alluding to the formation of new nation states or to the changes in the political structures of a given state. Oddly, there is no mention in the piece of the creation of an enormous array of new states after the Second World War, many of which had been former British colonies established during the British Century.

Thomson does not identify or seem to distinguish the glaring differences between the U.S. revolution, the French Revolution, Socialism, or Marxism. He seems to take for granted the formation of new political forms, without systematically evaluating them. His selection in this sense is very accidental, ironically "un scientific" in its character. Certainly, his lack of a definition for revolution does offer Thomson a great deal creativity and room for exploration, but at the same time diminishes the rigor of his conclusions. He appears to be mainly guided by intellectual changes rather than the social and political ones to which he seeks to attach.

There is a particular irony which stands out with regard to his discussion of the French Revolution. It was allegedly pushed by rationalism, but which also led to the despotism of Napoleon Bonaparte, suggesting a problematic historical pattern. France towards the end of the eighteenth century was a scientific superpower. These included so many innovations, as the formation of modern chemistry by Lavoisier, that science in fact would continue advancing into the following century; its biology under the influence of Cuvier represented a revolution in thought similar to that of Darwin at mid century. The French Revolution would not stop development of French science; and yet it still produced a Napoleon—as Germany would produce a Hitler during its peak scientific hegemony at mid century.

It is clear that while a scientific rationality will help pave the ground for democracy, it can equally have just as much of a chance of resulting in political tyranny as well that is far distant from it.

Although the work of Robert K. Merton is less directly related to topic, it was vastly more influential than Thomson's original essay. Merton's works are generally a rich source of intellectual insight and observation, and thus helps explain his influence—as revealed by bibliometric citation studies.

Dying in 2003, Merton had been a professor at Columbia University throughout much of his academic career. Though his work spans many topics, he is generally regarded as the founder of the sociology of science, well known for proposing the

predominance of Protestantism in the creation of and development of modern science. While his claims to a close correlation with Puritanism has not stood the test of time. Its more general variant, however, is still widely debated, and shows Merton's enormous insight.[8] Merton also evaluated the existence of multiple discoveries in science and its implications for the meaning of creativity in science.[9] Other concepts in sociology created by him included those of "unintended consequences", "self fulfilling prophecy", and the "Matthew Effect", the latter alluding to the idea that disparities of outcome emerge from disparities of initial conditions.[10]

In short, Merton implicitly noted that there is a power law distribution, also known as a Pareto Curve in economics, which impacts scientific development. As shown by Simonton in his psychological study of scientific genius, academic influence is not equally distributed between all scientists but are accrued to those members at the top of the hierarchy, a network dynamic which is not necessarily due to the author's intrinsic merit as a scientist or scholar. Network effects come into play in such a large host of social phenomena, that it is puzzling why Merton's works are not a required reading for all historians and social scientists, particularly those in small states as Puerto Rico.[11]

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[8] An entire volume was published by multiple scholars addressing this issue, *Puritanism and the Rise of Modern Science: The Merton Thesis* (1990).

[9] There are a surprising number of cases in the history of science who did not know each other but arrived at the same discovery. Alfred Russell Wallace and Charles Darwin are one such example, each postulating the notion of natural selection.

[10] The notion is taken from Bible, wherein it was noted that those that already have money will gain more wealth, while the poor will become poorer.

[11] His compendium of papers, *The Sociology of Science: Theoretical and Empirical Investigations* (1973) is highly recommended in spite of its age.

Again, we have to note the obvious point that science and technology do not necessarily correlate with democratic political patterns. In 1925 Germany, a letter was written by leading scientists, including Max Plank, of the superiority of German Civilization over that of all other nations. Though Planck would come to regret signing the letter, its sheer existence places in some doubt the fundamental relationship between science and democracy—or even education and democracy for that matter.[12] While, as Condorcet noted, it is an important factor in establishing a common ground of dialogue, it is most certainly the case that it is not the only factor involved.

As Herf has noted, Germany was characterized by a curious mixture of romanticism and a love for modern technology—a noxious mix which rejected key Enlightenment values today are so taken for granted. Surprisingly, Germany in 1925 was perhaps at the peak of its scientific power, as it was in the midst of two major scientific revolutions in physics: the quantum and the relativity revolutions. In this regard, the pictures of the attendees to the Slovay Congresses are images of the greatest luminaries of the century: Lorenz, Plank, Einstein, and others. When we consider that these revolutions were but only two of countless other world class scientific fields in Germany, one of the largest being organic chemistry, we cannot help but become puzzled before our Thomsian expectation. In spite of the fact that an enormous workforce existed that was extremely well educated in science, with a vast number of chemists and physicists, Germany still became an anti-democratic authoritarian state.

Does this invalidate our theory? Does this mean that science will have the opposite of its intended effect? Hayek at one points used the word "scientism" in a derogatory manner to identify the overvaluation of science in the modern world, and his

[12] Tragically, Planck's Berlin home was destroyed during WWII, which accounts for the utter lack of documentation of this important scientific luminary.

rejection of a view which implicitly suggested that any non-scientific approaches were invalid at face value.

There is a second criticism that can be made to Thomson's piece. His principal demarcations are intellectual ones, suggesting that he was as trapped by the rapture of scientific ideas—ideas which are so profound and rich within the context of Western intellectual history, that they can distract the scholar from the appropriate level of analysis required for a rigorous analysis. Ideas, in other words, the richness of scientific ideas can act like magnets drawing us away and distracting from the true focus of attention.

An example of this might be Thomson's discussion of the relationship between Marx and Darwin. As Giambattista Vico, whom sent a copy of his book, *Sciencia Nuova*, to Newton, but whom never received a response, Marx sent a copy of his *Das Kapital* to Darwin hoping to show Darwin how much he, Marx, had been influenced by his ideas. Darwin, ever the polite scholar, declined to review the book as it was outside of his purview and written in a language he did not understand. When Marx allegedly sought to dedicate the book to Darwin, the latter politely declined once again—or so the claim goes. While this example in and of itself is suggestive of the intellectual influences impacting Marx, in no way do they demonstrate how the theory of natural selection, as Darwin defined it, was in any way related to that of Marxism. It should be here noted that what "evolution" meant for Marx was very different form what it meant to Engels.

To truly prove the influence of Darwinism on Marxist theory, Thomson would have had to undertake a much more rigorous and detailed analysis than the one offered, proving that such a relationship existed rather than presuming it to be true. Curiously, Marx and Darwin, two of the most powerful thinkers of recent Western history, lived but a close distance from one another, but never actually met in person.

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We have seen a strong argument for the impact of science on politics. Most members of the Enlightenment shared the presumption of a universal human reason; if left to a genuine evidence based rational debate, all would agree, thus the realistic possibility of consensus between all citizens. Similarly, there was also a universality of common interests; the diverse parts of a body politic shared the same common interests, thus in theory a harmony between the part and the whole could occur, and in principle a successful democracy.

The dynamics do raise the question of what rationality actually means in practice. While notions of "absolute truth" today sound a bit comical today—we cannot assume that another universe would have the same laws of physics as ours do, and, as Popper showed, all truths are ultimately conditional—we should not discard the notion of truth per se. Truths of the Scientific Revolution are still as valid today as they were then, in spite of the quantum revolution, which complement rather than supplant Newtonian physics. The two are not mutually exclusive, much as television did not kill the radio but rather came to occupy its own particular social niches. Euclidian mathematical truths are still valid today in spite of the brilliant relativistic mathematics of Gauss and Reimann.

That being said, it is important to study the process of how commonly accepted truths become established, as these will have enormous repercussions on the body politic. As tragically demonstrated by tyrants as Putin and their political puppets, modern truths undergo a greater level of social construction than is generally recognized, thus making them subject to a certain level of external distortion independent of their actual truth content or supportive evidence. If truths are ultimately claims that the majority agree on, the manipulation of this social space leads to a gross distortion of what is today so firmly held and unquestionably believed, or "the world turned upside down" as Marx used to say.

To understand this, imagine what it would be like to live in the primitive world of 100,000 years ago, for example, which constitutes a counterpoint to our postmodern era.

While the final human body form exists, the content of the human mind are relatively "empty". There is no modern science at all, and the third technological revolution has not even begun to emerge on the horizon. There is no Twitter, and no internet. You cannot instantly share your thoughts of the world nor instantly know there is a mysterious virus that has emerged in China (Covid19). Virtual classrooms, where each student can "attend school", from the comfort of their homes have not yet appeared. University would be completely shut down, as occurred when Newton as a student at Cambridge. Go further back, and there are no newspapers at all, as the printing press has not yet been invented. One cannot even know what is going on in the national territory, if such a thing can be said to exist. It is world without news of any kind that is outside one's own immediate physical ambit.

Under this scenario, the only thing left are countless clusters of small families and tribes whose only truth is that which they speak to each other. There will exist a "near infinite" amount of languages different between each other, and hence in the absence of communication, the truths of each tribe, or their worldview, will be radically different amongst each other. While all truths would coexist per social group, a shared body of beliefs between all clusters in the same region would not be present.

This, in turn, is precisely what defines culture, demarcated by the very differences of each collectivity's worldview. As the number of social clusters decline, we may inversely observe the historical rise of near-global continental cultural clusters, for example English or Spanish clusters in North and South America respectively. For similar reasons, there will never arise a single universal culture given the highly improbable scenario of a universal language, given that each cluster will tend to retain its native tongue precisely due to the benefits obtained with its increase in size. We may wonder, however, whether the very growth of the state, as France and Germany, will tend to propel these towards authoritarian governments as the information transfers within the national region are hindered by fewer linguistic obstacles and gaps, and thus a more homogenous

information transfer. Or, simply put, one might speculate whether large states by their very size will tend to become autocratic.

In short, the establishment of truth and knowledge in a society does not miraculously appear from nowhere, but is rather played out in distinct social atmospheres, or what Habermas would call the "public sphere". While Habermas's case arose with rise of newspapers, the notion of the media in the context of the postmodern internet is still critical to understanding its dynamics. Today's postmodern landscape has a much more diversified set of information sources which are much more widely diffused and spread out. In sharp contrast, during the medieval past it was far easier to control information given the difficulties involved.

As a general rule, it was extremely costly to put something on paper at the dawn of modernity (1500). Books were then made of parchment, or dried skins, which took a great deal of time to prepare. Books were also written by hand; while the labor of the monks was free the sheer cost of books prior to the rise of print meant that books were inaccessible to the vast majority of people. Today, these books are referred to as "Incunabula", or books printed prior to 1501 and are today rare and highly prized. The rise of the printing press in 1453 by Gutenberg commoditized the book, and is generally regarded as a positive contribution to the rise of science. Their price is independent of the quality of their content; good books sell for low prices (canonical paperbacks) while the prices of bad books (colonial manuscripts freely available on *Archive.org*) leave the reader perplexed.

The benefits of the modern printing press were many. There was little discernible variation in the copies as all were exact copies, while handwritten manuscripts inevitably introduced errors. Printing also allowed for a much faster rate of production; with one stamp, 4 pages were printed at once. These changes allowed authors to a have much greater audience and influence, the peak of which actually occurred during the Enlightenment. Voltaire was an author who actually lived off the income from his book. Rousseau, that "anti-enlightenment

thinker", obtained quite a bit of petty cash, given that we wrote the most famous fiction of the eighteenth century, *Julie o Nouvelle Heloise* (1761). Today, nearly anyone can write something for entire world with a Wordrpess blog. One example might be that of Carmelo Rios, young environmentalist who routinely fought Monsanto. Although he recently died, his writings in blog form still exist and are readily available online—at least as long Google is still around.

The rise of the television by RCA further broadened the information transfer in a modern society. During the 1970s, there were only three television channels, ABC, NBC, CBS, which were watched by the entire United States—something which today seems ridiculously low. However, this meant that the entire United States generally had a common frame of reference. The news were also pervaded by models of conduct. Shows as "Leave it to Beaver" or "Father Knows Best" presented children as little saints with little if any violence as well a the absence of psychological cruelty. Their main tenor and character was that of peaceful and thoughtful conflict resolution.

This concentration of media power also helps explain why it was so easy to prosecute Nixon during the 1970s. The entire U.S. audience generally had the same information. As the same public hearings were broadcast on all the channels, it allowed the nation to quickly establish a common consensus: U.S. presidents should not abuse their enormous power, also enhanced by the technology of the era. While spying generally is not a domestic issue, it does constitute a violation of the U.S. Constitution, as the case of COINTELPRO in New York, but is allowed within the international ambit under the pretext of national security. Most surprising of the Nixon hearings was that even Republicans were strongly opposed to him. When there was no denying this general trend, Nixon resigned, which contrasts greatly to today. The Trump impeachment hearings failed in part because the public sphere is so vastly broken up into so many little pieces, allowing for an individual to remain within their own ideological cloud, following only those news channels which reinforce their own preexisting worldview—regardless of its falsity or lack of

authenticity. While the Fox news channel is one such example, it is not the only one.

There are countless websites and YouTube channels which also apply, as the "Alex Jones Show", and "Brightbart news" created by Trump advisor Steven Bannon: a Washington D. C. news source with a distinctly pro-trump point of view.

If the public sphere is so technologically broken up, can democracy possibly survive? Under such conditions, there is little possibility of common consensus, as each individual holds their own particular worldview and distinct set of mutually exclusive set of "facts" that directly clash.

Is this a return to the Neolithic world of some 100,000 years ago? While it is obviously not exactly the same, they do share similar traits. The year 2020 showed the presence of a great deal of demagoguery, most surprising of all being protests against the wearing of masks during the time of Covid19. Not only are the truth claims false, but they infringed upon the right to life of others for what is a trivial cost: the wearing of a cheap, protective and light mask. Claims that the government was infringing on "liberty" were trivial, and confuses liberty in a democracy for licentiousness, or the ability to do whatever you please—an acutely incorrect interpretation of "liberty".

The ancient historian Arnold Toynbee perhaps said it best. Society is a web of interactions:

> *Society is not a collection of persons but is a network of relations; it is the field of interactions of two or more agents."*[13]

Reciprocity is a key concept and principle underlying all viable democracies. Destroy the culture of

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[13] Or in Spanish: *"la sociedad no es una colección de personas sino un sistema de relaciones; es un campo de interacciones entre dos o más agentes."*

communal reciprocity, and all social relations are cut to pieces, severely downgrading the quality of life in a nation.

Part 3

The Impact of Science on Political Theory

Chapter 4

The Scientific Revolution in Sixty Seconds

We will here briefly provide a description of the Scientific Revolution and of Netwonianism which influenced the intellectual world of Europe during the next two centuries. It can be briefly described in five minutes, but could take a lifetime of study to fully understand it.

Trivial as it might sound, Isaac Newton was a moral man, not a god as he appears to be often presented in the older historiography. As a male child, not unlike other male children, he fought now and then at school, at one point striking the head of the pastor's son's against the wall of the school with such force, that his ear was lacerated—not unlike the *Carlitos Colón*'s wrestling matches in Puerto Rico during the 1970s. These traumas perhaps help account for Newton's life-long fighting spirit. Newton's father had died before he was born, thus leaving a helpless mother to fend for herself before what appeared to be an impending economic crisis. The mother descended from an upper class family, which, in spite of falling on hard times, preserved such upper class values as cherishing the importance of education.

The mother accepted the marriage offer of an older man, which had been granted in exchange that the only male heir be removed from the household, so that the new couple could begin their own family anew. So, at eight years of age, Newton was separated from his mother, and sent to live with his grandmother. Such was Newton's trauma, that at one point he menaced to burn their house down. There can be no doubt that the separation was as traumatic for the son as it had been for the mother. When the second husband, an elder man, died a few years later, Newton's

mother became heir to all of her former husband's wealth, which in turn was bequeathed only to Newton, rather than the children begotten with the second husband, thereby leaving Newton a substantial inheritance which freed him from any financial difficulties as an adult.

To understand Newton's scientific legacy, we first have to look at Aristotle's enormous intellectual legacy preceding it, of great sophistication and complexity. This legacy had been used by the Catholic Church to build up its theological construct, which turned to be but a castle built of sand.

Aristotle and his disciples at the Lyceum had constructed a cohesive cosmological vision, proving deep ties between its physics, or the explanation of movement, and its astronomy, or the structure of the universe. So cohesive was this worldview, that criticism of one aspect were never enough to lead to the collapse of its entire system. For example, Strato, whom later became director of the Lyceum after the death of Aristotle, noted irregularities in the Aristotelian explanation of motion. Observing that the stream of water falling off the roof split up into smaller droplets, he argued that the water was actually accelerating as it fell to the floor, contrary to the Aristotelian notion of constant motion before a given medium. Strato's important observation had no impact on the Aristotelian cosmological scheme.

Until a new scheme was itself built up, the Aristotelian cosmological system would remain standing. The Scientific Revolution created such an alternate cosmology, rivaling that of Aristotle in that it also tightly interlinked both astronomy and physics. At the same time, a new epistemology was established, regarding the limits of scientific knowledge, as well as its principal methods of discovery and proof, which would be followed by all consequent scientists: experimentalism and empiricism.

However, to understand Aristotle the astronomer cum physicist, one must first understand Aristotle the biologist, for it was via his study of living forms that the principal ontological principles were formed. It was to biology that Aristotle had

dedicated the majority of his time, and it is to be noted that his father had been a physician. When Aristotle goes into exile upon the death of Plato, he lives in the isle of Lesbos where he further developed his notions of natural history. Yet, to understand these, a brief look at the ideas of the Pre-Socratic will be useful, as it was in reaction to these ideas that Aristotle formed his own original notions of life and the cosmos. His view of the world was inherently biological.

The Pre-Socratics tried to explain the world on the basis of universals, which served as its fundamental component on which all other parts were built. There were different types of universals. Some, as air for Anaxmines, had a material basis; others as Pythagoras's number system were formal causes, and finally there were others which were "compound" in nature, as the *nous* invented by Anaxagoras which contained within itself all other substances of the universe. Thales claimed that water was the primary universal. Its lack of distinctive traits, its abundant presence, and its ability to become any other form made it the ideal universal. It could become a solid, as when it froze, or air, when it was overheated. The problem, of course, was then how to account for change. As Parmenides more generally stated, how can something emerge from nothing?

In his criticism of the Pre-Socratics, Aristotle showed that matter did not necessarily render form. We might have a good idea of the material an object was composed of, without knowing a thing about how it functioned or worked. More importantly, Aristotle pointed out that only by knowing the history and developing of an entity could one come to know its formal cause in biology.

A good counter-example might be that of the case of monsters. For Aristotle, while the mother provided the material of all biological entities, it was the father who rendered shape and form onto this substance. It was not until a creature was fully developed that we could come to know its function or finality in the universe. However, damages to the material base of the mother resulted in monsters, then defined as creatures which had not reached their final form. As a result, for Aristotle, the

explanation of the world was not to be found in its component universals but rather in the very functional processes of the universe. While all men died eventually, through reproduction it was the form of the species which became the true universal, persisting generation across generation of biological entities across the living realm.

Aristotle thus bases his physics on the finality of all matter, or the ends towards which it strove. All fire rose, all earth fell; each Empedoclean element had its place in the world. Each object thus had what was referred to as "natural motion", or the place or direction towards which it was determined to move inherently out of its own nature. Similar to the phenomenon of monsters, violent motion occurred when the natural course of an object's motion was violently interrupted by an external force, hence preventing the obtainment of its final destination. It is upon this biologically influenced physics, that Aristotle created his cosmological views.

Aristotle divided the world along the circle created by the moon into the superlunary and the sublunar realms—each with its own distinctive set of properties. The superlunar realm was composed of a fifth element, the *aether*, whose natural motion was circular, eternal and perfect. Stars, members of this realm, were exemplars of perfection: they never changed, died or were born. The sublunar world, by contrast, was the world of change and imperfection whose entities were composed of the other four elements, which decomposed and moved erratically about. Worse yet, natural motion was in constant conflict with violent motion, wherein its members were constantly prevented from fulfilling their purposes and roles in the universe.

It goes without saying that Aristotle's world view is profoundly anthropocentric, projecting the realities of human life onto the cosmos—which perhaps is what made it such an appealing philosophy for nearly 2,000 years. The universe was full of finality and purpose, as well as tragedy and defeat. In this, there can be no doubt that the Aristotelian world view was inherently "teleological": everything had a particular function and role in the universe. It is equally clear that the Catholic

Church sequestered this view, basing its entire theology around it. If for Aristotle the center of the universe was the center of the Earth, the Catholic Church transformed this universe into a "diablocentric" one, in which at the center of the Earth—so distanced from the perfect ethereal realm of the stars—hell could be found, the logical epitome of imperfection.[14]

The Scientific Revolution was inaugurated by Copernicus, who revoked this geocentric model, and for which it is "revolutionary". Newton's significance, therefore, rests in solving the principal problem created by the heliocentric universe, wherein the Earth revolved and rotated around these: how was one to account for its physics? For example, if it were true that the Earth was moving about so quickly, how could it be that things remained fixed on its surface, without flying off? How could birds fly in any direction, without the world rotating quickly beyond their reach? Only by creating a physics which explained the anomalies of the Copernican worldview, would it be able to become substitutive of it, and it is here were Newton's role became so important.

His establishment of the law of gravity rendered coherence to the new world view, hence why Alexander Pope claimed "all was light" in ample recognition of the genius that was Newton. As Cohen shows, "political revolution" was a concept in political theory borrowed from astronomy.

The rise of Newton as a public figure led to the creation of "Newtonianism". Newton, as Einstein, became one of the few scientists celebrated during their lifetimes, having had the fortune of discovering the reason for the order and structure of the universe: gravity. There were diverse variants of Newtonianism, one of which was promoted by John Theodosius Desaguilers. His 1728 poem, *The Newtonian System of the World, the Best Model*

[14] It is curious to note that the Catholic Church's incorporation of Aristotelian theology also led to the perpetuation of it philosophy, turning Aristotle into perhaps the most influential thinker in human history.

of Government suggested a relationship between physics and political forms as well.

Desaguliers had been Newton's assistant at the Royal Society, invited in 1714 to participate by Newton himself. Desaguliers prepared Newton's experimental apparatus, and soon thereafter was made a member of that society. This was a wise choice, as Desaguliers would help diffuse Newtonianism throughout England and Europe, offering some 1,000 talks on Newtonian science. Even though Newton dies in 1724, whereupon Hans Sloane obtains the president's chair, Desaguliers retains the same high standards previously set by his mentor. He also becomes the precursor to the first Industrial Revolution, in that his scientific analysis of diverse machinery revealed the manner in which their designed could be improved.[15]

Desagulier's poem is an allegory between the natural world and the political one. It is not an argument, but rather the suggestion of a similarity between the two realms, and is perhaps the first history of the Scientific Revolution ever written. There had formerly occurred a corruption of intellect and public morals. Although Greek science was not empirical, it had shown a great deal of rigor. This intellectual and ethical rigor was corrupted by the scholastics, who, though never mentiond by name, are readily identifiable by their traits: specifically the ample conjectures and suppositions without any verification whatsoever. A similar corruption of political life had occurred with the rise of fear and ambition; kings wanted it all, and coopted natural philosophy for their own ends.

With the arrival of Newton, the Greek system was restored. In the same manner in which the sun loves the comets at a distance, leading to their voluntary return, the new relationship established with the king was also characterized by love and the voluntary behavior which it triggers. Instead of being moved by fear, individuals were moved by love; instead of slavery, mutual respect predominated social relationship. Out of

[15] His example was imitated by John Smeaton, who scientifically identified the ideal form of a water mill.

their own free will, the faithful would return from distant lands, as the comets had from the stars, hence its implication for a sound political system.

But Newton the unparalleled, whose Name
No time will wear out of the Book of Fame
Celestial Science has promoted more,
Than all the Sages that have shone before.
Nature compelled, his piercing Mind, obeys,
And Gladly shews him all her secret Ways,
Giant Mathematicks she has no Defense
And yields its experimental Consequence:
His towering Genius, from its certain Cause,
Every Appearance, a priori draws
And shows the Almighty Architect's unaltered Laws.

Desaguliers was a Huguenot.[16]

The poem was written not only to receive the support of the king and receive his patronage, common as it was at the time. Science would not become professionalized for some 200 years. Desaguliers also wanted to provide a vision of the political order which could exist, in which each group was mutually respected. The comets of his poem alludes to the French Huguenots, and the character of British politics dominated by reason and liberty.

The same Newton provided a religious view of his science, and in this Desaguliers also did much to stimulate this idea. Having been such a close and intimate associate of Newton rendered authority to his definition of Newtonianism.

[16] French protestants suffered a wave of massive repression after Louis XIV revoked the Edict of Nantes in 1685. The traumatic St. Bartholomew's Massacre (1572) where thousands of Protestants were brutally murdered by Catholic believers, left a profound scar.

Chapter 5

Hobbes

Why did Darwin discover the theory of evolution and nobody else before him? After all, in contrast to the development of astronomy, so promoted by the increasing technological sophistication of its telescopes, or with the development physics, which had been stimulated by the advancement of sophisticated mathematics, the world of natural history is available to everyone. All we have to do is to literally go into nature and observe what is easily reachable, before our very eyes. It might even be suggested that the only requirement was a great deal of work, such that after countless hours of observation one would ultimately arrive at the notion of to Darwinian natural selection.

Cases as that of Iñigo Abbad y Lasierra, whom explored Puerto Rico during the eighteenth century, helps reveal the obstacles of pre-Darwinian theoretical biology.[17] When placed upon a broader conceptual background, it becomes relatively easy to understand the difficulties involved for such a view to emerge. The most simple explanation of all is that of Lovejoy's great chain of being. In its essence, this consisted of the notion of "plenitude" as its central concept: all of life was occupied by "slots" from the smallest to the largest, each animal having a particular function in the world. Per Aristotle, each living entity of the world occupied a particular niche, the topmost of which was man, whom had reason in contrast to all other beings. This

[17] Sun Yat Sen's history reveals that traditional Chinese held knowledge to be "easy" while "action" was hard; such claims to the presumptive ease of discovery is false.

view wholly tainted Abbad y Lasierra's outlook of Puerto Rico's living forms, blinding him to the idea of evolution.[18]

Within this schema, the notion of change, history and evolution is odd and did not fit; its tight construction was akin to a jigsaw puzzle which by definition locks its pieces into place as they are so neatly interwoven. It is hard to conceptualize how there could be change as all in the natural world, as all other beings would be affected by modifications of any other, thereby impacting its antecedents as well as dependants. If one animal changed, all others would be forced to do so as well.

The great chain of being helps to explain why the Church detested idea of history, as it would imply itself to have been a construction rather than a universal and eternal body. A history would reveal the Church not to be the result of divine intervention, but rather a byproduct of the actions of men. Thinkers of European history were actually killed for suggesting this notion, while others as Giambattista Vico sought to carefully straddle between historical accuracy and papal heresy.[19]

The great chain of being was a worldview which profoundly influenced the world of man and politics, making it easy to justify monarchy and monarchical rule. The monarch, after all, sat above all other citizens as men stood above animals in this schema of natural history. Rationalizations for the religious legitimacy of kings were many, grounded on the principle of plenitude. As this concept was eroded by the Scientific Revolution, the justification for monarchical social order began falling apart, no longer resting on unquestionable foundations.

The Western World suddenly saw itself with the need to form new worldview. While some of these, as Robert Filmer's *Patriarcha* sought to restore the old order, others, in turn,

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[18] It should be noted that there were other scientific conceptual factors affecting Abbad y Lasierra as well.

[19] Vico's separation of pagan from religious history allowed for the claim of separate rule-sets, and thereby evading Catholic Inquisitorial sanction, incarceration or burning.

revolutionized political thought. To understand these dynamics, we have to first understand Thomas Hobbes and John Locke, whom are perhaps the most important political theorists influenced by the emerging Scientific Revolution.

As Spragens noted, Hobbes's political theory has to be understood within the context of the destruction of a universal philosophy which had reigned supreme for more than 2,000 years, and which had rendered the world, both social and physical, coherent and understandable. Under Aristotelian scholastic philosophy, both man and nature had their function and purpose clearly defined; while each object sought to obey its internal motion according to its constitutive elements, all animals sought to develop into their final forms as adults, and all men sought out the community of men in which their true selves could be made manifest. Without the rudder of Aristotlelism to guide the world, would it end? The destruction of this worldview implied a universal chaos and the undoing of society.

Yet Hobbes is not whom most people believe he is. His emphasis on power was only part of a much broader cognitive revolution whereby Hobbes sought to inject scientific reasoning into the political process. In contrast to the anti-ethical derision with which he was seen, Hobbes, in fact, presented a methodic and careful reflection on power and of its consequences. He sought to use the enormous intellectual power of the geometric method he had observed in Euclidean proofs to establish unquestionable conclusions about the sociopolitical order, and ultimately the modern notion of sovereignty. The degree to which he succeeds suggests that he sought to establish a secular religion. By establishing social order while at the same time explicitly taking God out of the picture, he sets forth the rational grounds for a peace based on a careful evaluation of the condition of man and human nature. Hobbes's effort was the most direct attempt to create a science of politics, as modeled upon the infallible logic of mathematical proof.

Hobbes might have been motivated towards this endeavor after he visited Galileo in Florence, then a blind old man under house arrest by the Inquisition. It is unknown exactly what took

place between the two men, but one cannot help but notice the philosophical similarity between their two approaches. Interestingly, Hobbes did not see himself as a humanist, though undoubtedly his activities could be used to classify him under its label. Throughout his life, he translated many Greek classics, an exercise common to the humanists, a category into which Copernicus might also be placed. At the age of ninety, Hobbes was translating both of Homer's major works, the *Iliad* and the *Odyssey*. Yet Hobbes ultimately identified himself as a "scientist". Though the term is an anachronism, it aptly captures Hobbes's attempt to bring the rigor of natural philosophy, as it was then evolving, into the ambit of moral philosophy. Today, his ideas are the underlying standards of the realist position in the field of international politics.

Hobbes lived through a period of tremendous scientific innovation and tumultuous political change, interacting with a great many who now regarded as key figures of the Scientific Revolution: Bacon, Galileo, Descartes, Gassendi, Mersenne and others. Merely due to whom he interacted with, it is plausible to suggest that Hobbes would ultimately have had some sort of intellectual impact. Only eight years after Hobbes died, Newton would publish his groundbreaking *Principia.* Hobbes was well aware of Kepler. During Hobbes's first trip to Europe, Galileo was at the height of his fame; given the newly discovered satellites surrounding Jupiter and the existence of the moon's craters, the Aristotelian worldview was inherently problematic, according to Galileo.

Some of Hobbes's deeper interactions will help provide an idea his character. As a young man, Hobbes had worked as Francis Bacon's secretary as he was writing his famous works after being driven out of political power. Bacon is said to have commented that he actually liked Hobbes because, unlike other assistants, Hobbes actually understood the ideas and concepts Bacon was dictating to him. In spite of this contact, Bacon appears to have had a negligible influence on Hobbes.

Far from adopting Baconian empirical research paradigm as the path to truth, Hobbes becomes a rationalist, which brings

him into conflict with others as Thomas Wallis, the first professional mathematician in Cambridge. Unfortunately however, Hobbes was more of a hobbyist geometrician, and incorrectly claimed that had "squared the circle". Although Wallis on multiple occasions explained that he was wrong in his allegations of mathematical originality, Hobbes kept insisting in the correctness of his claim, leading to a paper battle that would be fought for more than a decade.[20] This is perhaps one of those rare instances where Hobbes had been utterly mistaken, but does provide some sense of his character.

Wallis and Robert Boyle had been founding members of the Royal Society (1662), which sought to make Bacon's empirical vision a reality. Shortly after its formation, Hobbes wrote piece criticizing that experimentalism was not the correct scientific method as the mere accumulating of data would not lead to scientific truths. It goes without saying that Hobbes was not invited to participate in the Royal Society.

Hobbes's interactions with Marín Mersenne and Rene Descartes were more profound, but no less conflictive. During his life, Hobbes took four trips to Europe, staying on one occasion for some 11 years in Paris during England's tumultuous years, specifically the assassination of British king Charles I. While in Paris, Hobbes met and joins the Mersenne circle of scientists, becoming good friends with Gassendi. Upon receiving a copy of Descartes *Meditations* for commenting, he presented an objection that appeared in the final volume as the 3rd comment—an objection which was discarded by Descartes.

The source of the animosity between them is somewhat puzzling in that both Hobbes and Descartes sought to mathematize the world. That Hobbes was a monist, believing that everything in the universe was reducible to motion, whereas Descartes came to be recognized worldwide for his dualism, was a key point of contention between the two mathematically influenced philosophers. For Hobbes, the notion "I think

[20] It would not be until twentieth century that Lindeman would prove this point.

therefore I am" was as absurd as the claim "I walk therefore I am." Hobbes clearly did not really understand the points of Cartesian philosophy, and when they actually did met in 1648, it resulted in an interaction so disagreeable that Descartes asked Mersenne to not longer share his ideas with Hobbes.

One might conclude that European science had little direct influence on Hobbes, given that his relationships with many of the scientists of the era were often acrimonious and full of contentious debate and conflict. However, it has to be pointed out that Hobbes's value as a thinker was well recognized by the community. Upon publishing *De Civie* in 1642, Descartes praised it as an important work, a treatise which would ultimately become the basis of his magnum opus, the *Leviathan* (1651).

It has to be emphasized that his greatest inspiration was Euclid. While on his second trip as the tutor of the Grafton child, he came across an open book in a private library, on whose page rested the Pythagorean theorem. At the late age of 40, Hobbes was flabbergasted, and came to see geometric proofs as the definition of what today we would refer to as the scientific method. This consisted of clearly and irrefutably establishing unquestionable definitions and axioms, only to then carefully and deductively work out their implications towards other irrefutable points and conclusions. In the process, an unbreakable edifice could be created.

The contemporary animus towards Hobbes was due to his apparent removal of God out of the picture. Living in Catholic France, he naturally came to fear for his life given the increasing tensions, and fled back to England in spite of its own difficult environment. Submitting to current authorities so as to obtain the safety of home, he was forbidden from discussing his works in public and was forced to write only in Latin rather than the vernacular, as he was accustomed to do. That Hobbes ended up publishing a second edition of *Leviathan* in Holland, as well as meeting important visitors which means that these threats could be taken with a grain of salt.

Hobbes's key argument can be simply stated. Man in a state of nature is in a state of war, of all against all. As not all

goods can be shared between men, men will naturally compete for these and thereby inevitably come into conflict. There is no sense of justice in a state of war, and commonly held notions of property and ownership do not exist under such a condition. The key traits of power are thus force and fraud; lying, cheating and killing are seen as "virtues" of sorts under such a state. Worst still, this state of war is not beneficial for men as it prevented them from developing a higher order civilization. All the arts and sciences are lost under these conditions.

Hobbes, as Montaigne and others, had avidly read the descriptions of New World indigenous societies. While at the university, his rejection of scholastic works was well known, spending more time at local bookstores. Hobbes was utterly fascinated with descriptions of the New World, and his magnum opus does accurately capture the violent atmosphere depicted by European travelers, as that of the *Crónicas de Michoacan*.

As a result, Hobbes comes to certain conclusions regarding natural law, in which the notion that society is a web of relations is implicitly embedded. We grant the same rights to others that we grant to ourselves, a conclusion which arises out of the intrinsic equality of men—specifically the equal likelihood of being killed. Given that others can easily obtain the instruments of death or combine and coordinate for the purposes of assassination, men can kill each other with relative ease—no matter how strong or powerful the victim as the case of Charles I. Consequently, in order to avoid this perilous result which goes against our personal self interest and well being, we forfeit certain powers, specifically the right towards violence, so as to gain the benefit of not being equally afflicted by others in the same way. In other words, by yielding our right to kill, we grant ourselves a relative amount of immunity of not being killed in turn.

Hobbes also observes the conditions under which men re-enter into a state of war. He details the number of offenses, which forces individuals to reassume their right to violence for their own self-preservation, resulting in a number of derivative secondary laws that arise therefrom. For example, men must

abide by their contracts or pardon past offenses so as to avoid the state of war arising from cruelty. Logically, there could be no exceptions, in that reserving for himself a right he would not concede to others would also result in a new state of war.

The cessation of man's inherent right to violence has an all-important important byproduct: the creation of a higher order civilization or a society of peace which allows for the arts, sciences and industries to flourish. There was a deeper lesson implicit in his discussion, however.

Because Hobbes recognizes that some men lacked the time or ability to understand his logical minutia, he therefore reduces all laws to a single one, the golden rule: do onto others, as they would have them do onto you, the main purpose of which was simply to avoid a state of war for the benefit of all involved, and enter into a more civilized age. Hobbes concludes with the fundamental natural law of all successful human societies: the requirement of reciprocity between all of its members.

Whether or not we agree with him, there was an inherent logic to the validity of his ideas that cannot be denied. Hobbes presents moral principles as natural law whose violation will introduce a state of war, and consequent dissolution of society; natural law and the state of war are inherently tied in his philosophy, for to ignore the first, would be to inevitably induce the second, which all rational men would naturally seek to avoid. It is here where "science", or more specifically Euclidian theory, intrudes into his law; it inevitably follows that one is a consequence of the other.

This did not necessarily mean, however, that its application would be as rigorously followed.

These apparently quaint ideas are not as foreign and exotic as they might appear to young students, and actually regularly guide our everyday behavior without our noticing it. A good example would be a traffic light. Why do most drivers generally obey traffic lights when they can be so easily ignored in that they only constitute a symbol, a light, without the physical power to actually restrain our actions?

As Hobbes suggested, we yield to others in the same manner that we would like others to yield to us. Failure to follow the traffic light would be to act against our common interest, either by creating an impassable bottleneck, with each car egoistically getting in the other's way and none being able to move, or simply to protect our lives. The horrific automobile accidents which occurred in Puerto Rico's roadways after Hurricane Maria emerged precisely because local conductors ignored Hobbesean truths. Although well aware of the existence of the light at a common intersection, they chose to blithely disregard it, as if their car had been the only on the road. Whether this was actually true or not can be answered by asking the wife of the dead husband killed for cheekily sailing over a traffic light. While we need not chose to follow the light, as so often occurred in Middle Eastern roadways, we do so at our own very real peril. The same might be said for all ordinary social interactions which occur on a daily basis—as well as of the relations between nations.

We might today fail to attribute reciprocity as a "universal law of nature", but we can readily follow and accept the logic of its implications—which have on a number of occasions been so well satirized in the television series "The Simpsons". If everyone did only what they wanted, listening to their own "inner child", the social order would collapse out of the predominance of egoism in society.[21]

While motion and mechanism form a part of Hobbesean philosophy, to place too much emphasis on this is to distort the character of his thought, and to make him more of a scientist than he actually was. Hobbes certainly dealt with one of the most profound social implications of the Scientific Revolution, particularly with regard to the political order, and hence a puzzle as to why Ferris gives him such undue treatment in his important work.

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[21] The series offers an interesting clue was to what occurs when psychologists and psychiatrists are placed in positions of power.

There is a contradiction in Hobbesean thought. For, if the moral law of reciprocity was a universal natural law, why would Hobbes have suggested the need for a leviathan at all? In contrast to Enlightenment figures, Hobbes had lost some faith in human reason, which explains the move. While men could be rational and reasonable, they were not always so; that they were not always scientific, mean that, ultimately, there would always be a need for an external source of absolute power and authority (i.e. the leviathan). In other words, while a citizen could recognize the inevitable logic and rigor of Hobbes's treatise, they would not necessarily abide by its dictates, ignoring, as men are wont to do, its future consequences. We all need some sort of guiding traffic light after all.

However, by postulating his solution, Hobbes failed to consider how this absolute power (leviathan) itself distorted social dynamics and the political order—itself inducing a state of war out of its very existence. While Hobbes had more than ample evidence to explore its implications, well described in the novel *Autobiography of Henry the Eighth*, he appears to have been too absorbed by his mission to scientize politics to fully appreciated its implications. Other thinkers which followed him would be a bit wiser in this regard.

Chapter 6

Locke

John Locke could not be more different from Thomas Hobbes. While Hobbes is direct and concise, offending everyone in his path, as well as conflicting with nearly all the scientists he knew, Locke is taciturn, contradictory and ambiguous. Zealously guarding his untarnished reputation, Locke never mentions Hobbes, in spite of being deeply indebted to him. Fifty years after Hobbes's death, Locke's predecessor was now seen in low repute. Scholars have been debating Locke for 200 years, and likely will continue for many more years due to the inherent ambiguities in his writing.

As Hobbes unequivocally calls for the golden rule, which he defines as the fundamental law of nature in a manner akin to what later would be seen as the law of gravity—treat others as you would have them treat you—Locke builds into his theory the equality of man into his state of nature. Yet for Locke, the only voters that counted were propertied voters, as women and slaves did not count in his equation.[22] Locke himself had investments in the Royal African Company, a slaving company, annually making 200£ from such investments and 40£ from his rental properties, which allowed him to live relatively well off as an adult. He also prepared an ineffective Carolina constitution, and was often in charge of British Caribbean colonies as Bermuda, Barbados, and Jamaica. He promoted the population movement from Caribbean to Carolina so as to fortify his investments.

Yet while Hobbes formally calls for the absolute power of the sovereign with nothing below it, Locke expresses the limits of governmental power and the conditions for the right to revolt

[22] would be used by these same groups to fight for political equality

against the arbitrary use of power such as the theft of property, harking back to Spain's governmental character. While he has been accused by some as providing the key justification for modern capitalist system, his works were originally written in the context of the Whig Revolution and for which it was intended: a religious conflict between Protestants and Catholics.

James, brother to King Charles II, was being manipulated by the French King Louis XIV in what was then referred to as the "popish plot", feared by many would become a pretext for the Catholic conquest of England. However, William of Orange and Mary were able to successfully establish Protestant rule in England, and ironically serving as the theoretical basis for the rebellion of American colonies from England. Locke had written of the preservation of land, liberty, and *estates*, or property, rather than the "pursuit of happiness" as expressed by Jefferson in the Declaration of Independence.

In spite of the distinctive differences in the manner which science influenced the formation of their respective political theories, both Hobbes and Locke made substantive contributions to the theory of democracy and sovereignty.

As noted by Kloppenberg with regard to Rousseau, there were problems in the practical application of Hobbes's ideas, specifically what might be referred to as his "secular religion." Maxims regarding how one should or should not behave had limits with regard to their sociopolitical impact. Even if reason dictated these to be true, as being a key functional aspect to all democracies, the specifics of their implementation determined the character of their outcome, as can be noted in the new British colonies.

One of the most odd and particular features of the establishment of British American colonies is that while many began on a positive note and high spirit, as the case of William Penn's Pennsylvania which started orderly, these all too quickly devolved into chaos. Its members often did not pay their fair share in taxes or communal responsibilities, demonstrating the

ever present "free rider" problem common to collectivities.[23] Similarly, while democratic values characterized the tenor of their public establishment, their founders typically placed themselves as monarchs exempt from the law. Unsurprisingly, many of their founders did not last long in power, a phenomenon that was as surprisingly true for Pennsylvania as it turned out to be for Massachusetts. Penn, for example, ended up traveling back to England hoping for the support of King James II; however when the latter was dethroned, along with it went Penn's financial lifeguard, later dying in debtor's prison.

The formation of the earliest of British colonies played an important role by helping European thinkers as Locke to establish models and ideas about the meaning of democratic rule. These diminutive and fragile British colonies first established covenants between all of its members prior to the selection of their political leaders. These small communities and villages served as foundational exemplars of democracy, and were characterized, for good or ill, by the fact that all members knew each other due to their diminutive size. John Dewey would also reflect on this fact two centuries later in his consideration of the political impact of modern industrialization and urbanization in America. The strength of the democratic ethos could be seen whenever a senatorial House of Lords, congressional members without elections, sought to be established. Their continually sound defeat showed the pervasiveness of a commonly held notion that all in a community were subject to the will of the people—even its most powerful leaders.

That John Locke learned from the example of the British colonies the value of the prior establishment of a constitution (convent), reveals that a historical feedback loop system was occurring: early British colonies impacted Locke, whom in turn impacted the further political development of the very same British colonies. By contrast, the influence of Locke's political writing in England itself would be relatively negligible. His *Two Treatise of Government* had been written in the context of the

[23] Some gained the benefits, while not paying for the costs.

legislative debate at the time, but were of obvious far broader importance for political theory in general.[24] Published in 1690, only upon his death does Locke come to make publicly known his authorship.

Prior thinkers as Hugo Grotius in *On the Law of War and Peace* (1625) argued that all laws could be reduced to two key principles: 1) the right to self preservation, and 2) the prohibition against wanton injury by others. Peace for Grotius was the primary aim of government, and its key maxims were designed to meet this principal framework. He further argues that when governments are formed, citizens surrender their personal sovereignty to state, reserving the right to rebel only in the case of tyrants.

Samuel Pufendorf's version in *On the Law of Nature and Nations* (1672) took a slightly different stance. He recognized an inherent interdependence of citizens, whom needed to cooperate in order to survive. The inherent functionality of his outlook referred to "moral persons" as the productive members of a society. Pufendorf also recognized the inherent logistical problems to all governance however. The formation of a "single will" out of a collectivity was impossible, thus there was an inherent need for the state which determined the safety of the group. Because individuals are not always able to understand or appreciate the purpose and function of government, it sometimes required the use of force for these ends. As Grotius, the right to rebel could only be exercised in case of tyrants, whom by definition imposed violence against the very same moral persons, thereby stipulating the unusual and extreme conditions of legitimate revolt.

Pufendorf had written in the context of Hobbes, whom argued that the state was the ultimate sovereign, this being the ultimate arbiter resolution of internal conflicts and disputes. The inherent clashes that occurred within the confines of the state could not be solved directly by citizens. When no agreement

[24]*Second Treatise of Government*

reached, these did not have recourse to the use of arms, but rather could only appeal to courts to resolve these.[25]

Locke shifts the ground of legitimacy from the king to the citizenry. In the *First Treatise* he attacks Robert Filmer's *Patriarcha* (1680), who claimed to provide a definitive proof of monarchy. For Filmer, the divine right of kings were derivative from the biblical Adam, whom had been given control over Earth. His treatise was widely read. Locke immediately obtains a copy of the book, and recognized that it could not go uncontested. In the *First Treatise* he demolishes Filmer's argument, while in the second treatise, Locke establishes the positive basis of government.

It has to be emphasized that these ideas could have gotten Locke killed; some of his associates were executed by the crown. Lord Shaftsbury, Locke's patron, was forced to go into exile. By the age of 53, Locke in fact had not written much at all, and in this he is similar to Newton. Had Locke died at the time, today neither he nor his magnum opus would be known at all. Locke follows Lord Shaftsbury to Holland, and like Hobbes, he spent

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[25]A similar stance is taken today in the case of the protection of citizens abroad; if a U.S. citizen travels abroad, it is the function of U.S. embassies to protect their interest, which leads to the following question. If Puerto Rico were to become a republic, it would in theory be responsible for the well being of its citizens, and hence be required to establish diplomatic consulates wherever Puerto Ricans reside, be it in the Caribbean (Dominican Republic) or in major U.S. cities (New York City, Orlando FL). These issues raise some of the logistical difficulties if it were to become nation. Puerto Rico unfortunately not only lacks the means to protect its citizens abroad, it cannot even do it internally as it has abrogated many of the key function of state. The peace and safety presumptive of Grotius and Pufendorf does not exist given the predominance of gated communities, a failure which reintroduces "a state of war" in the island. It goes without saying the all pervasive role of violence in Puerto Rican society is indicative of this condition regardless of its

nearly a decade outside of England due to its political turbulence. Locke is not as cosmopolitan as Hobbes, however, as he wrote mainly about English issues. While in Holland, he also changes his name to Dr. Van de Linden, one of his many changes of identity. Locke also moved locations frequently, and had formally claimed that the reason for his visit to Holland was due to its remarkable beer. Authorities in England, however, were informed of Locke's associations in Holland, for which his stipend is removed by university authorities.[26]

The incident reveals that even in Holland, Locke had treacherous internal enemies. Shaftsbury, incidentally, dies within a year of exile, likely a victim of assassination. Locke dealt with serious philosophical issues of enormous social implications, affecting the distribution of power and responsibility in a society, the erosion of monarchical absolutism, and the rise of democracy.

While Locke is markedly different from Hobbes, one of the common threads of their writings is the conditional nature of liberty. Rather than suggesting that freedom meant the ability to do whatever one pleased—what we might more appropriately term licentiousness—for both thinkers liberty in a society meant critical self-control or the virtuous mastery of one's natural desires and proclivities.[27] Locke, however, situated his personal

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[26] The stipend was conditional on his maintaining his condition as bachelor, and in theory could have remained for the rest of his life.

[27] With the Covid19 pandemic raging in the U.S., many showed incredible ignorance of the U.S. notion of liberty, claiming that using a mask was an infringement upon their liberty—an absurd claim. This particularly so in light of fact that it is not costly to wear a mask, whereas doing otherwise is extremely ocstly. So far, the worldwide pandemic had led to 30 million cases and 1 million deaths worldwide. Trump is damaging th worldwide standing of the United States for own personal economic gain, and aplty fits within Lockean definition of tyrant: a leader who

restraint within the context of both science and religion; for Locke, revelation had to be guided by reason, which was not necessarily an easy task. Profoundly religious, Locke argued that reason was key component of genuine religious thought. All citizens had the duty to think critically about the world around them; a belief which helps explains why Locke opposed both fanatics and atheists, believing neither to employ critical thinking.

He opposed the Roman Catholic Church for similar reasons, characterizing it as a magical cult—and example of which is the notion of transubstantiation. While now, the bread and wine of communion are seen to metaphorically represented the body and blood of Christ in liturgical rituals, they were previously seen as its real and literal manifestation. It is interesting to observe that periods of enormous social change tend to be characterized by the active persecution of "witches".[28]

Locke was present at the very beginning of the formation of the Royal Society in 1660, and would become deeply embedded into it. He was a close associate of Robert Boyle, one of the key founders of the institution and whom would publish two years later his most important work, the *Spring of Air.*[29] Boyle was a wealthy individual whom had set up a laboratory in own private home, oddly being fairly inconsistent in his attendance to the Royal Society's own meetings. However, Boyle was lionized by its then Secretary Oldenburg, whom had been Boyle's protégé. Boyle was a leader of the British *virtuosi* whom

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uses institution for his personal benefit, creating a state of war in the U.S.

[28] Incidentally, the scientist Robert Boyle disliked going against magic, writing much more than he actually published.

[29] This is known as "Boyle's law", one of the few privileges of science is to be awarded an eponym. The full title of the work was *A Defense of the Doctrine Touching the Spring and Weight of Air* (1662).

included both Robert Hooke and Christopher Wren, well known figures in the history of science.[30]

Five years older than Locke, the two would become such close friends that towards the end of his life, Boyle entrusted Locke with safeguarding his intellectual legacy. As his literary executor, Locke published Boyle's last posthumous work, *General History of the Air* in spite that a portion of the documentation had been lost by Boyle some twenty years before. In Boyle's *Memoirs of the Natural History of the Blood* (1683), the person most praised had been Locke, whom had encouraged the author towards the book. It had then been seen as important contribution to medicine, underlain by the then dominant miasmatic notion of disease.[31] Boyle's medical writings help account for the early association between the two men.

While Locke had been a teacher at Oxford, he began studying medicine and science generally, eventually becoming a part of Boyle's *virtuosi*. During a concentrated effort spanning decades, Locke began taking measurements of the weather, making detailed readings on a daily basis of the temperature, pressure, humidity, and so forth. Boyle had also given Locke a "pneumatic engine" (pump) to study conditions within mines, specifically the illnesses and the horrific labor conditions they tended to suffer. When the very same superstitious miners did not allow Locke's entry, Locke tried to use the engine for other purposes but was unable to due to technical malfunctions of the sensitive apparatus. Locke had also participated in Boyle's study of blood, helping him to distill blood, which created a horrific odors. Removing salts from the blood was no less pleasant.

During the Great Plague of 1655-6, Boyle was forced to move to Oxford, thereby stimulating a closer collaboration

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[30] Hooke would become Secretary Royal Society and enter into contentious conflicts with Newton and Wren. Wren was an architect who, in a debate with Edmond Halley, helped launch what would become the *Principia*.

[31] Boyle believed that mineral emanations combined with weather to induced epidemics.

between the two men. When Locke went to London due to politics on behalf of his patron Lord Shaftsbury, he would routinely visit Boyle. This same plague would remove Newton from university and result in his creation of calculus and early notions of the law of gravity by the age of twenty-four.

The relationship between Locke and Newton was not as some have suggested. There was quite a bit of an age difference between two, Locke being in his seventies while Newton was in his thirties. Locke had heard of Newton while in Holland and first read the *Principia* there. Since he was not as good of a mathematician required to truly understand it, he had Huygens verify its results. Huygens, it goes without saying, confirmed its claims, leading to Locke's positive review of the book.

Because Locke had already written most of his major works in political theory, it cannot be said that he was directly influenced by Newtonianism. However, the close few years the two spent together did impact Locke's theory of empiricism Both intellectuals shared an avid passion for religion, a similar worldview and outlook, and a mutual circle of scientific friends. As is well known, Newton had abrupt moments of mental breakdowns, on one such occasion writing a harshly worded letter to Locke, and just as quickly wrote back to apologize.

Locke accepted Newton for whom he was, with all his quirks and eccentricities, as well as his profound genius.

Chapter 7

Montesquieu

Montesquieu describes the key traits required for a functioning and successful democracy, and should be required reading of all students alongside Hobbes and Locke. If Locke provided the reasons for revolt, Montesquieu showed how a republic could be viably established by identifying some of the key ingredients that would make it work. In other words, he showed how, once a new nation separated itself from despotic government, it could remain free. In the 1760s both Locke and Montesquieu were the most cited political theorist; twenty years later, only Montesquieu would be named.

Charles Louis de Secondat, Baron de Montesquieu, is most well known for his notion of the separation of powers, but his contributions extends far beyond that. He observed that Rome had fallen because its judiciary was taken over by the Senate, thereby losing its own moral autonomy. Given that it is in the judiciary where citizens directly confront the full coercive power of the state, it was imperative for Montesquieu that its autonomy be forever retained; otherwise, as in the case of Rome, any republic would not stand. Recent trends in the United States and Puerto Rico do not bode well for the future of its respective democracies.[32]

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[32] Today, the Puerto Rico judiciary is similarly being taken over by politicians who lost elections, thus depriving citizens of a unbiased judicial system. Similarly, the death of Justice Ruther Bader Ginsberg of the U.S. Supreme Court one month before election became too tempting an opportunity by Republicans legislators—in spite of their vociferous opposition of Obama's candidate nine months prior to the election. That Trump should

It is important to note that Montesquieu was a magistrate who oversaw criminal matters at La Brede in Bordeaux for a decade, responsible for torture and executions. He wrote *Spirit of the Laws* in an attempt to present an epistemic paradigm of how viable societies functioned. His descriptions of the machinery of society would lead Montesquieu to become known as the father of sociology and grandfather of anthropology. Without a doubt, he is a transitionary figure between the feudal and the modern world, where some of the former's key traits were transferred to the latter. The nobility, which acted as buffers to monarchy and critical to its stability, played a similar role to that which the middle classes do today.[33]

Montesquieu was most concerned about the noxious effects of the concentration of power; the word "corruption" occurs more than 1,000 times in his magnum opus. Corruption for him always originated at the top (elite), was all too often used to justify the degradation of values. The corruption of those below served to legitimize corrupt elite behavior and rule by making corruption more common and palatable. Luxuries in this sense tended to lead democracies towards autocratic rule. The poor tended to sell their vote and often lacked the education to understand the issues before them. Inherited wealth was perhaps the most noxious of all, as great disparities of wealth led to an inflated sense of self importance whom often interpreted any kind of opposition as a personal affront.

On the other hand, Montesquieu was also concerned about excessive equality, as it also led to wanton behavior where genuine dialogue became impossible. As it is said in Puerto Rico,

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have the opportunity to alter the balance of power in the highest judiciary towards a more conservative view also reveals a very different political character of U.S. politics, with a substantially reduced moderation and virtue.

[33] If a person earns $70,000 per year, they are middle class; most in Puerto Rico and the US do not earn this amount. The wealthy in the US earn $200,000 or more per year, the highest earning annually $1 million.

everyone wanted to be a "*cacique"* (captain) but nobody wanted to be an "*indio"* (soldier). Such a loss of public spirit, emerging out of the twin extremes, usually meant the death of the republic.

The worst exemplar was Spanish despotism. It was feared that France, in intermediate position between it and England, might fall into that tyranny as well. Montesquieu used other exemplars from Asia to make his readers aware of the fact that such a phenomenon had occurred in history. In contrast to a republic where knowledge played a prominent role, ignorance was a key feature of despotism. The lack of an educational system in this sense was ruinous to republics. Knowledge allowed individuals to control the world, making it a better place not only for nature, but also for society.

Contrary to popular belief, Montesquieu was also well aware that governmental structures were not enough to establish a successful republic; it was a necessary but insufficient factor for a successful republic. As Hobbes and Locke had expressed, liberty was not licentiousness. Republics were like nets surrounding fish; they embodied a series of constraints that were always present but often invisible. Yet it was these series of constraints that became the key to a republic's success and longevity. The notion of a bounded liberty, which enabled equality and autonomy, allowed the republic to withstand political storms and torments. Science or natural philosophy had ennobling moral qualities that helped make men virtuous, contributing to a republic's stability.

The tempo of republics and despotic governments in this sense was very different. Despotism was characterized by efficiency and speed, yet the political liberty of the state was obtained at the expense to that of the individuals which composed it. Republics, on the other hand, had a far slower tempo, as ample time was required for discussion and debate. By definition, republics were inherently "inefficient"—yet their slow harsh debate allowed for the self correction of its course in cases of gross errors. This was precisely the key advantage of republics, one which is commonly ignored or overseen.

Montesquieu was also concerned with the culture of fear that characterized despotism. Torment and fear not only crippled an individual but Montesquieu also believed that they generated physiological effects in the body itself. There were direct biological mechanism affecting the body which were associated with these states of mind. Individuals no longer lived in the present but rather became eternally concerned about future—an attitude that when pervasive through society destroyed from within. As a result, Catholicism's notion of an afterlife for Montesquieu was horrific, in that it made injustices acceptable and even palatable.

This was to be sharply contrasted to republics or democracies where individuals were secure in their person and property, lacking a fear of arbitrary confiscation of their property or of meeting a sudden and unexpected death. Individuals in republics could live relatively unimpeded, according to their will. Although such freedom and lack of wanton injustice did not necessarily lead to happiness, there can be no doubt that it was a precondition to happiness, as it allowed individuals to live their lives as they wished. Such protections were a necessary factor to personal wellbeing. Commerce in republics also had a positive moderating effect in that it was more conducive to peace. To repeat, the key to a successful republic was bounded liberty: equality and autonomy.

It goes without saying that his *Spirit of Laws* was placed on *Index of Prohibited Books* by the Inquisition.

Although science per se is rarely mentioned in the book, Montesquieu did believe that it had positive moral effects. It was only through knowledge that good societies could be established—not perfect societies, but better societies. As Kant would later write, out of the crooked timber of humanity one could not expect perfect governments.

In this sense, Montesquieu separated moral from political analysis, arguing that the path to the republican success of Rome rested in a tension of powers—a dynamic that was also reflected in the British constitutional monarchy. He believed England was a democracy which mislabeled itself as a monarchy. Notably, the

English system became a key source of inspiration for the French philosopher. By counterbalancing powers, each power seeking its own self interest, England was able to maintain a stable republic. This notion would become a key concept in the formation of the US.

On the other hand, aggressive military expansion of empire, as the case of Rome again exemplified, was deadly for the republic. The Romans were inherently violent, a trait which enabled them to conquer the surrounding regions. As the tale of the *Rape of Lucrecia*, with the death of the monarchy began republic. The Roman senators, however, fearing that they might be crushed by the plebeians, were continually calling for military expansion, which allowed them to retain the upper hand in its interior political dynamics. This expansion, however, led to a negative feedback loop. While the tradition of adopting local customs as new groups were conquered was initially a favorable practice, easing the incorporation of new societies under its domain, as Rome expanded it became too large, resulting in unintended counter effects. Generals and soldiers became alienated from a metropolitan Rome that had become too dependent on them as well as too culturally distant. For Montesquieu, it was only a matter of time before one such general would have attacked the Republic; if not Caesar, then certainly another would have done so given the situation. In his analysis, Montesquieu focuses on the structural elements of history and social dynamics.

It is important to note that, in contrast to Hobbes, Montesquieu was born two years after the publication of Newton's *Principia.* His writings are thus to be contrasted with those of Hobbes and even Locke, in that they were never directly impacted by Newton. By the time of Montesquieu, Newtonianism had become established as a default model. In fact the *Spirit of the Laws* begins in much the same tone as Newton, claiming that it will first establish key principles (axioms), from which all else would follow in a manner that is curiously similar to the work of Vico.

Voltaire criticized that the *Spirit of Laws* was incoherent, a claim that would also be made for Vico, who was the lesser of the two thinkers[34], though he did try to follow the Newtonian model more closely, sending a copy of the *Sciencie Nova* to Newton, whom never responded. Montesquieu was proclaimed by D'Alambert, Bonnet and others as the Newton of society in their eulogies at the French *Academie des Sciences*, claiming that he had uncovered its laws.

It is clear that Montesquieu took a biological-medical model as his key metaphor. Societies for him were organic machines that were born and died; they had particular dynamics shaped by their particular contexts. The environment generated a particular culture, its moral cause, which in turn acquired its own momentum and character. The politician was to understand this dynamic, so as to be able to predict the impact of certain policies. The politician in this sense was akin to a physician, who sought to keep the patient healthy through observant care and counsel. In this he is similar to Aristotle, who looked towards final causes as the keys to understanding the universe and human societies.

Montesquieu might be said to take "ecological view." All animals fit into particular niches, which were unique onto themselves. What was good for one, not necessarily good for another.[35] The perception of the good and the beautiful varied between cultures; to become aware of this was as if being washed by a soap which eliminated all prejudices. The more self-knowledge one obtained, the less prejudiced one became.

Montesquieu however, was ultimately unable to identify its particular mechanism. While he wrote a great deal on learning, he did not publish how exactly the environment shaped character, and hence did not supply a mechanism of its relation.[36] This theoretical gap bothered Montesquieu greatly.

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[34] The Neapolitan writer did not achieve fame.

[35] Today we know that chocolate is poisonous for dogs and cats.

[36]The idea of a mechanism was a key idea of scientific revolution.

While today we would not necessarily agree with the details of his analysis, we might come to appreciate the logic of its general ideas, such as the impact of geography. Montesquieu argued that polygamous societies formed in the tropics due to the rapid maturation of girls, whom married too young before they had learned the skills necessary for their independence. Because they also matured quickly, they became elderly at an earlier age, which in turn stimulated the husband's marriage to another young girl, whom would then take her place, and hence the emergence polygamy. Monogamous societies in temperate regions, by contrast, had a different dynamic. Women matured much more slowly, thus were married at a more advanced age. This allowed women in temperate climates to acquire a far broader range of skills necessary for their independence, both economic and emotional. Given that men in temperate regions drank too much beer, which was to be contrasted to a woman's general sobriety, women gained the upper hand over men in the colder regions of the Earth.

Montesquieu's geographical explanations are notoriously inconsistent. There were all together too many exceptions to the rule, and was criticized for this by Condorcet. Montesquieu was neither a mathematician nor a physicist, and would not have been able to understand Condorcet's sophisticated mathematical reasoning, or much less his social statistics. Incidentally, Jefferson was good friends with Condorcet, knowing calculus to the point that he used it to design a new plough, and did admire Montesquieu's work very much. As a diplomat to France during the early revolution, Jefferson witnessed much of what happening.

The French Revolution as a rule tragically did not adopt the ideas of Montesquieu. Its general desire for "universal solutions" went against the anthropological grain of the *Spirit of the Laws*, which emphasized the geographical particularities of each society. The dislike for Montesquieu's congressional bicameral model likely stemmed from the notion that unicameralism was believed to embody the "general will" of the

people, a term borrowed from Rousseau. Montesquieu interestingly showed the need for a French "House of Lords", arguing that, in spite of its gross imperfections, in a representative government the elites would be voted out of power and wealth, which itself created a countervailing power.

This stance is somewhat contradictory, because in an unpublished tract, Montesquieu tried to establish the ideal form of government by postulating the need for equality of wealth. In this regard, he viewed the concentration of economic power similar to the concentration of political power. For him, inheritance and taxes were the principal tools by which the government should prevent extremes of poverty in society, in particular the potential famine which such sheer destitution implied. There can be no doubt that for Montesquieu, the unequal distribution of wealth was noxious for the wellbeing of the body politic, yet he was not a Marxist calling for a total redistribution of wealth given that he believed there were other ways around this problem.

Scientific experiences did shape Montesquieu's world view. When he inherited a magistrate position from his uncle, he also joined the Bordeaux Academy of Sciences. It was a small and insignificant provincial academy made up of only nine members which produced no important articles or books—with the exception of those by Montesquieu. That being said, the collective scientific academies of France helped create a novel value structure far different from the prior medieval one. The value of a scientific paper would come to depended on the work done by author rather than by his social standing or place of origin. Meritocracy became a common experience throughout the numerous provincial academies of sciences in France. Sadi Carnot, father of thermodynamics, would also later undergo through a similar experience. It is important to emphasize how revolutionary important their role was in creating a social structure based on merit, rather than the traditional ascriptive modes of Europe.

Montesquieu served as director of the Bordeaux Academy of Sciences for more than a decade, which had the positive effect

of exposing him to a much wider range of scientific literature than he would have otherwise seen. As director, he had to write summaries of these for the journal, and in the process became deeply embedded in scientific mentality of the period—in particular its biological and medical aspects. The biological notion of "balance" would be key to his works.[37] Montesquieu also presented a number of scientific papers, even if these were ultimately amateurish pieces. He wrote on intoxication, intermittent fevers, echo, transparency, the weight of bodies, the movement of the sea, and fossils, amongst other topics.

His first substantive work, *Persian Letters* (1721), became a major hit, as it took the original perspective of looking at Europe through foreign (Persian) eyes, and became a success that would forever change his life. Although nominated to the literary National Academy, his candidacy was rejected by the king because Montesquieu had not been a resident of Paris, which led to his consequent relocation to the city. He never joined the *Academie des Sciences* because he was not formally a scientist, although he did interact a great deal with its members, for which he was recognized after his death. He knew the creators of the *Encyclopedie*, as Diderot, whom argued that knowledge alone could make men virtuous. Montesquieu began an article "On Taste" for the *Encyclopedie*, which he never finished. In it, he noted that learning and curiosity were inherent traits to humanity, as opposed to acquired taste. Social signals traveled throughout the fibers of body. His essay was posthumously completed by Diderot, whom also attended his funeral.

Montesquieu had come to live in England for two years, between 1729 and 1731, and it was during this stay that he came to deeply appreciate British society and culture, describing key aspects of the British constitutional system before it was later modified. Montesquieu deeply influenced members of the

[37] At the time, the illness of body was defined as being caused by imbalances in the body. Today this notion might be referred to as homeostasis (Pasteur).

Scottish Enlightenment, whom read him avidly. These included leading thinkers as David Hume and Adam Smith; each of would come to create their own particular social science. Montesquieu was actually made a member of the British Royal Society in 1731, participating actively during these years, certainly far more than could be said for Robert Boyle in his day. Montesquieu, whom read Newton's *Optics*, cited it with some frequency in his early scientific writings, and did praise the Newtonian system in his *Observations on Natural History* (1721)—even though it cannot be said that he read or understood the *Principia.*

We may glimpse a view of Montesquieu's valuation of science in his writing about Aztec society, specifically his "Discourse on the motives that out to encourage us to the Sciences" (1725). In it, he argues that Cortés could have been easily defeated, as one can always create a new technology to counteract another. While the Mesoamericans did not have iron, they did have flint, which was far sharper than the Spanish metal. He noted that the Spaniards at all times expected to be destroyed, and it is amazing to consider that only a small handful of men were able to defeat an empire. For Montesquieu, what the Aztecs lacked was science. Had Descartes been to New Spain a century earlier, Cortés would have been easily defeated; the notion of a mechanical universe would have cured the Mesoamericans of their destructive prejudices—specifically the notion that Cortés and his men were gods.

The *Spirit of Laws* is distinctly anti-Spanish, as it was very critical of Spanish governance. The utter destruction of indigenous people to him was wholly cruel, arbitrary, and unfair because the Mesoamericans did not abide by Spanish customs. Humanity ultimately precedes citizenship, but Spanish actions led to their own demise. Given that the cost of mines was "fixed", the overproduction of metals led to their consequent devaluation. As the Spanish did not pay the abused indigenous miners, no local economy had emerged. The Spanish also did not reinvest in commerce, and thus in the end there was no long lasting

productivity or economic improvement. Contrary to popular belief and similar to the argument Brandeis would make regarding J.P. Morgan corporations, Montesquieu argued that Spain's relation to Spanish America had actually impoverished Spain over the long run, in both a financial and a moral sense. Given that Montesquieu equated Spain with slavery, it is to be noted that he was a distinct abolitionist.

Montesquieu did believe there were many benefits to science. They include giving people the ability to satisfy the inner curiosity all individuals have. It provides methods for building a new world; as the Chinese saying goes, it is better to know how to fish than to be gifted *pescado*. Science also endowed youth with the love of study—the only eternal passion that remains throughout life, and which was another key factor to happiness. The lack of interest in the world more often than not led men to ennui and listlessness, which was ultimately the cause of death. Finally, science was useful. He who mocks the compass, comes to appreciate its usefulness within the immensity of the high seas—as the case of Alonso Ramirez clearly attests. Science allowed men to fully furnish their talents and obtain the benefits of their labors.

The *Spirit of the Laws* was prepared in a span of over twenty years, and was actually completed while Montesquieu had already become blind. It goes without saying that he did not expect to finish the work, as he also went through a number of secretaries who helped him complete what is now a Western classic in political theory.

Chapter 8

Bounded Liberty

There can be no doubt that the Scientific Revolution had a profound impact on political theory of the era, greatly impacting such important thinkers as Hobbes, Locke and Montesquieu. However, the evolutionary character of this revolution, spanning over 150 years, meant that the intersections between natural philosophy, as science was then called, and moral philosophy, today's social science, would occur at different points and have varied sources of influence.

Each of the three thinkers had been influenced in a different manner by the emerging Scientific Revolution: Hobbes by geometry, Locke by biology and medicine, and Montesquieu by optical phenomena. Each were influenced by different key figures—Galileo, Boyle and Newton—as well as by diverse scientific strands respectively: rationalism, empiricism and experimentalism. Each man contributed his little grain of salt to political theory: sovereignty, rebellion and separation of powers.

However, in spite of their enormous intellectual differences and social contexts, all agreed that bounded liberty and reciprocity was an essential ingredient to a viable government and society. As Toynbee, each one of them recognized that since every society is an interconnected web of social relations, the actions men took as individuals directly impacted the quality of these civic relationships as a whole. Man in society did not act alone in the world, but rather imparted his virtue and character onto those around him. Thus all agreed it was necessary that freedoms be relative rather than absolute; constrained rather than uninhibited. Only in the social space was man able manifested himself and discover his true self and social nature, as Aristotle claimed. If citizens destroyed this social

space with misbegotten actions, they severely injured their own chances of success and survival.

While the development of political theory at this time was an extension of the Scientific Revolution, it did not occur in a direct manner as scientific influence is typically defined within the history of science. Its influence rested more in the change of outlook and attitudes towards phenomena rather than any one particular idea or extension of a specific scientific discovery.

It is also noteworthy to observe that all three were men of state; men with practical experience in the real world of daily affairs, social strife, and political conflict. Two of them, Hobbes and Locke, prudently went into exile when their lives appeared to be at risk. Though Montesquieu never took such a trip, his ample experiences as a local magistrate lent the young thinker with much experience about the human condition from which to build upon.

Certainly they all believed that some sort of scientific method could be applied to the study of society. In spite of the limitation of their efforts, they established the theoretical bedrock of the modern state—something which many take for granted, as if it were an inherent state of nature, not fully recognizing the enormous intellectual efforts required for its creation.

The story of sovereignty would proceed along a truer path than that which had been taken previously in world history. The direct influence of quantification would not be felt for various centuries.

Interlude: Murderous Sun

We are not evaluating the validity of the philosophical ideas, as this is not necessarily a book on political theory—even though it obviously treats political notions and actions. We are mainly concerned with the impact of scientific ideas and practices on human affairs in the pragmatist light of John Dewey.

For example, nobody today would seriously argue that human sacrifices are required for the sun to move. It is, without a doubt, an interesting topic to explore how such a notion could have possibly been believed in the first place.[38] Similarly, nobody today uses the term "absolute truths" in their routine parlance. Yet during the eighteenth century the phrase was as common as the term "postmodern" is today—and as natural to seventeenth century Europe as "sacrifice" had been for the ancient Aztecs. Both were scientific notions which structured their respective political worlds.

In the absence of science however, Aztec killings are as valid as British parliamentary debates. Under such a relativistic moral context, all manner of atrocities such as the theft of property or the violation of a women are acceptable. As no philosophical grounds existed as distinguish the validity of one claim from another, the only grounds for social order was force. Force, under such circumstances, is the only final arbiter of conflict resolution—a war against all as Hobbes would say, which by definition, made any prior consensus, contractual or not, null and void given that these could also be wantonly violated by force.

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[38] Knowing something about Aristotelian cosmology will help moderns understand how such a notion could begin to be "logical".

Therefore, one may suggest that only with the emergent precondition of the grounds of consensus, or the rise of modern science, that democracy could exist on some sustainable and enduring fashion. Prior to the Scientific Revolution, democracies were not a generally an accepted political form; while the democracy of Ancient Greece was adulated, it was nonetheless an exception to the historically common rule of autocracy. It is only after the seventeenth century that the political form of democracy begins to take hold and retain validity before the world.

The tragic death of the Afro-American actor Chadwick Boseman, who played T'challa in the *Avenger* movies, reminds us of another tragic fact that we often forget: all men are mortal—even the most wealthy, powerful, and famous. His character's world of Wakanda, however, does raise an important question: to what extent could there exist a hidden technologically and scientifically sophisticated society that was not "expansive" or "colonial"? In spite of the inherent fictional elements of the movie, to what degree does Wakanda represent a realistic suggestion, of an alternate reality? Historical cases are tragically non-existent.

The more realistic historical tendency, shown by Aztec case, is that of expansionism typically stimulated by any philosophy or technology that gives an added advantage to that particular social group over their neighbors. This benefit, plural or singular, will tend to promote geographic expansion, as more resources of all types will thereby be obtained: food, land, materials, or genetic.

In this light, i is striking to consider that the Aztecs were coextensive with men of the Renaissance as Copernicus, Da Vinci or Erasmus, living in the same time period of the sixteenth century although obviously in a very different mental and cultural world.

There can be no doubt that Aztec rule was based on force and lacked any social legitimacy, leading it to crumble like a house of cards upon the arrival of Cortés. Countless tribes opposed the typical sacrifices of family members, so brutal in character and nature as well depicted by Conrad and Demarest.

Before attacking the consequences of Columbus's new world discovery and conquest, we should not overlook the sheer brutality of early indigenous civilizations—a brutality grounded in their their "science" or natural philosophy and which functionally allowed for conflict resolution.

The Aztec, as early Europeans, had no notion of inertia, which today we take for granted: an object will continue on its path unless acted on by another object or force. However, as is commonly observed in every day life, on Earth all movement requires force of some kind things for its displacement. Upon this simple idea, there emerged an ideology of empire which fed in on itself: human sacrifice allowed the world to keep turning night to day, day to night. [39] Again, this notion shocks us as it can be easily rejected, given its falsity, but its consequences were no less politically significant.

Can we consider the Aztec case a valid data sample for the relationship between "science and democracy" and, in this sense, a warning of the potentially devastating ideological role of science?

Certainly, Aztec natural philosophy was not a science, formally speaking. Though it contained a certain amount of mathematics—its determination of Venus is as accurate as today's determination—Aztec astronomy lacked experimentalism and mechanism. It was impressive in its own right, given the limitation of its technological capability, and did embody ideas of the universe and the cosmos, of how it was ruled and operated. In spite of its non scientific character, the Aztec case is important by widening our field of view. The more cases that are brought into consideration, the more valid our conclusions will be.

We might question the exact manner in which natural philosophy interacted with politics. Was this relation ideological in character only, as in the justification of conqueror, or did the two have an ontological association as well, as a definition of

[39] For a fuller discussion of Aztec natural philosophy, see Fernós, *En Busca del Fénix*.

reality? For example, because the Aztec world was defined in a particular fashion, it had secondary political consequences: the incessant expansion throughout the region which today we call Mexico. To what degree could we say that the ambitions of power were unconsciously hidden in a Freudian-like manner within the content of science or in the creation of its notions of natural philosophy?

One should point out, as Conrad and Demarest do, their similarity to the case of the Incas in that natural philosophy had a political impact upon formation of empire. Inca ideas of life and death, as the Aztec notions of astronomy, led to the conquest of the surrounding social groups. Within each reigning family, their ancestral king was treated as if he were alive, carrying his bones to every public meeting where they were consulted for advice on specific problems and issues. Family corporations thus were formed, whose incentives consisted in the retention of taxes of the lands conquered by their ancestors—a tax which could not be used by the new state leader for its administration. Each new emperor had to conquer new lands, so as to obtain the requisite sources of revenue for his own rule of the state.[40]

Their cases might be compared to the ideology of civilization so prominently found in the British empire. In contrast to the two prior cases, there is no ontological redefinition of the world within British imperial ideology. In other words, no pretense is made to ideologically justify a colonial empire out of the nature of the world in the same sense as the Aztec. While it can be noted that biological distinctions were used to establish social boundaries and hierarchies, these did not serve as the purposes of empire per se. Just the opposite was true: empire was used to validate scientific ideas as those of eugenics.

There was no pretense made by the British that the nature of the world directly impinged on the nature of political forms as

[40] However, in both cases, the wider the expansion, the more costly it became to maintain the state; its cost-benefit ratio negatively tilted over the years away from an expansive empire towards a more decentralized association.

the Aztecs had, except with regard to racism. The civilizing justification was mainly a cultural one with social implications, but it was not based upon an ontological understanding of the natural world and cosmos. As Pomeranz noted, it was one where the British played the role of trustee until the conquered countries acquired science and civilization. In this sense the underlying ideology made it a temporary proposition at best, although Gandhi showed it did not come soon enough.

Given the enormous amount of time required for such a profound cultural change, there can be no doubt that it would last across multiple generations of British civil servants.

Part 4

The Impact of Science on Political Action

Chapter 9

Franklin

The depiction of Benjamin Franklin often given is a myth due in part to the fact that most historians who wrote about Franklin were not historians of science, and thus could not fully understand or appreciate his scientific significance. The typical image presented is that of a politician who dabbled in electricity, known for his invention of the lightning rod which saved many a colonial structure, but which was nothing but a passing fancy of his. Franklin's main recognition is that as one of the Founding Fathers of the United States, of a politician who also happened to be an amateur scientist. He sat in the committee which prepared the Declaration of Independence, and in fact it had been Franklin who proposed Jefferson for the task, recognizing Jefferson's extraordinary literary ability which Franklin also shared. With the emerging conflicts with Britain, Franklin guided the new nation by advising numerous committees, such as those for war preparation, the manufacture of saltpeter (gunpowder), and the creation of its first coinage, the Fusion cent with thirteen Olympic-like interlinked rings symbolizing the thirteen colonies bound together.

Yet Franklin really did not play that significant a role in the convention. In fact, substantive portions of his life had been spent abroad in France and England. In contrast to the younger generation of leaders, Franklin held many outdated ideas such as a unicameral congress or the notion of multiple unpaid executives. Being the oldest signatory of the Constitutional Convention at the age of 82 years, he made every effort to walk every day; his weakened state meant that he could only give the briefest of speeches, most of which were read out loud by others. He did provide some of the most memorable anecdotes of the convention, helping to establish the U.S. on a solid basis. While

many were concerned about the possibilities of errors in the constitution, the wise old man noted that, in the end, it did not matter. Any errors committed by the Founding Fathers could be modified by future generations with their ability to amend the document. The U.S. Constitution represented an endless experiment in democracy.[41]

Franklin's principal role during the Revolution had been that of obtaining France's support. His stay in 1778 was of critical importance for the U.S. cause. All throughout 1777, American revolutionaries had been loosing military confrontations with British forces. There can be no doubt that without French aid, the American rebellion would have been defeated. In order to understand Franklin's success, however, we must first understand his science.

Franklin was the world's leading scientific hero of the era, to the point that the mid eighteenth century was known as the "Age of Franklin" and it would not be too far to suggest that he could be regarded as an eighteenth century Einstein. As the latter, Franklin was seen as a sage of sorts, continually consulted on every single matter there could be. John Adams complained that such was the demand for his attention, they were continually interrupted in their diplomatic mission. It is perhaps hard to fathom how extremely famous Franklin was while in Paris; readily recognized on the streets, Franklin was continually hounded by strangers as images of his face had appeared in countless newspapers, busts, and paintings.

Franklin was not ignorant of his fame, noting that his face was more well known than that the face of the moon. He was more popular than even Leibniz or Newton, both founders of

[41] Franklin did certainly help guarantee the success of constitution, with his enormous wit and humor which he had often used throughout his life for political ends. "Better to hang together than separately," if they were not united. That the constitution was unanimously signed is a testament to such joyful wit in such a stressful moment. Ironically, the document had been approved by all signatories in a unicameral session.

calculus. French ladies had their hair prepared in a style known as the "coiffure style" which resembled Franklin's fur hat. Such was the public demand, that he was forced to move residence to a nearby suburb at Passy, at the outskirts of Paris so that the diplomatic mission would not be so hounded.

Franklin's fame, however, is in and of itself an indication of the horrific economic and social conditions that existed in France at the time, which would eventually explode into the French Revolution. While at Passy, he still received all sorts of solicitations. Soldiers sought out officer positions in the Continental Army; yet the enormous diversity of their military quality led Washington to issue a "cease and desist" order. Franklin for his part prepared a preprinted humorous automatic referral: please refer to person holding this letter for a character reference, as he is more intimately aquainted with the candidate. A man who requested 15 franks, abandoned his wife upon receiving the money; when the wife then complained to Franklin, she received 1 frank, but kept pestering him for months on end. Franklin, in Puerto Rican lingo, was a "*pan de agua"*—a softie good guy who found it hard to say no. Again, one must remember that these persistent requests were but an indication of the horrific state of France in at the time, clouds suggestive that a powerful storm loomed ahead.

Franklin was so popular that he even made King Louis XVI jealous. The latter had Franklin's image placed on the interior bottom of a chamber pot so that his mistress, a Franklin admirer, could better appreciate the North American thinker.

Franklin interacted mainly with intellectual circles rather than those of the French court. Franklin was so deeply integrated into the scientific epoch of his time that he helped shape that epoch. Denis Diderot told Catherine the Great of Russia, that Franklin's *Experiments and Observations on Electricity* (1753) should be required reading of all students in the land. Franklin had been prized by the Bordeaux Academy of Sciences, the same one to which Montesquieu belonged. The book went through 10 editions in more 5 languages, two centuries before the most popular scientific work of all, Darwin's *Origin of Species* (1859),

had been published.[42] Humphrey Davy recommended Franklin's book as an exemplary model of the experimental method.[43]

Franklin knew and interacted with the leading scientists of the period, and was on a first name basis with stellar figures of the history of science.[44] These included Stephen Hales, whom wrote a latter to Franklin stating that his experimental theories had been verified in England.[45] Franklin had regular correspondence with Sir Joseph Banks, whom served as president of Royal Society for forty years. The prior president to Banks had been discharged for disagreeing with King George III on the specific shape required for lightning rods. While the king wanted a spherical end, Franklin's experiments demonstrated that a pointed end was far more effective at drawing out electricity. The former president of the Royal Society, Joseph Pringle, told the king that nothing he said could violate the law of nature; the lightning rod came to be used for purposes other than those it had been intended: as an indicator of political alliances.

Franklin was also good friends with Condorcet and Turgot, and even with the Comte de Buffon—one of the most important scientists of the eighteenth century. He had been elected as member to both the Royal Society and the French Academy of Sciences, an achievement whose merit cannot be emphasized enough given the exclusiveness of these institutions. The French academy only had eight foreign correspondents, out of thousands potential candidates.

Yet Franklin moved with ease between both groups, the court and the savants. Adams said that Franklin was eminently suited for the diplomatic mission as he was the only American who knew the interior workings of France. By humorous

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[42] It would not be translated in Spain until 1992.*

[43]David would use electricity to discovery new chemical elements potassium, magnesium, calcium, barium, chlorine in what is known as electrochemistry.

[44]A reader with any familiarity with the history of science, will quickly recognize their names.

[45] Hales was one of earliest Newtonians in England.

contrast, Adams was quite the opposite in temperament and social tact, insisting on issuing the French an ultimatum in light of the collapsing military situation of the U.S.. Franklin, however, was well aware they were not in a position to do so.[46]

This scientific familiarity and prominence was a double edged sword, however. Franklin so felt himself to be a thoroughly English scientist, that at first he did not necessarily support the American cause. He initially had mixed feelings about the revolution, and his initial arguments for sovereignty presented a similar position to that of Baldorioty's: a federalist view seeking from England the recognition of American legislature or the right of North Americans to enact their own laws and statues. England for more than 150 years had not held any substantive reign over the North American colonies, but now, with the ascendancy of power by the House of Lords, it was increasingly encroaching into U.S. affairs. This encroachment was partly due to the Seven Years War, a conflict between England and France, won by England, but which was seen as mainly benefiting America. It was one of reasons for increase in taxes, which in turn spurred the U.S. revolution. An increase in taxes would become a key factor to both the U.S. and the French revolutions.

Franklin originally believed that if he could only get Britain to recognize American claims, this would be happy medium. In fact, he spent some twenty years unsuccessfully trying to get the British to listen to American concerns. After wasting countless years in futile efforts, when British spymaster Paul Wentworth tried offer a peace treaty, Franklin flatly rejected it. While in the past the offer would have been readily accepted, the turn of events had shifted the tide decisively. In this context, Franklin referred to the British empire as a Chinese vase, so fragile that once broken, could not be put back together again.

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[46] Adams was so aggressive in his requests of French authorities, that he was specifically forbidden from negotiating by the very King of France himself, Louis XVI.

While we will touch on the reasons for Franklin's change of heart, there is no doubt that the emotive effects of science was a double edged sword with regard to sovereignty; it had drawn Franklin a bit too closely to the metropolis. Science is after all a communal enterprise, particularly so experimental science, and at one point seemed to pull Franklin away from calls for American sovereignty. His son William, was in fact a Tory loyalist, whom had served as royal governor of New Jersey, for which he was imprisoned during the revolution. Franklin's unwillingness to speak for his son led to their falling out, which in turn caused Franklin to write his *Autobiography* in a similar manner to Tapia's own a posthumous testament to his son.

To truly understand Franklin's political role, we thus first have to understand his science, as it is upon the basis of that science from which his popularity stemmed and which was successfully used by Franklin for political ends during the North American revolution.

Franklin, in simple terms, was one of the first Newtonians who extended Newton's ideas into other fields of inquiry. In a line of carefully crafted experiments, Franklin showed the similarity between natural events and laboratory ones, thus epitomizing a key belief of the Enlightenment: that through science, reason would conquer ignorant superstitions. Specifically, Franklin conclusively demonstrated that electricity and magnetism were a key force throughout the entire universe; all bodies have some sort of electricity which he called an "electric fluid". He showed that the creation of electricity was not the generation of something new, but rather a differential in charge between the two bodies. As nature wanted to always remain in balance, the equalization of this differential is in effect what caused electricity.

Franklin provided the world with the key terms commonly used today in electrical science. These included the term "battery," the notion of negative and positive charge, and the idea that batteries could be arranged in series to produce an increasingly powerful charge, amongst others. Franklin in fact once electrocuted himself. He noted that his senses stopped

working immediately, being able to neither hear or smell; its impact was both "within and without", inside and outside of the body. Franklin was a Newtonian.

Newton's *Optics*, in contrast to his *Principia*, was a work readily available to the general public. In contrast to the magnum opus, *Optics* had been published in English, and contained readable descriptions of experiments which proved propositions humbly and clearly stated. Scholars as Shapiro have shown that Newton perceived his *Optics* to be a failed treatise given that he had been unable to establish a mathematical theory for optical phenomena similar to that which he established for gravity. There is distinction to be made between experimental and mathematical proof, the latter referring to strict proof, as in geometry, versus that found in the *Optics*. In it Newton established a series of "queries" which he had been unable to definitively prove, thus referring to these as hypotheses. There was enough experimental evidence to suggest their validity without conclusively doing so.

It is particularly noteworthy to point out how much humility was shown by one of the most important members of the Scientific Revolution throughout his work. The use of the term *hypothesis non fingo*, "I do not know, therefore will not guess", presented the most reasonable supposition using the available evidence at hand. Hence the term "queries" for Newton alluded to unproven statements, an attitude that was diametrically opposite to that of the scholastics, whom had been characterized by Francis Bacon as spiders who spun conceptual webs out of thin air, which ended in nothing. Their many treatises contained mindless speculation without any sort of attempts at their verification or validation.

Newton argues for the existence of the aether, a medium composed of particles that attracted and repelled one another. These particles served as the key basis for Franklin in his experimental work. Franklin argued that all bodies have an electrical fluid which was made up of particles which were so subtle and small, that they were invisible to the naked eye and could easily pass through physical matter. There was the mutual

coexistence of two kinds of particles, electrical and physical, and Franklin showed that they had distinctive properties. While electrical corpuscles repelled each other, they were attracted to material corpuscles—the combination of which accounted for their fluid behavior and their particular traits.

In a series of experiments, Franklin showed how these corpuscles behaved as they did. For example, he tested different bodies, discovering that the more blunt a body, the less likely it was to "throw off or draw" electricity from another body. He experimented with spheres and squares, observing that the edges and corners of squares tended to easily draw out electricity, generalizing these observations to conclude that the more acute an angle the better an object was at giving and receiving electricity.[47] He soon realized that just as a pointed iron rod will draw electricity in a laboratory, it will equally draw electricity away from a charged area of clouds in the sky. Franklin was so certain of his claim, that he quickly published a tract arguing for use of lightning rods to protect building structures as churches, and houses, without further experimentatal evidence. He even put one in his home, which was tied to a bell; every time an electrified cloud passed above, a bell would ring—whose constant ringing caused a fair amount of consternation to his wife.[48]

Franklin's electrical work shows how culturally radical his scientific conclusions had been. Certain phenomena in nature had been too mysterious to become subject of human understanding, lightning being a principal example. Lightning was like magic: mysterious and unfathomable. As a result, all

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[47] This explains why claims in natural philosophy as those by Louis XVI were so grossly incorrect.

[48] The ratio of ground strike in lighting is inversely proportional to climate. Temperate region have 9 / 10 lightning hits to the ground, while in tropical regions, 1/10 of all flashes do so. The reason for this is that hot climate clouds are more distant from ground, thus producing a far higher rate of side strikes between clouds.

sorts of religious significance was tied to it, then seen as a source of God's power and wrath, as a punishment for sinning. It was incorrectly believed that the ringing of churches bells would ward off lightning, but in fact it did just the opposite; during storms, church bell ringers were often killed by lightning, passing down from the spire to the wet chord directly into the hands of the ringers. More than twenty years after Franklin published his tract, there were still too many Americans who had not yet installed a lightning rod on their homes, one of the leading causes of destruction and death in temperate regions. It was even publicly argued that if anybody tried to stop lightning, it would worsen God's wrath, causing a worst event, as an earthquake, than the initial strike.

There was thus a real ideological battle over the meaning and significance of lightning, a dispute which was ultimately won by Franklin. It is perhaps interesting to note that Franklin hated to debate, preferring instead to let the sparkling results speak for themselves. Such culturally radical implications of Franklin's science served as the basis for his international fame. Franklin's able form of expression, as well as the enormous humility and deference with which he treated persons won him the respect and admiration of all—including King Louis XVI. Upon signing the treaty, the king privately met Franklin at a church to let him know of the enormous respect he had for the American scientist, an attitude quite different to his vituperative and offensive original reaction.

Franklin's diplomatic tenure in France between 1777 and 1778 shows how enormously varied the impact of science could be for sovereignty. Like Franklin's electrical fluid, science had both a positive and a negative side, and its impact could not be predicted beforehand. There is no doubt that Franklin used his enormous popularity in France to win over the French people to the American cause and, ultimately, King Louis XVI. Franklin had embarked on an ambitious program of political propaganda.

The character of Franklin's political writings is very different from that of prior political theorists discussed so far.

Franklin was not a political theorist as Thomas Jefferson or even John Adams, both of whom regularly used science in their writings for points of argumentation. Most of Franklin's writings were usually of a practical nature. He tended to write for specific ends and purposes, to solve a specific problems.

While the use of scientific allegories might have been frowned upon by him, the polyp became an important symbol.[49] Franklin used the metaphor to initially argue for a federated political relationship. Britain would be better off with individual parts that would regrow throughout world, thereby creating new markets for its manufactures. At one point Franklin wrote in favor of the annexation of Canada over that of Guadeloupe after the Seven Years War. Nearly inventing the field of demography, Franklin noted that agricultural lands created room for improvement, allaying British fears that the Canadians would steal engineers and thereby impact imperial manufactures. Franklin noted that large countries tended to agriculture; it was only in the context of the poverty of small states with few other means of subsistence that manufactures tended to flourish. Manufacturing, in other words, usually formed only in small regions with high populating densities.[50]

His American diplomatic mission in France was extremely important—as well as extremely dangerous. A Philadelphia woman who lived in France for some time warned Franklin that he was continually surrounded by spies. One of his diplomatic American colleagues, Arthur Lee, was so weary of the

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[49] The polyp was discovered during the century, and its properties always drew the awe from its audience. All pieces of the polyp that were cut, would regrow into their own body. If turned inside out, it would also regrow unlike any other living creature. Its miraculous powers of regeneration surprised everyone who came to witness them.

[50] Franklin's arguments on population were noted by Robert Malthus, who would greatly influence Charles Darwin and Alfred Russell Wallace, and suggestive of much broader impact in the creation of modern biology.

many spies surrounding them, that at one point he even suspected of Franklin himself of being one, likely due of his deep affiliation with European scientists. Franklin responded to these concerns that he simply did not care, as he would not do anything to give food for fodder of an ill reputation. He always behaved in ethical manner, never ashamed or fearful of how his actions might be publicly misrepresented. This was a key principle of his moral philosophy.

But the situation was in fact far worse than he imagined. There was a centrally positioned spy that almost jeopardized the mission at its very start: Edward Bancroft, whose role was not revealed for more than two hundred years after the fact. Bancroft had been a spy for Britain. Though accused by Lee as being spy, Lee's increasing paranoia led him to begin doubting everyone, and so lost his credibility. Archives have revealed that Bancroft was paid as much money for spying as for his professional diplomatic work, 1,000£ each, totaling some 2,000£, quite a lot for the era. Worst still, Bancroft was also using insider information to gain substantial advantages in the stock market.

Bancroft's treason was quite problematic, given that he played a key role as Secretary to the mission. Bancroft had been well trusted by Franklin due to his prior scientific achievements. Bancroft had previously served as a scientist for a sugar plantation in Guiana, discovering how to produce a new textile dye from a local tree, for which he was elected to the Royal Society with Franklin's support.

Bancroft's case, however, shows the limitations of spying. In spite of having the most intimate access, Bancroft was unable to turn the tide of American-French relations—though he was close. When word of the initial negotiations with France were leaked out, likely by Bancroft, the French became furious and briefly suspended negotiations, warning the Franklin delegation they needed to be more careful.

Without a doubt, it was a dangerous game for all parties involved. Yet, while Arthur Lee began panicking, Franklin kept

his composure; the mission was too important to fail.[51] Franklin in fact was well aware of all the spying that was going on, and actually used it to his own benefit. He made sure that both French and British spies transferred information he wanted their employers to know, and was not as naïve as he might have been supposed.

While he was often seen as a rural Quaker farm boy, Franklin was far from it, being mainly an urban scientist and innovator who was rarely in the countryside. However, he did used this image for own ends. His use of our now recognizable "Davy Boone hat" suggested that Franklin represented the frontier wilderness, or a version of Rousseau's virtuous noble savage—another propagandistic factor adeptly used for state ends.

France had initially backed down and were well aware of their precarious finances—but still wanted to humiliate Britain for its own defeat in the Seven Years War. Minster of Finance Turgot, a physiocrat and friend of Franklin, had been one of his promoters, stating that Franklin had "snatched lightning from the sky and the scepter from tyrants.", a rather emblematic phrase routinely attached to Franklin's portraits. In spite of their friendship, however, Turgot was well aware that France had little if any money to lend the American revolution. France's representatives were weary of getting into another entanglement, particularly the case should the U.S. come to lose the war. That in 1777 the British colonies were being soundly defeated did not make for a good case. Franklin's own home in Philadelphia had been occupied, which led to the theft of all his equipment and apparatus, including books, paintings—a loss which represented a huge personal blow to him.

However, in 1778 there was a military turn around. The Battle of Saratoga was won by colonial forces, having the effect of isolating British General Howe in Philadelphia—a fact

[51] In this regard, one might suggest that Benjamin Franklin became the basis of James Bond

Franklin made sure became well known throughout France, and which ultimately turned France's attitude around towards a much more supportive stance. The victory made it clear that the American colonies would be a strong partner; with French help, the revolution would likely be a success. The situation back in America, however, was still unclear and the colonial government was by then considering declaring a peace treaty by acceding to British demands.

A meeting was quickly arranged by Vergness, the King's military advisor, and in the record time of a few days, a trade and military pact was signed between the two states, the terms of which were very favorable to the American revolution, lending military assistance and financial support. Key French military engineers were sent, whom served to establish the basis of what came to be known as West Point. While ten percent of French income was ceded to the U.S., a non-exclusive trade pact was also established allowing the new nation to freely trade with all other nations. The French alliance was an unexpected life saver of North American sovereignty.[52]

Why did Franklin switch sides? Representing Philadelphia in Britain, and later the other colonies during a period of twenty years, between 1757 and 1775, Franklin was able to prove that the Penn family also had to pay taxes, and inversely, that they were not exempt from this responsibility due to their status.

At one point, Franklin was brought before the House of Lords, known as the "cockpit" or "*la gallera*" in Spanish, for questioning as a result of the rebellious Stamp Acts. The House of Lords was seeking to reestablish its authority, and did not have impending financial obligations. The British colony's riots, however, were actually destroying royal property. Franklin, by

[52]While the fairness and generosity of the French are to be commended, this pact would tragically become one of the causes of the French Revolution, throwing the French monarchy into a death spiral and producing one of the most chaotic and delay periods of world history.

then an older man in his late 70s, was forced to stand for hours on end during this meeting with politicians who wrongly believed that political power established philosophical truths—as the British King whom pretending to rule lightning. The experience was a rather humiliating incident, and Franklin was grilled about all sorts of details. It is to be noted that the when the treaty of alliance was signed with France, Franklin used the very same suit, unequivocally sending a message to Britain and to the historical record.

That being mentioned, it appears that the most important factor in Franklin's change of attitude was his study of Ireland—which for all sakes and purposes was but an internal colony ruled by England at home.

Franklin decides to visit this home colony and was utterly appalled by what he saw. The Irish were living in deplorable conditions: shoeless, shirtless, in mud huts, and treated little better than animals. The poorest American farmer was richer than the richest Irishman. Franklin observed that Britain treated other colonies similarly, as in India where the locals were condescendingly besmirched.

The lowly status of the Irish was the direct byproduct of their colonial relationship to England. All Irish laws required the King's consent, in that no laws could be passed without his prior approval. The British Privy Council could invalidate any prior laws and even reject any new amendments or modifications to the law that had originated in the Irish government. The Navigation Acts of 1663 prohibited the transport of goods to and from Ireland using non-British ships; all exchanges similarly had to occur within British ports. Finally, the Wool Act of 1699 prohibited the export of wool outside of England, thus giving her a monopoly and preferential access to Ireland's key source of wealth and income. It is no wonder that the Irish lived no better than dogs, and why Franklin began to have serious reservations about continuing such a relationship.

Franklin developed a new theory of sovereignty, curiously based on experiences with indigenous tribes who showed precedent with regard to sovereignty. The colonial option of a

federation had been partly modeled on that of the Iroquois Confederation. In the latter, each tribe retained their own identity, while collaborating in the larger group. Those who had purchased land from the Native Americans were able to establish a new social order, using a new set of laws, parliamentary decisions which could greatly differ from that which previously existed. In a similar fashion, Franklin argued that the establishment of colonies by the British in America represented unique and autonomous societies, which Britain needed to recognize.

Franklin's argument, however was ironically seen as too radical at the time, and was actually not included in negotiations with the British. England at the last minute tried to back track, offering pardons and bribes to all of those who helped restore the previous status quo. Again, the British gestures came too late; as Franklin noted, a broken China vase was impossible to put back together. Some might have contemplated the offers made by England, but the general hatred and animus towards England had grown to such a degree that it had become impossible to turn back the tide of popular opinion.

In spite of being a non-theorist, Franklin held many insightful views about morality, specifically with regard to problems concerning morality and human behavior in a democracy. Just as the prior thinkers we have touched on before, Hobbes, Locke and Montesquieu, the notion of virtue was a principal point of concern for Franklin, or what some have referred to as bounded liberty.

Franklin curiously had a particularly "scientific" view about the issue. He recognized that the science of morality had not yet emerged, which prevented men from being wolves to one another, devouring each other, nor preventing nations from striking at each other's throats. Franklin did believe that a science of morality could eventually emerge which would help to establish more democratic societies. In the meanwhile, however, he did all he could to advance the topic, as he had with electricity; he would guide others to their wellbeing through his own example.

In 1732 Franklin was going to write the *Art of Virtue*, recognizing a common problem. Many individuals, particularly the poor, wanted to be virtuous but simply lacked the knowledge to do so. In spite of the many writings on virtue, there were few "how to" books on the topic, commonly found the 1990s book market. That same year he began publishing *Poor Richard's Almanack,* which incorporated many of his original goals. It provided not only important information concerning weather and meteorological events, but also included a number of aphorisms on good behavior. We might refer to his approach as a "mechanical view of behavior". Franklin's almanac used simple phrases that would hopefully remind individuals to act virtuously and more easily improve the quality of their conduct. It was geared towards those who could not understand moral philosophy, or lacked the time to study it.

Franklin was well aware that simply telling an individual to be good did not necessarily make it so. From personal experience, he was well aware of its difficulties. When he was younger, he dedicated himself to live up to four virtues. However, he noticed that when he tried to abide by one, he would often forget another and fail on this account. When he later increased the list to thirteen virtues, he began marking entries in a journal book, with a table for each virtue. He would work on single virtue per week, to improve his behavior, and move on to the next virtue the following week. He soon ran out of booklets, and began using a chalkboard.

The experience made him realize that actually being virtuous was a difficult task. However, it also taught him that if he could improve his own conduct through constant and persistent effort, others could do so as well. It goes without saying that the process was much easier if one's original moral base of good habits were established as children rather than having to mend one's vices once they were already established as adults. It was a lesson that was also true for medicine, as it as it

is far easier to prevent illnesses through good eating and exercise than to regain health once it has been lost.[53]

More importantly, he realized that we tend to be slavish to custom without actually critically analyzing these beliefs. All cultural beliefs, Franklin held, should be studied and analyzed so as to asses their validity. In other words, we should not be blind to the winds of fashion or uncritically accept the judgment of religion or of one's own neighbors without subjecting these to a type of Lockean analysis. Various stories written in *Poor Richard Almanac* reflect these themes.

One such story is that of Polly Baker, a woman with five bastard sons who was regularly fined by the state for their illegitimate condition. In her defense, she, or rather Franklin, wrote that she had raised the kids on her own, never taking money from the state. In fact, the fines imposed worsened the wellbeing of the children as they took away the little available money she had, and thus the state's actions were actually counterproductive in light of their intended purpose. She (Franklin) explained that she had been an innocent victim. Her husband left her upon becoming a magistrate.[54] Never once had the children's father assisted her financially. She (Franklin) noted that if it was true that she would burn in hell for eternity due to her sins, then it made no sense to punish her in life. If God was going to punish her for eternity, why suffer doubly?

The story clearly revealed that the actions of the state were in fact unjust, cruel, and inhumane. Franklin's key point repeated throughout his stories is that we have many unquestioned innapropriate beliefs; through a critical analysis of these beliefs we would be able to arrive at more reasonable expectations of ourselves and others.

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[53] The typical portrait of Franklin is that of a gainly man, fat and easygoing. In fact, as a young man he had been considerably athletic and strong, being able to could carry two printing presses, one on each hand, where most men needed both hands to carry a singe one.

[54] Franklin detested lawyers.

Franklin in this sense appears to have imitated Voltaire, whom he once met at a celebrated event of the *Academie des Sciences*. Both, at the time seen as the grandfathers of the Enlightenment, embraced to the jubilation of all participants. Voltaire had written similar lessons in *Candide*, a 1753 story of the many sufferings of its fictional characters. All over the world, there were injustices. There was no heaven except that which we made for ourselves; only by tending our own gardens instead of the rest of the world would we find true happiness.

Franklin's *Autobiography* is similarly an example of this notion. It is the portrayal of a man who tended his own garden, and was all the better for it. Franklin's moral view is thus quite distinct. Through his aphorisms in *Poor Richard's Almanack* or in the guidance provided in his *Autobiography*, he hoped to provide reliable information to individuals so that they could become better persons, and exemplars of what has been termed bounded liberty that is so critical for a functional democracy. Franklin's aim was to help his neighbors through his own example and works, rather than to serve as a hypocritical judge who stood outside the world he condemned.

It is also a key to understanding why the view of Franklin as a politician who merely dabbled in electricity is an incorrect image of the man. Franklin in fact had worked over a decade on electricity, being allowed to do so because of his retirement at the age of 42 as a successful businessman earning 2,000£ per year when a normal year's salary might amount to 15£. He sought to dedicate his life to science, even when his magnum opus, published in 1753 by friend Peter Collinson of the British Royal Society, had been the compilations of Franklin's own letters.

Franklin the scientist saw himself forced to enter the political fray of the times given the needs of his community. When asked why he abandoned such important work as electricity, Franklin offered a hypothetical situtation involving Newton. If Newton had been in charge of a ship about to strike a cliff, the unquestionable importance of his physics would not have been grounds enough to deter him from the needs of his immediate responsibilities.

Chapter 10

Jefferson

There are various ways in which science impacted the politics of Jefferson. The first is what we might refer to as a positive or productive aspect: the attempt to introduce structural changes in government so as to establish rationality into as many of its processes as possible. An example would be the creation of sound, logical, and orderly procedures of Congress. Whom obtained the chance to speak? Previously, the most popular congressmen held a near tyranny over the podium, whereby the strongest were strengthened at the expense of the less popular speakers. Jefferson, by contrast, made sure all parliamentarians would be given a chance to speak regardless of their status. There were many other structural elements introduced by him, amply discussed by Cohen.[55]

The second manner in which science impacted Jeffersonian politics might be referred to as the negative or unproductive aspect, which principally regards the use of science for propaganda. Scientific conclusions, as those by the renown Buffon, greatly impacted the status of the new nation, affecting its international perception with all manner of political, cultural, and economic repercussions. Buffon's theory of degeneration was perhaps the most significant. Briefly stated, he argued that New World was inferior. Its animals tended to be smaller, weaker, and less robust than European variants. Native American Indians were also lesser men: sterile, hairless, and less virile. In a similar fashion, Europeans who moved to the Americas also

[55] It goes without saying that small but subtle changes are often the source of happiness, using the law to give men their due rather than to contravene their dignity.

acquired these traits; they degenerated in the new American context.

The implications of this theory were enormous, particularly so in light of the international stature and acclaim of Buffon. For decades, he had served as director of the Royal Garden in France, the *Jardin du Roi*, and had written a monumental *Histoire Naturelle* of 36 volumes where he attempted to order all of nature. Buffon was the most important natural historian of pre Revolutionary France, and his enormous scientific status lent his theory a powerful weight and influence. The role of his theory might fall under category of "soft" power in the realm of international politics as characterized by Nye.[56]

Buffon and others refused to change their minds. Raynal in a dinner at Franklin's house in Passy repeated the claim: Europeans were bigger and stronger, Americans were smaller, weaker. Franklin then asked all the Frenchmen at the table to stand up, followed by the American delegates. In effect, there was a rather visible size gap between the two, the American delegates being substantially taller than their French counterparts. Buffon himself was a rather small man, measuring only 5"3" in height, a small stature even by the standards of the era. Raynal refused to accede before the factual refutation, arguing that Franklin did not have enough points of data. Although a valid response, the glaring disparity should have immediately placed the claim into doubt.

In meetings with Jefferson, Buffon also reacted in the same manner, failing to recognize the implications of the basic facts before him. Jefferson presented the coat of an enormous cougar, as well as the exemplar of a giant moose more than ten feet tall. It had been such a huge specimen, that simply taking it to Europe was an enormously costly ordeal; the carcass had to be twice lugged around as the first specimen was not preserved on route. Buffon still would not change mind.

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[56]"Hard power" would refer to coercive military power, weaponry ad so forth.

So great were the geopolitical implications of Buffon's degeneration theory to the U.S. that fierce political enemies collaborated to defeat this negative image of America. While the newly formed United States had treaties with various European nations, many still needed to be ratified. The Russians had already pulled away from negotiations given the implications of Buffon's theory of degeneration, and it was feared that other important powers as Denmark might do the same. The theory took a life of its own. It was believed by Voltaire, which greatly surprised Franklin during their renown meeting; Kant had been similarly influenced by it. Bitter ideological rivals as Alexander Hamilton and Thomas Jefferson joined efforts to refute Buffon's negative propaganda.[57]

Hamilton was well aware of its implications. There were shifting perspectives on the understanding of money at the time, due in part to the work of Scottish philosopher Adam Smith.[58] The creation of credit was of enormous importance to a new nation emerging from war as the U.S., whom had no ample gold reserves to back up its currency—then seen a critical

[57] Jefferson, a plantation owner in Monticello Virginia, believed that the U.S. should be a nation of small farmers and an agricultural society, seeing the farmer as truly virtuous. It is curious to point out that John Adams was actually more of a farmer than Jefferson. Hamilton, for his part, represented an industrial view of the U.S.. Born in the Caribbean island of St. Croix, he associated with the elite and banking sector and sought to defend their interests in government—far different from his theatrical depiction by Lin Manuel Miranda.

[58] Though seen negatively by John Locke, in that money increased inequality, destroyed that necessary democratic ingredient of equality between men given that allowed accumulation. By contrast, in a barter economy, the obtainment of too much "property" had upper limits, as too much would spoil. Smith refuted many widely held misconception as the medieval notion of "just price", putting for what today we would refer to as supply-demand dynamics.

requirement. In effect, the new American nation had little access to capital, thus the perception of integrity had a direct repercussion on its ability to grow and develop; reputation was thus an invaluable resource for economic development.

It is perhaps easier to understand Hamilton's concern by looking at a specific example. The selling of government bonds allows the state to create money from thin air. Banknotes typically increased in value by an order of thirty, with valued notes fetching even higher gainings. Imagine getting $30,000 from only $1,000 or $30 million from $1 million. Buffon's notions would have stopped this process in its tracks. Many Founding Fathers personally recognized the enormous impact of one's reputation on one's financial well being.[59] Similarly, a bad reputation for America would have had tremendous financial consequences. Few creditors would lend money; few would purchase banknotes, and the new nation would be crippled at its very formation. After so much sacrifice, the last thing they wanted was to unnecessarily place its future in jeopardy, producing a failed experiment. Jefferson and Hamilton would both persistently fight this propaganda.

If Franklin had been the child of poverty, Jefferson was the product of affluence. His father had been a surveyor who bought land next to a river which served as a natural highway; canals and river systems in early America served as critical

[59] It is curious to mention that Franklin placed a great deal of emphasis on his image and perceived public persona, to the point of leaving a candle lit late into night so as to give the impression that he had been working late into the night. He also had he tendency to carry wheelbarrow of paper, so as to show his industriousness and effort—"tricks" which did help Franklin to establish a successful business. As Jose Arsenio Torres, an old political commentator whom along with my father had been a young Muñocista during the 1950s, used to say on the radio, "*La reina tiene que no tan sólo ser virtuosa, sino que tiene que aparentarlo también*." The queen needs to not only be virtuous, she must appear to be so as well.

transportation infrastructures. He taught his son mathematics at an early age but unfortunately died when Jefferson was but eight years old, leaving his large estate to him, in primogeniture. The substantive property was 11,000 acres, had 135 slaves, and was placed in charge of a guardian until Jefferson came of age. This wealth allowed Jefferson to get a very good education.

In contrast to Franklin, Jefferson was well versed in mathematics whom, as of yet, is only president able to read Newton's *Principia.* He might also be referred to as the Tony Stark ("Iron Man" movie franchise) of the Founding Fathers, such that he continually invented all sorts of tools, as a new plough, a copying table, and so forth. The list of Jefferson's inventions is endless, and in this regard he was very similar to Franklin, his senior.

When Jefferson turned 14, instead of obtaining control of the estate, he went to the College of William and Mary. While he was affluent, Jefferson was not so rich that could afford to study in England. Given Jefferson's strong scientific background, he was fortunate in being able to study with William Small, an important figure of the Scottish Enlightenment whom played a significant role in the history of technology.[60] Small introduced Jefferson to the sciences, as well as to the elite of the state, which greatly assisted his career in politics.[61]

The death of his wife Martha was very impactful; Jefferson became despondent and closed off from the rest of the world. When offered an opportunity to serve as American

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[60] William Small stimulated the formation of the Lunar Society, which met every full moon, one month apart, and with it brought James Watt and partner Bolton together. Bolton was a businessman while Watt was professor; their mutual assistance resulted in the invention of the steam engine, and with it the birth of the Industrial Revolution.

[61] The obtainment of a law degree was then done by apprenticeship. However, Jefferson saw law books as boring and tedious, so he studied them historically, analyzing how legal concepts had emerged over time.

delegate in Paris, he decided to go. There he interacted with John Adams and his wife Abigail Adams, the latter whom became a good friend of his. Serving in Paris meant that rare opportunity to not only get away from it all, but to also meet important scientific men as Buffon. While in the French capital, Jefferson as Franklin, saw the enormous wealth disparity and the appalling living conditions of the poor. Farmers were pushed beyond their limits to pay taxes, leading to much destitution. The economic pressures were such, that men had actually invaded women's professions in what was an odd role reversal between the genders. Jefferson observed that this dynamic, in turn, pushed women out of traditional occupations from cooking and into prostitution given the absence of other economic outlets. The ominous clouds of the French Revolution were approaching.[62]

While Jefferson was in France, the U.S. Constitution was being written. However, as Jefferson was good friends with James Madison, his letters to Madison helped give shape to its final body. He emphasized the importance of a bill of rights, formally placing strict limitations on the power of the government so as to prevent its abuse. The Bill of Rights drew the line as to how far it could go.

There were two schools of American thought regarding virtue in society, which were really two aspects of same republican coin. One variant was a Puritanical republicanism, which postulated that the success of the republic depended greatly on the virtue of its citizens, as that as frugality and hard work. Franklin naturally stood in this camp. Given that a low public morality would ultimately destroy the nation, many state laws sought to embed virtue into public governance by placing limits on wealth as well as the activities of its leaders. Agricultural republicans, on the other hand, argued that it was foolish to depend only on private virtue, given what was

[62] Jefferson actually did get to see the first years of the Revolution, but he returned immediately to the U.S., fearing for the well being of his daughters whom he had brought along to France.

commonly know of their character and the all-to-common tendency to decline into vice. They argued that an agrarian economy would help develop public virtue. More importantly, they placed structural restrictions which prevented individuals of low moral standards from causing enough harm to destroy the republic.[63]

Jefferson belonged to the latter school of thought, but combined both strands of republicanism to help put U.S. on a solid base at its formation. Both value internalizations as well as external structural components helped assure that the political experiment would not fail; both were mutually reinforcing.

During the French trip, Jefferson's youngest daughter died while under the care of the mulatto slave Sally Hemmings—whom years later would become mother of Jefferson's kids.[64] The death of his youngest alarmed Jefferson greatly, particularly so as the eldest daughter Martha had been staying with a French family. This arrangement in theory would allow the daughter to obtain the best education there was in France. Perhaps Jefferson hoped to inculcate enlightenment ideals to her, but instead the opposite occurred. The host French family used the opportunity for religious indoctrination. Martha, named after her mother,

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[63] It goes without saying that Trump's presidency has sorely tested the limits of these views, lacking the first (virtue) while demolishing the second (structural limitations).

[64] The only route to African-American equality is through the persistent emphasis on meritocracy, so erratically implemented here in Puerto Rico. While it is augmented that "equality" can only come through a system of quotas, as claimed by Palmira Rios (UPR), there are obvious problems with this approach. If implemented, it would reduce all social competition to reproduction; the ethic/racial group with the highest birth rates would 'win' the largest proportion of entrances to university, job placements and so forth. Not only would this policy reward irresponsibility, resulting in an unsustainable population explosion which would undermine the very principle of equality the position seeks to defend.

wrote a letter to her father expressing her decision to become a nun, and that she had already enrolled in a Catholic convent. Jefferson did not write back, and showed up soon thereafter at the convent to take his daughter away, making her the new hostess of the family.

One cannot emphasize enough the passion Jefferson felt for science. While in France, Jefferson preferred traveling alone, observing everything around him, taking notes, and conducing measurements for natural history. The founder of the science of stratigraphy undertook detailed studies of Indian mounds and helped to more firmlly establish the antiquity of Native American Indian cultures. Through a detailed study of their language, he traced linguistic differences over time much like today is done in genetics. Jefferson was able to rigorously estimate their history into the tens of thousands of years, showing that they had long antedated the arrival of Europeans. As Buffon, Jefferson contributed to the notion of a historical view of nature, a view surprisingly absent at this time in intellectual history. The past was like a vast ocean whose depths were unfathomable and unknown—and still unexplored.

Jefferson's proudest achievement was the *Declaration of Independence,* for which he wished to be remembered.[65] It had been written while his house in Monticello was occupied by the British army; Jefferson's political prominence had already made him a target of the British. As with Franklin, the revolution had a direct impact on their personal wellbeing, whose consequences could have easily resulted in their executions by the British government. Their courage and valor before these difficulties are often forgotten today.

The Newtonian elements of the document, have been well studied by Willis. There is abundant evidence of a Newtonian worldview in the document.

[65] Incidentally, both Adams and Jefferson died on the same day, as if to commemorate achievement.

> *When in the course of human events, it becomes necessary for a people to dissolve the political bands which have connected them with another, and to assume among the powers of the Earth the separate and equal station to which the Laws of Nature and Nature's God entitle them….We hold these truths to be self-evident: that all men are created equal, that they are endowed by their Creator with certain unalienable rights, among these are life, liberty and the pursuit of happiness..*

As in Franklin's case, whose scientific merit was not fully appreciated by traditional historians, Willis's argument for a Newtonian interpretation of the document was initially rejected by historians who only viewed the document within its political context.

Locke had an obvious influence. While Locke wrote of the right to life, liberty and estate—or the right to property, broadly defined—Jefferson writes of the broader condition of happiness. However, it was Newton whom so grounded the document. Willis's detailed linguistic analysis helps bring new meanings to words which are so taken for granted today.

In the Newtonian context, "necessary" was of great significance in that it suggested a world order pregnant with Newtonianism. In the Newtonian worldview, the planets moved in necessary orbits, and the universe had to be as it was because of its laws, the most important of which as the law of gravity. In other words, the Jeffersonian document reflected the cultural constructs of its own era.

Much importance was placed on David Rittenhouse's orrery, or a timepiece which accurately plotted the movements of the planets and moons, as if it were a miniature planetarium allowing one to contain universe in one's hand. While the ready availability of cellphones today tends to make us take this knowledge for granted, during the eighteenth century, such an

orderly universe was seen as an indication of God's existence.[66] To thus present American colonial complaints as the inevitable results of events was a means of safeguarding unalienable rights from the abuses of absolute power.

Jefferson's overt passion for science, however, meant that he was not always aware of its negative implications. Three particular examples stand out.

He believed that a universal standard of weights and measures existed and could be established—an erroneous notion constantly being corrected by Rittenhouse, a more rigorous scientist. Jefferson was perhaps too enthusiastic and too fanciful in his ideas to apparently appreciate the limitations of science. In this particular example, given that matter expands and contracts, minute changes have a huge impact on one's final determination. Even if a pendulum was used to measure, Rittenhouse pointed out that it would be influenced by temperature as well as by its particular location on the Earth along the line of latitude, as the pull of gravity varies between the poles and the equator.

Jefferson also naively believed that there would be a revolution every twenty years, such that each generation should have the ability to establish its own social order. This view suggested that the Constitution would have to be re-written every two decades. Jefferson greatly disliked the "tyranny of the grave", for good or ill, as when men inherited their parent's debts, and he played an important a part in eliminating such arrangements. Each generation could start financially anew.[67] The notion of a continual state of revolution was criticized by his good friend Madison. If implemented, it would wreak havoc to all contracts. As the end of the twenty year period was reached,

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[66] The image of the universe as clockwork was actually introduced by Henry More, a philosophy professor at Cambridge whose notions of time greatly influenced the younger Newton.

[67] To these ends, he established the law of bankruptcy allowing for individuals to begin with a blank slate. Your debts were your own and nobody else's.

nobody would want to sign a contract as it was about to become null and void; social chaos would shortly ensue.

His views on education were a bit unusual as well. Jefferson believed that only the top 1% should be selected for each consecutive grade level, so as to truly create an intellectual elite in America; and (hopefully) the best government. There were many arguments as to why this proposal was faulty, particularly since it would begin selecting candidates at a very young age while in elementary school, just as individuals are first acquiring basic and necessary skills. Assume for a moment there exists an unusual class of 10 geniuses. Under Jefferson's scheme, only one of them would be able to go onto higher education, and the process eliminated many talented people from future career paths. The notion was absurd, resulting in the opposite of its intended effect.

Jefferson, in short, was not a perfect man; no man is. We are not born with perfect ideas, and if these ideas are never publicly revealed, we will fail to appreciate the true range of their validity or error—as the case of Jefferson so clearly shows. Only through the process of public transparency in government can errors be spotted via a dynamic known as the "wisdom of the crowd," not unlike Adam Smith's invisible hand.

Jefferson's very own errors thus reveal the beauty of democracy: via our interactions with others, our own gross errors will hopefully be exposed and discarded, while at the same time new solutions will emerge and be implemented. Just as Franklin pointed out in the creation of the foundational document, the U.S. Constitution is a living document: a never ending experiment that is eternally perfectible by its very nature.

These errors also do not detract from Jefferson's most important contribution, his *Notes on the State of Virginia* (1785) which is at once both a political and a scientific tract. The book offered a vast range of evidence to disprove Buffon's degeneration theory. Befor discussing the work, however, we must first more fully understand Bufon.

The eighteen century was a great time to be a scientist. While many things remained unknown and unclear, new tools

became increasingly available to pry nature open. The century provided a brief window of opportunity for any man to participate in the ambit of science, and is know as the era of amateur science, one good example being John Herschel. Though Herschel was musician, he invented new telescopes which led to the discovery of new planets and played a key role in our understanding of the actual size and structure of the universe.[68] Herschel's case can be contrasted to that of Einstein's who in the twentieth century noted that he did not go into mathematics because it was already a well developed field.[69]

Fields we now call biology, geology, archeology were still relatively uncharted territories, and many key fundamental questions still needed to be resolved, which often clashed with religious interpretations.

What is the nature of life? Why is a person that was living but fifteen minutes ago is now inertless matter, cold to the touch, listless and lacking any personality? Both Leibniz and Buffon speculated that particles of life existed, called "monads" by Leibniz. Dennis Diderot believed Europe was on the cusp of another scientific revolution in the life sciences; soon the miracle of life would be explained just as Franklin had explained away the unfathomable mysteries of electricity.[70] During this era the

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[68] He identified "deep space" in that he recognized that nebulas were star clusters, leading to the notion of the island galaxy view of the universe.

[69] If a field is too developed, one will have to go through an inordinately long process to master the existing field. If a field is less developed, it is far easier to jump in and contribute key notions. If, however, a field is if too undeveloped, it is often a chaotic mess with little philosophical grounding. Those who solved it, left name in pantheon of the new gods; of men who as Franklin took the scepter of truth from God himself. Scientific development ultimately inherently will clashes with religion over the nature of the universe.

[70] Obviously this revolution would not being to occur until the nineteenth century, with the formation of physiology.

science of chemistry also emerged, which would begin to provide the necessary tools for such analysis. As Lavoisier and Laplace showed in their experiments, the processes of combustion and respiration were one and the same.

How deep is time? How old is the Earth or the universe for that matter? The Bible claimed that universe was 6,000 years old, but this historical point was one of contention in which science directly clashed with religion. We also see the gradual formation of geology and archeology. Buffon's notion of the history of time, one of his greatest contributions, is but a footnote in the *Epochs of Nature* (1778), published when he was 71 years old.

Buffon conducted a simple experiment. He mixed diverse metals, a mixture which faithfully reflected the composition of earth's core, and then measured its cooling rate, extrapolaing it to the Earth's history. He concluded that the Earth was at least 75,000 years old—a claim which went directly against the Catholic view of 6,000 years, and for which he was reprimanded by the Catholic Church. Although Buffon issued a sincere apology, he essentially did not change his position. Worst still, he theorized about its impact on life on earth.

Buffon proposed that its coldest regions were continually forming new animals which migrated to the tropics as the poles got colder. While he did not believe in evolution, Buffon did propose that animals changed in form over time as they moved from one region of the Earth to another—consistent with what would be his theory of degeneration. Because Buffon's scheme gave importance to cold regions, an importance which they did not previously have in Western intellectual history, he came to be lionized by Catherine the Great of Russia whom used its implicit positive propaganda for state ends. Buffon's conjectures would form the underlying foundation of later evolutionary theory, which obviously superseded it—which helps explain why Buffon is so poorly known to today. This process similarly occurred with

Descartes whose innovative constructs in early physics paved the way for others whose ideas superseded his own.[71]

Buffon also built on the work of Montesquieu, whom had deeply influenced him. He loved to point out that his first volume of *Histoire Naturelle was* published in the same year as *The Spirit of the Laws,* and suffered the same amount of attacks as its contemporary. While Montesquieu argued that human societies were greatly impacted by climate, Buffon actually argued that democracies could not exist in the tropics as its residents there were too lazy and indolent. However, Buffon was not as strict a determinist as might be presumed, and his other intellectual heroes included Newton, Locke, Leibniz—and himself, of course.

Georges-Louis Leclerc Buffon had actually been a mathematician in his early scientific career, and it is for his study of statistical theory and theory of games for which he was inducted into the *Academie des Sciences* rather than for the natural history he later came to be more famously known. He was commissioned by French Royal Navy to help identify the best trees for its masts. Although he completed the commissioned work, he did much more than this. Buffon undertook a complete statistical study of all the trees in France, after which he began examining all of the collections of animal species. It is perhaps no wonder that he was named Director of the *Jardin du Roi* as he was able to get a vast sample of data from which to work. He also convinced the king to obtain other collections as well, and it is perhaps no wonder that the *Jardin du Roi* became one of the few French institutions to survive the Revolution.

It was widely respected as being too important to be foolishly destroyed. Ultimately its name was changed to the Museum of Natural History. After the French Revolution, it became the setting for multiple revolutions in biology by men such as Lamarck, Cuvier, and Geoffrey St. Hillarie—the latter

[71] Descartes study of particle collision turned out to be grossly inconsistent.

who would become mentor and collaborator to Betances during his exile in France.

Buffon's theory of degeneration was grievously flawed, over generalizing from too little data. Buffon had never traveled to America and had not conducted any serious empirical research. It had been too greatly based on travelers' descriptions, which themselves were notorious as poor sources of information. One claimed that he had seen a bear bite into cow, blowing air into the cow with such force that it exploded.

The social impact of this theory was enormous, however, and was spread by many Enlightenment thinkers as Voltaire and Kant, as mentioned before. It was soon adopted by other writers as Cornelius de Paw and Abbe Raynal.

Raynal wrote comparative study of the East and West Indies. Curiously, he was a priest who had been dismissed by the Catholic Church for criticizing its stances on slavery and colonialism, arguing that priests were guilty in promoting these systems. After he was kicked out from the Catholic Church, he became the editor of the journal *Mercure de France,* which brought him into to contact with leading intellectual figures as Franklin. Raynal held oddly contradictory positions, being on the one hand critical of Americans—they showed no talent for poetry, mathematics, or science—while also admiring the American Revolution. Although the tone of his later work is hushed down, it still had a global effect nonetheless, further feeding into an ever growing European ideology of power.

Raynal also created essay contests, in which writers were asked to debate the detrimental or beneficial aspects of the discovery of America. Essay contests were rather typical for the period, and often generated interesting results, the most famous contest being that by the French Academy of Science on whether science was beneficial or detrimental to morality. Rousseau's answer pushed him into European recognition.

Discourse on the Sciences and Arts, known as *First Discourse, was* written on his way to visit Diderot in jail.[72]

[72] The second discourse is *Origin of Inequality.*

Overtaken by thought while walking in the rain, he realized the inhumanity of what was to come in the future given the new powers granted to men by science. Rousseau pondered the many injustices that men would commit to one another, and literally stood in the rain, crying to himself for an hour.

For Rousseau, science did not make men moral, but rather just the opposite: it created a new means of violence and of inflicting pain and suffering. Science to him had no inherent moral character, but rather tended to corrupt those societies it touched. All societies began as virtuous, but as science progressed and luxury increased, so did vice and crime. This was as true for Greece as it had been for Rome. Societies which rejected its development remained virtuous to Rousseau, as in the case of Sparta.

He complained that rarely were able thinkers ever in power, being far easier to constrain men by force than by enlightenment and reason. While early leaders debated virtue, new leaders evaluated men like herds of cattle and spoke only of business and money. If Socrates were to exist in the eighteenth century, he would suffer a far deadlier poison than hemlock: the poison of scorn and ridicule. We also find the first appearance of his famous allusion to the masks that man wear in society, pretending to like things which they detested, and detest things they adored; this attitude for Rousseau was a direct byproduct of scientific growth. In an advanced urban setting, people could not be counted on to be authentic.

Rousseau ended up winning the essay contest, which launched him as an influential writer; some accuse him of being the sole cause of the French Revolution. His ideas, however, rather nicely coincide with Geoffrey West's work *Scale* (2018). West, a physicist who studies urban growth, noted that demographic increase is followed by both an increase in science (patents) as well as an increase in crime. The same was true of many other social markers, such as the rise in the number of gasoline stations. All were a result of the logistics of urbanization. There is a log scale curve on which multiple features of urbanization could be plotted and reliably predicted,

suggestive as being a phenomenon akin to electricity in the creation of a differential between groups.

Jefferson's task was thus set from the start. His aim was not to prove that the animals of America were bigger, but simply to disprove the validity of Buffon's argument—a far easier task for which he was eminently suited. Jefferson had been collecting data on wildlife in Virginia since he had been a boy. He truly was an avid naturalist, and would likely have been one had if not been for politics. He showed, for example, that there were far more bird species in Virginia alone, a total of 170. While there were 18 species unique to Europe, 27 were unique in U.S. The average animal weight was of 55 pounds in the U.S. versus 27 pounds in Europe. He noted that Native Americans were actually very courageous, willing to take great risks and die for their families should they need to do so.[73]

It was clear that Buffon had not done his homework, and Jefferson was actually able to convince him late in life, based on enormous amount of empirical data he had gathered. However, it Buffon died a few months afterwards without ever amending his work. This book unfortunately obtained a momentum of its own, and it can be said that Buffon lost control of ideas which spread as if they had been sacred law—to the detriment of all Americans.

It thereby interesting in this context to contrast Jefferson's refutation of Buffon's scientific propaganda with Jefferson's own view of Spain and Spanish America.

On his return to Europe from South America, Alexander von Humboldt visited Jefferson at the White House in 1804. Jefferson, now president, was also president of the American Philosophical Society, the leading scientific society in the U.S. The two spent most of their time talking about natural history, specifically the distribution of species.[74] Humboldt was weary of

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[73] Jefferson was fascinated with native American culture. Since a child he had been collecting arrows in the new house.

[74] We might suggest Jefferson's possible role in Darwinian theory in light of Humboldt's enormous influence on Darwin.

publicly criticizing the Spanish. It had been too difficult to obtain travel passes, and perhaps such criticism could have had unforeseen negative political ramifications.

Jefferson's daughter noted that throughout the remainder of his life, her father spoke very fondly of Humboldt, whom had then been then a young man in his thirties versus the much older Jefferson in his sixties. The two corresponded greatly up until Jefferson's death. Much of the data provided by Jefferson would eventually become a part of Humboldt's multivolume tome *Cosmos*. It is said that Humboldt was last man to have known everything there was to know.[75]

Jefferson early in life had optimistically believed that democracy would spread everywhere. However, as he matured he came to change this view towards a position that was more in line with Montesquieu's ideas. For him, Latin America was a priest ridden continent, which was dominated by ignorance and fear rather than logic and science. Its citizens were easily subjected to abuse by cunning leaders who pitted them against each other and against their own self-interest. The rule of force existed because majority rule was not respected. The golden rule of democracies—do onto others as you would have them do onto you—was treated as if it belonged to some distant utopia. That key democratic principle, to respect for majority decisions and faithfully abide by them, was routinely ignored.

For Jefferson the essential traits so necessary for the success of a republic and its sovereignty—education and culture—were absent from Spanish American societies.

His views are strikingly similar to those of Iñigo Abbad y Lasierra in his *Historia Geográfica, Civil y Política de Puerto Rico.* In it, we find a rather unfavorable depiction of Puerto Ricans as lazy and ignorant. They did not dig deep mines for lack of science, and did not cultivate rich gardens, only picking the agricultural products which fell from trees. Mineralogy and

[75]After this date, information would grow too quickly for any single man to muster.

forestry were unknown. This view would continue to characterize U.S. – Puerto Rico relations long after their creation which, like Buffon's American theory of degeneration, acquired a life of its own—and still affects the view of many North Americans regardless of its actual validity in contemporary Puerto Rico.

As Buffon's theory of degeneration, the view of the lazy Latin has important implications for Puerto Rico and their international treatment, impacting credit, economy, and industry, potential trade deals, and so forth, much like the United States suffered in its early days. The constant request for financial aid only reinforces this perception. The question that might be asked is: how do we refute it? Through our actions or by our words?

Perhaps a bit of both.

> *History, I believe, furnishes no example of a priest-ridden people maintaining a free civil government. This marks the lowest grade of ignorance, of which their civil as well as religious leaders will always avail themselves for their own purposes... The different cast of their inhabitants [Spanish America], their mutual hatreds and jealousies, their profound ignorance and bigotry, will be played off by cunning leaders, and each will be made the instrument of enslaving others.*

Chapter 11

The French Revolution

The French Revolution was one of the most horrific episodes in world history. Although figures vary widely, it is estimated that some 1.4 million people died as a result. Imagine that half of the population of Puerto Rico were to suddenly collapse. When we consider that around 4,000 died during Hurricane María (2017), using this relative scale, one French Revolution would equal to 350 Hurricane Marias, with a similar range of destruction of lives and property.[76]

It was utter chaos; nobody knew whether they were going to live or be killed. Different groups fought each other for control, the Jacobins, the Montards, and the Girondist. Danton, whom once had been a close ally of Robespierre, is killed via the guillotine—an instrument of death symbolic of the period. Danton's biggest complaint was that he would not live to see that rat die, referring to his former associate. Robespierre in fact would himself be killed as well, both shot and placed before the weighted sharp blade. The young Robespierre decades before had argued for the placement of lightning rods throughout all of France; as a young lawyer for the poor, he was well aware of the gross injustices of the land.

Some regions were marked by near total anarchy. Prior to the Glacier massacre of 1792, Avignon had been under threat of a

[76] While this figure might be disputed, official figures for guillotine are around 14,000 while other estimates place at 50,000 executions. However, the general point of its horrific nature remains the same; it must have been a horrific experience to have lived through. is the same regardless of specific figure debated.

Catholic takeover. Early in the revolution, its church bells had been melted for the construction of armaments, which outraged the papacy. Given that the city had been a prior papal province, some locals feared that it would revert again to Catholic control. To forestall and prevent its reversion, some 60 fellow citizens whom belonged to the wrong side were gruesomely murdered by a small army led by a former rebel who had previously stormed the Bastille; the victims' bodies were thrown with some quicklime into the town's tower, then being used as a latrine.

The list of incidents is endless. The September Massacre of 1792 was contextualized by an Austrian army threatening France's borders. Rumors began to spread of a counter insurgency led from within the prison. In the panic of the moment, around a thousand prisoners were mercilessly killed, including 35 women and children without the benefit of appeal. Thomas Paine whom found himself in a French prison at the time, escaped with his neck intact by a sheer stroke of luck.

The death by guillotine of Louis XVI in 1793 sparked the Reign of Terror. If the King felt that his body and rule were untouchable and would last forever, this mistaken notion was quickly corrected. In fact, his predecessors, Louis XIV and Louis XV, had ignored the coming crises which had become so apparent to both Franklin and Jefferson, who interacted direclty with those on the street. Louis XVI tried to flee Paris for Prussia, but was caught. Marie Antoinette, an avid lecturer of Rousseau, became a prisoner in her own home.

If the untouchable could be killed, all psychological inhibitions were set free. The nobility would be next, and arrogance could no loner serve as a protective social barrier, but instead would incur a costly wrath. Anyone who even suggested a defense of the aristocracy was deemed a threat to France and killed immediately; to be named a counter-revolutionary was to come to know God sooner than expected. The realm of politics had turned deadly. Men and women were mercilessly drowned in the river; chained together naked and placed on a boat whose bottom trap door was suddenly opened, remniscent of Nazi gas chambers. They all sank to their graves without mercy.

The Bastille had become a symbol of the iniquities of old injustices, of torture and government repression. In its storming, the main lieutenant's head was savagely cut off and paraded on the streets. The extremes of violence witnessed are but an indication of the extremes of injustice which had been occurring in France, revealing a pent up anger that simply exploded like a bomb. It was a phenomenon perhaps not all too different from that of the Cuban Revolution, which Fidel Castro did not create but rather managed.[77] Such explosions of violence are symptomatic of deeper abuses of power, that when emerge, do so abruptly.

Lavoisier and Condorcet were killed, and one cannot emphasize enough the tragedy o this act. Thye had created chemistry and social statistics, respectively. Both had also initially supported the creation of the republic and hoped that the Revolution would improve the world; for its cause, they established key educational reforms while participating in the Committee on Public Instruction. While one might presume that the French Revolution was inherently anti-scientific for killing such distinguished scientists, this would be a false conclusion. French science certainly had risen due to its strong ties to the monarchy, but had also ignored the implication these associations would have in a time of mindless crisis. Both brilliant scientists were swept along with the current of social change.

The most puzzling feature of this historical phenomena was that France had been the world's leading scientific nation at the time. How such mindless destruction could have occurred in an age of science was a puzzle to many.

Georges Cuvier also traveled as a young man to Paris in 1795, at great risk to himself as there was still come uncertainty with regard to the security in the capital. His visit had been preceded by a period of great violence, that of 1793-1794. It was not altogether entirely clear that the violence would not start up

[77]As its European example, it exploded everywhere, itself a testament to the injustices suffered by Batista's repressive regime.

again, but Cuvier's daring move would launch his scientific career as well as a revolution in biology during the following century.

The significance of the French Revolution is well known. In short, it established the modern society social order based on a wholly different basis. It put an abrupt end to monarchical rule in France, led to the elimination of hereditary rights, and became a model to be imitated by other nations. While monarchism had been the predominant form of government prior to the revolution, republicanism would come to rule after it. The *Declaration of the Rights of Man* would express the new ideals: *liberté, fraternité, egalité*: all men were brothers, equal, and free.

It could be argued that science helped establish sovereignty in France, but it occurred through such a violent process that some have called into question its very validity. Need it have been so utterly violent or, worse still, did science contribute to this level of violence?

The French Revolution is a key example of the paradoxical role of science: a nation at peak of its scientific power descends into violent anarchy and utter chaos. But, like the phoenix arising from its ashes, France would be reborn into a new society in a series of steps akin to those of a phase change which show little initial change at first, followed by a drastic growth spurt and another period of stasis—so well depicted by its "S" curve.[78]

In 1787, 50% of all tax revenues were going to pay the French debt. Three different finance ministers tried to deal with the complex situation but were unable to do so because of the obstacles placed by noble privilege. Calonne suggested a direct tax on all land owners, regardless of social status, to help remedy its finances. The measure was blocked by the nobles.

Certainly the debt emerged due to diverse factors, and it cannot be placed solely on the shoulders of the U.S. revolution—even if it unquestionably contributed to the tune of 1.5 B livres,

[78] The pattern is also similar to that described by Rostow, Haskins and others.

or around $13 billion today. The prior Seven Years War with England 1756-63 and the costly reign of Louis XVI had been dead weights. The construction of the new seat of government at Versailles would come at a very high price, today amounting to $250 billion. The Sun King had also embarked on an aggressive foreign policy and on other costly foreign entanglements which had the opposite of their intended effect.

The price of food was also increasing due to a diverse number of natural disasters which included bad crops, severe storms, and repeated flooding in various years as 1787 and1788. The nobles tried to offset their own losses by increasing the charges to their tenant farmers, arrogantly believing they would not be affected by the crises, all while showing a lack of empathy towards its miserable victims, whom in turn were more than offended to see the frivolous wealth of the courts wasted on open display of vices. Two thirds of the population of France had been reduced to beggary while the rich partied. The disparity between elite behavior to the tragic reality of their countrymen was morally shocking.

The price of food skyrocketed during the period, growing to 88% of income. At its peak, the price of a loaf of bread rose to equal a month's salary, while at the same time servants had been mercilessly executed for stealing a few crumbs. New World meals as the potato had not been adopted in France, which would have ameliorated the situation substantively given its more robust and inexpensive nature. Potatoes are so fecund that, like weeds, can grow nearly anywhere. It is no wonder that the period gave rise of the famous French bakery; the diversity of breads, even those made of wood shavings, made the suffering more palpable.

The agricultural and economic crisis was compounded by a governmental one. French institutions had grown obsolete, inefficient, and uncoordinated. Controlled by the nobility, they had become ineffective self-perpetuating corporations led by hereditary office holders, not altogether too different from many

Puerto Rican institutions today.[79] While the population of the previous century had been marked by famine, it had also been kept at bay, hovering at the 1 million mark. During the eighteenth century, it had ballooned to 27 million.[80]

The causes of the French Revolution constitutes one of the oldest longstanding debates in the discipline of history, partly due to its importance in creating the modern era. For every argument, there is typically a counter argument equally valid—which denotes a diversity of extreme positions, all equally held as valid, humorous coexisting as if they were in some sort of quantum state. In short, the topic is a historiographical minefield due to its complexity and long-standing nature. It is easy to see the nightmarish sources of historiographical frustration.

For example, prior to the French Revolution there had been at least four famines; in 1693, 1708, 1740, and 1770. Why should 1778/9 have been any different? Why would this particular famine have had such a powerful social impact, when famines had routinely been part of most agricultural societies' circle of life without any long term impact other than the readjustment of the population to its resources in an ongoing balancing act?[81]

Conservative historians tend to place the greatest weight on the ideas of Enlightenment philosophy and philosophers as cause of revolution, characterizing these as active agents who had been plotting against the throne all along. The best example of

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[79]They do serve as a word of warning as to what can happen when the warnings are not heeded.

[80]Interestingly, the total population of the United States during the immediate postrevolutionary period was roughly the same size as that of Puerto Rico today (3M).

[81] This is known as a region's carrying capacity, or the calculation of the total number of individuals a given region or plot of land can sustatin. This number is not fixed, but rather varies according to specific conditions; in the modern era, this figure is not direclty determined by actual agricultural resources of the region, but are useful as a standard point of reference.

this position would be Taine (1876) whom attributed to the Enlightenment as the revolution's principal cause.

On the other hand, liberal historians tend to place greater emphasis on external causes, such as socioeconomic factors, a principle exponent of whom is Lefebvre (1939). For Lefebvre, effects should have precedent causes proportional to phenomena they explain. Big events have big causes, while minor events have insubstantial origins. The liberal view became the predominant interpretation after the 1930s. There has been a turn to cultural causality during the same period.

Moret (1933) wrote a sophisticated critique of Taine, and undertook a detailed study of the diffusion of Enlightenment ideas, detailing the gradual adoption of these ideas across the diverse social classes, from intellectuals and nobles, to the common folk. Moret concluded that while the Enlightenment a did not cause the French Revolution, it had been a necessary precondition.

An interpretation informed by the history of science interpretation is still in its early stages, but would be placed within this category (culture). Oddly, Ferris tends to exculpate the role of science in his treatment of the French revolution. The revolution to him was violent because it turned away from science. He seems to grunt as a green-eyed monster "science good, irrationality bad". As we will see, this is not necessarily the case, and Ferris appears to be seeing only what he wants to see—a problem unfortunately all too common in academia.

Some have placed the greatest blame on Rousseau, in particular his works as *Emile* and the *Social Contract* which were extremely influential and translated into all major European languages. When published, Rousseau was driven to exile in 1762. Book burning events were formed in Paris and Geneva—the latter being particularly harsh given that Geneva was his hometown. However, if *First Discourse* brought him national recognition, *Nouvelle Heloise* would turn him into an international sensation—so much so that its sales superceded nearly all other fictional and nonfiction works. By 1762,

Rousseau was a famous author.[82] As Voltaire, who would become his enemy, both men were some of the first writers to live off the income generated by their book sales.[83] Rousseau's formal income was gained as a music copyist. His principal idea was the concept of "general will", which tends to be misunderstood.

The links between the *philosophes* and the monarchy were certainly too close. The belief in the existence of absolute laws meant that there was a common form to all governments, and all could be held together by reason, according to D'Alembert. It was thus hoped that through "enlightened despotism," some measure of reform could be achieved directly through the king—suggesting the possibility of a peaceful revolution through consultancy. "Democracy" in this sense was a problem under its schema. If only reason lead to truth, why ever allow wide-ranging political debate to begin with? Religion similarly had to be eliminated from political discourse, as it was another source of irrationality and unnecessary conflict. The public sphere would thus be rather small and reduced, excluding the poor and the uneducated. These very problems were reflected in the 1793 Constitutional Convention.

The notion that a government was subject to universal laws as those of geometry—unvarying and unyielding laws—were also adopted by physiocrats as Turgot whom as finance minister in 1774 had been a mentor to Condorcet. Misreading the circumstances during a time of famine, Turgot "freed" price constraints on agricultural products as wheat—a good historical example of the laissez faire neoliberal creed today. His actions naturally led to bread riots and the chaos worsened as food prices abruptly rose; the creation of an unequal distribution of goods

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[82] *Nouvel Heloise* is a romantic novel of a tragic love story between male peasant and a noble female.

[83] In spite of ideological differences, both are buried in the Paris Pantheon, side by sides, and are regarded as the fathers of modern day France

during a time of crisis is usually not a good idea. In spite of Turgot's fall from power, however, he would influence Condorcet towards the creation of a social statistics. Condorcet's attempt to better understand the underlying mechanisms of society laid the groundwork for modern social sciences based on a quantitative analysis of society.

These views were opposed by Diderot, a close friend of Rousseau, whom argued that the government was not private property, nor the sole ownership of a few elites—perhaps an all too common assumption found in Puerto Rico.[84] Diderot in fact was the first to introduce the notion of "general will" in his article on "natural rights" for the *Encylopedie*. He noticed that the unjust tend to impose onto others that which they do not impose onto themselves, what today we would call a double standard. The general will for Diderot, is thus akin to an ethic of reciprocity. He observed that a government of three could be a tyranny if two members of the group gang up on the third one, and then impose will their wishes without due consideration of the third's opinions—and hence why reciprocity was so important to all democracies.[85]

Diderot's idea of a "general will" was adopted and expanded by Rousseau, whom in turn set the basis of the perception of events at the time, specifically an understanding of the injustices of the elite towards those below them. Rousseau as a young man had been an ambassadorial secretary, and traveled to Venice where he was exposed to the great pomp, wealth, and luxury of monarchical governments. He began wondering whether republics required Spartan simplicity, a notion which eventually becomes a credo of his. Although offered a pension by Louis XV, Rousseau turns it down.[86]

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[84] It is often the case that a person placed in a position of leadership all too often behaves as if they owned the public institution, forgetting its public nature.

[85] Similarly, consensual unions without mutual reciprocity do not long endure.

[86] Louis XV was widely noted for effeminate behavior.

In the *Origin of Inequality* (1754), Rousseau writes that luxury was a gross distortion; property was an artifice that distorted self preservation and corrupted self love by turning these into dependency and oppression. Property in short created institutional inequality, which was reinforced via the imposition of unjust laws. Rousseau's deep analysis on the realities of society were reflections of the most serious French social problems. His "general will" implied a required obedience to the ethic of reciprocity: do what is best for you, without harming others. One needed to shake off artificial relations and regain one's freedom from these, to restore the authenticity of natural relationships and personal independence. It was not a call to return to nature, as in the complete abandonment of civilization, and it was also not a rejection of science as it is also sometimes erroneously characterized.

One possible reason explaining the distortion of his ideas was his distinction between the of sovereign and government. Rousseau is emphatic in that his notions applied to sovereignty, rather than to government per se, as particular interests could take it over and distort the general will, confusing its own interest for the common good. The sole purpose of the law was to make virtue reign. Unfortunately, Rousseau does not try to work out structure of government, specifically determining how the general will was to be determined. This functional and logistical vacuum of his political philosophy is lamentable. His views were ambiguous, and thus subject to the manipulation. This ambiguity was astutely taken advantage of by Robespierre.

It might be objected that such a discussion has little, if anything, to do with science. However, an important little known fact was that Rousseau was a life-long amateur botanist.

Prior to dying (1778), Rousseau had been working on various botanical works. His letters to Madam Delessert were posthumously compiled and published as *Letters on Botany* (1782) before the Revolution, and could be found in Jefferson's library, along with works by of Buffon, Linnaeus, and others. Rousseau argued that one could understand botany without knowing the name of a single plant's species; to do so, one

simply had to study the interaction of its internal structures. Each part worked independently yet harmoniously together.

Rousseau had also been working on a botanical dictionary, and criticized botanists who knew many names but could not identify plants in nature. The dictionary was to be a work printed in the vernacular, rather than Latin, and was meant to be widely available. It promoted the study of the Linnaean binomial nomenclature, of which Rousseau was an avid follower. Dedicating the last 15 years of his life to botany, he collected an ample library of some 70 important books, and complained that none could be obtained in Paris which made their purchase expensive as he had to import these from other nations as England or Holland.

His *Reveries of a Solitary Walker* aptly captures his character; Rousseau liked to walk a great deal. On one occasion, instead of taking the stagecoach, he decided to walk all the way from Solothurn in Switzerland to Paris in 1732, for a total of 305 miles, as if one were to traverse each end of Puerto Rico three times over. As a result, Rousseau got to deeply know the region in a much more intimate manner, interacting with the locals, and taking his time to appreciate its local nature. It goes without saying that Rousseau was kind of a peripatetic, and recognized that his ideas came to him while in the open space of nature. He could not work sitting idly in a desk, noting that the forest offered better and more inspiring accommodations.

He also showed many traits of a scientist. In his numerous journeys, he dissected plants, and studied them with a microscope. Rousseau had also worked with Margaret Cavendish, a rich patron whom was an expert botanist.[87] Rousseau had no problem at all working for a woman, gathering specimens for her collection, and so forth. Their mutual skills and interests complemented each other's.

Though his botanical views appear after his main works had been published, they had a profound influence on his

[87] Note that this is not the same Margaret Cavendish who interacted with Hobbes a century earlier.

philosophical thought. His botanical ideas echo and resonate with his political philosophy. His notions of a pre-civilized state of nature came from his walks. In this, Rousseau's influences are is to be contrasted with Hobbes's, which were drawn mainly from travel literature and the inherent European conflicts with Native American Indians which obviously shaped his original ideas.[88]

For Rousseau, the state of untouched and unmediated nature was inherently plentiful, and in this he was also influenced by Buffon's study of the forest for the French navy. Buffon observed that untouched forests had a thick rich layer of fertile soil, inches thick with the cumulus of detritus and leaves, the latter which played an important part in the hydrological cycle. Leaves helped to retain and release moisture back into the air, and in the process helped to sustain and preserve life. Buffon's ideas thus contributed to Rousseau's notion of the decay of civilization, which was to be contrasted to the Lockean notion of a virgin nature which inherently held no value except that which was created through man's work, which drastically increased in value. By contrast, for Rousseau, the truth was quite the opposite. Humans negatively impacted the forest in that agriculture, as well as the cumulative effect of human activity, led to a degradation of the soil. Untainted nature for Rousseau had inherent value—both philosophically and morally as well. Rousseau in this would sit conformably in the modern environmental movement.[89]

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[88] It perhaps should be noted that that the widely read high school novel *Lord of the Flies* lied about its origins. Though based on true story, its actual outcome was opposite to the survivalist chaos of the drama. All lost teens collaborated with one another for their mutual survival.

[89] He would be what might be termed a "preservationist" who conserved nature for its own sake rather than for man's profit and wellbeing. Its key exponent was John Muir at turn of the century, whose views contrasted to those of the "conservationist" which saw forests had to be managed like a farm and whose key

Unmediated nature was thus critical to happiness in that authentic nature led to the obtainment of truth and morality. He would rather see apples and pears sitting on a forest floor than in an orchard. While natural fruits were typically smaller, uglier and less nutritious, their seeds germinated much more readily. As these were a genuine product of their environment, they presented men with an unadulterated truth which was genuine to their nature. For Aristotle, the nature of plants was solely a reproductive one; not movement, not consciousness, but rather propagation (reproduction).

By contrast, man's hand upon nature was corrosive and distorted both the ideas he received as well as his morality. Artificial double flowers might be very beautiful, but they were monstrous non-reproductive hybrids requiring the constant hand of man for their propagation. Our valorization of the useful had corrupted nature and distorted it as well. He noted that the term "weeds" was a concept embedded with human values that denoted an arbitrary rejection by society. However, a weed was only detrimental when seen from a human perspective, and in fact were no different from any other plant in nature, each which played a particular role in nature. Weeds obtained their negative depiction only when seen from the perspective of selfish human interests.[90]

Rousseau's fight with Margaret Cavendish rested precisely on the point. For him, exotic plants were blasphemous aberrations that had been taken out of their natural environment. One should perhaps remember that that Rousseau is making his claims at a time when European gardens were flourishing, thus showing his obstinate authenticity. Gardens were then as much in vogue as physics has been in our time. This philosophical discrepancy, more than anything, led Rousseau to break off his working relationship with Cavendish, which became a common

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exponent was Gifford Pinchot. There was a clash of views in Roosevelt administration.

[90] Please refer to Cook's ample body of work on Rousseau and botany for a more extended discussion of the subject..

pattern throughout his life. In spite of the fact that David Hume offered Rousseau shelter in England, rescuing him from political persecution in France year later, the two would have a falling out as well.

For Rousseau, understanding the true order of nature was the key to morality, as it endowed the observer with a sense of the genuine order of nature, as if touching the hand of God, its Author. Rousseau's vision is teleological, but not in an Aristotelian Catholic sense, in that the latter implied an external ends for human beings. Since men presented themselves as peak and culmination of nature, it was perhaps inevitable that they would also arrogantly pretend to be the final cause of nature's being and the purpose its existence. Goethe, follower of Rousseau, was equally critical of this view, as if cork trees existed solely for the purpose of topping wine bottles. Other thinkers as Kant would also be influenced by his ideas, suggesting the existence of a purpose without finality.

Nature had its own internal teleology for Rousseau, what today we would perhaps call evolutionary genetics. Although Rousseau did not know the ends or means, he could see that all plants had their own function, both internally in the interaction of their parts, as well as externally in their interaction with the environment. The latter today would be referred to as its ecological role. Freedom was thusly ultimately embedded into authentic nature. Each entity was free to act as it did, thus endowed human observers with a genuine sense of liberty and freedom—a critical component of which was autonomy, which was to be sharply contrasted with the condition of man in modern society.

Tampering with nature thus had direct repercussions for humanity, in that it created a false sense of self, normalizing a dependency that did not exist in nature; man-made plants without humans would not survive.[91] The artificiality of this

[91] Domesticated plants and animals today, far from "natural", would be the first to die in absence of man.

invented nature impacted our ideas of ourselves, our morality, and even our own bodies, much as the flames of Plato's cave.

We might ask, in light of Rousseau's ideas, what the consequences of biotechnology might be. Humanity is now literally transforming natural forms via genetic tampering and manipulation, not for its own sake but rather for human ends. Rousseau would be horrified with this transformation of Catholic teleology into an actual embodied physical reality. Rousseau would likely suggest that such a model contained the seeds of its own destruction. Given that man was ultimately a part of nature, this distorted relationship will ultimately alter human biological form as well.

As Israel shows, the concept of general will was used as a battering ram by Robespierre. In the debates during the creation of Constitution in 1793, Condorcet pushed for necessary structural elements of democracy which he felt were needed to insure its longevity. For him, a critical problem to be resolved in its design was to prevent vested interests from usurping the government for their own ends. Such reforms included the creation of a legislative body that was continually undergoing elections every year, and hence under continual public scrutiny—something necessary given that it served the function today assigned to the executive. Condorcet also argued for the power of popular assemblies to be able to revoke actions and laws they felt to be against the general wellbeing, as well as the ability to initiate investigations upon the receipt of public complaints. While the structure of Condorcet's government is drastically different from today's accepted models, their aim was pretty much the same: to prevent the inevitable abuses of power that arise when men are granted such powers.

However, the poor state of education made an authentic and measured discussion, as that which had occurred during the U.S. Constitutional Convention, impossible. Robespierre's camp simply lacked the ability and educational background to understand Condorcet's arguments and reforms. They instead began to disparage Condorcet, turning to calumny and defamation. The virulence of their tone was utterly shameful, no

longer characterized by polite civil discourse but rather by mud slinging at its lowest level. Condorcet is ultimately framed as a representative of the nobility, as an aristocrat and a counterrevolutionary, sentencing the important thinker to death.[92] There was no discussion or debate on the merits, or lack thereof, of the key points being made by Condorcet; there was no rational debate at all. For St. Just, the Constitution proposed by Condorcet was simply too intellectual, and pushed through the Convention a system of government that placed all power in Robespierre's hands.

Robespierre, meanwhile, constantly called for social unity, placing himself at the helm. Key political positions ended up being appointed by a central board rather than chosen as elected officials, which turned the French legislature into Robespierre's personal mouthpiece—a "*sello de goma"* (rubber stamp) as it is said down here in Puerto Rico. He claimed to be representing the general will, but the insanity of political power ultimately went to his head. By 1794 at a political festival, Robespierre put on a cape atop a false mountain and proclaimed himself to be the physical embodiement of France's general will. He would be executed shortly thereafter.

Because Rousseau had not been more specific with regard to his notion of the general will, it became an ideological instrument of coercive power leading to ends which he certainly would have opposed. A similar political dynamic occurred during the Communist Revolution, with Stalin seated at the helm, claiming to represent "the people".

Rousseau in a sense was the product of his society, as we all are to a degree. His pervasive enthusiasm for natural history and the sciences of the Earth was similar to the recent enthusiasm for physics during the 1990s; then, however, it was defined by botany, geology, mineralogy, oceanography, and so forth, much more wide ranging than we would accept today. Such was the enthusiasm at the time, that there were many scientific contests,

[92] To understand its meaning, consider that Jefferson or Franklin had been hung after the Constitutional Convention.

and even Robespierre would submit an entry into one such contest. Though he would not win, it reflected the French social atmosphere.

However, it did reflect other social pressures played by science in the dynamics of the French Revolution, in particular the *Academie des Sciences*.

The close relationship between the French scientists and the monarchy served to enhance their prestige and social power. Such relationship also furthered the institutionalization and professionalization of French science, which in turn elevated enthusiasm for greater participation—to such a degree that it would eventually cause social rife in its community and ultimately destroy the *Academie des Sciences* itself. Given the expectation that science is a common good, chaotic results are inevitable when a majority of its participants are not included in its halls.

There were many academic societies in France during the seventeenth century, but were rather unstable. Without sustained financial support, they enjoyed no permanence or longevity. Jean Baptiste Colbert, the Sun King's prime minister, saw that these could be used to state ends. He helped these obtain the support and promotion of the monarchy, which in turn come to serve the state. Their most important social function would be the evaluation of useful things; in short Colbert turned these into a technical consultancy bodies. Colbert's ideal was to bring all such organizations under state control, which ultimately led to a clash with many existing societies, as those in the area of medicine.

The formation of these institutions, however, resulted in important social and philosophical changes, one of which was the redefinition of the intellectual, onto which there was a transfer of the habits and traits of clergy. However, in contrast to the medieval intellectual, the modern intellectual interacted directly with society, no longer isolated from rest of world as many monks had been. There was also an important change of outlook, placing greater emphasis on rational procedures and analysis rather than the rote repetition of existing knowledge. While we

take these outlooks for granted today, they truly represented a new social criteria. During the medieval period, for example, the "old" had enormous weight due to its antiquity—an attitude that was still predominant in the medical community. However, the new presumption which emerged was that all claims now had to be evaluated and verified; truth claims were no longer taken at face value but had to be conclusively proven, which led such organizations as the *Academie des Sciences* to obtain a quasi-juridical function. These included the right to award patents, formally recognizing the origin of certain inventions, which prompted the rise of innovation in France.

The scientific society which emerged, however, became ultra elitist; membership was restricted to only 54 scientists throughout all of France. It goes without saying that there were many more individuals with an avid interest in natural philosophy than there were members in the *Academie*, which also contained its own internal hierarchy. Its core was even more reduced to only some 20 scientists, and it was they who held the principal reigns of power over the organization. The topmost members were the *pensionaires*, whom also commanded the highest salaries of 2,000 livres per year. Membership on its board of directors, whom held "voting rights", however, was not always based on merit. Political intrusion by the king was always present. Two such occasions were notable; the second nominees won, instead of first: Lamarck and Lavoisier.

The scientific academy at Paris was perhaps too successful. The drastic rise in popularity of science in France during the eighteenth century created an enormous pent up demand for entry, whose denial led a great deal of resentment. Many able men were unable to join. Its implicit claims to meritocracy was not faithfully honored. That scientists, original and unoriginal, were not given entry is clear when its membership roster over the century is analyzed.

A marked change in the age and rate of entry can be clearly observed. While in 1723 Dufay went from *adjoint* to *pensionarie* in only eight years, fifty years later Darcet would reach this rank as a relatively elderly scientist at 59 years of age,

doing so through a subterfuge. The average age of its members rose from 26 to 39 years of age as the century passed. The French Academy over time was seemingly reverting into a medieval guild, placing many restrictions of entry which, in turn, created an enormous pent up demand and cries for reform.

In 1785 Lavoisier, now director, enacted changes seeking to ameliorate these demands. He eliminated empty positions, created new sections as experimental physics and natural history—laying the basis for Cuvier's important role the following century. Lavoisier, however, did not modify the criteria for admission, and did not increase the number of members in the *Academie*, believing that such a move would degrade the quality of the institution.

The *Academie des Sciences* also intervened unfairly with other groups, making it obvious that did it not like or accept rivals, while rationalizing its actions upon claims to be enforcing high standards. This abuse of power blatantly occurred with the *Societé Linee*, formed by Louis Bose. While it can certainly be said that its character was more typical of the medieval period—it sought moral lessons from nature—the *Societé Linee* nonetheless generally promoted the Linnaean system, the basis of all classificatory systems today. There was an important issue at stake: taxonomical systems, three of which were in competition: those of Lamarck, Adanson, and de Jessieu. The *Academie des Sciences* argued that by closing the *Societé Linee*, it would help create a more neutral background for debate. Linnaeus apparently was simply not French enough to be considered worthy of due evaluation.

The members of the Paris academy also jealously guarded of their own personal influence and power within the number of provincial academies of science that existed. A trend became clear. Once a person entered the few available positions in the *Academie des Sciences*, they did not resign from their positions in the provincial academies, thereby further adding to the pent up demand by not freeing up a space for new scientists at the provincial level below. This naturally contributed to a great deal

of resentment, which came to boomerang back—as with case of Jean Paul Marat.

Marat was a journalist with an interest in science. In 1778 he presented a paper to the *Academie des Sciences* on electricity, the "*Decouvertes sur le Feu, l''Electricite et al Lumiere…*" which received a favorable view. Inspired by its positive reception, he quickly presented a second study with a much longer list of experiments, claiming to disprove Newtonian theory. Marat appears to have had a pathological appetite for fame, and while the Academy pretended to take this paper seriously, it took a long time to analyze. After nine months, the *Academie* had not yet issued a reply; when questioned, it claimed that the larger number of experiments included drastically increased the amount of time for review. Marat kept insisting on a response, and eventually got one: the paper was rejected because the *Academie des Sciences* did not have the time to complete its experiments. Even so, its representatives noted that it did not matter, as the paper's claims were doubtful from the very beginning. Marat was naturally furious and offended by the lack of dignity with which his scientific efforts had been treated. He was but one in a long line of rejects whom also abhorred the *Academie*'s presumptuous treatment of their work.

Marat, in contrast to many dejected others however, would become one of the most powerful men of the revolution, which would then have been hard to foresee. At the time of his submission, he was principally seen as one of many scientific quacks. As he rose in power during the French Revolution, he became the motive force behind its demise. The *Academie des Sciences* was also "killed" by the revolution as had Lavoisier and Condorcet.

The argument that it had been too closely tied to monarchy also produced a similar phenomenon that would play out elsewhere. The psychological impact of elitism and its exclusiveness by definition—in contrast to the inclusiveness of democracy—meant that the exclusion of Creole scientists by Spanish institutions would also create a great deal of resentment and hatred towards monarchical governance. Crushed scientific

expectations contributed to the undoing of monarchy and to the fight for independence and national sovereignty in Latin America, aptly described by Glick. The failure to honor another's social role and dignity had momentous political ramifications.

Recent historical work also shows that science enhanced the role of violence of the French Revolution. By naturalizing its violence, the field of natural history inhibited a critical evaluation of acts which had been justified as normal part of a natural phenomenon. The violence of the revolution came to be defined as that resembling a river current or a thunderstorm; one could shout and complain a great deal, but one's personal commands or pleas had no impact whatsover over their outcome. This contextualization eliminated individual human agency and moral responsibility. Some of the language used even alluded to prior intellectual frameworks: the violence had established such a chaotic environment that men were thrown back into a state of nature, thus civil laws were no longer applicable, an allusion to a Hobbesian state of nature.

Such depictions were ultimately expanded and became a part of the broader trend which sought to include natural phenomenon as earthquakes and volcanoes into its accountability. They were defined as events which, alhough chaotic, had positive outcomes. For example, some claimed that earthquakes were caused by a sudden mixture of elements, which by themselves were individually stable—as sulfur, salts, bituminous elements; when mixed they became explosive. For Buffon, the cause of earthquakes were hard to discern; they are sudden and unexpected, thus it was nearly impossible to discern a pattern. However, that they appeared in groups seemed to suggest an underlying pattern and causality. The term "revolution," appears in book which plotted all the known earthquakes in human history.

Earthquakes naturally had a close association with the social world given their human impact. There had been two tremendous and memorable earthquakes, with ominous implications. The Lisbon earthquake of 1755 killed 30,000

persons. What was striking is that Lisbon had been a successful town. Most particular of all, given that the phenomenon occurred on All Saints Day, the highest fatality rates occurred to those who had attended Church that Sunday, and thus it was hard to even suggest that the event was punishment from God as such event had typically been interpreted.[93] The view which eventually emerged that such phenomena were ultimately beneficial. Lisbon would rebuild, positively benefiting from the tragedy by eliminating its dependency on British commerce. Its citizens offered mutual assistance, thus leading to an enormous increase of a publicly oriented civic attitude.

These views led to a well-known debate between Voltaire and Leibniz with regard to the interpretation of the world. Leibniz argued that all nature had a finality and cause of some sort, calling it a theodicy. In what appeared to be a neo-Aristotelian position, everything had a purpose in nature, according to Leibniz. Voltaire, on the other hand, criticized the medieval notion as absurd. In order to demonstrate why it was absurd, Voltaire wrote *Candide*, as the suggestion that a lake existed simply so that one particular man could drown in it, akin to cork tree made for wine bottles noted by Goethe. One should not mistake consequences for intention and purpose in nature. To suppose that nature and the universe were inherently pastoral was to comit a gross folly.

During this period, however, it was Leibniz's interpretation that became predominant. Though Buffon disagreed with notion of final cause, he did argue for a similar position by noting that there was no room for disorder in nature. The anomalies in nature were always underlain by some deeper order which was ultimately self-regulating. While we may not understand this order today, it was hoped that its greater discernment would occur in the future. The popularity of mesmerism is illustrative of this increasingly predominant world view.

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[93] The Calabria earthquake of 1783 killed 40,000

Franz Anton Mesmer arrived to Paris in 1778, the year of Rousseau's death. By 1784, Mesmer had become extremely famous, popular, and rich. His philosophy, mesmerism, became so widespread, that a scientific committee was formed to evaluate its claims. Mesmer's basic argument was that there was a universal fluid uniting social and natural phenomena; changes in the physical world impacted the social one. Corruption in one followed the other, including the moral order, which echoed D'Holbach's notions in the *System de la Nature* (1770), another popular book of the time. D'Holbach's key insight, that man was not separate from nature, was taken to extremes by Mesmer, distorting D'Holbach's ideas into a "scientific astrology" of sorts not too distantly from Puerto Rican astrologist Walter Mercado.

There can be no doubt that individuals were seeking order to their lives in difficult socioeconomic and political circumstances.

Although Franklin sat on the committee which debunked mesmerism—as a science it was a complete fraud—the social phenomena itself was indicative that a cult of nature had emerged. Nature had become the main source of authority, which was no longer based on classic republican arguments pertaining to virtue, justice, and ethics. This cult of nature was used to exonerate those involved in the violent acts of the French Revolution. By looking at the future state of order, the immediate situation of chaos was defined as justifiable before the eyes of its participants and witnesses. The notion was ironically first applied by Danton, whom reinterpreted the monarchy as residing in a state of nature, which was then used to justify the assasination of the French king. Such rationalizations spread rapidly to other groups, and curiously had been preceded by the xenophobic killing of foreigners.

The monarchy had always claimed that the king was outside of the law, given that the sovereignty of the state was personally held by him, and hence was inviolable by definition. This argument was turned on its head by Danton. Given that the King existed outside of society, he thus existed in a state of nature, and hence became an aberration to justice; in effect

Danton turned the king into a Hobbesean enemy of the human race, given his standing outside of society. Because the law did not apply under this state of nature, society could impose a new evaluation. With such ideas, Danton turns the monarchy's very existence into an act of war against all French citizens.

The notion of natural right routinely appeared during the King's trial; of a total of 102 speeches, 68% alluded to the principle of "natural right". This notion was further extended to other political actors. Given that the people had become sovereign, nobles and the aristocracy as a whole were also criminals, which upset the natural social order by structuralizing injustice. These claims are similar to the Roman justifications for the ending of of tyranny. All tyrants could be justifiably killed in a public forum given their distortion and destruction of the public order.[94]

Ironically, when the Constitutional Convention posited that natural right underlay all civil laws, it ruled itself out of existence. All criminal offenses were thereby defined as absolute, leading the accused to be deprived of all civil and natural rights, implying they could be killed in a period of twenty four hours. There was no recourse to appeal whatsoever.

French Society had basically absolved itself of all moral duty and responsibility. The increased value of the state of nature diminished the role of classical contractualism (positive law) which had been established for the preservation of civil society.[95] By placing moral authority within nature, all restraints were consequently eliminated—inevitably leading to the tragic violence and terror which characterized the French Revolution.

The use of nature to absolve French revolutionaries of all moral responsibility ultimately turned the republic upside down

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[94] Inversely, assasinations not witnessed by an ample crowd were not considered as legitimate, and the perpetrators were treated as common criminals.

[95] If men were angels, there would be no need for laws; given that men at times are evil, the law is thus required.

soon after its very creation, with the rise of a dictator: Napoleon, the very antithesis of democratic rule.

Chapter 12

Shifting Tides

There is a glaring contradiction in Rousseau. As a young thinker, he first expresses his belief that science is morally detrimental, and hence noxious for democracy. Science simply facilitated a broader range of ways in which men could do evil to one another. Towards the end of his life, however, he expressed its exact opposite; for him botany is morally necessary. Only by observing authentic nature could men obtain a true image of liberty: that of autonomous individuals interacting with one another, which had become the bedrock of his philosophical principles. We may, however, account for the contradictory changes in position in that they were simply the result of his natural maturation as a thinker.

It should also be noted that that political independence gave Jefferson and Franklin a great deal of power to mold their societies as they wished, opportunities which were not afforded to both Baldorioty and Acosta, whom suffered the biting oppression of Spanish colonial administrators. Critically, this power was used by Jefferson and Franklin to establish what Acosta and Baldorioty had unsuccessfully dedicated their lives to: universities. Given their enormous importance for democracies, Jefferson formed the University of Virginia and Franklin the University of Pennsylvania. By contrast, even the most modest of political efforts as those of Padre Rufo and his intellectual descendants in Puerto Rico would be continually encumbered.

The importance of education for politics can be easily gleaned by looking at Condorcet's case, whom had worked in much detail what a French Constitution should look like. Condorcet was unfortunately also a victim of the enormous

educational disparity in France, which made the most fundamental of decisions—the formulation of a constitutional infrastructure—rationally impossible.

Jefferson's own views changed as well. In spite of early battles against the anti-American degeneration theory, he does seem to adopt it to some degree. Latin American nations could not develop, because of their degenerate anti-scientific culture. Politicians did not respect majority vote, thus ushered a continual vicious cycle of violence and repression—as Latin America's history so clearly attests. Ignored majorities explode in collective protest and violence, as that of the French Revolution. The fact that Jefferson and Franklin's actions were circumscribed within a democracy, however, means that we also cannot harshly judge them for their failings, such as the existence of slavery in spite of their declarations of the equality of man. Their need to consider the opinion of U.S. southern delegates meant there were limits to the possibilities of their actions. Such is what it means to live in a true democracy: routine compromises which emerge out of the functional need for public consensus.

There is no doubt, whatever the differences of view, that science came to play a role in shaping the ideas and events of the time. All thinkers and politicians sought to use it to improve the nature of the social order, regardless of which science they were particularly influenced by. The application of these new ideas helped revolutionize notions in the political world, key of which was Montesquieu in his proposition of the separation of powers. Although influenced by what we might today call anthropology, his early participation in the Bordeaux Academy of Sciences shaped his worldview. The most direct influence of Newtonainism came by way of America. Jefferson, who could read and understand the *Principia*, and sought to imbue an inherent rational order to North American government and society; just as one would not let emotion stand in the way of a scientific experiment, science and reason would similarly come to structure Jeffersonian institutional arrangements of American democracy.

Interlude: Fashionable nonsense

As scholars we tend to look for latest research, an important and necessary trait few would dispute. During graduate school, one professor recommended that only a review of the last ten years should be done—certainly a good piece of advice for topics with a vast range of publications and active research numbering in the hundreds or thousands. This wise piece of advice allows one to limit the total number, so as to get a reasonable handle on current literature. It also allows one to identify peers in one's field, and obtain a good idea of the current state of research within a reasonable amount of time.

However, we should not be blinded by the inappropriate projection of the scientific ethos. While the notion that the "latest is the best" usually applies to science, as it is often build up out of prior research, it does not necessarily apply to the humanities with its greater value laden structure.[96] The far greater amount

[96] A set of cultural values is being instilled onto new generations of students via their relationship with technology, be it cell phones, laptops, or game consoles, whereby the "latest" has typically come to be regarded as the "best", and in an instant discarding studies simply because of their longevity—something which might be considered a new form of age discrimination. The most worrisome aspect of this is that the tendency opens itself to gross manipulation by corporate interests so as to alter and distort existing academic standards, criteria, and established guidelines. The higher rates of investment allow for corporate backed academic articles to generate a displacement effect, whereby high quality research is removed from the purview of new generations of student populations. This is particularly the case with regard to studies of small state science, as the conquest

of competition to capture ears more often than not only produces a cacophony of voices, much as the rancorous green Puerto Rican parrots or "*cotorras*". Where a great amount of noise exists, it is often the case that the loudest wins.

In 1996, the physicist Alan Sokal was well aware that there is a lot of incoherent trash in academia, particularly in the postmodernist camp. If you have ever had the opportunity to read Derrida, you will enjoy its sophisticated cacophony of words without a coherent thought and much less a consistent and clear logical argument. Recognizing this absurdity, Sokal submitted the article "Transgressing the Boundaries: Towards a Transformative Hermeneutics of Quantum Gravity" to the journal *Social Text,* which was shortly thereafter approved for publication. The editors of the magazine widely claimed it as a revolutionary piece of scholarship, predicting that it would end up changing the field. In a certain sense, we could say that it did—but not in the manner the editors expected.

Three weeks after publication, Sokal revealed that "Transgressing the Boundaries" had been a "fake article" prepared by a computer using an algorithm which randomly selected between a given set of academic phrases. This was not altogether too different than if twelve monkeys had been randomly typing on twelve keyboards, whose result would not have produced the entire corpus of a literary giant as Shakespeare. The incident is now known as the "Sokal affair", which led to the publication of the book *Fashionable Nonsense* (1999) along with Jean Brickmont, a philosopher of science and physicist as well.

Sokal and Brickmont were attacking the sheer dishonesty that can all too often be routinely seen in academia, which is not only shocking, but represents a good example of that cliché that all that sounds good is not necessarily so. One should never

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of the small state represent a temptation to many corporate entities whom have orders of magnitude greater funds than the small state, contributing to the transformation of the small state into a literal captive of gargantuan corporate interests.

mistake the superficial aspects of academic language—diction, tone, and vocabulary—for rigor, logic and clarity. In fact, this is such an old problem in academia, that it was even alluded to by Francis Bacon during the sixteenth century in his "Idol of the Marketplace", criticizing the tendency towards a shiny surfaces covering over a dysfunctional luster. The sophisticated but unclear language often found in academia only lends itself to misunderstanding and conflicts rather than intellectual progress.

Sokal and Brickmont lead us to another important academic lesson. One has to be aware of broad categories of the literature one is interacting with; know the nature of the continent where one is standing, or as it is popularly said, learn to recognize the forest for the trees. Doing so will allow us to move much more comfortably in the literature, and avoid that unpleasant sensation of disorientation in the light of the vast amount of academic material that exists. Two particular examples can be given: the internalist - externalist debates in the history of science, and the distinction between Hispanic and Anglo-Saxon literatures of science.

The historiography of the history of science has been marked by distinctive periods of intense intellectual activity along certain lines, which developed unique exemplars of their kind. During the 1960s, Steven Toulmin, a philosopher of science, and June Goodfield, a historian of biology, created a small three volume series that stand out as some of the best exemplars in the field. Each volume looked at the history of a particular field, as astronomy, chemistry, my favorite one being the last: *The Discovery of Time* (1964). In it they explore the gradual awareness in Western culture of the vastness of time, in a manner not all too different from the discovery of the infinite universe, but in its chronological aspects. There is something to be said about subtleness of their ideas, and the original mix of science and philosophy that was an enormous joy to read.[97]

[97] This book was my first encounter with the history of science, and drew me into the field.

Contemporary history of science might be characterized as having a far greater focus on the social aspects of science. This historiographical trend is particularly useful for the study of particular periods, such as the rise of Nazi science, by analyzing a history made up of multiple layers that intersected at certain junctures. While certainly works of this realm are very important for the field, helping to account for its darkest moments, they could not be classified as intellectual jewels focusing strictly on the world of ideas.

A similar dynamic has perhaps occurred with regard to the notion of a Western Canon, or a body of literature that was formerly seen as so important that at one point it was a requirement for all university students. Certainly, this might have been overdone in the past, typically by insisting on the learning of Greek or Latin languages, but its general importance has to be recognized—as well as the deficiencies produces by an educational system which overlooks key works which produced the Western cultural legacy. These works are still important to know, and students need to be placed directly in touch with the foremost thinkers of the past to obtain the fullest appreciation of their own cultural heritage.

Again, today there has been a pendulum swing in the opposite position, a pattern well observed by Bertrand Russell in his *History of Western Philosophy*. The Western canon is now defined as "bad" and "eurocentrist", and not valued as highly as before; it is "patriarchal" or "narrow-minded" and "outdated" according to some. As Russell noted, the extremes tend to be noxious; what are you losing when the pendulum swings too far to one side?

Whatever might be argued against the study of the Western Canon, there is no doubt that we live in a Western world characterized by a given set of values which allow for rights such as free speech. It is therefore imperative to not only understand the true nature of these concepts, but also to know why and how these values came into being in the first place. This will allow one to better appreciate one's own society, as not all societies have such freedoms. Women living under the Taliban have been

openly stoned to death, while rival political candidates in Russia are routinely poisoned covertly, which further stifles its political atmosphere. That so many Trump MAGA followers rejected the use of masks by claiming it as a restriction of liberty only reveals their ignorance of their own Western political traditions as well as the increasing cultural decay of the United States.

The second example is that of the joint field of science and literature. How has the development of science impacted cultural expressions? The differences between the Anglo-Saxon treatment of the topic and that of the Hispanic world could not be more different, and greatly emerge out of their own distinctive scientific legacies—or lack thereof.

The topic "Science and Literature" is a substantive field of study in North American academia, with a whole host of resources, journals, bibliographic guides, and literary reviews. It began seriously at turn of twentieth century, with the exemplary work of Marjorie Hope Nicholson, whom almost single handedly founded the field during the 1940s. Her biography interestingly reveals that although she wanted to study philosophy, at which she was particularly good, she was advised by her counselor not to enter the field as it was likely she would not be hired. Philosophy departments the time simply did not hire women, and most women of that era usually end up in the field of literature.

Upon entering the academic world Nicholson became the only woman to teach at an Ivy League in 1940s. Oddly, she discovered intellectual history after obtaining her PhD. On a whim, she decided to attend a few classes at Columbia University with Arthur Lovejoy, whom was a recognized historian of science. Nicholson was ultimately able to fulfill her dreams of being a philosopher. She became editor of the *Journal of the History of Ideas.* At one point, she observed that since WWII, the calier of U.S. universities have declined due to the huge influx of soldiers, which led to a lowering of entrance standards.[98]

[98] The first widespread use of IQ tests were done by US military in the period, and its results were nothing to boast about.

The level of sophistication and development of the field can be obtained by noting that the Modern Language Association (MLA) has a section "Literature and Science", and there are entire bibliographies and encyclopedias written on the topic. This is to be greatly contrasted to that of Hispanic literature.

In contrast to the Baconian and Cartesian emphasis on clarity and logic, the seventeenth century Hispanic literature known as Baroque was its complete opposite. The Baroque is characterized by its incoherent langue: it is complex, obtuse, and one full of double meanings. This literary style actually has a great deal in common with medieval philosophy, and both are horrific to read given their unnecessarily complex expression. These traits, interestingly enough, also coincided with those of alchemy, which again is similarly characterized by unclear language and inconsistent terminology. That chemical references go by different names make it rather unclear to which element or combination is actually being referred. In the field of chemistry, exactitude can mean the difference between life or death of the experimenter.

The delayed entry of the Hispanic world into the ambit of modern science was due to multiple self-reinforcing factors. For example, the Inquisition created an environment of fear given the arbitrary nature of its arrests and persecutions, lacking any habeas corpus. Strange as it might seem to us today, one could not know the nature of the charges against one, the evidence used, nor did one have a right to question witnesses. This environment led to an enormous difference between the two respective cultural worlds, British and Spanish.

The attempts to study the relations between Hispanic science and literature can only result in bouts of delusional insanity. There is no internal consistency, its conclusions are difficult to understand, much less prove, and can be less reliably sustained as the grounds on which they are based do not "exist". That they should be utterly confusing takes us back to the study of Sokal and Brickmont. We may suggest that the lack of clarity and clear thinking of Baroque literature might have been due to the danger implicit in the discussion of science in Spanish

America, given the constant menace of arbitrary Inquisitorial arrest.

There is an important lesson in all of this. The reader should always ask himself, "Do I really understand this? Does this make sense? Does the evidence support the argument; or is the argument logically sound?" If this is not done, the young scholar might end up wasting a great deal of time on research that will have no long lasting value. In some cases, the "eternal student" tragically wastes an entire lifetime in their quixotic endeavor. Do not presume that just because you may not understand its meaning, that it is a necessarily significant academic study.

Humanity has a unique capacity for self-deception.[99]

[99] Sidky and Thompson are two separate scholars who have recently continued the work of Sokal and Brickmont.

Part 5

Scientific Rebels

Chapter 13

Lavoisider, War Hero

Danish astronomer Thomas Bugge visited France during a period of relative peace in 1798, spending six months there in an official capacity. Bugge had been invited to participate in an international conference on weighs and measures, and so was able to see more than most foreign visitors. While Humphrey Davy also visited Paris during this period, he did so only in passing and left no written memoirs. The Copenhagen observatory had been bombed by the British and was in process of reconstruction; it was the same observatory famously guided by Tycho Brahe as a key, though unwilling, member of the Scientific Revolution. The observatory had also been previously directed by Roemer whom was the first to provide a good estimate of the speed of light, using Jupiter as a measuring stick—an impressive achievement for the time.[100] Bugge's memoirs thus provides a good look at science during Revolutionary France towards end of the eighteenth century.

Bugge shows that the role of the scientist had been surprisingly elevated as a result of the French Revolution. Scientists as Berthollet, Fourcroy and Monge saved the nation from utter destruction. France was wholly unprepared for a war with Austria, needing 650,000 muskets but producing only 50,000 per year, and had only 25% of the saltpeter needed for gunpowder. The likelihood of defeat was imminent—had it not been for the heroic efforts by French chemists during the war.

Berthollet and other leading chemists began distributing thousands of pamphlets, which enabled the agile production of munitions throughout France. These pamphlets included

[100] The speed of light was not "infinite," as previously believed, but had measurable limits to the surprise of all.

instructions on the smelting of copper from church bells for muskets; the production of steel as carbonizing iron made it much stronger. They also provided instructions for the production of saltpeter using new chemicals which were more readily available, as potassium chlorate and potassium nitrate, along with a whole host of other topics.

Some 12,000 pamphlets were distributed throughout in all corners of France, which boiled down complex scientific knowledge into their bare essentials, understandable to the layman. These provided for the direct means of action throughout France, leading to a drastic increase in munitions. The nation had more resources than was imagined: noble holdings and church properties were confiscated and turned to useful ends.

Seemingly arcane reports that had lain dormant for years suddenly gained importance, as the Leblanc process for making sodium carbonate and its multiple byproducts such as glass. Others included the making of soda ash from common salt (sodium chloride), which was obviously in greater abundance. Some of Lavoisier's own reports were published under a pseudonym in spite of fact that the Revolution had killed the father of chemistry. Chemists, in short, turned the near certain military defeat of France around, which otherwise, would today no longer exist as a cultural entity.[101]

Saving France thus had greatly elevated the social status of the scientist; the notion of a "*savant"* was now held in highest national esteem. It was no longer perceived that scientists were locked away in ivory towers, isolated from rest of society, but rather their work was of direct and unquestionable benefit to the nation and deeply integrated into society. The change is similar to that which occurred to the physics community after WWII.[102]

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[101] While there would still be people, there and some political form but not the unique political entity based on a common culture what we refer to as a nation.

[102] As is well known, physicists created the atomic bomb, two of which helped put an immediate end to the war that looked like would last until the last breath of the last Japanese soldier. As is

The change in status was quite significant. Prior to French Revolution scientists had been forbidden from holding political office; they now commandeered entire institutions. Berthollet and others in effect established a global system of education for all of France via the *écoles nacionales*, 97 in total. Science had now become a central component of education, ironically following plans which both Lavoisier and Condorcet had established. This system had been based on the "revolutionary *écoles*" formed during the war, which had also facilitated the transfer of knowledge from Paris to the provinces in wartime.[103]

Science was transformed into a key component of culture in France. Meritocracy, which had nascently existed in only a few centers as the *Academie des Sciences* and some regional academies, became institutionalized throughout the entire French educational system.[104]

Science was also elevated at the popular level; individuals came to privately cherish science and draw personal identification from scientists. When Bugge interviewed Lalande, an old French astronomer, Lalande commented that he had never seen so many students interested in the exact sciences. He had been teaching for some 50 years, and was utterly astounded with the drastic increase he witnessed. To be a scientist now meant to be a national hero. Scientists in effect had become the most

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now well known, this action drastically raised their status and social standing, regardless of the later geopolitical implications it might have had decades later.

[103] Two young men, aged 26-30, were sent to Paris for a crash course training on critical military topics. They were, for example, shown how to established manufacturing operations, and took back with them what learned to the provinces of origin.

[104] One unfortunate byproduct is that that there was a consequent hypercentralization of French science; whatever power differential existed between the capital and the provinces was further increased. Paris became the focal point of all scientific activity, which served to undermined regional academies, as that of Bordeaux to which Montesquieu belonged.

important patriots, saving France at the last minute like a basketball player making a long shot at the last second. They became models to be imitated and cherished, again much like physicists in the U.S. after WWII. While their French counterparts did not have the same "radical" creations as that of the atomic bomb, their work was nonetheless just as impactful. Their respective military victories transformed scientists into saviors of the nation.

It is curious to ask, who will be the future scientific heroes of Puerto Rico: chemists, astronomers, biologists? It is hard to predict beforehand, as it will depend on contribution and the social context in which these contributions are made. The utilitarian aspect of science and its role in the preservation and success of the modern nation state is no less meaningful.

Chapter 14

Linnaeus

The discovery of America had profound repercussions in the European mind, and was a contributing underlying factor to the Scientific Revolution in various ways.

First, there was a shift from a definition of nature as a symbol to that looking at it in-and-of-itself; not as a symbol of God's intention or punishment, but rather for its own internal meaning or for its own sake. Second, there was a breakdown of the notion of the uniqueness of Christianity. New world people had their own set of religious beliefs, which were very different from Western ones in Christianity, be it Protestant or Catholic. That such Western religious beliefs were not universal raised questions about their nature and transcendence. Giordano Bruno during the Renaissance had argued for the existence of other worlds—a plurality of universes—something for which he was burnt at the stake. Bruno's theoretical claims blasphemously suggested that Christ was not universal; the discovery of America proved the idea as an empirical fact.

Finally, there was the emergence of the notion of novelty. Curiosity was something that had been frowned upon during the medieval period. There had been many prohibitions to the "inquiring mind", and it should be remembered that the fall of Adam was seen as having been caused precisely by curiosity. Pope Innocent III prohibited astronomy and monks were given manuals to stifle curiosity, defined as a sin by Isidore of Seville.

The discovery of the New World also drastically expanded the number of species known. Aristotle had identified some 500 species of animals while Theophrastus added 500 more species of plants and Discorides some 600 species of animals, whose total could be rounded out at some 2,000 species. By 1700, the number of known species had drastically jumped into the tens of thousands. John Ray in his three volume study of

plants identified 18,600 species alone, not counting animals. By the time of Linnaeus, the number of living organisms had increased to some 70,000 species.

It is somewhat hard to describe how momentous of a change this was, akin perhaps to the leap from the closed Aristotelian universe to our infinite universe, per Koyre. This drastic increase in the number of species naturally led to an utter taxonomical chaos, as one might imagine. This exchange of biological products is defined by Alfred Crosby as the *Columbian Exchange*. New world animals had neither been accounted for by Greeks nor could be found in the Bible, nor were they listed in the works of Pliny the Elder for that matter.

Europe acquired many new products: maize, beans, peanuts, potatoes, pumpkin, tomato, sweet tomato and so forth. So profound was the adoption of new world foods, that they often came to falsely be attributed as being of European origin, as the tomato in Italy, the basis of pasta. Manioc (*yautía* in Spanish) in West Africa also originated from the Americas. One third of all major food crops are today of American origin, and contributed to a population growth in Europe. As a percentage of total global population, Europe grew from 16% to 20% relative to that Asia.[105]

The reason for the original voyages was to replace the spice trade in the East, bypassing Middle Eastern routes. The enormous importance of spices arise not only because of their pleasant taste but because they are medically beneficial; they all have antibacterial properties. Oregano, *romero*, salt, pepper, and so forth all destroy bacteria pervasive in meats any other edibles. Natural selection dictated, generally speaking, that foods which taste good are beneficial to body, while foods that taste bad, usually are not. Unripe fruit, or example, is more acidic; their

[105] Europe in turn contributed new species to the Americas as sheep, cattle, pigs and horse. Some thrived in their new environments, as the omnivore pig; when left to populate in islands they later became an readily accesible source of food, as the *lechón asado* (roast pork) of Puerto Rico.

turn to sweetness help spread seeds large and wide, benefitting both consumer and consumed.

Many new world plants were also medicinal, cinchona being the best case as it was an effective treatment against malaria. The indigenous knew about its medicinal properties, and through them, this knowledge was passed onto the Jesuits, whom had a series of advantages the native Americans lacked. The network of 800 *colegios* (schools), the common language of Spanish, and the use of paper and print allowed new discoveries to be easily diffused easily throughout their Hispanic networks, which was the used to proselytize. The identification of the Jesuits as the new shamans also help explain why so many were brutally killed.

Another example was ginger, and its case shows pattern that would become worldwide: the case of biological prospecting and transplantation.[106] The colonization and conquest of new lands was deeply tied to obtainment of tropical materials from the New World, which gradually turned such materials from being exotics to daily necessities.

Ginger actually originated in China, and was transplanted to Hispaniola and Puerto Rico; it was seen as aiding in digestion and appetite, thus becoming an early source of economic growth during early colonial period, even if it was short-lasting. Hard as it is to believe nowadays, ginger became a enormously profitable market, more valuable than sugar during the sixteenth century. In 1587, two million pounds were exported to Seville annually. In 1606, 6,742 slaves worked on production, which can be contrasted to the 800 slaves laboring in sugar plantations.

In Puerto Rico, between 1582 and 1599, more than one million tons of ginger were exported to Seville, a considerable amount even today. The local island production began in 1564 with 100 tons exported. A report to the king showed some farms with 6,000 *arrobas* of export. Puerto Rico was the second largest exporter to Spain, Cuba then only exporting 2.7 tons. The *Consejo de Indias* tightly controlled the sale of this important commodity. When it was discovered that ginger could also be

[106] The case of Puerto Rico is detailed in Moscoso's work.

grown in Spain, the Caribbean market collapsed. It might be said that Puerto Rico was on route to becoming the "Haiti" of Spain, when we consider that Haiti produced sugar for nearly all France, one half of the world total in 1791.

The case of ginger is also illustrative one of the principal problems of being a colony: that of colonial dependence or the inability to control one's destiny, being subject to interest of other. Success under such circumstances usually leads to poverty, due to the unfair terms of trade.

Without a doubt, the discovery of new botanicals were a financial boom for Europe, stimulating the growth and development of botanical gardens, and later experimental stations. The first botanical gardens, however, had no plants at all and were of Roman origin, mimicking the biblical Garden of Eden, full of trees and fountains. Some of the most majestic can still be found in Andalusia (Spain). In short, the early botanical gardens were places of spiritual renewal, and hence were usually private in character. They gradually became public as they came to be associated with royalty, which increased the social status of its host.

Cabinets of natural history in 1730s were ostentatious shows of status, consisting of costly exotics placed in richly embroidered casings and a part of the early European system of patronage system. Carolus Clusius was hired by Maximilian II (Russia) for this reason. However, when the new emperor Rudolf rose to power, Clusius was dismissed—a common pattern that also existed in medieval Arabic science. Patronage systems were unstable by their very nature, and a scientist's income was always subject to the whim of ruler, a phenomenon similar to Arabic science in the hands of the caliphs.

The realization that plants could be useful and profitable altered their role and surrounding social structure. Botanical gardens became "botanical" as we know them today, in that they began growing a wide diversity of exotic plants. Medical faculties began requiring their establishment, leading to its increasing institutionalization. The formation of "herbaria", or catalogues of plants, also emerged during the sixteenth century.

Such was their growth that the most important biologists at time were typically associated with particular gardens, as Joseph Banks at the Kew Gardens in England. There was also a distinctive shift of outlook and mindset, which reflected the broader shift in mentality between the medieval period and the modern era. Conrad Gessner is good example. His emblematic natural histories sought in wildlife the teaching of moral lessons. The fox's intelligence was far more important than its strength. The fox would confront two hounds at the same time, offering moral lessons about the value of self-confidence. In that most dens were already occupied showed the painful lesson that what one desired was often already possessed by another. In these natural histories, the world was observed not for what it was but for what we needed it to be, offering moral lessons and personal guidance.

After 1650, emblematic natural history began to disappear, becoming more concerned with the strict scientific study of plants that only botanists could adore. Their growth was particularly acute in Germany and in north Italy, which led to an earlier appreciate of the enormous discrepancy to the classics. Leonard Fuchs was an early precursor, whose rich, accurate drawings set the ideal model early on. This northern region became the most studied area of the entire world, which is surprisingly still true today.[107] Natural history becomes eminently "boring" for the general public, as it was written principally for other botanists with an emphasis on minute and apparently insignificant details.

New World species ultimately created the problem of organization for European biologists. The number of biological entities were too varied and had grown too large, thus creating an urgent need for a new system of categorization. There emerged multiple classificatory systems, one of which was Tournefort's. His system however, was unsystematic and non-theoretical: every time a new species was discovered, the entire classificatory

[107] For an interesting discussion of this topic see Cooper.

system had to be redrawn.[108] The use of Tournefort's taxonomy turend into a logistical nightmare for botanists, who soon came to appreciate the various benefits of the Linnaean system.

The Linnaean classification system easily described a plant's key traits, which could be quickly compiled in a small book—which made it cheap to produce. In contrast to other systems, it did not require expensive illustration and drawings, which drastically increased their price, and reduced the potential number of users. Linnaean books were so inexpensive they could be obtained by anyone. They were written in a simple, clear, and unadorned language, distantly removed from a Baroque style or the obtuse languages of other systems. One simply needed to count the number and arrangement of a plant's sexual features to easily place the plant into a universal classification scheme. It is no wonder Rousseau was so enamored by it.

Linnaeus established a taxonomical hierarchy, easily remembered by the following phrase: "kings like to play chess on Fridays, generally speaking", alluding to the kingdom, phylum, class, order, family, genus, species hierarchy. Linnaeus also identified the lineage of man as "homo sapiens"—human beings placed as an intimate part of the natural world along with other animals. The term "mammalian" was identified by Linnaeus at a time when issue of reproduction very much became a concern in Sweden, whose low rate is still problem today.

Buffon in this sense had a very different mentality, often stating "*aquila non capit muscos*" or eagles don't catch flies. As a biologist, Buffon was more concerned with the broad overall picture rather than the little trivial details which he found to be "below" him. However, it is the small insignificant details that would create various scientific revolutions in the natural history. Ironically, while Linnaeus did not believe in evolution, he created the necessary tools required to prove its existence. The history of science is full of curious little ironies and unexpected outcomes—some large, others small.

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[108] A similar problem can be observed in early databases, which had to be redrawn with every new entry.

The causes of Linnaeus's strong utilitarian stance are fairly easily understood. Sweden had been beset by the continuous famines. The tragedy of seeing young children starve outside one's window as a university professor would shock even the most complacent today. Sweden would shift from nearly a century of war mongering to a battle for the economy. Linnaeus's notion of "cameralism" is similar in spirit to the idea of import substitution of Latin America in the 1970s, and had the same problems. The ideas was to locally produce every consumed item. However, as this was done via the protection of elites, it inevitably led to stagnant state industries that charged too much for a mediocre product. For Linnaeus, however, cameralism implied the importation and acclimatization of non-native species, which in theory would create new economies and amplify Sweden's food base. His binomial nomenclature was oddly seen by him as a secondary aspect of his principal economic policy—inverted to the manner in which it is understood today.

We may mention many such examples, the most notorious being that of China tea. On a number of costly occasions, Linnaeus attempted to get others to bring the plant to Sweden from China, whose samples underwent rather long and perilous journeys that few specimens ever survived. One plant that finally was successfully transported undamaged to Sweden, tragically ends up being eaten by the ship's rats shortly after the sailors went on land upon arrival. It had been the only plant to have survived the trip. The most successful example, on the other hand, was that of mulberry trees imported from the United States, required for the creation of a silk industry.

Linnaeus went on to actively support and participate in the creation of institutions for these ends, as the Swedish Academy of Sciences in 1739, originally named the Economic Society of Science. His publications were usually in the vernacular, and his educational proposals are remarkable in contrast to today's presumptions. Linnaeus argued that the university had to teach practical skills to every university student, rather different from today's universities where technical

education is implicitly frowned upon. What was "practical" during the eighteenth century was defined rather differently: learning how make pitch tar, firewood, bread; how to cure scurvy, and so forth. These were basic survival skills required in its particular Swedish environment.

Linnaeus also attempted to turn courses of natural history into a university requirement for all degrees. His efforts were often stillborn, but there are funny anecdotes in this regard. Physics and chemistry were both required for a degree in economics which hindered and frustrated many students. While a bit odd today, it is illustrative of his idea that science was a critical ingredient for economic development. He would often go too far in his ambition, however, placing the lives of his students in mortal danger.

Of Linneaus's nineteen students that would go on world-wide trips between 1745 and 1792, five would perish—including Pehr Löfling, one of Linnaeus's brightest students who died while traveling throughout Latin America. Prior to his demise, Löfling had shown that acclimatization, the key idea behind Linnaeus's projects, was patently false. In contrast to tropical flora, the plants of northern climates had protective buds, without which they would otherwise be exposed and whither. Löfling suggested the more realistic approach of employing a gradual intergenerational shift northward. Peter Kalm for his part traveled to the United States and was able to successfully return with his life intact and a mulberry tree, providing the foundation on which a silk industry could be established in Sweden. He became a professor early on, but came to detest the large number of expenses he had to pay out of pocket.

Incidentally, Linnaeus's doctoral students did not write their thesis, and in most instances the 40 page long essays were usually written by Linnaeus himself. The student was only expected to translate the vernacular thesis to Latin—a training very different from today's more rigorous approach.[109]

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[109] The case of China forms an interesting contrast to that of Sweden. In 1645 china closed off to the world after having

Linnaeus's eighteenth century case is an interesting counterpoint to Haskins's argument, clearly showing the narrow-mindedness of his 1950s definition of science. Haskins believed that modern science was only defined by "big science", thus created a set of conditions and criteria which would have been difficult for any nation, other than the most powerful as the United States after World War II, to comply with.[110] Implicit in Haskins's world view is the notion of "take off" by Walt Rostow. For Rostow, as for George Basalla in his "Spread of Western Science," there was an inevitable three stage take off model whose failure to successfully undertake implied an intrinsic national-cultural weakness of that state or nation. Haskins's biased definition of science meant that there were apriori technological and financial constrains to scientific participation, which in turn implied that small states could never hope to become "scientific" and achieve sustained economic development.

"Modernity" so to speak, would thus be inherently restricted by the state's very nature and socioeconomic size; the small state for Haskins would forever exist in a condition of underdevelopment.

Linnaeus's case shows Haskins's claims and presumptions to be false, and it should be emphasized that there are many more sciences other than physics, which are not inherently "big" in terms of price, technology and organizational structure.[111] In this context, it is important to discuss the notion of "appropriate technology", now forgotten but so commonly seen during the 1970s.

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expanded and exploring to Africa, and some argue that had reached the Americas. One has to wonder how the exposure to foreign ideas would have altered that nations" political history.

[110] Given this mindset, it was hard for Haskins to understand China's failure at a scientific revolution, in spite of having invented key technologies as compass, paper, or fireworks.

[111] Some fields of modern physics can be defined as being more mathematical in nature than technological.

In its simplest form, one does not need advanced machinery to link science to the economy, but rather the only technology that most appropriately suits a locality's given needs. Focusing our attention on the latest and most advanced technologies blinds us to the reality of local circumstances. In other words, it does not require millions of dollars to build technologies to meet a locality's needs, but rather these targets can be met within the constraints established by the local resources available—be they financial, scientific, technological. What is required is the creativity and originality necessary to meet existing needs—which implies that the accumulation of human capital is valuable in and of itself. Human capital allows a nation to create economic value out of thin air, specifically those that arise from ideas and discoveries, which further reduce a nation's external dependency.

The blind obtainment of foreign goods falsely presumes that all is greener on other side. We have to "*ser fiel a nosotros mismos"*, be true to ourselves as dependency has a noxious impact on cultural values and degrades mutual collaboration and the common sense of identity.[112]

[112] Phrase comes from Antonio Fernós with a book of the same title, of no immediate family relationship to the author.

Chapter 15

Latin American Independence Movements

It might be asked whether science was an intrinsic factor to the independence movement of Latin America in the nineteenth century or whether it was only a secondary feature, incidental and accidental to it. Did the search for autonomy simply reflect broader conflicts over institutional power, which occur in every area of human activity as in the world of sports, or was science intrinsically a major source of contention between Imperial Spain and the Creoles of Latin America, of which Puerto Rico was a part of during the long colonial era.

Thomas Glick, one of the foremost historians of science in Latin America, assigns a low rank to science as a historical cause of its independence movmeents. An influential scholar of Spanish history who studied formation of canal systems in medieval Spain, Glick reveals close intimate ties to the community he studies, which suggest biases in his analyses. If Glick had argued that science had been a central component of the revolutionary movement, it would make Spain look poorly, given the context of the black legend we alluded to earlier.

We are here, however, entering Plato's cave, where the play of light upon the cave walls deceives us as to its validity.[113] While nobody would deny science played a role in Latin American independence movements, the degree to which it did is up for debate. Both Glick and Ramos Lara describe conflicts over institutional power. In Glick we see an ample discussion of the case of New Granada where Mutis and José Francisco Caldas wanted greater control. In Ramos Lara, we witness the tragic loss of control over the *Seminario de Minería*. In spite of the fact that

[113] As Socrates noted, many people fool themselves by blindly accepting what they are told, without critically questioning it.

a Mexican scientific Creole Vazquez proposed the scientific institution, it was the Spanish scientist Elhuyar who ended up controlling the body.

Science was obviously a key feature of the conflict between Spanish and Creole Americans. There was a pervasive battle between scholasticism and modern physics, or between Linnaean taxonomical classification to scholasticism but also to the indigenous.[114] The only manner in which one's preferred methodology or epistemology and world view would grow and spread was for that group to obtain institutional control, thus the debate over this external control became key to local intellectual advancement given the colonial nature in which it was situated. While in the West these dynamics are taken for granted, given the well established value of the scientific worldview, this was not a benefit Creole scientists could assume of their monarchical counterparts. Our contemporary biases should not lead us to undermine the enormous difficulty of scientific practice within a repressive and arbitrary Spanish colonial setting.

Science, however, does not strictly align itself with nationalism per se. While in New Grenada Francisco José de Caldas was an avid Newtonian physicist and astronomer, in New Spain Spanish scientists had lent support to Linnaean taxonomy, the accepted scientific model in botany today. Thereby, "science" and "nationalism" in this sense did not strictly and mutually align, as if to say that all nationalists were modern scientists and all colonial authorities were strict scholastics. History is not so clear cut as this. That being said, there was an unquestionable amount of eurocentrism, which intrinsically assigned a lower value to indigenous classification and taxonomy, so well exemplified in the case of Francisco Hernández. We may conclude that, in spite of minor iconsistencies, science and nationalism did broadly align in colonial Spanish America.

If we look at the historical development of non-Iberian European science, a similar pattern emerges. Contrary to what

[114] There is enough evidence to suggest the conflict between scholasticism and Newtonian physics raged in the Puerto Rico of the nineteenth century.

might be presumed today, science did not emerge within the traditional university academic setting, but rather outside of it. Many of the most important key figures are examples of this trend. Copernicus was not a university professor but rather a bureaucrat in Poland. Tycho Brahe was a wealthy aristocrat due to fact that father had saved the prince's life and thus operated outside traditional academic institutions, as his assistant Kepler. Although Galileo had been a university professor, he ended up as a courtier for the Medici. While an exception could be made for the most important figure of the Scientific Revolution, in that Newton was a professor at Cambridge University, this is to stretch the truth a bit. Few students attended his class, and his principal arena of influence occurred as life-long president of the Royal Society, imbuing it with a cultural prestige and worldwide recognition.

In contrast to Spain, monarchical associations did not necessarily preclude scientific participation or collaboration in the rest of Europe. Most important practicing scientists had some sort of royal patronage, and hence did not necessarily need to compete over the few available academic slots at traditional universities. Galileo was constantly attacking scholastics at the various universities he worked. Galileo curiously obtained a great deal of pride from being a member of the *Academia de Lincei*, and had been one of the first Europeans to see early natural history material from Latin America, specifically Hernandez's famous work, for which he was duly impressed when asked to provide an opinion.

In short, the alternative institutional settings in Europe which existed outside of traditional academia, were associated with royal patronage. However, the situation of conflict over institutional control was so pervasive throughout Latin America precisely because Spain, and by extension its colonies, were completely bypassed by the rest of Europe during the formation of modern science. Spain's isolationist colonial policy meant that she would miss out from one of the most important revolutions of

intellectual history to have occurred in human history, the formation of modern science.[115]

Given that the relationship between the Spanish monarchy and Catholicism was far more profound and intimately tied, and even intruded deeply not only into Catholic institutional structure in the region, meant that such alternative academic opportunities available to the rest of Europe were not availabel to Creole scientists. Remember that Spain itself was deeply committed to defending the Catholic religious ideology it controlled in the Americas, whose institutions also acted as a powerful economic force within the region. When combined with the rigid control the Spanish monarchy had over local government, society and the economy, it can plausibly be argued that science inevitably led to a direct clash between the two parties.

The tendency to exculpate key institutions as secondary factors in Spanish intellectual and social history can also be observed within the history of another prominent religious institution: the Inquisition.

It is rather erroneously argued by Spanish scholars that the Inquisition did not suppress science, but rather that it was merely an incidental aspect to the delay of modern science in Spain. For them, the principal battle was that between Protestantism and the forces of the Counter-Reformation, not between Spain and science—and hence that science was but a secondary victim of broader religious conflicts. Such an exculpation could be defined as a posthumous secular letter of "*indulgencia"* for Spanish colonialism as a whole.

Whatever the actual motives, the final consequence remains the same: the repression of science and, ultimately, scientific backwardness which even Catholic France greatly frowned upon. While today everybody generally recognizes the importance and cultural-economic value of science, such was not the case during the Spanish colonial period. Spanish apologists are today merely swimming with the tide of popular opinion, instead of directly confronting key historical problems of Spanish culture and religious traditions.

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[115] Fernós, *En Busca del Fénix* (2006).

To deny the existence of active intellectual repression is to avoid a critical issue in Spanish intellectual history during the colonial period, aside from undermining the courage and determination of historical actors who sought to push intellectual progress forward. This is very much the case with Jose Julian Acosta, whom although merely sought a more inclusive incorporation of Puerto Rico into Spanish politics, was inevitably beset by the intellectual implications of this association. In spite of talking about the importance of science and the history of science in his works, Acosta never mentions Newton by name. Sir Isaac Newton shines by his absence, and his case clearly reveals that there was an active suppression of science in Puerto Rico during the colonial period.

Therefore, one can conclude that science, was an integral component in the fight for greater autonomy and sovereignty in Puerto Rico and Latin America. To have remained within colonial Spain would have been to persistently live in medieval Aristotelism in spite of its obvious obsolescence.

Chapter 16

Acosta

Jose Julian Acosta is one of the emblematic figures of the Puerto Rican Englightenment during the nineteenth century. He returned to the island with Baldorioty in 1853 from Spain, where the two had spent seven years studying science. They also traveled to key European scientific cities as Berlin (Germany), Paris (France) and London (England) to further deepen and expand their scientific training. Acosta plays a key role in the democratization of Puerto Rican society, helping shift the island towards a greater and belated popular sovereignty. Though the full obtainment of sovereignty was never completed, the move did help the island's broader acquisition of political power within the Spanish colonial setting. Even this small victory was fairly short-lived, however, interceded by the 1898 Spanish American War, by which time Acosta had already died (1825-1891).

Along with Baldorioty, Acosta played a key role in Puerto Rican abolitionism, arguing in Spain for the abolition of slavery, which was obtained in 1873.[116] That year in fact was special one, seeing the establishment of Spanish Republic, the legal end of slavery, and the creation of political parties, specifically the *Partido Liberal Reformista* by Acosta. All parties in Puerto Rican history owe their origins to this main one.

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[116] There is a good analysis of Acosta's civil rights battles by Teresita Martinez Vergne in her masters thesis written while the University of Texas (Austin). The thesis is available at the *Coleccion Puertorriqueña* at the University of Puerto Rico, Rio Piedras campus. It is a rewarding and insightful work, and thus highly recommended.

While studying in Spain, Acosta participated in the *Sociedad Recolectora de Documentos Históricos de la Isla de San Juan Bautista de Puerto Rico* (1851). Many things we take for granted today did not exist back then. There were no available historical materials about Puerto Rico in the island, forcing one to go to Spain to obtain these, and even then access was limited. Many of the historical documents obtained, as Iñigo Abbad y Lasierra's natural and civil history of the island, had actually been borrowed from a Cuban in exile, Domingo del Monte. This particular edition allows Acosta to write his own history of Puerto Rico in the footnotes given that it was forbidden to write history as a Creole.

There were contentious fights over what the past meant in colonial Puerto Rico, often of the most trivial nature. The issue as to where Christopher Columbus landed in Puerto Rico has been a surprisingly prominent debate in spite of being historically trivial, as well as an issue which ignores far larger and more important questions. Creating a particular historical interpretation during the ninteenth century was tantamount to blasphemy, and helps provide an idea of the political role the discipline of history itself assumed in the nineteenth century.

The group took advantage of the opportunity. The small cluster of Puerto Ricans studying in Europe copied the copious documentation by hand, while at the same time they were obtaining their science degrees at the University of Madrid. This was an enormous sacrifice at the time, particularly when seen from today's digital era where entire collections can be so easily copied and transferred with the press of a button. These efforts were actually led by Baldorioty, and included Betances, Ruiz Belvis, Tapia, Brau, and others. It is during their stay in Spain that Tapia visits them during his brief exile due to problems with colonial authorities. Both Acosta and Baldorioty take him up, as he had nowhere else to go. Though not a scientist, Tapia takes science classes which contributes to shaping his worldview.

The collective efforts of the *Sociedad Recolectora* resulted in the *Biblioteca Histórica de Puerto Rico*, published by Tapia in 1854 upon his return to Puerto Rico: a compilation of

original documents of over 587 pages. Again, the significance of their monumental efforts cannot be emphasized enough, as Puerto Rican history did not exist—at least not one written by Puerto Ricans. Salvador Brau becomes the first local historian, while a truly modern version would not be written until the publication of Fernando Picó's *Historia General de Puerto Rico*, odd as that might sound.[117]

While in Europe, Acosta was fortunate enough to meet Alexander von Humboldt. Humboldt, whom had previously traveled throughout Latin America, had met people from all social strata, including Simon Bolivar. Upon meeting Humboldt, the latter would relate anecdotes of Caldas whom he had personally known, likely stimulating Acosta into his history of science articles.[118] Acosta liked to recall that as boy he tended to read anything that could get hands on, and one day came across a book mentioning Francisco José de Caldas, becoming intrigued by him. A particular phrase of the book struck him "*Malogrado naturalista*!"

Acosta realized that, lacking historical material in Puerto Rico, any serious research would have to be done in Europe, so he prepares what appears to be his first history of science article. He produces a brief biography of Caldas, with whom he sympathized so much. Both Acosta and Caldas shared an avid interest for science but lived in societies which did not support this activity; the treatment of science was anemic in Latin America.

Acosta writes,

> *...mis naturales inclinaciones y mi posición han tenido cierta analogía con las suyas [Caldas]. Ardiendo en deseos de instruirme en medio de*

[117] Pico became a Jesuit priest and studied at Johns Hopkins University.

[118] Caldas at one point wanted to go to Europe with Humboldt, a request that was rejected.

> *una sociedad atrofiada, comprendí todos los obstáculos que encontró el joven Popayanés en su camino, y la heróica constancia con que supo vencerlos para colocarse tan alto en las regiones del pensamiento y de las ciencias de observación. Esta y no otra es la explicación de que haya podido bosquejar la fisonomía moral del primer sabio del Hispano-América.*

Upon his return to Puerto Rico in 1853, the expected position at the *Colegio Central* did not materialize to both Baldorioty and him upon the cancellation of the planned school. The formation of the school had ironically been the principal cause for their trip to Spain and of their support by local private institutions, with the aim of providing the island its first native-born science teachers.

The high school had been originally organized by the *Sociedad Economica Amigos del Pais*, also known as *Sociedades Patrióticas*. Its principal promoter was Padre Rufo Martínez Fernández, a Spanish scientist-Jesuit priest who had been exiled to Puerto Rico for his liberal pro-constitutional views. The project had also been jointly supported by the *Subdelegación de Farmacia*, whom played a big role in sponsoring the Colegio's future teachers.

Throughout the nineteenth century there had been a continual *alternanza* or erratic flux between liberal and conservative governors, which would wrought havoc with the island's nascent scientific efforts. It should be noted that, given the communication and transportation technologies of the time, Puerto Rico was rather distant to Spain, and its chosen governors tended towards a despotic attitude. It was criticized that even liberal governors often became authoritarian. It goes without saying that there was a great deal of unchecked power, well captured by the historian Isabel Gutierrez.

While Governor Norzagaray had helped to establish the *Colegio Central* with his calls for private sponsorship, the

projected high school was easily cancelled by the following Governor Pezuela. [119] This dynamic, the school's formation and consequent cancellation, epitomizes a pattern which would be repeated time and time again throughout the century across many parts of the island and Latin America—and which would most come to affect Baldorioty.[120] Fortunately Norzagaray, no longer governor, acted quickly and was able to procure a more delimited *Escuela de Comercio, Agricultura y Náutica* in 1854. The teaching of botany was handed over to Baldorioty, while that of geography to Acosta, whom hid his teachings of Copernican astronomy and the Scientific Revolution in such classes, without mentioning the name of Newton.

Acosta and Baldorioty served on a number of scientific committees. The Puerto Rican state, and society generally speaking, had a great need of the utilitarian benefits of science for such basic functions as basic problem solving, and the establishment of reliable information on which to base important state decisions. Acosta and Baldorioty also continually served on juries at *ferias* (annual fairs) for agriculture, industry, and the fine arts. These fairs stimulated a bit of scientific activity, showing the benefits that could be obtained when natural human competition is promoted—at least in theory.[121]

Good governance, in short, is highly dependant on good science; if decision makers are unaware of the facts, their decisions are likely to fail or, worse, have grave unintended consequences. Acosta's and Baldorioty's scientific knowledge and services were in constant demand in the first few years after their arrival, but this demand was oddly not enough to professionalize science. One simply could not earn a living as a

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[119]At the time, funding of education, and much less science, was not the responsibility of the state.

[120] For a good description of Latin American examples, see Miller.

[121]On one occasion, the secretary of fair actually tried to plagiarize all of its findings, and was as hard to believes and hocking then as it is today.

scientist in colonial Puerto Rico given that there were no universities to begin with—a constant complaint of Acosta. Again, a university education is something taken for granted today, both in Puerto Rico and in the United States.

Acosta goes with Baldorioty to Mona Island in order to study bird droppings, or guano, as a potential to enhance the island's revenues, a resource more valuable at time than it is today. Humboldt during his trip in Spanish America had identified their importance and abundant availability, undertaking chemical analysis of guano while in Peru and Chile, and finding that they were rich sources of potassium and nitrogen. In short guano served as a highly effective fertilizer for agriculture.[122] Guano was also a key resource used for weapons manufacturing, and had become a lucrative business. As the world population expanded, the scale and need of both munitions and fertilizers increased. Germany imported tons of it every year, and in Latin America, guano led to a war between Chile and Peru over guano islands in the Pacific Ocean.[123]

When Acosta entered the Mona cave system, he was flabbergasted. Its cave heights were ten time those of the Notre Dame Cathedral in France, offering its viewer a notion of what Kant meant by the sublime. However, the daily work setting and living facilities were extremely uncomfortable. Sleeping on the beach during a period of nine days, Acosta noted that he felt like a true Robinson Crusoe.[124] When compared to Ruben Berrios, whom spent an entire year sleeping on the beach at Vieques, Acosta acknowledges that he came to appreciate the comforts of civilization during his brief sojourn.

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[122] In a natural state, nitrogen is replenished in the soil through lighnting.

[123] These islands were full of bird droppings hundreds of feet high, which as a result of the dry weather had not decomposed over the centuries. Guano represented "free money".

[124] It is perhaps important to notice the influence of British literature on Acosta's worldview.

In spite of the sacrifice, the results of their study was inconclusive, as all good science should recognize when it needs to. Acosta and Baldorioty found it hard to tell whether the cave substances gathered was in fact guano, and recommended sending samples to London for a more comprehensive chemical analysis than that they could provide. While today we might presume that the two scientists found bat dung, the material appears to have been of mineral origin as it had high levels of calcium phosphate and a low nitrogen content. This meant that the Mona guano would not have been as beneficial for agriculture or munitions sales as expected. Note that the state of chemistry in Puerto Rico at the time was relatively backward. Though it would have been reasonable for state authorities to invest in chemical technologies, they obviously did not—at prima facie an irrational position for the same reason the study had been issued in the first place: its economic potential.

The expected bonanza from guano never materialized. Nonetheless, it was of critical importance to explore the possibility, and only Acosta and Baldorioty would be able to provide a sound answer.

Along with Stahl and Grivot, Acosta also participated in a committee for the study of sugar cane. One of the typical problem with monocultures as sugar cane is that once a disease catches on, it spreads like wildfire as all plants belong to the same genetic pool. It is a problem that still repeats itself today.[125] Being impacted by a common disease, the team found that its cure was actually rather simple, as noted by Acosta whom was the study's principal author. They correctly argued that the introduction of new varieties into sugar cane crops would ultimately produce a sugar cane specimen with greater resistance to the disease. As in the rest of biology, the strength of a species

[125] It is likely that the banana of tomorrow will not be the same one as today.

is not dependant upon its ideal forms but rather upon the diversity of its genetic stock; there are no supermans in nature.[126]

Acosta and Baldorioty also used scientific information to attack aberrant government policies as slavery by making simple and factually-based arguments. Acosta notes that the quality of life is not solely determined by the environment, alluding to Buffon-Jefferson debate, but rather it is determined by its laws. The legal structure which governs a population created its own social environment separate from that of nature, whose benefits, as justice or injustice, could actually be statistically measured. It was clear to him that that slavery was detrimental to both parties involved for many different reasons. Abolitionism was a better economic system, for both the slaves as well as for their masters.

He calculated that it was economically wasteful in terms of sheer statistical economic data, noting that productivity declined by at least a third (33%). Slavery also did not stimulate the formation of a market economy as salaries were not paid to the slaves, who in theory could then become buyers and sellers of goods but did not given their lack of money and capital to spend. He coldly noted that if *hacendados* were financially reimbursed for awarding freedom to their slaves, this would inject capital into the economy to get its market economy going.

The salary payment to the former slaves would lead to the creation of a healthy internal market, which, in turn, would require the formation of banks. There were no banks in colonial Puerto Rico, another aspect of modernity that is today usually taken for granted.[127] The formation of capital was mainly based on short term loans by the landlord's *tiendita* or store, which charged usurious fees for such loans.

Acosta's analysis is much more complex than has been described, but such is its main idea and tone. Thorough and rigorous empirical analyses were undertaken to show that such

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[126] This is why eugenicist notions of Nazi have opposite of intended effect and so horrific over all.

[127] See Baralt's history of the Banco Popular for a brief discussion of this issue.

claims were simply not true and, inversely, that their alleged benefits were but a myth. The analysis of economic repercussions greatly undermined the government's claims for certain public policies. That Spanish theories were disproved was perhaps Acosta's and Baldorioty's most powerful weapon, and possibly why the state felt so threatened by their rigorous empiricism.[128] In other words science, or a statistically based empiricism, was not just financially beneficial, but could also be morally and politically rewarding as well. It allowed for the sound questioning of governmental claims and, in turn, pointed the way towards specific social reforms—and hence why the two scientists were deemed to be such a threat to the Spanish monarchy and colonial system.

Both men naturally became involved in politics due to the avid resistance towards a change in the status quo, and it is curious to contrast their early lives to their later years, which were almost diametrically opposite.

The 1846 trip to Spain had actually included two other students: Eduardo Micault and Julian Nuñez, whom had been the original scientific grantees funded by the *Subdelegación de Farmacia*. Three of the four, however, were struck by *viruela* (smallpox) shortly after their arrival; Acosta's description is horrific. Nuñez began having "*un delirio espantoso*", shouting incoherently; his foggy mind was accompanied by an equally swollen brain, and dies on October 30, 1846. Micault's fate was no worse. His face, full of "*espirela negra,*" was deformed and looked horrific; he dies one week later on November 8, 1846. Since Baldorioty had already suffered the disease, he dutifully took care of all his companions, which must have been a strenuous ordeal to say the least.[129]

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[128] Baldorioty would similarly present an equally strong argument against the repressive system known as *libreta* using the same method.

[129] Incidentally, Baldorioty's original last name is actually "Castro", which is how his contemporaries actually referred to

Given the academic excellence of Acosta and Baldorioty, we may only speculate on what might have happened had Nuñez and Micault lived, and their deaths really do constitute a tragedy for the growth of science in Puerto Rico.

Prior to being invited on the trip, Acosta in fact would regularly walk to the harbor, jealously peering out at other more fortunate students on their way to Europe. He was anxious to advance his education, but when invited, he selflessly convinces Padre Rufo to take Baldorioty on the educational program as well. Tragically, Acosta's mother dies while he was in Europe, which must have been emotionally traumatic event and helps explain the tone and expressions of his writings.[130]

Acosta and Baldorioty had originally been assigned to study of pedagogy, to become teachers of teachers. With the unexpected death of Nuñez and Micault, the funding was switched over to the two remaining students for their scientific studies. While the *Subdelegacion de Farmacia paid* for Baldorioty, Padre Rufo covered Acosta's expenses. It is important to note, however, that there was a critical period of transition soon after the two students' deaths, which could have jeopardized their efforts.

Padre Rufo, whom had traveled with the four young men to Spain, requested funding for his stay during the upcoming four years—a request which was denied by the Spanish government and whom, bluntly speaking, forbid him to stay in Spain. While the monarchy did reimbursed Rufo for his stay, he was forced to return to Puerto Rico in mid winter season when cold front

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him. Given his father's abandonment, the son changes his last name for his mother's, "Baldorioty" to honor his faithful and hardworking mother.

[130] Acosta's father had in fact been wealthy when Acosta was young, but lost his fortune on a financially-draining sugar plantation in Rio Piedras. The family moved to Ponce, and when the father suddenly dies, his mother is forced to take care of their eleven children.

systems generated huge waves in the Atlantic—which although good for surfing, become dangerous to midocean navigation. As there were obviously no airplanes at the time, the journey took over a month rather than a few hours. This treatment is evocative of the Roman Catholic Church's treatment towards Galileo, whereby he had been forced to travel to Rome through a plague infested Europe.

Rufo was already in Cadiz, and about to embark for Puerto Rico when he hears the news of the tragic deaths. Again, given the ambiguities and uncertainties of communications at the time, Rufo was uncertain as to whether all four of the most promising Puerto Rican scientific youths under his tutelage had perished, likely placing him under a horrific emotional stress. Rufo writes a letter instructing the remaining students, if any, to return to Cadiz immediately, in effect canceling trip. Since he had been forced to return to Puerto Rico, Rufo also leaves avaliable funds for the return trip of the two students, 150 pesos each.

Acosta and Baldorioty, however, refuse. It did not make sense to them how, after so much sacrifice, they would so prematurely leave. They decided it was better to stay, at all costs, and make the best of their once-in-a-lifetime opportunity. This placed Rufo in a bind. As there was a legal delay between payments and receipts, these would naturally take long time before being received. One should remember that at the time there was no internet and no cell phones or smartphones, no banking apps to obtain immediate access to funds. Rufo thus opts to temporarily pay the way for both students until the payments were finally settled at some sacrifice to himself—for which both were eternally grateful.[131]

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[131] Ultimately, Acosta would obtain Padre Rufo's subvention, while the *Subdelegacion de Farmacia* covered Baldorioty's expenses. When Padre Rufo dies in 1855, both Acosta and Baldorioty take care of the arrangements, and would speak of his many lessons the rest of their lives.

Acosta and Baldorioty, whom had already shared early educational experiences together as teenagers at the *Seminario Conciliar*, undergo an ordeal which further strengthens their deep bond of friendship. They would hold an unbreakable bond for the rest of their lives. Periods of great difficulty often have unexpected benefits.[132] Their respective, political and economic fortunes, however, would be very different.

If we were to describe their political positions, it might be said that Acosta was a statehooder, akin to the current PNP in that he sought for Puerto Rico the rights any other provinces in Spain also held. Oddly, in Spain it had been forbidden to mention the word "colonial" in spite of the fact that both Puerto Rico and Cuba were Spain's last colonies in Americas. Baldorioty, on the other hand, could be characterized as an autonomist, akin to the PPD, whom sought greater political autonomy for the island without completely severing political ties to the metropolis. While today this position is taken for granted, during the Puerto Rico of the nineteenth century this view represented a radical stance and a substantive shift in perspective of colonial relations.

Both friends did serve as members of the Liberal Party and had served, at some point, as delegates in Spain—but that is where their similarities pretty much end.

The life of Acosta is ultimately a very different one, with an alternate trajectory. Though he spends a few weeks in jail, he is not broken by his stay at the cells of El Morro—unlike Baldorioty. Acosta is able to compose a poetic piece of his experiences in his own jail cell, almost a romantic essay. That crushed men do not write poetry suggests that, in contrast to Baldorioty, Acosta's prison sentence was not as difficult as he believed it to be.[133]

Acosta establishes a successful printing business to sustain his emerging family. He had married the daughter of a

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[132] It might be asked whether their reduction has a detrimental impact on culture, this case constituting an example of the technology's cultural change.

[133] In Spanish, " *hombres rotos no escriben poesía*."

prominent Venezuelan diplomat, whom while in exile routined the *Bótica de Babel*. While today it could be mistaken for one of the numerous *chinchorros* that today exist for drinking beer, then it was defined as temple of separatist thought. Gov. Echenique threatened the owner Babel with death if he did not shut down his *tertulias*, which had the desired effect. Acosta secretly imports a printing press from Cuba, and initially places it on an adjacent lot so the police would not understand its role nor its relationship to him. In this, Acosta is rather effective in evading government oversight for a just cause.

Eventually he becomes a major Puerto Rican printer, to the point that his biggest competitor was the *Boletin Mercantil,* an ultra conservative newspaper. The printing press, which had played an important role in the Scientific Revolution, actually arrived fairly late to Puerto Rico (1805). In spite of this existence since the mid fifteenth century, Spain, unlike England, did not take advantage of it for governmental transactions and other such affairs for three centuries.

When an *Instituto Civil de Segunda Enseñanza* is finally established, the high school closes after only a year. While it later reopens it is again closed shortly thereafter; its case is indicative of the persistent political instability of the island, rendering all academic and scientific activity uncertain.[134] Acosta became an on and off director and professor at the institute for various years: 1873-4, 1882-3, and 1883-4. Although he had been its first director, it was in a non-tenured position; as all tenureships were strictly only held by the Spanish peninsular faculty. When he resigns, this students endearingly ask him to return. These incidents would also echo in Baldorioty's own life as well.

The core subjects taught at the *Instituto Civil* were mainly scientific. According to Acosta, these included: 1) natural history, to understand the order of nature, 2) physics and chemistry to obtain a rational explanation of bodies, 3)

[134] This instability would also be echoed by Juan Bonnet Jr. more than a century later.

mathematics to have control of powerful tools of analysis, and finally but no less important, 4) geography to elevate one's spirit to the highest conception of universe. Again, what he really means by geography, under the constant threat of the Inquisition, is astronomy. As Franklin, Acosta provides important but subtle clues as to what he is trying to do.

Acosta also helps to create the *Ateneo Puertorriqueño* (1876), and had been the mentor of its key founder, Manuel Elizaburu. While Tapia tried to form an *Ateneo* shortly after his return in 1855, he explained that the conditions had been too onerous. Such was the need for an *Ateneo* in Puerto Rico, that during the first 12 years of its existence, more books were published by the organization than had been printed during the previous half century. In that same time span, the *Ateneo* published 155 books, versus the 100 books published in Puerto Rico between 1831 and 1876. During its first twelve years, 47 conferences were held, and the *Ateneo* was perceived by the state as dangerous center of *filibusteros*, not too distantly removed from the *Bótica de Babel*. Without a doubt, the *Ateneo* enormously boosted the intellectual life of the island.[135]

Acosta gave many talks on the history of science and technology at the *Ateneo Puertorriqueño* which included key topics which are today a routine part of a history of science curricula. Like a man from Mars, Acosta descended with a vast list of fascinating topics which were imitative of his own mentor, Padre Rufo. He offered talks on Kepler, barometers, Sydenhman; on technologies as the telephone, which almost nobody used at the time. Again, many of his themes are topics which today are taken for granted.

There is a certain tragedy to his life, however. Acosta never establishes a research paradigm, but instead is forced to dedicate his life to secondary non-scientific affairs that his printing press required of him.

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[135] Elizaburu would help create the *Colegio de Derecho* in 1912, which was later turned into the *Colegio de Abogados*, well known for its advocacy of civil rights in the island.

In this he is similar to case of Sun Yat Sen, first president of the Republic of China whom had studied parasitology under Patrick Manson, a British scientist in Hong Kong and founder of that science. As Franklin, Acosta was forced to turn aside from his beloved science to enter the political fray, and his case can be considered evidence of the key political function of science.

Arbitrary political orders are, by definition, antithetical to science.

> *La España de hoy no puede rivalizar con la Alemania, la Francia y la Inglaterra en adelantos científicos. Hase quedado atrás de estas naciones en el movimiento político e intelectual; ninguno de los diversos ramos del saber; ni las ciencias morales especulativas y sociales, ni las exactas en sus variables aplicaciones, han debido nada en estos últimos tiempos al genio español. El plan de estudios universitarios, no solo carece, de muchas aulas, multiplicadas en el extranjero, sino que también las obras de texto en la aulas existentes, son todas de escritores extranjeros, por lo común vertida en mala lengua castellana. El observador de la prensa no la vera producir libros, opúsculos originales, nacionales, en que se hagan adelantar las ciencias, ya con la exposición de hechos nuevos, ya con conveniencias aplicables, deducidas del gran caudal conocido. Traducir lo que otros escriben es el oficio de los españoles.*

Chapter 17

Baldorioty

Román Baldorioty de Castro is a neglected figure; no satisfactory biography of him exists. The best ones as those by Gautier Dapena and Cruz Monclova, offer very little from a history of science point of view.[136] It is even more tragic to consider that although Baldorioty is a key figure in Puerto Rican intellectual and scientific history, a great deal of documentation regarding his life and work has been lost. While the Acosta family preserved their predecessor's papers, Baldorioty did not have such fortune.[137] There is in effect no Baldorioty archive from which to gather substantive material for a thorough treatment that would be akin to that which Felix Ojeda has rendered for Betances.

Worst still, there is no *proceseres* archive in Puerto Rico, akin to the likes of Jefferson and Franklin whose works are readily available at the U.S. National Archives. While *proceres* in other parts of Latin America have archives dedicated to them, as in Cuba which makes their entire published works freely available online, an online archive of the *Sociedad Recolectora*'s participants is missing in an island with far greater financial resources. This is, again, suggestive of a repression whose existence emerges only when we look for such materials.

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[136] María Teresa Cortés Zavala's treatment of Baldorioty is highly biased, grossly ignoring the brutal realities of Spanish colonialism which were so vividly depicted by Tapia. This is particularly shocking given the consistent repression to which Baldorioty was submitted by such authorities.

[137] These were not donate to the UPR until a Condado basement flooding almost ruined the entire collection.

There is, in short, little concrete valorization of Puerto Rico's scientific legacy—something which is particularly odd given the public importance attributed to "culture" and the "knowledge society" in contemporary Puerto Rico. It is, however, not the only expression of public hypocrisy that can commonly be witnessed in the island. [138]

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[138] Pedreira's biography reveals Hostos to have been a brilliant but pathetic figure. His *Peregrinacion de Bayoan* was a call for unity of the Hispanic Caribbean, and there can be no doubt that he was a romantic, aptly observed by President McKinley. In this, his emotional outlook was similar to that of Jose Marti. Hostos at one point suggested that Puerto Rico be annexed by the United States, given his recognition of its more prominent democratic culture, a position he discarded later on. He ultimately moves towards separatism, and is invited by Betances to join the *independentistas* in New York after the *Grito de Lares*. Hostos's visit to New York was, bluntly put, a disaster.

As a young, and immature thinker with few life experiences, Hostos was a decade younger than the 36 year old Betances, but came across as arrogant. There was a touch of narcissism in his personality, as he believed he could easily manipulate others; when he could not, he would accused them of incompetence. Hostos, in short, wanted to be "cacique", in spite of the fact that he lacked any political experience or acumen for the charge.

He had previously studied law in Madrid, but dropped out. He did appropriately note that the *independentista* groups tended to fight between each other, a tendency that can still be observed today. The Cubans of the group placed him as editor of their local newspaper, but fired him soon thereafter for much of the same problems. Hostos believed he had all answers, and that he could impose his will on others without obstruction whatsoever.

His life is also a travesty. He travels throughout Latin America, promoting Puerto Rico cause wherever he went. He got by teaching French language classes and translating books.

Although at one point he was offered a tenureship (a *catedra*) in Argentina, Hostos rejects this offer. Late in life, he travels to Puerto Rico in 1898, and while he is publicly hailed as important figure he in fact had little political power or authority—the inevitable byproduct of spending most of his life apart from the nation he sought to defend. Self taught in constitutional law, he argues that the United States needed to dialogue with Puerto Rico, and is actually able to meet U.S. President McKinley, whom he is unable to convince. Hostos, one of the few Puerto Rican intellectuals recognized world wide, dies in 1903—not in Puerto Rico but rather in the Dominican Republic.

Pedreira in his brief study of Hostos, depicts him as a sort of Andres Bello, a Venezuelan romantic writer but in world of ideas. However, Hostos was a more analytical thinker, and in this respect his analyses were very systematic and thorough, evocative of James Clerk Maxwell's own intellectual style in physics. Hostos had been deeply influenced by August Comte, the latter whom was indebted to Condorcet. (While in jail waiting his execution during the French Revolution, Condorcet tries to write analysis of social development, creating a brief piece which becomes very influential.) Hostos similarly believed he could draw laws from history, a suggestive but highly problematic notion.

Ultimately Hostos has little impact on Puerto Rico's political outcome, as he had lived far longer amount of time outside of Puerto Rico than within it. His case is oddly similar to that of Betances, whom after the *Grito de Lares* leaves Puerto Rico and never returns. Tragically perhaps for the two *independentistas*, most of their lives were spent outside of Puerto Rico than within it. Hostos at one point in New York tells Betances to go back to Puerto Rico, but Betances, being the more sagacious, immediately rejects the idea as he knew it meant a death sentence.

Stahls's life is equally tragic. He had accumulated a great deal of flora, applying modern biology to the study of natural

Just as Newton was the most important scientist not mentioned by Acosta, Darwin is the most important scientist silenced by Baldorioty in his *Exposición Universal de Paris* (1867). It should be remembered that Baldorioty, though clearly well versed in chemistry and physics, was selected to teach botany at the *Escuela de Comercio, Agricultura y Náutica*. Darwin's *Origin of Species* had been published a decade earlier (1859) and immensely popular throughout Europe; in fact, *On the Origins* is one of the most widely purchased scientific books of all time.[139] We may also observe that in his *Exposición Universal de Paris* (1867), Baldorioty clearly saw biology as a means of economic improvement, through which one could

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history in his expeditions all over the island. His impressive collection, some of it which can today be found at the Smithsonian Institution. The doctor in Bayamon wanted to donate material to the government, and had also requested financial assistance for the creation of a museum, but this offer was never accepted. Stahl, as most men those days, had large family; he had also been a member of the *Partido Liberal*.

His scientific work was ultimately destroyed by local attrition, and his case makes it very clear that science simply did not form an integral part of Puerto Rico's value structure, even into the twentieth century. His realistic natural history drawings were posthumously found in a high school in Bayamon by Carlos Chardón, whom was able to rescue some of them. Ceide provides an appropriately emotional depiction of the injustices suffered by Stahl, and of their personal impact, but touches little on scientific background. There can be no doubt that Stahl also requires a serious biography. Stahl was a tragic victim, and his life is ultimately symptomatic of Puerto Rico's anti-scientific value system.

[139] Fernós, *From Galileo to Boltzmann*.

readily obtained increases in milk output or poultry volume, as had occurred in England during the last century.[140]

As Newton in Acosta, Darwin is ever in the background in Baldorioty's writings but is never explicitly mentioned, presenting a remarkable vaccum which needs to be explored further. Both men had been accused by the Spanish authorities for their anglophilism, and with good reason. We need to explore these silences, which are again substantive in light of the significance of the respective founders of modern science.

In this regard Baldorioty, as Acosta, shows a similar life pattern to that of Sun Yat Sen. During the early part of his life, Baldorioty was a scientist. He travels to Mona Island along with Acosta or inspects the viability of the *hornilla de evaporación* in Manati. By the second half of his life, however, he is dedicated entirely to politics. Baldorioty helps restore the *Partido Liberal* from its slumber, and invites Luis Muñoz Rivera to move from Aibonito to Ponce, to begin a newspaper and write powerful editorials championing the island's autonomy. Ponce was a flourishing city during nineteenth century open to native economic and social activity, which was to be contrasted to a San Juan so dominated by Spanish merchants and powers; Ponce at the time was an alternative metropolis where the native born Creoles had a far greater range of control.

As Acosta, Baldorioty also used statistics to show the falsity of governmental policies, arguing that the *libreta of jornaleros* led to a reduction of 1/5 (20%) in productivity. While its inefficiencies were not as large as those created by slavery, they were nonetheless substantial. He also pointed out that, if it was true as some claimed that climate determined laziness, the *libreta* would never cure the alleged disease. As a good Euclidian creating a standard mathematical proof, Baldorioty presents a

[140] Local farm activities, modification of biological form in fact influenced Darwin. He uses it as introduction in *Origin of Species,* imagining over much larger periods of time to help establish validity of notion*but in his writings

counterargument beginning with initially valid presumptions, to then show their contradictory conclusions.

Baldorioty also pushed for the formation of a banking system and a reform of the island's monetary system; the pervasiveness of the *moneda macunada* led to a number of fraudulent transactions in the economy. He also argued for educational reform, and went so far as to prepare a comprehensive plan which was not immediately enacted by the authorities.

Baldorioty was continually afflicted by the bugbear of Spanish Colonial repression. As we have seen, the *cátedra* or tenureship was not extended to both Acosta and Baldorioty in 1862 at the *Escuela de Comercio, Agricultura y Náutica* for being too critical of Spanish colonial authorities. The two thus had to fend for themselves and their increasingly large families in other ways. While Baldorioty served as a Puerto Rico delegate in Spain, he was offered the teaching of mechanics. When Laureano Sanz, that figure so detested by Tapia, became governor for a second time, Baldorioty went into self-exile to the Dominican Republic in 1874. Though he begins a *colegio* in the neighboring island, he was simply not paid enough and thus found it hard to make ends meet. Acosta provided some help by printing school materials for his friend, but these efforts did not diminish Baldorioty's financial difficulties.

After Sanz's removal in 1877, Baldorioty moves back to Puerto Rico and again attempts to establish an *Escuela Filotécnica*, taking inspiration from much of what he had written in the *Exposción Universal* (1867). The government, however, issues a propagandistic attack for his efforts on the front page of *La Gazeta,* in an unquestionable abuse of state power. Its aim was to destroy Baldorioty's reputation, making such absurd arguments that he was not certified as a teacher and hence was forbidden from opening the school—when in fact Baldorioty had previously been the one who issued such certifications due to his

elevated expertise.[141] At one point his political candidacy was similarly attacked due to his name change, from Castro to Baldorioty. Spanish conservatives argued that such a trivial name change invalidated his nomination to the Spanish parliment.

Baldorioty lived much of his life in poverty due to these persistent attacks and abuses of power by the local authorities, whom clearly felt threatened by his public persona. Tragically, Baldorioty lost a son and two daughters, leaving him distraught.

It should perhaps be noted that in 1870 when the *Partido Liberal* was formed, it was due to a relative period of absence of repression. It had been preceded by thirty years of repression under the *Leyes Especiales*, which governed Puerto Rico between 1830 and 1860. After the wars of Latin American independence, there was the overwhelming concern of a Puerto Rico independence revolution, creating a rather repressive state which contextualized the actions of Acosta and Baldorioty.

Baldorioty's essay "*America"* is very Jeffersonian in character. His implicit attacks of Buffon's arguments place greater emphasis on laws and a society's legal structure or the *clima moral* rather than the *clima fisico*. In contrast to Betances, Baldorioty was a pacifist whom argued that the consistent application of good laws would produce a beneficial change in the culture and economy of the island. He might have been a bit too optimistic.[142] Throughout the Spanish colonial empire, officials were not paid enough for their functions, and thus inevitably forced to obtain their salaries through extralegal means, thereby establishing an early precedent for corruption in the region which has mercilessly devolved in an an endless vicious cycle.

It is curious to note that Thomas Jefferson is also not mentioned in the article, but its implication is less certain and

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[141] Such absurd attacks have been rampant in Puerto Rico's political history, and are still true today.

[142] As pointed out by Chilean philosopher Lastarria, if those who enforce laws are corrupt, such just laws will not be enforced—a key problem throughout Latin American history.

clear to that of Darwin. There can be no doubt that Baldorioty was accused of anglophilism, and used the cases of Australia and Canada and other regions in the British commonwealth system to establish the meaning of *autonomismo*. It is perhaps important to emphasize again that Humboldt met Jefferson on his return trip, and actively corresponded during the rest of Jefferson's life. Given Acosta's interaction with Humboldt, it is not unreasonable to suppose that Baldorioty might have been influenced in this manner.

Baldorioty moved to Ponce to begin a newspaper but in fact, this was much more than just a geographical relocation. As Muñoz Rivera later, Baldorioty wrote a series of articles for *Asuntos de Puerto Rico* which rejuvenated the *Partido Liberal* and led to its transformation as the *Partido Autonomista*, which also resulted in the loss of influence of annexationists as Acosta within the party.[143] Baldorioty's series of articles were very influential, and ultimately led to the *Plan de Ponce* of 1886.

The Plan de Ponce became the party's political platform, apparently based on an eclectic interpretation of political theorists as Locke and Montesquieu. In it, we find the inclusion of the Jeffersonian notion of natural rights, which akin to the Bill of Rights, were inviolable by the state. Their fundamental nature meant that no state could make laws contravening these. It also sought a separation of powers a la Montesquieu, particularly so between the military (executive) and the civil (judiciary) which had been so conjoined throughout the colonial period, and which had created such gross abuses of power in the political system. We also find the Lockean principle of religious toleration embedded in its pages—in spite of the fact that there were no religious conflicts akin to those which had been seen in Europe. Jefferson's shadow and influence is pervasive, even though he is never explicitly mentioned by name.

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[143] When a young Spanish writer Cespedes took control of the party away from Baldorioty, it was Luis Muñoz Rivera who restored it in the same manner.

Baldorioty's *Partido Liberal* became too powerful, and began calling for a complete boycott of Spanish stores. This was seen by the Spanish authorities as a direct threat to peninsular economic livelihoods, and publicly characterized the boycott as an attempted genocide of the *peninusular* (Spanish) population of the island. Though an exaggeration, there can be no question of its powerful effect on *penninsular* monopolies and interests. What had been a political conflict became a brief economic war, which in turn was transformed into one of the worst periods of political repression in the island known as the *Compontes* of 1887.

Baldorioty was jailed at El Morro, and was so physically mistreated, that he ended up dying shortly thereafter at the age of 67 in 1889. Other scientists and intellectuals would also suffer the iniquities of Spanish colonial authorities in Puerto Rico.

Chapter 18

Finland

Miroslav Hroch is a Czech intellectual whose political analysis of small European states in 1968 was so highly regarded that it was immediately translated into English by 1971. His was the first to use a rigorous approach combining quantitative research and comparative history, to the point that Eric Hobsbawm initially did not want to read it for fear of learning he had been discredited. Its meticulously research provided a new model for the study nationalism.

It is generally recognized that nationalism emerged with modernization, in that most modern nations were formed after French Revolution. The period immediately following the Second World War is also marked by a sudden spurt of new nations, particularly with the formal ending of European imperialism. Britain was forced to cede her empire, giving rise to the large number of African nations—incidentally coinciding with Puerto Rico's "birth" as a commonwealth as well.

While power of the new ELA (*estado libre associado*[144]), was given to Luis Muñoz Marín, Nelson Dennis shows the island could have plausibly become independent under the leadership of Carlos Albizu Campos. Albizu was an incredibly talented Afro-Puerto Rican, as much a chemist as a Harvard trained lawyer—and vastly more competent than Muñoz Marín whom in his youth had also called for the island's independence and was allegedly afflicted by drug addiction. Albizu's rise to power was unfortunately blocked by powerful external actors.

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[144] The Puerto Rican ELA should not be confused with the British notion of "commonwealth".

The two, modernity and nationalism, are intimately interlinked, but why they should be so is still not entirely understood. We will thus briefly look at some theories of a complicated topic which underwent an enormous growth spurt in academic productivity during the 1980s.[145] Many of the insightful new theories which emerged were of a Marxist character, and provide an adequate backdrop to Hroch's own theories.

Although Tom Nair did not postulate a theory, he began a discussion on the issue by noting that it was commonly presumed by Enlightenment thinkers that progress would gradually and evenly spread throughout the world. However, history had shown that it obviously did not. First modernizers conquered others in the process of colonialism and imperialism. By contrast, second hand developers in less developed countries experienced progress through the distorted lens of conquest and repression. For his part, Michael Hetcher created the notion of "internal colonialism," observing that all colonialism first occurs internally—in particular with the take over of rural populations or other peripheral regions within the nation's confines. Through these interactions, colonizers learned how to colonize, and then spread to other parts of the world. In other words, lessons learnt internally were then apply externally what we formally know as colonialism per se, a second stage of sorts.

John Breuilly looked at thirty cases in an early innovative comparative approach, noticing differences in premodern and modern societies. In premodern societies, social functions were split between different bodies as guilds or churches, which were relatively self-contained. By contrast, in modern societies, social functions were given to specialized bodies in a much more delimited manner, which in turn allowed for the creation of nation state.

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[145] It is curious to point out that this academic expansion preceded the fall of Berlin Wall in 1991 and the collapse Soviet Union shortly thereafter. It is not clear the degree to which these studies impacted world events.

Ernest Gellner argued for a closer relationship between modernization and nationalism. He divided world history into three stages: hunter/gatherer, agricultural, and industrial, perhaps imitative of other thinkers as Jacques Ellul and Lewis Mumford. Given that hunter/gatherer were small entities, there was no need for a modern state. It might be pointed out that in these small collectivities, all social functions are shared within the same group of persons.[146] With the rise of agriculture, society increased in size, which generated its key distinctive features; each social actor was structurally fixed in place. The agricultural society was thus characterized by an ascriptive value system, whereby value was inherent to the person. Gellner might be said to adequately frame the Puerto Rican social value structure of the Spanish colonial period.

Industrialization for Gellner, however, changed all of these dynamics in that it introduced key functional social requirements, that consequently led to nations and nationalism. For example, the notion of perpetual economic growth required the constant creation of new knowledge, which in turn led to the establishment of a more rigorous educational system. All members received same basic training, which allowed for the broader proliferation of general abilities and in turn the exchange of specialized function between different members. In effect, it could be argued that Gellner posited the existence of social interchangeable parts within an economy as that seen in the history of technology, for the most efficient allocation of human resources.

Under its rubric, ascriptive values declined in contrast to the sharp rise of meritocracy. Again, in contrast to the agricultural value structures, in industrial societies value was

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[146] Relations of family, friends, and what we would call "work" were all interlinked, which meant that that loss of one had huge impact o the others, and hence on the individual. By contrast, each social field is separated in that different persons play different social roles, as family and work relationships. that were previously combined into one.

inherent only to a citizen's ability to perform a particular social function rather than as inherent to the person as an individual. This notion can be seen in sports players, whom as they age, inevitably decline in their athletic ability. The Michael Jordan of today, old, fat, and teary, is not the same hero of his youth who could do near-magic feats of prowess on the basketball court.

Eric Hobsbawm, for his part, took an instrumentalist approach. Nationalism is the result of competition between elites during a time of rapid social change, which allowed for creation of congruence and continuity without which the modern nation would otherwise result in chaos and social dissolution. For him, there is a congruity between technology, social transformation, and politics, which equated to nationalism.

Benedict Anderson, one of most popular authors, argued for the notion of "imagined communities," a term which is often misunderstood. He did not mean to say that the community was false, but rather that the size of a modern community and predominant anonymity forced its members to imagine their own nation via different mechanisms such as radio and newspapers or the mass media.[147] Other mechanisms contributing to this ideation included public education, museums, maps, monuments—all of which helped imbue the individual with a sense of belonging and identity.[148]

Anderson applied these ideas to the study of the formation of Latin American nations. Interestingly, language for him did not play a role in the rise of the modern nation state. Given that Spanish was shared between Spain and Spanish America, he

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[147] Modernity for Anderson implied a change in the meaning of time. During the medieval period, the religious view presumed that all events in the universe were simultaneous. During the modern period, the creation of clock, led to a subtle shift of meaning; simultaneous actors occupied the same space but were unaware of each other's presence.

[148] Anderson was influenced by rise of Asian nations as Vietnam and Cambodia whom broke with traditional schemes. Not only were they not of Western origin, but were distinctly anti-Western.

argued that it could not have functioned as a key motivator, as had occurred with other cultural colonizers. However, the conflict between Creole elites and Spanish was a key determinant, as Creole elites had been prohibited from obtaining positions of political power, as we have repeatedly seen. That economic power did not match political power led to a series of unfulfilled expectations, which ultimately undermined the structural foundations of Spanish colonialism. It is a theme that has been previously explored in other writers, from Glick to Ramos Lara.

There are some critiques of Marxist mistakes that are so commonly repeated they should be briefly mentioned. Marxists tend to attribute too much importance to overall structures, and in the process undermine the role of personal agency in human affairs. It goes without saying that humans are not blind and simple automatons to forces outside themselves.[149] Oddly, Marxists also undermine the powerful role of ideas in history, as these are typically undermined by their far greater emphasis to the structural setting. A final but no less damming critique is that Marxist studies are factually incorrect in their arguments, distorting the facts to fit the theory. For example, while Nairn claims that nationalism first emerged in the periphery, afterwards migrating then to the metropolis, the historical fact of the matter is rather that the opposite is true. Nationalism also often emerged between regions with in equal levels of income, or greater not less as has been claimed in Marxist analyses.

It is equally clear that nationalism is not necessarily tied to Enlightenment ideals, as irrational and anti-Western views have characterized some of the most successful efforts. The Pol-Pot in Cambodia killed thousands of innocent lives, well illustrated in the movie "The Killing Fields."

That being said, there is an interesting issue at the heart of Marxist theories of nationalism: how do we relate broader structural changes to individual actions? This is a classic problem of the social sciences, as pervasive in sociology as it is in

[149] If you know anything about Puerto Rican politics, the notion would appear to be rather quaint.

economics. There are statistical regularities in human behavior, in spite of the fact that each individual controls their own actions. Although there is no interrelationship between the historical actors, patterns continually reappear to such a degree that they are actually used today by the insurance industry, and leads to questions regarding the existence of free will.

Rather than compare Puerto Rico to Singapore, a repressive and autocratic island state, it is perhaps more useful to compare it to Finland.

While this might at first sound rather unusual given the drastically different cultures, geographies and histories, there are common structural elements between the two which render the contrast useful. As Hroch details, Finland is a small state—small in terms of autonomy rather than geography—which was occupied by two distinct foreign powers. Its national culture was preserved via academic efforts, and its capitalistic classes which had the greatest amount of exposure to the outside world were the ones most energetically pushing for independence. However, before entering into a detailed discussion of the case, it is important to first review some of Hroch's broader analyses of the small state theory.

Hroch, a Marxist, observes a marked difference in the process of modernization between imperial and colonized nations. While ruling nations underwent what might be termed an 'organic' modernization, from within and arising out of their own efforts and technologies, small nations are typically colonial subjugated nations whom experienced modernization from without. It is through the lens of such colonization that modernization is experienced, and as such it might be termed as 'inorganic'. Rather than emerging from its own internal dynamics, the colonial nation must always interact with forces outside of itself.

The small nation is itself characterized by three key features. 1) It does not posses its own ruling class. 2) While the small nation as a whole formed its own distinctive ethnic unit or autonomous culture, this does not coincide with its political autonomy. Finally, 3) while it might have had its own authentic

cultural production, this has either been obliterated by the ruling power or has undergone substantive deterioration as a result of its political relationship. Most importantly, as these relationships occurred over a long period of time, the relationship as a whole itself took on a structural character.

Small states as such are typically nations without history, with incomplete social structures given their colonial character. While the level of oppression they experienced has varied greatly, this variation does not negate the structural nature of their stratified relationship. The small state might have also been originally an independent state, but one which lost its independence—as tragically appears to be occurring to Hong Kong at the moment in its relationship to China.[150]

In short, while the modernization of ruling nations is a relatively 'simple' process, emerging out of its own internal dynamic, the modernization of small nations (colonial) is a vastly more complex one, arising out of the continual external intrusions of foreign factors upon its own internal dynamics. The subjugated character of their political relationship ultimately impinges on both the nature and structure of their culture and economy—but does not ultimately determine it.

Hroch presents a general three part schema for the emergence of a national identity and its eventual manifestation in political autonomy. During the first part, Phase A, scholars play a leading role in nationalism. They initiate the process by identifying common national cultural elements, recording these and helping to preserve them for posterity. The discipline of history plays an important role, but it is not the only active discipline. The second part, Phase B, is typically characterized by a long push for political unification, which goes on without apparent end. It is typically a rather long period, with little overt effect on the small nation's political status. Finally, the last part, Phase C, there finally emerges the final results of its efforts into

[150] Curiously, linguistic assimilation does not necessarily always lead to economic stagnation, as in the case of Ireland or Norway.

unique and autonomous political entity. The long push eventually has an impact, and the colony becomes its own independent state.

The similarities between Hroch's three phase political development model, to that of Basalla, Rostow, and Hastings are remarkable. We might refer to this overall three phase model as the 'airplane model of autonomy'. In all cases, we notice an initial external push by a foreign actor, a gradual accumulation of 'momentum' and its ultimate takeoff into autonomy, be this scientific, economic, or political.[151]

Finland was caught between two dominating powers: Sweden and Russia. Due to its size and mountainous regions, Finland was able to hold a relative degree of autonomy—an autonomy which increased after the Russian takeover, and which itself enhanced the mutual interdependence between its own internal classes (ruling elite and local peasants). Early on, the formation of key organizations as the Finish Literary Society and the Finish Art Association, amongst others, sought to preserve its culture, by identifying key works and distributing these through new editions.

While Finland was fortunate in having relatively little direct interaction with external agents from Sweden or Russia—such that language did not become a factor in its political relationship—its coastal trading regions were the ones which had most interaction with the outside world. This coastal 'triangle' formed by Tampere, Turku and Helsinki became key centers of nationalist activity, which coincided with distribution of nationalist periodicals and journals. These towns had the largest number of subscribers to such journals, which also coincided with its nationalist participation rate; 50% of all nationalists emerged from this region.

There are interesting differences and similarities to the Puerto Rico that are worthy of attention as those between

[151] It goes without saying the same structural criticism that can be made of one, can be made of the others.

Russia's takeover of Finland to that of the US conquest of Puerto Rico in 1898.

While it might be said that the US granted Puerto Rico political autonomy with the creation of the commonwealth ELA in 1952, there can be no doubt that the US has played a much more intimate and controlling role in its culture and politics. As well noted, during the fist half of the century there was the serious attempt at a linguistic assimilation of Puerto Rico through its educational system, well documented by Negron de Montilla. It goes without saying that this inhibited the scientific formation of the island given that, for example, mathematics cannot be smoothly taught when the referenced items alluded to, i.e. "peach", are unknown.

As well documented by Dennis and other writers as Maldonado, the nationalist mood which existed in the 1930s, as a result of the abuse and economic power of the sugar *centrales* as Aguirre, could have manifested itself in the gubernatorial election of nationalist leader as Pedro Albizu Campos. Albizu, as Immerwahr well documents, was an extremely capable leader, knowledgeable of science (chemistry) and whom learned law in the highest centers of learning in the US (Harvard University). Ablizu was offered the governorship position of Puerto Rico, but with certain strings attached; his rejection of the arrogant offer allegedly resulted in the election of the drug addicted Luis Muñoz Marin—an able writer but a far lesser scholar. Whether or not Albizu would have effectively served to lead the island's independence, it cannot be denied that the US actively thwarted the island's autonomous development during the first half of the twentieht century, decades before the Cold War had ever emerged in the 1960s.

Another common pattern between the two is striking for our particular purposes. When Finland sought to establish a high school system, or *gymnasiums*, as the *Colegio Central* in Puerto Rico, there was an enormous output of donors whom were enthusiastic of the needed measure. However, it was ultimately repressed by the respective dominant powers, whom well recognized the potentially powerful role of education in a

peripheral region—be it in the formation of nationalist feeling (teachers) or by the provisioning of the means of modernization and economic prosperity (science), which itself would impact political status.[152]

As Tapia wisely noted, states which are kept in a continual state of dependency have no need for recourse to independence.

[152] When grades and degrees are unmeritoriously given away, as happens too commonly throughout the multiple layers of the island's educational system, such a dynamic is tragically thwarted.

Chapter 19

Moral Onus

By the nineteenth century, the international context of colonial Puerto Rico had drastically changed. Key thinkers had long ago produced new political theories of sovereignty. New modern nation states had formed, as France and the United States, based upon notions of universal rationality and modern science. Weak states as Sweden were actively using science to prop up themselves using Linnaean binomial nomenclature and acclimatization theory as their new economic motors. Newtonianism itself had expanded worldwide creating new fields of study, so much so that the end of the century would culminate in another scientific revolution, that of relativity and quantum physics.

This radically different international context had, in turn, drastically shifted the terms of the political debate between Puerto Rico and Spain. Their political relationship no longer occurred in a medieval context so dominated by the great chain of being worldview, where each political entity had its hierarchical place and purpose, but rather new expectations had emerged with regard to the role and function of government as well as that of science in society. Nations were subject to powerful political laws akin to those of the natural order. The Spanish monarch could no longer offer acceptable claims for the legitimacy of their colonial regions, as these claims had long been rebuked in other European realms. This drastically different context by 1800 raises the question as to why the clamor for change in Puerto Rico did not occur earlier than it did.

This new context lies at heart of the political conflict between the two regions, and hence the tendency towards

violence.[153] The early nineteenth century had also been a period of revolutions in Latin America. Nearly all Latin American nations were created in twenty year window—all except Puerto Rico and Cuba. Spain greatly feared their loss, which helps explain the excesses of its repression. Yet Spain and the United States were merely reenacting Thucydides's well-known theme of his *History of the Peloponnesian War.* The interaction between an old power in decline to that of a new rising power, as Athens and Sparta, inevitably led to war. Cuba's persistent fight was used as an excuse by the U.S. to declare such a war in 1898 and occupy Spanish territories—but in the process this exemplar "city upon a hill" obtained colonies for herself under the incongruent banner of democracy.

The impact these broader international changes had on Acosta, Baldorioty, Stahl, Betances, Tapia was substantive.

Key scientific figures, now well recognized and established in the history of science, are missing throughout their writings, revealing an intellectual repression which goes unnoticed if one is ignorant of the history of science, not unlike the blindness of traditional historical interpretations of Franklin. Acosta talks about calculus, but not about Newton; he talks of geography, when he really means astronomy and cosmology.[154] Baldorioty describes generational morphological change of animals for human ends, yet never mentions Darwin. His *Plan de Ponce* introduces toleration of religion and a division of power, but nowhere do Locke, Jefferson or Montesquieu appear—

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[153] Violence, after all, is a sign of weakness—or of denied reciprocity.

[154]Remember that not only was Newton a well recognized figure, but by end of the nineteenth century another revolution in physics was underway, the quantum and relativity revolution. Spain was so scientifically backward, that public arguments for Thomism were still being made, essentially a continual call for medieval Aristotelian physics. It is, as Wolfgang Pauli used to say, so wrong that it was not even incorrect.

something rather remarkable given the relative absence of Protestantism in the island at the time.

There is an implicit moral onus in this historical debate which Spain and Spanish historians as Cortéz Zavala avoid, specifically the issue of whether such illustrious scientific names should have appeared in Acosta's and Baldorioty's writings. If, for example, one argues that the most important scientific revolutionaries should not necessarily have been mentioned in the *proceres*' writings, then no moral onus could be claimed of the Spanish colonial system or of its Spanish military governors. If, on the other hand, our answer is affirmative, then undoubtedly repression occurred in the Spanish colonial island at the deepest cultural and philosophical levels which no excuse can justify, akin to a type of national pedophilia.[155]

Acosta and Baldorioty were typically accused of being anglophiles, showing a love of the United States. It is curious to observe they were never accused of Francophilism, in spite of France's unquestionable scientific credentials. This suggests that it was generally believed that Catholic France represented a far lesser threat than British Protestantism. Spain was well aware of North America's respective intellectual influence during the nineteenth century, an awareness reflected in the particular charges against the two men. This observation would suggest, on the other hand, that science was an incidental victim of Spanish colonial repression.

The issue before us is thus to clarify whether science was a primary or secondary factor of such repression. This has been a core historiographical question underlying the *polemica* of Hispanic science, as the Inquisition for example. A substantive number of works of the Scientific Revolution appeared in the

[155] It would also imply that Puerto Rico did not have a genuine Habbermasian public sphere. Colonial Puerto Ricans lacked the democratic ability to talk, discuss key issues, offer key solutions and alternatives. In short, they grossly lacked a democratic atmosphere, whose benefits had been so well described by Montesquieu and Jefferson: the pursuit of individual happiness.

Index of Prohibited books. The typical argument presented by Spanish apologists is that science was not suppressed but rather was accidentally swept up within the religious persecution of Protestantism.[156] If we accept that science was a secondary and incidental victim of this repression, then Spain's moral onus is reduced. If we, on the other hand, accept that science was the direct victim of this targeted attack, then a heavy burden must be shouldered by the Spanish metropolis.

In a similar fashion, the same moral onus could be claimed for science in Puerto Rico during the Spanish colonial period.

In response to Spanish apologists, it may be observed that the results were the same, regardless of the intentions proclaimed or denied. In the end, Spain's policies unquestionably inhibited Puerto Rican and Latin American scientific growth, as well as their sovereignty. In both cases, medieval Inquisition and Spanish colonial repression had the same intellectual and political impact on the island's intellectual development, regardless of whether scientific repression had been a primary or incidental motivation.

[156] Counter Reformation emerges due to Protestant Revolution a number of secondary institutions are also formed the Index of Prohibited Books and the Jesuits. These are designed to counteract influence of Protestantism. However, main issue still arises is science a cause of the repression.

Interlude: A Plea for a Puerto Rican History of Science

The purpose of this essay is to provide background information which will help institutional academic leaders explain the reason for a program or concentration in the history of science and technology at a Puerto Rican university. While its emphasis will be towards the history of science, similar observation could be made with regard to the history of technology or other allied fields.

Aristotle was perhaps the first historian of science, given his tendency to review the ideas of his philosophical predecessors about particular topics to help establish his own. During the Colonial period, there were some histories of science written, but the field was not institutionalized until the migration of the Belgian chemist George Sarton to the United States during the fist half of the twentieth century.[157] Even then, by 1955 there were only five universities with history of science departments, these being Brown University, Cornell University, Harvard University, Johns Hopkins University and the University of Wisconsin. Given the unquestionable importance of science and its social impact after the Second World War, the field rapidly grew during the second half of the twentieth century. By 2013, there were more than 60 graduate programs offering masters and doctoral degrees in the field.

[157] There is an interesting historical debate with regard to its origins. The view presented here was sharply rebuked by Jose M. Lopez Piñero in his article for the compendium *Mundialización de la Ciencia* (2001).

The number of history of science and technology (HST) graduates in Europe is also substantive, in particular for Spain, France, Germany and England. Given that the latter three countries were of primordial importance to the development of science, its programs were widely supported by the sate, while those of Spain since the nineteenth century have sought to explore and make know its national contributions during the colonial period.

With regard to its intellectual development, there have been multiple generations of historians of science, the first consisting of figures such as Herbert Butterfield, Alexandre Koyre, and Marie Boas Hall. They explored scientific development from a philosophical point of view, typically focusing on Early Modern Europe. Butterfield, for example, explored the development of the idea of impetus, while Koyre explored changes in Western notions regarding the size of the universe. Such a school would later come to be known as "internalist", which also tended to idealize the first scientists as exemplars of rationality, a tendency well exemplified by A. R. Hall in his histories of Isaac Newton and the Scientific Revolution.

Since then, the field has flourished in too many diverse and complicated ways to be aptly described in such a brief space. Nonetheless, we may observe that the general HST historiographical development has continued expanding, incorporating a greater range of aspects and a diverse set of themes, such as its political ties (I. B. Cohen), its impact on technology (Edwin Layton), other poorly studied fields as chemistry (Allen Debus) and biology (Paul Farber) as well as expanded into other cultural regions such as Mexico (Elias Trabulse) and Brazil (Stepan). We can generally identify the tendency towards a greater inclusion of the irrational in studies of the Scientific Revolution, as seen in the work of Frances Yates, which were continued by Betty Jo Dobbs in her historical studies of Isaac Newton's alchemy. (Key to this development was the work of Steven Toulmin and June Goodfield during the

1960s.) The externalist school, which sought to situate science in its social context, grew rapidly during the 1980s and 1990s.

Given the lackluster scientific tradition in Puerto Rico, the professional efforts towards its history have naturally emerged only recently and the field has yet to become formally institutionalized at a university or higher education level. With regards to the books or writings dedicated to the topic, these begin to emerge principally during the second half of the nineteenth century.

Jose Julian Acosta along with Roman Baldorioty de Castro were some of the first formal Puerto Rican scientists who studied in Europe during the nineteenth century, regularly published histories of science in his *Almanaque Aguinaldo* (1857-1879). These articles sought to develop and understand the growth of science—but not its local development, of which Acosta himself was a participant, for rather obvious reasons of Spanish colonial repression. Examples of such works include descriptions of Johannes Kepler, Jose Francisco Caldas and other important figures. Surprisingly, Acosta met Alexander von Humboldt during his European university studies.

Of enormous importance for HST in Puerto Rico, Acosta helped to distribute important primary sources in the field, such as Iñigo Abbad y Lasierra's 1788 natural and civil history of the island (*Historia Geográfica, Civil y Natural de la Isla de Puerto Rico*) as well as the *Viaje a la Isla de Puerto Rico en el año 1797* written by the French botanist André Pierre Ledru. As he had with other Puerto Rican peers in Europe, whom compiled materials about Puerto Rico in Spanish Archives in the *Biblioteca Histórica de Puerto Rico* (1854) edited by Alejandro Tapia y Rivera, Acosta rescues the few scientific writings about the island in Europe which had been written during the eighteen century and distributes them via his publishing company along with other important scientific works.

We should emphasize that Acosta's efforts sought to identify primary materials rather than provide a historical interpretation about the scientific development of the island,

given the colonial political conditions he found himself in.[158] It is important to emphasize that both Abbad's and Ledru's works never impacted the scientific development of Puerto Rico given that they were published originally in Europe and only appeared in the island a century after their creation—due, again, to Acosta's extraordinary efforts.

After the Hispanic-American War of 1898, the impetus towards the development of scientific activity grew astonishingly quickly—at least with regard to the activity which had preceded it. The island became a good site in which to practice science, as seen by the multi-disciplinary and multivolume *Scientific Survey of Puerto Rico* by Nathaniel Britton and others. A local scientist whom had participated in these events also took up the mantle as a historian of science was Carlos E. Chardón. His *Los Naturalistas en la América Latina* (1949) is an important contribution to the field. Although there were other similar historical gestures by other scientists, these have generally lacked academic rigor and do not conform to common well-established historical standards in the HST field.

These first efforts towards history of science in Puerto Rico included those of a prior Agriculture Secretary Jaime Bagué, whom provided a positivist historical overview—a comprehensive list of names not too distant from being a phone book. Some contemporary historians have also followed the same methodology as Bagué in their efforts.

There were two substantive efforts in the Puerto Rico history of science after the Second World War, with respect to its institutionalization and intellectual development. The first was that of Jaime Bonnet Jr., a nuclear scientists whose father Juan Bonnet had been an agronomist at the Agriculture Department. Bonner Jr. established book clubs, conferences, and meetings about the topic, publishing works such as *Ciencias y Tecnología en Puerto Rico* and *Ciencia y Política en Puerto Rico*. Bonnet Jr. was director of the *Centro para Estudios Energéticos y*

[158] For a good discussion of the issue see Gervacio Garcia.

Ambientales at the University of Puerto Rico during the 1980s, and participated as well in the first efforts at nuclear energy in the island. Tragically, Bonnet Jr. died prematurely, being assassinated during a failed robbery attempt at a local *colmado* towards the end of that decade, placing an abrupt pause to the institutional development of the history of science in Puerto Rico.[159] Bonnet Jr. had directed a masters theses in the field prior to dying, that of Víctor de León Díaz (1979) whom also establishes his historical narrative in a positivist fashion.

Perhaps the most intellectually sophisticated effort which antecedes the 1990s was the work by Isabel Becerra de Weierich, whom wrote one of the best masters thesis that exists to date in the field: *Las primeras estaciones agronómicas en Puerto Rico* (1969). The subtle and sophisticated manner in which scientific themes were treated is remarkable still today, and it is tragic that Becerra de Weierich was never able to formally become incorporated into the History Department at the UPR-Rio Piedras campus or, for that matter, in any other academic institution of the island. It is to be noted that an institute of the history of science was established at some point at the UPR-Mayagüez campus. However, this body was dismantled by Elena Lugo so as to form an institution dedicated to bioethics—an institution which since its formation had been dominated by the religious sector of the island.[160]

After the new millennium (2000), although various studies by scholars have been written, their sum total have not coalesced into a historiographical school per se in the field, what we may denote as HST Puerto Rico. Some of these include, but are not limited to, scholars such as: 1) Libia González, whom edited a new edition of Ledru's work, 2) José Rigau, a medical historian who has written histories of botany in the island, 3) Ramonita Vega Lugo who has studied cholera and urbanism, and

[159] As previously noted, the notion that his death might have been a purposeful assassination should not necessarily be discarded offhand. Please refer to Epilogue.

[160] Fernós, *Biology and Ethics*.

4) this author before you, whom has been more focused on the boarder history of science in Latin America. There are other scholars whose works have touched the field, but who principally live and work in the United States. Most of these focused on the history of medicine, as done locally by 5) Miriam Lugo. These include 6) José G. Amador and 7) Nicole E. Trujillo-Pagán.

Although 8) Darryl E. Brock, prior scientist for Monsanto, studied the *Scientific Survey* for his doctoral thesis in 2014, regrettably his study does not abide by contemporary historiographical standards in that he did not identify the *Scientific Survey's* specific contributions to the science of the era, perhaps a common error seen today and which reflects the extremist externalist tendencies that have emerged in the field. As Bertrand Russell once pointed out in a different context, historographical tendencies move as if on a pendulum, from one side (internalist) to the other (externalist) with the passage of time.

What is odd about HST in Puerto Rico, even today in 2020, is that it approximates the state of the field in the U.S. in 1956, as reviewed by Thomas H. Grainger in his "Why Study the History of Science?"[161] Grainger noted that this historical field was dominated by the history of religion and the history of medicine; the history of science and its enormous impact on civilizations was still in diapers. We may make a similar observation with regard to the state of the field in Puerto Rico, noting that even today, there is a dearth of rigorous studies analyzing the impact of science and technology on Puerto Rican society and culture. This is particularly puzzling when one considers the enormous technological changes that have occurred between the nineteenth and the twentieth centuries in the island. Worst still, prominent Puerto Rican scientists whom have made great contributions to both small and large scientific revolution

[161] It also closely resembles the state of the field in Mexico during the 1970s, as well described by Elias Trabulse in his *circulo roto*.

are being forgotten and left behind, erased from our collective historical memory.

The benefits of the history of science have already been established after half a century of academic activity, which we will review below. We will also take some space to briefly indicate its particular benefits for Puerto Rico and the academic institutions in which it is established. There are multiple audiences that exist for the history of science, amongst these future scientists, future political leaders and students with a general philosophical interest in science, but whom do not have a formal desire to become scientists per se.

When studying the history of science and technology, the student will obtain a more profound and complex appreciation of the ideas which have nurtured scientific development, as well as a better notion about the actual character of this activity. As the important biologist cum historian of science Ernst Mayr once pointed out, seeing how certain ideas formed greatly aids in their understanding—akin to understanding legal principles by looking at the context in which such laws were formed, as Jefferson did. (It is said that there is no better way to study science than through its history). Similarly, it will provide the future scientist a more realistic understanding of his own field, learning that progress in science is not as clear or rational as he might have idealized or supposed. They will also be exposed to ethical dilemmas with which all scientific leaders have had to deal with at one point of another—coming to know the grave consequences which may occur when improper ethical stances are taken.

Science, as Grainger pointed out, is in an eternal state of change and development; it is not a fixed, immutable, and eternal entity. All science is built upon the achievements of their predecessors, and, as a result, it is both as limited as it is driven by these. Only in light of it history, Maienschein points out, can we better understand it progress. Finally, given the necessary specialization in contemporary science, the field will help establish a greater community between all scientists in their respective fields—physics, chemistry, biology—whom by definition are extremely specialized; through HST they will get to

know the achievements of their colleagues as well as of the common problem shared by all.

From a Puerto Rican point of view, the study of the history of science and technology will provide the student with a better idea of how difficult the attempt at its practice had been during the colonial period, as well as a better appreciation of the important role which all academic institutions play in the island. They will obtain an appreciation of how much has been achieved, as well as an idea of how much there still remains to be done. Similarly the student will obtain a historical respect for the factors which contribute to the well-being and culture of the island, as well as the reasons for its distinctive character. From the perspective of gender, it will help stimulate greater equality through the exemplar cases of open academic spaces irrespective of race, gender or creed. HST will also rescue from historical oblivion the modest scientific growth which has occurred in the island during the last two centuries.

Finally, and perhaps of greatest importance, the history of science and technology will help promote a genuine culture of democratic participation, stimulating the values pervasive in science regarding the importance of a rational discussion based on concrete evidence and critical analysis about presumptions and common social goals.

Part 6

Davids versus Goliaths

Chapter 20

On the noxiousness of avarice

Who wouldn't want to be a Marxist? We might suggest that Karl Marx confronted one of the fundamental problems of the human condition: human avarice. Half a millennium prior to Marx, Dante had already alluded to the very same problem in his *Inferno* of the *Divine Comedy* (1308). Avarice for Dante was the source of moral disorder and social collapse.

> *…your avarice afflicts the world*, *Trampling the good and lifting the depraved.* (Canto 18)

> *And he said to me: "Vain thought thou entertainest; The undiscerning life which made them sordid now makes them, unto all discernment, dim." (*Canto 7)

The life of the avaricious was one without discernment and judgment, which led men towards ignoble motivations and actions publicly regarded with disgust and disdain, which blinded them to truth and reason.

The problem of capitalism and corporations are nothing new in history. Avarice blinds those who are contaminated by it, and in this sense corporations merely provide a new context in which avarice manifests itself.

We may note that the modern corporation is a creature of the nineteenth and twentieth centuries, and did not exist when the United States was formed or when the French Revolution occurred, so beset by the privileges of the aristocracy and the abuses of monarchy—or, in other words, the medieval context in

which human avarice then manifested itself. The Founding Fathers of the United States detested the impact of money on politics, as noted by Thomson, which was perceived as a corrupting entity which distorted political institutions. There was nothing worse a the politician blinded by money, analogous to the function of modern party system which distanced voters from their own analyses and conscience.

During the eighteenth century, the joint stock company was not a corporation in the modern sense of the term, but rather had limited and particular functions—typically a common project from which all would benefit, as the construction of a bridge, for example. Given the ambition of the project and consequent costs of construction, these would be spread out over many different pockets, so as to not place too onerous a burden only one or a small group of persons.

The "joint stock" thus was originally a rather useful tool of financing which offered non-guaranteed investments to its stochholders and freedom of action to its founders, so that important risks could be taken. Not all joint stocks were successful, as all else in life, which did result in losses, for which the founders were not legally liable. The greater the risk, the greater the benefit, however. We might even go so far as to suggest that the original joint stock companies were the legal structuring of courage, which promoted risky actions without a guaranteed end but from which the community could greatly benefit when successful.[162] The joint stock, in short, was an important component to the formation of the culture of innovation of the Untied States, which underlay a new model of economic growth based on science and technological innovation.

The modern corporation has been tragically alienated from its origins, having been turned into the legal structuring of cowardice. Corporations rarely suffer the consequences of their actions, or what is known in economics as moral hazard. Today

[162] Typically most individuals want some guarantee prior to taking any actions, and without which such actions are usually not taken.

they typically receive a blank check of action, and in this sense modern CEOs might be said to be a new type of monarch—which helps explain many of the contemporary problems the United Sates is facing. A corporation's enormous financial power, which was previously used to invest in new technologies and innovation, has now been degraded towards the infamous buy-backs which do not result in genuine increases of economic productivity, bu rather continue to further degrade the economic base of the United States, which during the last half century had been the wealthiest nation in human history.

Drastic changes occurred towards the end of the nineteenth century. Elihu Root, a corporate lawyer whom became Secretary of State and Secretary of War, established a new legal definition for the corporation, which drastically modified its legal standing. The corporation would now come to be defined as a person; all of the rights which are granted to persons would come to be wantonly extended to the modern corporation as well. The cusp of the corporate abuse of power and political influence is perhaps the *Citizens United* decision by the U.S. Supreme Court in 2010, which conceded the right to corporations to grant enormous campaign donations as any other citizen would. The claim was that modern corporations needed to exercise their freedom of speech, a constitutionally protected right.

However, their enormous economic power is far greater than those of any individual citizen, even the wealthiest as Bill Gates, and hence have the capacity to drastically alter the context and purpose of the law, as well as the moral context of all decisions and actions in a society for their own self benefit. This is a notion that would have been preposterous to the U.S. Founding Fathers as Jefferson and Franklin, whom had sacrificed so much for its creation.

It might be questioned whether these institutional changes decisions and actions are as bad as they seem. The truth of the matter is that corporation operate under a blind law: the stock market. The goal of the modern corporation is to raise the value

of its own stocks, come what may, rather than necessarily innovate and generate a profit, though the two are often confused.

This desire for cheap money leads to countless examples of fraud in the corporate world. The first example is the Ponzi scheme by Bernie Madoff, who defrauded the incredible sum of $65 billion, a huge amount under any context. Madoff had even directed the Securities Exchange Commission, which lent enormous validity to his public claims.

Another prominent case of fraud is that of Elizabeth Holmes of the infamous Theranos biotech company. Holms claimed that a small electronic box would be able to provide a complete medical examination using only a single drop of blood. Holmes, whom outwardly pretended to be a new Steve Jobs, led to the loss of $600 million from her investors. Tragically, former Secretary of State George Shultz had supported Holmes, thus further enhancing her social legitimacy, in spite of being warned by his own grandson as to the biological falsity of her claims. Thirdly, Taylor Swift's new manager sold her original recordings for $300 million, a gain she will never benefit from. Only upon requesting a non-disclosure agreement from her that the scheme became public. Without a doubt, successful cultural creators tend to be defrauded, which is a chronic problem in capitalism. The temptation of cheap money is too much of a temptation for some individuals to bear.

The institutional change is dire because it tends to oversimplify complex human realities into mere issues of dollars and cents, costs or profits. The world, by definition, is complex. In fact, the successful state leader has to consider multiple strategic factors when making a decision, rather than single-mindedly focus on just one aspect. An example might be the phenomenon of outsourcing, or the exportation of manufacturing plants to foreign nations so as to take advantage of the variation in the value of national currencies. Without a doubt, the lower production cost in a foreign nation can lead to enormous gains, consistent with the demands of the stock market. However, when the full range of costs are considered, including their externalities, the decision is not quite so simple and clear cut.

Such decisions, however, come at an enormous cost, as can today be seen in the relationship between the US and China.

A nation without a manufacturing base by definition will be subject to the winds of international politics, well described by Immerwahr. In the case of war, a deindustrialized state will not have access to these products, be they steel or computer chips, which so dominate the modern economy. From a strategic military point of view, outsourcing is a long-term costly error, and oddly the opposite solution to that which Linnaeus proposed. If the reader will recall, Linnaeus sought to reduce dependency by increasing his nation's internal production of goods, in his particular case agricultural goods. The neoliberal philosophy which results in outsourcing actually worsened the problem Linnaeus tried to prevent: dependency upon the foreign exigencies of other nations, which can be disastrous in the circumstance of war.

We may make a similar criticism of Marxism. The world simply cannot be fixed with simplistic definitions and answers which are only expressed in a complicated manner so as to hide their true nature and flaws—a problem common to the intelligentsia, if we take a look at postmodernism or deconstructivism. The shift of power from fuedal nobles onto a communist superstructure only worsted the context of avarice by providing too much power to those at the top which directed this superstructure. The best example of this is the Soviet Union and the leadership of Stalin.

Stalin in short was a sadistic hillbilly who killed hundreds of thousands, directly or indirectly, and in the process destroyed the early formation of genetics in his nation. Stalin, who knew even less biology than Lysenko, placed him in charge over the Soviet scientific apparatus, whom sent one of its most important figures, Vavilov, to the gulag and ultimately to his death. Lysenko believed in the theory of acculturation, which as any modern biologist knows is mistaken. Though an alleged biologist

of the twentieth century, Lysenko did not know of Darwin, without whose ideas the world of biology makes no sense.[163]

Stalin, ironically, also epitomizes the inherent weakness of all authoritarian governments, in that absolute power will always result in arbitrary political decision making, for reasons which are obvious and simple. Nobody can know everything—particularly so the case of Stalin who had no university education. Lysenko was thus able to easily convince him that his agricultural policies were not causing famine in the Soviet Union. In a well known anecdote, when Stalin called for Lysenko demanding an explanation, Lysenko took out three potatoes from each coat pocket, claiming that the large ones originated from Soviet farms, hence it was impossible that his scientific theories could be the source of the famine-which in fact they were. Any undergraduate student of science can easily tell the sampling error committed by Lysenko in his explanation.

However, Lysenko's "science" and Stalin's gross scientific ignorance, led to the deaths of millions of Soviet citizens. In light of such ignorance, the communist system under Stalin—or any political system led by ignorance for that matter—could only be sustained via violence, which in and of itself had enormous repercussions on Soviet culture, and whose effects can still be seen today in Putin's new leadership.[164]

Again, historical reality is much more complicated than simplified corporate calculations suggest. The same notion applies to the relationships between the Soviet Union and the United States. In spite of their enormous conflicts, they had more in common than was apparent at prima facie. Both are political systems dominated by an isolated elite whom do not necessarily represent the public interest. The two in short are different names for similar political structures.

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[163] Lysenko was so poorly equipped scientifically, that Vavilov severely undermined the threat Lysenko posed to himself and to his field.

[164] Putin, as Lysenko, has sought to hide the truth of Covid19 before his own citizens and the rest of the world.

The same might be said of the relationship between democracy and science, according to Wang. Prior to the Cold War, science was perceived as essential to all democracy, as a bastion against fascism, tyranny and oppression. This was well typified in Edwin Pahlow's *Man's Achievement: The Age of Science and Democracy*, published in 1934, published shortly before the war began. Today, these facile views, regrettably, are not generally accepted as unquestionably valid, nor would the notion of the objectivity of science—akin perhaps to the notion of the universality of reason which, as Thomson showed, was held during the eighteenth century. Not all will arrive at the same conclusion given the same information. Quite the contrary is the case, in that science can produce anti-democratic tendencies.

Though C.P. Snow is today known as a scientist who wrote *Two Cultures and The Scientific Revolution*, he was not blind to the negative aspects of science. In fact, he was much more sagacious than might be presumed first hand. While the *Two Cultures* was a critique of the humanities for not taking science into greater consideration in the discussion of culture, during the Second World War he criticized the institutional costs of science. The creation of the megatron occurred in a social context beset by a complete lack of transparency, and which naturally conflicted with widely cherished scientific values of openness and information sharing. The use of science in the context of the Cold War resulted in the culture of secrecy, or what Shils has termed the "torment of secrecy." Fundamental truths were held to be "top secret" and hence could not be shared with other scientists, completely contradicting the most fundamental of scientific values so well expressed by Merton.[165]

Don K. Price took similar postures. Science had not only changed the North American economy, creating a new type of economic growth that was not based on capital accumulation but rather on technological innovation—which itself depended on

[165] A similar complaint was made by Eisenhower over the "military industrial complex", which threaten the very American democratic experiment.

new scientific discoveries, but one whose enormous growth threatened the very nature of the state. Science, in short, was making constitutional democracy irrelevant in the administration of modern affairs. The cherished balance of powers by Montesquieu no longer worked given the confusion between public and private interests. Enormous government contracts were granted to corporations, what former Republican senator Robert Doyle referred to as corporate welfare.

Modern problems were also characterized by a degree of scientific complexity, which was usually above the cognitive capacity of many leaders—a good example being global warming.

For decades, state leaders have avoided confronting the issue, to the point that it finally became so evident, that former Vic-President Al Gore created a documentary "An Inconvenient Truth" (2006) to raise alarms over its consequences, should they continue to go unheeded. Congressmen during the 1970s and the Reagan years the following decade had refused to accept its existence, thus delaying actions that were critically important at the time. Still today, its reality is being questioned by politicians as Ted Cruz, in a manner not altogether too differently from our most immediate threat: Covid19. Trump routinely rejected its significance and downplayed the importance of wearing masks at a time when their use would have drastically reduced its onset.[166] Tragically, Trump's claims are unquestionably believed by his own followers, who even upon the face of death refuse to believe its existence. The "fake news" turn out to be not so fake after all.

Yaron Exrahi incorporates these changes in the philosophical postures about the nature of reason into his own views regarding science and democracy. If science as a mediator of the political process is subjective, what then are the implications for the political process and for democracy itself? Exrahi, however, does not argue that its subjectivity undermines

[166] By the end of the year, it is estimated to surpass 20 million cases, a figure that would have been hardly conceivable in March when public notice began to be made.

the democratic process, but rather just the opposite. His views are rather more optimistic: science introduces a culture of evidence and empiricism into the political process, whereby all citizens become neutral observers, judging for themselves based upon the available evidence. As Ferris pointed out, this results in wisdom of the crowd dynamics, which in theory leads to a more certain judgment than that of any one particular individual. Naturally, these views contrasted with the ascriptive monarchical values in which the only social referent for truth was the monarch himself.

Similar dynamics occur between science and nationalism. As observed by Wang, colonialism and nationalism share certain common traits, to which we should not be blind, so that we might have a truer understanding of the nature of the political reality around us.

Chapter 21

The Pointilist Empire

Daniel Immerwahr is a descendant of Fritz Haber, an important German chemist who invented the ammonia synthesis, which is high in nitrogen and serves as a key ingredient for fertilizers. The process is a chemical reaction which occurs at very high pressures; if a powerful fire hose operates at 125 pounds per square inch, the Haber process runs at 1,000 psi. The pressures are so incredibly high, that it is no wonder that the gases fuse as they have nowhere else to go. Haber performed 6,500 experiments on 2,500 potential catalysts, to find only two, of which osmium turned out to be the critical elixir for the Haber-Bosch process to occur.

Haber's invention is Janus-faced, however. On the one hand, at the turn of the nineteenth century many feared and expected a food crisis to emerge as the production of crops could not keep up with their demand. In this sense, synthetic nitrogen was a godsend by allowing for food production to match global population growth; had it been otherwise, a global food crisis would have occurred one hundred years ago, which again was averted due to Haber's work. If 366 thousand tons of the material were consumed in 1905, by 1963 the figure rose to 13,990 thousand tons. In fact, the use of nitrogen fertilizer has grown to such a degree, that it is now its own problem, creating green algal blooms in bodies of water that kill all life. Instead of Rachael Carson's bird-less silent spring we now have silent fish-less ponds.

However, the historian Immerwahr is not the great grandson of Haber himself, but rather of his wife, Clara Haber, whose maiden name was Clara Immerwahr. Clara had also been a chemist in her own right, but over the course of their marriage, her career declined in direct proportion to Haber's increasing

success. This must have been tragic from her point of view, resembling Einstein's own relationship to his wife. Clara's story is certainly a very tragic one.

During the First World War, Haber also invented mustard gas, a deadly chlorine based gas which kills instantly. That ammonia is key ingredient for weapons manufacturing gave it a dual role, as a giver and taker of life. When hearing of this man-made monstrosity, Clara issued an ultimatum for her husband to stop his scientific work, as she clearly saw that use of the gas in war was inhumane, echoing Rousseau's lament. Science was leading to new forms of murder and torture. Clara took her own life as the ultimate protest, committed suicide when Haber refused to comply. The following day, Haber was at work on the front lines administering the lethal gas.

We might question de degree of autonomy scientists as Haber have in a modern day setting. Germany at the time had some 3,000 chemists competing for the same jobs which were often rather mundane. It is well known that Germany's social structure was very hierarchical.

It might even be suggested that Immerwahr's book seeks to restore Clara's history, in that it is a critical look at the geopolitical impact of science and technology. It is a profound and wide ranging analysis covering at two centuries and countless geographical regions, of which the main U.S. territories as Cuba, Puerto Rico, Philippines are included. The work naturally treats the U.S., the most powerful nation in history following WWII, greatly due to its scientific and technological culture.

Immerwahr's principal idea can be simply stated: science and technology altered the dynamics of empire. Previous empires as those of the nineteenth century required vast territories so as to guarantee their ready access to important raw materials. A host of scientific and technological changes, however, modified these dynamics, leading to a new formula for empire which did not require the conquest of vast regions given that many of these raw materials could now be synthesized from petroleum, and hence why oil became so important during the

twentieth century. While Immerwahr's argument is much more complicated than this, alluding to transport revolution with the invention of the airplane or the rise of standardization of parts, such is its main gist.[167]

The character of U.S. empire was thus "pointillist", based on a vast range of islands throughout the world.[168] Over 6,000 islands were part of its domain, increasing after the Hispanic American War of 1898 and making up 12.6 % of the total U.S. population. This might be contrasted to the total African American population of 8%. Around a fifth of the total U.S. land area alone exists in these regions. During WWII, the U.S. had some 30,000 military installations at 2,000 sites. Puerto Rico was one such site, which included various installations as Ramey Base (Aguadilla), Sabana Seca (Toa Baja), Roosevelt Roads (Ceiba), Fort Buchanan (Guaynabo), Campo Santiago (Humacao), and Vieques (Vieques). The total populating of these regions surpassed that of the U.S. in 1940, of 135 million versus 132 million.

This pointillist empire has allowed the U.S. to mythify itself, keeping its true nature hidden. The notion that the U.S. is a republic is essentially a myth and a deceptive self representation. The book is essentially a detailed exposition of this fact,

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[167] In contrast to European nations, the United States has an abundant supply of raw materials, but was still influenced by these dynamics.

[168] The rise of steel warships led Alfred T. Mahan to argue that the U.S. needed coaling refueling stations, and hence a strategic imperative. With advent of airplanes, however, coaling stations were no longer needed as one could fly over and bypass Pacific ocean entirely. Airplanes could literally "jump" over vast oceans and territories, thus further altering geopolitical strategic plans. While the U.S. had numerous military bases in Panama, the airplane also ultimately led to its hand-off by the U.S.. The same could be said for the Philippines, whose strategic value was altered with the advent of modern aviation, in spite of General McArthur's close personal ties to the region.

specifically of the geopolitical implications of modern science and technology for both itself, the United States, and its territories, as Puerto Rico. If Acosta and Baldorioty pointed out that there were two contexts, the geographical context as well as the legal context in which human life played out, Immerwahr showed that there is also a third context at work that should be considered: science and technology, which are ever changing affecting both our perception and control of the natural world.

Again, have to keep in mind the complexity of the world, and the context in which particular events happen. We do not operate in a metaphysical vacuum where only ideas and rational debate predominate, as in Greek philosophy, but in a complex geopolitical world where a whole host of dynamics are at play, each interacting with the other in complex and unpredictable ways—many of which we will not always be conscious.

The are unique dynamics of science and technology which render them invisible, in that they often tend to occur at the meso scale over various decades, and hence tend to receded into the background. They establish particular social structures which have relative stability, and are quickly taken for granted. An example of this phenomena are hydraulic damns which will exist for many decades across various generations and will be implicitly taken as a feature of nature. There are many other similar examples.[169] Immerwahr asks us to pierce the veil, and look at things which tend to be hidden from view so that we do not deceive ourselves from the actual dynamics.

Another example is the case of guano.

As we have already noted, agriculture during the nineteenth century was dependent on external natural sources of nitrogen and potassium. One of the best sources was guano, or dried bird poop accumulated over centuries in desert areas such as those explored by Acosta and Baldoritoy in Mona Island. This helps to account for why guano, rich in both, was such a valuable source during the nineteenth century. There was a big push by the

[169] While this particular claim is not made by Immerwahr, it is just as appropriate.

U.S. to obtain guano islands, an appeal stimulated by James Feynmore Cooper's writings. The U.S. tried to obtain the Chincah Islands near Peru, and guano mining began in Navassa, off the coast of Haiti. It was a noxious affair that involved labor deceptions to U.S. African American workers, portraying Navassa as a green paradise when the truth was just opposite. Guano harvesting is toxic for the lungs and skin, not too different from coal mining. Its desert conditions were distantly situated from cities and a rat population out of control meant that these communities had to be run as prison camps.

The Guano Islands Act was passed in 1856 and led to the acquisition of 97 islands throughout the world. However, these dynamics changed overnight with Haber's invention of synthetic nitrogen in 1909. The Germans had been desperate for raw materials given their dependency on the external international materials. Its status as a leading industrial chemical nation along with its abundance of coal provided the answer. Haber's invention of the ammonia synthesis drastically changed that equation. During both world wars, when Germany was cut off from key primary sources, synthetics became a critical alternative, and helps explain Hitler's quest for synthetic rubber and even synthetic gasoline from coal, odd as that might sound today.

From the point of view of our two principal historical actors, the rise of synthetics implies that even if Acosta and Baldorioty had discovered nitrogen rich guano in Mona Island at mid nineteenth century, the cherished economic bonanza would not have lasted very long. In other words, we should not romanticize the heroic actions of past figures, which appear to be even more heroic in light of the active hostility they suffered at the hands of a repressive colonial regime. In fact, Spain's repression in hindsight appears to be even more pathetic, given that its poor scientific status implied that colonial authorities were not wholly aware of the genuine outcomes of their policies. Repression was exercised for the sake of repression rather than for specific geopolitical reasons. In other words, the wanton nature of Spanish colonial repression should not be presumed as

an indicator of a greater scientific literacy than that which actually existed.[170]

The rise of synthetic nitrogen had enormous geopolitical implications for the United States. Many islands which had been previously sought out were suddenly no longer needed as the U.S. no longer required their primary resources. Even when offers for such annexations were nearly freely given away, as in the case of the Dominican Republic, these were bluntly rejected.

The American imperialism led by Teddy Roosevelt looked to past as the present was changing, leading to an inevitable conflict between empire and republic and its inherent clash of values. This contradiction was inherent in the very Insular Cases which established Puerto Rico as "foreign in a domestic sense"—an absurd legal terminology which broke every constitutional principle on which the US had been founded. It gave the U.S. Congress the power to change Puerto Rican political status at any time it wished to do so, and allowed it to oversee all of its laws in a manner not altogether different from the imperial relationship between England and Ireland that Benjamin Franklin had observed. Puerto Rican economic relationship to the U.S. is more similar to that of colonial Ireland than U.S. authorities would wish to publicly admit.

The causes of U.S. prejudice towards Puerto Rico are not too hard to identify; its black legend is based at its core on the island's abysmal Hispanic scientific and technological history. In short, it is the poor cultural-scientific legacy of all of Latin America. This inevitably had an enormous impact on the personal relationships between representatives of both sides, whom lived in entirely different cognitive worlds.

That Albizu Campus was initially an *estadista* (pro-U.S. annexationist) takes everyone at first by surprise. His father in fact welcomed the U.S. invasion and becomes part of its administration, whose contacts allow him to enter Harvard law school. Albizu, with prior training as a chemist, was widely recognized as a very able speaker. At one point, he tried to meet

[170] The case of ginger is another example.

Woodrow Wilson for the WWI peace treaty in New York, but was blocked in his attempt to directly travel there. He was not allowed to enter through the northern U.S., but was forced to travel throughout the U.S. South where abundant Jim Crow laws existed. By the time Albizu arrived at the conference, Wilson had already left, but his experiences were so distasteful that they would lead to an 180 degree turn towards the island's independence. He was not the only leader to undergo experience.[171]

Immerwahr clearly shows that the impact of science and technology on international geopolitics is immense, with enormous implications for the sovereignty of small nation states. By definition, these generally lack the resources of large states including both population (human capital) and material resources (i.e. coal) amongst others, and thus are typically at a disadvantage relative to their larger peers.

While Buffon did have a point with regard to impact of geography, it might also be observed that the geopolitical terrain is always changing due to science and technology which are never stable. These dynamics have profound implications for state leader, implying the need for awareness of one's cultural surroundings. To take these for granted will inevitably catch one off guard—as has the internet, whose wide range of repercussions were not intended by its inventors.

[171] Those who sought to meet Wilson in New York included Mao Zedong (China), Gandhi (India), Ho Chi Min (Vietnam), and Sayyid Qutb (Egypt)—all whom would become major leaders of their respective small states and strongly oppose colonial powers.

Chapter 22

Justice Louis D. Brandeis, Cowboy

If I were to tell you that one U.S. president was a racist and another was not, to presume apriori that the racist president was the worst of the two would not necessarily be a correct conclusion. Theodore Roosevelt once forced the rehiring of African American Minnie Cox after she had been fired as postmaster in Mississippi. By contrast, Woodrow Wilson's racist tendencies are so well known that, had Albizu Campos actually gotten to meet him, he likely would have become anti-American in spite of southern Jim Crow laws. It would be incorrect, however, to suppose that Teddy Roosevelt had been the better leader strictly as a result of his anti-racist outlook.

Teddy Roosevelt certainly had many contributions, and sought to preserve American wildlife by establishing a comprehensive national park system with help of John Muir and Gideon Pinchot. His actual actions towards large corporations and corporate interests, however, stood in sharp contrast with his aggressive anti-corporate public rhetoric, the latter which drew thousands of viewers wherever he went to speak—as in Kansas which had early on fought slavery and at the moment large corporations. Roosevelt, however, accepted JP Morgan, whom unbeknownst to most, funded him continually throughout his entire life, including his voyage to Africa in later years.

Roosevelt did not actually believe that trusts could be eliminated altogether but rather that he needed to make the power of the Presidency manifest through the Progressive movement. Nobody was above the presidency, not even JP Morgan—a powerful central banker who controlled a number of trusts that ranged across multiple industries as transportation, electricity, and steel. Roosevelt, in short, believed that the government had to match power with power, specifically meeting corporate

activity with a larger governmental bureaucracy full of aggressive watchdogs sitting on regulatory agencies with oversight authority, carefully scrutinizing every activity and potential abuse of corporate power.

However, as was criticized during the period, corporations had grown so large that these naturally sought to control those who would attempt to control them. This observation applied not only to scientific regulators, but would become an ongoing structural problem with is a revolving door of scientists and engineers between private industry and public regulatory agencies. This quid pro quo can be seen today in the Food Drug Administration (FDA) or the Federal Communications Commission (FCC). The reactionary tendency also occurred in a whole host of others forces which can powerfully impact big business, as politicians, journalists, and even university professors. For example, Morgan was able to get newspaper men to libelously misrepresent good politicians as Congressman Wright Patman of Texas, whom successfully set the basis of U.S. federal control over corporate activities decades before the hippie liberal movement ever emerged.

Woodrow Wilson took a very different approach from Roosevelt's. As a scholar, he was equal to the task of public debate with his political rival, an avid scholar and a scientist.[172] Wilson's main contention, simply put, was that the corporation was too large, and its enormous growth represented a serious threat to the American political experiment and to American democracy itself. Wilson believed that corporations should not only be regulated, but that they should also be broken up. Through vertical integration they had obtained too much power and size, affecting all about them. As the economist John Kenneth Galbraith once observed in a 1972 debate with William Buckley Jr., the modern corporation was so large it influenced enormous segments of American society, and hence by

[172] Theodore Roosevelt was one of only one of two presidents to have published scientific works, the second being Thomas Jefferson.

definition, had long ceased solely being a private concern. Instead, the modern American corporation had obtained a public status due to its range and grasp, and as such needed to be subject to strict governmental controls. Galbraith argued that the modern U.S. corporation had basically become too big to be blithely ignored, as an elephant on the savannah versus a mouse in the brush.

Wilson would go on to win the 1912 election, and in the process established many key institutions which further limited corporate reach. One of these would be the U.S. Federal Reserve. The purpose was to take back governmental control over a power that had been gradually waning, falling into the hands of enormous banks who did what they wished with the financial system, as those controlled by J. P. Morgan. Wilson would seemingly lose the conflict. World War I would force America's entry into the war, which in turn increased the power of the modern corporation by its greater centralization. Wilson would also suffer a debilitating stroke during the last two years of his presidency, leading to a partial paralysis, having great difficulty walking and expressing himself. Wilson's debilitated state, in turn, created a power vacuum which helped to further degrade many of the reforms which had been established.

The following three presidents, Harding, Coolidge, and Hoover, would become known as Andrew Mellon's puppets. Mellon, who adopted JP Morgan's mantle, became Treasury Secretary across the three presidencies over a period of 12 years. That Mellon owned more than 200 corporations meant that his decisions greatly impacted his personal pocketbook, and created a substantial conflict of interest—until he was ousted by Patman, the Texas legislator whose father had been abused by the banking industry.

There would be one exception to this overall trend, however. Wilson successfully placed Louis D. Brandeis in the U.S. Supreme Court.

Brandeis was a "radical" who had consistently fought giant corporations in favor of the "little guy"—small businesses, farmers and other lower and middle class economic actors. Upon

hearing of the nomination in 1916, a palpable gasp was heard on the Senate floor. Wilson fortunately had sufficient political clout to get Brandeis to the court, whom in turn reshaped the political landscape for decades to come. He did so simply by brining science to the court, matching the intellectual power of countless corporate lawyers. Brandeis, in short, establishing a new legal landscape of capitalism in the United States during the twentieth century.

Brandeis had actually helped Wilson's successful political campaign of 1916, laying out the key features of Wilson's corporate approach and rhetoric. Brandeis, as a young lawyer from a Jewish middle class family whom had gone to Harvard University, had actually become an important corporate lawyer in his early professional years. However, he became so disgusted with the experience, that he had a mid-life crisis at the age of 41, doing a 180 degree turn and changing his entire legal practice. As a public defender, he took on countless pro-bono cases and never looked back.

Brandeis was well aware that corporate men were specialists whose only focus was the interest of the corporation, which had to be contrasted to that of the general public and society at large. The change in the U.S. economic landscape throughout the nineteenth century had been rather drastic. At the beginning of the century the U.S. economy had been characterized by the pervasiveness of small businesses who more closely represented genuine market dynamics described by Adam Smith. In such a context, the traditional lawyer had been a generalist who oversaw cases in every walk of life, and thereby came to meet a large number of the members of his own community. The small town lawyer well knew their sufferings and experiences, and had a genuine sense of the nature of his social setting.[173]

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[173] Brandeis as a lawyer actively sought out to see different cases and was not content simply with just one more in his field of specialty; a large number of cases taken by him were outside his field of expertise.

Brandeis's principal argument was that, by obtaining so much power, modern corporations degraded the ability of other men to fairly compete in the marketplace. For example, modern corporations had so much capital that they could afford to easily undermine a competitor by sustaining lower prices to the point that it would consistently lose money—an unfair business practice which was not sustainable to the smaller competitor. Once this competitor was priced out of the market, the corporation would then drastically raise prices far above those which had originally existed, recouping losses but also injuring consumers. This was one such of many different corporate bully tactics used, often invisible to the regular consumer who would mindlessly buy the cheaper product, not being fully aware of the political impact his purchase made.

As Brandeis pointed out in the "Curse of Bigness," corporate men equated liberty with licentiousness, not understanding the principle of reciprocity that governs all sustainable democracies: the golden rule of doing onto others as they would have them do onto you. Brandeis called for "industrial democracy", which, to note, was not an attack on capitalism per se, as he came from family of small businessmen that had emigrated from Europe. Rather, Brandeis wanted to create a fair terrain for competition in the marketplace, so as to prevent large corporations from destroying thousands of small businesses as was occurring in the late nineteenth and early twentieth centuries.

While it might be argued that this business competition was beneficial in that it resulted in the lowest price for the consumer, to Brandeis it undermined the social foundations of democracy. As powerful corporations were growing in terms of size, scope and range, they were also swamping out governmental functions. It would be a trend that worsened during the twentieth century. AT&T had $75B assets, 1M workers, while GM had more assents than most individual states, and 10% of the U.S. federal budget. Woodrow Wilson had not been too sure how to downgrade size of corporation, and it was for this reason why Wilson had turned to Brandeis for assistance during

his campaign in the first place. Wilson had been a history professor at Yale University.

Brandeis's key contribution was simply to open the door to genuine governmental control of the modern corporation, doing so via science—specifically statistics. Curiously, Brandeis had an enthusiasm for science that was similar to that of Jefferson's, whom he greatly admired.[174] Brandeis actually formed and participated in the American Fair Trade League, an association of specialty producers in medicine, electronics, and machine tools. Brandeis liked to tinker, and generally appreciated the value of science. His tenure at the U.S. Supreme Court lasted between 1916 and 1939.

Long before his entry to the Supreme Court, as the principal lawyer in the case of *Muller v. Oregon* of 1908, Brandeis established legal precedent and the concept of "Brandeis brief", which itself upturned traditional legal argumentation. The case involved establishing a workday of ten hours for women, and the first to allow labor legislation in the U.S.—itself a very significant achievement which radically changed the legal context of workplace. The case helped place workers on a more equal footing with employers, whom until then had consistently argued against unions. Corporations claimed that the government could not intrude into any hiring practices as it violated the principle of "liberty of contract", given that each person had right to sell their labor as they saw fit. Labor was, in essence, a bargain between two private parties, and hence not subject to direct external interference.

Brandeis pointed out that the hiring and contracting of labor did not occur in a vacuum, as the social context of these practices had drastically changed. While a fair exchange might have occurred during the prior century, where actual bargaining over price and terms routinely occurred, such was no longer the case due to the enormous power of the corporation. In sum, the substantive disparities of power between the two parties meant

[174] This can be contrasted to Roosevelt whom saw Jefferson as a weakling for his continual desire for peace.

that there was effectively no negotiation whatsoever between the two parties in actual practice. If the worker did not accept the potential employer's offer, another would take their place, hence the worker was usually forced to accept the corporation's labor offer "as is" with little genuine agency over its terms.

Brandeis's general point of view was that the law needed to be modified and adapted to meet the exigencies of the existing circumstances. American society was not static, but experienced a continuous historical transformation; in spite of this reality, legal principles had failed to be adapted to these changing circumstances, which were new realities of which elderly judges were often unaware. It was the lawyer's role to bring stodgy judges up to par with America's new circumstances.

At the time, legal arguments were also characterized by too much formalism and hypothetical argumentation. The Brandeis brief, by contrast, was the first to substantially use statistics in its legal argumentation, so as to demonstrate these changing circumstances. In the particular case of *Muller v. Oregon* (1908), Brandies showed that overwork led to gravely serious health issues in women—in the same style that Acosta and Baldorioty used in their own attacks against unjust government policies of slavery and *libretas*. Brandeis, as Acosta and Baldorioty, looked at the social and economic consequences of such laws to clearly demonstrate they were not as unproblematic as they appeared.

One of Brandeis's most famous cases had actually been litigated against the Morgan corporation, specifically a train and transportation subdivision run by J.P. Morgan's own son. The lack of investment in its facilities had resulted in horrific accidents with mangled bodies and countless deaths; when reporters arrived at his son's home, the butler told reporters he could not be bothered by such issues. Brandeis showed that, contrary to all expectations, the Morgan train company was actually losing money; the private transportation corporation had not been as efficient as had publicly been claimed or presumed. There was in fact nothing worse than the lack of transparency,

whose absence usually lends itself to gross abuses of power; corporations acted as if they were beyond the purview of the law.

While the legal argumentation of *Muller v. Oregon* had been only two pages long, the attached statistical compendium was 100 pages. The lengthy compendium had been prepared by Florence Kelley. While Kelley's original version had attached data for men as well as for women, Brandeis chose not to include the data for males for fear of affecting its outcome. *Muller v. Oregon* was so ground breaking, that a large number of requests for copies of the case were made. Soon thereafter, labor legislation limiting working hours was enacted in various other states, as Virginia, Michigan, Louisiana (1910) and California, Washington, Illinois (1912).

It was said that, as a lawyer before the U.S. Supreme Court, Brandeis's eloquence and clarity of argumentation drew the attention of everyone in the room. The U.S. Supreme Court unusually extended time for his own argumentation, something rarely done in court cases, and the Court even went so far as to cite Brandeis in its final opinion.

Once on the bench, Brandeis continually attacked the corporation and the formation of closed monopolies. The large modern American corporation was somewhat of a recreation of medieval absolutism as monarchy or colonialism, which he referred to as "industrial absolutism". Brandeis pointed out the utterly unscientific nature of corporate decision-making.

Contrary to what is commonly believed, the Sherman Antitrust Act of 1911 had actually been undermined. The original intent of the act had been to destroy trusts; as it headed into congressional proceeding, however, this intent was thwarted. Worst still, over a twenty year period, it was further watered down. While its public language became harsher, in actual practice the law came to allow for the creation of mergers, thereby defeating the very sprit in which the law had been written in the first place. Under the revised version, corporations were able to contravene the law, while giving the public appearance of their formal legal compliance.

For example, under the Sherman Antitrust Act companies had been legally forbidden from buying each other's stock. However, if one company bought another corporation outright, the same act would no longer result in a legal violation. Hence the permissibility of mergers allowed corporations to easily bypass the specific restrictions of the Sherman Antitrust Act, in effect nulling the law by removing its fangs and teeth. In short, there were few consequences for corporate malfeasance, or what in economics is today referred to as moral hazard. One inevitable results was that the number of large corporations actually increased during first half of the twentieth century, contrary to the expectations of the Sherman Antitrust Act's original lawmakers.

Brandeis criticized corporate decision-making as unscientific, which itself was the inevitable result of growth of size. Bankers as J. P. Morgan were often in charge of too many companies. If a single company might require a lifetime of learning to fully understand its dynamics, the administration of dozens of them created what is today called a cognitive dissonance. Given the limitations of the human mind, it was an impossible task to administer them all appropriately.

As he pointed out in the "Curse of Bigness," this is akin to the example we saw of Stalin, whom was easily be fooled by Lysenko simply because he (Stalin) assumed too much power and control. It was therefore inevitable that some sort of abuse of power would come into play. These limitations could be readily seen in actual practice, given the lack of imagination of new responses to old problems, which only allowed such problems to perpetuate and worsen, as Arnold Toynbee noted in a different context. The inability to think clearly about a topic also led to the gross abuses of civil rights, which were routinely seen by the court, again when liberty was confused with licentiousness. The broader social implications of corporate acts and policies were not considered.

In short, corporate decisions were problematic as these were mediated only in the context of the stock market. It was impossible for the men in charge to obtain a proper understanding

of the facts at hand. There were too many of them to grasp, so in essence, they stopped being "scientific" in their inability to be empirical—Brandeis's notion of what it meant to be scientific. Good governance required good facts—the same Lockean empiricism was a requisite for all leaders, regardless of the domain in which they operated. The missing facts were the social consequences their policies entailed; superficially and destructively, only image branding was taken into account by such leaders.

There were also many textbook mythical fairy tales pertaining to corporations that are simply not valid. As the corporation has increased in size, it has even outwitted markets via its monopoly tactics; finances via the internal creation of capital, which made them less dependent on external capital; and even government regulations via its legal specialists who do nothing but look for flaws and ways to avoid complying with the spirit of the law.

Even its stockholders are duped, which is perhaps the most surprising thing of all. In a nineteenth century corporate setting, stockholders had real power. Meetings were solemnly held given their importance and accountability by its administrators, where voting by stockholders had a genuine impact on its character and nature. As corporations grew, however, stockholders lost power. Given that the number of stockholders increased to such a degree, each vote was infinitely diluted; the greater the size of the corporation, the greater the dilution. However, the appearance of stockholder agency was maintained in spite of its very obsolescence—and likely because of it. Each contemporary annual stockholder meeting is thus solemnly begun with a great deal of fanfare. The real control, however, is only held by stock holders with large voting blocks; it is they who have genuine decision making power within the modern corporation.

Worst still, this dynamic is exemplified in the treatment of its founders, typically made up of a charismatic entrepreneur the likes of Steve Jobs. It is said that an indication of whether the founder retains power in his corporation is whether the stock

price of a company rises or falls according to his health. As with the stockholder, however, there has been a substantive dilution of power of the original founder and entrepreneur, and most modern corporations are now run by committee with little regard for founder. Steve Jobs was certainly edged out in such a manner, but this was also the case with Rockefeller Jr. during the Teapot scandal.

In effect, the entrepreneur has made his position obsolete by growing the company to a very large scale, with horrific personal consequences for himself. Although Steve Jobs was kicked out of Apple Co., the very company he formed, he was fortunate in that he was able to recuperate, forming NeXT, the basis of Apple's ecosystem, and Pixar, only to later become CEO once again of Apple Co. in the late 1990s.

However, Steve Jobs's story is the exception to the rule. Most others have not been so lucky, with no second chances and no Hollywood happy endings—as was the case of Twitter co-founder Noah Glass. In the contemporary media landscape, all credit has been given to Jack Dorsey, when in fact he had been but a secondary player in its early years.

Chapter 23

The Sociobiological Roots of Avarice

A contrast between Nero and Bezos, as Feliciano noted, is illustrative of how we may come to understand avarice. We should not forget that Nero was an Emperor of Rome, and hence leader of one of the largest empires in history, while Bezos is founder and CEO of Amazon.com, one of the largest retailers in history. It goes without saying there are obvious differences between the two figures. However, for the sake of argument, let's assume that they are the same person. What is particular of the contrast is the obvious fact that they exist in different worlds, and hence there are radically diverse contexts in which they operate.

We may redefine the contrast in the following manner. While the two lived over the span of some 2,000 years, let us now assume the same for an entire community of individuals all whom have appeared and reappeared 2,000 years apart. How different would their lives be from each other? Would it result in the same outcome with only minor variations, or would the experiences be so different so as to appear as mutual strangers to one another? If the time span had been 200 years, would the results have been any different?

John Dewey in his "Eclipse of the Public" (1927) and Brandeis had insightful observations in this regard. Brandeis noted that while men do not change, their circumstances are continually shifting. This is very suggestive of how we may come to understand human avarice, specifically its causes and hence possibly how to better manage it.

Dewey argues that technological changes led to social changes which were so drastic, that they overturned the validity of the presumptions about democracy held by US Founding Fathers as Franklin and Jefferson. He provides a rigorous look over a two hundred year period, between 1700 and 1900.

Colonial life in the United States occurred in the context of the small town, a core setting with its own distinctive traits. Given the size, everyone knew each other in a small town, and hence were well aware of each other's characters and temperaments, strengths and weaknesses. For this reason, the electoral college was first established, as voting would lead to the selection of outstanding men above rest, given that their characters were well known by their own communities. Moral and able men would thus float to the surface in such a political setting.

However, by contrast, modern America in 1900 was a very different political beast. Its sheer size meant that most citizens did not generally know all members of a community, or even a majority of them. This new anonymity characteristic of modern social reality was reinforced by the abundant mobility of Americans, constantly relocating from one region to next. It also meant a decline in social consistency and a vast increase in the heterogeneity of communities. Most neighbors were now strangers to each other, and would likely remain so.

Modern technology also meant that there were many more distractions. Citizens were surrounded by an endless stream of mindless activities which distanced them from a mutual appreciation of their circumstances: movies, sports, and "motor car racing". Whereas previously the talk of politics was central to private discussions in the modern era; all talk was of anything but politics, consisting of and an endless series of mindless, dull topics of little weight, such as lives of actors, and so forth.

The combination of these factors had an enormous impact on American democracy for Dewey. The principal political actor by the early twentieth century was no longer the citizen but rather the political party, an organization greatly frowned upon by the early founders, as noted by Thomson. Factionalism, which had been so decried during the eighteenth century and a principal concern of Madison, was now the norm. These factors also led to a tendency towards a two-party system. Modern political systems were usually dominated by two parties, rather than three, four, or five as a stable political form. Power now rested mainly between these two groups; a revolving door of political positions

and seats of political power were routinely exchanged between the two principal rival parties. Third parties under this scenario typically did not last very long.[175]

Social problems also became more complex, a good example being that of farmers during the great depression. Farmers were being impacted by greater forces, which they little understood. It usually meant that rational actions taken because they appeared to be reasonable had the opposite consequences, worsening the issues. We now know that with declining prices, attempts to increase income by growing more produce as corn will only further decrease prices, creating a vicious cycle. While its irrationality is well explained by economics supply and demand curves, it required a great deal of expertise, time and effort to understand market forces. Most farmers lacked the means for such a concentrated effort; usually going about their lives concerned with more immediate and tangible issues before them.

These dynamics lent a greater importance to the role of experts in American society. Participation in politics became, akin to the actions of the stockholder in a modern corporation, an empty activity that was undertaken only once a year: the process of voting. This contrasted greatly with the continual political activity of early American bygone years. After voting, citizens usually did not again enter the political fray again for four more years until the following election. This is certainly not what U.S. Founding Fathers had in mind when they thought of "politics" in a republic.

Politics was thus carried out in parallel worlds, with their own internal truths and rules, as those of the halls of Congress whose linkages to the actual community were often either small or non existent. In fact, the principal concern of James Madison had been precisely that selected representatives would forget they were supposed to represent others.

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[175] A three party system was not a stable longterm arrangement, according to Dewey.

Technological change, for Dewey, had killed the "public" and in turn undermined the basis of American democracy. The cultural changes created by technological change had impacted the way individuals interacted with each other, as well as their identities and social norms—and, ultimately, the manner in which collective decisions were being made. The public, as it used to exist during the eighteenth century, had died by the twentieth century. Now there were instead multiple "publics." American democracy of the 20th century was a very different beast from American democracy in the eighteenth century, which itself suggests why sociology is so important.[176]

As noted by Justice Brandeis, men stayed the same throughout history while their contexts varied. This implies that social outcomes as those of a Nero and a Bezos are more impacted by the contexts of their actions than by the distinctiveness of their personalities. In other words, for Brandeis as for Dewey, technologically induced cultural change had profound implications with regard to the principles humanity chose to live by, and his life-long efforts were meant to adapt the law to meet the changing circumstances in which men lived.

Let us now expand our temporal landscape beyond two hundred or 2,000 years and look into the dawn of humanity at 200,000 years ago or so at the dawn of humanity (*homo sapiens*).

It could be suggested that avarice is the natural manifestation of a natural human psychological trait which has become maladaptive under modern social circumstances.

Although avarice had an adaptive value in early human history, with the drastically changed social circumstances, avarice acquired traits which were noxious to the well being of those involved. In short, avarice became non-adaptive in a modern setting, detrimental to both the self and society. The important question to answer is why this would be the case.

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[176]In theory, it is supposed to look at society from a macrosocial view of the community, or society as organism with own unique dynamics—even if in practice it often fails to meet its academic expectations.

We know that without modern refrigeration, foods usually rot and decay relatively quickly; they simply do not keep for weeks and months on end, particularly so in the tropics and in the case of meats. In a primitive context, eating quickly, as much as one could, allowed early humans to maximize benefit of a good whose value quickly declined, given the ever present reality of food spoilage. Many carnivorous animals devour their prey for good reason. We may equate eating quickly with the psychological trait of avarice, as suggestive of over-reaching ambition or taking a greater share than would be normally allotted. In other words, avarice could be defined as cheating.

Interestingly, it is know that traditional human hunters in primitive communities inversely share meat for pretty much for same reason. Successful hunts actually tend to be rare, the vast majority ending up in failure. When they do occur, it is often the case that there might suddenly be too much meat that could not be consumed by the individual or his family, which would go to waste. Meat-sharing in this context can be seen as hedging against the future, betting on the existence of insecurity or as an indirect savings technique which protected against the certainty of food scarcity in the future.

In other words, if I share meat with you today, you will share meat with me at a later date when I am in need tomorrow. Ethical behavior in this context arises out of sheer self interest. If I do not share now, I will likely not get food in the future, and possibly starve to death. If, on the other hand, you do not share meat in the present, in spite of the fact that I have shared food with you in the past, would also place your future survival into question.

We might suggest that avarice is a misplaced psychological transfer of a specific tendency between two radically different contexts, which would help account for its noxiousness.[177] While today it usually applies to non-perishable

[177] Oddly, we have come to expect that natural foods have similar traits and characteristics as that of processed foods, such as resilience and durability.

goods that can be readily exchanged for any goods and services, in the Neolithic past it would have been an exchange of perishable goods that had no lasting impact or value as these were ultimately destroyed—which hence tend to encourage virtuous trade. With the exchange of non-perishable goods, however, the extremes of avarice are reinforced because of its enduring consequences for the wellbeing of the individual, such as increase in status which is itself an intangible benefit of social and economic consequences that also improves the apparent or perceived well-being of the individual.[178]

Let us now turn to industrial avarice in Puerto Rico.

[178] This line of thought is presented so that other interested parties might further explore it.

Chapter 24

John Dewey and the new Goliaths

The establishment of the Puerto Rican commonwealth (ELA) in 1952 had particular economic consequences. It had been preceded by Operation Bootstrap in 1947, presumably for the purpose of self-guided economic development. The end result, however, of this economic development can be called industrial mimicry. Some early manufacturing concerns were established under Rexford Tugwell, then governor of Puerto Rico and also president of the University of Puerto Rico. These included cement, glass and cardboard factories, but were quickly sold off to local entrepreneurs or closed as it represented alleged socialist experiments—a no-no in Cold War America.

At first, the local economy was developed on the basis of labor intensive industries, typically clothing manufacturing, which alleviated the island's chronic unemployment problem. Political leaders could also publicly claim to be boosting the economy, and thus gain political leverage.

However, the pattern that would emerge from this became a noxious one that had nothing to do with local development properly speaking. By providing tax havens for exogenous companies, true industrialization was not genuinely nurtured in the island as it became dependant on foreign capital, foreign technology, and foreign corporations. Secondary local business concerns derivative of these foreign enterprises would disappear when their flight risk became manifest.

It might be plausibly asked the degree to which such an effort would have succeeded had it done otherwise, genuinely relying on local capital, corporations, and technology. One can suggest that at the time, there were few other alternatives available given the generally low educational level and poor educational facilities of the island, itself the result of colonial

imposition as documented by Negón de Montilla. There is some doubt the endogenous effort would have succeeded. However, it should be pointed out that other institutions were also created by Tugwell so as to assist genuine local developed. These included FOMENTO, the *Banco de Desarrollo*, the *Junta de Planificación*, the *Autoridad de Comunicaciones* (AC), the *Autoridad de Fuentes Fluviales* (AFF), and so forth. Ironically, a gringo North American socialist laid the necessary groundwork for the island's genuine endogenous capitalist economic development—its true industrialization—but were resources misused by consequent political leaders.

Many of these chess pieces, as Pedreira would call them, have now been tragically removed under the neoliberal policies of the two principal parties, the *Partido Popular Democráatico* (PPD) and the *Partido Nuevo Progresista* (PNP). Some recent tragic examples include the *Banco de Desarrollo* and the *Junta de Planificación*, the latter severely weakened in recent years.[179] Other bodies were impacted by sheer technological change, as when the AFF was converted to the *Autoridad de Energía Electrica*, given the shift from hydropower to petroleum-generated electricity. The *Autoridad de Comunicaciones*, which provided telegraph and telephone service in the Caguas region, was absorbed under the Puerto Rico Telephone Company (PRTC).[180]

The tragedy of these economic policies is that, in the desperation to meet immediate needs of economic development, the long range goal of local economic autonomy a la Linnaeus, was soon forgotten.

Secondhand industrialization has been a well studied phenomena. There exist well defined stages, which are obvious when seen in hindsight. At first, the second-hand industrial nation

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[179] Planners have little real power in the island's decision-making process, in spite of their valuable expertise.

[180] It had impressively introduced the telex, a type of quasi internet.

produces simple industrial goods, say tooth brushes, which help to establish an early industrial base. Gradually the chain of production is improved and enhanced to produce higher quality goods as electronics, as the necessary underlying infrastructures of human capital is formed, itself also stimulated by such developments. The process is continually repeated in ever increasing cycles of technological sophistication. This is how many Asian tigers and China rapidly advanced; they began producing simple products, and then gradually increased their complexity. In short, it is unrealistic to try to start at end with sophisticated electronics, not unlike like a baby wanting to run before it can even walk.

Changes which occurred during the 1960s, as an increase in the price of labor through the establishment of a minimum wage law following U.S. standards, ultimately impacted the island's magic economic formula.[181] This increase in the price of labor made Puerto Rico too expensive a manufacturing site relative to those of other parts of the world. Since modern corporations began turning to other parts of the less developed world, where hourly wages could be had in cents on the dollar, the island turned to capital goods industries.

These did not generate as many jobs, given they were large complex industrial facilities with little actual manpower. As a result, the high price of labor no longer became a significant factor in economic rationale and corporate decision making. However, as these industries do generate a great deal of income for the government, the increased revenue allowed the government to supply more services to the community, as publicly funded schools hospitals and infrastructure works, aside from making some politicians extremely rich. One could, in theory, cut the cake into smaller fractions while receiving bigger pieces as well; the island's magic tricks had not disappeared.

In this first capital-intensive phase, the petrochemical industry was predominant between the 1960s and the 1970s and

[181] The establishment of the minimum wage in Puerto Rico was even fought by some in business sector.

included companies as Phillips, Union Carbide, Monsanto, CORCO, and others. Given that the global price of oil was so extremely low in those years, the original intention of the program was to bring cheap Middle Eastern petroleum to Puerto Rico, for it to be processed in the island, and then redistributed throughout the rest of world. While this phase did generate some technical and construction jobs, they were but a drop in the bucket relative to the gains of its principal beneficiaries: foreign corporations.

New facilities were inaugurated with a great deal of fanfare and pageantry; Luis Muñoz Marín was routinely photographed at ribbon cutting events so as to demonstrate the great economic progress the island was making. Such programs were of little direct benefit for labor creation, however. The person in charge at FOMENTO overseeing these was Rafael Durant, whom worked under Teodoro Moscoso.[182] Countless letters were written by local mayors and persons seeking employment during the 1960s, most of them going as unfulfilled as had Franklin's military recruits in eighteenth century France.

This new magical formula initially sounded like a good idea. The government gets easy money, corporate costs are reduced, and the island receives a more advanced infrastructure—in theory. However, the formula again collapsed in 1973, and is a key to why Puerto Rico's economic development model during the last half century has been so faulty—a model that is still oddly promoted today as if the last fifty years hadn't occurred. Such a lack of original responses are perplexing as Toynbee would note; they are dependant on too many externalities. Upon the change of one factor, the profit formula is altered and suddenly the model becomes non viable. In this particular case, the price of petroleum skyrocketed in 1970s, thus making the entire economic miracle a sham, based

[182] Moscoso joined JFK's Alliance for Progress in a bid to fight communism throughout Latin America via efforts at local development.

entirely on an arbitrary non viable legal framework. Millions were spent, and millions were lost.

Today a vast empty plant shamefully sits on south off to the oceanside, observable when one drives on the main highway #52 to Ponce. The experience should have been a warning to the pharmaceutical industry that had already arrived in the island for similar reasons during the 1970s, but it was a call not heeded.[183]

With the arrival of petrochemical companies, many other problems followed, the most troublesome of which was pollution and contamination, the residues of industrial processes. In spite of being highly toxic, they were dumped into estuaries and other natural bodies of water, whose life and biodiversity threatened to become stagnant toxic ponds, or Carsonian "silent rivers of death" as Bonnet Jr. feared.

A second and equally noxious problem was the consequent reduction of local sovereignty, as a result of this coporate intrusion, hindering the ability of a people to determine its laws, social order and fate. The island was impacted by the very powerful forces of the modern corporation, always threatening its decision-making ability, removing it from local hands and transferred onto more powerful actors. These problems are well illustrated in the case of Salinas.

Salinas is the fourth largest municipality in Puerto Rico, with an alluvial floodplain created by Nigua River which produces an enormous amount of water. During the 1960s although some 23M gallons were extracted, it had little impact on its hydrological output. It is here where the infamous Central Aguirre of 1930s was located, a leading industrial producer of sugar. Salinas is also the site of the Aguirre State Forest and Jobos Bay where endangered sea turtles and *manati* (sea cows) live, a site not to be confused for the one that sits on the north coast in Isabela under the same name. The municipality also has the second largest mangrove system in the island.

[183] Incidentally, after crossing the cordillera central after Coamo, the beach in front of the driver is the municipality of Salinas.

With the rise of high-end "mimicry industrialization" or *industrializacion mimética* in Spanish—in appearance without actually being so as nonvenomous insects whose coloring resembles those of wasps—diverse petrochemical and pharmaceutical industries were established. The largest of these in Salinas were the Philips Puerto Rico Core (1965), with a refining capacity of 20,600 barrels a day. It also included Phillips Paraxlyne (1977), whose secondary products were toluene, paraffin, and benzene—all feedstock for commonly used products such as nylon.

Salinas had so much good water, that the AEE wanted to establish a nuclear plant, proposing the largest such plant in the Americas for the purposes of guaranteeing a steady flow of electricity to these highly energy dependent industrial facilities. Another chemical corporation who wanted to establish industries in region was Monsanto.

Monsanto as a firm has had two different identities. In the 1970s, it sought to make nylon products in the island. However, with invention of the weed killer Roundup, the corporation sought to establish a plant in 1978 which would have cost $40M, and whose sole function was to produce 30M tons of the weedkiller, now known to be highly carcinogenic. Monsanto claimed that Roundup had no health side effects, and was only as dangerous as table salt to humans.

In fact, the detrimental health effects and environmental impact of these plants was enormous. The AEE's nuclear power plant NUPLEX would have released 1.6M gallons of high temperature water per minute into Jobos Bay. At the time it was claimed by its representatives that such an action was beneficial to the pristine bay, deceptively claiming that the number of fish would increase. Fortunately, the *Junta de Control Ambiental* (JCA) took Monsanto to court, demonstrating that its claims that not true. Worst still, there is a geological fault running under region, showing that Monsanto's study had not been rigorous enough, leading to the cancellation of the plant.

There was also a great deal of opposition by local leaders to Monsanto. Many local groups actively participated, as

Mission Industrial, a Protestant based group. Influenced by liberation theology, the island's Catholic Church also played a role in the popular opposition. Some local political parties, as the *Partido Socialista Puertorriqueño* (PSP) headed by Carlos Gallisá did so as well.

As might be expected, there were many corporate efforts of infiltration into these groups, causing a great deal of internal strife from within. While the Bancroftian undue influences resulted in the implosion of Mission Industrial and the PSP, the two groups were able to successful raise awareness of the distortion of environmental truths by corporate lawyers who only sought out corporate interests at the expense of the public wellbeing. The desire to monopolize the enormous quantities of local resources, as the island's pristine water systems, ultimately led the JCA to reject Monsanto's requested use of the Salinas site in 1979. When Monsanto then shifted to Guayama, other corporate interests intervened, as SmithKline French Pharmaceuticals, the predecessors to Glaxo Smith Kline. Since the Monsanto plant would have used consumed much of the available legal U.S. quotas of carbon dioxide for the region, the facility was cancelled as well.

The pharmaceutical industry in Puerto Rico is no different. They are enormous enterprises which generate profits many times greater than the actual budget of the island. In 2013 alone, the industry had profits of nearly $1trillion. If an individual drug as Actimmune costs $600,000 per year or Myalept $500,000 per year, their respective companies would need to sell only 18,000 tablets annually or 50 tablet per day to make up the Puerto Rico budget of $9B. These high fees come at a burdensome cost to the U.S. consumer, where drugs have been drastically increasing in price in a market that has little price regulation. The 18% profit margins of the entire pharmaceutical industry is enormous when compared to that of any industry and serves to reduce the overall quality of the US medical system.

Pharmaceutical companies are true financial goliaths. One company alone has profit margins orders of magnitude greater than total budget of Puerto Rico. When we compare Puerto

Rico's 2006 budget to the annual profits of each pharmaceutical company, the differences are staggering. Stockholder reports reveal their respective profits for 2006: Pfizer $ 40.73 B, Johnson & Johnson $38.26 B, and Novratis $25.73 B. If Puerto Rico's annual budget does not even match a single company's annual net profit, much less would it to all of their combined profits, at a rate of less than 1% of the total. Puerto Rico is an "ant" relative to pharma's "boot," and the suggestion that the pharmaceutical industry has no political impact on the island is naïve and disingenuous.

As expected, the establishment of 936 companies was followed by an increase in unemployment of 25% and an enormous disparity emerged between Puerto Rico's GNP and GDP, or the difference between national income to the goods produced. GDP grew by 150% relative to GNP during this period. Worst still, Puerto Rico's government debt also increased between 1970 and 1996, going from $0 to $15B by 1995. It exponentially worsened after pharma left in 2006, to the tune of $70B by 2017.

It is to be noted that the prior limitation on extra constitutional debt meant that such debt had been severely capped, and had been relatively minor in 1970. These limitations were eliminated during the PPD Rafael Hernández Colón administration. The substantive changes in 1996 during the PNP Pedro Rosselló administration led to an even worse outcome, whose results were also rather predictable.

The final elimination of the 936 tax exception in 2006, ultimately produced a new 4% tax on pharmaceutical corporate revenue which was unprecedented, but literally saved the island from near total financial collapse. For this, we must recognize the heroic act by PNP Larry Seilhamer, whom placed himself at great personal risk for the measure, given the vast sums of money

involved.[184] Without a doubt, the tax was rather unexpected by a pharmaceutical industry which generated billions in revenue every year. Seilhamer's corporate tax helped make up for the island's chronic budgetary deficit; had it been otherwise, a worse social crisis than actually exists would have occurred—something which, give its difficulties, is hard to believe.[185]

The work of Joseph Kenneth Galbraith is illuminating in this regard. He pointed out that there are inherent "techno structures" whose dynamics do not coincide with political cycles. As science and high technology are incorporated into manufactured products, a new level of complexity is introduced requiring a degree of planning that is far longer than that which previously existed non high sci-tech product. An example would be the case of Ford Co.'s. two cars. The Model T simple was, by modern standards, incredibly simple; if a change was needed, it could be easily and quickly incorporated into the assembly line. By contrast, the Ford Mustang is such a significantly complex automobile, that changes could not be introduced one day to next.

We may observe that Galbraith's observations are even more valid in the case of the computing industry as Intel chip makers, visibly demonstrated in the last few years in its commercial battle with AMD, or in Puerto Rico's pharmaceutical industry whose fixed costs to produce drugs create techno structures whom, out of sheer logistics, acquire a life of their own.

Again, the cycle of these techno structures do not coincide with political cycles, which in turn generate the tendency of corporate intrusion into the island's politics. This is particularly

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[184] The tax was likely seen by corporate leaders as highway robbery, whom likely felt themselves to exist outside of the law and local fiscal realities.

[185] Via the federal government, the pharmaceutical industry shouted and was eventually able to place limitation on the new tax.

the case when democracy intrudes into the internal dynamics of the industry, as with a government tax. It is here where the modern corporation, out of its own internal economic rationale, intrudes into both local and U.S. legislation, so aptly demonstrated by Grusky and Jasanoff respectively.

Grusky shows how deeply the pharmaceutical industry had co-opted local politicians in Puerto Rico. During the 1989 political status hearings in Washington D.C., all local parties called for the protection of the 936 tax exception clauses. The "936 coalition" was made up of those benefiting from existing status, including diverse corporations the pharmaceutical and banking industries.

Due to the 936 clause, the pharmaceutical industry in Puerto Rico has served as a type of defacto local low-interest Federal Reserve Bank for local banks, given that these were required to deposit their earnings in such banks, generating a free source of capital which could then be used to issue interest-generating loans. Local banks were able to drastically reduce their costs of capital, which in turn led to relatively high profit margins. In short, local banks benefited from the corporate welfare of easy money. Not all local island bank benefited from this abundance, however, as there has been a continual concentration within the banking sector during last 50 years, the *Banco Popular de Puerto Rico* being its largest beneficiary. A large number of other local banks either merged or were closed in the process, as *WesternBank* originally based out of Mayagüez.

The 1989 hearings were held in Washington D. C., and were attended by all major political parties and leaders of the era. This older political generation included Rafael Hernandez Colón (PPD), Carlos Romero Barceló (PNP), and Ruben Berrios (PIP). All parties opposed the elimination of 936. Some politicians might have believed they would have an important role in the hearings, becoming a new type of Luis Muñoz Marín affecting the outcome of the deliberations. But in fact none of them did, given the powerful impact of the Galbraithian techno structures.

It was clear during the hearings that the economic interests of the 936 were of such a pervasive influence, that the

presiding Chairman Bennet Johnston tried to get pharmaceutical lobbyists prohibited from having any undue lobbying capability or influence. However, he was unable to do so after consulting congressional legal office. The *Cámara de Comercio* and the Securities Industry Association, which represented the banking industry, argued that they were "above petty party politics," only interested in the island's long-term economic well being. This was a particularly disingenuous characterization given that political status lay at the very heart of the 936 debate.

Two things were done to undermine the proceedings.

Although the UN Decolonization Committee requires that in order for the process of decolonization to occur, power must first be transferred to local leaders, Johnston ignored such claims. He used a legal formalism in arguing that the ruling did not apply to the island, as Puerto Rico had been formally taken out of UN colonies list in 1952. The claim, while legally true, is factually false, in that the Insular Cases stipulated that the sovereignty of Puerto Rico is held by the U.S. Congress. In other words, in spite of claims to the contrary, the U.S. would retain firm control of the hearings and local political power. This ground rule ultimately impinged on Puerto Rico's sovereignty, and the island's soverignty would remain in Congressional hands.[186]

The 936 Coalition, as the banking and pharmaceutical sector were known, were also able to get the "Uniformity clause" applied, which also made a mockery of the hearings. Under this clause, the U.S. Constitution had to be uniformly applied to the island as it underwent its status transition in the same manner as those of other territories previously incorporated. This decision, rational at the start, had enormous political consequences as the 936 federal tax exception clause for Puerto Rico's capital intensive industries would not apply if it decided to become a state. Given the state of the current consensus—all political

[186] It is to be remembered that the U.S. was then still in the midst of the Cold War, and would not accept any threats to power or its sphere of influence.

parties had rejected the elimination of the 936 tax clause—Puerto Rico thus inevitably retained its colonial character. The introduction of the uniformity clause killed off all other political alternatives to that of the status quo on which the 936 corporations of the pharmaceutical and banking industry depended.

The island's failure to obtain sovereignty was profoundly impacted by powerful corporations during these status hearings, whose war chests and human capital resources far exceed those of the local government and its claimants. Any calls for independence were inherently considered as nonviable per the terms of the discussion. Since it was also unquestionably presumed that Puerto Rico has no natural resources—a claim which as we have seen is factually incorrect—only added water to the fire. One of the very reasons for the existence of capital intensive industries in the island is precisely due to the abundant availability of pristine aquifer water for all sorts of chemical and biomedical manufacturing processes—much of it received in cents on the dollar.

However, if the 936 Coalition thought it was out of the woods, it thought incorrectly by not taking into consideration the unpredictable nature of politics, human behavior, and history,

In 1996, Bill Clinton had entered a second presidential term. Although the U.S. was having a financial bonanza in 1990s, it still wanted to reduce government spending as this was the peak of neoliberal thought. Pedro Rosselló, the new Puerto Rican autocrat, abruptly and without any rigorous professional assessment, called for the abrupt end of 936, opening the door to one of the most radical changes in Puerto Rico's economic landscape which, once opened, could not be closed. Rosselló had no secondary backup plan or serious economic or financial planning at all underlying his expressions—ironic when one considers that he is the son of psychiatrist.

Newt Gingrich and other Republicans were quick to seize on the opportunity, as it would not involve an increase in taxes, per the lemma of the Republican party. Puerto Rico lost what

had been a goldmine, killing the golden goose who laid the golden eggs without having so much as a viable substitute already in place. Again, one of the key errors of the autocrat is that he will inevitably act rashly and irrationally given his lack of understanding of the facts—or what Brandeis would term unempirical and unscientific.

The grave economic reprercussions of these political decisions were not felt immediately. Given that its full economic impact would not be implemented for a decade, local governmental leaders were slow to proactively take actions so as to preemptively address the challenges of the inevitable crises—not unlike their actions during 2020's Covid19 pandemic.[187] Such was the delay that a historian actually told me in 2005 that the financial concern over the grave loss of the 936 was illusory, to my complete astonishment. All too often, that which is not directly seen or witnessed is often presumed to not exist, as with the case of Covid19 or computer hacking which invisibly occurs to most victims in the background without them ever becoming aware of its existence. It is an all too common tragic human error.

The political leaders of traditional parties after 1996 did not appear willing to confront the island's new economic reality, and as a result began borrowing to make up for the difference in national income. Possibly it had been hoped that some solution would be found, so that its citizens would not be as immediatley affected, or that the issue would somehow be miraculously fixed—but no such cure emerged. Puerto Rico's debt soon began to increase, slow at first but faster as each year passed by. In fact, the island's politicians simply kept rapidly compounding the debt in an exponential growth curve after 2006, when the tax exceptions formally ended. It was not until the island finally reached crisis that these were forced to implement the very same

[187] Governor Wanda Vazquez's forgettable health Secretary claimed that the disease would "stay in China", and hence that there was no need for concern.

tax the pharmaceutical companies had been so actively seeking to avoid by transferring their facilities to the island after 1989.

Strom Thurmond, a racist U.S. legislator, had already eliminated the local bankruptcy clause in 1984 so quietly nobody noticed—as if knowing for certain Puerto Rico would end up in default forty years ago. While bankruptcy is a universal financial tool available to every political entity, Caribbean countries have had a long history of financial mismanagement.[188] Puerto Rico's financial situation was worsened by fact that its Constitution guarantees the securing of bond payments prior to that of any other obligations, even when such payments place in jepoardy the very functionality of the local government.

All of this amounts to the perfect economic storm—unless there is some sort of radical change

[188] During the late nineteenth century, it was feared that this would be pretext for German entry into the U.S. sphere of influence. This concern was vehemently expressed by Elihu Root whom once noted that one had to know character of the Kaiser to understand the implications of Caribbean debt. This, in turn, is what led so many U.S. intrusions into its island nations.

Interlude: The Arecibo Observatory

Depending upon the time scale used, the completion in 1963 of the Cornell radar observatory at Arecibo (Puerto Rico) nearly coincided with the political transformation of the island from an outright colonial territory to a commonwealth eleven years prior. This relative short time, within a historical framework, makes for a rather hard categorization of whether both were, and continue to be, examples of colonial politics and colonial science.[189]

Whether Puerto Rico is a colony or not has been debated in the United Nations since 1952 and remains unresolved. Though a resolution was then passed affirming its non-colonial character and the definition of its status one of domestic American concern, the issue has been brought up year after year either by countries who recently gained independence in Africa and Asia or those with communist interests such as Cuba and the Soviet Union. Though most Puerto Ricans since then have indirectly reaffirmed some sort of a relation to the United States, 90% of votes are split between the statehood and commonwealth parties. *Independentista* candidate Ruben Berrios rightly questions this vote's validity by pointing out that the island needs to have full control over its decision. How can a slave decide if he wants to remain a slave unless he becomes free in the first place? A fearful slave mentality influences political decision-making, according to the PIP leader.

Similarly whether the Arecibo Observatory is an example of stage two (Colonial science) within George Basalla's model is hard to determine. Though Basalla points out that it is only a

[189] This essay was written in 1995. I would like to thank the Australian historian of science R. W. Home for his observations.

heuristic model and the stages may overlap, the model's outcome is rather uncertain and may not necessarily lead to a self-developing scientific community (stage three). One problem, independent of the actual history of the observatory, lies in his theory. These stages were developed with certain historical periods in mind where technology, or the lack thereof, helped give these periods their distinct characteristics. Colonial science, according to Basalla, is marked by its isolation from the metropolis, both physically and intellectually. The colonial scientist is inferior not because of ability, but rather due to his lack of access to institutions which exist in the metropole.

However, the rise of modern technology has rendered these categorizations obsolete in some way. A scientists may be operating at the periphery, yet may travel to the center in a day or immediately talk to his colleagues by telephone, or write letters via email as is the case today. Whereas the less advanced technologies as sailing ships helped form isolated and discrete pockets of activity during the colonial period, between the fifteenth and nineteenth centuries, silicon technology has taken away their privacy. Thus, Basalla's theoretical categorization is thus also rendered problematic as the distance between the metropolis and the periphery has been comparatively reduced.

The aim here is to discuss the parallel ambiguity in the categorization of colonial science, in particular the Arecibo Observatory, and colonial politics, specifically the commonwealth status of the island, or the shifting bedrock on which science is founded. Just as Puerto Rico is a commonwealth which retains colonial vestiges, the Arecibo Observatory reflects some elements of colonial science but which do not necessarily imply a shift to independent science as the Basalla model would suggest. The complexity of the historical reality, with traces of both dependence and autonomy, are hard to pigeonhole within the given theoretical frameworks. Instead, it can be argued that the combination of political and scientific elements place the observatory in a category altogether unconsidered by Basalla, whom wrote his essay long before the world wide web was invented.

The powers granted to Puerto Ricans in their newly created 1952 relation to the United States go hand in hand with the simple helplessness that exists with regard to its power in determining its day to day affairs. Though a Resident Commissioner attends the halls of the U.S. Congress in Washington D.C. who can speak before the House and lobby for Puerto Rican interests, he has no power to vote upon federal laws and policies which affect the island. Jimmy Carter wanted to relocate Haitians at Fort Allen in southern Puerto Rico precisely because of the lack of political reverberations.

Similarly, when in 1987 Sen. Robert Dole wanted to get rid of the 936 tax benefits which accrue to companies residing in the island, the only reason this policy was not passed was due to opposition by Charles B. Rangel, whom claimed it went against the interests of his constituents in New York. Ronald Reagan's *Caribbean Basin Initiative*, a plan to extend such tax incentives throughout the region in order to prevent the spread of communism, would have had equally serious repercussions upon the local economy, yet its residents were powerless to influence its potential outcome.

Though citizens of the mainland, Puerto Ricans do not hold the same power to control their destiny in the same way constituents from the mainland states have. Puerto Ricans are essentially helpless in affecting the political decision-making process and, aside from making a lot of noise, can only be passive observers to the events affecting them. It is perhaps no wonder that superstitions exercise such a strong role in the island culture; according to Keith Thomas, magic arises in areas that profoundly affect humans yet over which they have little control.

There are a number of other examples of a colonial helplessness. Puerto Ricans have to fight in wars that they have no say over. This contrasts strikingly to the former colonies of Britain who, now under a commonwealth—a loosely united group of states—not only do not have to fight in the wars of the mother country but can even declare war upon her. Although tax incentives are an economic benefit to the island that bring in mainland companies, they are a setback in preventing the local

government from taxing this source of revenue to build up the island's infrastructure. The welfare revenues that are given to the island do not nurture and grow the economy as they are used for consumption, such as food stamps or housing, rather than production. Ninety percent of the industry in the island is financed by foreign rather than domestic Puerto Rican investment.

Similar to the characteristic vagaries of sugar mono-cultivation, with its erratic rise and fall of prices in the international market, modern industries which have operated in the island, such pharmaceutical, electronic, and petroleum companies, are also subject to the unpredictable fluctuations of markets into which their products are exported. As with the mono-cultivation of sugar, much of the food has to be imported as agriculture is negligible. Though conditions have certainly improved on the surface, in that Puerto Ricans can now vote for a governor whereas as a formal colony of the U.S. he was hand-picked by the U.S. president, the right to self government, a principle of the U.S. Constitution, is far from being a realized actuality. Though not wholly a dependent colony, it is not wholly autonomous either.

Despite all of these facts, there is one which topples the colonial definition: Puerto Ricans have the ability to choose their political status. Puerto Ricans do not have to "declare war" on the United States, perhaps unlike the Irish, because there is no apparent direct coercion by the metropolis. The principal reason the status has not been decided is due to the lack of a simple and clear majority within the populace—a situation more common than expected in other island states as New Caledonia. The majority is rather evenly divided between the commonwealth and the statehood parties; the independence party has a minuscule following. To this one might counter argue that the options are not evenly balanced—that the cultural differences between PR and the U.S., and the poor local economy would serve as hindrances to political annexation. Independence, on the other hand, would not have any serious repercussions to the United States.

Yet even these arguments reflect an implicit desire for the colony to become part of the US rather than to separate itself from it. The forced suppression by the metropolis, on the other hand, implies a reaction to the desire by the periphery to attain control over its circumstance by breaking old ties, not by strengthening them. Nonetheless, whatever the outcome or difficulties that exist with regard to decision-making powers, these do not invalidate the existence of an inherent democratic right to choose a political outcome, regardless of what that decision might ultimately be.

The dependent relation toward the metropolis which characterizes colonial politics also taints colonial science. The relationship will be geared towards the interest of the metropolis which dominates the colonial, according to Basalla. The context of the Cold War and the rising prestige of science during the post atomic era were motivations within the U.S. sphere of interest, rather than those of the Puerto Rican arena, which dominated the formation of the Arecibo Observatory.

Though these concerns ultimately affected Puerto Rico, the intellectual and political motivations of the island at the time were more geared towards relations with the United States than with the Soviet Union, and thus played a secondary role. Helping the metropolis attain its own goals became one of the aims of the island. Titles such as "Russians Building Huge Telescope" reveal American concern over Soviet science and the competition thereby created. Inquiring into the purpose for such a telescope, the author of the article assures us that "the Soviet telescope will probably investigate celestial radiation." The space race to the lunar sphere was analogous to racing towards the ionosphere.

The 305 meter $9.3 million radio observatory, by far the largest and one of the most expensive at the time, was built with these multiple intentions in mind. The creation of such a multifaceted policy is rather effective; although any one particular purpose might become obsolete, its diversity of purposes offers a greater guarantee and longevity and profitability to any project. W. E Gordon, the leading figure behind its creation, described its intended uses in a 1961 article.

These included the study of the upper and lower ionosphere, ionospheric drifts; observations of planetary, lunar, and solar phenomena; hydromagnetic disturbances and shock waves; and of radio sources (now known as pulsars). Other scientific benefits included the ability to determine the ionic composition of the upper atmosphere, improve the precision of the astronomical unit (i.e. improving the measure of the size of solar system), and the analysis of the rate of precession of Mercury with its profound implications for Einsteinian theory.

That the motivations for the project were couched in scientific interests helped hide the fact of their military applicability as well; while the knowledge generated by science may be neutral, the uses of this knowledge generally are not necessarily unbiased. The study of the ionosphere was important for the detection of atomic testing and ballistic missiles at a time of disarmament debates and friction with the USSR. Though later its use would focus on the study of celestial phenomena, this initial impetus towards the ionosphere principally resulted from concerns emerging out of Cold War geopolitical interests.

The military institutional framework and funding during its formative stages helps illustrate this point. Initial funding was provided by the Department of Defense's Advanced Research Projects Agency. The Air Force Cambridge Research Labs (CRL) monitored its construction, and for a period, the Air Force Office of Aerospace Research monitored its use and research. Also, much of the expertise required to build the reflector had been generated by a decade of research at the Antenna Laboratory of the at the CRL as well. The observatory had been a military investment in a promising science.

The multiplicity of intent is also revealed by the initial selection process of a suitable location. Before it was built, the need to reach the ionosphere theoretically required the design of a receiver of enormous spherical width, whose size, in turn, dictated that the architectural structure would have to be a ground-supported system. The largest existing radio telescope at the time was that at Jordell Bank with a paraboloid width of 76 meters; a standing system three times its size would collapse.

This architectural requirement, in turn, affected the topography to be sought out. Puerto Rico was a suitable local because it had a limestone geological layer which collapses upon itself through porous erosion, creating topological pockets similar to those found in Yucatan, Mexico (i.e. Chichén Itza). This pocketing, furthermore, was also beneficial because it helped eliminate the noise created by the surrounding man-made radiation affecting the quality of its incoming signals.

A process of compounding interest occurred: meeting requisite demands satisfied a number of other, often unforeseen, demands and thereby reduced the effort required, providing another stimulus to the project. A similar phenomena occurred with regard to the internal structure of the antenna. Reshaping it from a parabolic to a spherical design meant that the angle at which the observatory received signals would be doubled as it would require a movable transmitter/receiver. Scientifically, Puerto Rico was a perfect locale given that its tropical location gives it constant access to the planetary belt (equatorial) in the sky.

There were non scientific factors, political and institutional, that were also considered. "[Puerto Rico has] the advantages of a government friendly toward the United States and professional scientists at the University of Puerto Rico." The sentence implies a government independent and coequal with that of the United States. However, if one considers the lack of political powers the island held as well as its great dependency on the mainland, this claim was far from being an accurate portrayal. Nonetheless, the fact that Puerto Rico had the ability in theory to choose its political status, meant that the U.S. would give it diplomatic consideration in light of a potentially different future political relation. Rather than mock the relative political weakness of the island, the scientific *dramatis personae* of the metropolis involved were treating it in a democratic fashion. An inadvertent imperialist, the United States was willing to politically acknowledge and aid the birth of a new nation.

In actual practice, however, the U.S. was evolving economic and scientific interests that further tied it to the island

and renewed its colonial relations, both political and scientific. Given the original cost of the observatory, the establishment of the Arecibo Observatory can be perceived as an enormous capital investment that no reasonable investor would want to loose. This cost also made it prohibitive for the local government to ever dare undertake such a venture on its own, had it conceived of the project in the first place.

Out of the fifteen largest U.S. radio telescopes built in the 1960's, Arecibo was the third most expensive in a top category of $13-9 million. The lower category do not compare in cost—out of the fifteen, eleven of these observatories cost did not pass the two million dollar mark. Similarly, the U.S. has been constantly adding to the value of their investment in the improvements made to it throughout the years, whose total sum cost as much, if not more, as the original observatory; the value at constant dollars has not been calculated. In 1974, improvements such as replacing the wire mesh with aluminum panels, adding cables, a new feed platform, new radar transmitter, and so forth, totaled $8.8 million. In 1985 the diameter was enlarged to 1, 200 feet and the cable system was replaced. Currently, it is being upgraded for a total cost of $22 million and the observatory has a replacement value of $100 million.

If the U.S. was willing to grant Puerto Rico political independence, then why would it be devoting greater financial resources to it? The two stances are contradictory; you don't wean a baby by giving it more milk. Should the government become hostile in a post-independence stage, a possibility in a self-interested international political arena, the U.S. in turn would be subject to the loss of a substantial investment. Such is what occurred in Chile during the 1980's when changes in government threatened the existence of both American and European observatories; national appropriations of foreign assets, institutional and financial, have been common throughout the modern history of Latin America.

Situations as these place the metropolis in a position of relative dependency; in order to maintain its assets, it has to cater in some manner to the host nation (periphery). Unless it has

control over the internal situation—such as what Robert Oppenheimer recommended over the control of nuclear weapons by the United Nations—the U.S. would be subject to the uncertain vagaries of diplomatic relations. Yet to have such control and security meant that these host nations would no longer be autonomous political entities but have either become colonies or have been incorporated outrightly into the metropolis. There seem to be an inverse correlation between security and autonomy; greater security for one often means less autonomy for another.

It's history has indeed displayed many characteristics of colonial science besides those previously mentioned. That there already existed a magnetic observatory at San Juan to correlate observations and a ionospheric sounder at Ramey Air Force Base to calibrate the radar prior to the observatory's construction does point to the gradual rising number of scientific technologies resulting from a metropolitan relation. The same might be said of the companies that reside in the island. The shift in the type of factories, from labor intensive ones as the textile industry in the 1950's, to the current capital or "knowledge-intensive" one as electronics or pharmaceuticals plants, operating in the island has meant that the work force had to acquire the scientific knowledge base for such jobs than it would otherwise. Certainly the Observatory itself has had such an impetus to the training of young adults in some form of science—a picture of the observatory shows a Puerto Rican operator. Science has been gradually transferred to the island as a result of Puerto Rico's contact with the U.S..

Other characteristics of colonial science also exist. The very scientists whom provided the initial stimulus for its development and who later became directors, W.E. Gordon and Gordon Pettengill, were trained in the U.S. with ties to mainland institutions. Gordon was a physicist at the Center for Radiophysics & Space Research of Cornell U. and Pettengill an astronomer at the MIT Lincoln Laboratory. Those who use the observatory are also primarily trained in U.S. universities.

Gordon wrotes in 1964 that the observatory, "forms an integral part of the graduate program of Cornell University...professors on campus...guide the doctoral research of some fourteen graduate students, of whom four have conducted experiments at Arecibo."

The early articles of the observatory in *Sky and Telescope* magazine describe students from Cornell and Florida State University utilizing the observatory, but no mention is made of any student from the local university (UPR). It is not clear whether arrangements had been made to enable such students to use it. The role of the U.S. is so predominant that the participants from the colony took on secondary functions relative to those from the metropolis.

Given the predominant aspects typical of colonial science, however, we cannot conclude that the Observatory could be categorized as such. A different dynamic is at work. The science is so controlled by the metropolis, that, rather than being a colony, it can be defined as having become incorporated into the metropolis. If the predominating motifs of colonial science are 1) an institutionally-weak isolation that is 2) dominated by metropolitan interests, the first element was not present and the second eventually became obsolete with regard to its military use. The Observatory is an outright part of the metropolis itself.

We draw upon the following evidence, some of it reiterated, for the first point, its institutional isolation. The great initial investment by the U.S. helped make it one of the leading astronomical institutions of its day; it could "detect an echo 20,000 times stronger than when Venus [was] first contacted by radar in 1961 from Millstone Hill." The Arecibo Observatory was sixteen times more powerful than the Jordell Bank observatory (England), and eleven times than that at Green Bank (West Virginia). We do not have an image of a scientist working on the fringe of the science but rather of one at the very center of astronomy, using a technology empowered by the fears generated from the Cold War.

Similarly, there is literally no isolation. In actual practice, the geographical proximity of one to the other was not great, at least when contrasted to the distance that separated Indonesia

from the Netherlands or India/Australia from England during the Colonial Period. Whatever distance these exists, some 3,000 miles, is shortened by modern communications technology, as was pointed out earlier.

Though the influence of such technology should not be unrealistically overemphasized, there were other connections between the two. That Puerto Ricans are U.S. citizens meant that they had access to educational institutions in the metropolis and could re-enter the Observatory as educational representatives of such institutions, however distant they were from these. The Observatory was also meant to be used in direct conjunction with other U.S. observatories. It was used, for example, to detect the size of the Crab Nebula along with those at Green Bank and at the Naval Research Lab (Sugar Grove, West Virginia). Lastly, the great investment, both initial and ongoing, by the metropolis insured a strong connection between the two.

As to the second point, through the years the United States has stepped back in its domination over the observatory. The rhetoric has changed its emphasis from Cold War benefits to its use by the world community of astronomers; it has now become a scientific vehicle cutting across national borders. The former director is not a metropolitan scientist but rather an Uruguayan one—Daniel Altschuler. In a 1992 interview, Altschuler stated that the use of the observatory was "determined by [the] international scientific community."

A quick perusal of the Observatory's newsletter and *Bulletin* does reveal a number of local and traditionally non-metropolitan scientists. Students from UNAM (Mexico) and UPR, L Rodriguez, L Lizano, A Ruiz, and J Alonso, are studying high velocity winds; M Maia and L da Costa from Brazil are doing a red shift survey of a particular declination strip. As was pointed before, students with Latin names (Hispanic or of Latin American birth) at U.S. universities also conducted a number of projects—F. Camilo (Princeton), T.N. La Rosa (Alabama), C. Pantoja (Oklahoma), and J.M. Cordes (Cornell).

The newsletter is also quick to emphasize its local contribution. "Puerto Rico is home for over 3,000,000 U.S.

citizens who are grossly under-represented among the ranks of scientists. Very few extra-curricular opportunities exists that provide positive and entertaining exposure to these fields. At Arecibo, we see an ideal opportunity to positively affect this large, minority population." In a position of relative dependency, the goals of the periphery are presented into those of the metropolis.

The problematic ambiguity in the classification of Puerto Rican science and politics lies in the odd mixture of autonomous and dependent characteristics. In the political arena, the island cannot be said to constitute a colony despite its legislative helplessness because it theoretically has the right to choose a political solution; this ability to define itself has not been coerced by the United States but was rather created with the commonwealth status of 1952. Similarly, despite the aspects of colonial science which were so prevalent in the early years of the Arecibo Observatory (institutional domination by metropolitan scientist with agendas presiding over local ones), it cannot be said to be colonial science for a number of reasons. The interests of the metropole have come to coincide with those of the periphery, with its emphasis on contributions to Puerto Rico. That the Observatory was built with multiple intentions in mind meant that its original self-interested Cold War purpose could at a later time be translated to a universal interest in the science of astronomy and, by extension, the interests of Puerto Rico.

To overemphasize the colonial aspect or the ulterior purposes of the metropolis, however, is to distort its political dynamics. Whatever pretensions the scholar may make to the injustice of the Observatory's existence, the fact remains that the observatory is a source of pride to the Puerto Rican people similar to what it may have been for its creators. The Puerto Rican anthem, the Phosphorescent bay, El Yunque, the Cuevas de Camuy, and the Arecibo Observatory all constitute part of what Carr would call a schizophrenic nationalism. The Observatory constitutes a part of the geographical landscape analogous to these other features—it has been built into the Puerto Rican soil in more ways than one. Yet a nation cannot forge an identity by

ignoring existing elements. Nations, as science, are composed of disparate and contradictory elements.

Similarly, the issues of politics and science do not remain in isolated categories but interact with each other. That they both contain dependant elements means that they could be forged into one, a possibility Basalla did not consider. Though the United States is diplomatically willing to recognize the final decision of the Puerto Rican people, especially if it was independent, it's own motivations tends to draw it into a much closer relation to the island. The initial and constant financial investment on the Observatory and on the island and the constant interchange of student bodies, in particular of Puerto Ricans going to elite U.S. universities such as Cornell, somewhat raise the issue of whether that political question of choice is viable one in the first place.

Exchanges like those that occur at Arecibo are self-reinforcing. It is in the mutual self interest of both parties to continue the relationship through the observatory—the United States is able to use it and Puerto Rico derives a gradual acquisition of scientific knowledge, practice, and prestige. Science contributes in this way to political issues; through science, peripheral areas are drawn into the metropolis.

Political issues, inversely, also affect scientific ones. Basalla assumes that the transition stage of Colonial science in the scientific enterprise ultimately leads to a self-generating science; Western science is spread by contact between Western nations and foreign ones, who then gain enough momentum to go on their own. Yet the uncertainty of the Puerto Rican political status, greatly based upon Puerto Rican economics, raises serious questions about Basalla's assumptions.

Science needs money to grow. Spending on science not only points to the values a community holds dear, but likewise to the facts of its economic endowment. The question of whether the Observatory was an example of colonialism, even in the strongest sense, would have been a moot point if the financial resources to build it had not been there in the first place; radioastronomy could not have existed without them. If Puerto Rico becomes independent, the fear that the economy will

collapse might put an end to the little science that has been placed in the island. This economic collapse is likely given the poverty of natural resources in Puerto Rico, at least in contrast to other islands as the Dominican Republic or Haiti, and the relative poverty of the Caribbean. The current economy in Puerto Rico is an artificial economy generated by U.S. interests. Thus the transition to independence in one (politics), may actually lead to a greater dependence in the other (science) in light of likely negative economic consequences. The original connection to this Western nation does not necessarily lead to the acquisition of science; other factors come into play.

Recent essays have also raised questions about the validity of Basalla's model. A diffusionist model presumes that knowledge is legitimated in the metropolis, yet the social mechanisms which create this legitimization tend to reinforce a status quo. Intellectuals traveling to the center for their training acquire a science only to bring back a particular image of the central questions of their day. Successive generations of these scientists traveling to and fro in their embryonic stages create a sort of geological layering of the respective intellectual periods of their host nations; this generation gap in turn create cultures of personalism in science and prevent cooperation between individuals at the periphery. The poverty of institutional and educational resources also maintains the organic and creative foci within the metropole. It might be said scientific and economic autonomy go hand in hand.

Both cases of political and scientific activity are ambiguous because they represent periods of transition. What that transition actually entails, and the direction to which it is headed, is similarly uncertain.

Part 7

Small State Science

Chapter 25

The dynamics of the Small State

To whom does the Arecibo Observatory belong, Puerto Rico or the United States? If your answer was "Puerto Rico," you might be a "*nacionalistas esquizofrénicos*,"[190] according to Raymond Carr, given that it is actually administered and owned by Cornell University rather than Puerto Rico per se. This would, however, be a rather disingenuous claim, given that all of science might be said to be "schizophrenic" given the vast number and diversity of its points of origin. The Arecibo Observatory is, without a doubt, a source of pride to most islanders, whether or not it was built or administered by Puerto Ricans. It sits in the island as any other natural phenomenon, and its scale renders it with a touch of the Kantian sublime. Its collapse on December 1, 2020 due to the lack of maintenance by its North American custodians was a genuine tragedy for the island.

If your answer was the "United States," then you might share a slave mentality, according to Ruben Berrios, given the little amount of control over how it functions, the purposes of its use, or to whom its use is given. As with other features of Puerto Rican life, this lack of control in many social domains helps account for prominence of spiritualism in the island, be it Afro-American santeria or the upper-middle class theosophy of Alan Kardeck. Magic typically arises in areas which enormously impact humans but over whom little control is actually had, according to Keith Thomas, in his renown *Religion and Decline of Magic*.

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[190] "Schizophrenic nationalists" in English.

The truth is likely somewhere in the middle. Politics and science are not isolated categories but rather interact with one another; they do not exist in a vacuum. We might answer this question with another one: could Puerto Rico have built an observatory of the same scale on its own? More importantly, why was it constructed in the first place? One cannot understand Arecibo Observatory independent of its context.

Completed in 1963 at the cost of $9.3 M, it was the third most expensive radio telescope of 15 built during the 1960s. Paid for by the Department of Defense Advanced Research Projects Agency (DARPA), it was 16 times more powerful than the Jordell Bank Observatory (UK), then the third largest radiotelescope of the world, and 11 times stronger than one at Green Bank (Virginia), then the world's largest steerable radiotelescope. It was also 200,000 times more sensitive to Venus echo than the Millstone Hill Observatory (Massachusetts). The Arecibo Observatory had been preceded in the island by the ionospheric sounder at Ramey and magnetic observatory in San Juan, the two of which were nowhere near in scale and power.

It should be noted that the large size dictated a ground installation, which had unexpected secondary benefits. Anything larger than Jordell would collapse on itself, and thus its designers were forced to place it resting on the ground. Puerto Rico's karstic zone in this sense was a perfect fit, and an ideal location could be easily identified simply by looking at a map, the surface of which of full of pockets made out of porous limestone.[191] One of its benefits was a shift in the design from a paraboloid to a spherical antenna, which doubled the angle at which it could receive signals. Its ground indentation also eliminated man-made radiation, another secondary and unintended benefit.

Sputnik was launched 1957, placing the USSR first in space, which helped launch the Cold War's space race, won in 1969 by the U.S. with its Apollo lunar landings. This context

[191] This itself is due to internal erosion; limestone was used as water filter in elite homes during the nineteenth century.

offers clues as to the Arecibo Observatory's purposes, which one need not strain too much to identify.

The Arecibo Observatory was funded by the U.S. principally for the Cold War. Its analysis of the ionosphere could detect nuclear explosions, thus giving the U.S. an ear on Soviet activities that might impact its national security and wellbeing. In short, it served to verify Soviet claims of compliance, much as Acosta and Baldorioty had in establishing the validity of the Spanish colonial government's ideological propaganda. It contributed an added advantage to nuclear detection during Cold War, one of various environmental mechanisms which also included seismological analysis and oceanographic testing. The explosion of nuclear weapons are so large that they leave a visible footprint on the *globo terraquio* (Earth) itself.

However, there were numerous secondary scientific benefits that existed regardless of its original military intent, such as the identification of the size of the Crab nebula, the discovery of pulsars, for which Russell Hulse and Joseph Taylor won a Nobel Prize,[192] or the study of Venus which served as a dire warning about the impact of the greenhouse gases.[193] These many important discoveries, however, do not undermine the basic fact that such were secondary to its principal military strategic value during the Cold War, without which it likely would not have been funded by the US in the first place. As W. E. Gordon, principal founder, noted during the 2003 anniversary "*we were at the*

[192] The discovery of binary pulsar systems showed the existence of gravitational waves, as had been predicted by Einstein.

[193] Venus, whose surface is wrapped by in clouds of sulfuric acid was invisible to optical observatories, was found to have surface temperatures of 867F. The Arecibo Observatory contributed to the development of notion of "global warming", Venus being an extreme example of this process. It was studied by James Hansen at NASA, who became a radical environmentalist as a result of his research.

right place, at the right moment."[194] Given that today's scientific decisions are made by committee, Gordon recognized that it would likely not have gotten funded otherwise. They did not know what they were doing, and as young men they brazenly pushed the project forward.

Large instruments, due to their enormous costs, typically have multiple functions as these to help justify the large investments. Today the construction cost of the Arecibo Observatory without additional features would be $80M dollars, when we adjust the original $9.3M price tag for the effects of inflation. It should be considered that this calculation does not include the Gregorian reflector, which itself cost $25M in 1997. The total replacement value of the observatory today would equal roughly to $100M. Furthermore, when we consider that large projects typically go over budget, its final price would likely be far larger, perhaps double or triple its original cost in 1963. When we take into consideration the price of recent mega projects as the *Coliseo* and the *Tren Urbano*, $250M would not be an unrealistic estimate.

Given that it would be of no immediate practical benefit, and in light of Puerto Rico's current budgetary deficit of $73 billion, which is now barely making ends meet, it is very unlikely at the Puerto Rican government itself would fund the totality of such a project.[195]

We might ask, on the other hand, could Puerto Rico have funded such a project back in 1963?

It is important to point out that in 1960, the portion of the GNP dedicated to the government was $187M, or a budget that is

[194] All of the presentations given at the 2003 anniversary can be obtained at https://archivo.ictal.org.

[195] The local government routinely fails to pay its contractors, which in effect are forced to act as the island's Federal Reserve by having to carry its debt, without charging interest. This administrative behavior is utterly shameful.

10% that today in 2020 dollars.[196] Worst still, astronomy was then not a well developed science in the island. It is thus somewhat questionable whether its scientists at the time would have conceived of such a radiotelescope in the first place.

The island, when contrasted to the U.S., also lacked any incentives to build such a gargantuan non-utilitarian instrument. Puerto Rico did not compete with another nation as the U.S. with the USSR during the Cold War, nor did the island posses nuclear weapons in 1963.[197] Unlike the U.S., Puerto Rico lacked a rival of equal magnitude; the USSR is of the approximate size, power as U.S., of approximate scientific manpower, with very good core set of physicists and mathematicians.

In short, Puerto Rico lacked both the resources and the incentives to build such a large observatory, and we may reasonably conclude that it would have been very unlikely to have funded it at all, even if such funding existed. The final project in any case would have resulted in a much more modest apparatus, and certainly not as ambitious and far-reaching as the final instrument ended up being—which ironically is what made it unique and so iconic.

It has to be recognized that the Arecibo Observatory was part of far larger dynamics associated with the United States, and only incidental to the island per se. In short, it was a part of larger metropolitan geopolitical conflicts, which were not necessarily shared by its colony (Puerto Rico).

After World War II, the United States was the most powerful nation in the world and in history, with regard to its scientific, economic, and military prowess. By comparison, Puerto Rico did not even come close with regard to available

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[196] This change reflects not only the effects of inflation, but the general overall growth of the government during the last half century.

[197] The Cold War is "cold" precisely because nuclear weapons made the cost of war too high. It was irrational to initiate a first strike as it would result in complete nuclear annihilation: no rival would be left standing.

resources, scientific or otherwise. The island is simply a small actor on a far larger stage, for which it is important to understand the dynamics of the small state and its likelihood of scientific development.

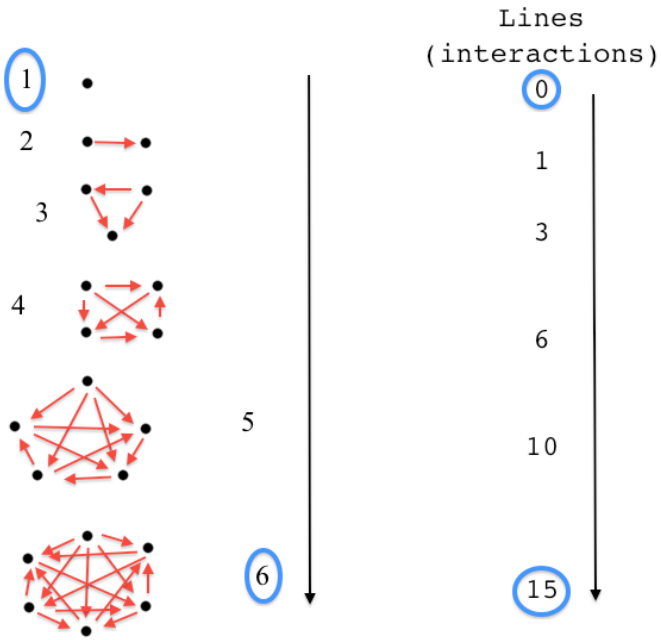
There are intrinsic limitations to the growth of science in small states, well revealed across multiple statistical sources, which in turn leads to a third key question for our purposes.

If science plays a positive role to both sovereignty and democracy, what do the limitations of scientific development in the island mean for its democracy and sovereignty, and for its long term political health? If are we to assume that Haskins is correct in the impossibility of scientific development of small island nations, should we then also conclude that Puerto Rico can never have a viable democracy? This conclusion would be tragic when one considers the enormous sacrifices made in the name of Puerto Rico.

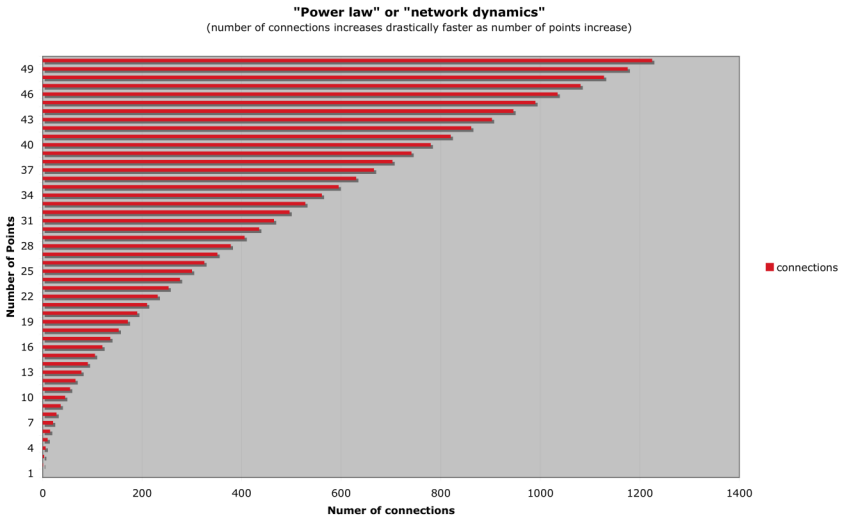
The small state has very particular dynamics given its geographic size, and one has to point out the curious irony that we now take into serious consideration ideas similar to those proposed by the Comte de Buffon regarding the impact of climate and geography—however in a much more articulated and rigorous manner. There is an ample empirical base supporting the impact of national size—geography, population, economy—on its scientific output.

The greater a geographical region's size, the greater the diversity of its scientific activity, similar to the distribution of orchids in the Caribbean, as statistically measured by Ackerman. Without a doubt the number of species drastically increases with the increase in the size of the island. While Puerto Rico, with a surface area of 8,897 km^2 has 252 endemic species, Cuba with an area of 114,524 km^2 has 2,940. In the smaller islands of the Eastern Antillies as St. Marín, Montserrat, St. Vincent and Guadeloupe, we see a similar relationship. Incidentally, the greater the amount of foreign trade, as measured by its GDP, the greater the percentage of foreign orchids in the respective islands, which might used as a proxy for the presence of external philosophical ideas.

These dynamics are also referred to as power laws or network dynamics, which aquire distinctive emergent properties out of their size, defined by the simple formula x= (n)(n-1)/2. As the number of points increases, the number of connections between the different points increase at a substantially higher rate. While three points only creates three interactions, six points lead to fifteen, fifty to 1,225 and so fourth. While its growth is not exponential, it is nearly exponential, and hence why such formuals are called power laws, given the tendency for the largest obtain a disproportionately wider share of the benefits relative to those below it. Larger economies will have a richer and more diverse set of interactions than smaller ones, and the same is true across a whole host of social activities as science.



Graphic 1: Network dynamics



Graphic 2: Power law growth curve

As Vital wisely showed, the geopolitical dynamics of the small state are inherently different from the larger one; while the first is always on the defensive, the latter is always offensively trying to modify or alter the political actions of others.

Given that a large state has a larger territory, a larger population, and a larger economy, it will be relatively autonomous.[198] It will have large internal markets, which will by nature be characterized by a greater diversity and be less dependent on foreign primary resources. This allows the large state to more smoothly sail over international challenges to its sovereignty precisely because it is less reliant on external sources. The absence of alternatives to external sources is an indicator of political vulnerability, giving the non-dependent state more freedom of diplomatic action than the dependent one.

A small state, on the other hand, is characterized by the opposite dynamics. The small state's reduced territory, population base, and economy renders it much more dependent and vulnerable to international exigencies, and thus is typically

[198]It should be noted that population is often used as a proxy for economy, or as a measure of per capita income.

marked by a higher vulnerability index. For example, because its market is small and lacks resources, by necessity it is forced to depend on international trade so as to import the goods and resources it needs; however, due to its limited internal economic output, it is also through this external trade, specifically its exports, upon which it is able to generate the income necessary to consistently obtain such goods in the first place.

Because of its limited capability in terms of size and diversity of producers, the small state also tends to export a far smaller number and diversity of products, which further renders it more vulnerable to financial shocks and externalities. If, for example, the country depends exclusively on coffee export for its main source of revenue, fluctuations in the international price of coffee will have an enormous impact on its income stability, as has routinely occurred in Puerto Rican history. This will, in turn, impact the feasibility and effectiveness of its governance by making its own sources of income erratic and unreliable, which will further degrade its alternatives and decision making process. Ironically, the more developed a small nation, the more difficult it will be to further progress as it lacks the diversity of local resources required for its continued advancement.

In short, the small state is stuck at a glass ceiling of economic development, from which it cannot move in spite of its early successes—a reality of most biological creatures of the world.

What is particularly distinctive is that the smaller a country, the greater the tendency will be towards the dominance of a single export product as well as to the dominance of a few firms. This is strikingly similar to the phenomenon known as insular dwarfism and insular gigantism in biology. Creatures that somehow become trapped in an island will either grow disproportionately in size, birds growing to the size of elephants, or shrink disproportionately in size, as elephants shrinking to the

size of birds. While the example is an exaggeration, such is the general idea.[199]

The small size will also have a number of geopolitical implications. Given its inherent vulnerability, the small state is usually on the defensive. It tends to be forced to react to events outside itself, while the large state is assertive and will rather tend to try to affect the outcomes of other states. Rather than being affected by external affairs, the large state is doing the "affecting", the opposite condition of small state. Incidentally, while there are very few large states, there are many small ones, which also make small state collaboration difficult as a totality—a phenomenon that has also been observed in relation to the upper and the lower classes.

Although the larger state will have a larger diplomatic bureaucracy, its policy will tend to be incoherent and inconsistent due to the large number of persons involved. By contrast, the small state can have far more coherent diplomatic responses for the inverse reasons. However, the limited resources of the small state bureaucracy will result in inherent limitations of information gathering, which will tend make it reliant upon the large state for its own sources of information, which, in turn, creates a potential for indirect dominance. As information has been gathered for purposes of the large state, it will likely result in the internalization of the external state's goals and agendas—and hence a form of indirect conquest with a minor amount of effort or cost by the large state.

It will also mean that small state decision makers lacking rigorous sources of information will be more prone to rash personal decision making, as seen in the case of Pedro Rosselló. Their example again can be contrasted to those of decision making in large state whose ample resources—empirical data, experts and institutional assistance—will usually result in

[199] This coincidence which lead to the question of the degree to which processes in biology are also reflected in processes of the economy, an interesting question worth exploring by both social scientists and by biologists as well.

decisions built upon the rigorous analysis of reliable information, Donald Trump notwithstanding.[200]

Military benefits also emerge out of a state's size. During a military conflict, given that a much larger region will have to be covered during a land invasion, it will generally take more time to occupy, thus making it much more difficult for the enemy to obtain a decisive military advantage. The large state will also tend to have a larger and more diverse number of industrial and military centers, which implies that the destruction of one will not necessarily lead to its surrender. Its large size and greater resources allows for a greater amount of creativity in its military response.

Again, the opposite is the case for the small state, which might have just one important metropolitan or industrial center that, once occupied, assures its military defeat. This can be seen in the case of Puerto Rico, where the capital of San Juan is its most important administrative and economic center. Even if the citizens of the small state are able to abandon the principal city, these will be rendered helpless, as in the case of Switzerland during WWII. This in turn implies that having a more ample variety of important urban areas, or a greater diversity of important and commercial industrial zones helps to strengthen the small state against external threats. In the case of Puerto Rico, previously important urban regions as Mayagüez and Arecibo have declined greatly, and it would be a prudent state policy to strengthen such secondary urban regions—even at cost to San Juan.

Economic blockades will also be less effective when used against a large nation, given the larger number of internal resources where multiple substitutive industrial centers can readily continue to export, which explains why such efforts are rarely attempted in a majority of cases. The large state has too large of an area to cover, making it too costly in terms of an enemy's resources to properly control, decreasing the probability

[200] Donald Trump's incompetence as a large state leader is further exposed by his negligible use of such ample resources.

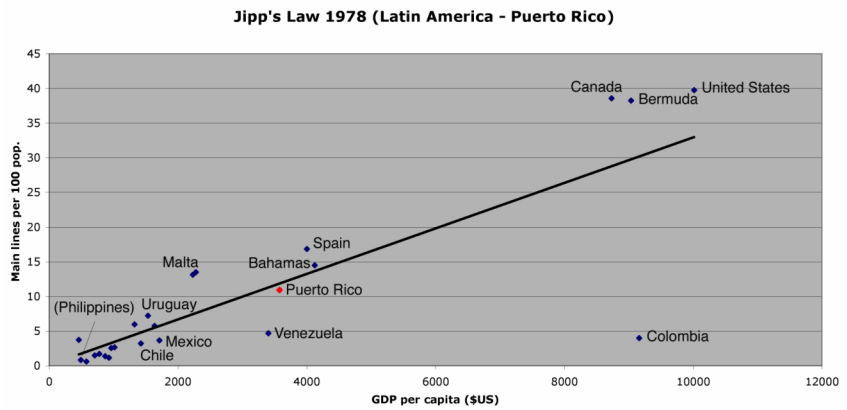
of success for these very reasons. Yet, again, the opposite is the case for a small state in that blockades can have disastrous consequences, particularly so when we consider their tendency towards a monoculture economy. Blockades basically act as bombs to the small state economy, as was attempted with the Tydings-McDuffie Bill early in the twentieth century Puerto Rico after the Riggs assassination. The very threat of U.S. sugar quotas in effect represented a formal declaration of war by the US.

These dynamics these help explain some of the international contours of the Cold War. When there are two principal large state power players, in this case the U.S. and the Soviet Union, the tendency for the small state is to pick a side or suffer retaliation by the other rival power, placing it in a situation of double jeopardy when it fails to do so. Under such circumstances, neutrality as a political stance is costly for the small state, which results in the polarity of international bipartidism not too distant from its domestic political counterpart. However, in a multipolar world as that which exists today, neutrality is a much more effective strategy for small state given the greater complexity of assessment.

The small resources of the small state also means that it is simply unable to invest to the same degree in military preparedness as the large state. The same share of a budget will enable a very different set of goals and military realities for their respective governments.

For example, 1% of the Swedish GNP in the 1960s was $190M, which amounted to the cost of a single aircraft carrier; by contrast, 1% of the U.S. budget, enabled the purchase of 50 aircraft carriers. This implies a much greater financial sacrifice and hardship should Sweden wish to match U.S. military preparedness. Just to have the same number of aircraft carriers, Sweden would be forced to allocate 50% of it budget to the military, destroying other important functional aspects of the Swedish state. Under such conditions, it is simply not plausible to match the goals of its large state counterpart, not altogether too different to a contrast between a poor man and Bill Gates, whose

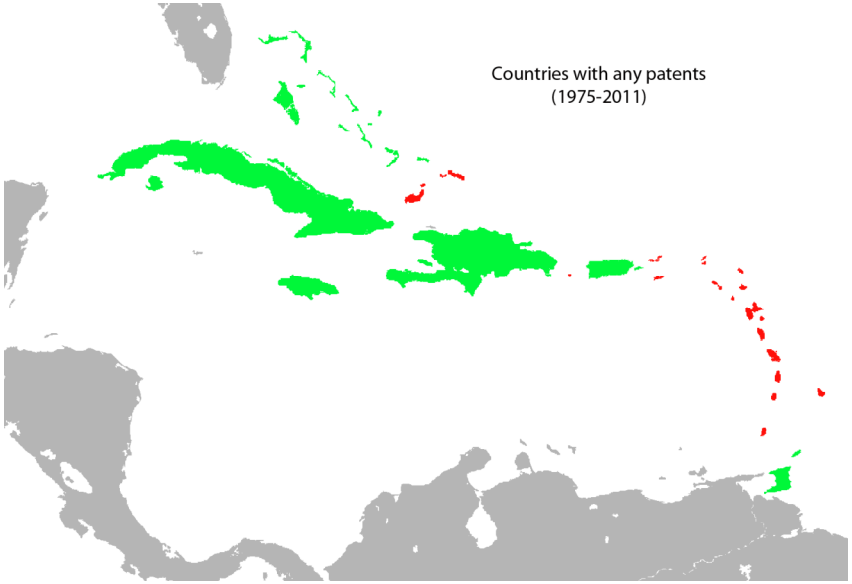
enormous discretionary income might be said to approximate towards infinity while the former approaches zero.

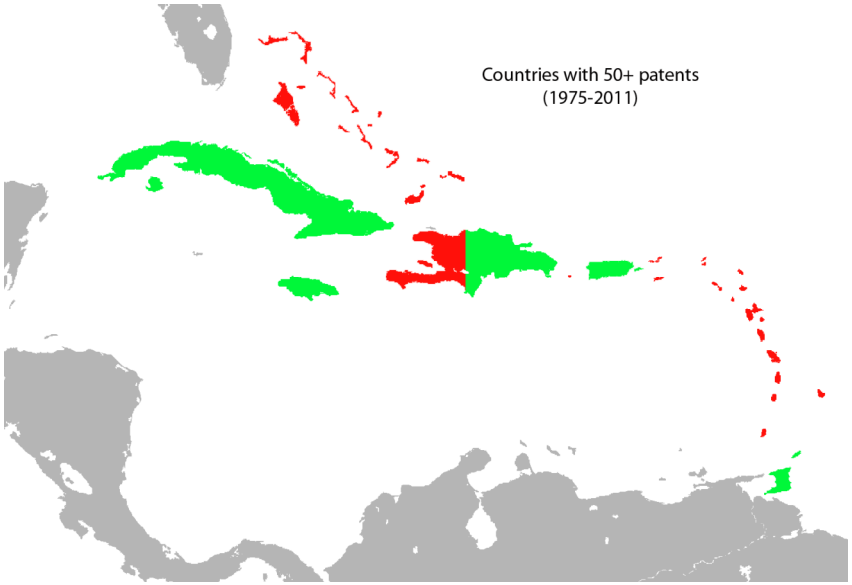


Graphic 3: Jipp's Law and Puerto Rico (1978)

Small state dynamics also apply to a whole host of areas throughout the social landscape, from telephone lines and services proportional to income per capita, known as Jipp's Law, to the vast breadth of investment in science and technology, which will also be proportional to national income.

With regard to patents in the Caribbean, geographic size can serve as an indirect proxy of patent production, though with some disclaimers. When the number of patents are mapped relative to the Caribbean islands' geographic size, the close relationship is quite marked. While the smallest of islands produced at least one patent durin a thirty year period, none of them did so above fifty patents. If the larger island nations as Jamaica, Puerto Rico and the Dominican Republic were able to produce at this level, when the standard was scaled up to 1,000 patents, only Cuba remained standing. The patent productivity of Caribbean islands fall by the wayside relative to their size, the smaller ones drifting out as if by some gentle tropical breeze.


Countries with any patents
(1975-2011)


Countries with 50+ patents
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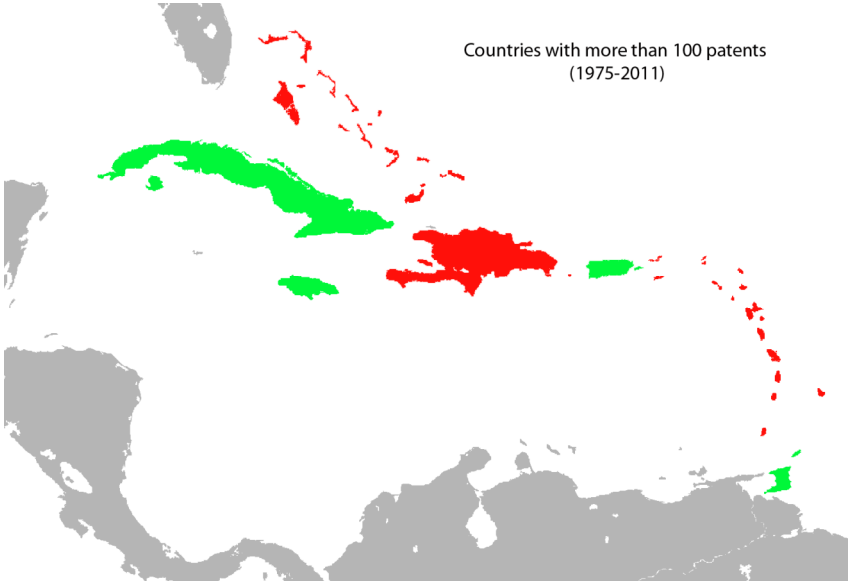
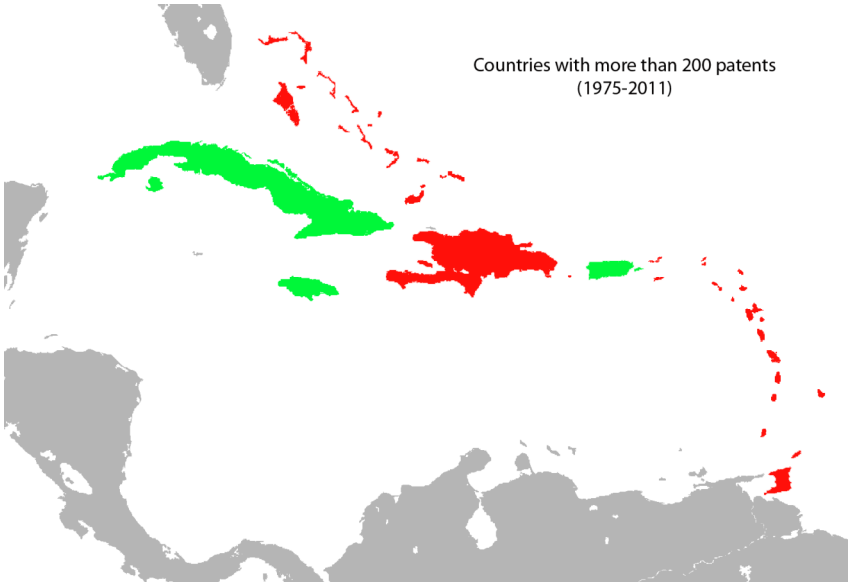
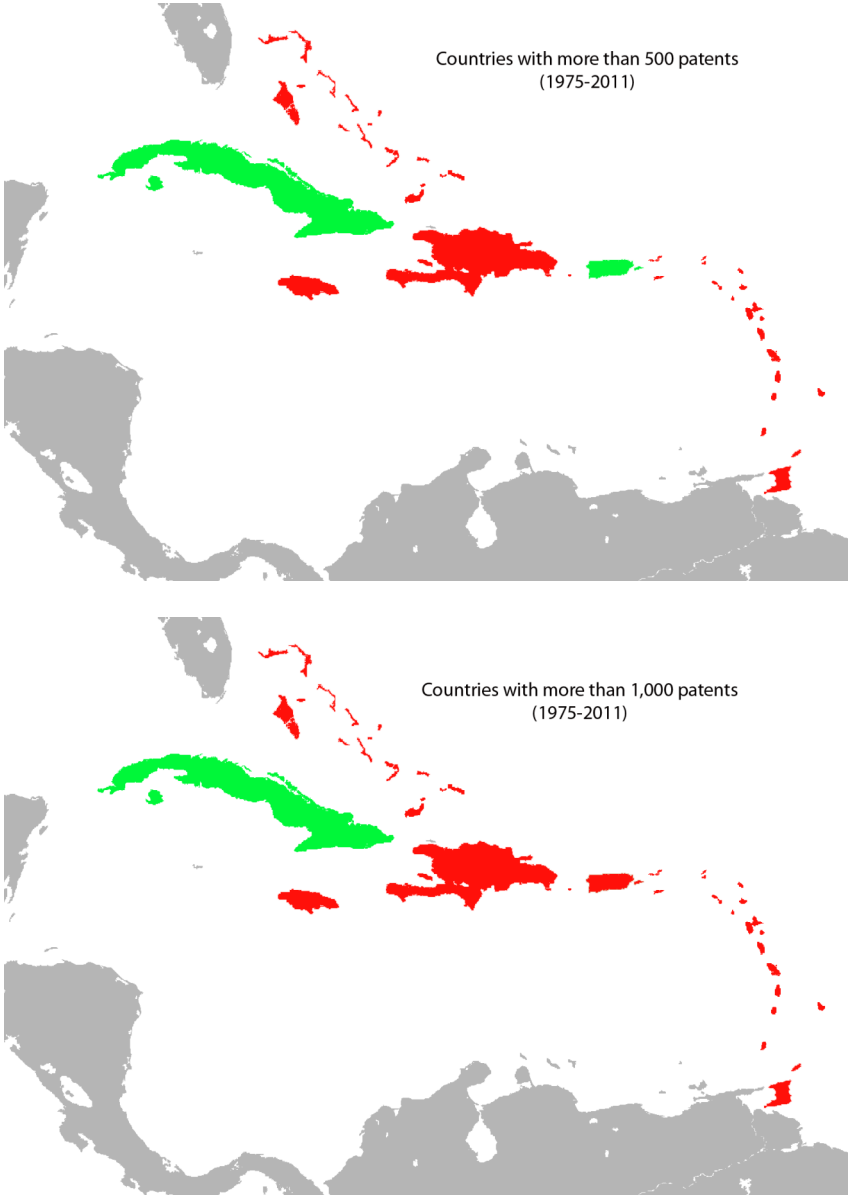

Countries with more than 100 patents
(1975-2011)

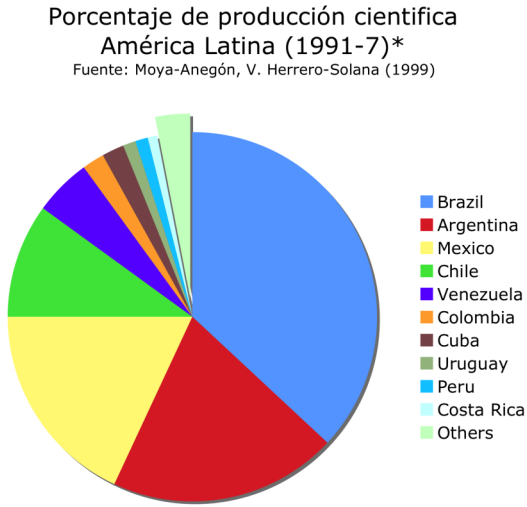

Countries with more than 200 patents
(1975-2011)



Graphic 4: Patents in the Caribbean (1975-2011)

Legend: Green: island with patents; Red: island without patents.

This same dynamic is readily visible across a whole range of statistical indices of Latin American science. The largest and more powerful countries, Brazil, Argentina and Mexico, are the ones to produce vastly more science, both in terms of GDP or as a measure of the economically active population (EAP). Brazil and Venezuela have the highest percentage of investment in RD, while Central American nations the lowest. The most highly cited papers come from Chile and Argentina, while work from Ecuador and Surinam is ignored. Bolivia's one major scientific facility sharply contrasts to the 18 in Chile and Argentina. Far more women practice science in Brazil and Paraguay, than they do in Nicaragua and Honduras. The sum total of Caribbean production is so small that it is often not even accounted for in science statistics of the contient.



Graphic 5: Science in Latin America (1991-1997)

Certainly, while the large size of the African continent is inversely proportional to its tiny scientific output, the key determinant is the size of the economy. While U.S. scientific output is correlated to its size, the case for Latin America is

inversely so for much of the same reason: an economy orders of magnitude smaller in size. By contrast, tiny Europe—geographically small but an economic gargantuan—stands out for its abundant scientific output, which is regularly consumed and highly cited throughout the world due to its high quality.

While these observations might sound comonsensical—a larger richer state will produce more science because it is obviously larger and richer—its imprtance lies with the emphasis of context. It is the natural human propensity to presume that we all live in the same social space, in spite of the statistical fact that we do not. Scientific production can never be truly understood in *vacuo*. It is only when placed in context that their dynamic can be more fully understood—and Puerto Rico is no exception to the rule.[201]

These considerations are of critical importance when assessing particular science policies for small island regions or states. If policy makers and state leaders in LDCs cannot presume that large state goals should be their own, as the well-criticized adoption of nuclear weapons by Brazilian scientist Goldemburg, more strikingly does it apply to small island state leaders. They must resist the strong temptation of emulating broader international policy changes simply because it is politically convenient to do so, as emulation theory so insightfully explains.[202]

For example, a decade ago, it was fashionable to use Singapore as an economic development model for Puerto Rico, as mistakenly claimed by Angel Collado Schwartz. Not only is Singapore a dictatorship lacking a democratic tradition, but it is also one of the island nations with the highest vulnerability indices of world, being the tenth most vulnerable in a 111 country

[201] As a general rule, only by placing subjects in some context is it that they acquire meaning.

[202] The broader change in international politics reduces the political costs of adopting policies which previously would have been rejected. Fernos, "Nuestra telefónica"

sample. One of the reasons for its vulnerability is its over reliance on exports, whose export dependence stood at 176%.

Small island nations tend to be more exposed to natural disasters. As islands often lie on the edge of continents, they are also the first to be hit by hurricanes, earthquakes, or volcanoes. Most islands are themselves result of volcanic activity in the first place. Barbados during the hurricane season was much more strongly hit than Puerto Rico, given that some islands only had one grocery store, thus making it impossible to meet the needs of it population when destroyed. The island population's survival came into question and ultimately had to be abandoned.

It is important to note, however, that a small island can be economically poor yet have a low vulnerability index, such as Cape Verde, off coast of Africa. Their low dependence on exports, implies a relatively lower level of threat by natural disasters than one would imagine.

It is rather fortunate that Puerto Rico is an intermediate size in the context of the Caribbean. The size of Puerto Rico's land mass creates a heat bubble at night which usually prevents trade winds from blowing inland during the nighttime.[203] Its nights are thus usually calm as a result—in contrast to the very small islands Bahamas and Barbados which are best by continual trade winds. While the smallest Caribbean islands can easily promote tourism via their pristine beaches and blue ocean waters, life in them is surprisingly harsh. The constant winds are a continual reminder of the incredible power of the oceans in which they sit.

This geographically defined meteorological boundary might be used as an economic or scientific indicator. Typically, however, population size is used in such studies, figuring in the 1 million and 5 million boundaries. The principle question, however, is whether Puerto Rico is big enough to have a substantial self-sustaining scientific base. However we might

[203]The larger the area, the greater the propensity to invert the direction of the wind, creating a 'land breeze' flowing outwards to the ocean.

answer this question, there can be no doubt that its size—geographic, populational, or economic—will play a big role in our final answer.

We might also ask whether the theory of the small state, as one based on Geoffrey West's work, constitutes the rebirth of the theory of degeneration by Buffon. Are we biasing ourselves with the same subjective and prejudicial manner as Buffon once did, which so negatively impacted the fortunes of the Americas? Buffon, when viewed from this modern perspective, might have been more correct than has been assumed.

Early American colonies had relatively small populations, and, as noted by Dewey, the small town served as the context of all social activity; colonial life was really one more of survival and hence inherently defensive in nature, and as such reflected similar dynamics of the small state. Given their size, many colonial regions would have been impacted by the same dynamics as those of the small state, specifically a reduced intellectual vigor relative to the rich philosophical life of the *Academie des Sciences* in Paris or the Royal Society of London. France, as England, had substantial metropolitan sizes at the time which we know to have enormously contributed to eighteen century science—a claim of which there can be little doubt when we look at the examples of Laplace, Lavoisier, Berthollet and so forth.

If one were to limit the definition of Buffon's theory, removing its pejorative aspects of degeneration as well as its injudicious application, one might then suggest that Buffon had the seed of a valid theory. While he is remembered today as a natural historian, it is important to note that he began his scientific career as a mathematician via the analysis of games of chance. As such, he would have been perceptive to a correlation, in that the number of mathematically trained individuals would have been quite marked between the two regions.

While Buffon certainly over-generalized this notion, applying his claims to the entirety of life in the two respective regions, it might be said that there was a germ of truth in the idea that there existed an enormous disparity of scientific output

between the two regions, which would be consistent with what we know regarding the impact of economic and population size on the technological and scientific production, according to West.

That being said, the claim that small state science is merely an updated version of the same pejorative theory as Buffon's theory of degeneration would be to make a substantive error.

What might be termed as "smallness theory" a la Geoffrey West has features which sharply distinguish it from its predecessor. Size is a feature which impacts all regions of the world, regardless of their location. The theory is characterized by empirical and mathematical rigor, in sharp contrast to that to Buffon, whom as we have seen before conducted no rigorous empirical research. In other words, unlike degeneration theory smallness theory is not a theoretical construct limited to only one nation or a particular cultural group, and, as noted by West, an increase in size would has negative repercussions for the large state. Not all is cheeky and rosy in the metropolis given the equally problematic increase in crime which is also directly proportional to population size.

We may thus conclude that small state theory is not the prejudiced and one sided theory which so marked Buffon's ideas on degeneration, but rather constitutes a more mature set of ideas. As the famous Spanish philosopher José Ortega y Gasset once noted, philosophy is made up of a never-ending circular journey, where each step of the way results in a broader range of understanding.

Chapter 26

Science Policy for Small States

Tell me if any of this sounds familiar, which I suspect it will. There is a lack of rational objectivity in the governmental decision making process; kinship ties are one of the principal determinants of decision making over and above professional expertise. Politician's sons and daughters are nepotistically given positions of power, amply epitomizing the general absence of meritocracy throughout the labor market. Decisions and contracts are based more on personal relationships and associations than on critical analyses of internal traits per se; the best candidates are not chosen but rather those with the right connections; *apadrinado* as they are called here in Puerto Rico, easily obtain professional jobs.

There is an absence of confidentiality given the role played by personal relationships in institutional affairs, be it education or government. Confidentiality, which is so critically important to any innovation system, is grossly lacking throughout countless institutional bodies, not just in fields of innovation as science and technology.[204] The police are not the only culprits, but lawyers as well, in spite of confidentiality that is pledged at the beginning of their careers.

While one would expect the size of the government to be small, given that it sits in a small economy and region, what happens is actually the contrary. The portion of national income

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[204] Confidentiality is critical for scientific and technological progress; otherwise the participants will not receive the economic benefit of their effort. This is the reason Jefferson established the 1794 patent law, so as to create an incentive to innovation, which is not an "inherently" normal and organic social process, contrary to expectation.

that goes to government is disproportionate to this income and contribution. A study by *Estudios Técnicos* showed that a Puerto Rican legislator makes more money than one in the state of California, in spite of the fact that the latter state is more prosperous by more than a tenfold factor.

A specialist, be it a scientist or an engineer, has a very difficult time working in government. Those who do work in government tend to do so in areas they were not trained for. In spite of having higher education, masters or doctorates, those who are fortunate enough to work in their areas of specialty are continually drawn away to other fields as they are bombarded with requests and in practice, cannot specialize exclusively in their field of expertise. Far too many technical functions are carried out by non experts in bureaucratic positions for which they are generally unqualified, hence directly impacting the functionality and effectiveness of that government agency or institution.

All of these are not necessarily descriptions of Puerto Rico, contrary to what the reader might presume, but rather general descriptions of various island nations, ranging from Fiji, as described by Forsyth, to Jamaica, described by Ventura. All of the difficulties of the latter cases fall under a simple concept established by Max Weber, the rationalization of government—or, more precisely, the absence of rationalization in the small state.

Weberian rationalization is pervasive in large countries where things run efficiently, as they should. Governmental processes are orderly and coherent and make logical sense; employees generally feel justified by the appointments given and received, and the institutional aspect of governance feels like a smooth machine, whose interconnected parts are relatively well harmonized and appear to be working perfectly. There are no unnecessary wait times, and so forth.

The vast difference between the governance in the small and large state might even lead to an overappreciation of the large state and an underappreciation of the smaller one. As Betances noted, in small nations problems are more readily

observable than in large ones, which become isolated and hidden due to their size. The typical *pitiyanki* can only recognize the more readily apparent local chaos, in contrast to the orderly processes of U.S. governance whose problems typically remain embedded in their immediate locality, which leads the *pitiyanki* to idealize large state political systems while entirely rejecting those of the small state, in our case Puerto Rico. The disparities between the two are regarded as somehow "inherent" to the two geographical areas, and make the *pitiyanki* eternally regretful of his current status; only by making the island part of the United States will the *pitiyanki* believe the island's problematic character will effectively solved. Given the pervasiveness of the two cultural spheres, the Hispanic and the Anglo-Saxon, the *pitiyanki* believes that only by destroying his own native culture, regardless of whatever merits it might have, will he be able to restore harmony, peace and justice in the social domain of his political habitat.

The *pitiyanki*, however, is tragically mistaken for reasons one might already guess. The disparity between the two political entieies is not necessarily due to the predominant Anglo-Saxon Protestant culture of the United States, but rather mainly arises out of its large state condition. Its large size dictates the need to establish an efficient functional system, for to do otherwise would result in the large state's collapse. To simply be able to function, the large state requires efficiency, given the operational constraints of its own structure.

In other words, the presence of irrationality in the governance of small states as Puerto Rico is not necessarily a function of its Hispanic tradition, whose colonial heritage certainly lacked strong ties to science during its formative period. Although this tradition is a contributing factor, that such diverse cases exist across radically diverse cultures as Jamaica and Fiji show that its principal causes stem altogether from factors other than culture. Rather, this irrationality is a by product of the small state condition, whereby the impact of size become much more understandable when observed in this context. The condition of the small state has a high explanatory function that cannot be

attributed merely to the cultural or political system in which they reside.

One example would be the higher probability of its professional experts being mismatched to need, being either underemployed, by not working with their trained skill set, or simply being unemployed. This dynamic is understandable when one considers the following.

In the small state, university systems will tend to have a reduced diversity of degrees, which means that a narrower range of skills will be obtained, and in turn lead to a mismatch between national economic demand and the particular skill sets of the university graduates. It will also result in an over concentration in particular skill sets, which, as a result, its university graduates will not be readily absorbed into the economy. The smaller number of universities and fields in the small state will thus likely lead talented students and those from more affluent families to study abroad. However, they will be more likely to acquire a knowledge base that is more appropriate to meeting the needs of the large state rather than the particular needs of the small island. Both cases, however, result in the same a labor-skills mismatch, which occurs at a substantial cost to the employee.

Small state dynamics create a whole host of consequence for governance and administration, whose character was alluded by Carr, but with broad implications that were entirely ignored by the British scholar.

For example, if it is true that collective irrationality is the result of smallness as shown by Forsyth and Ventura, therefore no matter what party enters into power, *Independentista*, PPD, PNP, MVC, or the *Partido Dignidad*, they will all tend towards the same irrational result regardless of their economic orientation (socialist / capitalist) or political status stance (independence / annexation), given that the state will remain small no matter what its political status is.

This implies, in turn, that any change in the political status of the island will be of negligible impact in resolving its core problems. Even substantial modifications to the current

political arrangement of the commonwealth, or what is referred to as the "enhanced commonwealth" or "*ELA mejorado*" will not inherently fix some of the worst issues affecting Puerto Rican society. Through every election and the political dialogue of its debates, too many have been attributing the wrong causes to the wrong effects, and in turn, and have sought out answers where they may not necessarily exist—specifically the issue of political status. Bluntly put, changes in the political status of the island will not be magical cure-all to its persistent socioeconomic problems, but actually serves to detract from genuine discussions of its true nature—and consequent identification of viable solutions.

One has to point out the utter tragedy of this dynamic, given the political persecutions which have occurred throughout the island's colonial history—and the impact such political persecutions have had on the daily life of countless of its citizens. The futility and banality of such encounters has been recognized to a degree by the *Movimiento Victoria Ciudadana* (MVC) which excludes status from its political agenda, as seen in the 2020 elections in Puerto Rico. The traumatic experience with capital intesive industries should have heeded a warning of its dangers.

This in turn leads to another question.

If a change in political status will not profoundly impact the irrationality of the small state government as that of Puerto Rico, then what will? What policy alternatives and options exist which could improve the Puerto Rican condition, or that of any other small state for that matter?

Our aim here is not to provide a complicated answer to a simple question, but rather help guide the way for both science policy makers, as the study of the small state this is still a relatively new topic that is not only poorly understood but whose study itself is continually beset by larger corporate actors in the academic literature. The field, in short, still needs a great deal of rigorous research and original investigation.

The worst problems of small state which impact scientific developed are well describe by Ventura. These include: small market, a small economy, and thus a reduced funding set for

science, which in turn leads to an overly aggressive competition for resources between island scientists. Its small economy all too often creates a vicious cycle of distrustful relations between scientists in these regions.

That the Caribbean region is a colonial one formed by multiple European nations implies that the diversity of cultural structures within it is enormous when seen as a totality. There are many languages, different customs, and so forth, which constitutes a diversity which by itself inhibits collaboration across the entire Caribbean, particularly so when breaches of reciprocity, or distrust is introduced into these relationships.

The tendency towards technological dependency on an island's mother country itself tend towards bad exchanges with the exterior. As island representatives cannot appropriately evaluate contracts because of a lack of requisite expertise and ample support structure, these result in detrimental and costly losses rather than long term economic gains. The lack of valorization of science by politicians is another such example. While politicians might pay artificial homage to science, such as giving funds for the creation new buildings, scientific institutions in the Caribbean are the first to be gutted during an economic crisis—a point implied by Fernandez.

Ventura himself, as Chairman of the Science Research Council of Jamaica, was obviously very frustrated with the events that had unfolded in his island. What is particularly surprising is that, in spite of being principally an agricultural nation, its problems so closely match those of Puerto Rico. Scientific planning or the formation of science policy is generally not a part of national planning, its scientific activity is not directly tied to its own local economic output. Just the contrary, in that scientists are often seen as irrelevant to daily needs, revealing a fundamental dissociation between science and the local Caribbean economy.

As Ventura aptly notes, one of the key roles which would enhance the status of science before the populace would be to tie it directly to the actual economic needs of those througout the entire economic ladder. Such a process would do more to

enhance the status of science before the general public, than the most sophisticated policy treatise. Science would be seen as having a direct benefit rather than begin an some esoteric body of of little concrete value, the latter being an inverted status to that which science obtained during the French Revolution for the exact opposite reasons.

There are a number of implications of the small state theory.

The analysis of small state dynamics will set the upper boundaries to what science policy can realistically achieve. We can generally agree that, whatever the specifics, the statistical determinants that operate within it are deep and profound. There is simply too much data demonstrating the effect of size on scientific growth. However, this is not to say that small state theory determines the particular details of such a policy as, for example, whether a particular science project should be supported or whether scientific disciplines should be given priority over others, say chemistry over biology. Rather, it is to simply observe that small state dynamics will create severe constraints of action and policy outcome, which should be used as guidelines for realistic policy expectations.

Over the last fifty years, there have been countless science policy documents prepared for Puerto Rico, which have simply ended up in the dustbin. Pedro Rosselló had one which was frankly risible in that it had not yet done necessary and rigorous background research to truly understand the nature of scientific innovation per se.

It is important to again point towards the notion of "appropriate technology." Instead of looking at the most advanced sciences of the richest nations of the world, as Haskins, we should look in our own backyard and seek to identify and develop these, as Linnaeus.

A critical aspect of any science policy would be to link science to the economy in a substantive manner, as Ventura noted. Otherwise, science will only drain money from national coffers, without ever assisting economic development and, in turn, the further availability of funds for scientific activity itself..

Its character will remain distant and elite, with little genuine benefit to the lives of those in the community.

This exploration also suggests that Hostos, that Caribbean romantic as Marti, might have actually been right all along—specifically his plea for the formation of a Caribbean wide federation between the islands constituting the greater Hispanic Antilles: Cuba, Santo Domingo, and Puerto Rico. These could form the key nodes of a Caribbean Confederation. Under such circumstances, Puerto Rico might be able to obtain sovereignty by joining along with other nations to form a political totality that is greater than the sum of its parts—perhaps. The purpose of such a federation would be to overcome the particular restraints imposed by the inherent small size of their territories, a trait shared by all the islands of the Caribbean.

When considered in light of the advanced telecommunications that exist today as well as pervasiveness of smart phones, technologies which were not available to Hostos or Marti, less developed island nations could establish common markets of talent, ideas, and products.

Interlude: On the benefits of democracy for the would-be tyrant

Throughout the book we have presumed that democracy and sovereignty are positive goals to be desired, as much as slavery and colonialism are to be rejected for inversely similar reasons: the presence or absence of personal agency. However, it is perhaps useful to briefly touch on why this is the case so as to demonstrate democracy's virtues, and in this Justice Brandeis serves as a good jumping board.

When reflecting on the aspects which made the United States Supreme Court stand out and so unique, Brandeis identified a number of key traits. Brandeis noted that the nine member court sought out dissidenting opinions, rather than "[steam]rolling these over", as commonly occurs in Puerto Rico.[205] In other words, rather than the majority completely ignoring and bypassing the minority and their opinions, their views were activity sought out and discussed by the U.S. Supreme Court, whereby the presumptions of all the opinions were analyzed in a Socratic manner. This democratic spirit was structured into its procedures, such that the deliberative process would first begin via the distribution of every justice's printed opinions, which then would be debated, and was followed by a second round of distributions and deliberations, before ever first hearing the claimant's case in person.

Deliberative processes wherein 1) opposition views are not solicited or persistently ignored, 2) a laughable amount of

[205] The Spanish phrase "*pasandole el rolo*" in English means to "steamroll" a person or a group.

time is provided for deliberation, or 3) public deliberation about the key issues between all members was obscured or denied were sure signs of the absence of a fair democratic hearing. As Diderot pointed out, a tyranny can be had by a majority of two in a group of three as it can by a single individual. In spite of the vast range of repressive measures that can be used towards these ends, the final result was the same: the squelching of contrary opinions rather than their reciprocal consideration.

Yet, given the innate human tendency to abuse of power, why should a tyrant reasonably reject the power they wield? Why should reciprocity be followed by the tyrant when it can be so wantonly undermined? We may identify two principal features of anti-democratic behavior that are inimical to the interests of those who would pretend to impose their opinion and beliefs on others via tyrannical processes, which inversely also reveals democracy's benefits for those who would seek to destroy it.

The first of these is simply that, the greater the tyranny, the greater the probability of harm to the tyrant's physical wellbeing. The statistics bear this out time and time again. To be an emperor in Imperial Rome was to have the world's deadliest career, 60% of these were brutally killed in some fashion or other. The early modern period was no different, as testified by the historically based *Autobiography of Henry the 8th* or the television series "Game of Thrones", heavily influenced by the historical War of the Roses in England. The death rate of young potentially kings and queens was extremely high; those who were in line for enormous positions of power were all too easily assassinated given their childhood naiveté and simple adult dependency.[206] In other words, as Hobbes in *Leviathan* warned, there are an infinite number of ways in which anybody can be assassinated; autocrats and monarchs are not except from this

[206] Only by practically isolating their children form the external world, could a king or queen live to see their progeny become rules. King James of England mysteriously lost ten children, leaving no Catholic heirs except his protestant daughter Anne.

rule. To wield their power, autocrats by necessity will still depend on a whole host of subalterns to make their will manifest, which in turn introduces opportunities for outcomes other than those originally intended.[207] In short, being a tyrant, as smoking, is dangerous to one's health.

The benefits of democracy simply lie in the wider distribution of the costs of power between many different individuals, whereby no singe point of failure could be present. This phenomenon, interestingly, can also be observed in the banking industry.

The development of steel, which allowed for the most impenetrable of bank vaults, initially had one critical flaw: the bank manager who held the keys. The key holder became that one critical point of failure, and an all too temping target for those who sought its treasures. If a manager would not yield to a direct personal threat, threatening a loved one would often help secure access to the vault. These inherent vulnerabilities led to a series of measures in the banking industry which distributed the costs of power between many diverse agents, human and non-human alike, thus eliminating the substantial and unnecessary danger in which bank managers had been previously placed.

While the greater distribution of power implied that the consequent benefits could also no longer be concentrated, it insured the would-be tyrant could enjoy these, as wealth is of no use when one is no longer alive to benefit from them.

This distribution of the costs of power leads us to the second benefit to the potential tyrant contemplating the obtainment of absolute power: the cognitive costs of power are also more widely distributed, and, as a result, the flaws of decision-making or failed state actions make them much harder to pin down on a single individual. A discussion of the recrimination towards Benjamin Franklin and Thomas Jefferson for their inability to end slavery in the formation of the U.S.

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[207] It is perhaps for these reasons why corporate assassinations now occur so slyly, so that the original culprits are never suspected.

Constitution is a good case in point, and illustrative of what is here meant.

The claim that Franklin and Jefferson were hypocritical Founders who "established" slavery by not opposing it in the formation of the Constitution ironically proves its exact opposite. It presumes they had the absolute power to will slavery out of existence, as if they had been tyrants with entire freedom of state action the likes of Stalin. It is precisely due to the fact they operated in a democratic environment, well described by Kloppenberg, that so limited their freedom of constitutional influence.

It is not well known that the U.S. colonies actually served as an inspiration for the political writings of John Locke. That compacts established upon their founding were done so prior to the selection of any state leader or administration was of enormous influence to Locke's ideas in the *Two Treatise*. While many of its leaders appeared to be irreplaceable monarchs, as those of Massachusetts and Pennsylvania, these quickly fell from power as a result of a deeply held democratic culture.

In Franklin and Jefferson's particular circumstance, the positions of early American southern delegates could not be so easily discarded. That slavery made up the core machinery of these agricultural economies meant that all southern representatives would have voted against the Constitution should slavery have been prohibited in it, and hence would have placed in jeopardy the good of all parties involved. As Franklin noted, in spite of its many errors, the Constitution was an eternal experiment which could be modified and improved at some future date. Otherwise, as he noted, if they did not hang together, they would all be hung separately by Britain for treason.

It is precisely because Jefferson and Franklin were not tyrants whom had to take into serious consideration opinions they did not share, a much more nuanced historical judgment should be made of them. The historian should not be quick towards rash generalizations but must consider the realties under which historical actors operated before coming to any honest appraisals of their actions and views. In fact, both Franklin and Jefferson

are ideal exemplars of classical democratic liberalism, precisely because they took into serious consideration the ideas and opinions of those with whom they disagreed.

Conclusion

It is very tempting, and naïve, to attribute the formation and advancement of democracy solely to that of science, merging two of most cherished Western values of the twentieth century into a unified framework as Ferris attempts to do. Ferris's historical interpretations defending liberal democracy are ironically more "Marxist" than he cares to imagine in that he obscures facts which do not neatly fit with the values of his historical schema. As Edelstein and Miller have shown, natural history played a prominent role in naturalizing the extremes of violence of the French Revolution, in an all too similar fashion to the manner in which the Aztec leadership turned their natural philosophy into an ideology of genocide and colonization. Similarly, Ferris's complete dismissal of Hobbes's important observations constitutes a significant historiographical gap, a puzzle which would behoove a young scholar to analyze. While Hobbes begins with the rigor of Euclidean geometry, he concludes with the mindfulness of secular religion.

Ferris supposes that the rise of the scientific mentality in a society will inevitably produce a democratic culture, so lacking throughout much of the world. He intends to convert science into an elixir of justice—a silver bullet that will transform all non-participatory autocracies into exemplars of popular conscientious thought and action. While it is certainly that case that the scientific ethos shares many of the same principles as those of the democratic mentality, to presume that this process will somehow occur automatically and inexorably without analyzing its core mechanisms is to presume a determinist stance similar to the that

of Lynn White's work on medieval technology.[208] Plant the seed of science into a nation, and like an acorn the oak of democracy will automatically flourish from the ground of national politics—a notion from which any student upon reading Bloch's magnum opus in an introductory course of historical methodology will be disuaded.

Puerto Rico's case is a good counterpoint.

Although Spain sought to isolate her colonies during the colonial period, she could not keep them forever contained, blind to what was happening in the rest of the world. After nearly a two hundred year gap, the Scientific Revolution arrived to the island with an exiled Jesuit priest Padre Rufo whom sought to spread a new view of the world radically different from the medieval Catholic stance which predominated. The sacrifices that his students Acosta and Baldorioty undertook, first by risking their lives in a *viruela* infested Spain, and then later by risking their lives confronting colonial tyrants that Puerto Rico's military governors represented, were done so as to plant the seed of modern science in insular soil.

While Ferris is correct in showing the enormous political stimulus which emerged out of the scientific spirit, the blowback by the vested interests of its rulers and the monarchy led not only to their arrest, but, in Baldorioty's case, ultimately to their execution. Other leading intellectuals at the forefront of scientific or medical thought of the era, as Betances and Hostos, would be exiled from the island for the majority of their natural lives for similar efforts. The ambitions of Betances and Hostos had been of an even more radical nature than those of Acosta and Baldorioty: full-fledged independence.

Puerto Rico's case shows that to presume the arrival of science will inexorably result in democracy is mistaken. The very occupation by the United States in 1898 is itself a testament to the detrimental role of science for sovereignty in international politics.

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[208] Introduce the stirrup, and the world of feudalism will magically emerge.

The disparities of national power between the US and Spain in 1898 were enormous, arising precisely out of the North America's longstanding colonial scientific tradition and Spain's utter rejection of this intellectual revolution, which meant that Spain would lose the Hispanic American War the very moment it began. It is this substantive contrast of national power between different regions which led to colonialism and imperialism in the first place. In spite of the US's long-standing democratic tradition, the all too easy to abuse power that emerges when such elevated differentials of scientific-technological levels exist were too difficult to avoid. Democracy's exemplar fell on its feet when the tempting fruit of imperialism was paraded before it.

Absurd rationalizations as those of the Insular Cases, 'foreign in a domestic sense' also echo the Aztec quasi-scientific ideologies of dominance. While in theory Puerto Rico could have obtained its long sought-after independence in 1898, abiding by the democratic promise of the US, the island slipped once again into being a colony of another large national power. Throughout the twentieth century, the US and its representatives have routinely intervened in the island's organic political processes, whose noxious cultural impact is not all to different from that which Franklin had observed of British colonialism in Ireland.

It is precisely for these reasons that scientific and technological development have become the most desired goals of nearly all postcolonial nations; the greater economic and military power that scientific development brings helps insure the integrity and viability of national sovereignty.

Unfortunately, that small nation states appear to have inherent limitations to their scientific development—a phenomena which arises out of their small state condition—suggests that their ability to obtain and retain sovereignty is of a rather limited character. While the small state might be able to obtain legal sovereignty, as in the case of Puerto Rico, in actual practice its political agency is routinely undermined by external actors, be they governmental or economic. The recent incursions by China into the political system of Hong Kong, a liberal

democracy established during British colonialism which China had previously agreed to respect, is another indication of this phenomenon.[209] The fruit that a colony represents was too tempting to be avoided.

The rise of the modern corporation, on the other hand, has domestically meant that small island states as Puerto Rico simply become instruments of corporate power. As with the large nation state, the enormous disparities of resources between the small state and the transnational corporation imply that the latter acts as a political enclave within an external political system, turning the island into a second order colony: a colony within another colony. These disparities of resources, in turn, also results in other grave distortions of the political order. Genuine freedoms and rights implicit in the US Constitution are routinely breached by corporate actors when their economic interests come to be threatened. While in theory all states have the sovereign right to tax any economic actor within its political domain, the legal distortions created by these disparities of economic power echo and reflect those which occur at the federal level due to the Insular Cases. In both, the principle of sovereignty which typifies all nations is routinely subverted for the benefit of exogenous actors, be this stock market valuation for pharmaceutical corporations or the national security exigencies of Cold War dynamics.

In spite of the many promises of development and civilization that such an association with the United States implied, Puerto Rico remains mired in the poverty of a continual debt cycle little different to that seen prior to World War II. As the *Oxford Compantion to the Politics of the World so* aptly noted in 1993,

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[209] Taiwan's larger state and more prosperous economy, arising out of technological innovation, help protect it from Chinese control. However, the disparity between the two states regarding their military size and power place some question as to its long term viability.

> *In the twentieth century the story of Puerto Rico is of an ongoing effort to overcome almost 500 years of colonialism…The island's staggering federal dependency, $6.2 billion in 1988, or thirty-four percent of Puerto Rico's $18.4 billion GNP, rendered its economic model nonexportable. Its dynamic industrial economy is heavily dependent on exceptions from federal and local taxes.*

Thirty years later the situation has not only worsened, but it has done so at an unprecedented rate. Little has fundamentally changed in paradise in spite of all purpoted claims to modernity. Were we to let the ravages of time take their natural course, the predictable outcome would be not unlike that of the French Revolution: hunger, famine, and violence.

What is to be done? Puerto Rico needs to move from a culture of the *situado* to a culture of science. Gallizá and Hostos might have pointed a possible way forward: that of Caribbean solidarity. Whether this solution can in fact be successfully implemented to more fully equalize power in the Caribbean basin remains to be answered.

Epilogue

Immerwahr is more correct than he might presume to be; Puerto Rico is an invisible colony. While the 1952 farce might have given a certain degree of political autonomy that would have been difficult during much of the colonial period, the repression over its political process has been hidden by the powers of science and technology. In this, the United States is also closer to China than would be apparent at first glance, precisely because the Chinese state apparatus of political control is rather overt and visible, placing video cameras on every street corner which stream the actions of its citizens in real-time for the state to see and judge.[210] Yet to presume that the tools of US repression are no less pervasive and noxious would be to also commit an error.

The number of Puerto Rican political leaders at the cusp of their influence that have died after the turn of the millennium is somewhat astonishing. The death at the age of 68 from pancreatic cancer of William Miranda Marin (PPD) came as a surprise to many. Miranda Marin did not hide his strong autonomist streak, so much so that he stood closer for the independence of Puerto Rico than its statehood. He unwisely passed up the opportunity to govern Puerto Rico in 2005 so that a young candidate, Alejandro García Padilla, could assume the throne of power. Given that Garcia Padilla's gross incompetence became widely and publicly manifest—a type of local Dan Quale—the opportunities for the success of his political rival were nearly guaranteed prior to his early demise. Miranda Marin,

[210] George Orwell had been wrong with regard to where the all-seeing state would exist.

whom had rather successfully served as Caguas's mayor for more than a decade, would have been the likely winner in any upcoming election had he chosen to run for the governorship, and hence why his unexpected death in 2010 came as such a shock to many.

Yet Miranda Marin is only the tip of the iceberg. Countless other leading figures that represented the best of the Puerto Rican political tradition also unexpectedly died. David Noriega, an *independentista* who led the Blue Ribbon Committee during Sila María Calderon's PPD administration, and whom had also previously uncovered fraud in the island's scientific institutions, died at too young an age.[211] Although Luis A. Delgado Rodriguez, president of the *Alianza Pro Libre Asociación Soberana (ALAS)*, was a lesser known figure, he also unexpectedly died in the same year as Noriega. Delgado Rodriguez had written a prominent letter to then President Barack Obama on April 22, 2013 calling for a recognition of Puerto Rican political rights. We may also mention Hector Ferrer, whom also belonged to the PPD, died from esophageal cancer at the young age of 48 in 2018. After Anibal Acevedo Vila's federal accusations and departure form politics, Ferrer assumed the command of the PPD, preventing it from collapsing in on itself. As in the case of Miranda Marin, Ferrer's political future held a near certain guarantee, until his unexpected and untimely demise.[212]

Many other prominent figures, whose strong voice held a great deal of public weight and social influence, also died prematurely, as those of Mara Negrón, a young professor of literature at the University of Puerto Rico (Rio Piedras), or Manuel Alvarado, whom played a prominent role in the UPR history department. Both died from cancer, the former from

[211] *Instituto del SIDA*.

[212] Ferrer was an athletic figure, having played baseball in his youth and regularly participated in island triathlons.

leukemia, and the latter from pancreatic cancer.[213] Teresita Martinez Vergne's death from cancer in the US, a Puerto Rican history professor, to a degree resembles that of another outspoken female historian of science, Margaret J. Osler. While Martinez Verge had been forced to leave the University of Puerto Rico for her outspoken nature, Osler suddenly died at the peak of her career in 2010, just as she was emboldening the field. Other scholars as Carlos Alberty Fragoso, a specialist of the *independentista* literature of Francisco Matos Paoli, died before his time at the age of 62, also due to cancer.

Some cases that have not mentioned were obviously due to their poor medical health, as that of Benny Frankie Cerezo, whose diet rich in *lechón* led to a fatal cardiac arrest. Although Cerezo had been a lawyer in favor of statehood, he had long participated in a number of important political fights with his close friend Jose Arsenio Torres—the earliest of which was in 1974 over the Puerto Rico Telephone Company.

This is not to say that efforts to assassinate Cerezo did not occur. He had worked at a new and promising journal, *Avanze*, in which intellectual leaders of diverse and often opposing parties, including Arsenio Torres (PPD) and Noel Colón Martínez (PIP), also collaborated. They were very fortunate that a bomb placed in the bathroom's lavatory exploded while they had unexpectedly decided to go out to lunch one fateful summer day in 1974; had they decided to remain in their offices, as they usually did, many of them would have certainly perished in the blast.[214] Similar bombings occurred of the offices of other prominent political figures, as Carlos Galliza, whom had been member of the PIP

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[213] I was personally once able to witness Mara Negron's powerful presentation at a 2004 conference on science and literature, which had been held at Nilita Vientos Gaston's home. She was an impressive sight to behold. Unfortunately, the videotaped conferences were never released to the public by its organizers.

[214] It is suspected that the bomb was planted by ultra-right Cuban exiled by Fidel Castro.

and the PSP as well. Juan Bonnet Jr.'s murder during a *cafetin* robbery attempt in the 1980s might be placed in this same category.[215]

Given that these figures lived in relatively democratic, but not peaceful societies—Puerto Rico has one of the highest rates of crime per capita in the United States—one might wonder what the contributing factor to their demise could be.

The use of medicine for political repression in Puerto Rico and the United States during the modern era, if true, would certainly not be a new phenomena in world history. While the latter can be easily accounted for by the dynamics of concentrated power of the absolutist monarchy, one may wonder how to precisely account for the questionable deaths of these political figures or public notables of the twentieth century.

As we have seen, the early deaths by poison for many a potential king were all too frequent during the medieval period. The very requisite of the Hippocratic Oath, to not use medicine to do harm, is itself an indicator that such had likely been the case and attests to the wisdom of Brandeis's observations. Yet, while a premodern physician might have attempted to kill an unwitting victim, the poor understanding of biology and medicine would have likely rendered many such efforts unsuccessful, and helps contextualize why its deadly use in the modern era is so morally shocking as it will have a far greater likelihood of success.

All patients have the expectoration that, given the efficacy of modern medicine, the physician is the closest guarantor of health that exists in the contemporary world. To then turn to this figure and be led to one's demise is an injustice tantamount to that which was portrayed in the "Red Wedding" episode of the television series "Game of Thrones", where a joyous wedding celebration was turned into the horrific bloodbath of nearly an entire family. The physician or his staff, which have traditionally held in abeyance akin to that of medieval saints, are transformed by such evil actions into modern demons.

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[215] The notion that his death might have been a purposeful assassination should not necessarily be discarded.

The work of Nelson Dennis sheds a clue as to its dynamics.

Pedro Albizu Campos's death has been well documented and explored by a number of scholars, whose work Dennis summarizes in some detail. The images of Albizu Campus resting on a bed with his grossly swollen legs traveled the world over and made everyone conscious of the injustices that were being perpetrated in Puerto Rico in the name of civilization and democracy.[216] Dennis documents that Albizu in his prison cell in Old San Juan had seen brief "flashes of lights", as if someone had turning on and off a machine located behind his prison wall; other prisoners experienced these painful lights as well, before developing similar biological symptoms of radiation exposure. In effect, Albizu had been turned into a guinea pig of ionizing radiation for the ends of political repression. In this, his fate would be similar to that of many other human guinea pigs who unknowingly participated in radiation experiments, well documented by Welsome.

What is relevant to our particular discussion, however, is the fact that the instrumentation used for this invisible torture was hidden behind a brick wall, so that representatives of U.S. government could plausibly deny its existence. Worst still, the authorities accused Albizu of suffering from psychiatric illnesses as schizophrenia by arguing that he had been 'seeing things' which did not exist—well aware of the falsity of this interpretation. Albizu's case clearly reveals the explicit intent to actively hide the existence of medical repression in a rather sadistic manner, which invalidated the authentic experiences and expressions of its victims' suffering, and their natural claims for due justice. In other words, medicine was used to kill precisely because it could so aptly hide the intent and manner of the killing, preventing the natural consequences of democracy from ocurring.

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[216] Albizu's political participation had taken a turn towards an active incitement for political change.

As in many geometric proofs, the use of a counterpoint is illustrative for these ends.[217]

The ease with which information can be diffused in the modern era plays a prominent role in these dynamics, particularly so as they occur within a democratic context. Consider a scenario where repression is done in the open. Were Albizu to have been zapped before potential witnesses would have created an immediate news cycle that would have spread throughout the world in an instant. This outcome, in turn, would have implied that the 'brand value' of any individual, government, or corporation implicated in these crimes would have collapsed to zero, aside from further considerations of being held criminally responsible for such acts. As Al Pachino's criminal mastermind exemplified throughout the entire movie "The Score" (2001), not being seen or identified allows the perpetrator to freely walk away without ever confronting the social consequences of his crime.[218]

In other words, the presence of sophisticated information technologies within a democratic political context implies that all such criminal acts of repression, be they politically motivated or not, would tend to be covered up in the most sophisticated manner, such that its their perpetrators will not be identified. As Justice Louis D. Brandeis noted, while men do not change, their circumstances do. Aware that such are the conditions under which they operate, the most sophisticated of criminal state actors will try to make it appear that the death of their unfortunate victims had arisen from natural causes, preemptively freeing

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[217] While cases as those of Cornelius Rhoads are suggestively similar, in that medical experimentation appears to have been done on Puerto Rican patients without their knowledge or consent, it is not relevant to our purposes because the intent of the procedures had apparently been for medical rather than political reasons.

[218] While Pachino's character places an emphasis on sight, with today's artificial intelligence, sound would also serve as a fingerprint to identify the perpetrator.

them from incarceration or execution that would occur otherwise.[219]

Presuming that the historical past is too far a 'distant country' can blind us to consistent historical patterns occurring about us. While Fernando Pico once asked how a power could emerge which would obtain so much influence so as to obtain the control over the life or death of a person, the medical implementation of this power over death is likely being used precisely to modify and change the balance of political power in a colonial setting. In other words, the power of death that modern medicine implies more often than not precedes the life of political power. The question then becomes one of the identification of the culprits.

There are two broad profiles which can be used to suggest possible candidates, akin to that which existed for Arecibo Observatory: those with the means, be they monetary or biological, to implement such outcomes and those with the strongest motivations to undertake such high-risk actions. In both cases, the historical actor that comes closest to the culprit profile would be the infamous 936 coalition, consisting of the pharmaceutical and banking industries of the island, as these still retain the greatest interest in the preservation of the status quo as well as the monetary and biological means of doing so.[220] Except for suggestive comments made by a radiohost, there is at the moment no conclusive and definitive evidence for such a claim, due in part to the nature of the criminal acts perpetrated.

Yet, if true, the use of medicine for political repression in Puerto Rico would constitute one of the most noxious examples

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[219] Perhaps Hollywood knows more than we give it credit, given that such scenarios have also been depicted in its plots, as in the case of various George Clooney movies as "Michael Clayton" or "Syrianna" .

[220] The cold blooded assassination of Doral banking executive Maurice Spagnoletti in 2011, shot in the head while sitting in his car during a traffic jam, suggests a far bolder attitude in the banking industry than that which is usually presumed.

in which science impacts democracy, undermining it and turning it into a marionette of ulterior purposes other than the popular general will. The egregious abuses within the context of such substantive disparities of power between the two would constitute another example tantamount to national pedophilia. It goes without saying that such an injustice would also constitute a justification for the immediate elimination of Puerto Rico's colonial status, as its existence breaches the most fundamental rights elucidated by Thomas Jefferson: the right to life, liberty, and the pursuit of happiness.

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Index

936 tax law, 274, 276, 277, 278, 279, 283, 341
abolitionism, 187
absolute laws, 140
absolute truths, 44, 90
Academia de Bellas Letras, 27
Academia de Lincei, 184
Academie des Sciences, 38, 82, 85, 113, 127, 149, 150, 151, 152, 170, 315
Acosta, Eduardo Eugenio, 17
Acosta, Juan Euclides, 17
Actimmune, 273
Adam, son of God (Bible), 72
Adams, Abigail, 119
Adams, John, 97, 105, 116, 119
adjoint, 150
aether, 54, 102
Africa, 173, 180, 250, 281, 314
  Cape Verde Islands, 314
Air Force Cambridge Research Labs, 286
Air Force Office of Aerospace Research, 286
aircraft carrier, 307
Alianza Pro Libre Asociación Soberana (ALAS), 336
All Saints Day, 154
Alvarado, Manuel, 336
American Fair Trade League, 255
ammonia synthesis, 243, 247
Anaxmines, 53
Anderson, Benedict, 214
anglophilism, 206, 209
anthropology, 78, 159

apadrinado, 317
Apollo lunar missions, 297
aquila non capit muscos, 177
Arab, 20, 85
aristocracy, see also patrician, noble, 134, 156, 234
Aristotelism, 52, 54, 55, 60, 61, 90, 146, 173, 222
Aristotle, 52, 53, 54, 55, 58, 82, 88, 145, 172, 225
Arnat, 19
ascriptive hiearchy, 84, 213, 242
Asia, 79, 173, 281, 361
  Cambodia, 214, 215
  China, 35, 45, 110, 174, 178, 179, 180, 201, 217, 238, 249, 269, 279, 332, 335
  Fiji, 318, 319
  Hong Kong, 35, 201, 217, 332
  Philippines, 244, 245
  Russia, 116, 218, 285
  Singapore, 216, 313
  Vietnam, 214, 249
Asian tigers, 269
astrology, 155
Atlantic Ocean, 197
Autoridad de Comunicaciones, 268
Autoridad de Energía Eléctrica, 272
Autoridad de Fuentes Fluviales, 268
Aztecs, 10, 86, 90, 91, 92, 93, 94, 330, 332, 346
Bacon, Francis, 25, 61, 62, 102, 162
Baker, Polly, 112
Banco de Desarrollo, 268
Banco Popular de Puerto, 276, 344
Bancroft, Edward, 106
banking industry, 116, 194, 197, 207, 252, 276, 277, 327, 341
bankruptcy, 123, 280
Banks, Sir Joseph, 99, 176
Barceló, Carlos Romero, 276
Baroque, 165, 177
Bastille, 134, 135
Batista, Fulgencio, 135
battery, 101
Battle of Saratoga, 107
benzene, 272
Berrios, Ruben, 192, 276, 281, 296
Berthollet, Claude Louis, 168, 170, 315
Bezos, Jeff, 261, 264
big science, 12, 180
Bill of Rights, 119
binary pulsar system, 298
Black Legend, also *Leyenda Negra*, 24, 182, 248
blasphemy, 188
blockade, 306
Bolivar, Simon, 189, 359
Bonaparte, Napoleon, 23, 40, 157
Bond, James, 32, 107

Books and other
Almanaque Aguinaldo, 227
America, 30, 70, 100, 108, 110, 116, 117, 124, 128, 130, 159, 172, 182, 208, 252, 256, 262, 267, 332, 345, 348, 350, 354, 355, 356, 359, 361
Art of Virtue, 111, 358
Asuntos de Puerto Rico, 209
Avanze, 337
Bible, 21, 25, 41, 126, 173
Biblioteca Histórica de Puerto Rico, 18, 188, 227
Boletin Mercantil, 199
Bulletin (Arecibo Observatory), 291
Candide, 113, 154, 360
Ciencia y Política, 29, 228
Ciencias y Tecnología en Puerto Rico, 228
Columbian Exchange, 173, 347
Cosmos, 131
Crónicas de Michoacan, 64
Das Kapital, 43
De Civie, 63
Declaration of the Rights of Man, 136
Dictionary of Scientific Biography, 24
Discourse on the Sciences and Arts, 128
Divine Comedy, 234, 343
Educación científica de la mujer, 13
Emile, 139
Encyclopedie, 24, 85
End of History, 36, 349
Epochs of Nature, 126
Experiments and Observations on Electricity, 98
Exposición Universal de Paris, 205
Fashionable Nonsense, 161
First Discourse, 128, 139
General History of the Air, 75
Hamlet, 19
Histoire Naturelle, 115, 127
Historia General de Puerto Rico, 189, 357
Historia Geográfica, Civil y Natural de la Isla de Puerto Rico, 227
History of the Peloponnesian War, 222
History of Western Philosophy, 163, 359
Horas en prisión, 8
Iliad, 61
Journal of the History of Ideas, 164, 346, 359

Julie o Nouvelle Heloise, 47
La Gazeta, 8, 207
Letters on Botany, 142
Leviathan, 63, 326, 352
Lord of the Flies, 144
Los Naturalistas en la América Latina, 228
MacBeth, 19
Meditations, 62
Memoirs of the Natural History of the Blood, 75
Mercure de France, 128
Notes on the State of Virginia, 124
Observations on Natural History, 86
Odyssey, 61
On the Law of Nature and Nations, 71
On the Law of War and Peace, 71
Optics, 86, 102
Origin of Inequality, 128, 142
Origin of Species, 98, 205, 206
Patriarcha, 59, 72
Persian Letters, 85
Philosophical Transactions, 20
Principia, 12, 61, 75, 76, 81, 86, 102, 118, 159, 345, 359
Puritanism and the Rise of Modern Science The Merton Thesis, 41
Rape of Lucrecia, 81
Ratio Studorium, 23
Religion and Decline of Magic, 296
Reveries of a Solitary Walker, 143
Roberto d'Evreux, 17
Scale The Universal Laws of Life, Growth, and Death in Organisms, Cities, and Companies, 129
Sciencia Nuova, 43
Scientific Survey of Puerto Rico, 228, 230
Second Treatise of Government, 71, 355
Social Contract, 139
Social Text, 161
Spirit of the Laws, 78, 81, 83, 87, 127, 356
Spring of Air, 74
System de la Nature, 155
The Discovery of Time, 162
The Newtonian System of the World, the Best Model of Government, 56
Two Cultures and The Scientific Revolution, 240, 359
Two Treatise of Government, 70

Viaje a la Isla de Puerto Rico en el año 1797, 227
Boone, Davy, 107
Bordeaux Academy of Sciences, 84, 98, 159
Bose, Louis, 151
Boseman, Chadwick, 91
botanical gardens, 175
Boyle, Robert, 62, 74, 75, 86, 88, 348
Brahe, Tycho, 168, 184
Brandeis brief, 255, 256
Brandeis, Louis D., 87, 250, 252, 253, 254, 255, 256, 257, 258, 259, 261, 264, 279, 325, 338, 340, 345, 360
Brau, Salvador, 188, 189
Breuilly, John, 212
British Empire, 93, 100
British Imperialism, 93, 100
British Privy Council, 109
Britton, Nathaniel, 228
Brode, William, 30
Bruno, Giordano, 172
Buckley Jr., William F., 251
Buffon, Georges-Louis Leclerc, 21, 99, 114, 115, 116, 117, 119, 121, 124, 125, 126, 127, 128, 130, 132, 142, 144, 153, 154, 177, 208, 249, 301, 315, 316
Bugge, Thomas, 168, 170
bureaucracy, 251, 305
Caesar, see also Emperor, 81
Calabria earthquake of 1783, 154
calcium phosphate, 193
Caldas, Francisco José de, 182, 183, 189, 227
Calderon, Sila María, 336
caliphs, 175
Cámara de Comercio, 277
Campos, Albizu, 11, 211, 219, 250, 339
Canada, 105, 209
canal systems, 182
capital goods industries, 269
capital intensive industries, 277, 278
capitalism, 12, 69, 234, 237, 253, 254, 268, 320
carbon dioxide, 273
Caribbean, 1, 19, 33, 68, 72, 116, 175, 203, 280, 283, 294, 301, 308, 311, 312, 314, 322, 324, 334, 354, 361
  Bahamas, 314
  Barbados, 68, 314
  Bermuda, 68
  Cuba, 174, 198, 199, 202, 222, 244, 281, 301, 308, 324
  Dominican Republic, 7, 32, 72, 204, 207, 248, 294, 308
  Eastern Antillies, 301
  Guadeloupe, 105, 301
  Haiti, 32, 175, 247, 294
  Hispanic Antilles, 324

Jamaica, 68, 308, 318, 319
Montserrat, 301
Navassa, 247
St. Marín, 301
St. Vincent, 301
Caribbean Basin Initiative, 283
Carlitos Colón, 51
Carnot, Sadi, 84
Carr, Raymond, 292, 296, 320, 345
Carter, Jimmy, 283
Casa de Contratación, 26
Castro, Fidel, 8, 16, 135, 195, 202, 208, 227, 337, 344, 347
Catholic Church, see also Catholicism, 23, 24, 26, 39, 52, 54, 55, 57, 59, 63, 69, 121, 126, 128, 134, 146, 147, 172, 185, 223, 273, 326, 331
Catholic convents, 70, 121
Cavendish, Margaret, 143, 145
Center for Radiophysics & Space Research, 289
Central Aguirre, 271
Centro para Estudios Energéticos y Ambientales, 229
CEO, 236, 260, 261
Cerezo, Benny Frankie, 337
Chincah Islands, 247
cholera, 229
Christianity, 172
cinchona, 174
Citizens United, 236
civil rights, 187, 200, 258
civilization, 64, 65, 93, 94, 142, 144, 192, 333, 339
Clairaut, Alexis, 38
Clavius, Christopher, 23
Clooney, George, 341
Clusius, Carolus, 175
COINTELPRO, 47
Colbert, Jean Baptiste, 149
Cold War, 219, 240, 267, 277, 285, 286, 290, 291, 292, 297, 298, 300, 307, 333, 350, 352, 361
Colegio Romano, 23
Collado Schwartz, Angel, 313
Collinson, Peter, 113
Colón Martínez, Noel, 337
colonialism, 35, 108, 109, 128, 175, 185, 202, 212, 215, 218, 242, 257, 281, 284, 285, 290, 291, 292, 293, 300, 325, 332, 333, 334, 335
Columbus, Christopher, 92, 188
commonwealth, see also *Estado Libre Asociado*, 11, 209, 211, 219, 267, 281, 282, 283, 284, 292, 321
Communist Revolution, 148
Compontes (Puerto Rico), 210
Concept

acclimatization (biological), 178, 179, 221
appropriate technology, 180, 323
autocracy, see also despotism, 13, 46, 78, 216, 278, 279
autonomism, 8, 198, 209, 335
avarice, 234, 235, 238, 261, 264, 265, 266
axioms, 63, 81
bicameralism, 83
bounded liberty, see also social reciprocity, 79, 80, 88, 110, 113
branches of power
  executive, 32, 147, 209, 341
  judiciary, 77, 209
cameralism, 178
cognitive dissonance, 258
common frame of reference, 47
concentration of power, 61, 78, 84, 109, 148, 187, 204, 215, 219, 236, 263, 277, 287, 333, 341
confidentiality, 28, 317
contractualism, 156
crooked timber of humanity, 80
cult of nature, 155
culture of fear, 35, 56, 63, 80, 131, 165, 211, 240, 257, 293
degeneration, theory of (Buffon), 114, 116, 124, 126, 128, 132, 159, 315, 316
enclave, 32, 333
enlightened despotism, 38, 140
equality, 64, 68, 78, 79, 80, 84, 116, 120, 159, 232
equality of wealth, 84
factions, 262
general will, 83, 140, 141, 142, 147, 148, 342
Golden Rule, see also Principle of Reciprocity, 6, 65, 68, 131, 254
great chain of being, 58, 59, 221
happiness, 69, 80, 87, 113, 114, 122, 145, 223, 342
human rights, 39
imagined communities, 214
industrial absolutism, 257
industrial democracy, 254
industrial mimicry, 267
insular dwarfism, 304
insular gigantism, 304
laissez faire, see also physiocracy, 140
law of gravity, 55, 68, 76, 102, 122, 123

Matthew Effect, 41
monsters, 37, 53, 54
moral hazard, 235, 258
moral persons, 71
natural law, 64, 65, 67
network effects, 41, 302
republicanism, 38, 80, 119, 155, 348
novelty, 25, 172
outsourcing, 237, 238
Pareto Curve, 41
physiocracy, see also laissez faire, 107
plenitude, 58, 59
power law, 302
Principle of Reciprocity, also Golden Rule, 6, 23, 49, 65, 66, 67, 88, 141, 142, 222, 254, 322, 326
rationalism, 14, 39, 40, 44, 61, 88, 114, 221, 226
rationalization of government, 318
repression, 10, 37, 57, 135, 159, 185, 186, 202, 207, 208, 210, 212, 222, 223, 224, 227, 247, 335, 338, 339, 340, 341
republicanism
Agricultural, 119
self fulfilling prophecy, 41
separation of powers, 77, 88, 159, 209
separatism, 199
small state, 41, 105, 160, 180, 216, 217, 249, 301, 303, 304, 305, 306, 307, 315, 316, 318, 319, 320, 321, 323, 332, 333
sovereignty, 9, 10, 11, 12, 13, 60, 69, 71, 88, 89, 100, 101, 104, 108, 109, 131, 136, 142, 153, 155, 186, 187, 221, 224, 249, 271, 277, 278, 301, 303, 324, 325, 331, 332, 333, 352, 353
standardization of parts, 245
state of nature, 63, 68, 89, 144, 153, 155, 156
state of war, 63, 64, 65, 67, 72, 74
sublime, 192, 296
techno structures, 275, 276
teleology, 146, 147
theodicy, 154
tyranny, 9, 40, 79, 114, 123, 141, 156, 240, 326
unicameralism, 96, 97
unintended consequences, 41, 191
violence, 35, 47, 64, 65, 71, 72, 129, 135, 136, 153, 156, 159, 222, 239, 330
virtue, 12, 13, 73, 78, 79, 85, 88, 107, 110, 111,

116, 117, 119, 120, 129, 142, 155, 266
weeds, 137, 145, 272
wisdom of the crowd, 124, 242
Concpet
caciquismo, 28
cork trees, 146
regeneration, 105
Condorcet, Marie-Jean Antoine Nicholas de Caritat, 38, 42, 83, 99, 135, 140, 147, 152, 158, 170, 204
Congress, 114, 248, 263, 277, 283
Consejo de Indias, 174
Constitutional Convention (France), 140
Constitutional Convention (U.S.), 96, 148, 156
Coolidge, Calvin, 252
Cooper, James Feynmore, 247
Copenhagen observatory, 168
Copernicus, 26, 55, 61, 91, 184, 191
CORCO, 270
Cordero, Rafael, 16
Corporation, 37, 87, 93, 137, 234, 235, 236, 241, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 263, 267, 269, 270, 271, 272, 276, 278, 333, 340
Amazon.com, 261
AMD, 275
Apple Co., 260
AT&T, 254
BASF Co., 21
Bayer Co., 21
Ford Co., 275
Glaxo Smith Kline, 273
GM, 254
Johnson & Johnson Co., 274
Monsanto Co., 47, 230, 270, 272, 273
NeXT, 260
Novratis Co., 274
NUPLEX, 272
Pfizer Co., 274
Philips Puerto Rico Core Co., 272
Phillips Co., 270, 272
Phillips Paraxlyne Co., 272
Pixar, 260
RCA, 47
SmithKline French Pharmaceuticals, 273
Twitter, 45, 260
Union Carbide, 270
Corruption, 56, 78, 208
bribery, 110
Holmes , Elizabeth, 237
Madoff, Bernie, 237
nepotism, 317
poison, 129, 338
Ponzi scheme, 237
spying, 47, 105, 106, 107
Theranos, 237
Corrutpion

political persecution, 321
Cortés, Hernando, 86, 91, 202, 347
Counter Reformation, 23, 224
Covid19, 6, 45, 48, 73, 239, 241, 279
Cox, Minnie, 250
Crab Nebula, 291
Creole, 16, 27, 152, 182, 183, 185, 188, 206, 215
Crusoe, Robinson, 192
Cruz Monclova, Lidio, 347
Cruz, Ted, 241
Cuban Revolution, 135
currency, see also money, 116
Cuvier, Georges, 21, 22, 40, 127, 135, 151
Da Vinci, Leonardo, 91
Dante, 234, 343
Danton, Georges, 133, 155
Darwin, Charles, 31, 40, 41, 43, 58, 98, 105, 130, 205, 206, 209, 222, 239
Davy, Humphrey, 99, 107, 168
de Condillac, Etienne Bonnot, 19
de Linden, Dr. Van. See also John Locke, 73
de Paw, Cornelius, 128
Declaration of Independence, 69, 96, 121
Deconstructivism, 238
del Monte, Domingo, 188
Delessert, Madam, 142
Delgado Rodriguez, Luis A., 336
Democracy, 6, 9, 10, 11, 12, 13, 14, 16, 30, 33, 35, 36, 39, 40, 42, 44, 48, 69, 70, 73, 77, 78, 80, 91, 92, 97, 110, 113, 124, 127, 131, 141, 147, 152, 158, 159, 222, 240, 241, 251, 254, 261, 262, 264, 276, 301, 325, 326, 327, 330, 331, 333, 339, 342
Denis, Nelson, 98, 347
Department of Defens Advanced Research Projects Agency, 286
dependency theory, 30
Derrida, Jacques, 161
Desaguilers, John Theodosius, 55
Descartes, Rene, 63, 165
Descartes, René, 19, 61, 62, 63, 86, 127
despotism, 7, 40, 77, 79, 80, 190
Dewey, John, 70, 90, 261, 262, 263, 264, 267, 315, 348
Diderot, Denis, 85, 98, 125, 128, 141, 326
Discorides, 172
Dorsey, Jack, 260
double flowers, 145
Doyle, Robert, 241
Durant, Rafael, 270, 348
dyes, 21, 106

Earth, 2, 21, 22, 26, 55, 72, 83, 92, 122, 123, 126, 148, 298
earthquakes, 104, 153, 314
economics, 12, 21, 28, 32, 36, 37, 41, 51, 73, 83, 84, 87, 98, 114, 117, 119, 137, 174, 178, 179, 180, 181, 185, 193, 194, 195, 198, 205, 206, 210, 213, 215, 216, 217, 218, 219, 220, 221, 235, 236, 240, 247, 248, 252, 253, 256, 258, 263, 266, 267, 268, 269, 270, 276, 278, 279, 280, 283, 287, 293, 294, 300, 304, 306, 313, 314, 316, 317, 320, 322, 323, 332, 333, 334
Education, 16, 17, 18, 19, 22, 23, 38, 42, 51, 78, 79, 118, 120, 124, 131, 147, 158, 163, 170, 179, 191, 192, 196, 213, 214, 219, 220, 239, 317
  Brown University, 225
  Cambridge University, 45, 62, 123, 184, 345, 346, 347, 348, 349, 351, 352, 353, 358, 359, 360
  colegios (Jesuit), 23, 174
  College of William and Mary, 118
  Columbia University, 40, 164
  Committee on Public Instruction, 135
  Cordero, Rafael, 16, 17
  Cornell University, 225, 290, 296, 346, 356, 358
  écoles nacionales, 170
  elementary school, 124
  Escuela de Rafael Cordero, 16, 17
  Florida State University, 290
  Harvard University, 211, 219, 225, 248, 253, 345, 353
  Johns Hopkins University, 189, 225, 350
  Princeton University, 291, 344, 350, 352, 353, 356
  revolutionary *écoles*', 170
  UNAM (Mexico), 291
  university, 7, 18, 124, 158, 164, 178, 184, 192, 225, 227, 289, 291, 293, 318, 320
  University of Madrid, 18, 188
  University of Pennsylvania, 158
  University of Puerto Rico, 120, 202, 290, 291, 336
  University of Virginia, 158, 358
  University of Wisconsin, 225
  Yale University, 255
Egypt, 249
Einstein, Albert, 12, 42, 55, 97, 125, 244, 298
Eisenhower, Dwight D., 240

ELA mejorado, see also *Estado Libre Asociado*, 321
electoral college, 262
electric fluid, 101
electrical corpuscles, 103
electricity, 96, 99, 101, 103, 110, 113, 125, 130, 152, 250, 268, 272
electronics, 255, 269, 289
Ellul , Jacques, 213
emblematic natural history, 176
Empedocles, 54
Emperor, 93, 175, 261, 326
empiricism, 23, 52, 56, 61, 62, 76, 88, 128, 130, 172, 194, 242, 259, 301, 305, 316
enhanced commonwealth, 321
Enlightened Despotism, 38, 140
Enlightenment, 19, 38, 42, 44, 46, 67, 101, 113, 128, 138, 139, 212, 215, 345, 349, 352, 353, 355, 358, 359
entrepreneur, 259, 260
Erasmus, Desideius, 91
Estado Libre Asociado, see also commonwealth, 11, 29, 211, 219, 267, 321
ethics, 155, 265
Euclid, see also geometry, 60, 330
eurocentrism, 163, 183
Europe, 8, 9, 16, 17, 18, 19, 22, 25, 27, 51, 56, 61, 62, 84, 85, 90, 115, 125, 130, 173, 175, 184, 185, 188, 189, 196, 197, 205, 209, 226, 227, 228, 254, 313, 346, 347, 348, 352, 353, 358
  Denmark, 116, 168
  England, 9, 14, 20, 21, 22, 25, 56, 62, 63, 69, 70, 73, 79, 80, 85, 96, 99, 100, 109, 110, 118, 137, 143, 146, 176, 187, 199, 206, 226, 248, 290, 291, 315, 326, 348, 360
    London, 76, 187, 193, 315, 343, 345, 348, 349, 353, 356, 357, 360
  France, 8, 9, 13, 17, 21, 24, 40, 45, 63, 79, 83, 84, 96, 97, 98, 99, 100, 104, 105, 106, 107, 108, 109, 115, 119, 120, 121, 127, 128, 133, 134, 135, 136, 137, 140, 146, 148, 149, 150, 159, 168, 169, 170, 171, 175, 185, 187, 192, 221, 223, 226, 270, 315, 347, 348, 350
    Avignon, 133
    Bordeaux, 78, 84, 98, 159, 170

Calonne, 136
La Brede, 78
Paris, 62, 85, 97, 98, 119, 134, 135, 139, 140, 143, 150, 151, 155, 168, 170, 187, 205, 315, 351
Passy, 98, 115
Versailles, 137
Germany, 7, 9, 21, 22, 40, 42, 45, 176, 187, 192, 226, 243, 244, 247, 280, 348, 352
Berlin, 42, 187, 212, 344
Greece, 91, 129
Holland, see also Netherlands, 63, 72, 73, 76, 143
Ireland, 109, 217, 248, 332, 343
Italy, 24, 173, 176
Florence, 60, 257
Rome, 77, 80, 81, 129, 197, 261, 326
Venice, 24, 141
Netherlands, see also Holland, 25, 291
Poland, 184
Portugal, 22
Prussia, 134
Spain, 8, 9, 16, 17, 18, 19, 21, 22, 23, 24, 25, 26, 27, 28, 35, 36, 37, 69, 87, 99, 130, 174, 175, 182, 184, 185, 186, 187, 188, 190, 195, 196, 198, 199, 207, 214, 221, 222, 223, 224, 226, 247, 331, 332, 343, 348
Andalusia, 175
Cadiz, 197
Madrid, 203, 343, 345, 347, 354, 357
Seville, 174
Sweden, 177, 178, 179, 218, 221, 307
Switzerland, 143, 306
Geneva, 139
Eurpe
England
London, 76, 187, 193, 315, 343, 345, 348, 349, 353, 356, 357, 360
exogenous companies, 267
exotic plants, 145, 175
experimental stations, 175
experimentalism, 23, 52, 56, 57, 62, 88, 92, 99, 101, 102, 151, 175
experts, 263, 305, 318, 320
export dependency, 314
Exrahi , Yaron, 241
externalities, 237, 270, 304
extra constitutional debt, 274
fake news, 241
famine, 178, 265
famines, 9, 84, 138, 140, 178, 239, 334
Farber, Paul, 226
farmers, 119, 263

Federal Communications Commission, 251
Federal Reserve Bank, 276
Federalism, 100
Feminism, 68, 83, 90, 119, 134, 164, 255, 256, 257, 312
ferias, 27, 191
Fernández, Juan, 30, 32, 190
Ferrer, Hector, 336
Ferris, Timothy, 11, 36, 66, 139, 242, 330, 331, 349
fertilizer, 192, 243
fertilizers, 192, 243
feudaism, 78
Fiestas de San Juan, 17
filibusteros, 200
Filmer, Robert, 59, 72
fireworks, 180
FOMENTO, 268, 270
food, 173, 243, 265
Food Drug Administration, 251
forest, 143, 144, 145, 162
Fort Allen, 283
fossils, 22, 34, 85
Fourcroy, Antoine Francois, comte de, 168
Francophilism, 223
Franklin, Benjamin, 22, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 115, 116, 117, 118, 119, 121, 122, 124, 125, 128, 134, 148, 155, 158, 159, 200, 201, 202, 222, 236, 248, 261, 270, 327, 328, 332, 345, 346, 350, 351, 352, 355, 356, 358
Franklin, William (son), 101
French Revolution, 38, 40, 83, 98, 108, 119, 127, 129, 133, 135, 136, 138, 139, 149, 152, 153, 155, 156, 159, 168, 170, 204, 211, 234, 323, 330, 334, 345, 348, 349, 350, 351, 353, 356, 362
friendship, 107, 198
Fuchs, Leonard, 176
Fukuyama, Francis, 36, 349
Furtado, Celso, 30
Galbraith, John Kenneth, 251, 275, 349
Galilei, Galileo, 23, 24, 31, 60, 61, 88, 184, 197, 205, 349
Gallisá, Carlos, 273
Gandhi, Mahatma, 94, 249
García Padilla, Alejandro, 335
Garden of Eden, 175
gasoline, 129, 247
Gassendi, Pierre, 61, 62
Gates, Bill, 236, 307
Gautier Dapena, José A., 202, 349
GDP, 36, 274, 301, 312
Gellner , Ernest, 213, 349
General Macedo, 7
Gessner, Conrad, 176
ginger, 174, 175, 248
Gingrich, Newt, 278

Ginsberg, Ruther Bader, 77
Girondist, 133
Glacier massacre of 1792, 133
Glass, Noah, 260
global warming, 241, 298
GNP, 274, 299, 307, 334
God, 60, 63, 104, 112, 122, 123, 125, 134, 146, 154, 172
Goethe, Johan Wolfgang von, 146, 154
Gore, Al, 241
government bonds, 117
Great Plague, 75
Greeks, Ancient, 25, 56, 61, 163, 246
Green Bank Observatory, 290, 291, 297
Gregorian reflector, 299
Grito de Lares, 8, 18, 28, 203, 204
Grotius, Hugo, 71, 72
Grusky, Sara Lynn, 276, 351
guano, 192, 193, 246, 247
Guano Islands Act, 247
Gutenberg, Johannes, 46
Haber process, 243
Haber, Clara. See also Clara Immerwahr, 243
Haber, Fritz, 243, 244, 247
hacendados, 194
Hales, Stephen, 99
Hamilton, Alexander, 116, 117
Harding, Warren, 252, 350
heliocentrism, 26, 55
Hemmings, Sally, 120
heresy, 59
Hernández Colón, Rafael, 274
Hernández, Francisco, 183
Herschel, John, 125
Hetcher, Michael, 212
Hippocratic Oath, 338
Hispanic American War, see also Spanish American War, 7, 22, 245, 332
history of science, 14, 20, 21, 24, 29, 30, 31, 33, 34, 41, 75, 89, 99, 139, 162, 163, 164, 177, 186, 189, 200, 202, 222, 225, 226, 228, 229, 230, 231, 232, 281, 337
  Brickmont, Jean, 161, 162, 165, 166
  Butterfield, Herbert, 226
  Cohen, I. B., 55, 114, 226, 345
  Comte, Auguste, 21, 38, 99, 204, 301
  Conrad, Goeffrey W., 91, 93, 176, 346
  Crosby, Alfred, 173
  Debus, Allen, 226
  Demarest, Arthur A., 91, 93, 346
  Dobbs, Betty Jo, 226
  Voltaire, 19, 46, 82, 113, 116, 128, 140, 154, 360, 361
  George Basalla, 180, 281

Glick, Thomas, 153, 182, 215, 350
Goodfield, June, 162, 226
Grainger, Thomas H., 230, 231, 351
Hall, A. R., 226
Hall, Marie Boas, 226
Haskins, Caryl P., 136, 180, 301, 323, 351
Herf, Jeffrey, 42, 351
Herrera, Amilcar, 30
Immerwahr, Daniel, 243
Israel, Jonathan, 147, 352
Jacobs, Margaret, 14
Jasanoff, Sheila, 276, 353
Koyre, Alexandre, 173, 226
Layton, Edwin, 226
Lovejoy, Arthur, 58, 164
Maienschein, Jane, 231, 355
Mayr , Ernst, 231, 355
Merton, Robert K., 11, 37, 38, 40, 41, 240, 356, 361
Mumford, Lewis, 213
Nicholson, Marjorie Hope, 164
Osler, Margaret J., 337
Russell, Bertrand, 41, 105, 163, 230, 298, 359
Sarton, George, 225
Science and Literature, 164
Shapiro, Alan, 102
Shils, Edward A., 240, 359, 361
Simonton, Dean Keath, 41
Snow, C.P., 240
Sokal, Alan, 161, 162, 165, 166
Spragens Jr., Thomas A., 60, 360
Taine, Hippolyte, 139
Thomas, Keith, 283, 296
Toulmin, Steven, 162, 226
Wang, Jessica, 11, 240, 242, 353, 354, 361
Weber, Max, 318
Yates, Frances, 226
Hitler, Adolf, 40, 247
Ho Chi Min, 249
Hobbes, Thomas, 11, 13, 58, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 71, 72, 73, 77, 79, 81, 88, 89, 90, 110, 143, 144, 326, 330, 351, 352, 356, 358, 360
Hobsbawm, Eric, 211, 214
homo sapiens, 177, 264
Hoover, Herbert, 252
House of Lords (England), 70, 84, 100, 108
Hroch , Miroslav, 211, 212, 216, 217, 218, 352
Huguenots, 57
Hulse, Russell, 298
human capital, 181, 249, 269, 278
human sacrifice, 90, 92
Humboldt, Alexander von, 130, 131, 189, 192, 209, 227, 355, 358

Hume, David, 86, 146, 355, 360
Hurricane María, 66, 133
hurricanes, 314
Hutton, James, 21
Huygens, Christiaan, 76
hybrids (plant), 145
hydrological cycle, 144
hypothesis non fingo, 102
Iberia. See also Spain, 22, 25
ideology, 10, 11, 37, 47, 92, 93, 94, 104, 116, 128, 140, 148, 185, 298, 330
Idol of the Marketplace, 162
imbalance of payments, 30
Immerwahr, Clara. See also Clara Haber, 243
impeachment, 47
imperialism, 211, 212, 248, 332
import substitution, 178
Incas, 93, 346
Incunabula, 46
Independentista, 281, 320
Index of Prohibited Books, 80, 224
Indian mounds, 121
Industrial Revolution, 22, 56, 118, 347
inertia, 92
information gathering, 305
innovation, 27, 61, 150, 235, 236, 240, 317, 323, 333
Inquisition, 60, 80, 165, 185, 200, 223, 224
institutionalization, 149, 175, 228
Insular Cases, 32, 248, 277, 332, 333
intelligentsia, 238
internal markets, 194
ionosphere, 285, 286, 298
Iroquois Confederation, 110
Isaac Newton, 51, 186, 226
Isidore of Seville, 172
Jacobins, 133
Jardin du Roi, 115, 127
Jefferson, Martha, 118, 120
Jefferson, Thomas, 7, 22, 39, 69, 83, 96, 105, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 130, 131, 134, 142, 148, 158, 159, 202, 208, 209, 222, 223, 231, 236, 251, 255, 261, 317, 327, 328, 342, 344, 346, 348, 358, 361
Jesuits, 19, 23, 24, 26, 174, 189, 224, 331
Jim Crow laws, 249, 250
Jobs, Steve, 237, 259, 260
Johnston, Bennet, 277
joint stock company, 235
joint stocks company, 235
Jordan, Michael, 214
Jordell Bank Observatory, 286, 290, 297
jornaleros, 206
Junta de Control Ambiental, 272
Junta de Planificación, 268
Jupiter, 61, 168
Kalm, Peter, 179

Kant, Immanuel, 80, 116, 128, 146, 192
Kardeck, Alan, 296
Karst, 297
Kelley, Florence, 257
Kepler, Johannes, 61, 184, 200, 227
Kew Gardens, 176
kingship, see also monarchy or monarchs, 10, 56, 57, 59, 62, 72, 85, 93, 99, 104, 127, 140, 150, 155, 174, 177, 326, 338
Kloppenberg, James, 6, 69, 328, 353
knowledge intensive economy, 289
labor intensive industries, 267
Lalande, Joseph Jerome, 170
Lamarck, Jean Baptiste, 127, 150, 151
Laplace, Pierre Simon, 24, 126, 315
las Casas, Bartolomé de, 24
Latin, 12, 13, 19, 23, 24, 30, 32, 63, 131, 132, 143, 153, 159, 163, 178, 179, 182, 184, 186, 189, 191, 192, 202, 203, 208, 214, 222, 224, 230, 248, 270, 288, 291, 312, 346, 350, 354, 355, 356, 361
Latin America
  Argentina, 204, 312
  Brazil, 226, 291, 312
  Chile, 13, 192, 288, 312
  Guiana, 106
  Mexico
    Yucatan, 287
  Mexico, see also New Spain, 17, 21, 93, 226, 230, 287, 291, 312, 353, 360
  Panama, 32, 245
  Peru, 24, 192, 247
  Venezuela, 199, 204, 312, 344
Latin America, see also Spanish America, 12, 13, 19, 23, 24, 30, 32, 131, 153, 159, 178, 179, 182, 184, 186, 189, 191, 192, 202, 203, 208, 214, 222, 224, 230, 248, 270, 288, 291, 312, 346, 350, 354, 355, 356, 361
Lavoisier, Antoine Laurent, 21, 38, 40, 126, 135, 150, 151, 152, 169, 170, 315
law, 118, 133, 187, 194, 197, 208, 211, 231, 235, 236, 246, 248, 253, 255, 256, 257, 258, 259, 271, 273, 277, 332, 333, 337, 356
law of gravity, 22, 24, 44, 56, 82, 86, 102, 121, 122, 152, 183, 347
layering effect, 34
laziness, 206
Leblanc process, 169
lechón asado, 173
Ledru, André Pierre, 227, 228, 229, 354

Lee, Arthur, 105, 106, 348
Lefebvre, Georges, 139
Leibniz, Gottfried Wilhelm, 97, 125, 127, 154
Letelier, Valentin, 13
Leyenda Negra, see also Black Legend, 24
Leyes Especiales, 208
Liberal Democracy, 38
linguistics, 45, 121, 122, 217, 219
Linnaeus, Carolus, 142, 151, 172, 173, 177, 178, 179, 180, 238, 268, 323, 353
Lipset, Seymour Martin, 33
Lisbon earthquake of 1755, 153
Literature and Science, 165
little science, 12, 294
Locke, John, 60, 68, 69, 70, 72, 73, 74, 75, 76, 77, 79, 81, 88, 89, 110, 116, 122, 127, 209, 222, 328, 344, 345, 347, 348, 355, 358, 359, 360
Löfling, Pehr, 179
Lord Byron, 19
Lorenz, Hendrik Antoon, 42
Lugo, Elena, 229
Lyceum, 52
Lysenko, Trofrim, 9, 238, 239, 258
Madison, James, 119, 123, 262, 263, 346
magic, 74, 101, 103, 269, 283
magnetism, 101
Mahan, Alfred T., 245
mammalian, 177
Manson, Patrick, 201
manufacturing, 170, 192, 237, 238, 244, 267, 269, 278
Mao Zedong, 249
maps, 214
Marat, Jean Paul, 152
Marie Antoinette, 134
Martinez Vergne, Teresita, 187, 337
Marxism, 38, 40, 43, 44, 234, 238
Max Plank, 42
mechanism, 23, 66, 80, 82, 92
Mellon, Andrew, 252
Mendez y Pelayo, Marcelino, 25
Mercury, 286
Meritocracy, 120, 150, 213, 317
Mersenne, Marin, 61, 62, 63
Mesmer, Franz Anton, 155
mesmerism, 154, 155
Mesoamerica, 86
metropolis, 101, 198, 206, 215, 224, 282, 284, 285, 287, 288, 290, 291, 292, 293, 294, 316
Middle class, 78, 252, 253
military, 7, 10, 18, 25, 37, 81, 97, 98, 100, 107, 108, 115, 164, 169, 170, 171, 209, 223, 238, 240, 245, 270, 286, 290, 298, 300,

306, 307, 331, 332, 333, 352
military industrial complex, 240
milk, 206, 288
Millstone Hill Observatory, 290, 297
mimicry industrialization, 272
minimum wage law, 269
Miranda Marin, William, 335, 336
Mis Memorias, 9, 18, 360
MIT Lincoln Laboratory, 289
mobility, 262
Modern Language Association, 165
modern societies, 212
modernity, 46, 194, 212, 334
monarchism, see also kingship, 8, 10, 26, 37, 59, 72, 78, 80, 81, 108, 135, 136, 140, 149, 152, 155, 185, 195, 196, 234, 257, 331, 338
monarchs
Catherine the Great, 98, 126
Charles I, 62, 64, 69
Charles II, 69
George III, 99
James II, 70
Louis XIV, 57, 69, 134, 353
Louis XV, 98, 100, 103, 104, 134, 137, 141
Louis XVI, 98, 100, 103, 104, 134, 137
Maximilian II, 175
Queen Elizabeth, 25
Queen Isabel, 33, 37, 190, 229, 351
Rudolf, 175
Sun King, see also Louis XIV, 137, 149
William of Orange, 69
monarchy, see also kingship, 8, 10, 26, 59, 72, 78, 80, 81, 108, 135, 140, 149, 152, 155, 185, 195, 196, 234, 257, 331, 338
Monastic culture, 46, 149, 172
moneda macunada, see also money, currency, 207
money, 29, 41, 98, 106, 107, 112, 116, 117, 129, 192, 194, 235, 237, 254, 256, 270, 274, 276, 293, 318, 323
money, see also currency, 29, 41, 98, 106, 107, 112, 116, 117, 129, 192, 194, 235, 237, 254, 256, 270, 274, 276, 293, 318, 323
Monge, Gaspard, 168
Monopolies, see also trusts, 210, 257
Montaigne, Charles Louis de Secondat, 19, 64
Montaigne, Michel, 19, 64
Montards, 133

Montesquieu, Charles Louis de Secondat, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 98, 110, 127, 131, 159, 170, 209, 222, 223, 241, 344, 353, 356, 359
monuments, 214
moose, 115
morality, see also virtue, 110, 119, 128, 145, 146, 147
Moret, Daniel, 139
Morgan, J. P., 87, 250, 251, 252, 256, 258
Morvilliers, Nicholas Masson de, 24, 25
Moscoso, Teodoro, 174, 270, 356
motion, 52, 54, 60, 62, 66
motor car racing, 262
Movie
Movimiento Victoria Ciudadana (MVC), 320, 321
Muir, John, 144, 250
Muller v. Oregon, 255, 256, 257
Muñoz Marín, Luis, 211, 270, 276
Muñoz Rivera, Luis, 206, 209
Museum of Natural History, 127
museums, 214
mustard gas, 244
Myalept, 273
nacionalistas esquizofrénicos, 296
Nair, Tom, 212
nationalism, 9, 10, 183, 211, 212, 213, 214, 215, 217, 242, 292, 332
Native American Indian, 114, 121, 144
natural disasters, 137, 314
natural philosophy, 10, 23, 26, 56, 61, 79, 88, 92, 93, 103, 150, 330
natural rights, 141, 156, 209
Naval Research Lab, 291
Navigation Acts of 1663, 109
Nazi, 134, 163, 194
Negrón, Mara, 336
Neoliberalism, 140, 238, 268, 278
Nero Claudius, 261, 264
newspapers, 8, 18, 45, 46, 97, 199, 203, 206, 209, 214, 251
Newton, Isaac, 12, 14, 31, 38, 43, 45, 51, 52, 55, 56, 57, 61, 72, 75, 76, 81, 82, 86, 88, 97, 101, 102, 113, 118, 122, 123, 127, 184, 186, 191, 205, 206, 222, 344, 345, 347, 359
Newtonianism, 14, 55, 56, 57, 76, 81, 122, 221
nitrogen, 192, 193, 243, 246, 247
Nixon, Richard, 47
Nobel Prize, 22, 298

nobility, see also aristocracy, 78, 134, 136, 137, 139, 148, 156, 238
Noriega, David, 336
North America, see also United States, 12, 98, 100, 101, 108, 132, 159, 164, 223, 240, 268, 296, 332
Norzagaray, Fernando, 190
Notre Dame Cathedral, 192
nous, 53
Nye, Joseph, 115, 357
nylon, 272
objectivity, 11, 240, 317
Oldenburg, Secretary Royal Society, 74
Olivares, Gaspar de Guzmán, 22
Operation Bootstrap, 267
Oppenheimer, Robert, 289
orchard, 145
orrery, 122
Ortega y Gassett, José, 25
Oviedo, Gonzalo Fernández de, 37
oxygen, 20
Pachino, Al, 340
pacifist, 208
Pahlow, Edwin, 240
pamphlets, 168, 169
paraffin, 272
Parmenides, 53
Partido Autonomista, 209
Partido Dignidad, 320
Partido Incondicional, 7
Partido Independentista Puertorriqueño (PIP), 29, 276, 281, 337
Partido Liberal, 187, 205, 206, 208, 209, 210, 344
Partido Nuevo Progresista (PNP), 29, 198, 268, 274, 276, 320
Partido Popular Democrático (PPD), 29, 198, 268, 274, 276, 320, 335, 336, 337
Partido Socialista Puertorriqueño, 273
patents, 129, 150, 308, 311
Patman, Wright, 251, 252
Patrician, see also Noble, Aristocracy, 84, 141, 178, 214, 215
Pauli, Wolfgang, 222
pedagogy, 196
pendulum, 123, 163, 230
Penn, William, 69, 108
pensionaires, 150
periphery, 215, 282, 285, 288, 292, 294
petrochemical companies, 271
petrochemical industry, 269
petroleum, 244, 270, 284
Pezuela, Juan de la, 17, 19, 191
pharmaceutical industry, 271, 272, 273, 274, 275, 276, 277, 280, 284, 333, 341
philosophes, 140

philosophy, 21, 38, 54, 55, 60, 61, 63, 65, 66, 88, 91, 93, 106, 111, 123, 138, 142, 144, 155, 162, 164, 165, 238, 246, 316, 330, 351
Picó, Fernando, 189
pillars of Hercules, 25
Pinchot, Gideon, 250
pitiyanki, 319
plague, 29, 76, 197
Plan de Ponce, 209, 222, 344
Plato, 53, 147, 182
plebeian, see also poverty, 81
Pliny the Elder, 173
poetry, 128, 198
polémica de la ciencia española, 24
polémica, also *leyenda negra*, Black Legend, 24, 25
political party, 39, 187, 262, 273, 276, 278
political status, 29, 217, 220, 248, 276, 277, 284, 287, 293, 320, 321
politics, 9, 11, 14, 29, 31, 44, 57, 59, 60, 61, 67, 76, 78, 92, 114, 115, 118, 130, 134, 158, 186, 195, 206, 214, 215, 219, 235, 238, 262, 263, 275, 277, 278, 281, 282, 285, 292, 293, 294, 313, 331, 336, 346, 351
Pol-Pot, 215
polygamy, 83
polyp, 105
Pomeranz, Kenneth, 94, 358
Pope Innocent III, 172
Pope, Alexander, 55
Popper, Karl, 44
popular sovereignty, see also Democracy, 10, 187
positive law, 156
Positivism, 228, 229
Postmodernism, 39, 44, 46, 90, 238
potassium, 99, 169, 192, 246
potato, 137, 173, 239
poverty, see also plebeian, 78, 84, 105, 109, 117, 175, 208, 294, 333
premodern societies, 212
Pre-Socratic philosophy, 53
Price, Don K., 240
Prim, Juan, 18
Pringle, Joseph, 99
printing press, 20, 25, 45, 46, 112, 199, 200
Proceres, 8, 9, 13, 36, 202, 223
Acosta, José Julian, 8, 9, 13, 16, 17, 18, 27, 32, 34, 35, 37, 158, 186, 187, 188, 189, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 205, 206, 207, 208, 209, 222, 223, 227, 246,

247, 256, 298, 331, 343, 355, 358, 359, 360
Albizu Campos, Carlos, 11, 211, 219, 248, 250, 339, 340
Baldorioty de Castro, Ramón, 8, 9, 13, 16, 17, 18, 27, 32, 34, 35, 36, 100, 158, 187, 188, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 202, 205, 206, 207, 208, 209, 210, 222, 223, 227, 246, 247, 256, 298, 331, 344, 347, 349, 361
Betances, Ramón Emeterio, 6, 8, 9, 18, 128, 188, 202, 203, 204, 208, 222, 318, 331, 357
Elizaburu, Manuel, 200
Hostos, Eugenio María de, 13, 203, 204, 324, 331, 334, 352, 357
Martínez Fernández , Padre Rufo, 20, 158, 190, 196, 197, 200, 331
Micault, Eduardo, 195, 196
Nuñez, Julian, 195, 196
Ruiz Belvis, Segundo, 18, 28, 188, 345
Stahl, Agustin, 7, 9, 13, 17, 193, 205, 222, 345
Tapia y Rivera, Alejandro, 9, 16, 17, 18, 19, 20, 27, 28, 30, 32, 35, 36, 37, 101, 188, 200, 202, 207, 220, 222, 227, 358, 360
professionalization, 149
proofs, 52, 60, 63, 72, 102, 206, 340
propaganda, 104, 114, 116, 117, 126, 130, 298
Protestantism, 19, 23, 41, 69, 172, 185, 223, 224, 273, 319
Puerto Rico, 1, 3, 7, 8, 9, 11, 13, 14, 16, 17, 18, 19, 21, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 41, 51, 58, 66, 72, 77, 78, 120, 131, 132, 133, 138, 141, 143, 148, 158, 171, 173, 174, 182, 183, 186, 187, 188, 189, 190, 192, 193, 194, 196, 197, 198, 199, 200, 202, 203, 204, 205, 207, 208, 210, 211, 216, 218, 219, 221, 222, 223, 224, 227, 228, 229, 230, 231, 244, 245, 246, 248, 266, 267, 268, 269, 270, 271, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 285, 287, 288, 289, 291, 292, 293, 296, 297, 299, 300, 301, 306, 307, 308, 313, 314, 317, 318, 319, 321, 322, 323, 324, 325, 331, 332, 333, 334, 335, 336, 337, 338, 339,

341, 343, 344, 345, 346, 347, 349, 351, 352, 354, 355, 356, 357, 358, 360, 361
Aguirre State Forest, 271
Arecibo, 2, 32, 281, 282, 285, 288, 290, 292, 293, 296, 297, 298, 299, 300, 306, 341, 346, 350, 356
Bayamon, 7, 8, 205
Caguas, 268, 336
Campo Santiago, 245
Cataño, 7
Cuevas de Camuy, 292
El Morro, 198, 210
El Yunque, 292
Fort Buchanan, 245
Guayama, 273
Isabela, 271
Jobos Bay, 271, 272
Manati, 206
Mayagüez, 28, 276, 306
Mona Island, 192, 206, 246, 247
Nigua River, 271
Ponce, 196, 206, 209, 271, 344
Ramey Air Force Base, 245, 289, 297
Roosevelt Roads, 245
Sabana Seca, 245
Salinas, 271, 272, 273
San Juan, 7, 16, 17, 188, 206, 289, 297, 306, 339, 343, 344, 345, 346, 347, 348, 349, 352, 354, 355, 357, 358, 360, 361
Vieques, 192, 245
Puerto Rico books
Bell Book & Candle, 34
Borders, 34
Tekes, 34
Puerto Rico Education
Ateneo Puertorriqueño, 200, 344, 346
Colegio Central, 32, 190, 219
Escuela filotécnica, 8
Instituto Civil de Segunda Enseñanza, 199
Seminario Conciliar, 20, 198
Puerto Rico history of science
Bagué, Jaime, 228
Becerra de Weierich, Isabel, 33, 229
Bonnet Jr., Juan, 29, 30, 31, 32, 34, 82, 199, 228, 271, 338, 344
Brock, Darryl E., 230
Chardón, Carlos E., 205, 228
Fernández, Juan., 30, 32, 190
Fernós, Rodrigo, 1, 92, 181, 185, 205, 229, 349
González, Libia, 229
León Díaz, Victor de, 34, 229
Lugo, Miriam, 230

Rigau, José, 229
Rios, Carmelo, 47
Vega Lugo, Ramonita, 229
Puerto Rico science
Abbad y Lasierra, Iñigo, 34, 58, 59, 131, 188, 227, 228, 343
Ackerman, James, 301, 358
Agriculture Department of Puerto Rico. also *Departamento de Agricultura de Puerto Rico*, 29, 228
Arecibo Observatory, 2, 32, 281, 282, 285, 288, 290, 292, 296, 297, 298, 299, 300, 341, 346, 356
Bótica de Babel, 199, 200
Centro para Estudios Energéticos y Ambientales, 229
Corporación para la Transformación Tecnológica, 32
Departamento de Agricultura de Puerto Rico, also Agriculture Department of Puerto Rico, 33
Gordon, W. E., 285, 289, 298, 350
Pantoja, Carmen, 291
Pettengill, Gordon, 289
Ramirez, Alonso, 26, 87
Sociedad Económica Amigos del País, 27
Sociedades Patrióticas, 190
Subdelegación de Farmacia, 190, 195
TROPICO, 32
Puerto Rico technology
Puerto Rico Telephone Company, 268, 337
Tren Urbano, 299
Pufendorf, Samuel, 71, 72
pulsars, 286, 298
Puritanism, 41
Putin, Vladimir, 44, 239
Pythagoras, 53
Pythagorean theorem, see also geometry, 63
Qutb, Sayyid, 249
Ramon y Cajal, Santiago, 22
Ramos Lara, María de la Paz, 182, 215
Rangel, Charles B., 283
Ray, John, 172
Raynal, Abbe, 115, 128
Reagan, Ronald, 241, 283
red shift survey, 291
refrigeration, 265
Reign of Terror, 134
Renaissance, 91, 172
Republic, see also Republicanism, 72, 77, 79, 80, 81, 119, 131, 135, 156, 245, 248, 263
Republican party, 278
Resident Commissioner, 283

revolution, 21, 22, 27, 39, 40, 44, 45, 55, 60, 83, 88, 100, 101, 107, 108, 121, 123, 125, 134, 136, 138, 139, 140, 152, 153, 208, 222, 245, 332
Rios, Palmira, 120
Rittenhouse, David, 122, 123
Robespierre, Maximilien Francois, 133, 142, 147, 148, 149, 353
Roman Catholic Church, See also Catholic Church, 74, 197
Roman Empire, 16, 74, 81, 156, 175, 197, 227, 344
Romanticism, 19, 42
romero, 173
Roosevelt, Teddy, 248, 250
Root, Elihu, 236, 280
Rosselló, Pedro, 274, 278, 305, 323
Rostow, Walt, 136, 180, 218
Roundup, 272
Rousseau, Jean Jacques, 12, 46, 69, 84, 107, 128, 129, 134, 139, 141, 142, 143, 144, 145, 146, 147, 148, 155, 158, 177, 244, 346, 348, 351, 355, 356, 358
Royal African Company, 68
Royal Society of London, 27, 56, 62, 74, 75, 86, 99, 106, 113, 184, 315, 345, 348
rubber, 148, 247
Ruiz y Pavón, 24
Russia, 9, 98, 126, 164, 175, 218, 219
Sagan, Carl, 32
saltpeter, 96, 168, 169
Sanz, José Laureano, 17, 207
savant, 169
schizophrenia, 292, 296, 339
scholasticism, 23, 56, 102, 183, 184
science
  agriculture, 105, 144, 191, 192, 193, 213, 246, 284
  amateur science, 125
  archeology, 125, 126
  astronomy, 26, 52, 55, 58, 92, 93, 162, 168, 170, 172, 183, 191, 200, 222, 289, 290, 292, 300
    cosmology, 52, 90, 222
  biology, 22, 26, 40, 52, 53, 58, 80, 82, 85, 88, 93, 105, 125, 127, 136, 147, 162, 173, 174, 176, 177, 193, 204, 205, 206, 226, 231, 237, 238, 304, 305, 323, 338, 339, 341
    genetics, 9, 121, 146, 238
    taxonomy, 151, 173, 177, 183
  botany, 142, 143, 145, 148, 158, 183, 191, 205, 229, 346
  chemistry, 20, 21, 40, 42, 99, 126, 135, 162, 165,

169, 179, 192, 193, 199, 205, 211, 219, 225, 226, 231, 243, 247, 248, 272, 278, 323
ecology, 82, 146
electrochemistry, 99
genetics, 9, 121, 146, 238
geography, 24, 26, 83, 191, 200, 216, 222, 249, 301
geology, 22, 34, 85, 125, 126, 148
mathematics, 21, 23, 26, 44, 58, 62, 76, 83, 92, 118, 125, 127, 128, 200, 219, 315
geometry, 60, 63, 88, 102, 140, 330, 340
statistics, 127, 206, 255, 256, 312, 326
medicine, 7, 53, 75, 82, 85, 88, 111, 149, 150, 229, 230, 237, 255, 273, 331, 337, 338, 339, 340, 341
meteorology, 75, 111, 192
mineralogy, 148
natural history, 7, 34, 37, 53, 58, 59, 121, 127, 130, 148, 151, 153, 175, 177, 179, 184, 199, 205, 330
neurology, 22
oceanography, 121, 148, 197, 245, 286, 298, 314
parasitology, 201
pharmacy, 18
physics, 22, 24, 42, 44, 52, 54, 55, 56, 58, 83, 113, 127, 129, 145, 148, 151, 161, 169, 180, 183, 199, 204, 205, 221, 222, 231, 289
quantum physics, 22, 42, 44, 138, 221, 222
thermodynamics, 84
science policy, 29, 30, 321, 322, 323
Science Research Council of Jamaica, 322
Scientific Revolution, 42, 82, 125, 177, 180, 221, 223, 230
Scottish Enlightenment, see also Enlightenment, 86, 118
Second World War, see also World War II, 39, 211, 225, 228, 240
Securities Exchange Commission, 237
Securities Industry Association, 277
Seilhamer, Larry, 274
Seminario de Minería, 182
September Massacre of 1792, 134
Seven Years War, 100, 105, 107, 137
Shaftsbury, Lord, 72, 73, 76
Shakespeare. William, 19, 161
shamansim, 174

Sherman Antitrust Act, 257, 258
Shultz, George, 237
Sigüenza y Góngora, Carlos, 26, 354
silk, 178, 179
Sir Walter Scott, 19
situado, 17, 334
Sky and Telescope, 290
slavery, 8, 10, 56, 87, 128, 159, 187, 194, 206, 250, 256, 325, 327, 328
Sloane, Sir Hans, 56
Slovay Congresses, 42
Small Business Bureau of Puerto Rico, 28
small state, 41, 105, 160, 180, 216, 217, 249, 301, 303, 304, 305, 306, 307, 315, 316, 318, 319, 320, 321, 323, 332, 333
Small, William, 118
smallness theory, 316
smallpox, see also *viruela*, 195
smallpox, see *viruela*, 195
Smeaton, John, 56
Smith, Adam, 38, 86, 116, 124, 253
social statistics, 38, 83, 135, 141
Socialism, 40
Sociedad Recolectora de Documentos Históricos de la Isla de San Juan Bautista de Puerto Rico, see also *Proceres*, 18, 35, 188, 202
Societé Linee, 151
sociology, 40, 78, 215, 264, 356
sociology of science, 40
Socrates, 129, 182
soda ash, 169
Sokal affair, 161
South America, see also Spanish America, Latin Ameirca, 45, 130
space race, 285, 297
Spagnoletti, Maurice, 341
Spanish America
  New Granada, 182, 350
  New Grenada, also Colombia, 183
  New Spain, see also Mexico, 17, 26, 86, 183
Spanish America, see also Latin America, 24, 87, 130, 131, 132, 166, 183, 187, 192, 214, 350, 353, 362
Spanish American War, see also Hispanic American War, 187
spiritualism, 296
Sputnik, 297
squaring the circle, 62
St. Aquinas, 22
St. Augustine, 22
St. Hillarie, Geoffrey, 127
St. Just, 148
St. Thomas (Virgin Islands), 19, 23

Stalin, Joseph, 9, 148, 238, 239, 258, 328
statehood, see also annexation, 198
stockholders, 259
Strato, 52
sugar, 106, 174, 175, 193, 196, 219, 271, 284, 307
suicide, 244
Sun Yat Sen, 58, 201, 206
surfing, see also oceanography, 197
Swedish Academy of Sciences, 178
Swift, Taylor, 237
Sydenhman, Thomas, 200
synthetic nitrogen, 243, 247, 248
synthetic products, 243, 247, 248
taxation, 93, 136, 267, 274, 275, 276, 277, 278, 279, 283, 333, 341
Taylor, Joseph, 237, 298, 360
tea, 178
technological change, 230, 244, 261
technology, 22, 29, 42, 47, 86, 91, 118, 160, 180, 181, 198, 200, 213, 214, 225, 226, 230, 231, 232, 244, 246, 249, 262, 267, 275, 282, 290, 291, 308, 317, 331, 332, 335
  agriculture, 105, 144, 191, 192, 193, 213, 246, 284
  aspirin, 21
  barometer, 200
  biotechnology, 147
  cell phones, 160, 197
  communications, 20, 197, 291
  engineering, 22, 26, 105, 108, 251
  flint, 86
  Ford Mustang, 275
  hornilla de evaporación, 206
  ice-making machine, 19
  lightning rod, 96, 99, 133
  microscope, 22, 143
  Model T, 275
  navegation compass, 25, 87, 180
  navigation, 6, 26, 197
  pneumatic engine, 75
  printing press, 20, 25, 45, 46, 112, 199, 200
  radio, 44, 117, 214, 285, 286, 288, 297
  sail boat, 66, 282
  smartphones, see also cell phones, 197
  smelting, 169
  steam engine, 22, 118
  steel, 169, 238, 245, 250, 327
  telecommunications, 324
  telegraph, 19, 268
  telephone, 200, 268, 282, 308
  television, 44, 47, 66, 326, 338

transportation, 118, 190, 250, 256
teleology, 54, 146
territories, 37, 125, 222, 244, 245, 246, 277, 324
tertulias, 34, 199
Thales, 53
Theophrastus, 172
theosophy, 296
Thomism, 26, 222
Thomson, David, 38, 39, 40, 43, 235, 240, 262, 360
Thucydides, 222
Thurmond, Strom, 280
tiendita, 194
toleration of religion, 222
toluene, 272
tomato, 173
Tony Stark, 118
Torres, Jose Arsenio, 117, 337
Tournefort, Joseph Pitton de, 176
Toynbee, Anrold, 48, 88, 258, 270
Trabulse, Elias, 21, 226, 230, 360
Trump, Donald, 47, 48, 73, 77, 120, 164, 241, 306
trusts, see also monopolies, 250, 257
Tugwell, Rexford, 267, 268, 344
Turgot, Anne Robert Jacques, 99, 107, 140
U.S. Constitution, 47, 97, 119, 124, 147, 277, 284, 328
U.S. Federal Reserve, 252
U.S. Founding Fathers, 12, 96, 97, 117, 118, 235, 236, 261, 263, 346
U.S. science
NIH, 33
NSF, 33
U.S. South, 249
U.S. Supreme Court, 77, 236, 252, 255, 257, 325
UN colonies, 277
UN Decolonization Committee, 277
Unamuno, Miguel de, 25
unemployment, 320
United Nations, 277, 281, 289, 361
United States, 9, 12, 13, 18, 22, 25, 30, 31, 33, 34, 40, 47, 72, 73, 77, 96, 97, 100, 107, 108, 116, 119, 120, 124, 130, 132, 136, 138, 147, 159, 164, 171, 178, 179, 180, 192, 202, 203, 204, 221, 222, 223, 225, 230, 234, 236, 239, 244, 245, 247, 248, 250, 251, 252, 253, 254, 255, 257, 262, 263, 269, 273, 276, 277, 278, 280, 281, 283, 284, 285, 287, 288, 289, 290, 291, 292, 293, 294, 296, 297, 298, 300, 307, 312, 319, 325, 327,

328, 331, 333, 335, 338, 339, 352, 353
Alabama, 291
California, 257, 318, 351, 354
Carolina, 68
Florida
Orlando, 72
Illinois, 257
Kansas, 250, 355
Louisiana, 257
Massachusetts, 70, 297, 328
Michigan, 257, 354
New Jersey, 101
New York, 47, 72, 203, 204, 249, 283, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362
New York City, 72
Oklahoma, 291
Pennsylvania, 69, 328
Philadelphia, 105, 107, 108
Texas, 187, 251, 252
Virginia, 116, 130, 257, 297
Washington, 18, 39, 48, 98, 257, 276, 283, 356
West Virginia, 290, 291
university, 9, 14, 18, 21, 23, 64, 73, 76, 120, 158, 163, 164, 178, 179, 184, 192, 225, 227, 239, 251, 289, 290, 291, 293, 320
urbanization, 70, 129, 229
USSR, see also Soviet Union, 286, 297, 300
Vavilov, Nikolia, 9, 238, 239
Ventura, Arnoldo K., 318, 320, 321, 322, 323, 361
Venus, 92, 290, 297, 298
vernacular, 63, 143, 178, 179
Vico, Giambattista, 43, 59, 81, 82
virtuosi (England), 74, 75
viruela, see smallpox, 195, 331
Vital, David, 303, 361
volcanoes, 153, 314
Vulnerability Index, 303, 304, 305, 313, 314
Wallis, Thomas, 62
Walter Mercado, 155
wars, 208, 247, 283
Washington, George, 18, 39, 48, 98, 257, 276, 283, 356
Watt, James, 22, 118
Wentworth, Paul, 100
West Point, 108
West, Geoffrey, 129, 315, 316
Western Canon, 163
Willis, Gary, 121, 122
Wilson, Woodrow, 249, 250, 251, 252, 253, 254
Wool Act of 1699, 109

World War I , also First World War, 25, 180, 252, 300, 333
World War II, also Second World War, 25, 42, 164, 169, 171, 180, 244, 245, 300, 306, 333
Wren, Christopher, 75
yautía, see also manioc, 173
Zúñiga, Diego Pedro de, 25

Science and Sovereignty

This book explores the impact of modern science on Western notions of sovereignty and its extension and interpretation within the Hispanic world. While the Scientific Revolution richly contributed to innovations in political theory, influencing thinkers as Montesquieu, Locke, and Hobbes, the diffusion of these ideas to Puerto Rico would be held back by monarchical Spanish colonialism for nearly two centuries. The historical gap was of such an extent, that when modern science finally did arrive during the nineteenth century, its adoption and impact would be negligible. The changing political circumstances of the twentieth century, and the new world of corporate technology would also drastically impact its modern implementation in the tropical island.

About the Author

Rodrigo Fernós, Ph.D. teaches at the University of Puerto Rico, Rio Piedas. Some of his books include: Biology and Ethics (2018), Medicine and International Relations in the Caribbean (2006), and Science Still Born: The Rise and Impact of the Pan American Scientific Congresses, 1898-1916 (2003). He specializes in the relationship between metropolitan and colonial science.