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THE ECONOMICS OF TRADE LIBERALIZATION:  
CHARLES S. PEIRCE AND THE SPANISH TREATY OF 1884

BY

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AND

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CHOPE WORKING PAPER NO. 2017-11

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CENTER FOR THE  
HISTORY OF POLITICAL ECONOMY  
AT DUKE UNIVERSITY

# **The Economics of Trade Liberalization: Charles S. Peirce and the Spanish Treaty of 1884**

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## **Abstract**

In the 1870s and 1880s, the scientist, logician, and pragmatist philosopher Charles S. Peirce possessed an advanced knowledge of mathematical economics, having mastered and criticized Cournot as early as 1871. In 1884 he engaged in a multi-round debate with the editors of *The Nation* over the economics of trade liberalization in the case of a proposed trade treaty with Spain concerning import tariffs on Cuban and Puerto Rican sugar. The debate is reconstructed and related carefully both to Peirce's understanding of mathematical economics and to his philosophy of science.

**JEL codes:** B17, B16, F10, B31, B41

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## **The Economics of Trade Liberalization: Charles S. Peirce and the Spanish Treaty of 1884**

In the second decade of the new millennium, trade policy is in the forefront of American politics – *plus ça change*, . . . A hundred and thirty years earlier, opinions over trade policy were just as fiercely debated. Even the much deplored habits of partisanship and lack of intellectual engagement with those that we disagree with were as much in evidence then as now. In his famous essay, “The Fixation of Belief,” Charles Sanders Peirce (1839-1914) offers the following story to illustrate the *method of tenacity*, which he will contrast with the scientific method, for fixing belief:

I remember once being entreated not to read a certain newspaper lest it might change my opinion on free-trade. ‘Lest I might be entrapped by its fallacies and misstatements,’ was the form of expression. ‘You are not,’ my friend said, ‘a special student of political economy. You might, therefore, easily be deceived by fallacious arguments upon the subject. You might if you read this paper, be led to believe in protection. But you admit that free-trade is the true doctrine; and you do not wish to believe what is not true.’ [WP 3.249; also CP 5.377]<sup>1</sup>

Peirce is most famous as the founder of the American school of philosophy known as *pragmatism*. He was also a polymath – an important mathematician, logician, scientist, as well as, philosopher. And, as it turns out – though it is one of his least appreciated sides – Peirce *was* a special student of political economy; and in 1884 he applied his knowledge of economics in a public debate over a trade treaty between the United States

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<sup>1</sup> Following standard conventions among Peirce scholars, references to Peirce’s *Collected Papers* are generally indicated as “CP volume number.paragraph number” (e.g., “CP 6.289” = *Collected Papers* volume 6, paragraph 289). Some references are to larger divisions (e.g., chapters) and these are indicated explicitly (e.g., “CP 1, ch. 4.”) Similarly, some references to the *Collected Papers* are to material from editorial apparatus that is not divided into paragraphs, and these are indicated by volume and page number (e.g., “CP 8, p. 283”). References to the *Writings of Charles S Peirce* are given as “WP volume number.page number” (e.g., “WP 5.26” = *Writings* volume 5, page 26).

and Spain.<sup>2</sup> His intervention in the debate over the Spanish Treaty illustrates Peirce’s mastery of the most advanced economics of his era, showcasing its utility in clarifying questions of practical policy, and it provides a surprising economic case study of Peirce’s “model-based” philosophy of science.

### **1. The First American Mathematical Economist**

In 1871, Peirce was almost certainly the first mathematical economist in the United States. The most advanced mathematical economist in the world was the French mathematician, astronomer, and historian of science Antoine Augustin Cournot (1801-1877), who published his *Recherches sur les Principes Mathématiques de la Théorie des Richesses* in 1838. Over the next three decades very few people read Cournot’s masterwork. The first reviews appeared in 1857 and 1864 (Cherriman 1857 (see also Dimand 1995); de Fontenay 1864). And William Stanley Jevons and Leon Walras, the marginalist economists whose later regard for Cournot rescued his *Recherches* from obscurity, had yet to read the book. Peirce, in contrast, had not only read Cournot, he had mastered his analysis.<sup>3</sup>

Unlike Jevons and Walras, who, though central figures in the mathematization of economics, were not up to Cournot’s mathematical standard, Peirce was levels above Cournot. As we showed in an earlier article, Peirce not only mastered the *Recherches*, but gave a superior interpretation of Cournot’s analysis of market structure to the ones common in the literature and anticipated Bertrand’s (1883) criticism of Cournot’s analysis of duopoly by more than a decade.

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<sup>2</sup> Ketner and Putman (1992) provide a capsule summary of some of the key points; and Brent (1998) offers a full-scale biography.

<sup>3</sup> Wible and Hoover (2014) offers a detailed account of Peirce’s engagement with Cournot..

Peirce’s intellectual projects were highly varied, and economics was never his central focus; yet economics contributed important ideas to Peirce’s thinking on pragmatism, logic, and the philosophy of science. Nevertheless, the trade was not only one way. Peirce made two exemplary contributions to economic analysis: the first was his paper, “The Economy of Research” (1879; also WP vol. 7, ch. 2; WP 4.73-78), which was the most advanced application of mathematical economics to any applied problem up to that time; the second was an intervention in the public policy debate over a trade treaty with Spain in 1884 and 1885<sup>4</sup>. This intervention is our focus. Although the debate in the pages of *The Nation* was conducted in plain English – not in mathematics – we show that Peirce’s trenchant and precise analysis was grounded implicitly in his mastery of the economics of Cournot and Ricardo. It was mathematical in substance, if not in form.

Mathematics for Peirce was the most fundamental science, but its essence was its form of reasoning that was, at once, self-contained, working out the implications of arbitrary hypotheses according to rules supplied by mathematics itself, and also observational, formulating those hypotheses diagrammatically and investigating them in much the same manner as an empirical scientist would investigate objects in the world. (Peirce interpreted “diagram” broadly to embrace all kinds of mathematical representation (CP 4.233, Peirce 1898[1992], Lecture 3; also see Kettner and Putnam 1992, pp. 2-3, 68-71, 74-75). The essence of mathematics for Peirce is not its formalism but its method of reasoning. For Peirce, David Ricardo – even more than Cournot – represented the

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<sup>4</sup> A comparison of the roughly contemporaneous works represented in Darnell’s (1991) six edited volumes of early mathematical economics provides good evidence of the cutting-edge quality of Peirce’s “Economy of Research.” We are currently writing a book on Peirce’s engagement with economics. One chapter of that book will consider Peirce’s paper on the economy of research in detail, while a companion paper to this one addresses his analysis of Ricardian inference (Hoover and Wible 2017).

mathematical approach to economics, despite his unfamiliarity with the mathematician’s technical tools. Peirce went so far as to name to what he regarded as a fundamental form of mathematical reasoning the *Ricardian inference*.

While we have carefully investigated Peirce’s Ricardian inference elsewhere (Hoover and Wible 2017), it may be helpful to provide a brief sketch and to frame its relevance to the kind of economic analysis that Peirce offers of the Spanish Treaty. Exactly, how to interpret Peirce’s Ricardian inference is open to debate. One option identifies it with what Peirce referred to as the *primipostnumeral syllogism*, which is an inferential form analogous to mathematical induction (or what Peirce called *Fermatian inference*) but, unlike mathematical induction, applicable to uncountably infinite sets. A second option identifies Ricardian inference with what Peirce calls the *analytical method*. We believe that Peirce saw these two interpretations as deeply related to the point that, for him, they may ultimately be the same. Nonetheless, it is the aspect of Ricardian inference as the analytical method that most readily applies to his analysis of the Spanish Treaty.<sup>5</sup>

The analytical method for Peirce is  
to substitute for those problems others much simpler, much more abstract, of which there is a good prospect of finding probable solutions. Then, the reasonably certain solutions of these last problems will throw a light more or less clear upon more concrete problems which are in certain respects more interesting.

This method of procedure is that Analytic Method to which modern physics owes all its triumphs. It has also been applied with great success in psychical sciences also. (Thus, the classical political economists, especially Ricardo, pursued this method.)<sup>6</sup> [CP 1.63-64]

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<sup>5</sup> Parts of the remainder of this section are drawn verbatim from Hoover and Wible (2017, section 4).

<sup>6</sup> Weighing into contemporary debates among political economists over *Historismus* versus *a priori* methods (and anticipating debates between Institutionalists and neoclassical economists, Peirce goes on: the Analytical Method “is reprobated by the whole Hegelian army, who think it ought to be replaced by the ‘Historic Method,’ which studies complex problems in all their complexity, but which cannot boast any



Analogy is the core of the analytical method. Peirce divided inference into deduction, induction, and abduction. Deduction constitutes necessary reasoning. Abduction and induction are related to hypothetical reasoning – abduction introducing hypotheses and induction testing or precisifying them. The form of abduction is:

The surprising fact, C, is observed  
But if A were true, C would be a matter of course,  
Hence, there is reason to suspect that A is true. [CP 5.188]

Induction amounts either to the gathering of facts that refute an abductive hypothesis or to making measurements – especially statistical estimations – that help to pin down free parameters or otherwise lend greater precision to a hypothesis. Peirce's view is similar in some respects to Popper's (1963) logic of science as one of conjectures and refutations. There is, however, a key difference: where Popper denies that the origin of conjectures is a scientific matter at all, Peirce maintains that abduction has its own distinct logic.

Abduction and induction are cooperative forms of inference, with abduction setting the framework for inductions and inductions evaluating abductions. Peirce goes further and suggests that there is actually a fourth, hybrid form of inference, which he terms "analogy" that combines the character of abduction and induction (CP 1.65). It is analogy that forms the basis of the analytical method to which Peirce attributes so much scientific success in economics, as well as in the physical sciences. Peirce defines *analogy* as "the inference that a not very large collection of objects which agree in various respects may very likely agree in another respect" (CP 1.69).

What Peirce appears to have in mind is something closely akin to the way in which modern economists, as well as scientists in many other disciplines, employ models

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distinguished successes" (CP 1.64; cf. Keynes 1917, pp. 314-327; Robbins 1935, pp. 79-83, 1998, Lectures 25 and 26; Schumpeter 1954, ch. 4, part 2).

as inferential tools. Self-consciousness about modeling in any science is largely a post-World War II phenomenon. Earlier, the word “model” in the sciences almost always referred to physical representations such as an orrery or a patent model. Yet there is good reason to think that it is not anachronistic to see the concept of modeling in Peirce’s understanding of analogy as a distinct form of inference. Peirce takes *analogy* to be an English translation of Aristotle’s *παράδειγμα*, which is the etymological source of *paradigm*. “Paradigm” is, in the wake of Kuhn’s *Structure of Scientific Revolutions* (1962), widely used, but it was an obscure, largely grammatical term in Peirce’s day, and Peirce would not have invested it with Kuhnian resonances. According to the *Oxford English Dictionary*, the root word “*δειγμα* (*deigma*) designates a “sample [or] pattern,” while the prefix *παρά-* (*para-*) conveys the idea of “analogous or parallel to, but separate from or going beyond” that pattern. The word itself aptly conveys the strategy of analogical reasoning that Peirce attributed both to physics and to classical political economy and maps very nicely onto modern practices in which stripped down or idealized root models are elaborated successively to come closer to empirical observations while maintaining their underlying basic character and tractability.<sup>7</sup>

Peirce clarifies analogy as a mixed type of inference with an extended analysis of Kepler’s discovery of his laws of planetary motion: “the greatest piece of Retroductive reasoning ever performed” (CP 1.72-74, especially CP 1.74).<sup>8</sup> Kepler began with Copernicus’s hypothesis of the planets in circular orbits around the sun and Tycho Brahe’s and his own observations. The analogy was, if we can use the terminology anachronistically, between Kepler’s mathematical model, with its precise orbits, and the

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<sup>7</sup> On the history of models in economics, see Morgan (2012).

<sup>8</sup> Peirce uses “retroduction,” “hypothesis,” and sometimes “presumption” as synonyms for “abduction.”

actual observations. The analogy was not, at first a good one: the Copernican model fit the data rather badly. Out of keeping with Popper’s later methodological pronouncements, Kepler did not simply scrap Copernicus’s model. His procedure was not haphazard, but systematic and conservative, in the sense that at each new abductive step, he tried to preserve his quantitative success hitherto – that is, to stay within the bounds of error already achieved – and to use the specific ways in which the hypothesis fell short to suggest the next abductive step. Kepler’s own abductive contribution was to consider the dynamical implications of the sun, which he knew to be vastly larger than any of the planets and which he conjectured exercised some vaguely-defined causal power over them. Alternating abductions to introduce modifications and inductions to characterize the nature and degree of the deviations between conjecture and data, Kepler refined the model:

never modifying his theory capriciously, but always with a sound and rational motive for just the modification – of most striking simplicity and rationality – which exactly satisfies the observations, it stands upon a totally different logical footing from what it would if it had been struck out at random, or the reader knows not how, and had been found to satisfy the observation. [CP 1.74]

The analytical method for Peirce is largely the method of refining and precisifying analogies or, as a modern economist might put, a method of modeling.

## **2. The Spanish Treaty**

Peirce’s intervention in the debate over the tariff provisions of the Spanish Treaty provide us with one of the few illustrations of his actually engaging in economic analysis rather than discussing its scope and method. The debate was a reaction to an editorial in *The Nation*, a periodical founded in 1865 and still published today, to which Peirce was a frequent contributor of book reviews. Although Peirce, who was committed to free trade,

clearly favors the treaty, it is his positive, not normative, analysis that interests us. That analysis provides an example of Ricardian inference in practice. It is Ricardian inference under either interpretation of that term; for underlying Peirce’s analysis is an application of Cournot’s mathematical economics, with its reliance on the differential calculus, which is, Peirce tell us undergirded by the primipostnumeral syllogism; and it takes Cournot’s supply-and-demand model as its template and successively modifies it to address the issues raised by *The Nation*’s editors in the rounds of the debate.

*The Nation*, of course, was not an economics journal, and both its editors and Peirce frame the discussion in ordinary language, not in the formal apparatus of Cournot’s economics. We will nonetheless engage in a rational reconstruction of Peirce’s analysis that will display a pattern of analogical reasoning less momentous, but of the same kind as the pattern that he attributed to Kepler. The reconstruction does not in any material way distort history; for the connection of Peirce’s reasoning to Cournot’s is transparent to the most casual observer, and the underlying invocation of calculus and the doctrine of infinitesimals is remarked on explicitly by his interlocutor at *The Nation*.

Before the ratification of the Thirteenth Amendment to the U.S. Constitution in 1913, which permitted the direct taxation of personal incomes, tariffs were the largest source of federal government revenue. Tariff policy was vastly important both to internal government finance and to international trade. Until the Treaty of Paris, which ended the Spanish-American War in 1898, Cuba and Puerto Rico were Spanish colonies and the principal suppliers of sugar to the United States. Starting in 1882, the U.S. government opened negotiations with Mexico, Santo Domingo, and Spain to establish commercial treaties with reciprocal trade agreements. President Chester Arthur observed in his fourth

state-of-the-union address that “[t]he countries of the American continent and the adjacent islands are, for the United States, the natural mart of supply and demand” (quoted in Foster 1885, pp. 55) A preliminary agreement, applying not to Spain itself, but only to Cuba and Puerto Rico, was signed in Madrid in January 1884, and negotiations were begun on a permanent treaty. The commercial convention was agreed in November 1884 and transmitted to the Senate for ratification on 1 December 1884. It is at this point that Peirce’s engagement begins.

*The Nation* in the 1880s, just as in the 21<sup>st</sup> century, was an organ of “liberal” opinion, although the nature of liberalism has changed radically over a century and a quarter. Liberals of the 1880s were acolytes of free trade. On this point – as a general proposition – Peirce and the editors of *The Nation* were in complete agreement. Yet, President Arthur’s commercial treaties, including the Spanish Treaty, were “very widely objected to as being hopelessly objectionable in their details, even by those who consider the principle of them sound” (Foster 1885, p. 55). The New York Free Trade Club published a report entitled “The Spanish Treaty Opposed to Tariff Reform” (Foster 1885, p. 55). On 11 December 1884, *The Nation* weighed in against:

If we are unable to approve of the treaty in its present shape, or in any shape in which it is likely to be presented, we are moved by no prejudice against reciprocity in general, or against the author [Minister John W. Foster] of the important negotiation now before the Senate. [*The Nation* 1884a, p.491]<sup>9</sup>

The bare facts of the trade, according to *The Nation* (1884a), were these: Cuba and Puerto Rico together supplied something more than half of the 2,300 million pounds

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<sup>9</sup> *The Writings of Charles S. Peirce* (WP 5.144-148) reprint Peirce’s exchange with the editors of *The Nation*, beginning with his first reply, but they do not reprint the original article that prompted the first reply.

of sugar imported into the United States with a value of \$91 million dollars.<sup>10</sup> The import duties on the sugar from the two islands raised between \$20 and \$25 million for the U.S. Treasury. The treaty sought to remove the tariff (about 2¢ per pound) on Cuban and Puerto Rican sugar in exchange for duty-free status for some American agricultural and manufacturing exports – many others remaining subject to substantial Spanish duties.

### 3. The Debate

#### 3.1. ROUND ONE

*The Nation* judged that the exchange of tariff relief was not symmetrical or fair: “What the treaty amounts to is a scheme to purchase a small market in the West Indies at a present cost of \$20,000,000 per annum and at a growing cost hereafter . . .,” which was too high a price to be regarded as wise policy. The central rationale behind *The Nation*’s objection to the treaty was their conclusion that, with respect to sugar itself, American consumers would reap no benefit whatsoever and that the benefits to increased exports of other goods were too small to offset the direct losses of sugar duties: “If so large a sacrifice of revenue is to be made by the Treasury, surely the consumers of sugar ought to reap a share of the benefit.” The key to their analysis is the following positive claim:

Sugar cannot be cheaper to American consumers so long as any portion of our supply comes from countries paying the tax. The Cuban planters will simply pocket the duty which would otherwise go into the Treasury of the United States. If an appropriation of \$20,000,000 per annum were made by law as a bonus to the Cuban planters, the effect would be the same.

It is this analysis that Peirce would challenge in a letter to the editor the next week (Peirce 1884; WP 5.144).

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<sup>10</sup> In constant 2012 dollars based on the consumer price index (CPI), this is the equivalent of \$2.2 billion. Sugar was a relatively more important part of consumption bundles in 1884. An equivalent share of per capita GDP would amount \$22.1 billion in 2012.

Peirce’s objected to *The Nation*’s claim that the consumers would not reap any benefit from the cut in tariffs on Cuban and Puerto Rican sugar so long as sugar was also imported from other countries that paid the full tariff. He poses three questions for the editors:

- First, given the profit advantage that they claim would accrue to the “Spanish ports” (i.e., the ports of Cuba and Puerto Rico), he asks would they not immediately increase their exports to the United States, even to the point of importing sugar from other countries for re-export?
- Second, would these additional exports of sugar not inevitably either a) reduce the price of sugar in the United States or b) displace sugar imported from countries without a tariff advantage?
- Third, if sugar exports were reduced from non-Spanish ports would not the land removed from sugar production be the “worst fitted” for sugar production leaving the “worst of the land then producing sugar for us . . . better than the worst of the land now doing so?” And would not, then, competition force the price to fall as a result?

Peirce’s interrogatory analysis is readily reconstructed in Cournot’s supply-and-demand paradigm. The textbook analysis that follows is commonplace in the 21<sup>st</sup> century, but would have been cutting-edge in 1884. Peirce conceptualizes the situation with as simple an analytical framework as will address the questions. Let us assume that there are two sugar suppliers, call them Cuba, standing for itself and Puerto Rico, and Manila, the capital of the Philippines. (The Philippines was another Spanish sugar-exporting colony, but one not subject to the reciprocity treaty.) Furthermore, suppose that there are no domestic American sugar producers. (In fact, as becomes noted in the exchange, Louisiana is at this time a minor sugar producer.) And suppose that Cuba and Manila produce only for export and export exclusively to the United States.

The left-hand panel of Figure 1 plots production exported through Manila as a function of the gross price (inclusive of the tariff) of sugar in the United States. The supply curve ( $S^M$ ) is upward sloping to reflect Peirce’s fundamentally Ricardian

assumption that land comes in qualities ranked from best to worst, in which the output of the best land will cover wages and profits at the lowest price, while each less productive unit of land can be brought into production only at a higher price adequate to cover the higher per unit costs of production.<sup>11</sup> The black supply curve ( $S^C$ ) in the center panel reflects the same situation in Cuba. Manila and Cuba are shown to have about the same supply curves, so that they divide the American market near equally, reflecting the *status quo ante* as reported by *The Nation*. The right-hand panel reflects both supply and demand in the American market. The black supply curve ( $S^{US}$ ) is the horizontal sum of the black supply curves for Manila and Cuba ( $S^M + S^C$ ).

The American market is completed by moving past Ricardo to introduce Cournot’s downward-sloping demand curve ( $D^{US}$ ). Equilibrium in the American market occurs at the point ( $Q_0^{US}, p_0$ ). At price  $p_0$ , the market is divided between Manila, producing  $Q_0^M$ , and Cuba,  $Q_0^C$ . Of course  $Q_0^{US} = Q_0^M + Q_0^C$ .

Peirce’s three questions are answered by considering the effect of a reduction in the tariff on Cuban sugar. After the reduction, the producer will make the same revenue net of the tariff at each level of production at a 2¢ lower price, which corresponds to a downward parallel shift of the Cuban supply curve to the gray curve ( $S^{C'}$ ). This results in an additional willingness to supply sugar to the United States at each gross price, resulting in a rightward shift of the U.S. supply curve to the gray curve ( $S^{US'}$ ) and a

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<sup>11</sup> Following Ricardo, Peirce recognizes two distinct, but logically similar margins. In the quotation immediately above, he refers to what modern economists refer to as the *intensive margin* – that is, to the increasingly smaller additions to output that result from the increasing use of inputs (labor, fertilizer, etc.). Elsewhere he refers to what modern economics the *extensive margin* – that is, to the increasingly smaller output that arises from bringing intrinsically and increasingly worse land into production. (CP 4.115; Ricardo 1821[1951], pp. 70-72). Here Peirce refers to the extensive margin.



movement of the equilibrium down and to the right to point  $(Q_1^{US}, p_1)$ . Each of the implied answers to Peirce’s rhetorical questions are affirmed;

- First, at the new price  $p_1$ , Cuban exports increase. (The model in this form does not address the question of re-export.)
- Second, the new price is indeed lower, so demand in the United States increases; and, at the lower price, supply from Manila decreases, so that sugar from Cuba has, in fact, displaced sugar from Manila.
- Third, since the supply curve rank-orders the productivity of the land from best at the bottom left to worst at the top right, the reduced supply from Manila implies that the worst land in production for export from Manila after the tariff cut is better than the worst land in production before the tariff cut.

### 3.2. ROUND TWO

The editor of *The Nation* delivered a reply hard on the heels of Peirce’s intervention in the same number of the magazine (*The Nation* 1884b; WP 5.144-146). The editor argued, first, that sugar must have the same price in the New York market, no matter its conditions of production. Second, that the planter in Manila and Cuba would both, therefore, receive the same revenue per pound, but the planter in Manila would have to cover the tariff out of that revenue while the planter in Cuba would not; but, in any case, the revenue would have to be high enough to cover the costs of the planter in Manila or else he simply would not ship sugar to New York at all. Third, if Cuba could supply all of the U.S. market and something more besides (i.e., if the Manila planters were shut out of the market by the price advantage of Cuban planters), then competition among Cuban planters would drive the price of sugar down in the New York market. But in the case in

which Cuba were unable to supply the whole market, then the balance of the imports must come from Manila (or other markets), and the price must be high enough to cover the tariff (or the sugar would not come at all). In that circumstance, the Cuban planters would feel no pressure to lower their prices and would pocket the full value of the tariff cut.

The editor then considers the actual situation in the U.S. markets. Some have suggested that Cuba and Puerto Rico together could supply the whole U.S. market. But, he argues, even if that were possible in 1884, the demand for sugar in the U.S. was growing rapidly and the available land in Cuba and Puerto Rico was finite, so that it would be unlikely that Cuba and Puerto Rico could monopolize the U.S. market, even in the near future. And in that circumstance, some sugar paying the tariff would be imported from Manila and other producers, “which would, by virtue of the economic law already stated, be the sign and evidence that American consumers were deriving no benefit from the treaty.”<sup>12</sup>

The editor answers Peirce’s third question by claiming that the considerations that it raises presume that the U.S. is the only export market for producers other than Cuba and Puerto Rico, so that lost demand translates into the idling of some land of inferior productivity and, therefore, raising the quality of the land at the margin of profitability, which is tantamount to lowering the costs of production at the margin. But, say the editors, in reality sugar is exported to other countries; Manila and other producers shut

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<sup>12</sup> The editor also answers Peirce’s re-export argument by pointing out that tariff relief applies only to sugar actually grown in Puerto Rico or Cuba. He acknowledges that Cubans could export the full amount of their own domestic consumption, replacing it by imported sugar for their own use; but, since their domestic market is small, that would add little to their duty-free export capacity. He also acknowledges, but minimizes, the possibility of cheating on re-export.

out of American markets would simply increase their exports to England and other markets, so that no increase of productivity and no reduction in costs would occur.

A fortnight later, *The Nation* published Peirce’s rejoinder to the editor’s reply (Peirce 1885). The editor’s argument, he noted, required that the tariff reduction result in an increase in exports from Cuba and Puerto Rico to the U.S. and a corresponding decrease from other countries completely offset by increased exports from those countries to other sugar importers, such as England. “But now I object,” says Peirce, “that a great volume of trade will not spontaneously divert itself from one market to another without any motive.” The relative price of sugar must change among importing countries if sugar is to be diverted from one market to another. If, as the editor had argued, the price will not fall in the United States, then it must rise in England; and, if it rises in England, then demand must fall in England, so that the amount of sugar exported from the countries other than Cuba and Puerto Rico would have to fall to some degree. Production would be diminished accordingly, and “somebody [would be] forced out of the sugar-growing business.” That could not happen if no prices in any market had fallen.

Peirce poses a dilemma. The first horn: if prices rise in the non-U.S. market (or fall in the U.S. market), then the suppliers other than Cuba and Puerto Rico must diminish production, reducing their supply price as inferior land is taken out of production; so, contrary to the editor’s assumption sugar, trade is not simply redirected from the U.S. to England. Second horn: if no prices change, then no demand is diverted, and Peirce’s original argument applies. Peirce asks, “How can you escape this dilemma?”

In the second paragraph of his letter to the editor, Peirce elaborates on the analytical foundation of his argument. He notes that sugar from countries other than Puerto Rico and Cuba are produced under a variety of conditions – some barely paying the cost of production, some highly profitable; some more profitable if sent to the United States than to England, some equally profitable to whichever market it is sent. If the proposed tariff reduction were to decrease the amount of sugar from these countries sent to the United States, the particular producers who would cease to ship to the United States would be those who are at the margin of profitability (i.e., those producers of sugar “which there is now scarce any inducement to ship here”). On *The Nation*’s own analysis, the diversion of this higher priced sugar would remove the rationale for keeping U.S. prices high. Peirce’s point is that *The Nation* maintains that if any non-tariff-advantaged producer is willing to ship to the United States, the price in the United States must cover all the costs, including the cost of the tariff. To which he says, yes, but that is true for the marginal unit shipped, for the unit for which the producer is indifferent whether he sends it or not. All the other producers – the ones with higher productivity whether in Cuba, Puerto Rico, or Manila – collect a Ricardian rent but do not affect the price, which is determined only by this point of indifference. The diversion of exports from the non-favored countries necessarily lowers the price at that point of indifference, and so necessarily lowers the price in the United States. The argument is pure Ricardo.

### 3.3. ROUND THREE

The editor of *The Nation* (1885) replied to Peirce’s second intervention: “We ‘escape this dilemma’ by the use of infinitesimals.” He concedes that, yes, Peirce is right that the price would have to fall in the United States in order to justify additional demand for

Cuban sugar. But he says, a tiny fall ( $1/32^{\text{nd}}$  of a cent per pound) “or even less” would be sufficient to secure the entire American market, and this tiny fall would be the outer limit of the price fall that would be observed. The editor pulls the number out of thin air and implies that the demand curve for sugar in the United States turns horizontal (becomes infinitely elastic) at a price ever so slightly below the current price – not impossible, but not grounded in any evidence or argument.

The editor failed to address the major point of the second paragraph of Peirce’s intervention, which is to reassert the lesson from the Ricardo’s theory of rent, that land will be drawn into production in order of its productivity and that costs of production, including cost such as tariffs and transportation, are related to price only for the marginal land. The editor acknowledges his failure: “Mr. Peirce’s second paragraph, he will permit us to say, carries us into the region of differential calculus beyond our depth.” “Quite so,” Peirce might have, but did not, reply – the correspondence ended with the editor’s having the last word and using that last word to resolve the dispute in his favor with the introduction *deus ex machina* of an unsupported factual claim.

#### **4. A Keplerian Strategy**

What is interesting for our purposes is Peirce’s dialectical strategy. His first letter offered an excellent example of his Analytical Method: a complex issue in international trade was reduced to a problem “much simpler, much more abstract,” for which a clear cut solution was possible, and Peirce suggested that it threw all the necessary light on the issue raised by *The Nation*. Our diagrammatic reconstruction was completely true to Peirce’s verbal account and used no formal resources beyond those that he had mastered in his study of Cournot. Then *The Nation* raised the stakes, claiming that additional real-

world complexities vitiated the salience of Peirce’s implicit analogical model. The complications pointed out were not abstruse data, but were genuine empirical features of the world – particularly, the facts that the United States was not the only market for sugar in the world. We want to suggest that Peirce’s response to the editor’s new challenge was very much of the same nature as Kepler’s successive abductions leading to his planetary laws. Just as Kepler invoked the prepotency of the sun to enrich the dynamics of the planetary system, Peirce proposes to exploit geographic comparative advantage – the idea that each producer may be especially well situated relative to different producers. We can reconstruct Peirce’s analysis in a second model.

Again, consider two producers – Cuba, standing for Puerto Rico as well as itself, and Manila, standing for producers not favored under the proposed treaty. The editor implies that, while Cuba and Manila, supply the United States, Manila is especially well suited to supply England exclusively. Tariffs in this respect include not only literal duties, but also any cost associated with bringing the sugar from a producer to a market.<sup>13</sup> The problem of the optimal allocation of production from multiple producers to multiple consumers in markets in which each producer faces different costs of marketing with respect to each consumer is a relatively complex one, involving two interrelated but distinct decisions: First, for any producer A, should it sell only to consumer  $\alpha$  or only to consumer  $\beta$  or to both? Second, conditional on producer A selling to a consumer, how much should it sell? It is an constrained optimization problem with possible corner solutions. Fortunately, for a diagrammatic analysis, we can follow Peirce’s hint to focus

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<sup>13</sup> Elsewhere, Peirce gives an analysis of the effect of a change of import duties on the price of consumer goods: “we must understand by the *duty*, not merely what goes to the government, but what has to be paid in consequence to brokers, bankers, and increased expenses of all kinds caused by the change in the law” (CP 4.115).

on the situation in which a producer is at the point of indifference as to whether it ships to a market or not.

In general, each producer will ship to the market to which it is most favorably situated, and will ship to the second market only if the price in that market rises enough to overcome the differential costs of the tariff. Consider, first, the situation shown in Figure 2 in which Manila ships exclusively to England. Let us assume for simplicity (and without loss of generality) that the English impose no tariff on sugar from Manila. We can, then, put the supply curve for sugar from Manila (the black curve  $S^M$ ) in the same left-hand panel as the demand curve for England ( $D^E$ ). Similarly, assume that Cuba ships exclusively to the United States, but that Cuba faces a tariff. The supply curve for Cuba is the black curve in the right-hand panel ( $S^C$ ) and the gray curve ( $S^C + T_{US}^C$ ) plots the supply price to the consumer in the United States equal to the producer’s supply price plus the tariff. The gap between the two parallel curves corresponds to the size of the tariff. Initially, the two markets are disjoint with the equilibrium between Manila and England at point  $(Q_0^M, p_0^E)$  and equilibrium between Cuba and the United States at point  $(Q_0^C, p_0^{US})$ . The after-tariff price received by Cuban producers is  $p_0^C$ .

When will Manila wish to ship sugar to the United States, which corresponds the actual situation in 1884? It is less advantageously placed than Cuba, which is reflected by the gray curve in the left-hand panel ( $S^M + T_{US}^M$ ), in which the gap between it and the parallel supply curve ( $S^M$ ) indicates the U.S. tariff on sugar from Manila. It will want to enter the U.S. market only if the price that it receives for its sugar in the U.S. covers its cost of production plus the tariff. The point  $(Q_0^M, p_1^{US})$  is the point of indifference at

which an infinitesimal quantity of sugar could be equally well shipped from Manila to the U.S. or to England. At any price below  $p_1^{US}$ , Manila would not earn enough to overcome the disincentive of the tariff. At any point above  $p_1^{US}$ , it would want to divide its production between the two countries (a problem that would require a new set of diagrams to represent adequately). At the initial equilibrium, with the price in the U.S. market  $p_0^{US} < p_1^{US}$ , the markets are disjoint. If the tariff is raised so that the gray curve ( $S^C + T_{US}^C$ ) shifts vertically to become the thin gray curve ( $S^C + T_{US}^{C'}$ ), the price rises to  $p_1^{US}$ , and the two markets are at equilibrium at exactly the point at which Manila is indifferent to joining the U.S. market. Any tariff higher than this corresponds to the situation at the time at which the Spanish Treaty was negotiated.

Imagine that the tariff on Cuban sugar is initially well above  $p_1^{US}$ . Because Manila would be shipping sugar to the United States, we cannot describe the equilibrium completely with these diagrams, which assume disjoint markets. What is clear, however, is that any small cut in the Cuban tariff, will result in it selling more sugar to the United States at a lower price. This was Peirce’s conclusion from his simpler model in Figure 1, and it carries over here, because it depends only on the downward-sloping demand curve for the United States, which is unaffected by the disjointness of markets. But once the price reaches  $p_1^{US}$ , any further fall results not only in further cuts to price but in a shutdown of the trade in sugar between the Manila and the U.S. The collapse in U.S. demand for sugar from Manila also cannot be shown accurately on Figure 2, but it amounts to a leftward shift of the total demand curve (English plus American demand), and must result in a fall in both output and price as the markets, previously integrated into



a world market, disintegrate into the two disjoint markets shown in Figure 2, and the equilibrium moves down the supply curve ( $S^M$ ) to the equilibrium at point  $(Q_0^M, p_0^E)$ . Exactly as Peirce claimed, the lower output corresponds, by the construction of the supply curve, to a higher productivity for the marginal producer trading through Manila than does the higher output. And as Peirce also asserted, none of the supply or demand shifts is possible without changes in prices altering the relative “inducements” to ship to one country or another.

## 5. Epilogue

The debate over the Spanish Treaty was one of the vital political issues of the early 1880s – not on as large a scale, though inspiring the same sorts of arguments, as the debate over the North American Free Trade Agreement (NAFTA) in the early 1990s and, again, in the presidential campaign and beginning of the Trump administration in 2016-17. The letter to the editor of *The Nation* that immediately proceeded Peirce’s first letter foreshadowed Ross Perot’s charge that the “giant sucking sound” we would hear after ratification of NAFTA would be U.S. jobs flowing to Mexico. The correspondent identified only by the initials T.E.C summarized the net effects of the treaty: “In other words, we are asked to pay the Cubans \$30,000,000 for the privilege of making not over \$5,000,000” (T.E.C. 1884). The correspondent goes on to question the negotiator’s loyalty and his education, as well as his patriotism: “Really, Mr. Editor, is Mr. [John W.] Foster a Yankee? Did he ever learn to *kalkerlate*?” *The Nation* itself was an important player in the debate (see Foster 1885, p. 55). Peirce had tried to bring scientific political economy to bear on a key problem in public policy, but, in the end, to no avail: Grover

Cleveland was elected president in November 1884 and one of his first acts on his inauguration in March 1885 was to withdraw the Spanish Treaty.

Despite a clear victory in the battle over economic analysis, Peirce had backed the losing side in the immediate political argument. Seven years later, the editor's dig at the application of the differential calculus to political economy still rankled:

Some newspapers maintain that all doctrines involving [the differential calculus] ought to be struck out of political economy because that science is of no service unless everybody, or the great majority of voters, individually comprehend it and assent to its reasonings. [CP 4.114]<sup>14</sup>

Naturally, Peirce found such arguments no more persuasive with respect to economics than he did with respect to mathematics or any other science. "But whether people be wise or foolish," he concluded, "it remains that there is no possible way of establishing the true doctrines of political economy except by the reasonings about *limits*, that is, reasoning essentially the same as that of the differential calculus" (CP4.114).

Peirce's debate with the editor of *The Nation* remains of interest, partly because it reflects the sophistication of his grasp of the economics of his day, being an exceptionally trenchant example of economic analysis. His audience was a popular one, but the ease with which his argument is reconstructed using the more formal apparatus of Cournot, suggests an integration of abstract economic theory with real-world policy concerns uncommon in the economic science of the 19<sup>th</sup> century. And it provides a compelling case study of analogy (or, as we might say today, modeling) as a scientific mode of inference, displaying Peirce's readiness to see economics as a discipline, different in its

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<sup>14</sup> Peirce goes on to name the newspaper in mind as the *New York Post*. But the reference is almost certainly to *The Nation*, which the *Post* had purchased in 1881 and which served as its weekly literary supplement. He packages his disagreement in fulsome praise of the newspaper in general. It is unclear whether Peirce is sincere, satirical, or venal: he earned essential income from writing for the *Nation*, as well as other periodicals.

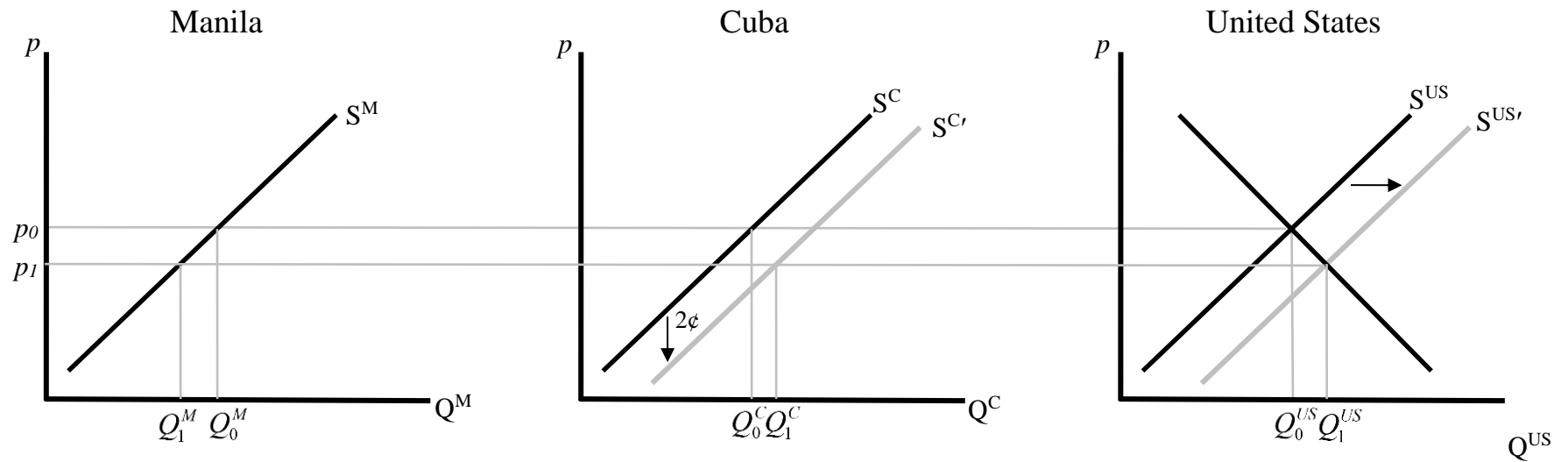
scope and precision, but no less scientific and using essentially the same logic as physics, chemistry, and biology.

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**Figure 1. Peirce's First Model of Tariff Reduction**



**Figure 2. Peirce's Second Model of Tariff Reduction**

