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COULD THE U.S. IRON INDUSTRY HAVE  
SURVIVED FREE TRADE AFTER THE CIVIL WAR?

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Could the U.S. Iron Industry Have Survived Free Trade After the Civil War?

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### **ABSTRACT**

An unresolved question concerning post-Civil War U.S. industrialization is the degree to which import tariffs protected domestic manufacturers from foreign competition. This paper considers the impact of import tariffs on the domestic pig iron industry, the basic building block of the entire iron and steel industry. After reviewing the contentious political debate surrounding the pig iron duties and estimating the elasticity of substitution between domestic and imported pig iron, a standard trade model provides estimates of how tariff reductions would affect domestic prices, production, imports, and welfare. The results suggest that, had the tariff been eliminated in 1869, domestic output would fall by about 15 percent and the import market share would rise from about 7 percent to nearly 30 percent. These relatively modest effects suggest that a substantial portion of the domestic industry could have survived a significant tariff reduction.

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## **I. Introduction**

An unresolved question concerning U.S. industrialization after the Civil War is the degree to which import tariffs protected domestic manufacturers from foreign competition. The role of the tariff in assisting the iron and steel industry has been particularly controversial in view of the industry's growth from a fledgling import-competing sector in the mid-nineteenth century to the largest manufacturing sector in the United States by the end of the century. Industry representatives argued at the time that high tariffs were critical to its survival and successful growth. Later independent assessments stressed America's abundance of natural resources, technological advances, and expanding domestic demand as the key factors, but were equivocal about the importance of the tariff. A representative claim that "neither the general trend nor the annual fluctuations [in domestic production] appear to be perceptibly influenced by downward changes in the tariff," for example, is hedged with the caveat that "without the duty the industry would have encountered severe foreign competition which might have hampered its development."<sup>1</sup>

How important was import protection to the post-Civil War iron and steel industry, an industry that began on such a small scale yet became an industrial giant? What would have been the consequences of a significant tariff reduction or even free trade on the industry's output? How did the import-substitution policy affect economic welfare? Despite the importance of these questions to our understanding of America's mid- to late-nineteenth century industrial development, economic historians have not established a consensus view of the role of the tariff. Early qualitative discussions of iron

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<sup>1</sup> Quotation from Berglund and Wright (1929), pp. 116, 129.

protection by Taussig (1915) and Temin (1964) tended to be agnostic about its effects.<sup>2</sup> Subsequent quantitative studies, in particular those by Sundararajan (1970) and Baack and Ray (1973), failed to reach definitive conclusions about the importance of the tariff.<sup>3</sup> Thus, the effects on protection on the post-Civil War iron and steel industry is still an open question.

This paper seeks to determine the impact of tariff protection on domestic pig iron production, the basic building block of the iron and steel industry, around 1869. Pig iron, the product of blast furnaces, is an intermediate stage of iron fabrication used by rolling mills to produce iron sheets, rails, and bars, and by other mills to produce nails, wire, and related products. The pig iron tariff raised the domestic price of this intermediate product to a host of other import-competing, iron-consuming industries and was therefore particularly controversial after the Civil War. Section II reviews the contentious political debate over the pig iron tariff. Section III provides estimates of the elasticity of substitution between domestic and imported pig iron, a parameter that is crucial to determining the effect of the tariff on the domestic industry. Section IV then employs a standard trade model to assess the impact of tariff changes on imports, domestic output, and domestic and import prices. This model

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<sup>2</sup> Taussig (1915, p. 151) suggested that “no one can say with certainty what would have been” the effects on the industry without the tariff, but conjectured that “the same sort of growth would doubtless have taken place eventually, tariff or no tariff; but not so soon or on so great a scale.” Temin (1964, p. 213) wrote that “the tariff increased the incentive of American manufacturers to expand their production, although the extent of this increase cannot be known.”

<sup>3</sup> Sundararajan (1970) and Baack and Ray (1973) use reduced form regressions to suggest that the tariff played a dominant role in promoting the domestic pig iron industry. Yet Sundararajan found a significant but negative coefficient on the tariff before 1890 and insignificant results thereafter, while Baack and Ray found a positive and significant effect of the tariff only after 1900, a period when the United States was a frequent net exporter of pig iron. Furthermore, they fail to identify supply and demand or to calculate the magnitude of the tariff’s impact on domestic production. The more recent studies of Head (1994) and Irwin (2000) will be discussed further below.

suggests that domestic output would have fallen about 15 percent and the import market share would have risen from about 7 percent to almost 30 percent had free trade been adopted in 1869. Section V concludes by putting these findings in the perspective of other related research.

## **II. The Debate over the Pig Iron Tariff**

Congress engaged in an extensive debate after the Civil War over the possible reduction of the high import tariffs that had been imposed during the war. Many tariffs had been raised in conjunction with higher direct taxes on domestic producers, but were not reduced when those domestic taxes were abolished. Congress raised the tariff on pig iron imports to \$9 per ton in 1864, for example, in part to counterbalance a domestic tax of \$2 per ton levied on domestic producers. Although the domestic tax was eliminated in 1866, the \$9 duty remained in effect. The pig iron tariff, along with other tariffs on intermediate goods and raw materials, was especially controversial. Any measure that raised the cost of production of iron-consuming industries, themselves often import-competing final goods producers, came under particular scrutiny.

The question facing Congress in the immediate post-war period was whether or not to reduce these import duties. The Special Commissioner of the Revenue, David Wells, strongly urged Congress to cut tariffs, the pig iron duties foremost among them. Originally a protectionist, Wells became obsessed with what he perceived were the inequities of the tariff. With increasing stridency, he attacked high protective duties in his annual reports.<sup>4</sup> In his report for 1868, Wells argued that the pig

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<sup>4</sup> In July 1866, Wells remarked that “I have changed my ideas respecting tariffs and protection very much since coming to Washington. . . . I am utterly disgusted with the rapacity and selfishness

iron tariff was “a striking illustration of an instance where a duty originally levied for revenue and protection, or as an offset to internal taxes, has been continued long after its object has been fully attained, for the interests of the few, but to the detriment of the many.” According to his report, the domestic cost of producing pig iron was roughly \$26 per ton, but the duty raised the domestic price to at least \$37 per ton. The difference, he argued, was pure profit for domestic producers: “The manufacturers of pig iron have, to the detriment of the rolling-mill interest, and to the expense of every consumer of iron from rail to a ploughshare, and from a boiler plate to a tenpenny nail, realized continued profits which have hardly any parallel in the history of legitimate industry.”<sup>5</sup>

In his next and final report, Wells again singled out pig iron as “a conspicuous example” of where “excessive and unnecessary duties have been imposed and maintained, with a view of enhancing the costs of articles indispensable to many other branches of production; and this, too, with a full knowledge and demonstration of the fact that the detriment thereby brought to industry in general, far outweighs any measure of benefit which can possibly accrue to the special or class interest thus favored.” “The usual and almost the only argument offered in reply to such” criticisms, Wells observed, “is that a continuation of the present duties imposed on pig iron is necessary to insure employment to American labor.” Wells countered by charging that high pig iron prices reduced employment even more in the many other industries that required iron as a major input to production, such as construction and railroads. He speculated that lower pig iron prices would enable the shipbuilding industry to sell an

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which I have seen displayed by Penn[sylvania] people, and some from other sections on this subject.” Quoted in Joyner (1939, p. 44).

<sup>5</sup> Report of the Special Commissioner of Revenue for the year 1868, pp. 46ff.

additional 600 iron ships, requiring the employment of 30,000 workers — “more than two and a half times as many are at present directly engaged in the manufacture of pig iron.”<sup>6</sup>

Wells held that a tariff reduction would not spell disaster for domestic producers. “All the facts show that a reduction or entire repeal of the duty would in no degree affect the manufacture” because domestic profits would simply fall. “Under an abatement or repeal of the duty no more pig iron would be imported than at present, for the American manufacturer would simply reduce his price, and thus retain, as now, full command of the domestic market.” A tariff cut was thus in order: “In view, therefore, of the above facts, the Commissioner would recommend a reduction of the existing duty of *nine* dollars per ton on the importation of pig iron to *three* dollars; and in this recommendation the Commissioner has good and sufficient reason to believe that he is sustained by a majority of the proprietors of rolling mills and other workers of iron, who are not at the same time interested in the production of pig iron; while members of the American Iron and Steel Association have not hesitated to express their sympathy with any movement looking to some abatement of duty in this particular.”<sup>7</sup>

Wells’s criticism of existing tariffs created a firestorm among protectionist members of Congress, some of whom sought to stop publication of his report and payment of his salary. The House Committee on Manufactures investigated Wells and complained that “they do not conceive the promulgation of special theories to have been part of the duty imposed upon the commissioner.” The Republican majority accused him of using “fallacious and unreliable” statistics on cost of pig iron production and therefore reaching conclusions that were “grievously in error” and which aimed “to

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<sup>6</sup> Report of the Special Commissioner of Revenue for the year 1869, p. 83.

<sup>7</sup> *Ibid.*, p. 86.

subvert the protective policy of our country.’<sup>8</sup> The committee produced testimony from industry representatives suggesting that domestic production costs were around \$32-35 per ton, close to the prevailing price, rather than the lower costs and higher profits implied by Wells’s figures.<sup>9</sup>

William D. Kelley, a representative from Pennsylvania known as “Pig Iron Kelley” for his trenchant support of iron and steel interests, repeatedly attacked Wells in speeches before Congress. The Wells report, he charged, “abounds in propositions inimical to the best interests of the country.” Protection was a “boon to the American consumer” because, Kelly argued, “protection invariably cheapens commodities.” The tariff led to greater domestic output which raised the wages of labor, but also stimulated competition and technological advances that ultimately reduced prices. Free trade would fail to guarantee low prices, Kelley stated, because then the country would be at the mercy of foreign monopolists: “The day the telegraph announces that we have reduced the duty on pig and railroad iron will be the day on which the price of British iron will go up.”<sup>10</sup> Other members of Congress defended Wells’s integrity and reiterated his argument that high tariffs on intermediate goods were not desirable from the standpoint of consuming industries. One representative described the high price of pig iron as “an incubus that is weighing us down” and preventing other manufacturing industries

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<sup>8</sup> Examination of Statements in the Report of Special Commissioner of Revenue, House Report No. 72, 41<sup>st</sup> Congress, 2<sup>nd</sup> Session, May 19, 1870, pp. 33, 63, 65.

<sup>9</sup> Several minority members attached a dissent in which they argued that “the majority of the committee seem to consider the manufacturing interest of the country confined to mines, furnaces, and mills, forgetting that, however important these branches of industry may be, they only furnish the raw materials for industries immensely greater and of vastly more importance to the consumers of the country.” *Ibid.*, p. 119.

<sup>10</sup> Congressional Globe, January 11, 1870, pp. 369ff. *Ibid.*, March 25, 1870, pp. 201, 209.



from flourishing, dubbing it the “destroyer of our shipyards, the robber of all classes, the retarder of railroad progress.” Another dismissed as “absolutely preposterous” Kelley’s claim that protection reduces prices.<sup>11</sup>

Although various tariff bills floundered in 1867-68, Congress reduced revenue tariffs (on such goods as tea, coffee, sugar, and wine) in March 1870, but maintained most protective duties and even increased a few (such as on marble, steel rails, and nickel). The only compromise on the protectionist duties was a 22 percent reduction in the pig iron tariff, from \$9 to \$7 per ton. The American Iron and Steel Association (AISA) denounced this action: “the recent reduction in the duty on pig iron by the Forty-first Congress was unwise, and injurious to the general interests of the country: that in this cause mainly should be attributed the fact that the make [i.e., the production of pig iron] in 1871 did not exceed that of 1869, as many contemplated” (quoted in Hogan 1971, p. 174). The AISA feared the tariff cut would effectively “transfer the duties thereby lost to the Treasury to the pockets of foreign manufacturers,” thereby implying a significant terms of trade loss for the United States.<sup>12</sup>

The modest reduction in 1870 was followed by a 10 percent cut in all import duties in 1872, but the lower \$6.30 per ton pig iron tariff was short lived due to its repeal in 1875. Yet political interest

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<sup>11</sup> Congressional Globe, March 25, 1870, pp. 218ff.

<sup>12</sup> The AISA even claimed that “the consumers of three quarters of all the pig iron made in the country not only did not ask for the reduction of the duty from nine dollars to seven dollars per ton, but actually opposed on the ground that it would check the vast preparations at that time being made to increase home production, and enlightened consumers of iron of all kinds know that their interests are promoted by the prevalence of a policy that gives them a home supply of the materials used in their business, at a price regulated by an uninterrupted home competition.” Quoted in Hogan (1974, p. 175). These statements represented the views of James Swank, the staunchly protectionist secretary of the AISA, not necessarily the full membership of that organization. See Tedesco (1985).

in tariff reform continued and, in the early 1880s, Congress appointed a Tariff Commission to gather views on a possible tariff change. Not surprisingly, pig iron producers voiced the opinion that the tariff should not be reduced. One Michigan manufacturer stated that he had virtually no profit margin, and that “any reduction of the price caused by a reduced tariff . . . must be followed either by depriving the workman of labor, or lowering his wages.”<sup>13</sup> A few iron users argued for lower tariffs: one shelf hardware manufacturer said that the industry could compete better with lower cost materials and that the pig iron tariff simply protected large profits of producers who got by using outdated equipment. Another civil engineer reported that employment in bridge construction would be substantially higher but for the high domestic price of pig iron.

The Tariff Commission recommended a slight reduction in the pig iron tariff, from \$7 per ton to \$6.72 per ton. Their report (1882, pp. 17-18) went on to caution that “it is believed by the commission that a further reduction of the duty on pig-iron than that recommended would result disastrously to that important industry,” noting that imports comprised over 10 percent of domestic consumption and that the ad valorem duty was only 34 percent. Considering “the present depressed condition of the industry, a radical reduction would be neither wise nor politic,” they argued.

Congress adopted the Tariff Commission’s recommendation in legislation passed in March 1883. Pig iron output soared during the 1880s, however, due to booming railroad construction and higher domestic demand for iron and steel products in general. Although the pig iron tariff continued to

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<sup>13</sup> Quoted in Tariff Commission (1882), p. 839. In asking that the duty be raised to \$8 per ton, one manufacturer wrote that “the duty on pig iron is mainly a protection to American labor against the cheap and poorly paid labor of Europe” (ibid., p. 2175).

be controversial, no further changes occurred until 1894, when Democratic tariff legislation reduced the duty to \$4.00 per ton. By then, U.S. producers were much less dependent upon the tariff than they had been two decades earlier as the United States was on the verge of becoming a major net exporter of iron and steel products.

### **III. The Elasticity of Substitution between Domestic and Imported Pig Iron**

While the tariff debate in the two decades after the Civil War focused particular attention on pig iron, the economic impact of the pig iron tariff and the possible consequences of its removal remains an open question. The impact of the tariff depends largely on the elasticity of substitution between domestic and imported pig iron in U.S. consumption. If domestic and imported pig iron were imperfect substitutes and the elasticity of substitution between them low, then the products would not be significantly in competition with one another. In that case, any tariff reduction would have a muted impact on domestic output and trade flows. By contrast, if the elasticity of substitution was high (the limiting case is where domestic and imported products are perfect substitutes), then the effect on domestic output and trade flows would be greater. For a given tariff change, therefore, a larger elasticity of substitution would bring about greater changes to domestic output and trade but a lower impact on economic welfare.

Pig iron is generally viewed as a relative homogeneous commodity, in which case the elasticity of substitution between domestic and foreign iron would be very high. Yet there are also reasons to expect that this elasticity would be far from infinite. Imperfect substitutability may reflect not only differences in product quality and price, but also delivery, convenience, and transport charges that

make domestic and imported pig iron, to some degree, different commodities. Even today, as Jondrow, Chase, and Gamble (1982) document, long supply lags and supply uncertainty associated with purchasing iron and steel from foreign producers imply imperfect substitutability between similar product categories in the iron and steel industry. As a result, empirical research on international trade takes the elasticity of substitution as a parameter to be estimated.

#### *A. Estimation Approach*

One estimation approach is based on the Armington (1969) assumption that products are differentiated by country of origin; see, e.g., Reinert and Roland-Holst (1992) and Blonigen and Wilson (1999). A country's consumers are assumed to derive utility from consuming a composite of domestic and imported goods that are linked in a constant elasticity of substitution (CES) functional form.<sup>14</sup> A typical CES representation is

$$Q = \alpha [M^{(F-1)/F} + (1-\alpha)D^{(F-1)/F}]^{F/(F-1)},$$

where  $Q$  is the composite quantity of pig iron demanded,  $M$  is the quantity of imported pig iron,  $D$  is the quantity of domestic pig iron for domestic consumption,  $\alpha$  and  $\alpha$  are calibrated parameters, and  $F$  is the elasticity of substitution between imported and domestic pig iron.

Given the prices of domestic and imported pig iron (denoted  $p_D$  and  $p_M$ ) and a desired level of  $Q$ , expenditure minimization results in the following expression:

$$M/D = [\alpha/(1-\alpha)](p_D/p_M)^F.$$

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<sup>14</sup> The Armington framework assumes that the utility derived from the domestic and imported goods is weakly separable from total utility, such that the marginal rate of substitution between the two goods is independent of consumption of other goods. Demand is also assumed to be homothetic so that the relative market shares are independent of total expenditure on the goods.

After taking logs, this yields a standard equation to estimate the elasticity of substitution:

$$\log [M/D]_t = F \log [P/(1-P)] + F \log [p_D/p_M]_t + \epsilon_t$$

While instrumental variables estimation is not frequently employed in estimating this equation,  $p_D$  and  $p_M$  can be treated as endogenous and materials and factor costs (both domestic and imported) can be used as instruments.

One concern about using estimated parameters to evaluate the effects of a policy change is the extent to which different parameter estimates could result from different model specifications. Shiells, Stern and Deardorff (1986) propose an alternative method of estimating the elasticity of substitution that employs a more flexible demand system. They estimate the following equation:

$$\log (M)_t = \alpha + \theta_{MD} \log (p_D/p_{CPI})_t + \theta_M \log (p_M/p_{CPI})_t + (\log (y))_t + \beta \log (M)_{t-1} + \epsilon_t$$

where  $p_D/p_{CPI}$  and  $p_M/p_{CPI}$  are relative prices (domestic and import prices divided by some domestic price index),  $y$  is total domestic expenditures on pig iron (i.e., demand is potentially non-homothetic), and a lagged dependent variable is included to account for partial adjustment. The elasticity of substitution can be calculated from the estimated parameters as  $F = \theta_{MD}/2_D + \beta$ , where  $2_D$  is the share of total spending on pig iron devoted to domestic production,  $\theta_{MD}$  is the cross-price elasticity of demand for imported pig iron, and  $\beta$  is the elasticity of demand for imported pig iron with respect to total pig iron expenditures.

Both the Armington and the Shiells-Stern-Deardorff methods were used to estimate the elasticity of substitution between domestic and foreign pig iron to determine if these methods yielded similar results. The data are based on annual time series from 1867-1889. (The data sources are described more fully in an appendix.) Figure 1 presents the domestic and foreign prices of pig iron and

shows how the relative price of domestic pig iron evolved during this period. Figure 2 depicts the import market share during this period. The results are presented on Table 1. Columns (1)-(3) reports the results from the Armington specification. Column (1) finds an elasticity of 2.25, which increases slightly to 2.56 if one instruments for the relative prices. Column (3) indicates that this finding is robust to the inclusion of a time trend.

Columns (4) and (5) report results, without and with instruments, arising from the Sheills-Stern-Deardorff approach. According to the column (5) results, the short-run cross price elasticity of import demand is 2.24, which (taking  $\alpha_D$  as 0.98 and  $\alpha$  as 0.62) implies an elasticity of substitution of 2.9. Using the coefficient on the lagged dependent variable to solve for the long-run elasticities yields a long-run cross price elasticity of 5.10 and an implied elasticity of substitution of 6.6.<sup>15</sup>

Both estimation methods yield an elasticity of substitution of about 2.5 to 3.0, although the long-run elasticity could be as high as 6 to 7.<sup>16</sup> As a sensitivity check on the simulations below, results will be reported using both the lower and the higher elasticity values.

### *B. The Geography of Protection*

A frequently mentioned hypothesis regarding protection during this period related to the geographic impact of protection. High transportation costs were thought to insulate iron and steel

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<sup>15</sup> One cannot reject the hypothesis of that the demand elasticities sum to zero, i.e., that import demand is homogeneous of degree zero and there is no money illusion. A Wald test of  $O_{MD} + O_M + \alpha = 0$  yields an F statistic of 0.21 and an associated p-value of 0.65.

<sup>16</sup> These estimates are quite similar to contemporary estimates for iron and steel products. Shiells, Stern, and Deardorff (1986) estimate an elasticity of substitution of 2.986 for steel mill products using annual data from 1962-78, and Reinert and Roland-Host (1992) estimate the elasticity of 3.08 for iron and steel foundry products using quarterly data from 1980-88.

producers in the interior of the United States from foreign competition. Hence, a tariff reduction might adversely affect producers along the east coast, but would have little impact on producers west of the Appalachian mountains.<sup>17</sup>

This view was fully debated at the time of the Wells reports. Wells had written that “if the duty on pig iron were entirely removed, the American producer in the interior would still enjoy a protection in the cost of transportation to the extent of at least \$1.50 per ton for every one hundred miles that intervene between the place of production and the port of entry, which circumstances renders the transport of a single pound of foreign pig iron to any considerable distance into the interior a matter of ordinary commercial impossibility.”<sup>18</sup> Seeking to rebut this claim, the Committee on Manufactures in Congress collected evidence that pig iron imported into such ports as New York, New Orleans, and Montreal could ship the goods to interior cities such as Cleveland, St. Louis, and Chicago at much lower rates. Whereas Wells’s figures implied a \$11.40 per ton cost of moving pig iron from Montreal to Chicago, for example, the committee’s evidence suggested the actual figure was closer to \$2 to \$3 per ton. The committee called Wells’s discussion of freight rates most unfair and condemned him for “conspicuous disregard of facts easily procurable.”

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<sup>17</sup> Taussig (1915, pp. 145-46), for example, states that “had there been no duty on iron, the price at the seaboard would unquestionably have been lower than it was . . . The freight charges from the seaboard would have impeded competition from imported iron, raising the price at which it could then be supplied . . . the free admission of iron, while it might have caused prices to be lower, would at no time . . . have caused a decline in the heart of the country by the full amount of the duty in force.” Warren (1973, p. 14) also suggests that interior producers may have been less efficient because of their inability to serve a large market: “Distance protected the interior producer but the same isolation forced small-scale operations on him.”

<sup>18</sup> Report of the Special Commissioner of Revenue for the year 1869, p. 83.

If transport costs protected interior producers from foreign competition, then domestic production in those regions should be less sensitive to import price movements than that located closer to the eastern seaboard. This hypothesis can be evaluated by estimating the elasticity of substitution (between domestic production and imports) on a regional basis. Table 2 presents estimates of the elasticity using regional production of pig iron. What is quickly apparent is that there is no statistically significant difference in the regional elasticities of substitution. While the elasticity is highest in the South, suggesting that producers there would have been slightly more vulnerable to any tariff reduction than producers located elsewhere, the magnitude of this effect is not substantial. This finding supports Congress's view that navigable rivers ensured that producers in the American hinterland were not immune from import competition in iron. To the extent that transportation costs insulated some producers from foreign competition, that effect could be manifest in different regional levels of production rather than in different regional elasticities of substitution.

#### **IV. Effect of the Tariff on Prices, Production, Imports, and Welfare**

This section takes a standard, simple partial equilibrium model that is frequently used in trade policy analysis and applies it to the post-Civil War pig iron industry. The pig iron industry is considered small enough relative to the overall economy to justify a partial, rather than a general equilibrium, approach.<sup>19</sup> The basic model treats domestic and imported goods as imperfect substitutes, and

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<sup>19</sup> According to the Census of 1870, for example, the value of products in the iron and steel industry was 6 percent of total manufacturing output, and employment in iron and steel was 4 percent of total manufacturing employment. These figures for iron and steel include much more than just the output and employment of the pig iron industry.



provides a comparative static analysis of tariff changes on prices, production, imports, and welfare. A brief, non-technical sketch of the model will be presented here, but a more detailed description of the model can be found in Rousslang and Suomela (1988), Jones (1993), and Francois and Hall (1997).<sup>20</sup>

The model assumes that domestic consumers demand a product that can be supplied by domestic and foreign producers. When the tariff on imports is reduced, the domestic price of imports falls by a magnitude determined by the extent of the tariff reduction and the elasticities of foreign supply and consumer demand. This price reduction decreases demand for the domestic substitute good by a magnitude determined by the elasticity of substitution in consumer demand. As a result, domestic production falls and domestic producers's surplus is lost, while imports rise and domestic consumers's surplus is gained.

To make the model operational, it is calibrated using market data for a benchmark year and then subjected to exogenous policy changes whose effects work through the specified (and constant) elasticities of domestic and foreign supply and consumer demand, in addition to the elasticity of substitution. The underlying supply and demand equations are often taken as linear (or log linear) in prices for computational simplicity, but then the results can be misleading when considering large policy changes because they are based on local approximations of small changes in the exogenous variables. Therefore, to consider the impact of large policy shocks, such as free trade, the non-linear model set out explicitly in Francois and Hall (1997, pp. 139-140) is employed here.<sup>21</sup> As just noted, however,

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<sup>20</sup> The structure of the model also has some similarities to that used by Fogel and Engerman (1969) in their examination of the growth of the antebellum iron industry.

<sup>21</sup> The reader is invited to consult Francois and Hall for complete details on the structure of the model. See also [www.intereconomics.com](http://www.intereconomics.com) for spreadsheet applications.

additional information on those elasticity values is required before implementing the model.

#### *A. Other Elasticity Parameters*

Aside from benchmark values of production and imports, three additional parameters are required to calibrate the model: the elasticity of total domestic demand for pig iron (regardless of source), and the elasticities of domestic supply and foreign export supply.

Francois and Hall (1997, p. 138) show that the elasticity of (composite) pig iron demand ( $O_Q$ ) can be represented by the following relationship:  $O_Q = (O_{MD}/2_D) - F$ . Taking  $2_D$  as 0.98 (the sample average), the results from column (5) of Table 1 imply that the short-run value of  $O_Q$  is -0.6 and the long run value  $O_Q$  is -1.4.

The elasticities of domestic supply and foreign export supply are also important parameters. The former determines the extent to which a tariff-induced fall in domestic prices translates into lower domestic output, and the latter indicates any foreign supply constraints that might generate adverse terms-of-trade effects from lower tariffs. Along with other corroborative evidence, a major demand shock — the great “iron famine” of 1879-80 — helps identify these elasticities. The “iron famine” was a large, unanticipated shock to U.S. demand, starting in the spring of 1879 and continuing through 1880. The demand surge could not be met through domestic production and drove domestic prices and imports up dramatically.<sup>22</sup> The price of domestic pig iron rose 62 percent, from \$17.63 per ton in 1878 to \$28.5 per ton in 1880, as depicted in Figure 1. This exogenous event helps identify the impact

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<sup>22</sup> According to the 1880 Census (1883, II, p. 9), “All iron and steel products were in such demand by American consumers that the iron and steel works of this country were unable to meet it. The home supply was supplemented by large importations, and even these could not be made with sufficient rapidity to meet the urgent wants of consumers.”

of U.S. demand shocks (due to tariff change or otherwise) on import prices. Pig iron imports jumped by a factor of seven, from roughly 71,000 tons in 1878 to nearly 600,000 tons in 1880. Yet the pig iron export price of Britain, the dominant source of U.S. pig iron imports, rose by less than 20 percent between 1878 and 1880. The implied export supply elasticity is nearly 40. This overstates the true elasticity because the price of U.S. producers was not held constant in this experiment. In the simulations considered below, the foreign supply elasticity will be taken as 15; there is no significant change to any of the results for elasticity values above 10.

Is such a large export supply elasticity plausible? In 1878, on the eve of the American “iron famine,” just 0.5 percent of Britain’s pig iron production (and 3.5 percent of its exports) was destined to the United States. U.S. demand comprised a small part of Britain’s overall production, whereas Britain supplied more than half of U.S. imports in 1875, and consistently more than 80 percent after 1880. A modest diversion of British output to the United States would therefore translate into an enormous increase in U.S. imports. Indeed, the tremendous demand shock in 1879-80 resulted in 8 percent of British production (38 percent of exports) being sent to the United States, but by 1884 after demand cooled just 2 percent of British production was exported to the United States (Carr and Taplin 1962, pp. 165, 167). That such large quantities were shuffled between markets with only a muted effect on British prices indicates a high export elasticity and relatively minor terms of trade effects. This interpretation is consistent with Taussig’s (1915, p. 146) assessment: “During the first decade of the [post-Civil War] period, say until the year 1880, it is not unlikely that Great Britain could have sent to the United States all the iron that would have been imported there, if free of duty, without such pressure on the British coal and iron mines as to have caused enhanced cost and permanently enhanced

prices.”<sup>23</sup>

There are no existing estimates of the elasticity of domestic supply of pig iron, although Temin (1964, p. 213) says it “seems likely” that “the domestic supply curves for iron and steel producers were either very elastic or else expanding rapidly enough to have the same effect.” An econometric effort to determine the elasticity of domestic supply (results not reported here) resulted in an estimate of 0.8, which initially strikes one as implausibly inelastic. Yet using the “iron famine” demand shock to identify the domestic supply elasticity, we find that between 1878 and 1880 the domestic price rose 62 percent while domestic output rose 67 percent, implying a supply elasticity of 1.08. Using different base and end years does not change this finding significantly: between 1879 and 1880, the implied supply elasticity is 1.22, while over the longer period between 1879 and 1881 the implied supply elasticity is 3.04. This experiment does not hold the price of foreign goods constant, however, and therefore overstates the true elasticity. Yet much smaller elasticities generate an extreme insensitivity of domestic output to domestic prices and would also mean that tariff changes would have little impact on domestic output. In the simulations below, therefore, the short-run elasticity of domestic supply is assumed to be 1.1 and the long-run elasticity is assumed to be 3.0.

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<sup>23</sup> After 1880, however, Taussig believed that the United States did possess some terms of trade power with respect to Britain: “with the extraordinary increase in the American demand after 1880, the additional quantity could not have been supplied from Great Britain except on harder terms . . . [then] it is probable that the removal of the duty and the consequent demand on Great Britain for iron would have caused the price of British iron to go up. . . . A great increase in the demand on the British iron masters for iron, consequent on the absence of the American duty and the lessening of American product, might have raised the price in Great Britain, not only temporarily, but over the whole period.” By 1890s, however, the United States had acquired a comparative advantage in pig iron and became a net exporter.

*B. Simulated Effects of Tariff Changes*

Having settled upon a set of approximate elasticity values, the effects of tariff reduction on resource allocation and economic welfare can be evaluated. The base year is chosen to be 1869. In that year, domestic consumption of pig iron was approximately \$63.6 million, of which \$58.9 million arose from domestic production and \$4.7 million from imports. The import market share, by value, was 7.4 percent. The average ad valorem tariff applied to pig iron imports was about 60 percent. There is nothing particularly unrepresentative about this benchmark year when compared with adjacent years (in terms of business cycle effects or abnormal import market share), and it is chosen because it occurs at the height of the political controversy over post-Civil War tariffs reductions, but is also before the 1870 tariff reduction.

Table 3 presents the results for three counterfactual policy scenarios: (i) a reduction of the tariff from 60 percent to 47 percent, corresponding to the actual 22 percent tariff cut (from \$9 to \$7 per ton) implemented in 1870; (ii) a tariff reduction from 60 percent to 20 percent, corresponding to the Wells proposal for a 67 percent tariff cut (from \$9 to \$3 per ton); (iii) a tariff reduction from 60 percent to 0 percent, corresponding to free trade. For each of these scenarios, the short-run and long-run impacts are considered using the short-run and long-run elasticities described above.

Columns (1) and (2) consider the actual tariff cut implemented in 1870. The short-run and long-run response indicates that the domestic price falls by a trivial amount (less than 1 percent) and, as a result, domestic output declines by less than 2 percent in the long-run. Domestic output falls more in the long run scenario because of the larger elasticity of supply, but also cushions the fall in domestic prices, which explains why the price decline is slightly lower in the long-run. The large elasticity of

supply from the rest of the world implies that import prices rise only slightly (about 2 percent) with the tariff reduction.

Why are these effects so small? Even though the tariff is reduced by 22 percent, the domestic price of imports only falls by about 6 to 7 percent. At most, with a perfectly elastic supply of imports, the domestic price of imports would be expected to fall only 9 percent, calculated as  $(1 + t_{1870})/(1+t_{1869})-1$ , or  $(1.47/1.60)-1 = -0.09$ . If imports prices rise slightly as a result of the tariff change, the domestic price would not fall by quite this amount, which explains the 6 to 7 percent decline in the simulation. As a result of the tariff reduction, the volume of imports rises by 20 percent in the short-run and by 40 percent in the long-run. While this sounds impressive, imports are quite small in comparison to domestic production. In fact, the import share of the domestic market only rises from 7.4 percent to just under 10 percent.

This *ceteris paribus* counterfactual is not, of course, directly comparable to the actual outcome observed, but it tempting to undertake such a comparison despite the fact that many things other than the tariff changed between 1869 and 1870. In 1870, when the tariff cut was implemented, overall pig iron consumption fell by 1.5 percent, suggesting a slight cyclical downturn during this period. Both domestic production and prices fell by 2.7 percent while the volume of imports rose about 14 percent, increasing its market share by about one percentage point. This outcome is somewhat reassuring in view of the above results. In the absence of the industry recession, one can imagine the actual outcome having been quite comparable in magnitude to the results found here: domestic prices would not have fallen quite as much, and imports would have been slightly larger, closer to the figures found in the simulation.

Panel B of Table 3 considers the welfare effects stemming from this tariff change. The terms of trade losses are minuscule in comparison to the welfare gains from reducing the deadweight production and consumption losses associated with the high initial tariff. The long-run welfare gain of \$2 million is approximately 1/30th of the value of total domestic expenditures on pig iron.

Under the Wells proposal for a 67 percent tariff cut (from 60 percent to 20 percent), the simulations suggest that domestic prices would fall by as much as 3 percent and domestic output by as much as 10 percent. If the tariff reduction fully passed through to domestic prices, then the domestic price of imported pig iron would be expected to fall by 25 percent (calculated as  $[1.20/1.60]-1 = -0.25$ ), but due to the slightly higher import prices the simulated fall is about 20 percent. The long-run welfare gain is about \$8 million, or 13 percent of total expenditures on pig iron.

Would this nearly 25 percent fall in the domestic price of imported pig iron really translate into just a 10 percent decline in domestic output, raising the import market share (by value) from about 7 percent to about 18 percent? To be sure, imports in this case surge up to about 200 percent, but that still translates into a relatively modest change in the market share. Somewhat corroborative evidence comes from the experience in 1878-80. Then the price of domestic pig iron rose by a factor of 3 in comparison to the price of imported pig iron, as Figure 1 indicates, yet the market share of imports (by volume) rose from 3 percent to just 13 percent, as shown in Figure 2. Domestic consumers were apparently willing to pay a substantial premium for domestic pig iron even though they were free to import foreign pig iron at the world price plus the tariff. This actual experience is somewhat reassuring in that it adds to the plausibility of the simulations here.

Finally, if the tariff had been simply abolished, as considered in columns 4 and 5, domestic pig

iron production could have fallen by about 15 percent (long run response). The most import prices could have fall is 37.5 percent, but again the less than perfectly elastic supply of exports means that import prices fall by about 30 percent here. The market share of imports rises to nearly 30 percent. Thus, even with free trade, domestic producers retain a substantial portion of the domestic market.

The last column considers a worst-case scenario from the standpoint of the domestic industry: free trade in the context of the perfect substitutes model. In this limiting case, the elasticity of substitution between domestic and imported pig iron is infinite. In this situation, domestic output falls by 50 percent and imports capture about 70 percent of the domestic market. The welfare gains to pig iron consumers, however, is much larger in this instance.

### *C. Discussion of Results*

What is striking about the results presented above is the relatively muted effects of tariff changes on the domestic industry. This suggests that a substantial portion of the U.S. pig iron industry could have survived much steeper tariff reductions than actually implemented, and that the adverse terms of trade effects of tariff reduction would have been trivial. To some extent, the limited substitutability of domestic and imported pig iron in consumption generates this result. Imperfect substitutability is not driving all of the results, however, because even with perfect substitutability about half of the industry's output would continue to be produced even under free trade.

Although the imperfect substitutes trade model is a standard one in contemporary trade policy analysis, participants in the nineteenth-century debate would dispute several aspects of its structure and would therefore dissent from its implications. William "Pig Iron" Kelley and other tariff proponents would argue that protection would not result in permanently high domestic prices because the tariff



would eventually reduce prices. Yet, indisputable, U.S. pig iron prices substantially exceeded U.K. prices for several decades until the end of the century; one can argue about whether 30 years is a short or long period and whether the tariff was principally responsible for this price decline. Kelley would also argue that import prices would not fall with lower tariffs because foreign producers would simply exploit their market power and raise prices. If true, this proposition creates a contradiction for the protectionist position: if the lost tariff revenue is merely soaked up by foreign exporters who raise their export prices, then lower tariffs might be welfare-worsening but would not harm the domestic industry since domestic prices would not fall. Yet there is little evidence that British iron and steel exporters exercised significant market power. They appear to be highly competitive with one another and with other producers in Germany, Belgium, and elsewhere (Carr and Taplin 1962).

Revenue Commissioner David Wells would contend that the tariff reduction would not reduce domestic output because producers could survive by cutting their prices and accepting lower profits, since (by his reckoning) the world price was roughly the same as their costs. Yet if pig iron producers were reaping such large profits, as Wells suggested, why were these profits not dissipated through greater output among existing producers or additional market entry? Surely there must have been some elements of increasing costs in the industry or some marginal suppliers who did not wish to produce more at existing prices. If domestic prices were, in fact, to decline as a result of a tariff reduction, then these marginal suppliers would have reduced their output or have gone out of business.

While the possible objections from the nineteenth century interested parties do not appear compelling, this last point highlights one of several shortcomings of the model. One shortcoming is the inability of the model to describe the dynamic adjustment of domestic firms to the tariff reduction. The

model here does not indicate how the industry would become rationalized in light of the greater foreign competition. Temin (1964, p. 167) notes that “the growth of the iron and steel industry in the late nineteenth century was accomplished through a growth in the size of plants rather than through an expansion in the number of plants.” We do not know, however, if downsizing in the industry would be accomplished by the same firms producing less output or by fewer firms producing about the same level of output.

Second, there is a question of whether abandoning protection for pig iron producers would have jeopardized iron and steel producers due to linkages between the sectors. Census data do not provide details on the degree to which pig iron and final goods producers were linked through vertical integration. Temin (1964, p. 111) suggests that during this early period most producers were not vertically integrated: “. . . iron was cast into pigs as it came from the blast furnace and could be transported easily in that form. In fact, the Trenton Iron Company’s blast furnaces were fifty miles away from its rolling mills. . . . the market for pig iron was competitive in nature, with most of the blast furnaces selling their production the open market . . . less than one-fourth of the pig iron produced in 1860 was made by integrated firms.” By the time of the U.S. Steel consolidation in 1901, however, most iron and steel producers were vertically integrated due to the economies of casting hot pig iron into its final form. If firms were not vertically integrated but could purchase pig iron on the open market, then pig iron protection would have operated as tax on purchasing sectors. Irwin (2000), for example, describes how domestic tinplate production did not require vertical integration and was clearly harmed by the negative effective protection it received as a result of the higher domestic price of iron.

Finally, would the domestic industry have enjoyed its tremendous growth during and after the

1880s had it been much smaller in size due to low tariffs? The boom in railroad construction and in the demand for other iron and steel products was exogenous to the domestic pig iron industry and almost surely would have occurred regardless of the height of U.S. tariffs. The question is the degree to which the domestic industry would have participated in this boom had tariffs been lower. The model here simply yields a one-time level effect on domestic output from tariff reduction. Unless there is some dynamic aspects of production or hysteresis in capacity investment choices, then the industry would have grown with domestic demand but just have a smaller share of the market. In considering the steel rail industry, Head (1994) introduces industry dynamics in the form of national learning by doing. Under that assumption, a change in trade policy can have persistent (and not one-off) effects on the industry evolution. In the case of pig iron, Allen (1977) finds that most productivity improvements in the pig iron industry during the 1880s were due to changes in the engineering and chemical aspects of resource use and production, unlikely to have been directly touched by changes in trade policy.

## **V. Conclusions**

The effects of tariff policy on U.S. industrialization in the mid- to late-nineteenth century has remained an open question among economic historians. The analysis in this paper suggests that, had the tariff been eliminated in 1869, domestic output would fall by about 15 percent and the import market share would rise from about 7 percent to nearly 30 percent. These relatively modest effects suggest that a substantial portion of the domestic industry could have survived a significant tariff reduction. While there has been relatively little work by economic historians on post-Civil War trade policy, these findings are comparable to other results from the antebellum period. Harley (1992) finds that between

one-third and one-half of U.S. manufacturing would have been eliminated had import tariffs been abolished in 1859, Fogel and Engerman (1969) report that domestic competition was more important than imports or tariff policy in determining the fate of the charcoal iron industry, and Engerman (1971) find that tariff policy was much less important than British iron prices in determining the volume of U.S. imports. These findings are broadly consistent with the results of the simulations performed here.

## Data Appendix

The price of domestic pig iron is that of no. 1 anthracite foundry pig iron at Philadelphia as reported by the American Iron and Steel Institute and published in the Statistical Abstract of the United States, 1893 (Washington, D.C.: GPO, 1894), p. 339. This is the longest consistent, readily available time series data on U.S. pig iron prices. The price of foreign pig iron is no. 3 pig iron at Cleveland (U.K.) as reported in B. R. Mitchell, Abstract of British Historical Statistics (New York: Cambridge University Press, 1988), p. 763. This time series is highly correlated with two other potential series, U.K. exports prices from Britain's Central Statistical Office, Annual Abstract of Statistics, various years (where the correlation is 0.98 over 1867-1889) and U.S. pig iron import prices (correlation 0.82) which includes all sources of imports.

The volume of U.S. production and imports of pig iron (in tons) is taken from Statistical Abstract of the United States, 1879 (Washington, D.C.: GPO, 1880), p. 134 and Statistical Abstract of the United States, 1893 (Washington, D.C.: GPO, 1894), p. 221. The regional production figures are also found from this source, but various years must be consulted to generate a complete time series. A question can be raised about a potential bias in the estimate of the elasticity of substitution due to imports of basic versus spiegeleisen pig iron. This should not be a concern in the period under consideration here. In 1876, only about 8 percent of pig iron imports (by quantity and value) was spiegeleisen. In 1883, 84 percent of pig iron imports (by quantity) and 74 percent of imports by value were non-spiegeleisen. By 1889, the value and the quantity of spiegeleisen imports exceeded those of regular pig iron and became dominant by mid-1890s. This is one reason for ending the sample at the end of the 1880s.

The domestic price of iron ore is that of old range Bessemer ores as reported in Lake Superior Iron Ore Association, Lake Superior Iron Ores (Cleveland, 1938), p. 322. The foreign (U.K.) price of iron ore is the unit value import price taken from the Great Britain's Central Statistical Office, Annual Abstract of Statistics, various years. Imported iron ore in Britain was the marginal source of supply and comprised nearly half of domestic consumption of ore. The price of coal in the United States is that of anthracite coal (Schuylkill whiteash lump coal at Philadelphia) from the reports of the American Iron and Steel Association as reported in the Statistical Abstract of the United States, 1893, p. 338. The price of coal in the United Kingdom is average export price taken from B. R. Mitchell, Abstract of British Historical Statistics (New York: Cambridge University Press, 1988), p. 748. This series is highly correlated with the index of pithead coal prices in B. R. Mitchell, Economic Development of the British Coal Industry, 1800-1914 (New York: Cambridge University Press, 1984), p. 54. The annual sterling-dollar exchange rate is taken from Mitchell, Abstract of British Historical Statistics, p. 702. The U.S. consumer price index is taken from P. A. David and P. Solar, "A Bicentenary Contribution to the History of the Cost of Living in America," Research in Economic History Vol. 2 (Greenwich, CT: JAI Press, 1977), pp. 1-80.

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**Table 1: Estimates of the Elasticity of Substitution between Domestic and Imported Pig Iron**

Sample period is 1867 to 1889. Standard errors are corrected for heteroskedasticity. Instruments include domestic and imported iron ore and coal prices, domestic expenditures on pig iron, and the sterling-dollar exchange rate.

	log (M/D) (1)	log (M/D) (2)	log (M/D) (3)	log (M) (4)	log (M) (5)
Constant	4.09 (0.35)	4.34 (0.38)	4.40 (0.63)	-10.09 (4.65)	-6.23 (6.15)
log ( $p_D/p_M$ )	-2.25 (0.59)	-2.56 (0.60)	-2.69 (0.81)	--	--
Time	--	--	-0.01 (0.02)	--	--
log ( $p_D/p_{CPI}$ )	--	--	--	1.67 (0.55)	2.24 (0.88)
log ( $p_M/p_{CPI}$ )	--	--	--	-2.09 (0.62)	-2.59 (1.11)
log (y)	--	--	--	1.07 (0.40)	0.62 (0.53)
log ( $M_{t-1}$ )	--	--	--	0.24 (0.24)	0.56 (0.33)
Adj. R <sup>2</sup>	0.40	0.39	0.36	0.76	0.65
Instruments	No	Yes	Yes	No	Yes
AR (1) Correction	No	No	No	Yes	Yes



**Table 2: Estimates of the Elasticity of Substitution by Region**

Standard errors are corrected for heteroskedasticity. Dependent variable is  $\log(M/D)$ , where M is volume of imported pig iron and D is volume of domestic production, by region. East Coast includes production in New York, New Jersey, Maryland, and Virginia. Interior includes Pennsylvania, Ohio, and Kentucky. Midwest includes Illinois, Wisconsin, and Michigan. South includes Alabama and Tennessee. Data are only available for the years 1872-1889, with the exception of 1877.

	East Coast (1)	Interior (2)	South (3)	Midwest (4)
Constant	2.62 (0.76)	3.83 (0.76)	0.03 (0.72)	3.84 (0.76)
$\log(p_D/p_M)$	-2.51 (0.96)	-2.82 (0.60)	-3.33 (1.02)	-2.83 (1.04)
Time	-0.04 (0.02)	-0.01 (0.02)	-0.11 (0.02)	-0.01 (0.02)
Adj. R <sup>2</sup>	0.36	0.31	0.36	0.31

**Table 3: Estimated Effects of Tariff Removal circa 1869**

Assumptions: The benchmark pig iron tariff in 1869 was 60%. The actual tariff cut was to 47%; the Wells proposals was for a tariff of 20%, and free trade is a tariff of 0%. The short-run elasticity assumptions are:  $F=3$ ,  $O_Q=-0.6$ ,  $\epsilon_{US}=1.1$ ,  $\epsilon^*=15$ . The long-run elasticity assumptions are:  $F=6.6$ ,  $O_Q=-1.4$ ,  $\epsilon_{US}=3$ ,  $\epsilon^*=15$ . The value of domestic output is \$58.9 million and the value of imports is \$4.7 million.

**A. Resource Allocation**

	Actual Cut Short Run (1)	Actual Cut Long Run (2)	Wells Proposal Short Run (3)	Wells Proposal Long Run (4)	Free Trade Short Run (5)	Free Trade Long Run (6)	Free Trade Perfect Substitutes
Percent Change in Domestic Pig Iron Price	-0.7%	-0.5%	-2.8%	-2.6%	-5.7%	-5.5%	-25.1%
Percent Change in Shipments of Domestic Pig Iron	-0.8%	-1.7%	-3.0%	-7.7%	-5.5%	-15.8%	-53.9%
Percent Change in Border Price of Imported Pig Iron	1.3%	2.4%	4.3%	7.9%	6.9%	12.6%	19.3%
Percent Change in Internal Price of Imported Pig Iron	-6.9%	-5.9%	-21.8%	-19.1%	-33.2%	-29.7%	-25.1%
Percent Change in Imports of Pig Iron	20.6%	42.0%	86.6%	213.1%	171.7%	489.1%	1,323.8%
Import Market Share (by value) (1869 = 7.4%)	8.3%	9.8%	11.0%	18.4%	13.9%	29.4%	70.5%

Table 3, Continued

B. Welfare Effects (in millions of dollars)

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Deadweight Loss Triangles	\$1.09	\$2.29	\$3.70	\$8.88	\$6.04	\$16.30	\$41.70
Terms of Trade Effect	-\$0.00	-\$0.00	-\$0.06	-\$0.06	-\$0.20	-\$0.37	-\$0.57
Net Welfare Effect	\$1.09	\$2.29	\$3.64	\$8.82	\$5.84	\$15.97	\$41.13

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Figure 1

### Import Share of U.S. Pig Iron Market, 1867 - 1889

(in tons)

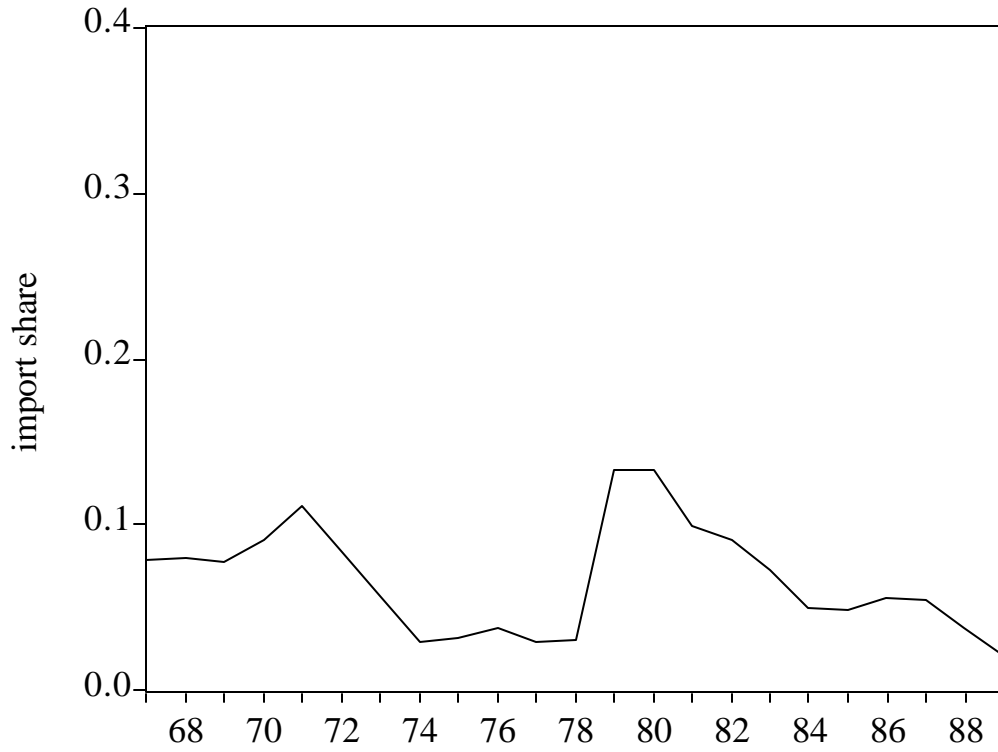
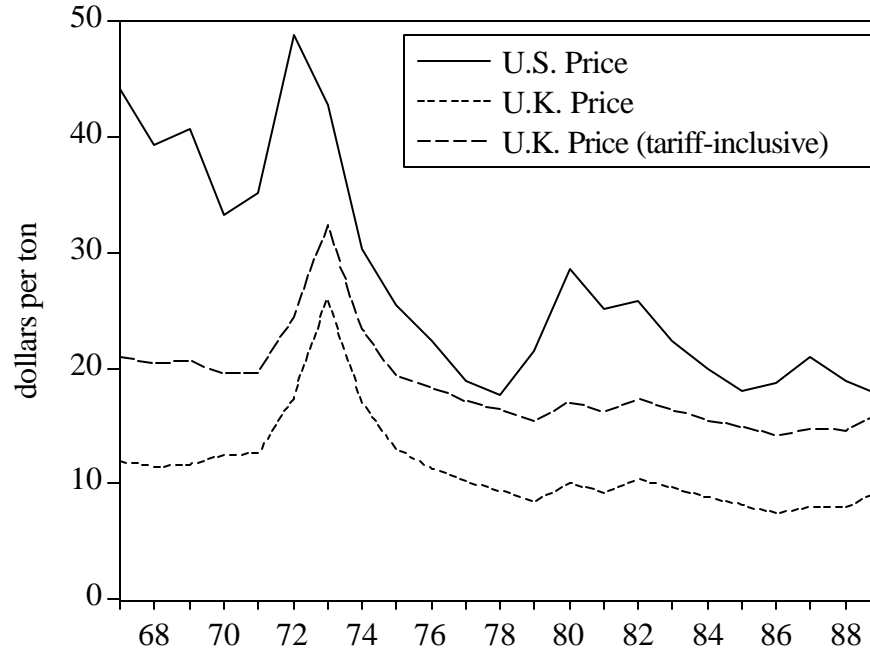


Figure 2

### Pig Iron Prices, 1867-1889



### Relative Price of U.S. Pig Iron, 1867-1889

