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Abstract

Until the late nineteenth century, the British alkali industry enjoyed a colossal export market in the United States. Yet, as several scholars have already noted, the highly protectionist Dingley Tariff of 1897 caused a precipitous and irreversible decline in the volume of British alkali exports to the United States. Drawing upon an abundance of textual evidence, this study argues that, in addition to the climactic Dingley Tariff, previous American tariff acts in 1883, 1890, and 1894 also exerted a pronounced influence on the volume of British alkali exports to the United States. Further corroborating this claim is a regression analysis that employs, as an explanatory variable, newly constructed annual estimates of the *ad valorem* equivalent tariff that the United States imposed upon alkali imports from Britain.

Approaching the British alkali industry from a microeconomic standpoint, this study also argues that one particular British alkali firm, Brunner, Mond & Co., mitigated its financial exposure to American tariff policy by acquiring, in 1887, a minority shareholding in a nascent American alkali firm, the Solvay Process Company. Profits from Brunner's shareholding in the Solvay Process Company substantially offset the profits that Brunner, Mond & Co. lost as the result of its diminished alkali exports to the United States. The other dominant British alkali firm, the United Alkali Company, did not fare so well.

JEL Codes: N61, N63, N71, N73, N81, N83

Keywords: alkali, chemicals, tariffs, trade, Britain, United States, nineteenth century

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Introduction

The British alkali industry of the late nineteenth century relied heavily upon the export market, with the leading foreign consumer of British alkali being the United States. In fact, during the early 1890s, the American market accounted for no less than an astonishing three-fifths of British alkali exports.¹ Yet, following the passage of the highly protectionist Dingley Tariff (1897), British alkali exports to the United States diminished so precipitously that, by the early 1900s, all but the most optimistic observers acknowledged that the British alkali industry had lost the American market irretrievably.²

Admittedly, the Dingley Tariff was not the first piece of American legislation to revise the specific tariffs imposed upon the various classes of alkali imported into the United States.³ The Mongrel Tariff (1883), McKinley Tariff (1890), and Wilson-Gorman Tariff (1894) were each products of the ongoing political *Sturm und Drang* surrounding the great tariff question of whether the United States ought to gravitate more toward protectionism or free trade. These three acts altered the specific tariff on at least one class of alkali. The American tariff acts of this period typically enumerated five broad classes of alkali: bicarbonate soda, caustic soda, sal soda, soda ash, and soda crystals, each of which served a different industrial purpose, or in the case of bicarbonate soda, a household purpose.

Scholars have repeatedly noted the connection between the Dingley Tariff and the abrupt decline in British alkali exports to the United States. Nonetheless, preceding

¹ United Kingdom, House of Commons, *Annual Statement of the Trade of the United Kingdom with Foreign Countries and British Possessions* (London: Her Majesty's Stationery Office, various years).

² Cheshire Record Office (CRO), DIC UA 3/7, *Reports of Proceedings at General Meetings*, 1891-1925.

³ Whereas a specific tariff levies a fixed duty per quantity of good imported, an *ad valorem* tariff levies a duty calculated as a percent of the value of the good imported. In the late nineteenth century, the United States imposed specific tariffs on each of the classes of alkali imported.

tariff legislation also revised the specific tariffs imposed on the five classes of alkali; the effect of these earlier tariff acts on British alkali exports has remained hitherto unexamined by the academic community. Accordingly, the first line of inquiry of this study assesses whether American tariff policy impacted the volume of British alkali exports to its single largest foreign market, the United States, during the period from 1880 to 1905, a span of time covering the passage and aftermath of four tariff acts, including the momentous Dingley Tariff. In this first part of the study, the methodology entails constructing annual estimates of the *ad valorem* equivalent tariff that the United States imposed upon the collective basket of alkali imports from Britain. The *ad valorem* equivalent tariff then serves as an explanatory variable, alongside several control variables, in a time-series regression against a dependent variable of British alkali exports to the United States. Here, the objective is to determine if the *ad valorem* equivalent tariff on British alkali is a statistically significant explanatory variable.

One of the most salient features of the British alkali industry during the late nineteenth century was the oligopolistic control that two firms, the United Alkali Company (UAC) and Brunner, Mond & Co. exerted over it. Formed in 1890, the UAC merged forty-five firms that produced alkali using the increasingly obsolescent Leblanc process, in an effort to preserve the commercial viability of these Leblanc manufacturers by reducing the costs of administration and distribution.⁴ Indeed, the formation of the UAC was a reaction to the growth of the highly profitable Brunner, Mond during the 1880s.⁵ Brunner, Mond produced alkali using the newer and cheaper ammonia-soda process, known less technically as the Solvay process.

⁴ L. F. Haber, *The Chemical Industry During the Nineteenth Century* (Oxford: Clarendon Press, 1958), 182.

⁵ For the annual profits of Brunner, Mond, see W. J. Reader, *The Forerunners, 1870-1926*, vol. 1 of *Imperial Chemical Industries: A History* (London: Oxford University Press, 1970), 513.

While discrepant processes (Leblanc and ammonia-soda) constituted perhaps the most obvious difference between the two firms, there were other essential differences, as well. In 1887, Brunner, Mond began to acquire a minority shareholding in a fledgling American alkali manufacturer, the Solvay Process Company (SPC) of Syracuse, New York, with the intention of maintaining a certain degree of access to the American market and, more importantly, to the profits ensuing there from.⁶ This strategy proved farsighted when, a decade later, the Dingley Tariff raised the specific tariffs on the various classes of alkali, especially soda ash, to a level that afforded the SPC sufficient protection to capture much of the American market. From a profitability standpoint, Brunner, Mond presumably mitigated its losses by investing in a firm protected behind a tariff wall. Thus, the second line of inquiry of this study considers the extent to which Brunner's partial ownership in the SPC limited the former firm's financial exposure to the American tariff on alkali. The methodology in this second part of the study involves calculating the volume of Brunner's American alkali market, or more precisely, the volume of the American market upon which Brunner, Mond laid claim to the profits: the sum of a) Brunner's annual alkali exports to the United States and b) the SPC's annual alkali sales in the United States multiplied by Brunner's share of ownership in the SPC. The volume of Brunner's American alkali market then serves as the dependent variable in a log-log regression aimed, ultimately, at determining how much Brunner, Mond reduced its financial exposure to American tariff policy by making a foreign portfolio investment in the SPC.

This study does not intend to present two disparate lines of inquiry, but rather to examine holistically the relationship between American tariff policy and the British

⁶ Kenneth Bertrams, Nicolas Coupain, and Ernst Homburg, *Solvay: History of a Multinational Family Firm* (Cambridge: Cambridge University Press, 2013), 49.

alkali industry from complementary macroeconomic and microeconomic vantage points. The first area of inquiry, the macroeconomic, poses the question of whether American tariff policy affected British alkali exports to the United States during the period from 1880 to 1905, a span of time covering the passage and aftermath of four tariff acts. The second area of inquiry, the microeconomic, poses the question of whether a foreign portfolio investment in the SPC enabled Brunner, Mond to mitigate, in any appreciable way, its financial exposure to American tariff policy. In attempting to answer the two questions, this dissertation does not limit itself to quantitative analysis alone, but instead relies equally upon a profusion of rich textual evidence from both sides of the Atlantic. Through a balanced quantitative and qualitative approach, this study reaches conclusions that represent novel contributions to the rather cursory literature on the relationship between American tariff policy and the British alkali industry, which is discussed in the next section.

Literature Review

The consensus among economic historians, including this author, is that the Dingley Tariff effectively ended British alkali exports to the United States. However, the scholarly literature on the British alkali industry during the late nineteenth century makes only occasional reference to American tariff policy prior to the Dingley Tariff. In *The Chemical Industry During the Nineteenth Century* (1958), L. F. Haber points out that the Wilson-Gorman Tariff prompted a temporary increase in British alkali exports to the United States by reducing the specific tariffs on bicarbonate and caustic soda.⁷ For both of these classes of alkali, the Wilson-Gorman Tariff revised the duties

⁷ Haber, 216.

downward from 1¢ to 0.5¢ per pound.⁸ The Mongrel Tariff and McKinley Tariff also lowered the duties on several classes of alkali, but these tariff acts garner even less attention in the extant literature. In fact, despite the Mongrel Tariff having lowered the duty on caustic soda from 1.5¢ to 1¢ per pound, there is not a single reference to this tariff act in any of the secondary source material on the British alkali industry.⁹

Altogether, the scholarly literature lacks a comprehensive treatment of American tariff policy toward alkali imports, which were almost exclusively from Britain.

Compared to the American tariff on alkali, more has been written about Brunner's minority shareholding in the SPC. W. J. Reader provides an account of this investment in the first volume of *Imperial Chemical Industries: A History* (1970). He writes, "From 1887 onwards, by a series of agreements, Brunner, Mond handed over their American trade to SPC, relying for their American profits in future on their shareholding and not on export from Winnington."¹⁰ Reader describes how the growth of the SPC represented an incursion into Brunner's American market, and how Brunner, Mond therefore brokered an agreement with the SPC in 1887: Brunner, Mond was allowed to purchase 2,000 non-voting shares in the SPC, and the SPC was guaranteed, until 1892, four-ninths of the portion of the American alkali market jointly supplied by the two firms.¹¹ He then argues that Brunner's partial ownership in the SPC curtailed the former firm's financial losses in the wake of the Dingley Tariff, which had the effect of almost completely barring Brunner, Mond and the UAC from the American market.¹²

⁸ United States, House of Representatives, *Tariff Acts Passed by the Congress of the United States from 1789 to 1909*, 61st Cong., 2nd sess., 1909, H. Doc 671, 469. This tariff act also lowered the duties on sal soda and soda crystals from 0.25¢ to 0.125¢.

⁹ *Ibid.*, 321.

¹⁰ Reader, 64.

¹¹ *Ibid.*, 98-100. In 1886, Brunner, Mond and the SPC together supplied slightly more than half of the American alkali market.

¹² *Ibid.*, 174.

In *The History of Foreign Investment in the United States to 1914* (1989), Mira Wilkins corroborates Reader's description of how Brunner, Mond swapped guaranteed access to the American alkali market in exchange for profits from the SPC.¹³ She then evaluates the quality of the SPC as an investment, boldly stating that the SPC was "by far the largest and most successful of all the foreign investments in [American] heavy chemicals."¹⁴ However, Wilkins does not address whether the SPC, as an investment, was successful enough to fully compensate Brunner, Mond for financial losses resulting from the Dingley Tariff.

Kenneth Bertrams, Nicolaus Coupain, and Ernst Homburg, the authors of *Solvay: History of a Multinational Family Firm* (2013), do not regard Brunner's minority shareholding in the SPC as a saving grace in the face of the Dingley Tariff, at least not in the same way that Reader does. Moreover, these authors portray Brunner, Mond and the SPC as natural competitors only reluctantly collaborating with each other. On this note, Bertrams et al. point to the inevitable tension between the firms; the SPC wanted to expand its share of the American alkali market, which Brunner, Mond was loath to relinquish.¹⁵ The authors provide a more numerical analysis than do Reader and Wilkins. One number of particular importance is the share of Brunner's minority ownership in the SPC, which the authors determine to be 16.7 percent in 1887.¹⁶

Neither Reader, Wilkins, nor Bertrams et al. offer any quantification of the extent to which Brunner's minority shareholding in the SPC mitigated Brunner's financial exposure to the American tariff on alkali. Reader casually claims that this investment assuaged the impact of the Dingley Tariff on the profitability of Brunner,

¹³ Mira Wilkins, *The History of Foreign Investment in the United States to 1914* (Cambridge, Massachusetts: Harvard University Press, 1989), 404-405.

¹⁴ *Ibid.*, 410.

¹⁵ Bertrams, 50.

¹⁶ *Ibid.*, 49.

Mond. Yet, the impreciseness of this claim invites a range of interpretations; the profits from Brunner's minority shareholding could have constituted a paltry sum or, alternatively, a full compensation for the financial losses resulting from the Dingley Tariff. The impreciseness of Reader's claim leaves a scholarly gap that this study fills. Furthermore, in keeping with the first line of inquiry, this study explores the extent to which Brunner's partial ownership in the SPC limited the former firm's financial exposure to the American tariff on alkali throughout the late nineteenth century, and not just Brunner's exposure to the Dingley Tariff alone.¹⁷

The relationship between American tariff policy and the British alkali industry in the late nineteenth century is germane to several extra-alkali clusters of literature in the field of economic history. The findings of this dissertation carry implications for two scholarly arguments, in particular. The first argument is articulated by Stephen N. Broadberry in "How Did the United States and Germany Overtake Britain? A Sectoral Analysis of Comparative Productivity Levels, 1870-1990" (1998). The second argument is laid forth by Charles Feinstein in "Exports and British Economic Growth (1850-1914)" (1996). To be sure, this dissertation is worthwhile partly because of its potential to converse with the two aforementioned writings.

Broadberry tackles the immense question of how American (and German) aggregate labor productivity surpassed British aggregate labor productivity. He points out that, after 1870, the ratio of American manufacturing labor productivity to British manufacturing labor productivity remained fairly consistent at two-to-one.¹⁸ Therefore, the American lead in aggregate labor productivity did not derive from any further

¹⁷ Since Brunner, Mond only acquired its minority shareholding in the SPC in 1887, the Mongrel Tariff cannot be considered here.

¹⁸ Stephen N. Broadberry, "How Did the United States and Germany Overtake Britain? A Sectoral Analysis of Comparative Productivity Levels, 1870-1990," *Journal of Economic History* 58, no. 2 (June 1998): 380.

widening of the gap between American and British manufacturing labor productivity. Instead, the American lead in aggregate labor productivity derived, in part, from the population and resources of the United States shifting out of agriculture and into manufacturing.¹⁹ In so doing, the United States reallocated resources to a sector of the economy that enjoyed a substantial, though stable, labor productivity lead over Britain. But what were the mechanics of the shift out of agriculture and into manufacturing, including alkali manufacturing? To what degree did American tariff policy accelerate the shift? In response to the latter question, this dissertation might rightly constitute a sort of case study. Though this dissertation does not endeavor to address the same questions that Broadberry does, it nevertheless elaborates upon an aspect of his argument: the United States shifting population and resources into manufacturing, in this case the manufacturing of alkali.

Feinstein reassesses the so-called traditional hypothesis that the diminishing growth rate of British exports in the late nineteenth century inhibited the overall economic growth of Britain. Feinstein points out that, whereas total British exports grew at an average rate of 3.5 percent per annum between 1856 and 1873, this rate dropped to 2.6 percent per annum between 1873 and 1913.²⁰ Likewise, moving from the earlier to the later interval, the growth rate of total British industrial output fell from 2.9 to 2.0 percent per annum.²¹ The parallel decline in the growth rates of exports and industrial output underpins the traditional hypothesis of “export-retarded growth,” as Feinstein refers to it.²²

¹⁹ Ibid., 383. The other factor that drove American aggregate labor productivity to surpass British aggregate labor productivity was the United States improving its relative labor productivity in services.

²⁰ Charles Feinstein, “Exports and British Economic Growth (1850-1914),” in *International Trade and British Economic Growth from the Eighteenth Century to the Present Day*, ed. Peter Mathias and John A. Davis (Oxford: Blackwell, 1996), 78.

²¹ Ibid., 77.

²² Ibid., 78.

Feinstein identifies four propositions that must hold true, in order to affirm the traditional hypothesis of export-retarded growth. The first two propositions resonate most closely with this dissertation. The first proposition is “that the changes which initiated this deceleration in export growth rates had their origin in the process of foreign industrialization, and were essentially independent of developments within Britain.”²³ The second proposition is “that the dominant effect of the extension of this industrialization to other countries was increased competition for Britain, and a resultant loss of markets.”²⁴ At the level of the whole British economy, Feinstein determines that the historical evidence supports these two propositions. However, at the level of individual British industries, these two propositions need not always hold true, or might hold true for a period other than late-Victorian Britain. Feinstein openly acknowledges that foreign industrialization and the consequent decline of British exports occurred to varying extents depending upon the particular industry, with the steel industry experiencing especially rapid development in foreign countries.²⁵ This dissertation sheds light on whether Feinstein’s two propositions hold true for a particular industry: the British alkali industry, which was hardly a trivial component of the British economy in the late nineteenth century. In reference to the first proposition, the analysis in this dissertation collaterally answers the question: was there the exogenous development of an alkali industry in the United States? In reference to the second proposition, the analysis in this dissertation also answers the question: did the development of an American alkali industry result in the decline of British alkali exports to the United States? By answering these questions, this dissertation assesses whether or not the British alkali industry conformed to the traditional hypothesis of export-retarded

²³ Ibid., 80-81.

²⁴ Ibid., 81.

²⁵ Ibid., 88.

growth, Feinstein's third and fourth propositions notwithstanding. The dissertation returns to Feinstein's and Broadberry's arguments in the conclusion section.

Estimating the *Ad Valorem* Equivalent Tariff

The procedure for constructing annual estimates of the *ad valorem* equivalent tariff that the United States imposed upon the collective basket of alkali imports from Britain involves three steps. First, for every one of the twenty-six years between 1879/80 and 1904/05, the volume of each class of alkali (bicarbonate soda, caustic soda, sal soda, soda ash, and soda crystals) that the United States imported from Britain is multiplied by the specific tariff applicable for that particular class, with the product being the tariff revenue realized by the United States Treasury Department for that class of alkali. Second, the Treasury Department's tariff revenues for each of the various classes of alkali are added together, with the sum being the aggregate tariff revenue realized by the Treasury Department for the collective basket of alkali imports from Britain. Finally, dividing the Treasury Department's aggregate tariff revenue by the total value of alkali imports from Britain yields annual estimates of the *ad valorem* equivalent tariff.

British alkali exports to the United States—alternatively, American alkali imports from Britain—are recorded in the *Trade of the United Kingdom*, and likewise in the United States Treasury Department's *Foreign Commerce and Navigation of the United States*. Unless otherwise noted, this study relies upon the American trade statistics on alkali imports from Britain, and for good reason.²⁶ The main problem with the British trade statistics on alkali exports to the United States is that the *Trade of the United Kingdom* only begins disaggregating alkali into its constituent classes in 1901,

²⁶ United States, Treasury Department, Bureau of Statistics, *Foreign Commerce and Navigation of the United States* (Washington, DC: Government Printing Office, various years).

whereas the *Foreign Commerce and Navigation of the United States* records individual classes of alkali for the entire period from 1879/80 to 1904/05.²⁷ Another reason, albeit obvious, to rely on the American trade statistics is the greater congruence between the classes of alkali recorded therein and the classes of alkali enumerated in the tariff legislation. Nevertheless, there is a drawback to using the American data; it does not correspond with the calendar year, but rather with the American fiscal year, which ran from July 1 to June 30. Consequently, the American and British data are desynchronized by a half-year, since the latter align with the calendar year. Comparisons between American and British trade statistics, when necessary, are complicated by this unavoidable half-year lag.

Soda ash and caustic soda, the two classes of alkali that composed the bulk of imports, are the only two classes to receive consistently separate treatment in the *Foreign Commerce and Navigation of the United States* for every year between 1879/80 and 1904/05. Bicarbonate soda loses its separate listing after 1891/92, by which time annual American imports of bicarbonate soda from Britain amounted to a paltry 3.4 million pounds, or 0.8 percent of total alkali imports from Britain by both volume and value.²⁸ During the mid-nineteenth century, there developed in the United States a nascent alkali industry, which was especially successful at manufacturing bicarbonate soda.²⁹ Thus, American imports of bicarbonate soda diminished steadily throughout the 1870s and 1880s. What little bicarbonate soda the United States imported from Britain after 1891/92 is relegated, within the American trade statistics, to a single category designated for “all other salts of soda,” an ambiguous category which this study soon

²⁷ *Trade of the United Kingdom* (1901).

²⁸ *Foreign Commerce and Navigation of the United States* (1892).

²⁹ For a brief discussion of early American bicarbonate soda production, see William Haynes, *American Chemical Industry*, vol. 1 (New York: D. Van Nostrand Company, 1954), 286-287.

addresses. In estimating the *ad valorem* equivalent tariff, the calculations include bicarbonate soda for the years between 1879/80 and 1891/92, but not thereafter.

Another class of alkali, sal soda, requires some clarification. Prior to 1892/93, the American trade statistics account for sal soda under the category of soda ash, which was by far the largest class of alkali imported into the United States from Britain. Beginning in 1892/93, however, the American trade statistics create a separate listing for sal soda, which constituted a substantial 5.4 percent of total alkali imports from Britain in that year.³⁰ Fortunately, the inclusion of sal soda under the category of soda ash prior to 1892/93 does not pose a challenge for estimating the *ad valorem* equivalent tariff because the Tariff Act of 1875, the Mongrel Tariff, and the McKinley Tariff all imposed the same specific tariff upon both soda ash and sal soda: 0.25¢ per pound.³¹ In 1894, only after the creation of a separate category for sal soda, the Wilson-Gorman Tariff reduced the tariff on sal soda to 0.125¢, while retaining the 0.25¢ tariff on soda ash.³² By the late 1890s and early 1900s, though imports of sal soda had declined, sal soda's share in the collective basket of alkali imports had more than doubled, peaking at 11.8 percent of total American alkali imports from Britain in 1903/04.³³ In sum, the calculations for estimating the *ad valorem* equivalent tariff fully account for this increasingly significant class of alkali, and are not at all complicated by its inclusion under the category of soda ash before 1892/93.

In estimating the *ad valorem* equivalent tariff, soda crystals present the greatest difficulty. The Tariff Act of 1875, Mongrel Tariff, McKinley Tariff, Wilson-Gorman Tariff, and Dingley Tariff all enumerated a specific tariff for soda crystals. Yet, the American trade statistics do not include a separate category for soda crystals, which are

³⁰ *Foreign Commerce and Navigation of the United States* (1893).

³¹ *Tariff Acts Passed by the Congress*, 321, 373.

³² *Ibid.*, 469.

³³ *Foreign Commerce and Navigation of the United States* (1904).

presumably incorporated into the category of “all other salts of soda.” What portion of this category is composed of soda crystals? The British trade statistics offer clues. In 1901, the first year for which the *Trade of the United Kingdom* disaggregates alkali into its constituent classes, Britain exported 4.8 million pounds of soda crystals to the United States.³⁴ In 1900/01, the American trade statistics note that “all other salts of soda” imported from Britain amounted to 10.2 million pounds.³⁵ Thus, approximately one half of the “other” category was composed of soda crystals in 1900/01.

In *Chemical Foundations: The Alkali Industry in Britain to 1926* (1980), Kenneth Warren provides figures on the British export of soda crystals to the United States, which he claims were 20.0 million pounds in 1896.³⁶ This grossly overstated figure far exceeds the 8.7 million pounds of “other” alkali that the *Foreign Commerce and Navigation of the United States* records as having been imported from Britain in 1895/96.³⁷ Warren’s source for this figure is an anonymous article published in *The Times* on November 26, 1906. The article was an installment in an unmistakably biased series that championed the Leblanc process for manufacturing alkali and, at the same time, identified the “crushing weight of hostile tariffs” as instigating the decline of the Leblanc process.³⁸ Accordingly, the anonymous author of the article was likely inclined to exaggerate British exports of soda crystals to the United States on the eve of the Dingley Tariff and, in so doing, accentuate the adverse impact of this act.

Due to the unreliability to Warren’s source, this study defers to the fragmentary evidence yielded by the British trade statistics and assumes that, for every year between 1879/80 and 1904/05, soda crystals comprise one half of “other” alkali. Therefore, in

³⁴ *Trade of the United Kingdom* (1901).

³⁵ *Foreign Commerce and Navigation of the United States* (1901).

³⁶ Kenneth Warren, *Chemical Foundations: The Alkali Industry in Britain to 1926* (Oxford: Clarendon Press, 1980), 192.

³⁷ *Foreign Commerce and Navigation of the United States* (1896).

³⁸ The series was later published as a book, *The Struggle for Supremacy* (Liverpool: N.p., 1907), 64.

estimating the *ad valorem* equivalent tariff, one half of “other” alkali is multiplied by the duty on soda crystals, so as to obtain the Treasury Department’s tariff revenue for soda crystals. For this particular class of alkali, one further assumption is necessary. Prior to the Dingley Tariff, the United States imposed a single specific tariff on soda crystals. However, the Dingley Tariff departed from previous tariff legislation by differentiating between concentrated and non-concentrated soda crystals, setting the tariffs at 0.3¢ per pound of the former and 0.2¢ per pound of the latter.³⁹ Lacking any record of the ratio of concentrated to non-concentrated soda crystals imported by the United States, this study presupposes that the Dingley Tariff imposed a duty on soda crystals equal to the average of the duties on concentrated and non-concentrated soda crystals: 0.25¢ per pound.

The category of “other” alkali ranged from 0.1 percent of total American alkali imports from Britain in 1880/81 to 22.6 percent of these imports in 1904/05.⁴⁰ After assuming that soda crystals comprised one half of “other” alkali, there remains yet an additional one half of “other” alkali unaccounted for in the calculations. This additional one half of “other” alkali covers various miscellaneous classes of alkali, including bicarbonate soda beginning in 1892/93.⁴¹ Given that the additional one half of “other” alkali only constituted between an estimated 0.0 and 11.3 percent of total American alkali imports from Britain, and given the near impossibility of determining the volumes, however negligible, of each miscellaneous class of alkali imported, this study assumes that the unaccountable alkali imports were subject to the same *ad valorem* equivalent tariff that the United States imposed upon the 88.7 to 100.0 percent

³⁹ *Tariff Acts Passed by the Congress*, 549.

⁴⁰ *Foreign Commerce and Navigation of the United States* (1881 and 1905).

⁴¹ A partial list of the miscellaneous classes of alkali follows: arseniate, bichromate, chlorate, chromate, hypo-sulphite, monohydrate, nitrite, sesquicarbonate, silicate, sulphide, and sulphite of soda, as well as combinations thereof.

(depending on the year) of alkali imports that are accountable. In short, the unaccountable alkali imports are removed from the calculations. Recall that the final step in constructing annual estimates of the *ad valorem* equivalent tariff involves dividing the Treasury Department's aggregate tariff revenue by the total value of alkali imports from Britain. The unaccountable alkali imports are excluded from the numerator because no tariff revenue arising from these miscellaneous alkali imports is ever calculated. The unaccountable alkali imports are excluded from the denominator by subtracting one half of the value of "other" alkali imports from the total value of alkali imports.⁴² Hence, the full equation for computing the *ad valorem* equivalent tariff can be written as

$$T_y = \frac{\sum(t_{a,y} \times q_{a,y})}{V_y - 0.5m_y} \times 100$$

where a contains the five accountable classes of alkali (bicarbonate soda, caustic soda, sal soda, soda ash, and soda crystals), and where y contains the twenty-six years between 1879/80 and 1904/05. T stands for the *ad valorem* equivalent tariff, expressed as a percent, that the United States imposed upon the collective basket of alkali imports from Britain. The variable t represents the specific tariff for each class of alkali a . The variable q represents the volume of each class of alkali a imported into the United States from Britain. V stands for the total value of alkali imported from Britain. And finally, the variable m represents the value of "other" alkali imported from Britain.

Indeed, the aggregate tariff revenue realized by the Treasury Department for the collective basket of alkali imports from Britain is difficult to estimate, if not for the aforementioned reasons, then for the simple reason that the many classes and variants of alkali bewildered American customs officials charged with enforcing the tariff acts.

⁴² Implicitly, this action assumes that soda crystals comprised not only one half of the volume of "other" alkali imports, but also one half of the value of "other" alkali imports.

Correspondence between the Assistant Secretary of the Treasury Department and the New York Collector of Customs sheds light on this challenge. In 1888, an importing firm appealed the Collector of Customs' decision to levy a duty of 1¢ per pound—the specific tariff for caustic soda—on a mixture of caustic soda and lime.⁴³ The firm argued that the mixture was no longer caustic soda, but rather an entirely separate chemical not enumerated in the Mongrel Tariff. Upon appeal, the Assistant Secretary of the Treasury upheld the Collector of Customs' decision, but without offering any explanation for doing so. In classifying alkali imports, the Collector of Customs entered murky waters perhaps better navigated by a trained chemist than a government functionary.⁴⁴ And while misclassifications of alkali surely occurred from time to time, the effect of these misclassifications upon the American trade statistics and the Treasury Department's tariff revenue is unascertainable.⁴⁵

A further consideration in constructing annual estimates of the *ad valorem* tariff is that the tariff acts rarely became legally effective on the first day of the American fiscal year, July 1. At the beginning of the period considered in this study, 1879/80 to 1904/05, the Tariff Act of 1875 was in effect.⁴⁶ The Mongrel Tariff was passed on March 3, 1883 and went into effect on July 1, 1883, in perfect alignment with the American fiscal year.⁴⁷ The McKinley Tariff, however, was passed on October 1, 1890

⁴³ United States, Treasury Department, *Synopsis of the Decisions of the Treasury Department on the Construction of the Tariff, Navigation, and Other Laws, for the Year Ended December 31, 1888* (Washington, DC: Government Printing Office, 1889), 465-466.

⁴⁴ See also United States, Treasury Department, *Synopsis of the Decisions of the Treasury Department on the Construction of the Tariff, Navigation, and Other Laws, for the Year Ended December 31, 1889* (Washington, DC: Government Printing Office, 1890), 151.

⁴⁵ G. R. Hawke considers the effect of misclassifications as negligible in "The United States Tariff and Industrial Protection in the Late Nineteenth Century," *Economic History Review* 28, no. 1 (February 1975): 88.

⁴⁶ The Tariff Act of 1875 was essentially an extension of the highly protectionist Civil War tariff regime. See Percy Ashley, *Modern Tariff History: Germany, United States, France*, 3rd ed. (London: John Murray, 1920), 190.

⁴⁷ *Tariff Acts Passed by the Congress*, 321.

and went into effect on October 6, 1890.⁴⁸ Because the McKinley Tariff was effective for the majority of the 1890/91 fiscal year, the specific tariffs enumerated in this act are applied for the whole of the 1890/91 fiscal year, in the calculations for estimating the *ad valorem* equivalent tariff. The Wilson-Gorman Tariff was passed on August 24, 1894 and went into effect on August 28, 1894.⁴⁹ Likewise, because this act was effective for the majority of the 1894/95 fiscal year, its specific tariffs are applied for the whole of the 1894/95 fiscal year. The Dingley Tariff was passed on July 24, 1897 and went into effect immediately, in nearly perfect alignment with the American fiscal year—an especially beneficial coincidence that well enables this study to isolate the impact of the climactic Dingley Tariff.⁵⁰ Therefore, the specific tariffs enumerated in the Dingley Tariff are applied for the whole of the 1897/98 fiscal year.

The annual estimates of the *ad valorem* equivalent tariff that the United States imposed upon alkali imports from Britain are presented in Table 1, alongside F. W. Taussig's figures for the *ad valorem* equivalent tariff that the United States imposed upon all dutiable goods imported from all countries, which he compiles from the *Statistical Abstracts of the United States*. Several observations follow from a comparison of these two series. But for the single fiscal year of 1897/98, the American tariff on British alkali was consistently less than the tariff on dutiable imports in general, with the mean of the former being 33.44 percent and the mean of the latter being 46.10 percent.⁵¹ From a purely numerical standpoint, the American alkali industry

⁴⁸ Ibid., 373.

⁴⁹ F. W. Taussig, *The Tariff History of the United States*, 8th ed. (New York: G. P. Putnam's Sons, 1931), 290. The Wilson-Gorman Tariff did not become effective on August 1, 1894, as mentioned in the text of the act, but rather on August 28, 1894.

⁵⁰ Ibid., 549.

⁵¹ Included in the 46.10 percent are duties that the United States imposed for the purpose of revenue, and not for the purpose of protection. The duty on coffee represents a classic example.

Table 1. *AD VALOREM* EQUIVALENT TARIFFS, 1880-1905

<i>Year ending June 30</i>	<i>Alkali imports to the United States from Britain (percent)</i>	<i>All dutiable imports to the United States from all countries (percent)</i>
1880	27.34	43.48
1881	28.13	43.20
1882	33.20	42.66
1883	31.78	42.45
1884	28.83	41.61
1885	30.08	45.86
1886	31.96	45.55
1887	34.52	47.10
1888	37.06	45.63
1889	37.59	45.13
1890	33.20	44.41
1891	26.99	46.28
1892	24.97	48.71
1893	25.51	49.58
1894	30.92	50.06
1895	29.68	41.75
1896	30.41	40.18
1897	30.62	42.41
1898	50.45	48.80
1899	51.42	52.07
1900	44.28	49.24
1901	39.16	49.64
1902	34.52	49.78
1903	34.90	49.03
1904	30.55	48.78
1905	31.33	45.24

Sources: For the *ad valorem* equivalent tariff on alkali imports into the United States from Britain, see text. For the *ad valorem* equivalent tariff on all dutiable imports into the United States from all countries, F. W. Taussig, *The Tariff History of the United States*, 8th ed. (New York: G. P. Putnam's Sons, 1931), 527-528.

received comparatively less protection than other industries.⁵² While the Dingley Tariff temporarily afforded the alkali industry the same numerical level of protection as American industry overall, the rising price of alkali after 1899 eroded the *ad valorem*

⁵² Note well, however, that a comparatively low *ad valorem* equivalent tariff might provide sufficient protection for a certain industry, while a comparatively high *ad valorem* equivalent tariff still might not provide sufficient protection for another.

equivalent tariff; remember that the United States imposed specific tariffs on each of the various classes of alkali imported.⁵³

For the period from 1880 to 1905, the tariff on British alkali exhibits greater dispersion than the tariff on all dutiable goods. The coefficient of variation is 0.20 for the tariff on British alkali and 0.07 for the tariff on all dutiable goods. The substantial degree of diversification inherent to the across-the-board tariff on all dutiable goods produces a relatively lower coefficient of variation. In contrast, the tariff on British alkali depends entirely upon an idiosyncratic group of goods collectively known as alkali, hence the relatively higher coefficient of variation. Nonetheless, the coefficient of variation for the *ad valorem* equivalent tariff on British alkali is not particularly high, compared to the coefficients of variation for the *ad valorem* equivalent tariffs on other goods, such as pig iron. V. Sundararajan extracts from the *Foreign Commerce and Navigation of the United States* annual figures for the *ad valorem* equivalent tariff that the United States imposed upon pig iron imports from all countries, though overwhelmingly from Britain.⁵⁴ Calculated for the period from 1880 to 1905, the coefficient of variation for the tariff on pig iron is 0.40, or twice the coefficient for the tariff on British alkali. Preliminary evidence suggests that the *ad valorem* equivalent tariff on British alkali did not fluctuate exceptionally much.

Altogether, the *ad valorem* equivalent tariff on British alkali was the outcome of three determinants: the specific tariffs enumerated in American tariff acts, the price of each class of alkali, and the relative share that each class of alkali held in the collective basket. Moreover, none of these determinants were inconsequential or minor. Legislative revisions of the specific tariffs occurred at four junctures between 1880 and

⁵³ *Oil, Paint and Drug Reporter* (New York: William O. Allison, various years).

⁵⁴ V. Sundararajan, "The Impact of the Tariff on Some Selected Products of the U.S. Iron and Steel Industry, 1870-1914," *Quarterly Journal of Economics* 84, no. 4 (November 1970): 594-595.

1905, with the Dingley Tariff's increase of the duty on soda ash from 0.25¢ to 0.375¢ per pound representing the most aggressive and influential revision of a specific tariff on a class of alkali.⁵⁵ As for the price of alkali, it declined throughout the 1890s and dropped off sharply between 1897 and 1899, only to rise again thereafter.⁵⁶ The late 1890s trough in the price of alkali inflated the *ad valorem* equivalent tariff for those years, ostensibly exaggerating the effect of the Dingley Tariff. Thus, both legislative revisions and diminished prices caused the tariff on British alkali to exceed 50.0 percent in 1897/98 and 1898/99. The decline in the price of alkali between 1897 and 1899 was certainly not an exogenous phenomenon; full attention is given to the matter in a later section of this study.

The third determinant of the tariff on British alkali, the relative share that each class of alkali held in the collective basket, surely ought not be disregarded. Here, the main trend was the falling share of soda ash, which accelerated after the passage of the Dingley Tariff. Whereas the Mongrel Tariff, McKinley Tariff, and Wilson-Gorman Tariff left untouched the specific tariff on soda ash, the Dingley Tariff revised the duty upward, prompting both an absolute and proportional decrease in American imports of soda ash. Even still, soda ash remained the largest class of alkali imported into the United States from Britain for the entire period under consideration.⁵⁷ The relative share of caustic soda increased rapidly during the three years governed by the Wilson-Gorman Tariff, which lowered the duty on caustic soda from 1¢ to 0.5¢ per pound.⁵⁸ In fact, between 1893/94 and 1896/97, the share of caustic soda increased from 12.3

⁵⁵ *Tariff Acts Passed by the Congress*, 549.

⁵⁶ *Oil, Paint and Drug Reporter*. While there were different prices for each of the classes of alkali, these prices tended to move in lockstep.

⁵⁷ *Foreign Commerce and Navigation of the United States* (1905). As late as 1904/05, soda ash constituted an impressive 60.1 percent of the basket of alkali imports from Britain.

⁵⁸ *Tariff Acts Passed by the Congress*, 469.

percent to 26.1 percent.⁵⁹ Yet, this temporary proportional increase was reversed by the Dingley Tariff, which raised the duty on caustic soda from 0.5¢ to 0.75¢ per pound.⁶⁰ In tandem with the shrinking relative shares of caustic soda and soda ash were the growing relative shares of sal soda and soda crystals, though American imports of all classes of alkali declined, in absolute volumes, following the passage of the Dingley Tariff.

Tariff Policy and British Alkali Exports

American tariff policy toward alkali—represented numerically in the annual estimates of the *ad valorem* equivalent tariff—emanated from a fiery political struggle, not between manufacturers and consumers, but instead between manufacturers and manufacturers. The few American alkali manufacturers operating in the 1880s and 1890s sought from the United States Congress greater protection in the form of higher tariffs. Meanwhile, American glass, paper, and soap manufacturers, for which alkali was an intermediate good, vigorously resisted upward revisions of the specific tariffs on the various classes of alkali, believing that higher tariffs would drive up the price of alkali, thereby increasing their costs of production.

In making the case for greater protection, American alkali manufacturers cited higher wages in the United States than in Britain; these manufacturers argued for a tariff policy that would correct for the wage differential. One such alkali manufacturer was the Church & Dwight Company of Syracuse, New York.⁶¹ In 1896, E. Dwight Church, the First Vice-President of the company, wrote to the Congressional Committee on Ways and Means:

All we ask or expect is that such rates of duty will be given on alkalis, alkaloids, etc., competing with our makes as will compensate for the difference in labor and costs of

⁵⁹ *Foreign Commerce and Navigation of the United States* (1894 and 1897).

⁶⁰ *Tariff Acts Passed by the Congress*, 549.

⁶¹ Both the Church & Dwight Company and the SPC were located in Syracuse, New York, for reasons addressed later in this study.

raw materials between this and competing foreign countries. And we consider it proper to say right here that we are subjected to most severe competition from a powerful combination of foreign manufacturers, who under the existing tariff rates practically control this market. We refer particularly to the United Alkali Works, Limited, with operations which include almost the entire alkali section of and contiguous to St. Helens, England, and also the works of Messrs. Brunner, Mond & Co., Limited, successors to the Murgaetroyd [*sic*] Ammonia, Soda, and Salt Syndicate, Limited, of Middlewich, England.⁶²

The wage differential between the United States and Britain was, by no means, a new argument put forward by the alkali manufacturers. Earlier, in 1889, William B.

Cogswell, the General Manager and part owner of the SPC, reported to the Committee on Ways and Means that, if the specific tariff of 0.25¢ per pound of soda ash were eliminated, the SPC would reduce its wages by 15 percent.⁶³ Evidently, Cogswell was convincing; in 1890, the McKinley Tariff left the duty on soda ash intact.⁶⁴

In the United States, the glass, paper, and soap manufacturers—the chief purchasers of alkali—responded to the tariff in two ways. First, these manufacturers claimed that the tariff on alkali increased the costs of production, which the manufacturers were forced to pass along to consumers.⁶⁵ Laying forth this argument, the glass, paper, and soap manufacturers beseeched Congress to revise downward the specific tariffs on the classes of alkali.⁶⁶ Second, these industries used the tariff on alkali as a justification for seeking greater protection for themselves.⁶⁷ Essentially, the

⁶² Committee on Ways and Means, *Tariff Hearings: Hearing before the Committee on Ways and Means*, 54th Cong., 2nd sess., 1896, 130.

⁶³ Committee on Ways and Means, *Revision of the Tariff: Hearing before the Committee on Ways and Means*, 51st Cong., 1st sess., 1889, 342.

⁶⁴ *Tariff Acts Passed by the Congress*, 373.

⁶⁵ Though protective tariffs raised the price of manufactured goods, consumers gained from a consequent decline in the price of agricultural goods during this period. See Douglas A. Irwin, “Tariff Incidence in America’s Gilded Age,” *Journal of Economic History* 67, no. 3 (September 2007): 599.

⁶⁶ Committee on Ways and Means, *Tariff Hearings: Hearing before the Committee on Ways and Means*, 53rd Cong., 1st sess., 1893, 15.

⁶⁷ Committee on Ways and Means, *Revision of the Tariff: Hearing before the Committee on Ways and Means*, 51st Cong., 1st sess., 1889, 15.

glass, paper, and soap manufacturers were petitioning Congress for compensating duties.⁶⁸

To be sure, American tariff policy toward alkali was forged out of a domestic political debate, which occurred throughout the 1880s and 1890s, and not just during the immediate run-up to the Dingley Tariff. Moreover, American tariff policy toward alkali was both variable and consequential well before the Dingley Tariff. Toward the end of his letter to the Committee on Ways and Means, E. Dwight Church stated,

The reduction of the duty in the present so-called Wilson-Gorman act on sal soda or soda crystals from one-fourth to one-eighth of a cent per pound has been most detrimental, and indeed almost ruinous, to our interests, enabling our foreign competitors to largely control the American market. In simple justice to ourselves, as well as to the interest of the public revenue, sal soda or soda crystal should be made dutiable at one-fourth of a cent per pound, the same as soda ash, being the rate in the tariff acts of 1883 and 1890.

The Government statistics show an increase in the importation of these products in the year 1895, under the present low rate of duty, of about 12,000,000 pounds over the year 1894....⁶⁹

The case of the Church & Dwight Company illustrates that, just as the Dingley Tariff injured the British alkali industry, so too did the Wilson-Gorman Tariff injure the American alkali industry. Contrary to what the scholarly literature suggests, the Mongrel Tariff, McKinley Tariff, and especially the Wilson-Gorman Tariff were, with respect to alkali, significant pieces of legislation in both intention and effect.

Furthermore, the British alkali industry was quite sensitive to American tariff legislation years before the passage of the Dingley Tariff. Brunner, Mond and the UAC kept very much abreast of the tariff deliberations in the United States, regularly reporting any developments at annual shareholder meetings. In 1895, at the general meeting of the UAC, the Chairman of the company described how, during the previous

⁶⁸ If Industry A produces an intermediate good for Industry B, a compensating duty augments the level of protection already afforded to B by the level of protection afforded to A, in proportion with the intermediate good's share in the total costs of production of B. See Taussig, *Tariff History*, 196-197.

⁶⁹ Committee on Ways and Means, *Tariff Hearings: Hearing before the Committee on Ways and Means*, 54th Cong., 2nd sess., 1896, 131-132.

year, merely the uncertainty over the final formulation of the Wilson-Gorman Tariff was enough to hinder the UAC's sales to the United States.⁷⁰

It was imperative that the British alkali industry of the late nineteenth century monitor American tariff policy, since the industry relied so heavily upon exports to the United States. In the late 1880s and early 1890s, approximately half of Brunner's total *sales*, let alone *exports*, were to the United States.⁷¹ The American market was no less important for the UAC. In 1887, the Leblanc firms controlled an impressive 48.5 percent of the American market, while Brunner, Mond held 37.0 percent.⁷² A handful of American alkali manufacturers supplied the small remainder of the domestic market.⁷³ Interestingly, the United States received only a trickle of alkali exports from countries other than Britain. In Continental Europe, a rather large alkali industry grew up under moderately protectionist regimes.⁷⁴ However, the Continental alkali firms were not competitive enough to gain a foothold in the American market. In 1891/92, the United States imported 0.4 million pounds of alkali from Belgium, 0.6 million from France, 5.3 million from Germany, and 421.0 million from Britain.⁷⁵ Indubitably, Britain controlled the American alkali market.

Thus, when the Dingley Tariff went into effect in 1897, the British alkali industry found itself uniquely exposed, compared to its Continental counterparts. Over the next two years, British alkali exports to the United States fell off precipitously. Both Brunner, Mond and the UAC fully acknowledged the gravity of the situation, but

⁷⁰ CRO, DIC UA 3/7, *Reports of Proceedings at General Meetings*, 1891-1925.

⁷¹ Reader, 98.

⁷² Ibid.

⁷³ In the 1880s and 1890s, the main American alkali firms were the Church & Dwight Company, Mathieson Alkali Company, Michigan Alkali Company, Pennsylvania Salt Manufacturing Company, and SPC.

⁷⁴ Warren, 187-189.

⁷⁵ *Foreign Commerce and Navigation of the United States* (1892).

maintained a tinge of optimism amid the adversity posed by the Dingley Tariff. In 1898, John Brock, the Chairman of the UAC, addressed shareholders:

As our trade lay very largely with the United States, [the Dingley Tariff] has of course for the present considerably circumscribed our business with that country, and we have had to carefully consider what steps we should take in order to retain it, for we certainly do not mean to retire from that market (hear, hear, and applause).⁷⁶

Ultimately, the shareholders' applause was never vindicated, seeing as though the UAC failed to recapture its American market. Brunner, Mond followed a somewhat different course, which is lengthily detailed in the next section of this study. At any rate, both firms practically stopped exporting alkali to the United States by the early 1900s.⁷⁷

Suffice it to say, the workshop of the world ceased functioning as the workshop where the United States bought its alkali.

All of the foregoing textual evidence lends credence to the connection between American tariff policy and British alkali exports to the United States for the rough period from 1880 to 1905. But does such a relationship hold up to statistical scrutiny? The methodology for testing whether American tariff policy impacted British alkali exports to the United States involves a time-series regression using annual data. The dependent variable, the volume of American alkali imports from Britain, comes from the *Foreign Commerce and Navigation of the United States*, and is presented in Table 2. The key explanatory variable, the estimated *ad valorem* equivalent tariff that the United States imposed upon alkali imports from Britain, is taken from the previous section of this study (see Table 1).

The first of two control variables is the volume of British alkali exports to Scandinavia. The rationale for including this unlikely control variable deserves some elaboration. In the late nineteenth century, the British alkali industry routinely faced the indictment that its international competitiveness suffered, not because of foreign tariffs,

⁷⁶ CRO, DIC UA 3/7, *Reports of Proceedings at General Meetings*, 1891-1925.

⁷⁷ Warren, 192.

Table 2. BRITISH ALKALI EXPORTS TO THE UNITED STATES, 1880-1905

<i>Year ending June 30</i>	<i>British alkali exports to the United States (million pounds)</i>	<i>Year ending June 30</i>	<i>British alkali exports to the United States (million pounds)</i>
1880	368.4	1893	508.3
1881	337.9	1894	317.3
1882	356.8	1895	395.5
1883	412.5	1896	337.9
1884	398.4	1897	250.3
1885	366.0	1898	134.7
1886	396.3	1899	77.1
1887	389.0	1900	108.5
1888	391.1	1901	54.9
1889	401.9	1902	42.5
1890	435.4	1903	39.1
1891	447.4	1904	31.4
1892	421.0	1905	29.3

Source: United States, Treasury Department, Bureau of Statistics, *Foreign Commerce and Navigation of the United States* (Washington, DC: Government Printing Office, various years).

but because of technical sluggishness, exemplified by the British alkali industry's retention of the comparatively inefficient Leblanc process.⁷⁸ Perhaps then, the volume of American alkali imports from Britain was determined by the technical efficiency (or inefficiency) of the British alkali industry. More broadly, perhaps the volume of American alkali imports from Britain was determined, at least in part, by the overall productivity of the British alkali industry within an international context. Accordingly, the regression employs a control variable that captures the British alkali industry's productivity.

In the 1880s and 1890s, there blossomed an appreciable trade between Britain and the Scandinavian countries of Denmark, Norway, and Sweden.⁷⁹ Alkali was certainly a part of this trade. At the time, Scandinavia could just as easily have purchased alkali from countries other than Britain; Germany and France were net

⁷⁸ *Ibid.*, 185.

⁷⁹ S. B. Saul, *Studies on British Overseas Trade, 1870-1914* (Liverpool: Liverpool University Press, 1960), 107.

exporters of alkali during this period.⁸⁰ If the Continental alkali industry became more productive than the British alkali industry, owing to either greater technical efficiency or any number of other reasons, Scandinavia could have switched from purchasing British alkali to purchasing German or French alkali. The reverse holds true, as well. In this sense, the volume of British alkali exports to Scandinavia proxies for the relative productivity of the alkali industry in Britain, as compared to the alkali industry in Continental Europe.

During the late nineteenth century, the Scandinavian countries of Denmark, Norway, and Sweden were unique in that each of these countries admitted alkali free of any duty.⁸¹ The volume of British alkali exports to Scandinavia is therefore a fitting control variable; the series is unaffected by protective legislation. Although other countries admitted alkali free of duty, only industrial and industrializing countries, such as the Scandinavian nations, represented anything more than a negligible and sporadic market for alkali. To give an idea, in 1885, Britain exported fourteen times as much alkali, by volume, to Scandinavia than to all of British India.⁸²

The volume of British alkali exports to Scandinavia is calculated by aggregating the volumes of British alkali exports to Denmark, Norway, and Sweden, which are recorded in the *Trade of the United Kingdom*. Because this control variable comes from the British trade statistics, and because the dependent variable comes from the American trade statistics, the control variable is inescapably lagged by a half year, as discussed earlier.⁸³ One further complication arises from the *Trade of the United Kingdom* disaggregating alkali into its constituent classes beginning in 1901. For certain

⁸⁰ Warren, 187-189.

⁸¹ United Kingdom, House of Commons, *Foreign and Colonial Import Duties* (London: Her Majesty's Stationery Office, various years).

⁸² *Trade of the United Kingdom* (1885).

⁸³ Leading, as opposed to lagging, this control variable by a half year does not materially alter the statistical significance of any of the coefficients in the regression equation.

classes of alkali, British exports to each of the Scandinavian countries are not recorded separately, thereby precluding any reliable calculation of the total volume of British alkali exports to Scandinavia for the years 1901 to 1905. As a result, the time-series regression covers just the twenty-one years from 1879/80 to 1899/1900, with the control variables dating from 1880 to 1900.

The second control variable is the year-on-year percent change in Charles Feinstein's index of total British industrial production.⁸⁴ This variable controls for the possibility that macroeconomic movements affected the volume of American alkali imports from Britain.⁸⁵ While any comprehensive analysis of the relationship between macroeconomic fluctuations and trade volumes falls outside the scope of this study, it is nevertheless worthwhile to employ a control variable that captures some degree of macroeconomic movement in the exporting country, especially given the tendency of firms to push exports when domestic demand ebbed.

The results of the time-series regression are presented in Table 3. As the adjusted R^2 indicates, the regression explains 64 percent of the variation in the volume of American alkali imports from Britain. Only the constant and the coefficient of the *ad valorem* equivalent tariff are statistically significant, and are so at the 1 percent level. This statistical finding nicely corroborates the abundance of textual evidence that American tariff policy determined the volume of alkali imports from Britain in the 1880s and 1890s.

⁸⁴ Charles Feinstein, *National Income, Expenditure and Output of the United Kingdom, 1855-1965* (Cambridge: Cambridge University Press, 1972), Table 51.

⁸⁵ Incidentally, it was during the late 1880s that American and British business cycles began to desynchronize. See Saul, 117.

Table 3. REGRESSION: BRITISH ALKALI EXPORTS TO THE UNITED STATES

<i>Dependent variable: British alkali exports to the United States, 1880-1900</i>	
<i>Ad valorem</i> equivalent tariff	-11.66 * (-4.07)
Time	-0.69 (-0.11)
British alkali exports to Scandinavia	2.08 (0.58)
British industrial output	-0.55 (-0.15)
Constant	686.75 * (5.22)
	n = 21 R ² = 0.71 Adjusted R ² = 0.64

Notes: * indicates significance at the 1 percent level. The t-values are listed in parentheses.

It might be argued—and not unreasonably—that the small number of observations is a weakness of this regression.⁸⁶ Unfortunately, only annual data are available for the variables. Working with this annual data, the selection of the years 1879/80 to 1899/1900 as the time span for the regression is not arbitrary. The motivation for choosing this range finds articulation in the words of the economic historian Percy Ashley: “To the great disturbance and distress of business, and during the short period of fourteen years, from 1883 to 1897, there were four complete revisions of the tariff.”⁸⁷ Thus, the time span of the regression, from 1879/80 to 1899/1900, covers the fourteen years described by Ashley, as well as several years on each end, in order to account for the full transitions surrounding the Mongrel Tariff of

⁸⁶ Of course, the critical t-value is higher, given the smaller number of observations. Even still, the constant and coefficient of the *ad valorem* equivalent tariff are statistically significant at the 1 percent level.

⁸⁷ Ashley, 190-191.

1883 and the Dingley Tariff of 1897. The four tariff acts passed between 1883 and 1897 arose out of a renaissance in the tariff debate, following the relatively dormant period of the 1870s. In some respect, the renaissance ended with the passage of the Dingley Tariff, which remained in effect for an astonishing twelve years until the Payne-Aldrich Tariff (1909). Indeed, the Mongrel Tariff, McKinley Tariff, Wilson-Gorman Tariff, and Dingley Tariff together form an identifiable cluster of American tariff legislation, which serves as a temporal undergirding of the analysis in this study.

The time span of 1879/80 to 1899/1900 also corresponds to the evolution of the American alkali industry. In the 1870s, there operated in the United States only a handful of alkali manufacturers, and just a single producer of soda ash: the Pennsylvania Salt Manufacturing Company.⁸⁸ By the early 1900s, the American alkali industry had greatly expanded, in terms of both the number of producers and the volume of production. The rise in the volume of production was nothing short of meteoric; whereas the whole of the United States produced 40.3 million pounds of alkali in 1880, the SPC alone was producing over 500 million pounds annually by the 1900s.⁸⁹ The twenty-one-year range of the regression covers the fullness of this transition.

A drawback of the regression equation is the high residual for 1896/97. The statistical explanation for the high residual is that American alkali imports from Britain registered a considerable decrease in 1896/97, the year before the enactment of the Dingley Tariff and its higher duties on alkali. There remains the question of why such a decrease occurred prior to the Dingley Tariff. The secondary source material has neglected this important question until now.

⁸⁸ Haber, 148.

⁸⁹ Edward H. Hempel, *The Economics of Chemical Industries* (New York: John Wiley & Sons, 1939), 160; CRO, DIC BM 5/1, *Statistics*, 1884-1908.

Turning to politics, the Dingley Tariff came on the heels of the American presidential election of 1896, which has been memorialized for its association with the national debate over the money supply, with the Democrats supporting the monetization of silver and the Republicans supporting adherence to the gold standard. While the money supply was the focal point of the election of 1896, there were other matters at stake, as well. The Republicans espoused a strong policy of protection, and initially tried to center the election on the tariff question, before the Democrats forced the issue of the money supply.⁹⁰ When the Republicans emerged victorious from the election of 1896, tariff reform was high on their legislative agenda, so high that the freshly inaugurated President McKinley called a special session of Congress for the purpose of drafting and passing a new tariff act.⁹¹ The Wilson-Gorman Tariff, aside from being insufficiently protectionist for the Republican palate, also left a shortfall in the budget of the United States.⁹² For these reasons, it was only a matter of time before Congress replaced the Wilson-Gorman Tariff with a highly protectionist and revenue-generating piece of legislation.

In the early months of 1897, businesses likely anticipated the Dingley Tariff, and the American alkali firms were no exception. Rather than wait idly for higher duties, American alkali manufacturers began to compete amongst themselves for the soon-to-be-forfeited share of the domestic market held by British firms. The minutes of the March 15, 1897 general meeting of the UAC provide a vivid account of the competition:

⁹⁰ F. W. Taussig, "The United States Tariff Act of 1897," *Economic Journal* 7, no. 28 (December 1897): 593. The Republican campaign slogan was intended to be "Protection and Prosperity."

⁹¹ *Ibid.*, 592. During the 51st Congress, the future President William McKinley served as the Chairman of the Committee on Ways and Means in the House of Representatives. Under his supervision, the Tariff Act of 1890 was crafted. Hence, the Tariff Act of 1890 became known as the McKinley Tariff.

⁹² Taussig, *Tariff History*, 324-325.

When [the election of 1896] was decided in favour of Mr. McKinley, then immediately began the movement for an increase of the Tariff. All this unsettled trade; and the promise of increased demand for our goods fell away. This change was felt keenly by the American manufacturers of Sodas, and they began a severe competition with each other, by which prices were run down to a figure unprecedentedly low...Of course, while this war of prices was going on, we considered it best to stand aside to a large extent, and to let the domestic makers take the loss...⁹³

Therefore, via unprofitably low prices, competition amongst the American alkali manufacturers hastened the demise of British alkali exports to the United States many months before the passage of the Dingley Tariff on July 24, 1897, hence the high residual. The unprofitably low prices hurt not only the UAC's exports to the United States, but also Brunner's.⁹⁴ Between 1895/96 and 1896/97, Brunner's alkali exports to the United States declined by 26.4 percent.⁹⁵ Yet, for Brunner, Mond, there was a silver lining: though American alkali firms were driving out British exports, Brunner, Mond partially owned the largest American alkali firm: the SPC.

Before moving on to the next section, it is necessary to digress briefly and clarify the composition of the British alkali industry. In the late nineteenth century, two major players dominated this industry: Brunner, Mond and, after 1890, the UAC. Still, there were other firms operating in Britain. In the late nineteenth century, the third largest British alkali firm was Chance & Hunt, a Leblanc manufacturer that refrained from joining the UAC in 1890.⁹⁶ Furthermore, during the 1890s, several small alkali firms cropped up. One such firm, Murgatroyd & Company, was founded in 1893 and employed the ammonia-soda process.⁹⁷ However, the firm was short-lived, having been bought out by Brunner, Mond in 1895.⁹⁸ In bringing up the example of Murgatroyd & Company, this study does not intend to shift the focus unduly in the direction of smaller

⁹³ CRO, DIC UA 3/7, *Reports of Proceedings at General Meetings*, 1891-1925.

⁹⁴ CRO, DIC BM 3/1/2, *Board Minutes*, 1890-1898.

⁹⁵ CRO, DIC BM 5/1, *Statistics*, 1884-1908.

⁹⁶ Stephen Miall, *A History of the British Chemical Industry* (London: Ernest Benn, 1931), 20.

⁹⁷ Reader, 108.

⁹⁸ *Ibid.*, 111.

British alkali manufacturers, but rather to point out that the British alkali industry encompassed large and small firms alike.

Tariff Policy and Brunner, Mond

The SPC was incorporated in 1881 with an initial capitalization of \$300,000. Solvay & Cie. of Belgium, the originator and licensor of the ammonia-soda process, contributed \$100,000.⁹⁹ Rowland Hazard, a Rhode Island industrialist whose family already made a fortune in the textile business, contributed a further \$100,000; William B. Cogswell, a mining engineer, invested \$95,000; and three other individuals contributed the remaining \$5,000.¹⁰⁰ The investors believed that their venture, aptly named the Solvay Process Company (lest anyone mistakenly assume that the firm used the inefficient Leblanc process!), would successfully compete against the British alkali firms for the American market.

From its very inception, the SPC seemed to have everything going for it. Perhaps the greatest strength of the SPC was its location in Syracuse, New York, where salt, limestone, and water, the main inputs in the ammonia-soda process, were abundant.¹⁰¹ Salt was only recently discovered in the region in 1878.¹⁰² Hazard and Cogswell recognized the importance of this discovery, and were eager to capitalize upon it, just as soon as they obtained a license for the ammonia-soda process from Solvay & Cie. The SPC further availed itself of the bountiful natural resource endowments of the region when the firm acquired the nearby Tully salt beds in 1889.¹⁰³ This acquisition represented a degree of vertical integration that seldom existed in the

⁹⁹ Bertrams, 48-49.

¹⁰⁰ Ibid.

¹⁰¹ Reader, 98.

¹⁰² Hempel, 25.

¹⁰³ Bertrams, 49.

British alkali industry. In Britain, the alkali manufacturers typically purchased salt from separate firms and, after 1888, from the Salt Union.¹⁰⁴ In fairness, Britain hardly possessed inferior natural resources for the production of alkali. The British alkali industry of the nineteenth century flourished, in no small way, because of the rich salt deposits of Cheshire.¹⁰⁵

Access to railways and frontage on the Erie Canal further enhanced the location of the SPC.¹⁰⁶ The Church & Dwight Company, an American alkali manufacturer primarily engaged in the production of bicarbonate soda, was also drawn to the opportune location of Syracuse and built a factory there in the 1890s. The SPC gained a steady customer in the Church & Dwight Company; each year, the SPC sold \$200,000 worth of soda ash to the Church & Dwight Company, which the latter further refined into bicarbonate soda, the only major class of alkali marketed to households.¹⁰⁷

Far from being guaranteed, the success of the SPC depended upon the vicissitudinous tariff policy of the United States remaining favorable to domestic alkali manufacturers. For example, in 1889, the SPC invested \$400,000 in equipment for the production of caustic soda.¹⁰⁸ In speaking before the Congressional Committee on Ways and Means later that same year, Cogswell stated, “If the tariff should be lowered materially on caustic soda, we should have to stop our works.”¹⁰⁹ Though the McKinley Tariff of 1890 did not lower the duty on caustic soda, American tariff policy held the

¹⁰⁴ Reader, 103-104.

¹⁰⁵ On this point, Sir Alfred Mond wrote, “In this industry, as in the case of many others, England had an early predominance of manufacture, which was largely due to the favorable conditions obtaining as regards raw materials...” G. R. Porter, *The Progress of the Nation*, New ed. (London: Methuen, 1912), 413.

¹⁰⁶ Haynes, 270.

¹⁰⁷ Church & Dwight Archive (CDA), *General Ledger*, 1896-1902. The Church & Dwight Company maintains an informal archive, which has been overlooked by scholars in recent decades. The author wishes to thank Mr. Jim Levine of the Church & Dwight Company for generously granting access to this wealth of material.

¹⁰⁸ Committee on Ways and Means, *Revision of the Tariff: Hearing before the Committee on Ways and Means*, 51st Cong., 1st sess., 1889, 343.

¹⁰⁹ *Ibid.*

potential to render nearly worthless the SPC's \$400,000 investment in causticizing equipment. The American alkali industry was born out of significant risk-taking.

Brunner, Mond shouldered a portion of this risk when, in 1887, the British firm purchased a \$200,000 minority stake in the SPC, by then capitalized at \$1.2 million.¹¹⁰ Brunner's foreign portfolio investment in the SPC was surely not an arbitrary one. Throughout the mid 1880s, the SPC gradually encroached upon Brunner's American market, with the effect of reducing the profits that Brunner, Mond derived from this critical region of the world. By acquiring a financial position in the SPC, Brunner, Mond attempted to continue profiting from the American market, albeit indirectly through a foreign portfolio investment. The original shareholders of the SPC were prepared to allow Brunner, Mond to acquire a financial position, but only on the condition that the SPC was guaranteed, until 1892, four-ninths of the portion of the American alkali market jointly supplied by the two firms.¹¹¹ Thus, Brunner, Mond exchanged profits from exports for profits from investment. Meanwhile, the SPC gained market share, whilst avoiding internecine competition.

Brunner's minority shareholding came with the further caveat that the British firm surrender its voting rights, through an irrevocable proxy, to the Hazard family.¹¹² In the 1880s, antitrust sentiment was building in the United States, and the stipulation that Brunner, Mond surrender its voting rights reflected this sentiment. The American investors held an irrevocable proxy for some of Solvay & Cie.'s shares too.¹¹³ Brunner's willingness to relinquish its voting rights was indicative of the true intention

¹¹⁰ Wilkins, 404; Bertrams, 49.

¹¹¹ Reader, 98-100. Brunner, Mond and the SPC could still expand their joint share of the American market, though at the expense of other American manufacturers or the British Leblanc manufacturers.

¹¹² *Ibid.*, 100.

¹¹³ Bertrams, 83.

behind this foreign portfolio investment: passively earned profits, and not active control.

Whether Brunner, Mond initially conceived of its investment in the SPC as a financial hedge against American tariff policy is uncertain. W. J. Reader and the author of this study are inclined to think so.¹¹⁴ However, as the 1890s wore on, Brunner, Mond clearly recognized how its minority shareholding in the SPC mitigated the British firm's financial exposure to the American tariff on alkali. Brunner, Mond augmented its investment in the SPC whenever the directors of the SPC increased the authorized capital, which happened recurrently. In 1892, the authorized capital of the SPC was doubled from \$1.5 to \$3.0 million, and shortly thereafter increased to \$4.0 million in 1895, as recorded in the *Board Minutes* of Brunner, Mond.¹¹⁵ Recall that the SPC began with an initial capitalization of only \$300,000. Each time that the directors of the SPC authorized additional capital, the current investors were permitted to increase their shareholdings pro rata, with one minor exception. On at least two occasions, when the directors of the SPC authorized the issuance of more shares, a small number of shares were "reserved to be sold at the discretion of the Trustees."¹¹⁶ In such a way, Brunner's stake in the SPC became slightly diluted. While Bertrams et al. are correct to claim that Brunner's shareholding in the SPC amounted to 16.7 percent in 1887, a close inspection of the *Board Minutes* of Brunner, Mond reveals that, by 1895, the shareholding had fallen to 15.9 percent, with Brunner, Mond owning 6,370 of the 40,000 shares issued.¹¹⁷

Now, this study turns to quantitatively addressing the question left unanswered by the secondary source material: to what extent did Brunner's minority shareholding in the SPC mitigate Brunner's financial exposure to the American tariff on alkali? Put

¹¹⁴ Reader, 98.

¹¹⁵ CRO, DIC BM 3/1/2, *Board Minutes*, 1890-1898.

¹¹⁶ Ibid.

¹¹⁷ Bertrams, 49; CRO, DIC BM 3/1/2, *Board Minutes*, 1890-1898.

Table 4. BRUNNER'S AMERICAN ALKALI MARKET, 1888-1904

<i>Year ending June 30</i>	<i>Brunner's alkali exports to the United States (million pounds)</i>	<i>SPC's alkali sales in the United States (million pounds)</i>	<i>Brunner's 16 percent share of the SPC's alkali sales in the United States (million pounds)</i>	<i>Brunner's American alkali market (million pounds)</i>
1888	106.0	86.2	13.8	119.8
1889	114.4	102.7	16.4	130.8
1890	138.9	110.9	17.7	156.7
1891	137.0	122.5	19.6	156.6
1892	148.9	158.1	25.3	174.2
1893	175.1	152.4	24.4	199.5
1894	128.2	150.8	24.1	152.3
1895	158.7	190.2	30.4	189.1
1896	143.9	218.0	34.9	178.8
1897	105.9	264.2	42.3	148.2
1898	44.0	363.2	58.1	102.1
1899	21.5	469.7	75.1	96.6
1900	61.1	549.0	87.8	148.9
1901	26.3	509.1	81.4	107.7
1902	19.0	573.2	91.7	110.7
1903	17.2	635.5	101.7	118.9
1904	14.1	654.3	104.7	118.8

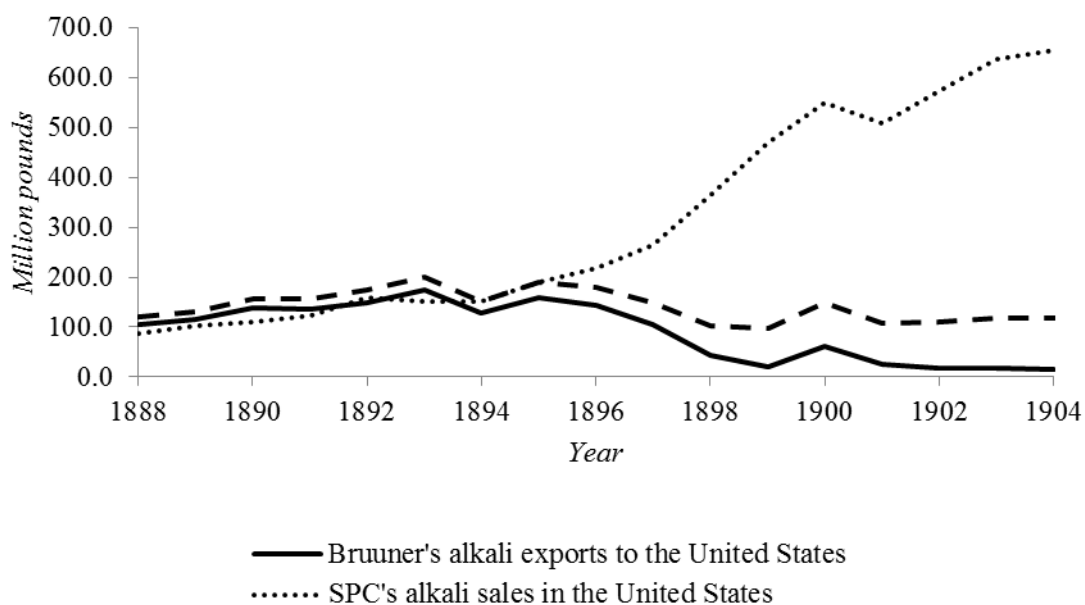
Source: CRO, DIC BM 5/1, *Statistics*, 1884-1908.

another way, to what extent did Brunner, Mond, operating at the microeconomic level, counteract the financial effect of American tariff policy, operating at the macroeconomic level? In light of the disastrous impact of the Dingley Tariff on the British alkali industry, these questions take on an even greater meaningfulness.

The first step in the methodology entails determining the volume of Brunner's American market, or more specifically, the volume of the American alkali market upon which Brunner, Mond laid claim to the profits, both directly through its exports from Winnington and indirectly through its partial ownership of the SPC. The volume of Brunner's American alkali market is therefore calculated as the sum of a) Brunner's exports to the United States and b) 16 percent of the SPC's sales in the United States,

Figure 1. BRUNNER'S AMERICAN ALKALI MARKET, 1888-1904

Source: CRO, DIC BM 5/1, *Statistics*, 1884-1908.



representing the portion of the SPC's sales of which the profits accrued to Brunner, Mond. This study settles on the round figure of 16 percent for Brunner's stake in the SPC, since the actual share of ownership was somewhere between 15.9 and 16.7 percent, at various points in time.¹¹⁸

Table 4 and Figure 1 present data on Brunner's annual alkali exports to the United States and the SPC's annual alkali sales in the United States. The two series are taken from Brunner's *Statistics*, a ledger that records a plethora of data relating to the operations of both Brunner, Mond and the SPC; Brunner, Mond evidently exercised great diligence in monitoring the operations of the SPC. In the ledger, both Brunner's alkali exports to the United States and the SPC's alkali sales in the United States are recorded as monthly data, which enables the construction of annual series that harmonize with the American fiscal year, running from July 1 to June 30. Because the monthly data go from June 1887 to December 1904, the two constructed annual series

¹¹⁸ Because 16 percent lies toward the lower bound of the range, the selection of this figure is biased against the postulations of this study.

span just the seventeen years from 1887/88 to 1903/04. The final column of Table 4 gives the volume of Brunner's alkali market in the United States, as calculated by the author.

The log of the volume of Brunner's alkali market in the United States serves as the dependent variable in a log-log, time-series regression. The principal explanatory variable is the log of the estimated *ad valorem* equivalent tariff that the United States imposed upon alkali imports from Britain. The volume of British alkali exports to Scandinavia is dropped from this regression, and for good reason. As mentioned before, a reliable calculation of the total volume of British alkali exports to Scandinavia is unachievable after 1900, owing to the peculiarities of recording in the *Trade of the United Kingdom*. Including this control variable would reduce the already small number of observations in the regression from seventeen (1887/88-1903/04) to thirteen (1887/88-1899/1900). Hence, the variable is dropped. The year-on-year percent change in the index of British industrial production is retained, in levels, as a lagged control variable in this regression.

The results of the regression are presented in the first column of Table 5. As expected, only the constant and the coefficient of the log of the *ad valorem* equivalent tariff are statistically significant, and are so at the 1 percent level. The virtue of performing this regression as log-log lies in the interpretation of the coefficient of the log of the *ad valorem* equivalent tariff as the elasticity of Brunner's alkali market in the United States to the American tariff on alkali. The coefficient of -0.74 indicates that, on average and *ceteris paribus*, a 1 percent increase (e.g. from 30.0 percent to 30.3, not from 30.0 to 31.0 percent) in the *ad valorem* equivalent tariff on British alkali resulted in a 0.74 percent decrease in the volume of Brunner's American market. Though certainly not immune to American tariff policy, the volume of Brunner's American

Table 5. REGRESSION: BRUNNER'S AMERICAN ALKALI MARKET

	<i>Dependent variable: Brunner's alkali sales in the United States (log), 1888-1904</i>	<i>Dependent variable: British alkali exports to the United States (log), 1880-1900</i>
<i>Ad valorem</i> equivalent tariff (log)	-0.74 * (-3.61)	-2.01 * (-4.62)
Time	-0.01 (-1.28)	0.00 (0.10)
British alkali exports to Scandinavia		0.02 (1.05)
British industrial output	0.00 (0.15)	0.01 (0.63)
Constant	7.62 * (11.23)	12.27 * (10.23)
	n = 17 R ² = 0.65 Adjusted R ² = 0.57	n = 21 R ² = 0.76 Adjusted R ² = 0.70

Notes: * indicates significance at the 1 percent level. The t-values are listed in parentheses.

market—again, more precisely, the volume of the American alkali market upon which Brunner, Mond laid claim to the profits—responded in a less than unit elastic manner.

The second column of Table 5 adapts the time-series regression from Table 3 to a log-log format, with the volume of American alkali imports from Britain and the *ad valorem* equivalent tariff that the United States imposed upon those alkali imports both now expressed as logs. This log-log, time-series regression keeps the same control variables as in Table 3, and covers the twenty-one years from 1879/80 to 1899/1900. As Table 5 shows, only the constant and the coefficient of the log of the *ad valorem* equivalent tariff are statistically significant. The coefficient of the log of the *ad valorem* equivalent tariff is -2.01, with the interpretation being that, on average and *ceteris paribus*, a 1 percent increase in the *ad valorem* equivalent tariff on British alkali resulted in a 2.01 percent decrease in the volume of American alkali imports from

Britain. Whereas the volume of Brunner's alkali market in the United States exhibited an inelastic response to the tariff on alkali, the volume of British alkali exports to the United States exhibited a highly elastic response to the tariff on alkali.

In a counterfactual exercise, assume that Brunner, Mond did not acquire a shareholding in the SPC. Under this scenario, the volume of Brunner's American market would have been no more than the volume of Brunner's alkali exports from Winnington to the United States, which likely would have exhibited a highly elastic response to American tariff policy on par with the highly elastic response exhibited by the overall British alkali industry's exports to the United States. By making a foreign portfolio investment in the SPC, Brunner, Mond substantially reduced how elastically the volume of Brunner's American market responded to the American tariff on alkali.

Instead of comparing the elasticity of Brunner's American market with the elasticity of the overall British alkali industry's exports to the United States, it might be tempting to compare the elasticity of Brunner's American market with the elasticity of just Brunner's alkali exports to the United States. Doing so, it might be argued, would provide a more accurate representation of the extent to which Brunner's shareholding in the SPC reduced how elastically the volume of Brunner's American market responded to the *ad valorem* equivalent tariff on British alkali. However, this line of reasoning ignores the fact that, beginning in 1887, Brunner, Mond contractually limited its exports to the United States as a condition of purchasing shares in the SPC. Returning to the counterfactual world briefly, had Brunner, Mond not acquired a minority shareholding in the SPC, the elasticity of Brunner's alkali exports to the United States would have more closely resembled the elasticity of the overall British alkali industry's exports to the United States than the elasticity of Brunner's legally restricted alkali exports to the United States. Accordingly, the most fitting comparison is between the elasticity of

Brunner's American market and the elasticity of total British alkali exports to the United States.

Given all of the assumptions in the analysis, as well as the slightly different time spans covered by the two regressions, fixating upon -0.74 and -2.01 as the exact elasticities to the American tariff on alkali is akin to chasing after a will-o'-the-whisp. Moreover, these elasticities are only averages; the point elasticities vary over the entire range of the *ad valorem* equivalent tariff that the United States imposed upon alkali imports from Britain. Here, the crucial observation is that, to a very considerable degree, Brunner, Mond reduced how elastically the volume of its alkali market in the United States responded to the American tariff policy toward alkali.

The argument originally put forward in this study is that, by acquiring a minority shareholding in the SPC, Brunner, Mond greatly mitigated its financial exposure to the American tariff on alkali. Yet, how does the elasticity of a market correspond to the financial exposure of a firm? Two assumptions are necessary. The first assumption is rather pedestrian: Brunner's marginal revenues exceeded its marginal costs. As the volume of Brunner's American market increased, so too did Brunner's profits increase, *ceteris paribus*. The reverse would need to hold true, as well. The second assumption is likely to incite greater skepticism: the average profit margin on alkali produced by the SPC equaled the average profit margin on alkali produced by Brunner, Mond. In other words, from a profitability standpoint, Brunner, Mond would remain indifferent between the following two scenarios: a) increasing its alkali exports to the United States by 16.0 million pounds or b) the SPC increasing its alkali sales in the United States by 100.0 million pounds, with 16 percent of the profits from these additional sales accruing to Brunner, Mond. The results of the log-log regressions in Table 5 are only illustrative of Brunner, Mond mitigating its financial exposure to the

Table 6. NEW YORK CITY WHOLESALE PRICES OF ALKALI, 1897-1901

<i>Month</i>	<i>70% caustic soda (¢ per pound)</i>	<i>48% soda ash (¢ per pound)</i>
April 1897	1.90	0.85
October 1897	1.75	0.78
April 1898	1.45	0.70
October 1898	1.40	0.65
April 1899	1.45	0.75
October 1899	1.75	0.95
April 1900	1.85	1.00
October 1900	1.80	0.90
April 1901	1.90	0.90
October 1901	1.90	0.90

Source: Oil, Paint and Drug Reporter (New York: William O. Allison, various years).

American tariff on alkali insofar as this British firm did not curtail its average profit margin per unit of alkali by expanding its overall American market to encompass an indirect American market via partial ownership in the SPC. Of course, had the SPC's average profit margin per unit of alkali sold in the United States exceeded Brunner's average profit margin per unit of alkali exported to the United States, Brunner, Mond would have mitigated its financial exposure to American tariff policy even more so. At a minimum, the task now is to prove reasonable the assumption that the average profit margin on alkali produced by the SPC equaled the average profit margin on alkali produced by Brunner, Mond. Three points follow.

First, Brunner, Mond and the SPC used the same process (ammonia-soda) for manufacturing alkali. In this respect, the two firms employed a process that was both technically innovative and financially rewarding, as compared to the Leblanc process.¹¹⁹ However, it was hardly a foregone conclusion that, in the early 1880s, when the merits of the ammonia-soda process were still being debated, there would have

¹¹⁹ For an excellent discussion of the profitability of the Leblanc and ammonia-soda processes, see Peter H. Lindert and Keith Trace, "Yardsticks for Victorian Entrepreneurs," in *Essays on a Mature Economy: Britain after 1840*, ed. Donald N. McCloskey (London: Methuen, 1971).

developed in the United States an alkali industry based upon this method of production. As late as 1889, the Alkali Inspector in Britain wrote the following about the competition between the Leblanc and ammonia-soda processes: “How long this precarious balance of force will be maintained must be left for the future to disclose.”¹²⁰ In any event, the SPC employed the ammonia-soda process, and the not-too-distant future disclosed that the SPC was on the winning side of technology—along with Brunner, Mond.¹²¹ Thus, between the two firms, there did not exist discrepant processes to drive a divergence in profitability.

Second, even a rudimentary comparison of the money wages in the American and British alkali industries is revealing.¹²² This author’s very preliminary findings are that money wages in the American alkali industry did not greatly exceed money wages in the British alkali industry, with the implication being that wages cut into the American alkali industry’s profits only marginally more than the British alkali industry’s profits. Church & Dwight’s *Time Book* records the biweekly wages of its non-salaried employees, including both factory and office workers.¹²³ In the *Time Book*, the first complete biweekly interval runs from January 6, 1894 through January 19, 1894, during which time 299 employees earned wages. The mean biweekly wage was \$17.45, or \$8.73 per week. The median biweekly wage was \$16.78, or \$8.39 per week. These figures are broadly consistent with the money wages of workers in the British alkali industry. In 1892, the average weekly wage at the Widnes Alkali Works, taking into consideration both factory and office workers there, was £1 12s., or \$7.78 at the

¹²⁰ United Kingdom, House of Commons, *Annual Report on Alkali &c. Works* (London: Her Majesty’s Stationery Office, 1889), 12. In Britain, the Alkali Inspector was a government official who ensured compliance with the Alkali, &c. Works Regulation Acts of 1881 and 1892.

¹²¹ J. H. Clapham, *Machines and National Rivalries (1887-1914)*, vol. 3 of *An Economic History of Modern Britain* (Cambridge: Cambridge University Press, 1938), 173.

¹²² A more exhaustive comparison of wages in the American and British alkali industries is an area ripe for further research.

¹²³ CDA, *Time Book*, 1894-1895.

gold-standard peg of \$4.86 per £1.¹²⁴ To be sure, this study does not allege that wages in the American alkali industry equaled wages in the British alkali industry. Instead, the goal here is to provide evidence, even if fragmentary, that money wages in the American and British alkali industries were not so wildly divergent as proponents of the Habakkuk thesis might be inclined to believe.¹²⁵ Altogether, it is highly unlikely that there existed a large enough wage differential between Brunner, Mond and the SPC to create a massive chasm between the average profit margins of these two firms.

The third point in support of the assumption that the average profit margin on alkali produced by the SPC equaled the average profit margin on alkali produced by Brunner, Mond comes from data on the price of alkali in the years following the passage of the Dingley Tariff. The *Oil, Paint and Drug Reporter* was a weekly bulletin that published the New York City wholesale prices of the various classes of alkali. Table 6 presents the New York City wholesale prices of 70% caustic soda and 48% soda ash, as listed in the *Oil, Paint and Drug Reporter* for the first week of April and October of each year from 1897 to 1901. As already discussed in an earlier section of this study, competition amongst the American alkali manufacturers drove down the price of alkali on the eve of the Dingley Tariff. However, by 1901, the price of alkali recovered to a level more than one-third higher than its trough in late 1898.¹²⁶ Although the SPC's profitability was compromised by the low price of alkali, which likely caused the SPC's average profit margin to fall short of Brunner's average profit margin between 1897 and 1899, this episode was not sustained for long.

¹²⁴ D. W. F. Hardie, *A History of the Chemical Industry in Widnes* (N.p.: Imperial Chemical Industries, 1950), 120.

¹²⁵ H. J. Habakkuk, *American and British Technology in the Nineteenth Century* (Cambridge: Cambridge University Press, 1962).

¹²⁶ *Oil, Paint and Drug Reporter*.

The textual evidence certainly does not refute the argument that Brunner, Mond substantially mitigated its financial exposure to American tariff policy by investing in the SPC; if nothing else, the evidence supports the argument. At the May 30, 1899 general meeting of Brunner, Mond, Sir John Brunner boldly stated, “I can congratulate you, gentlemen, upon the fact that we have so soon been able to recover from the heavy blow under which we suffered as the result of the practical loss of the American trade.”¹²⁷ No doubt, backing these celebratory words were dividends from the SPC, as well as the capital appreciation of Brunner’s shares in the SPC.¹²⁸ Both before and after the Dingley Tariff, the UAC looked with envy upon Brunner’s foreign portfolio investment in the SPC.¹²⁹ In a display of corporate pride, the directors of the UAC did not refer to Brunner’s shareholding in the SPC explicitly, but rather through thinly veiled references: “...we must follow the example of some of our competitors, and have an interest in manufacturing in the countries themselves.”¹³⁰ In large part, because of Brunner’s foreign portfolio investment in the SPC, Brunner, Mond forged ahead, while the UAC slipped further and further behind.

To imply that Brunner’s and the UAC’s profits hinged solely on the American alkali market is misleading. Still, it is not coincidental that, in the aftermath of the Dingley Tariff, Brunner’s profits grew and the UAC’s profits remained anemic.¹³¹ Figure 2 presents the net profits of Brunner, Mond and the UAC in the years 1895, 1900, and 1905. That Brunner’s net profits increased between 1895 and 1900 stands as

¹²⁷ CRO, DIC BM 3/12, *Minutes of Shareholder Meetings*, 1881-1929.

¹²⁸ Reader, 100. Because the SPC retained earnings, dividends alone are an inaccurate measure of the SPC’s profitability.

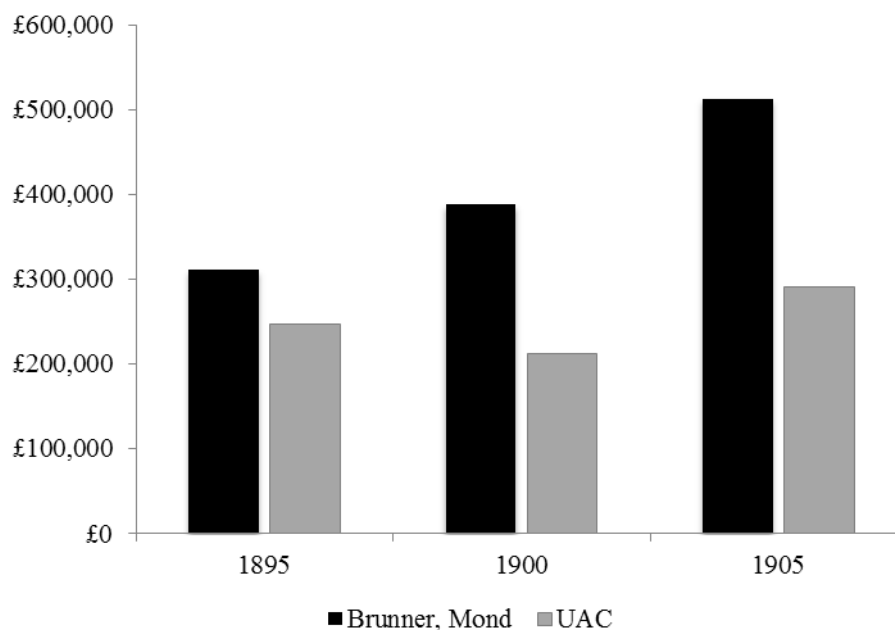
¹²⁹ CRO, DIC UA 3/7, *Reports of Proceedings at General Meetings*, 1891-1925.

¹³⁰ Ibid.

¹³¹ Reader, 513-514.

Figure 2. NET PROFITS OF BRITISH ALKALI FIRMS,
1895-1905

Source: Reader, 513-514.



a testament to the resiliency of this firm's decision making within a dynamic international context. Yes, the ammonia-soda process contributed to Brunner's success, but so too did the SPC.

In the late 1890s, the UAC hoped for a revival of its American market, which might have actually occurred, had the United States returned to lower duties on alkali.¹³² And given the frequency of American tariff acts in the 1890s, perhaps the UAC was simply biding its time until the political pendulum in the United States swung away from protectionism. To what extent the UAC believed that the United States might return to lower duties on alkali is difficult to judge. Needless to say, the UAC probably did not suspect that the Dingley Tariff would be the longest-governing tariff act in American history. Regardless, the UAC's exports to the United States ceased long before the passage of the Payne-Aldrich Tariff in 1909. By 1900, and certainly by 1901,

¹³² CRO, DIC UA 3/7, *Reports of Proceedings at General Meetings*, 1891-1925.

the common sentiment amongst the directors of the UAC was that the company had lost its American market irretrievably.¹³³ The loss of the American market placed the UAC in a rather unenviable position at the dawn of the twentieth century. Between 1897 and 1900, the UAC's total annual sales of caustic soda had fallen 17.0 percent.¹³⁴ And even worse, total annual sales of soda ash had fallen 31.2 percent.¹³⁵

In 1898, the UAC belatedly followed in the footsteps of Brunner, Mond by establishing the North American Chemical Company of Bay City, Michigan.¹³⁶ The North American Chemical Company primarily manufactured potassium chlorate, a minor class of alkali used in the match industry.¹³⁷ The UAC conceived of the North American Chemical Company as a vehicle for circumventing the 2¢ per pound specific tariff that the Dingley Tariff imposed upon potassium chlorate.¹³⁸ In 1899, John Brock, Chairman of the UAC, touted the North American Chemical Company as “an interest in manufacturing in the protected country” and as “a very satisfactory investment.”¹³⁹

In reality, the UAC's investment in the North American Chemical Company represented an amateurish imitation of Brunner's investment in the SPC. First, the UAC created the North American Chemical Company after the enactment of the Dingley Tariff and after the American alkali firms captured the share of the American market once held by the British alkali firms. By 1899, the dust (or ash, to make the expression more fitting) had already settled. Second, the North American Chemical Company was an expensive venture relative to the small market for potassium chlorate. The total cost

¹³³ Ibid. Whereas Brunner, Mond was a minority shareholder in the SPC, the UAC was the majority shareholder and creator of the North American Chemical Company.

¹³⁴ CRO, DIC UA 5/6, *Statistics of Annual Production and Sales, 1897-1927*.

¹³⁵ Ibid.

¹³⁶ Wilkins, 408.

¹³⁷ Ibid.

¹³⁸ CRO, DIC UA 17/17, *An Outline History of the North American Chemical Company of Bay City Michigan, 1898-1928*.

¹³⁹ CRO, DIC UA 3/7, *Reports of Proceedings at General Meetings, 1891-1925*.

of constructing the plant in Bay City amounted to approximately \$1.3 million.¹⁴⁰ For the UAC, under constant pressure to resume its dividend payments, which it had suspended in 1898, financing the construction of a new and likely unprofitable plant was an especially untimely and imprudent decision, even if the directors of the UAC believed that they did right simply by emulating Brunner, Mond. W. J. Reader best summarizes the North American Chemical Company in claiming that it was “not distinguished by success.”¹⁴¹

As typified by the SPC and the North American Chemical Company, financial capital flowed out of Britain and into the American alkali industry. But until now, this study has neglected the incalculable flow of human capital from the British alkali industry to the American alkali industry. This topic deserves at least a few words. In the late nineteenth century, Britain exported to the United States the technical know-how for manufacturing alkali. Particularly during the 1890s, many British chemical engineers and process laborers traversed the Atlantic and left their imprints upon the nascent alkali industry in the United States. In 1892, more than twenty men associated with one aspect or another of the British alkali industry journeyed from Runcorn and Widnes, England to the remote location of Saltville, Virginia, where they oversaw the construction of a soda ash factory for the newly incorporated Mathieson Alkali Company.¹⁴² The Michigan Alkali Company, incorporated in 1894, also benefited from the technical expertise that Britain exported to the United States.¹⁴³ John Baptiste Ford, the founder of the company, sought vertical integration for his already successful plate-

¹⁴⁰ Wilkins, 408.

¹⁴¹ Reader, 228.

¹⁴² W. F. Glasscock, *The Spread of the Ammonia-Soda Process Throughout the World and the Trade in its Products, 1863-1963* (N.p.: Imperial Chemical Industries, 1969), 25. The author wishes to thank Dr. Kenneth Bertrams of the Free University of Brussels for sharing a copy of this report.

¹⁴³ *Ibid.*, 38.

glass business.¹⁴⁴ To assist him in building a soda ash factory, Ford arranged for two brothers formerly employed by Brunner, Mond to travel from England to Wyandotte, Michigan.¹⁴⁵

The designs for the North American Chemical Company's Bay City plant were drawn up in England by Dr. Ferdinand Hurter, the head of the UAC's Central Research Laboratory.¹⁴⁶ Hurter himself was Swiss, but had immigrated to Britain in the 1860s to work for the Leblanc firm of Gaskell Deacon & Company.¹⁴⁷ As a Swiss-born chemist working in Britain on the designs for a plant in the United States, Hurter exemplified the international flows of human capital that characterized the alkali industry of the late nineteenth century. In the United States, Hurter's designs were executed by an engineer that the UAC sent over from Britain.¹⁴⁸

The SPC, however, did not draw upon the expertise of chemical engineers and process laborers from Britain, but rather from Belgium and France.¹⁴⁹ In this regard, the SPC stood out from the American alkali firms that came into existence during the 1890s. The SPC's orientation toward Continental Europe ought not come as a surprise; recall that the firm of Solvay & Cie. of Belgium was an initial investor in the SPC, whereas Brunner, Mond was not. If anything, Solvay & Cie.'s role as the main provider of technical know-how to the SPC reaffirms the purely financial motivations behind Brunner's investment in the SPC.

Notwithstanding the exceptional case of the SPC, the British alkali industry routinely exported human capital to the United States. Obviously, such a nebulous

¹⁴⁴ Haynes, 273.

¹⁴⁵ Ibid.

¹⁴⁶ CRO, DIC UA 3/7, *Reports of Proceedings at General Meetings*, 1891-1925. The Bay City plant was Hurter's final contribution to the alkali industry, as he died suddenly in 1898.

¹⁴⁷ Reader, 118.

¹⁴⁸ CRO, DIC UA 3/7, *Reports of Proceedings at General Meetings*, 1891-1925.

¹⁴⁹ Wilkins, 402.

export as human capital does not appear in any of the trade statistics. Nonetheless, in a story about the relationship between American tariff policy and British alkali exports, the export of human capital deserves at least passing mention. Absent the transfer of technical knowledge from the British alkali industry to the American alkali industry, even the most protective tariff policy would likely fail to induce the manufacture of alkali in the United States.

Conclusion

The most suitable ending for this study is the year 1905, when three otherwise separate developments concurrently and collectively signaled the end of active British involvement in the American alkali market. First, in 1905, Brunner, Mond entirely ceased exporting alkali to the United States.¹⁵⁰ Second, that same year, having long since held the title of the largest alkali plant in the United States, the SPC's Syracuse facility became the largest alkali plant in the world.¹⁵¹ The third and most telling development was that, in approximately the year 1905, the United States attained a self-sufficient level of alkali production.¹⁵² Indeed, the American alkali industry had entered into adulthood.

Yet, the title of this dissertation refers specifically to the British alkali industry. The British alkali industry of the late nineteenth century was distinguished by its colossal export market: the United States. In 1890, Britain exported eleven times more alkali to the United States than to its second largest foreign market, Russia.¹⁵³ Thus, when the United States Congress passed a quick succession of tariff legislation that revised the duties on alkali, the British alkali industry found itself destabilized in no

¹⁵⁰ Bertrams, 81.

¹⁵¹ Wilkins, 403.

¹⁵² Glasscock, 45.

¹⁵³ *Trade of the United Kingdom* (1890).

small way. This study has endeavored to chronicle the complex relationship between American tariff policy and the British alkali industry. But more than that, this study has examined the relationship from macroeconomic and microeconomic vantage points.

The first line of inquiry, the macroeconomic, addressed the effect of American tariff policy on the volume of British alkali exports to the United States. After considering an abundance of textual evidence from both British and American sources, this study concludes that the vicissitudinous American tariff policy of the late nineteenth century impacted British alkali exports to the United States. And while the British alkali industry most acutely felt the Dingley Tariff, prior tariff acts were hardly inconsequential pieces of legislation with no bearing upon the volume of alkali that the United States imported from Britain. In particular, the Wilson-Gorman Tariff's downward revisions of the specific tariffs on several classes of alkali prompted an increase in the volume of British alkali exports to the United States, much to the dismay of American alkali manufacturers and to the delight of the American manufacturers that used these classes of alkali as material inputs. Supplementing all the textual evidence, a time-series regression revealed that the estimated *ad valorem* equivalent tariff that the United States imposed upon alkali imports from Britain—a series constructed purposely for this study—is a statistically significant determinant of the volume of American alkali imports from Britain.

The second line of inquiry, the microeconomic, investigated how a single British alkali firm fared amid a changing American tariff policy toward alkali. This study concludes that Brunner, Mond substantially mitigated its financial exposure to the American tariff on alkali by making a foreign portfolio investment in the SPC, located by the tariff wall. Thus, when Congress enacted the Dingley Tariff, Brunner, Mond was able to evade any crippling effect upon the firm's financial condition. This finding

settles the uncertainty in the scholarly literature over the extent to which Brunner's minority shareholding in the SPC compensated for the loss of profits from direct exports to the United States. As Reader and Wilkins suspected, though never quite proved, Brunner's financial interest in the SPC compensated for the bulk of the lost profits.

The two findings of this study, macroeconomic and microeconomic, nicely coalesce. Between 1880 and 1905, American tariff policy affected British alkali exports to the United States. And cognizant of this interplay, one British alkali firm, Brunner, Mond, acted so as to render its profits less dependent upon its direct alkali exports to the United States. Hence, an occurrence at the macroeconomic level elicited a response at the microeconomic level.

Insofar as this study has touched upon elements of arguments put forward by Stephen N. Broadberry and Charles Feinstein, this study has corroborated their findings. In the late nineteenth century, there quickly arose in the United States an alkali industry that spanned several firms, thousands of employees, and many millions of dollars in capital. If only as a case study, the late nineteenth century development of the American alkali industry nicely aligns with what Broadberry describes as the United States devoting an increasing share of its population and resources to the manufacturing sector. Moreover, the late nineteenth century development of the American alkali industry, no doubt, conforms to Feinstein's first proposition of there being a foreign industrialization. The effect of the developing American alkali industry was a decline in the level of British alkali exports. In this sense, the British alkali industry more than conformed to Feinstein's second proposition; more than a decline in the growth rate of alkali exports, there was a decline in the level of alkali exports. This dissertation did not simply corroborate the arguments of Broadberry and Feinstein, but also subtly recast

them in the light of American tariff policy. It is the humble opinion of this author that the scholarly literature on comparative industrialization has much to gain from a better understanding of tariffs, which this dissertation has hopefully facilitated in some small measure.

All in all, by 1905, the British alkali industry parted with its old mainstay, the American market. In the years after 1905, there followed a tiny trickle of British alkali exports to the United States—the last vestiges of a once great trade. Within the British alkali industry, individuals gradually came to accept the loss of the American market. One can detect a measure of closure in Sir Alfred Mond's words: "Industrial countries of modern times naturally develop their own resources and supply themselves with products which they had before imported mainly from Great Britain."¹⁵⁴

Postscript

American tariff policy did not sound the death knell for the British alkali industry. In 1904, Britain still accounted for half of the global production of soda ash.¹⁵⁵ Moreover, the brief period from 1905 to 1913 witnessed a pronounced resurgence in British alkali exports; the author leaves this trend to be chronicled by a future dutiful scholar. For now, just a few words on British alkali exports in the period from 1905 to 1913 must suffice. If nothing else, this postscript seeks to temper what might be the exaggerated impression of the reader: that the loss of the American market was tantamount to the loss of all foreign markets. Such was not the case.

While it was originally envisioned that this study would cover the span of time from 1880 to 1913, it became increasingly obvious to the author that a fundamental

¹⁵⁴ Sir Alfred Mond in Porter, 414.

¹⁵⁵ Stephen N. Broadberry, *The Productivity Race: British Manufacturing in International Perspective, 1850-1990* (Cambridge: Cambridge University Press, 1997), 160.

shift in the orientation of British alkali exports happened several years before the First World War, in approximately the year 1905. Therefore, the decision was made to treat the period from 1905 to 1913 as separate. In just this short interval of eight years, annual British alkali exports to all countries increased from 528.4 to 813.9 million pounds.¹⁵⁶ Driving this phenomenal growth in exports were developing markets for alkali in both Asia and the British Empire.

Once again, Brunner, Mond proved itself more forward-thinking than the UAC when, in 1899, Brunner, Mond sent employee Henry Glendinning to China to scout out opportunities for exporting more alkali to that country.¹⁵⁷ Shortly thereafter, Brunner's alkali exports to China began to skyrocket.¹⁵⁸ Following the example of Brunner, Mond, the UAC cultivated its own export market in Japan. In 1910, the UAC alone exported 20 million pounds of alkali to this rapidly industrializing country.¹⁵⁹

Exports to the Empire followed a similar course. Although much of the scholarly emphasis has been on the growth in British alkali exports to India, the growth in exports to Canada was equally dramatic. Between 1905 and 1913, Canadian imports of British soda ash increased from 10.0 to 34.4 million pounds per annum, making for a compound annual growth rate of 16.8 percent.¹⁶⁰ Insofar as the British alkali industry turned its head toward the Empire during the years leading up to the First World War, the British alkali industry was ushering in a trend that many other British industries would follow in the interwar period.¹⁶¹

¹⁵⁶ *Trade of the United Kingdom* (1905 and 1913).

¹⁵⁷ Warren, 193.

¹⁵⁸ Reader, 226.

¹⁵⁹ *Ibid.*

¹⁶⁰ *Trade of the United Kingdom* (1905 and 1913).

¹⁶¹ Broadberry, "Overtake Britain," 394-395.

In 1926, Brunner, Mond and the UAC, along with the British Dyestuffs Corporation and Nobel Industries, combined to form Imperial Chemical Industries.¹⁶² This four-way merger represented the most significant restructuring of the British alkali industry since the formation of the UAC in 1890. As indicated by the name of the company, Imperial Chemical Industries catered to an Empire-wide market and, in this respect, built upon groundwork already laid by Brunner, Mond and the UAC in the 1900s and 1910s. More recently, in 1991, Imperial Chemical Industries sold its alkali business to Penrice, an Australian alkali firm.¹⁶³ Penrice's British alkali business operated under the revived name of Brunner, Mond.¹⁶⁴ In 2006, the Indian firm of Tata Chemicals purchased Brunner, Mond and, in 2011, dropped the venerable name in favor of Tata Chemicals Europe.¹⁶⁵

In 1920, the SPC merged with four other American chemical firms to create the giant Allied Chemical and Dye Corporation.¹⁶⁶ Brunner, Mond simply exchanged its shares of the SPC for shares of the new company.¹⁶⁷ In 1985, the Allied Chemical and Dye Corporation closed down the century-old Syracuse alkali plant, once the largest in the world.¹⁶⁸ According to the Allied Chemical and Dye Corporation, alkali could be produced more cheaply elsewhere.¹⁶⁹

Tariffs remained a fixture of the international economic order well into the twentieth century. Following the Dingley Tariff, succeeding tariff acts revised the duties on alkali. A glimpse at the specific tariff imposed upon soda ash in the twentieth

¹⁶² Reader, 451-466.

¹⁶³ Robert Peston, "ICI to Sell UK and Kenyan Soda Ash Groups to Penrice," *Financial Times*, June 27, 1991.

¹⁶⁴ *Ibid.*

¹⁶⁵ "Chemicals Manufacturer Renamed After Indian Parent Group," *Liverpool Daily Post*, April 5, 2011.

¹⁶⁶ Reader, 318.

¹⁶⁷ *Ibid.*

¹⁶⁸ Tony Jackson, "Allied to Shut Soda Ash Plant / US Industrial and Chemical Group to Close New York Factory," *Financial Times*, April 27, 1985.

¹⁶⁹ *Ibid.*

century reveals that the Payne-Aldrich Tariff lowered this duty to 0.25¢ per pound, which was a return to the duty imposed by the Wilson-Gorman Tariff.¹⁷⁰ The Underwood-Simmons Tariff (1913), a triumph for the free trade movement, completely removed the duty on soda ash; thus, this major class of alkali remained free of any duty for the duration of the First World War.¹⁷¹ The Fordney-McCumber Tariff (1922) brought back the duty of 0.25¢ per pound of soda ash, which was maintained under the Smoot-Hawley Tariff (1930).¹⁷² However, these revisions were mostly cosmetic changes made to reinforce, in spirit, movements in American tariff policy toward either protectionism or free trade. In the twentieth century, the specific tariffs that the United States imposed upon the various classes of alkali existed more in the statute books than in practice, since the United States no longer imported anything more than a negligible volume of alkali.

¹⁷⁰ *Tariff Acts Passed by the Congress*, 705.

¹⁷¹ *Tariff Act of 1913*, 63rd Cong., 1st sess. (October 3, 1913), 119.

¹⁷² *Tariff Act of 1922*, 67th Cong., 2nd sess. (September 21, 1922), 868; *Tariff Act of 1930*, 71st Cong., 2nd sess. (June 17, 1930), 601.

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