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ABSTRACT

We study the relationship between tariffs and labor productivity in US manufacturing between 1870 and 1909. Using highly dis-aggregated tariff data, state-industry data for the manufacturing sector, and an instrumental variable strategy, results show that tariffs reduced labor productivity. Tariffs also generally reduced the average size of establishments within an industry but raised output prices, value-added, gross output, employment, and the number of establishments. We also find evidence of heterogeneity in the association between tariffs and value added, gross output, employment, and establishments across groups of industries. We conclude that tariffs may have reduced labor productivity in manufacturing by weakening import competition and by inducing entry of smaller, less productive domestic firms. Our research also reveals that lobbying by powerful and productive industries may have been at play. The era's high tariffs are unlikely to have helped the US become a globally competitive manufacturer.

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1 Introduction

The US manufacturing sector came of age between 1870 and World War I. In 1870, the US was a commodity exporter and an importer of manufactured products. By the 1890s, US manufacturers were increasingly competitive in global markets. Commodities played a decreasing role in US exports. During this period, US tariff rates averaged 35%, providing significant shelter from international competition. Did tariffs boost US manufacturing productivity and help the US to emerge as a globally competitive manufacturing exporter? Our evidence suggests they did not.

One view of this period contends that US manufacturing owed its success, in part, to protectionism. For example Allen (2014) argues, "It is difficult to imagine how this pattern of development could have been realized without a protective tariff." According to this view, US tariffs eliminated British and other foreign competitors from American markets, helping US industry to thrive. F.W. Taussig, the leading expert on US tariffs and trade in the early 20th century, was largely agnostic about the impact of tariffs on US manufacturing. However, he claims, without quantitative evidence, that certain industries like silk textiles, plate glass, and woolen worsted textiles would not have arisen without tariffs (Taussig, 1931, p.22).[1]

On the other hand, Irwin (2000*b*) disputes the idea that tariffs made a crucial difference for US manufacturing.[2] Even without tariffs, international competition would have been low because of America's large domestic market and relative geographic isolation from other economies. Moreover, lobbying and political economy forces, always in play in the US, potentially led to inefficient outcomes. Finally, natural resources may have mattered more. For example, massive iron ore deposits near Lake Superior helped reduce input costs for US iron and steel producers allowing for lower unit costs and greater international competitiveness (Allen, 1979; Irwin, 2000*a*). Access to other resources like coal, petroleum, and other mineral inputs allowed US industry to gain price competitiveness with foreign competition (Wright, 1990).

[1] The Beard-Hacker thesis also suggested that tariffs were important for US manufacturing growth in this period (Beard and Beard, 1933; Hacker, 1940). Yoon (2020), using a calibrated general equilibrium model, concludes tariffs had a negligible effect on TFP in US manufacturing and the US share of world manufacturing, but did raise overall manufacturing output by over 20% (Table 7, p. 152). Harris, Keay and Lewis (2015) find evidence that tariffs directed to certain "infant" industries promoted productivity growth in Canada after 1879. Tena-Junguito (2010) studies cross-country evidence which shows tariffs retarded productivity growth in poor countries but had the opposite effect in richer countries. Lehmann and O'Rourke (2011) show that manufacturing tariffs were associated with faster growth in GDP per capita in the late 19th century and early 20th century.

[2] Irwin (2017) synthesizes the evidence supporting the argument that tariffs were not a cause of the rise of US manufacturing in the 19th century.

To this debate, we contribute new, comprehensive data as well as the use of an identification strategy that avoids the endogeneity of tariff policy. For data, we develop an industry-level database of tariffs spanning three decades (1870-1900) by digitizing the universe of tariff-lines and imports from official data in benchmark years. We match these data to state-level Census of Manufactures data for over 80 highly dis-aggregated manufacturing industries between 1870 and 1909. Next, our main empirical method develops a single equation, instrumental variables approach to isolate the causal impact of tariffs on manufacturing labor productivity at the industry level. To identify the causal effect of tariffs, we rely on the fact that many US tariff lines were specific tariffs. Specific tariffs caused actual tariff rates to be a function of exogenous foreign price shocks. Given this, we are able to adopt, with suitable adaptations to our environment, the identification strategy of Greenland and Lopresti (2024) who investigate both the effects of tariffs on imports and imports on structural change in the US between 1900 and 1940.

We test whether the data are consistent with several specific hypotheses connecting tariffs to labor productivity. The first of these is the idea that tariffs gave domestic manufacturers an incentive to invest and/or innovate by clearing the US market of foreign competition. If tariffs raised such investment, then we should find relatively higher productivity in industries with relatively higher tariffs. Another channel by which tariffs could promote productivity, especially in "young" or emerging industries, would be learning-by-doing as emphasized by the broad literature on tariffs and growth and recently examined in Yoon (2020). In this view, tariffs allowed domestic manufacturers to claim larger market share, benefiting from larger production runs and increasing returns to scale.[3]

Lobbying and politics might have also mattered. If so, US tariffs could be the effect, not the cause, of industrial fortunes. Tariffs may have merely acted as transfers from consumers to manufacturing producers with an associated potential welfare cost due to higher final goods and inputs prices. If the lobbying/rent-seeking hypothesis is valid, then we would expect OLS regressions to be significantly biased and for our instrumental variables estimate to potentially reveal the nature of such a bias.

Following basic economic theory, the effect of tariffs on prices and quantities depends on market structure. In competitive, import-competing-industries, tariffs raise both prices and domestic output. Tariffs may also allow entry of smaller, less productive firms which could drag average productivity downwards (Melitz, 2003). Additionally,

[3] Yoon (2020) also considered the idea of increasing returns along the lines of the new economic geography. Klein and Crafts (2020) and Klein and Crafts (2012) show that new economic geography models provide significant explanatory power for the location and productivity of US manufacturing sector in this period.

with imperfect competition, domestic prices may rise while domestic output could also be restricted. We also test for such heterogeneity.

We have several key findings which add value to recent research. First, we conclude that there is no evidence that higher US tariffs promoted labor productivity in the manufacturing sector. This result is largely consistent with Irwin (2017), but our methods and data are significantly different from this previous work. Second, we explore results in a dis-aggregated dataset. Our evidence is consistent with two conclusions from the calibrated general equilibrium model of Yoon (2020): tariffs played a minimal role in explaining the rise of the US share of global manufacturing output in these years and tariffs raised overall manufacturing output relative to a no-tariff counterfactual. However, we go beyond the scope of Yoon (2020) by using reduced form methods with dis-aggregated data which allows us to focus on labor productivity variation within manufacturing, not just productivity for the sector as a whole. Third, we find that tariffs induced entry of establishments generally leading to smaller average establishment sizes in American manufacturing. All of these findings are suggestive of a role for firm level heterogeneity as in Melitz (2003), a channel which was not explored in Yoon (2020) or in any other work on the topic of which we are aware. Finally, our empirical tests also reveal significant bias in OLS regressions, providing new quantitative evidence consistent with the lobbying hypothesis.

Using a comprehensive dis-aggregated data set also allows us to delve into heterogeneity. For instance, we find some evidence that in the emerging industries of the "second industrial revolution," higher tariffs were associated with higher labor productivity. However, these results are not highly economically or statistically significant. We also explore a range of other relationships such as the impact of tariffs on average establishment size, gross output, value added, employment, and the number of establishments in an industry. We find interesting differences in the association between tariffs and these variables across different sets of industries. Some of these differences appear to relate to the level of concentration of ownership and competition in these industries.

We begin by providing an overview of the literature on tariffs and manufacturing productivity in US economic history. Next, we provide a road map for the hypotheses which we test based on standard theoretical motivations. We then discuss our methods and data sources. Next, we present our main results relating tariffs to manufacturing labor productivity and other industry outcomes. We also offer some narrative evidence at the industry-level in order to understand our econometric results in historical context and to better understand how tariffs might have had heterogeneous impacts as a function of industry characteristics. We conclude by examining what our new data and methods can answer about the larger debate and what they cannot.

2 Tariffs, the Manufacturing Boom, and Structural Change after the Civil War

2.1 US Tariff History: 1870 to the Early 20th Century

Figure 1 shows the average tariff in ad valorem equivalent terms by year across all products. The average tariff in ad valorem equivalent terms, AVE, is defined, as usual, as the ratio of total tariff duties to the total value of imports based on data from United States Bureau of the Census (1975). We also present the average tariff for manufacturing industries in our estimating sample. Figure 1 also shows that tariffs remained relatively high throughout the period. The overall average tariff rate declined from around 45% in 1870 to just below 30% by 1900. Figure 1 shows that the average tariff in ad valorem equivalent terms for the industries in our estimating sample was about 35% and thus on average somewhat higher than in other sectors.

Figure 2 shows the average ad valorem equivalent tariff by SIC 2-digit industry. The highest four industries in 1870 include Tobacco (21), Apparel (23), Food (21), and Textiles (22). The lowest industries are Electrical Products (36), Lumber and Wood products (24), and Paper Products (27). There is some change by 1900, but Tobaccos and Apparel and Textiles remain in the top four, while Publishing (27) and Basic Metal Products (33) have moved into the bottom four. As we discuss below there is significant within industy change in the tariff rates in our period.

2.2 The US Manufacturing Boom after 1870

The US economy transitioned from an agricultural economy to an industrial powerhouse by the last decade of the 19th century. Eysenbach (1976) reports that the US share in world manufactured exports was 2% in 1872, 11% in 1900, and 14% by 1913. The share of the labor force in agriculture fell from 48% in 1870 to 32% in 1910 (United States Bureau of the Census, 1975, series D12 and D16). The share of national income paid to the agricultural sector fell from 20% in the 1869-79 period to 17% by 1903-13. The share going to manufacturing rose from 14% to 19% (United States Bureau of the Census, 1975, Series F217 and F 219).

These structural changes also led to the US becoming a net exporter of manufactured products by the early 20th century. The growth of exports and imports reflected changing comparative advantage and changes in overall trade costs. For exports, "crude materials" and "crude food" products fell from 42% of merchandise exports in 1870 to 40% in 1914. However, "finished manufactured" exports doubled their share from 15% in 1870 to 31% in 1914 (United States Bureau of the Census, 1975, Series U213-U218).On the import side, "crude products," many of which were industrial inputs, rose from 23% in 1870 to 47% in 1914. Finished manufactures fell from 40% of merchandise imports in 1870 to 24% in 1914. Between 1870 and 1914, net exports of finished manufactured goods rose from a deficit of -$118 bn. ($56bn. - $174 bn.) to a surplus of $276 bn. ($725bn. - $449bn.) (United States Bureau of the Census, 1975, Series U219-U224).[4]

2.3 Tariff Policy and American Economic Development

Prior to the Civil War, a view developed that the US could not succeed in becoming a leading manufacturing nation without the help of tariffs. Alexander Hamilton suggested in his *Report on Manufactures* that the US would remain an agricultural economy unless it resorted to strategic trade policy with tariffs playing a major role. The aim of subsidies and tariffs was to offset foreign protectionism and to provide shelter to domestic producers so that nascent US industries could "learn" to become more productive. Eventually, the US would be able to compete with the more advanced economies such as Great Britain. Henry Carey and others like Friedrich List promoted the idea of economic nationalism with Carey viewing free-trade as tantamount to being (re-) colonized and ravaged by Britain in the same way as India and China were allegedly being shoved into economic subservience. Henry Clay promoted a view that came to be called the "American System" which advocated for high tariffs on manufacturing.

Tariff rates were raised substantially during the Civil War to generate revenue to fund war efforts. After the Civil War, the budget of the federal government improved, and Congress attempted to reduce tariffs. However, as detailed in Taussig (1931), Congress could not reach consensus. Reform efforts largely failed, and tariff rates remained elevated on many manufactured products throughout the post-Civil War period, continuing into the 20th century. Taussig (1931) argues that tariffs which were once expected to be temporary had come to be seen as quasi-permanent by the late 19th century.

Revenue considerations mattered for the level of tariffs early in the post-Civil War

[4]It is important to remember that the US remained a relatively self-reliant economy in this period. The share of imports in GDP averaged 5% while the share of exports fluctuated between 6% and 8%. If we scale by gross production using our Census of Manufactures data, the median export share across our SIC-3 digit industries was 1% and the median import share across those industries was 2.5%. The data on gross exports and imports presented here also reveal that two-way, intra-industry trade was prevalent since both exports and imports of manufactured products rose between 1870 and 1914.

period. In the 1870s, Congress lowered "revenue tariffs" on products like coffee and tea, eventually deciding to remove coffee and tea from the list of dutiable products. This itself reduced the average tariff rate by several percentage points since coffee and tea made up 7.3% of imports by value in 1870 and these products initially had an average tariff of 50% and 75% respectively. Irwin (2017) reports that the Tariff Law of 1870 maintained most protective duties on raw materials and manufactured goods. In 1872 Congress approved small reductions on tariffs for many manufactured industries like cottons, woolens, metals, paper, glass, and leather.

Politics mattered for the evolution of tariffs after the 1870s. Irwin (2017) emphasizes the over-arching goal of Congress and interest groups was to restrict foreign competition. To that end, the tariff reductions of 1872 were repealed in 1875. The Tariff Law of 1890, known as the McKinley tariff, raised rates on dutiable products but allowed a larger class of products to enter the country duty-free. In 1894, Democrats controlled Congress and approved lower tariffs in the Tariff Law of 1894. These declines were reversed in 1897 after the Republicans returned to power in Congress.

Congress used log-rolling and political horse-trading to raise tariffs across a range of industries (Baack and Ray, 1983). Generally, the Republican party and their northern industrialist backers supported protection of manufacturing while the Democrats favored lower tariffs. By the early 20th century, some Republicans had switched camps. According to Becker (1982), Robert LaFollete, an anti-tariff Republican from Wisconsin, believed tariffs "preserved those manufacturers with outmoded machinery" and allowed efficient firms to "achieve excessive profits." Nevertheless, in the period we study, US tariff rates and trade policy partly depended on which party controlled Congress. Irwin (2017) describes in great detail the cast of colorful characters who actively promoted protectionism. For instance, William "pig iron" Kelley, was a Republican member of Congress from Pennsylvania who has been described as someone who "thinks tariff, talks tariff, and writes tariff every hour of the day" and even allegedly dreamed of tariffs. Republican Reed Smoot of Utah, first elected to the senate in 1903, was given the moniker of the "apostle of protection" arguing for protection of Utah's sugar beet industry from foreign competition. It is clear that tariffs were essentially up "for sale" in the US political system throughout the period.

There is no evidence that any branch or agency of the US government had a clear, over-arching strategic trade policy aimed at specific industries despite earlier efforts to promote an "American System." While some industries were certainly protected from foreign competition for national security reasons, most notably, shipping and maritime transportation, there was no government sponsored policy to actively promote particular industries. To the extent that some industries obtained more protection from foreign competition than others, it would seem that lobbying, outright political corruption and/or economic and political power played a large role and "industrial policy" was not attempted (Bensel, 2000).

The recent economic history literature emphasizes the forces of the "new" economic geography, natural resources, and innovation as key drivers of structural change. Economic geography models suggest that firms co-locate in order to reap advantages from agglomeration. These productivity spillovers come in the form of knowledge sharing, better access to cheap and diverse materials and inputs, and labor market externalities. Klein and Crafts (2020) indeed find evidence that agglomeration and economies of scale were a key determinant of manufacturing labor productivity growth in the late 19th century and the early 20th century. Moreover, Klein and Crafts (2012) estimate a model of industry location decisions showing that natural resources and market potential mattered for explaining the economic geography of the American economy in the late 19th century and early 20th century. This is consistent with the idea that economic actors of the time perceived the productivity benefits emphasized in the economic geography literature.

Abundant natural resources were key in promoting growth and exports in American manufacturing.[5] In an influential paper, Wright (1990) suggests that the rise of US manufacturing, in general, was attributable to excellent access to inexpensive domestic natural resources. Wright claims that resources changed the American comparative advantage since key exports of the early 20th century including automobiles and parts and farm implements relied on excellent access to low-cost natural resources like copper, petroleum, aluminum, coal, and iron ore. As discussed above, Irwin (2000*a*) and Irwin (2000*b*) also emphasize the role of natural resources in generating competitive and comparative advantages for US manufacturing.

3 Theoretical Motivations

The impact of tariffs on prices and quantities according to basic economic theory depends on market structure. In competitive industries, with homogeneous products and an autarky domestic price above the world price, tariffs raise the price of an import-competing product and also increase domestic output. In markets with imperfect competition and concentration of ownership, tariffs that largely diminish foreign competition may cause domestic prices to rise while domestic output could also be restricted.

[5] Taussig (1931) notes the abundance of iron ore, coal, and other minerals favored US manufacturing and made tariffs redundant, especially in many iron and steel products.

More elaborate economic theories show that tariffs can affect productivity, average establishment size, and other industrial outcomes such as employment. Harris, Keay and Lewis (2015) apply a model of increasing returns and domestic oligopoly to the National Policy of 1879 in Canada which raised tariffs for a number of industries. Their linear demand model focuses on the impact of tariffs on market size. Under higher tariffs, demand for domestic, import-competing output is higher, and there is entry of new firms. In addition, incumbent domestic firms increase gross output, raise output per firm, reduce markups, decrease prices, and hire more workers. Finally, after tariffs are raised, domestic manufacturing experiences a rise in labor productivity.

Tariffs may have an ambiguous effect on investment in new processes and product innovation. One view is that lower competition can give domestic manufacturers higher revenue and profits by clearing the US market of foreign competition. On the other hand, lower tariffs and greater exposure to foreign competition may lead to greater investment and innovation or elimination of the least productive firms in an industry (Amiti and Konings, 2007; Melitz, 2003. Williamson (1974) argues that post-Civil War tariffs played a direct role by reducing the price of capital goods relative to non-durable consumer manufactured goods which increased investment. Theory predicts that such investment could lead to relatively faster growth of labor productivity in industries benefiting from this type of tariff policy.

"Learning-by-doing" is another channel by which tariffs could promote productivity growth, especially in "young" or emerging industries, as emphasized by the broad literature on tariffs and growth. In this view, tariffs allowed domestic manufacturers to claim larger market share, benefiting from larger production runs and increasing returns to scale. Yoon (2020) considers the idea of increasing returns along the lines of the new economic geography but found little evidence in favor of it in his calibration of a general equilibrium model.

Tariffs could also be driven by lobbying. Baack and Ray (1983) discuss two possibilities in the late 19th century. One possibility is that "important" industries may be successful in lobbying for protection. On the other hand, industries in "decline" could also attempt to garner protection to avoid their imminent demise. These are described as "pressure group" factors by Baack and Ray. They also include a role for "revenue" factors and "industry characteristics." The former would apply to products with inelastic demand such as tobacco and alcohol. The latter include what economists now refer to as "downstreamness" or complexity. High value-added industries with increasing returns typically have concentrated ownership, facilitating lobbying for protective policies. If true, US tariffs may have merely acted as transfers from consumers to manufacturing producers with an associated potential welfare cost due to higher final goods and input prices.

Schularick and Solomou (2011) study the relationship between aggregate economic growth and tariffs prior to World War I. They report that some influential papers had found a positive relationship between growth in aggregate labor productivity and the lagged level of tariffs.[6] They demonstrate that this positive relationship between tariffs and growth was most evident in the 1880s, but they argue that the relationship is driven by confounding factors. Following the global economic slowdown of the 1870s and the associated price level deflation, tariffs were relatively high as of 1880 in many economies. This happened partly because deflation raised the ad valorem equivalent of specific tariffs and also because many governments (e.g., Germany in 1879 and France in 1883) reacted to economic depression with protectionist measures. Previous studies neglected to control for these overall changes in the economic environment. Therefore it is important to recognize the potential for reverse causality.

Regarding the impact of price declines on tariffs, the observation in Schularick and Solomou (2011) did not distinguish between the tariff exclusive prices of imports and domestic prices. These may vary, especially in the short-run. In what follows, we show how we can leverage the exogeneity of changes in tariff-exclusive foreign prices and the structure of protection to identify the impact of tariffs on manufacturing outcomes. With our disaggregated data we can distinguish domestic-industry shocks from foreign suppliers' price shocks at the detailed product level which we use to generate exogenous changes in US tariff rates.

4 Methods

We are interested in explaining state-industry-level outcomes as a function of tariffs according to the main hypotheses in Section 3. Following a specification close to those in the literature (e.g., Amiti and Konings, 2007), we estimate the following equation

$$\ln(y_{kst}) = \beta_1 \ln(1 + \text{AVE}_{kt-10}) + \mu_{ks} + \delta_t + \varepsilon_{kst} \tag{1}$$

where y is an outcome such as real labor productivity (real value-added divided by the total number of workers), k indexes industries, s indexes states, and t indexes the final years of the census periods in our sample. In addition AVE is the average ad valorem tariff equivalent of tariffs for industry k (total tariff revenue in dollars divided by the total

[6] See O'Rourke (2000) and Clemens and Williamson (2004).

value of imports in industry k) measured in the initial year of a ten-year census period, μ is a set of state-industry fixed effects, δ is a set of period fixed effects, and ε is an error term.[7]

We are concerned about the potential endogeneity of the gross tariff term $\ln(1 + \text{AVE})$ in (1). To address this, we use an instrumental variable for tariffs which was developed by Greenland and Lopresti (2024). We use short-horizon changes in import unit values interacted with product-level reliance on specific tariffs, to predict short-horizon changes in overall the ad valorem equivalent of product-level tariffs. We then aggregate these predicted tariff changes within industries to generate an excluded instrument which predicts the tariff term, $\ln(1+\text{AVE})$. The instrument leverages variation in exogenous foreign price changes as well as variation across industries on the reliance on specific tariffs. The use of specific tariffs in the US tariff code caused the realized ad valorem equivalent tariff level to be a function of foreign price changes.[8]

Define the ad valorem equivalent of the tariff on product c in year t as

$$\text{AVE}_{ct} \equiv \tau_{ct} + \frac{f_{ct}}{p_{ct}} \tag{2}$$

where τ is the statutory ad valorem tariff, if any, f is the statutory specific tariff in dollars per physical unit, if any, and p is the tariff-exclusive (F.O.B.) price, proxied here by the unit value. The unit value is the total value of the import divided by the number of units. Also define the share of total revenue collected for a product c coming from specific tariffs as

$$\text{STS}_{ct} \equiv \frac{f_{ct}}{p_{ct}\tau_{ct} + f_{ct}}. \tag{3}$$

Given these definitions, an approximation of the percentage change in the gross tariff rate on a product c is given by

$$d\ln(1 + \text{AVE}_{ct}) \approx -\Delta\ln(p_{ct})\text{STS}_{c,t-1}\frac{\text{AVE}_{c,t-1}}{1 + \text{AVE}_{c,t-1}}. \tag{4}$$

Next, define "realized protection"

[7] We relax the parametric assumption of linearity between tariffs and labor productivity and estimate an instrumental variables, semi-parametric version of 1 in Appendix A.2. The standard errors are estimated using a cluster-robust estimator with clustering at the state-SIC 3-digit industry level. We also estimate cluster-robust standard errors using the wild bootstrap as a robustness check in Appendix A.3.

[8] Crucini (1994) emphasizes that price changes would alter the average tariff rate in the US due to the nation's reliance on specific tariffs. We emphasize we are referring to the ad valorem tariff equivalent on the tariff-exclusive price. Information on pass-through to US consumer or producer prices is not available at a dis-aggregated product level.

$$\Delta\text{RP}_{ct} \equiv -\Delta\ln(p_{ct})\text{STS}_{c,t-1}.\text{[9]} \tag{5}$$

Realized protection, ΔRP, can be used in the spirit of a *shift-share* design to help construct our instrumental variable.[10] We use ΔRP to predict the level of the ad valorem equivalent tariff on a product in the initial year of a ten-year census period. The shift is determined by one-year changes in the log of the unit values of imports. The lagged share of tariff revenue collected from specific tariffs is determined by the lagged values of prices and quantities imported, and the statutory regulations which governed each tariff line.

To construct an instrumental variable, we first predict the one-year change in the log of the ad valorem equivalent of product level tariffs using ΔRP.[11] To do so, we estimate the following equation in repeated cross-sections of tariff-line data from *FCNUS*

$$\Delta\ln(1+\text{AVE}_{ct}) = \gamma_0(\Delta\text{RP}_{ct}) + \delta_t + \eta_{ct} \tag{6}$$

where Δ is a one-year difference, δ_t is a set of year indicators, and η is an error term. Next, we obtain the predicted value of the one-year proportional change in the gross tariff rate (1+AVE) at the industry level relative to the initial level of the ad valorem tariff equivalent. To do so, we average the exponentiated values of the predicted product changes within an industry and then take the logarithm of the average to obtain our excluded instrumental variable (IV)

$$IV_{kt} = \ln\left[\frac{\widehat{1+\text{AVE}_{kt}}}{1+\text{AVE}_{kt-1}}\right] = \ln\left(\frac{1}{N_{kt}}\Sigma_{c\in k}\exp\left[\widehat{\gamma_0}\left(\Delta\text{RP}_{ct}\right)+\widehat{\delta_t}\right]\right) \tag{7}$$

[9]For small changes in prices/unit values, this identity is a highly correlated approximation of the formula $\ln(1-\frac{\Delta p_t}{p_{t-1}}\text{STS}_{c,t-1})$ used in Greenland and Lopresti (2024).

[10]The recent literature has explored the shift-share research design and the conditions under which a shift-share instrument can identify the causal effect of changes in the endogenous variable of interest (Goldsmith-Pinkham, Sorkin and Swift, 2020 and Borusyak, Hull and Jaravel, 2022). Borusyak, Hull and Jaravel (2022) show that identification follows from the quasi-randomness of shocks while the weights can be endogenous. On the other hand, the Goldsmith-Pinkham, Sorkin and Swift (2020) approach relies on the exogeneity of the weights and makes no explicit assumptions about the exogeneity of shocks. Our instrument, while of a shift-share type, is constructed with two exogenous parts.

[11]We estimate this stage at the product level since aggregation leads to measurement error. *FCNUS* did not report unit values for ad valorem tariff only goods, so that aggregation would lead to very imprecisely measured changes in tariffs of such product bundles. We also use a short-horizon to deal with the fact that products change names over time and have not yet been, and were not historically, concorded. In addition, the product space changes over time and tariff laws change over longer horizons which complicates inference on changes in tariffs. The latter problem could lead to endogenous adjustment of tariffs which is useful to avoid. These features distinguish our baseline approach from the baseline models of Greenland and Lopresti (2024) which use ten-year changes in aggregate price indexes as a shift and STS at the industry level as the share in their shift-share analysis.

where the " $\frown$ " symbol represents a predicted value and N_{kt} is the number of products within an industry k in year t. Variation in this instrument is driven by the assumed exogenous variation in the shifts (unit prices) and shares (STS) present in ΔRP.

We rely on the assumption that both the share (STS) and the price shocks are exogenous or uncorrelated with the error term in our estimating equation (1). Irwin (2017) asserts that unit value changes for imports were determined on the (foreign) supply side and not by local conditions in the US which acted as a price taker for imports. Regression results also are consistent with this conjecture.[12] This implies that the unit value changes are conditionally as-good-as randomly assigned. Greenland and Lopresti (2024) note that specific tariffs were re-introduced to the US tariff code in the tariff law of 1861 (Morrill tariff) after such tariffs had largely been suspended since the tariff law of 1845. They also note that the post-1861 realized protection measure has no explanatory power for imports prior to 1861.

The share of revenues (STS) coming from specific tariffs also seems to be determined by factors besides historical price movements and lagged demand shocks for imports. As discussed in Section 2, historical research argues, using qualitative historical evidence, that industrial characteristics were not *systematically* related to the share of revenues generated by specific tariffs (Irwin, 2017 and Bensel, 2000).[13] Our data set enables us to examine the exogeneity of these revenue shares in more detail. In particular, we have estimated equations in which we regressed the shares of specific-tariff revenue in each SIC 3-digit industry on the share of labor employed in each SIC 3-digit industry, its gross output, the level of labor productivity (or labor productivity growth over the preceding ten years), as well as year and SIC 3-digit industry fixed effects. The results discussed in Appendix A.1 reassure us that our instrumental variable is valid. There is no systematic relationship between these industry variables and the share of total tariff revenue generated by specific tariffs.

As shown in Figure 3, ΔRP is a very strong predictor of the changes in product level tariffs at a one-year horizon. The average one-year change in the log of the gross tariff, ln(1 + AVE), in our sample is -0.002 with a median of zero. The bottom decile is

[12] We ran a regression at the product level in our repeated cross-section dataset of products, of the one year change in log unit values on the lagged level of imports, the log change in the value of imports, SIC-year dummies, and the product-level value of the share of tariff revenue collected from specific tariffs, STS. Neither of the coefficients on the import terms, the lagged value of STS, nor the joint test for the vector of coefficients are statistically significant. This suggests that price changes are exogenous to domestic supply and demand shocks at the industry and economy level as well as being unrelated to observed changes and levels in import values.

[13] Historically, specific tariffs gave Congress less control over the revenue generated from a tariff, but they helped avoid under-invoicing associated with ad valorem tariffs (Hawke, 1975).

-0.07 and the 90th percentile is 0.06. Conditional on having a specific tariff then these statistics are -0.004 (ave.), -0.002 (median), -0.12 (bottom decile), and 0.06 (90th decile). Products with only an ad valorem tariff have no significant changes since each of our one-year changes fall within a given tariff law regime.

5 Data

Our results rely on two comprehensive historical databases which we have assembled. The first is the universe of tariffs at the product level for the United States for eight benchmark years between 1869 and 1900. The other main source is the US Census of Manufactures. These two data sets provide rich information on trade policy over time and a range of outcomes for the manufacturing sector such as gross production, value of materials/inputs used, labor inputs (number of workers), and number of establishments.

5.1 Tariff Data

We hand coded tariff data from the *Foreign Commerce and Navigation of the United States* (*FCNUS*). *FCNUS* reports a text-based name for an imported product, the dollar value of imports by product, the physical quantity imported (if recorded) of each product, the dollar value of total duties collected (if any), and the product-level statutory tariff rate for each year. The number of tariff lines we hand-digitized totals roughly 8,300.

We collected tariff data for the fiscal years ending in June of 1870, 1880, 1890, and 1900 as well as the fiscal years immediately preceding these.[14] Product names were recorded as given in the data source and then standardized across major headings for major commodity groups. We assigned each unique product an SITC (revision 2) code at the highest level of dis-aggregation possible. We chose the SITC (revision 2) since this system has already been used by economic historians for the compilation and analysis of countries' historical trade data (Huberman, Meissner and Oosterlinck, 2017; Meissner and Tang, 2018; Hungerland and Wolf, 2022).[15] The SITC (revision 2) provides a good

[14] Between 1866 and 1910 there were eight major changes in tariff policy. Our tariff data fall under four separate tariff laws. These are as follows. The Morrill Tariff of 1861 was in effect in fiscal years ending June 1869 and June 1870. The Tariff Law of 1875 was in effect in the fiscal years ending in June 1879 and June 1880. The "Mongrel Tariff" of 1883 was in effect in fiscal years ending June 1889 and June 1890. Finally, the Dingley Tariff of 1897 was in effect in fiscal years ending June 1899 and June 1900.

[15] Hungerland and Altmeppen (2021) discuss the relevance and usefulness of SITC coding in the context of late 19th century German trade statistics. Many of the same issues are true and applicable in our data set. Prior to the 1950s, there was no universally accepted standardized product list for traded commodities, although the League of Nations had begun work on the issue in the late 1930s. The SITC (revision 2) classification was initiated by the United Nations in 1947. Revision 2 of the SITC system made some modest

link between products commonly traded in the early post-World War II years and our period. We then use available cross-walks between SITC codes and SIC industries to assign products to industries. We ensure that each product was assigned to only one SIC 3-digit industry.

Statutory tariffs are recorded in four ways. Some products have an ad valorem tariff rate that is a percentage of the declared value of a product. Second, some products have specific tariff rates expressed as a nominal amount in dollars per physical unit of the product (e.g., $1 per pound). Another common type of tariff was a compound tariff that applied both ad valorem and specific tariffs. Finally, the US admitted some products duty free. We can also calculate the ad valorem equivalent tariff rate at the product level. To calculate this value, we divide the tariff revenue by the value of imports at the product level. Such a measure can also be calculated within industries (or SITC categories) or across industries by dividing total tariff revenues by total imports. In this case, the ratio can be interpreted as the import-value weighted average of the ad valorem equivalent tariff rates.[16]

Finally we calculate unit values as the total value of imports divided by the physical quantity. Imports to the United States were valued at the port of departure exclusive of tariffs and all other costs. Unit values are thus the import-value-weighted average prices of products over the course of a fiscal year coming from all US trade partners.

5.2 Manufacturing Data

Data for manufacturing come from the US Census of Manufactures for 1870, 1880, 1890, 1900, and 1909.[17] Our state-level data include all available data for US manufacturing industries included in the Census of Manufactures. These data include gross output, the value of materials used in production and other costs, nominal wages, number of establishments in an industry, and the number of workers in an industry.

To create a measure of labor productivity, we divide value added (gross output mi-

re-classifications to the earliest SITC iterations from the 1950s and 1960s, in some cases providing more detail for certain items. Coding at the 3-digit level and above remained largely the same as in the initial versions.

[16]This ratio is not reliable if there are prohibitive tariffs since such tariffs would have zero revenue. In this period, most tariff lines have non-zero import values in most years. Out of 8,296 tariff lines in 1870, 1880, 1890 and 1900 there are 49 products with no recorded import values. This is 0.5% of the sample.

[17]Officially, the periods covered by the US Census of Manufactures were from June to May of 1870, 1880, 1890, and 1900. However, efforts were made by the census to ensure that census data refer to production in the calendar year when the censuses were published (Easterlin, 1957). As for the 1909 Census of Manufactures, a new law specified that the manufacturing censuses relate to the year ending December 31 preceding the population census, hence the year 1909 rather than 1910 (Washington, D.C.: United States Bureau of the Census, Department of Commerce, 1913, page 18).

nus total materials costs) by the number of workers in an industry. We deflate labor productivity using price deflators at the SIC 2-digit industry level since more dis-aggregated price indexes are unavailable. The sectoral price indices were calculated using sectoral price data from Davis (2004) and Kendrick (1961), and they are weighted by sectoral weights calculated from the Census of Manufactures in the relevant years.

The U.S. Census of Manufactures, while an excellent source of state-industry level data, is not without its challenges. First, the 1870 and 1880 censuses report the number of workers and not the number of employees which begins only in 1890. Therefore, we use the number of workers to be consistent over the entire period 1870-1909.

Next, there are no SIC codes reported in the censuses before 1947. Here we use the assignment of industries into SIC 3-digit categories created by Klein and Crafts (2020) and used in Klein and Crafts (2021). To assign an industry listed in the U.S. Census of Manufactures into to the relevant SIC 3-digit category, we used detailed descriptions of activities to make a match between census data and SIC industries. The 1909 Census of Manufactures excluded so-called hand trades which are industries providing repair work or work based on individual orders, (e.g., bicycle repairs, furniture repairs, blacksmithing, jewelry engraving or millinery). To make the data comparable, we have excluded the hand trades in other years as well. Furthermore, we have excluded repair shops from car manufacturing after 1890 (when they appear), since these shops did not conduct manufacturing activity.

The Census of Manufactures also reports a special industry category called "All Other". This industry category contains less than one percent of any state's total manufacturing employment and includes those industries that might have had a small number of firms in order to prevent the identification of those firms. As a result, this category contains a heterogeneous set of industries which makes it difficult to assign it to any of the SIC categories. We have decided to assign it to SIC 399 – miscellaneous industries.

Our state-industry manufacturing dataset is based on the data underlying Klein and Crafts (2021) who construct decadal state-industry data at the SIC 3-digit level. The unbalanced panel is composed of 78 unique industries and 46 states/territories in 1880, 80 unique industries and 46 states (and territories) in 1890, 84 unique industries and 48 states (and territories) in 1900, and 74 industries and 48 states in 1909. Not all industries were active in each state. As a result, we have 6,783 observations with complete Census and tariff data data for our baseline sample.

The panel is unbalanced for several reasons. First, new US states enter the data set between 1870 and 1909. Second, we observe "new" industries entering data that previously did not produce in any state. Such entry is largely driven by the emergence of brand new "second industrial revolution" sectors such as electrical machinery and equipment or automobiles.Third, industry exit is largely driven by reclassification in 1909 census or ceasing production within a state. Fourth, already producing industries may be active in different sets of states from one census year to another. We discuss at length the nature of our panel data set and the industry selection processes in Appendix A.4. We also assess the impact of sample selection with a panel data selection estimation strategy as a robustness check to our main results.

5.3 Summary Statistics

Table 1 gives a broad over-view of the data in our estimating sample. The arithmetic average in our sample of the log of industry gross tariffs, $\overline{\ln(1+\text{AVE})}$, is 0.27 with a standard deviation of 0.16. This translates to an equally weighted geometric average tariff rate across all industries of 0.31 or 31% in ad valorem equivalent terms (i.e., $\exp(\overline{\ln(1+\text{AVE})}) = \exp(0.27) - 1 = 0.31$). In our sample, the average, within industry, change between census years in the log of $1 + \text{AVE}$, is -0.01, with a standard deviation of 0.09, -0.10 at the 10th percentile and 0.09 at the 90th percentile.

The sample average of the share of specific tariffs in total tariff revenue ($\overline{STS}$) is 0.33 with substantial inter-industry variation and a standard deviation of 0.38. As we showed above, variation in this share is relevant for our identification strategy. The geometric average value of labor productivity was $1,652, the geometric average of value added was $693,000, and the geometric average of gross output was $1.4 million. Across states/territories, industries employed an average of 419 workers and on average consisted of 42 establishments. We also present summary statistics for ten-year changes in these variables for reference with one of our robustness checks which rely on models in log differences.

6 Results

6.1 OLS Results

Table 2 presents results from our baseline estimating equation (1). We show results for six dependent variables: labor productivity (i.e., real value added per worker), average establishment size (proxied as the ratio of real gross output to the number of establishments), real value added, real gross output, number of workers, and the number of establishments. OLS results are in Panel A while instrumental variable results are in

Panel B.

Results in Panel A, column (1) of Table 2 show a negative relationship between tariffs and productivity with an OLS point estimate for the coefficient on tariffs of -0.34 (p-value = 0.000). A one-standard deviation rise in gross tariffs, $\ln(1 + \text{AVE})$, of 0.16 is associated with a decline in labor productivity of about one-tenth of a standard deviation of the dependent variable. This policy change would be the equivalent of lowering productivity by roughly 5%.

Figure 4 shows a (residualized) scatter plot for the OLS relationship between labor productivity and the ten-year lag of tariffs.[18] Data are at the state-SIC 3-digit level for the four census years 1880, 1890, 1900, and 1909. Labor productivity and tariffs are negatively related in the graph with a slope of -0.34.

6.2 Instrumental Variables Results

We present our instrumental variables regressions in Panels B and C in Table 2. Panel B includes state-SIC 3-digit industry fixed effects and year effects while Panel C includes state by SIC 3-digit industry fixed effects and a full set of state-by-year indicators. The latter flexibly control for unobserved shocks and trends in the manufacturing sector affecting all industries at the state-level. These could include labor market shocks, ongoing trends in structural change, or factors such as economic geography that benefit a state's manufacturing sector generally.[19]

Results in both panels show that there is a negative relationship between tariffs and productivity. In Panel B the coefficient on the log of gross tariffs is equal to -4.41 (p-value = 0.028) while in Panel C it is -3.98 (p-value = 0.045). The impact on the dependent variable is now significantly larger than in the OLS results.

Our results in Panel B imply that if gross average tariffs fell by 0.1 or 10 log points, labor productivity in the sample would increase by 44.1 log points. Starting from the mean level of value added per worker, this is equivalent to an increase of about $900 per worker. In other words, this experiment would be equivalent to raising the average level of productivity from $1,635 to the 72nd percentile of $2,541 per worker.[20]

[18] Data are residualized after controlling for state-industry fixed effects and period fixed effects.

[19] We also included, but do not report, results using regional dummies or region by year indicators. Regional dummies soak up potential spatial correlations across states. Results are qualitatively similar to our baseline findings in Panels B and C.

[20] For clarity, our control variable for tariffs is $\ln(1 + \text{AVE})$, where AVE is the ad valorem equivalent tariff. Define φ as the approximate percentage change in gross tariffs, then $\varphi = \ln(\frac{1+\text{AVE}_1}{1+\text{AVE}_0})$ when gross tariffs change from $\ln(1 + \text{AVE}_0)$ to $\ln(1 + \text{AVE}_1)$. Then if the sample geometric average of the ad valorem equivalent of tariff rates, $\text{AVE}_0 = .31$ and $\varphi = -0.1$, $\text{AVE}_1 \approx .185$. This is a 40% or 12.5 percentage point drop in the geometric average of AVE_0. A change of -0.1 in the log of the gross tariff is also equivalent to

The first stage which predicts the level of tariffs at the industry level has a coefficient on the predicted change in the industry tariff rate of 0.31 (p-value = 0.000). The Kleibergen and Paap (2007) statistic indicates that the instrument is relevant, as shown by the F-statistic of 15.56.[21] We also report the Anderson-Rubin F-statistics which is robust to weak instruments.[22]

In columns (2) through (6) we present results for dependent variables besides labor productivity. We focus for now on the instrumental variables results.

Higher tariffs decrease output per establishment (Column (2) of Panel B). The point estimate suggests a one standard deviation rise in $\ln(1 + \text{AVE})$ would reduce the average establishment size in a state's industry by one standard deviation of the dependent variable. Since smaller establishments are on average less productive, the implication is that one way in which high US tariffs led to slower growth of labor productivity was by encouraging entry of smaller, less productive establishments.

The "extensive margins" are positively related to tariffs (columns (3) through (6)). These four models cover the logarithms of real gross output, real value added, number of workers, and the number of establishments. The coefficient for real gross output is not statistically significant in Panel B but it is marginally significant in Panel C. The coefficients on tariffs in the models for value added are significant at better than the 10% level. The coefficients on gross tariffs in the models for the log number of workers ($\hat{\beta}$ = 17.75, p-value = 0.005) and for the log number of establishments ($\hat{\beta}$ = 17.64, p-value = 0.003) are statistically significant at better than the 1% level. The impact of a one standard deviation rise of the tariff on the number of workers is 1.3 standard deviations of the dependent variable and for the number establishments it is 1.6.

Our results are consistent with the "lobbying" view of Baack and Ray (1983). The instrumental variables results for labor productivity in column (1) produce coefficients on the tariff variable that are negative (like the OLS coefficient), but they are substantially larger than the OLS coefficients in absolute magnitude. This could be because "capable" (large, fast-growing, important, or more politically influential) industries lobby for (and get) tariffs. For instance, suppose industries performing well in terms of productivity growth for reasons besides tariffs lobby for and receive tariff protection. Suppose also the true effect of tariffs on productivity growth is negative. Then, the remaining term in

about 2/3 of the sample standard deviation of $\ln(1 + \text{AVE})$.

[21] We note that in the just-identified case, as is ours, the Kleibergen and Paap (2007) statistic is equivalent to the effective F-statistic proposed by Montiel-Olea and Pflueger (2013). See also Andrews, Stock and Sun (2019).

[22] The rule of thumb cut-off for the first-stage KP F-statistic is 10, which our regressions exceed. The recent literature cautions us to be conservative in assessing the strength of the first-stage regressions, therefore we report the Anderson-Rubin weak instrument robust statistic as per Andrews, Stock and Sun (2019).

the omitted variable bias formula is the product of two positive terms. The first is the correlation between tariffs and unobserved "capability" (positive) which is multiplied by the effect of unobserved/omitted "capability" on productivity (also positive). OLS would be biased upwards. IV eliminates the bias, revealing a much larger negative impact of tariffs. A similar logic holds for average establishment size

But what about the "extensive margins" where we find positive effects and an apparent downward bias (towards zero) in OLS? Here, it may be that heterogeneity is in play. Some theoretical models and assumptions such as those outlined in Harris, Keay and Lewis (2015) argue that tariffs will lead to larger firm size, more sectoral employment, and more entry. On the other hand, theoretical models such as Melitz (2003) find that tariffs can cause entry, but only of smaller, less productive firms. Our results are more consistent with the latter view. We now turn to analysis that will allow for greater exploration of heterogeneity in the impact of tariffs.

6.3 Heterogeneity

"Infant" or "emerging" industries seem to have benefited more from tariffs than the average industry. Taussig (1931) believed that silk textiles, certain metallurgical industries including steel rails, and potentially plate glass could be examples.[23] To investigate this idea, we assigned a set of industries to be "second industrial revolution" or emerging industries. These industries include advanced chemicals (rubber, oil, dyes, etc.) as well as consumer and producer goods (bicycles, machinery, railroad equipment, electrical equipment, etc). These industries account for 6% of total gross output in our sample in 1880 rising to about 8% by 1910. In addition, the median (average) level of log real value added per worker of this sub-sample is 7.85 (7.81) versus 7.26 (7.35) in the remaining sample.[24] In Table 3 we restrict analysis to the set of these "young" industries.

For these "second industrial revolution" industries, tariffs are positively associated with productivity according to our IV results in Table 3 (Column (1) Panel B). The point estimate of the IV coefficient on tariffs is 14.32 (p-value = 0.061). The impact is economically large. A one standard deviation rise in gross tariffs, $\ln(1 + \text{AVE})$, is associated with a 2.38 standard deviation rise in labor productivity. A 25% decline in the geometric average tariffs on these "new" industries from 18% to 13.5% which is equivalent, when starting

[23] Yoon (2020) found a quantitatively small role for tariff-induced learning in his calibrated general equilibrium model. Irwin (2000*b*) found little evidence of learning-by-doing in the US tinplate industry, although technology transfer from Great Britain appears to have benefited domestic producers. Head (1994) found some evidence for learning effects in the steel rail industry.

[24] The SIC 3 digit industries we categorize as "second industrial revolution" are 283, 286, 287, 289, 291, 295, 299, 302, 306, 308, 347, 351-359, 362-365, 369, 371, 375, 382, 384, and 386.

from the average of 18%, to a change in gross tariffs, $\ln(1 + \text{AVE})$, of -0.038, would be associated with a decline in labor productivity of $54\%(\approx -0.038 \times 14.32)$.

An across the board rise in US tariffs would not have had a positive effect on US manufacturing labor productivity. This is because the "second industrial revolution" industries were only about 8% of total gross production in 1910 and 6% in 1880. Although these "emerging" industries might increase their labor productivity from higher tariffs, the vast majority of US manufacturing would experience lower productivity according to our instrumental variables results in Table 2.

A back of the envelope, partial equilibrium, calculation allows us to gauge the impact of a rise of 0.10 in $\ln(1 + \text{AVE})$ on overall labor productivity. Assuming constant shares in gross output, the across the board rise in tariffs would have dragged labor productivity down in the entire sample, mainly composed of non-"second industrial revolution" industries, by about 44% (i.e., $-4.41 \times .1$). However, the "second industrial revolution" industries would have seen their productivity increase by 144 log points (i.e., 14.41×0.1). The overall drop in manufacturing labor productivity of approximately 26% would have been economically substantial.[25]

In the "second industrial revolution" sample, we find that tariffs are not significant determinants of average establishment size, real gross output, or real value added although the coefficients on tariffs are positive. Oppositely, tariffs are negatively associated with the number of workers and establishments in these industries, but none of these coefficients is statistically significant.

We next explore heterogeneity by focusing analysis on subsets of related industries within several 2-digit SIC industries.[26] We categorize, these industries into three groups, ex post, based on the sign of the coefficient on gross tariffs in models of the "extensive" margins (i.e., the partial effect of tariffs on workers, number of establishments, gross output, and value added).

The first group for which results are presented in Table 4 has a largely positive and statistically significant association between these "extensive" margin outcomes and tariffs. The second group (Table 5) has mainly negative and statistically significant coeffi-

[25]Our calculation for overall change in labor productivity uses the weighted average of the logs of labor productivity in two sectors ("second industrial revolution" and "traditional") with weights in total gross output from 1910 of 8% and 92%, respectively. These weights may overstate the counterfactual since they apply to 1910 when the share of the "traditional" industries was 92% while it was 94% in 1880.

[26]We run our baseline regressions on three industry groups. Group I: 22 and 23 (Textile and Apparel), 24 and 25 (Lumber and Furniture), 33 and 34 (Metal and Metal Products, 38 (instruments), 39 (consumer goods); Group II: 20 and 21 (Food and Tobacco, 26 and 27 (Paper and Publishing), 37 (Transportation Equipment); Group III 28 and 29 (Chemicals/Petroleum/Coal), 32 (Glass), and 35 and 36 (Machinery and Electrical Goods). We omit SIC 31 (Leather and Footwear) since the Census of Manufactures re-classified these industries in 1910 leading to drastically influential and un-representative changes in all outcome variables.

cients on the tariff variable in models of the extensive margin. The third group in Table 6 has positive or negative coefficients which are mainly statistically insignificant. This classification reveals meaningful heterogeneity across industries that we explore with narrative evidence below.

As for the intensive margin, there is little evidence that tariffs are positively related to labor productivity in Tables 4, 5, and 6. Only two groups of industries, Instruments (SIC 38) and Wood and Paper (SIC 24 & 25), have a positive coefficient on tariffs which is statically significant at conventional levels. Generally, when labor productivity is the dependent variable, the coefficients on tariffs are negative and significant (Textiles, Metals, Paper, Transportation, Chemicals and Petroleum) or statistically insignificant (Consumer Goods, Tobacco, Glass, and Machinery/Electrical).

Six out of eleven industries in Tables 4 through 6 display a negative relationship between tariffs and average establishment size (gross output per establishment) of which few coefficients are statistically significant. The exceptions which are statistically significant and positive are Consumer Goods and Food and Tobacco. Food and Tobacco consists of many industries, but several of them are well known for their high level of concentrated ownership and anti-competitive behavior in the period. By 1900, meatpacking was dominated by the "Big Five" (Huang, 2024). American Tobacco, created in 1890, remains a true exemplar of concentrated ownership and market power from the late 19th century. Famously being tried under anti-trust legislation in the first decade of the 20th century, American Tobacco was forced to dissolve in 1911.

Finally, tariffs also seem to raise prices. We regress the average growth rates within census periods of the SIC 2-digit price indexes on $\ln(1 + \text{AVE})$ in the initial year of the census period, the log level of the price index in the initial year of the census period, and census period dummies. Results are illustrated in Figure 5, showing that 2-digit SIC industries with higher tariffs tend to have slightly higher growth rates in their price levels.

6.4 Alternative Specifications

We have explored a number of alternative models and econometric specifications to better understand the robustness of our findings in Table 2. We discuss these results below.

6.4.1 Input Tariffs

So far we have neglected the role of input tariffs which might also be important. Our calculations show that the level of tariffs on "inputs" for industries and industry tariffs are highly correlated. A regression of industry "nominal" tariffs on input tariffs (omitting the constant) reveals a coefficient of 1.05 with a t-statistic of 26.98.[27] In Table B2 we present results from the same specifications used in Table 2 but we also include the ten year lag of the average ad valorem equivalent of input tariffs, $\ln(1+\text{AVE of Input Tariffs})$. We use a similar procedure as for "nominal" tariffs to find an excluded instrument for input tariffs.[28]

Both "nominal" and input tariffs are negatively correlated with labor productivity but neither are statistically significant when included together. Input tariffs are a statistically significant determinant of average establishment size ($\hat{\beta} = -15.01$ p-value < 0.01) and the number of establishments ($\hat{\beta} = 18.45$ p-value < 0.01). The coefficients for "nominal" tariffs are qualitatively in line with results in Table 2, but they are less precisely estimated. Our bottom line on input tariffs is that they had similar negative effects to own-industry or "nominal" tariffs. Input tariffs likely raised prices of foreign inputs and domestic substitutes and reduced access to various products which could lead to lower productivity consistent with Amiti and Konings (2007).

6.4.2 Differences and Growth Rates

In Table B3 we present results from a model of long-differences. We difference equation (1) so that the dependent variable is now the long difference between the end points of each census period of the logarithms of each of our six outcome variables and the explanatory variable is the lagged ten year change in $\ln(1 + \text{AVE})$. Differencing in this way, mechanically removes the state-SIC 3-digit fixed effects from the model but still removes unobservable heterogeneity at the state-industry level. A new set of census period intercepts remains after differencing.

[27] To calculate the average ad valorem equivalent of input tariffs, we used the input-output table of Leontief (1941) for the USA in 1919 to calculate cost shares for a sub-set of SIC 2-digit industries. We then used these cost shares and information on tariffs for those input industries to calculate the cost-share weighted average of input tariffs for each SIC 2-digit industry. In our sample the average of these "input" tariffs was 36% in 1870 versus 36% for all nominal tariffs for all industries. In 1880 and 1890, input tariffs averaged 26% in both years and industry nominal tariffs averaged 36% and 30%. In 1900 average input tariffs diverged a bit from the overall average of tariffs falling to 23% versus 34% overall. These average nominal tariff rates vary slightly from the indicative numbers in Figure 1 for two main reasons. First, we are referring to the exact estimating sample here. Second, in Figure 1 we refer to the total value of duties divided by total import values for all industries regardless of whether they appear in our estimating sample or not. The numbers here are simple arithmetic averages of the industry ratios for our estimating sample whereas the values in Figure 1 are the import weighted averages of the industry ratios of tariff duties to import values.

[28] Specifically, we use the instrumental variable for each input industry to create the import-weighted average of the excluded instrument for the input industries of a given SIC 2-digit industry. Many industries use inputs from their own 2-digit industry. In this case, we leave the output industry out of the input tariffs and the import weights.

Results are qualitatively consistent with those in Table 2. Tariffs are negatively related to labor productivity and average size of establishments and positively related to the number of workers and establishments. The coefficients on tariffs for real value added and real gross output are not statistically significant.

Tariffs are also negatively associated with the growth rate of labor productivity. In Table B4 we present results in the spirit of empirical growth models such as that studied in Lehmann and O'Rourke (2011). This model can be written as

$$g(y_{kst}) = \alpha_1 \ln(1 + \text{AVE}_{kt-10}) + \theta_1 y_{ks,t-10} + \mu_{ks} + \delta_t + \upsilon_{kst} \tag{8}$$

where we calculate $g(.)$ as the average annual growth rate. For instance, in a ten-year census period, we have $(\frac{y_{kst}}{y_{ks,t-10}})^{(1/10)} - 1$. We use the lagged level of gross tariffs, $\ln(1 + \text{AVE}_{kt-10})$ as the key explanatory variable, and we include the lagged level of the dependent variable, state by SIC 3-digit industry fixed effects, and a full set of period dummies. The sample now starts in 1870 and runs until 1910. The average annual growth rate of labor productivity is 0.027 with a standard deviation of 0.059. The marginal effect of the lagged level of gross tariffs on labor productivity is -0.32 (p-value = 0.067). A one-standard deviation decline in the level of lagged gross tariffs would lead to a fall in the growth rate of labor productivity of 0.86 standard deviations.

Tariffs are also associated with smaller growth rates of average establishment size ($\hat{\alpha}_1 = -1.05$, p-value = 0.061), faster growth in value added ($\hat{\alpha}_1 = 1.07$, p-value = 0.061), faster growth in the number of workers ($\hat{\alpha}_1 = 1.45$, p-value = 0.03) and faster growth in the number of establishments ($\hat{\alpha}_1 = 1.74$, p-value = 0.01). Although tariffs are positively associated with growth in gross output, the coefficient is not highly significant. In all six models of Table B4 we find a negative and highly significant term on the lagged level of the dependent variable. While these models are supportive of our baseline results, there is the possibility that the inclusion of the lagged dependent variable and unit fixed effects leads to a "Nickell" bias in our short-panel estimates. For this reason, we prefer our baseline model in levels from Table 2.

Our baseline results are strongly robust to these other methods and models. We present further robustness analysis in the Appendices to this paper. There we explore bootstrap methods of calculating our standard errors, semi-parametric models of our baseline results in levels, and a panel data sample selection model with an endogenous variable.

7 Narrative Evidence

To understand our results better, we focus next on the narrative evidence regarding the relationship between tariffs and outcomes for some of the two-digit industries studied above in Tables 4 through 6.

7.1 Textiles and Apparel SIC 22 & 23

This set of industries (woolens, cottons, silk, and other natural fibers) benefited from relatively high tariffs (Figure 2). According to our regressions, higher tariffs led to lower labor productivity (Table 4).

The sample averages of product-level ad valorem tariff equivalents for cotton and silk manufactures were about 45% in 1870 and 1880. By 1900, finished silk product tariffs stood at 55% with cottons remaining at 45%. The sample average of the product-level ad valorem equivalent tariff rate in woolen manufactures was nearly 70% in 1870 and 1880, 62% in 1890, and 94% in 1900.

Despite high nominal tariffs, these industries faced substantial foreign competition. Imports of woolens were 22% of total domestic production in 1870, 20% in 1890, and 5% in 1910 (Taussig, 1915, p.333). In cottons and silks, foreign competition was also prevalent and especially strong in certain parts of the silk industry. Taussig (1915) notes that imports of silk laces, mainly from European producers, were about four times the value of domestic production despite nominal tariffs of 60%. American producers in textiles and apparel tended to produce lower quality, capital intensive items as measured by unit values, thread counts, etc. compared to European producers. Although protection was elevated, American producers still could simply not compete on high-quality, handmade products, leaving the American consumer to pay dearly relative to world prices for such products.

In the woolen industry, nominal tariffs were high because manufacturers asked Congress for, and received, "compensation" due to high tariffs on imports of raw wool.[29] Raw wool tariffs were 30% in 1870 and rose to between 45% and 55% from 1880 through 1900.

With such high tariffs, there was almost certainly an incentive for domestic producers to enter the market. As Table 4 shows, higher tariffs were associated with higher gross real output, workers, and establishments. These industries are nearly classic cases

[29] The official legislative record is littered with references to "compensation" by way of tariffs on cloth in order to make up for tariffs on raw wool (e.g., United States Congress, 1890, p.9398.)

where tariffs pull in resources at the expense of foreign producers. In the American case, this was especially true in low quality textile products.

Throughout the period, the industry experienced relatively strong domestic competition and avoided concentration. Nevertheless, many manufacturers, especially in cotton and woolens persistently attempted to economize on marketing and "coordination" costs by consolidating and concentrating ownership, but most often they failed to achieve significant vertical (and horizontal) integration (Clark, 1929). The American Woolen Company, for instance, controlled only a small share of the machinery applied to production in the industry. Clark (1929) also emphasizes the decentralized nature of the silk industry.

Returning to productivity, we conjecture that relatively high tariff rates sheltered producers from foreign competition especially in lower quality product ranges, leading to less investment in processes and products and less competition than would have otherwise occurred. Despite this, these industries did witness significant upgrading of machinery and equipment, but sometimes with an apparent lag compared to European competition. For instance, the cotton industry adopted new combing machinery circa 1900 which had already been pioneered in Europe. In addition, new machines like the Northrup, Crompton, and Knowles looms raised the ratio of capital to labor in the closing decades of the 19th century. The silk industry also made significant progress in mechanization of standardized production (Taussig, 1915). Clark (1929) suggests that these trends seem un-related to tariffs and are more related to healthy regional competition between the South and North. Our bottom line is that while domestic forces kept these industries afloat, tariffs restricted competition and probably led to lower productivity than would have otherwise been the case.

7.2 Paper and Publishing SIC 26 & 27

Tariffs for these two industries were among the lowest across the SIC 2-digit industries. The paper and pulp making industry, the upstream industry in this pair, enjoyed, on average, a 15% tariff with rates on some of their key products as high as 37%. Downstream, printing and publishing were were less protected with an average tariff of about 11% with the tariffs on some of their products as high as 22%.

Despite publishing industries having some of the lowest tariffs by 1900 in our sample, it does not mean that they were not heavily protected from foreign competition. The so-called "manufacturing clause" of the 1891 Platt-Simmonds Act served as a non-tariff barrier. This act allowed foreign authors to secure US copyright as long as their books were printed from type set in the United States. The Act also led to a shakeout in the American publishing industry, eliminating the producers of "cheap" or pirate books (unauthorized copies of foreign work) thereby raising the price of books sold in the US. The share of all published books by domestic authors also rose from 30% to 70% McVey (1975).

As Table 5 shows, tariffs had a negative effect on labor productivity as well as other "extensive margin" variables we examined. As for employment, the effect of tariffs is negative but not statistically significant. Tariffs seem to have no effect on average establishment size in our linear model.

To check for heterogeneity, we present semiparametric estimates. Figure 6, mostly confirms our estimates from the linear model for all but the growth of the number of establishments. Employment, while negatively related to tariffs, shows a substantial variation, which yielded the insignificant coefficient in Table 5. For average establishment size, we see a negative and then a roughly flat relationship at higher levels of tariffs, leading to a small negative but insignificant coefficient in the linear model.

Paper making and publishing also underwent significant technological changes in the postbellum United States, probably unrelated to the tariff. The introduction of wood pulp in the late 1860s profoundly transformed the industry by lowering the price of raw materials. Mechanization and improvements of printing presses lowered the prices of printed materials even more and the industry was one of the early adopters of electricity (Scranton, 2018). The printing and publishing business also matured by the mid-1870s, establishing themselves as separate industries. The use of wood pulp changed the geographical pattern of production as wood and paper mills relocated closer to the sources of wood (Hunter, 1955). Meanwhile, mechanization acted to increase capital intensity and the size of firms (Weeks, 1916 and Studley, 1938).

Concentration of ownership and limited competition occurred near the turn of the twentieth century with the emergence of International Paper, a conglomerate consisting of seventeen paper and pulp mills (Heinrich, 2001). With its size, the industry perhaps used its economic muscle to receive tariff protection on its output from Congress. Nevertheless, the average tariff of the paper industry was the lowest of all SIC 2-digit industries between 1870 and 1900 and the fourth lowest in 1910. One reason paper tariffs might have stayed low is that printing and publishing firms also actively lobbied for lower tariffs on paper so as to take advantage of cheaper paper imports, especially from Canada (Heinrich, 2001). This downstream industry was ultimately so successful that Congress abolished tariffs on Canadian newsprint in 1913.

Overall, the results are consistent with the idea that tariffs on the imports of paper products limited foreign competition (mainly Canada), allowing less efficient, higher cost domestic firms to survive. These higher costs were passed on to the publishing industry. Higher costs of inputs and other non-tariff barriers likely pushed value added per worker down in this industry too.

7.3 Chemicals, Petroleum, & Coal SIC 28 & 29

The chemical (SIC 28) and petroleum/coal (SIC 29) industries experienced relatively low tariff protection by contemporary standards. The average tariff was 23% in 1870 dropping to 18% by 1900. Since many chemical products were intermediate inputs into the production of other industries, especially textiles, and paper and printing firms, these downstream industries exerted considerable political pressure to keep the tariffs on chemicals low (Haynes, 1954). The US was a net exporter of petroleum products early on due to its massive endowment and the institutional arrangements which allowed its exploitation (Wright, 1990).

The technological advances in this sector were enormous, but even here, in certain sectors the US lagged behind European competitors.[30] By 1914, the United States had a large chemical industry focusing on petrochemicals, the production of explosives, and inorganic chemicals (Douglass, 1971 and Mowery and Rosenberg, 1998). Technological progress went hand-in-hand with organizational changes and the development of product-specific distribution networks which allowed firms to exploit economies of scale and scope (Chandler, 1990). The production mode tended towards a continuous, high-volume process and the industrial structure is generally characterized as highly concentrated (James, 1983).

Industrial mergers occurred at the turn-of-the century which saw, for example, the creation of General Chemical in 1899 (a merger of eleven producers of sulphuric and related acids), or the Barrett Company in 1896 which consolidated seven coal-tar product firms. By 1910, the structure of the American industry with a monopolistic or oligopolistic structure along many product lines was defined. However, the literature has also noted that many medium-size firms coexisted along side of large integrated industrial plants

[30] The case of industrial fuels like petroleum, natural gas, and coal and coke also illustrates that natural resources may not have been decisive as discussed in Clark (1929). In the 1890s America lagged European producers in developing by-product coke ovens. The processes and associated specialized capital had been developed in Europe in the 1880s and American producers delayed adoption. The Belgian-owned Solvay Process Company introduced a new factory in the US in 1892 to produce ammonia after having developed these techniques a decade or more earlier in Europe. While there was delay in adoption of new technologies, it appears that production of such by-products ramped up quickly in the first decade of the 20th century. America also lagged behind Europe in benzol production despite being characterized as a resource-rich territory. According to Clark (1929), "We were still dependent upon Europe, however, for part of our supply of creosote, benzol and similar derivatives, *notwithstanding the fact that we had an abundance of raw materials in the United States for their production...*" (emphasis added).

(Chandler, 1990 and Haynes, 1954). This heterogeneity is consistent with our finding in Figure 7 that high tariffs were associated smaller average size of establishments, but moderate tariffs were associated with larger establishment sizes.

The main competitors of American chemical producers were German firms. Despite the fast growth due to technological and organizational advances in many branches of chemical and petroleum industry, American firms still lagged behind German firms in pharmaceuticals and in man-made dyes (Chandler, 1990). During our period of study, imports of pharmaceuticals were larger in 1900 than in 1870 and that of dyes remained quite stable. Foreign competition in these branches remained stiff but might have have been larger in their absence.

Table 6 shows that tariffs had a negative and statistically significant impact on labor productivity. There does not seem to be a systematic effect of tariffs on average establishment size, value added, and gross output. Sub-industries with relatively high tariffs had higher employment and and a greater number of establishments The semi-parametric estimates of equation (10) presented in Figure 7 are revealing. First, when we examine the relationship between total valued added and tariffs in Figure 7, we see that there seem to be parts of the tariffs distribution where tariffs exerted a positive effect, but the majority of the observations, especially in the middle part of the distribution do not show any systematic pattern. On the other hand, when we look at the graph in Figure 7 depicting the relationship between tariffs and employment, it is clear that higher tariffs led to higher employment, but this graph also reveals that the lower part of the tariff distribution shows a negative slope. Both graphs suggest that tariffs exerted their negative influence on labor productivity by raising employment and having a small effect on value added.

As for the number of establishments, there is some qualitative evidence that tariffs helped firms in dye stuffs to survive foreign competition (Haynes, 1954, pp. 311-12). However, Table 6 shows no systematic relationship for the whole sector, which is confirmed by the semi-parametric estimates presented in Figure 7. If we take into account that some branches of the chemical and petroleum industry were monopolistic and oligopolistic, while others remained more competitive, the lack of a systematic effect of tariffs on the number of establishments is consistent with such industrial organization.

Based on our regression results and the narrative evidence, one possibility for why tariffs reduced productivity is that tariffs in the industry inhibited American firms from becoming larger, more efficient exporters. Import tariffs often act as a tax on exports (Irwin, 2017). In a sector in which the US clearly had dominance in some sub-industries (e.g., petroleum), tariffs may have led to output and exports being smaller than they otherwise might have been.

7.4 Metals SIC 33 & 34

The two metal industries considered here included basic metal products from foundries and rolling and drawing mills (SIC 33) and more elaborate manufactured products such as tinplate and other iron and steel forms, steel and iron railway rails, wire and rods, wood screws and nails, cans, hand tools, and weapons (SIC 34). Both industries were emblematic of the the late 19th century US manufacturing boom.

In 1870, the average tariff for SIC 33 was about 40% but by 1900 it had fallen to less than 20%, one of the lowest amongst all SIC 2 industries. SIC 34 saw its average ad valorem equivalent tariff stay constant at about 40%. Steel rails, a crucial input for the transportation industry in the period benefited from (specific) tariffs of almost 100% in ad valorem terms circa 1880.[31]

Results in Table 4 show a negative relationship between tariffs and labor productivity but a positive and significant effect of tariffs on value added, gross output, the numbers of workers and establishments. Since tariffs were falling in the period for basic metal products, it is therefore plausible that labor productivity was positively affected by reduced protectionism in the sector. However, while SIC 34 had stable tariff rates on its output, drawbacks on imported raw materials were received when using these imported materials as inputs for final goods exports. These might have helped bolster productivity as per Table B2.[32]

This diverse industry thrived in the period not only due to falling tariffs which made the industry more competitive, but due to resource discoveries and advanced technological changes. On the resource side, Lake Superior iron deposits helped reduce costs for producers. The process of transportation of iron ore eastwards from the Great Lakes to Pittsburgh and beyond was highly mechanized from the earliest years of our period (Clark, 1929). New advances in steel furnaces from the Bessemer process, to open hearths, and eventually blast furnaces also helped make US businesses more productive. Throughout, there were attempts to concentrate ownership such as US Steel, the steel billet pool, the American Steel and Wire Company and the Shelby Steel and Tube Company etc.[33] However, given the massive scale required in many of these industries, large establishments would have probably been more productive. Table 4 shows that lower tariffs

[31] See Head (1994) for a study of the tariff on steel rails.

[32] Drawbacks are mentioned in Taussig (1931) and Clark (1929).

[33] Temin (1964) notes that many of the domestic steel rail producers were linked to railroad companies. The latter such companies were unopposed to high tariffs on steel rails since they could merely pass the costs on to their customers.

indeed raised average establishment size but the effect is not highly significant.

To assess the impact of tariffs on growth in the entire industry, we can multiply our coefficient of -3.31 from Table 4 by the fall in the sample average of the the log of the gross ad valorem equivalent tariff rates of -0.09 which shows that labor productivity was about 0.29 log points (i.e., roughly 33%) higher due to the fall in tariffs.

Our bottom line on this large and diverse industry is that while lower tariffs may have played a role in raising productivity for some sub-industries, falling input costs and technological advances also mattered.[34] Oppositely, higher tariffs for other sub-industries would have significantly reduced, not raised, labor productivity.

7.5 Transportation Equipment SIC 37

These industries included many modes of transportation equipment ranging from the old – yet still prevalent – means of transport such as wagons, buggies, and horse-drawn carriages, locomotives, boats and ships, to newer product ranges like bicycles and automobiles (United States Census Office, Department of Commerce, 1902). According to Table 5, tariffs had a negative effect on labor productivity.

In 1870 the average ad valorem tariff equivalent rate in the entire SIC 37 industry was about 44% rising to 50% by 1900. In 1890, transportation equipment was the third most protected industry. This change in the average reflected the rising import share of highly protected finished railroad equipment and the falling share of carriages, wagons, and other older modes of transportation which had tariffs of about 35%. Motor vehicles and equipment had a relatively high tariff that never fell below 40% and reached nearly 58% in 1880 and 1890. Very few of these industries faced stiff foreign competition. For instance, imports of carriages and parts was less than 1% of US production between 1880 and 1900. Likewise, imports of automobiles and parts were also never economically significant.

The industry experienced massive changes in the decades we study. In particular, the electric streetcar and automobiles began to supplant the older transportation technologies of horse-drawn carriages and wagons (Douglass, 1971, chapter 35; Hilton and Due, 1960; Geels, 2005; Klepper, 2007; Klepper, 2010). Although the mass production of cars had to wait until the end of the first decade of the twentieth century, and a lot of experimentation with the propulsion technology was still taking place (steam vs electric vs internal combustion engine), the speed and scope of the technological changes led to intense "battles" for survival epitomizing the process of "creative destruction." To avoid

[34] Our bottom line is consistent with Temin (1964) who summarized that the effect of the tariff on the iron and steel industry were "uncertain."

further damage from these ongoing changes in the the once-booming business of wagons and carriages, manufacturers made sure that Congress knew foreign competition was unwelcome (United States Congress, 1893, pp. 402-408). This is supportive of Baack and Ray (1983) who pointed out that industries in decline may have lobbied for tariffs in this period.

Despite the ongoing research and development into technological changes that favored automobiles versus carriages, the auto industry lagged behind its European counterparts. According to Foreman-Peck (2019), "US engineers and designers continued to address into the twentieth century problems already solved in Europe," attributing this backwardness to "lack of market integration and competition compared to Europe...*and the 45% protective tariff*" (emphasis added).

Consistent with this verdict, according to Table 5, tariffs had a negative effect on labor productivity, average size of establishments, gross output, valued added, the number of establishments, and employment.[35]

We also see significant heterogeneity of the impact of tariffs within the industry. Consider a semi-parametric specification like equation (10) discussed in the Appendix. This model shows that the relationship between tariffs and the growth rate of the number of establishments is negative in some parts of the distribution, but positive or constant for the higher ranges of tariffs (Figure 8). The demise of establishments in the horse-drawn carriages industry (relatively lower tariffs) seems to have been hastened by tariffs. On the other hand, the number of establishments producing automobiles (products with relatively higher tariffs) seems to be either un-related to or possibly promoted by tariffs.

Tariffs seem to have worked to ossify these industries by reducing import competition and domestic competition. There is no evidence that higher tariffs on the more modern, motorized transportation technologies led to accelerated labor productivity growth. Instead the evidence suggests that the US auto industry lagged behind foreign competition in Europe in adopting solving problems of product development. The enormous technological changes in production processes occurring post-1910 were quite possibly delayed by tariffs insofar as they reduced capacity and competition which reduced the need to learn and adopt the best practices already developed by European producers. Indeed, the most significant changes to productivity would occur only after 1910 in an environment of falling tariffs.

[35] In fact, motor vehicles raised its share of workers in the transportation industry (SIC 37) from 16% in 1870 to 48% in 1910. Carriages and other transport equipment (SIC 379) decreased its share of labor in SIC 37 from 67% in 1870 to 34% in 1910. The share of gross output in SIC 37 going to motor vehicles (SIC 371) was 24% in 1870 and 58% in 1910.

8 Conclusion

We study the relationship between tariffs and outcomes in US manufacturing between 1870 and 1909. Tariffs remained high throughout the period and across most industries in comparison to other nations at similar levels of development. At the same time as tariffs remained high, many US industries became globally competitive, increasing exports of high, value-added products and allowing the US to reduce reliance on imports of such goods. This transformation was unlikely due to trade policy, and progress may in fact have been hindered by the high tariffs of the post-Civil War era.

Our research finds no positive relationship between tariffs and labor productivity in manufacturing. The possible exception to this conclusion is a small set of two dozen industries that were at the vanguard of the "second industrial revolution." In these industries, there may have been some positive effect of tariffs on labor productivity, but there is still some uncertainty given the large standard errors on these coefficients. Moreover, the importance of these sectors in overall production was small, so the effect on overall labor productivity in manufacturing would likely also have been small.

Looking beyond labor productivity, tariffs seem to have played a significant role in the allocation of resources in this period, according to our results. Tariffs are associated with higher prices and smaller average establishments. On average, tariffs raised the number of workers employed, the number of establishments, gross output and value added.

We also emphasize heterogeneity. In some industries, higher tariffs were positively associated with the "extensive margin" of total output, value added, number of workers, and establishments. These were often industries with low barriers to entry producing lower quality products such as in textiles. In other industries, especially those in which ownership was concentrated, tariffs appear to have reduced gross output, value added, the number of workers and establishments. Processed foods and especially tobacco are examples of this dynamic.

Our research reaches these conclusions by collecting a new, dis-aggregated data set of tariffs which we have matched to industry-level Census data. These data allow the application of a credible empirical strategy to investigate how tariffs mattered for the American economy in the 19th century.

Prior to our work, researchers had mainly relied on case-studies or calibrations of general equilibrium models using aggregate data. Our data and empirical findings allow for a better understanding of the impact and dynamics of US tariffs at both an economy-wide level and at a more granular level than previous research.

Our baseline results are consistent with several explanations which are not mutually incompatible. One is the idea that tariffs weakened international competition. In so doing, tariffs allowed smaller, less efficient firms to operate. Second, firms in a less competitive environment may have been less likely to invest in new products and processes. Finally, firms and industries may have lobbied to obtain protection which could have led to an economic mis-allocation of resources.

We are unable at this point to draw any conclusions regarding the overall welfare consequences of US trade policy in the 19th century. However, we can firmly say that tariffs did seem to matter for resource allocation in this period. Second, we can, with great certainty, rule out the idea that high tariffs played a strong role in boosting labor productivity in American manufacturing. American productivity leadership, emblematic of this period, was almost certainly not a function of US trade policy and tariffs.

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Tables

Table 1: Summary Statistics for Tariffs and Industry Outcomes Data, 1880 - 1909

	mean	sd	p10	p90
Levels				
ln(value added/worker)	7.41	0.78	6.49	8.43
Real ln(value added)	13.45	2.03	10.79	16.04
Real ln(gross output)	14.21	2.13	11.40	16.96
ln(workers)	6.04	2.02	3.37	8.62
ln(establishments)	3.76	1.65	1.61	6.07
Lagged ln(1+AVE)	0.27	0.16	0.07	0.48
Lagged ln(1+AVE) input tariffs	0.25	0.07	0.16	0.34
Share of Specific Tariffs (STS)	0.33	0.38	0.00	0.96
Ten-Year log Changes				
Δ ln(value added/worker)	0.25	0.57	-0.36	0.95
Δ ln(output per establishment)	0.43	1.02	-0.65	1.59
Δ Real ln(value added)	0.63	1.15	-0.56	1.91
Δ Real ln(gross output)	0.64	1.18	-0.56	1.95
Δ ln(workers)	0.37	1.13	-0.77	1.63
Δ ln(establishments)	0.21	1.00	-0.85	1.29
Δ Lagged ln(1+AVE)	-0.01	0.09	-0.10	0.09

Notes: Table 1 shows summary statistics for our baseline estimating sample in Table 2. The AVE is calculated as tariff revenue divided by the value of imports. The sample average share of specific tariff revenue in total tariff revenue collected is the average of sample industry ratios. Real variables are measured in 1870 dollars. Data are for all industries and states for which data are available in our baseline sample of Table 2.

Table 2: Tariffs and Various Industry Outcomes

	Value Added per Worker	Gross Output per Establ.	Real Value Added	Real Gross Output	# Workers	# Establs.
Panel A: OLS Regressions						
$\ln(1+AVE_{t-10})$	-0.34***	0.71***	-0.42**	-0.19	-0.07	-0.89***
	[0.09]	[0.18]	[0.20]	[0.20]	[0.20]	[0.18]
Year FEs	Y	Y	Y	Y	Y	Y
SIC 3 x State FEs	Y	Y	Y	Y	Y	Y
N	6788	6788	6788	6788	6788	6788
N SIC x States	1962	1962	1962	1962	1962	1962
R^2	0.78	0.81	0.86	0.87	0.86	0.82
Panel B: IV Regressions						
$\ln(1+AVE_{t-10})$	-4.41**	-10.11**	13.19**	7.63	17.60***	17.75***
	[2.00]	[4.81]	[5.58]	[4.99]	[6.26]	[6.01]
Year FEs	Y	Y	Y	Y	Y	Y
SIC 3 x State FEs	Y	Y	Y	Y	Y	Y
N	6788	6788	6788	6788	6788	6788
N SIC x States	1962	1962	1962	1962	1962	1962
Kleibergen-Paap F-stat	15.06	15.06	15.06	15.06	15.06	15.06
Anderson-Rubin F-stat	8.10	5.56	5.67	2.15	9.64	9.56
Anderson-Rubin F-stat p-value	0.00	0.02	0.02	0.14	0.00	0.00
Panel C: IV Regressions - State x Year Fixed Effects						
$\ln(1+AVE_{t-10})$	-3.98**	-11.27**	15.16**	9.57*	19.14***	20.84***
	[1.98]	[5.00]	[6.20]	[5.45]	[6.89]	[6.76]
State x Year FEs	Y	Y	Y	Y	Y	Y
SIC 3 x State FEs	Y	Y	Y	Y	Y	Y
N	6788	6788	6788	6788	6788	6788
N SIC x States	1962	1962	1962	1962	1962	1962
Kleibergen-Paap F-stat	13.77	13.77	13.77	13.77	13.77	13.77
Anderson-Rubin F-stat	6.28	6.96	6.70	3.00	10.34	12.39
Anderson-Rubin F-stat p-value	0.01	0.01	0.01	0.08	0.00	0.00

Notes: Table 2 shows the relationship between several outcomes for state-level SIC 3-digit industries in four census years (1880, 1890, 1900, and 1909) and the level of $\ln(1 + \text{AVE})$ at a ten year lag. The dependent variables are measured at the state-industry level. Estimation is by OLS or two stage least squares as indicated. Excluded instrument is the average of the predicted change in $\ln(1 + \text{AVE})$ at the product level within an SIC industry. Predictions are generated with a regression of the one-year product level change in $\ln(1 + \text{AVE})$ on time dummies and the Greenland-Lopresti measure of realized protection using product level changes in import unit values and the share of specific tariff revenue for the item. Period fixed effects are included in Panels A and B while Panel C uses state by year fixed effects. Standard errors are clustered at the state-SIC 3-digit industry level.

Table 3: Tariffs Various Industry Outcomes – Second Industrial Revolution

	Value Added per Worker	Gross Output per Establ.	Real Value Added	Real Gross Output	# Workers	# Establs.
Panel A: OLS Regressions						
ln(1+AVE$_{t-10}$)	-1.10***	1.51***	0.19	0.33	1.29**	-1.18**
	[0.25]	[0.56]	[0.56]	[0.54]	[0.56]	[0.50]
Year FEs	Y	Y	Y	Y	Y	Y
SIC 3 x State FEs	Y	Y	Y	Y	Y	Y
N	959	959	959	959	959	959
N SIC x States	305	305	305	305	305	305
R^2	0.69	0.79	0.85	0.85	0.82	0.75
Panel B: IV Regressions						
ln(1+AVE$_{t-10}$)	14.32*	13.30	9.30	4.78	-5.01	-8.51
	[7.61]	[9.01]	[9.22]	[8.19]	[8.04]	[8.14]
Year FEs	Y	Y	Y	Y	Y	Y
SIC 3 x State FEs	Y	Y	Y	Y	Y	Y
N	959	959	959	959	959	959
N SIC x States	305	305	305	305	305	305
Kleibergen-Paap F-stat	5.05	5.05	5.05	5.05	5.05	5.05
Anderson-Rubin F-stat	13.96	3.47	1.36	0.37	0.41	1.26
Anderson-Rubin F-stat p-value	0.00	0.06	0.24	0.54	0.52	0.26

Notes: Table 3 shows the relationship between several outcomes for state-level SIC 3-digit industries in four census years (1880, 1890, 1900, and 1909) and the level of $\ln(1 + \text{AVE})$ at a ten year lag. The dependent variables are measured at the state-industry level. Estimation is by OLS or two stage least squares as indicated. Excluded instrument is the average of the predicted change in $\ln(1 + \text{AVE})$ at the product level within an SIC industry. Predictions are generated with a regression of the one-year product level change in $\ln(1 + \text{AVE})$ on time dummies and the Greenland-Lopresti measure of realized protection using product level changes in import unit values and the share of specific tariff revenue for the item. Period and state-SIC 3-digit industry fixed effects are included in all specifications. Standard errors are clustered at the state-SIC 3-digit industry level.

Table 4: Tariffs Various Industry Outcomes, State Level Data (by SIC 2 Industry Groups)
Positive Effects on Extensive Margins

	Value Added per Worker	Gross Output per Establ.	Real Value Added	Real Gross Output	# Workers	# Establs.
SIC 22 & 23 Textile and Apparel						
$\ln(1+AVE_{t-10})$	-4.73*	-7.38	15.08**	12.56**	19.82***	19.94***
	[2.77]	[5.96]	[6.92]	[6.16]	[6.44]	[7.57]
N	695	695	695	695	695	695
Kleibergen-Paap F-stat	17.53	17.53	17.53	17.53	17.53	17.53
SIC 24 & 25 Wood and Furniture						
$\ln(1+AVE_{t-10})$	2.56***	-0.03	38.05***	37.83***	35.49***	37.86***
	[0.95]	[1.67]	[6.02]	[6.04]	[5.52]	[5.88]
N	556	556	556	556	556	556
Kleibergen-Paap F-stat	60.78	60.78	60.78	60.78	60.78	60.78
SIC 33 and 34 Metals						
$\ln(1+AVE_{t-10})$	-3.31***	-4.17	8.26***	5.95**	11.57***	10.11***
	[1.22]	[3.29]	[2.92]	[2.86]	[3.79]	[3.24]
N	871	871	871	871	871	871
Kleibergen-Paap F-stat	51.30	51.30	51.30	51.30	51.30	51.30
SIC 38 Instruments						
$\ln(1+AVE_{t-10})$	8.44**	-48.65***	38.46**	36.92**	30.02*	85.57***
	[3.71]	[14.90]	[17.13]	[16.36]	[16.75]	[21.61]
N	319	319	319	319	319	319
Kleibergen-Paap F-stat	19.34	19.34	19.34	19.34	19.34	19.34
SIC 39 Consumer Goods						
$\ln(1+AVE_{t-10})$	0.48	36.39***	72.91***	77.25***	72.43**	40.85**
	[5.39]	[13.49]	[27.16]	[28.64]	[28.11]	[16.60]
N	479	479	479	479	479	479
Kleibergen-Paap F-stat	14.65	14.65	14.65	14.65	14.65	14.65

Notes: Table 4 shows the relationship between the levels of several outcomes for state-level SIC 3-digit industries for census years (1880, 1890, 1900, and 1909) and $\ln(1 + \text{AVE})$ lagged ten years. The "extensive margin" is defined as total value added, gross output, workers, and establishments. The dependent variables are measured at the state-industry level. Estimation is by two stage least squares as indicated. Excluded instrument is the average of the predicted change in $\ln(1 + \text{AVE})$ at the product level within an SIC industry. Predictions are generated with a regression of the one-year product level change in $\ln(1 + \text{AVE})$ on time dummies and the Greenland-Lopresti measure of realized protection using product level changes in import unit values and the share of specific tariff revenue for the item. Period and state-SIC 3-digit industry fixed effects are included in all specifications. Standard errors are clustered at the state-SIC 3-digit industry level.

Table 5: Tariffs and Various Industry Outcomes, State Level Data (by SIC 2 Industry Groups) Negative Effects on Extensive Margins

	Value Added per Worker	Gross Output per Establ.	Real Value Added	Real Gross Output	# Workers	# Establs.
SIC 20 & 21 Food & Tobacco						
$\ln(1+AVE_{t-10})$	-0.60	5.31***	-3.71***	-0.78	-3.11***	-6.09***
	[0.50]	[0.82]	[0.99]	[1.03]	[0.97]	[0.98]
N	1184	1184	1184	1184	1184	1184
Kleibergen-Paap F-stat	136.00	136.00	136.00	136.00	136.00	136.00
SIC 26 & 27 Paper & Publishing						
$\ln(1+AVE_{t-10})$	-1.81***	0.20	-3.12***	-2.40***	-1.31	-2.60***
	[0.31]	[0.62]	[0.89]	[0.87]	[0.79]	[0.66]
N	478	478	478	478	478	478
Kleibergen-Paap F-stat	55.78	55.78	55.78	55.78	55.78	55.78
SIC 37 Transportation Equipment						
$\ln(1+AVE_{t-10})$	-4.31***	-5.32*	-13.56***	-11.97***	-9.26***	-6.65*
	[1.09]	[2.85]	[3.36]	[3.22]	[3.05]	[3.44]
N	271	271	271	271	271	271
Kleibergen-Paap F-stat	20.49	20.49	20.49	20.49	20.49	20.49

Notes: Table 5 shows the relationship between the levels of several outcomes for state-level SIC 3-digit industries for census years (1880, 1890, 1900, and 1909) and $\ln(1 + \text{AVE})$ lagged ten years. The "extensive margin" is defined as total value added, gross output, workers, and establishments. The dependent variables are measured at the state-industry level. Excluded instrument is the average of the predicted change in $\ln(1 + \text{AVE})$ at the product level within an SIC industry. Predictions are generated with a regression of the one-year product level change in $\ln(1 + \text{AVE})$ on time dummies and the Greenland-Lopresti measure of realized protection using product level changes in import unit values and the share of specific tariff revenue for the item. Period and state-SIC 3-digit industry fixed effects are included in all specifications. Standard errors are clustered at the state-SIC 3-digit industry level.

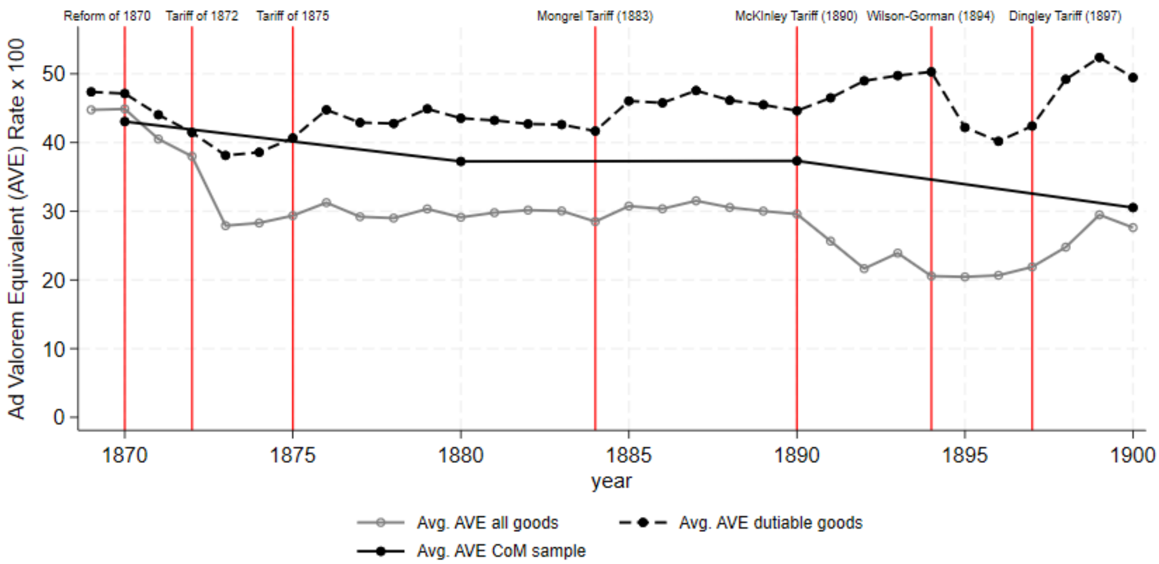
Table 6: Tariffs and Various Industry Outcomes, State Level Data (by SIC 2 Industry Groups) Neutral Effects on Extensive Margins

	Value Added per Worker	Gross Output per Establ.	Real Value Added	Real Gross Output	# Workers	# Establs.
SIC 28 & 29 Chemicals/Petroleum/Coal						
$\ln(1+AVE_{t-10})$	-8.01***	-6.28	-2.66	-2.99	5.35	3.29
	[2.96]	[4.14]	[4.09]	[4.30]	[4.70]	[3.16]
N	521	521	521	521	521	521
Kleibergen-Paap F-stat	12.00	12.00	12.00	12.00	12.00	12.00
SIC 32 Glass						
$\ln(1+AVE_{t-10})$	-0.22	2.81**	1.67	1.88	1.90	-0.93
	[0.64]	[1.16]	[1.24]	[1.19]	[1.40]	[0.95]
N	595	595	595	595	595	595
Kleibergen-Paap F-stat	41.25	41.25	41.25	41.25	41.25	41.25
SIC 35 & 36 Machinery & Electrical Goods						
$\ln(1+AVE_{t-10})$	3.12	1.36	-12.94	-15.48	-16.06	-16.06
	[4.17]	[8.52]	[9.35]	[10.58]	[11.66]	[11.66]
N	347	347	347	347	347	347
Kleibergen-Paap F-stat	3.96	3.96	3.96	3.96	3.96	3.96

Notes: Table 6 shows the relationship between the levels of several outcomes for state-level SIC 3-digit industries for census years (1880, 1890, 1900, and 1909) and $\ln(1 + \text{AVE})$ lagged ten years. The "extensive margin" is defined as total value added, gross output, workers, and establishments. The dependent variables are measured at the state-industry level. Estimation is by two stage least squares as indicated. Excluded instrument is the average of the predicted change in $\ln(1 + \text{AVE})$ at the product level within an SIC industry. Predictions are generated with a regression of the one-year product level change in $\ln(1 + \text{AVE})$ on the Greenland-Lopresti measure of realized protection using product level changes in import unit values and the share of specific tariff revenue for the item. Period and state-SIC 3-digit industry fixed effects are included in all specifications. Standard errors are clustered at the state-SIC 3-digit industry level.

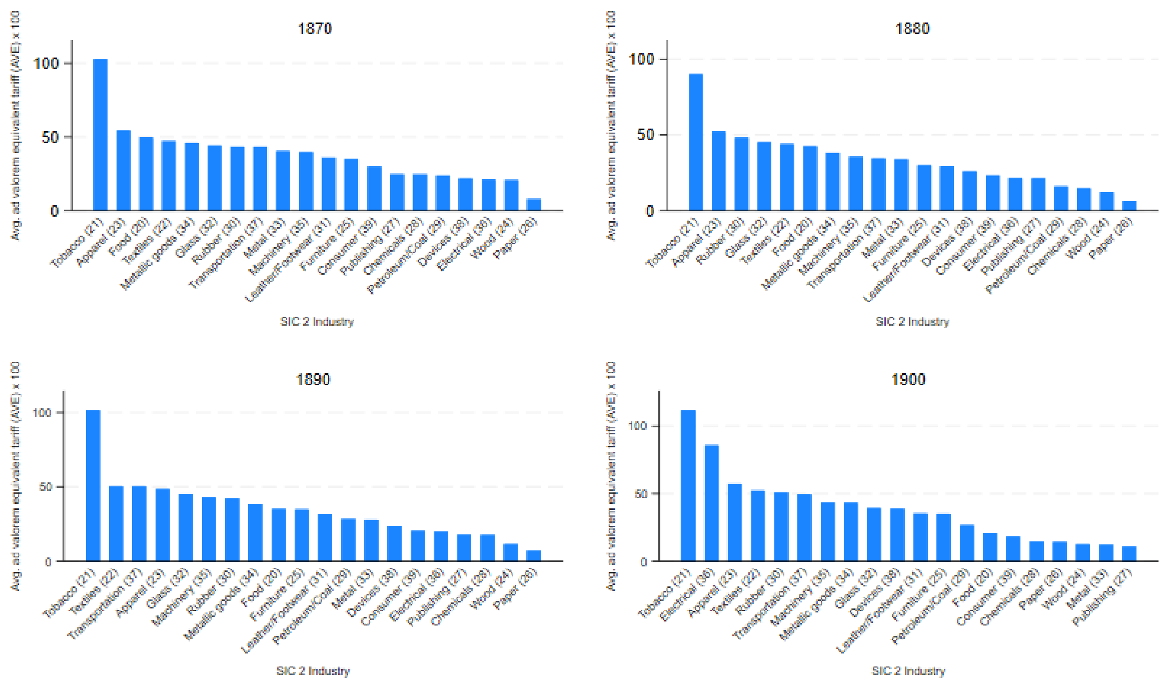
Figures

Figure 1: Major Tariff Laws and Average Tariff Rates, 1869-1900



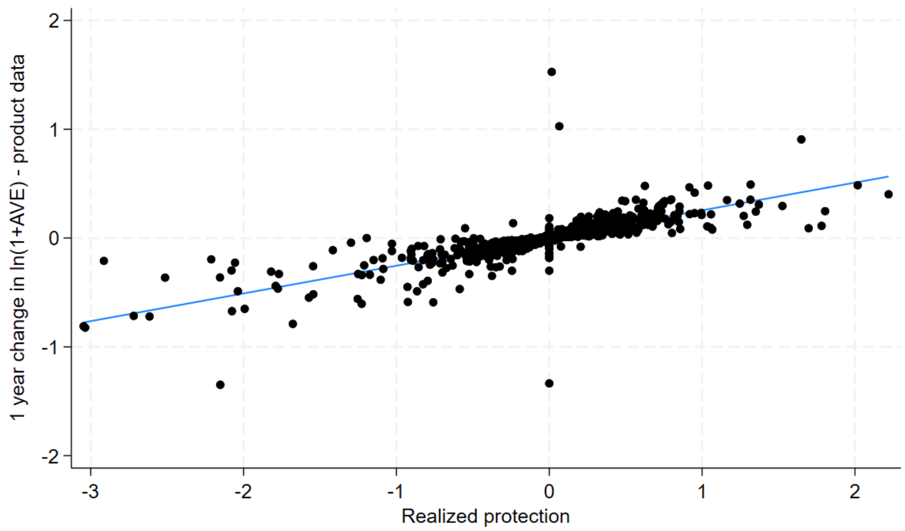
Notes: Figure 1 shows the annual average ad valorem equivalent (AVE) tariff rate (x 100) for all US imports, all US imports subject to a tariff (dutiable goods), and for the four census years for our sample which come from the Census of Manufactures. AVE is calculated as the total tariff revenue divided by the total value of imports. Trade and tariff data are for fiscal years ending June 30. Finally, we place vertical lines in each calendar year in which there was a major change in the US tariff law. Tariff laws approved by Congress are discussed in Taussig (1931) and Irwin (2017).

Figure 2: Average Tariff Rate by SIC 2-Digit industry in 1870, 1880, 1890, and 1900



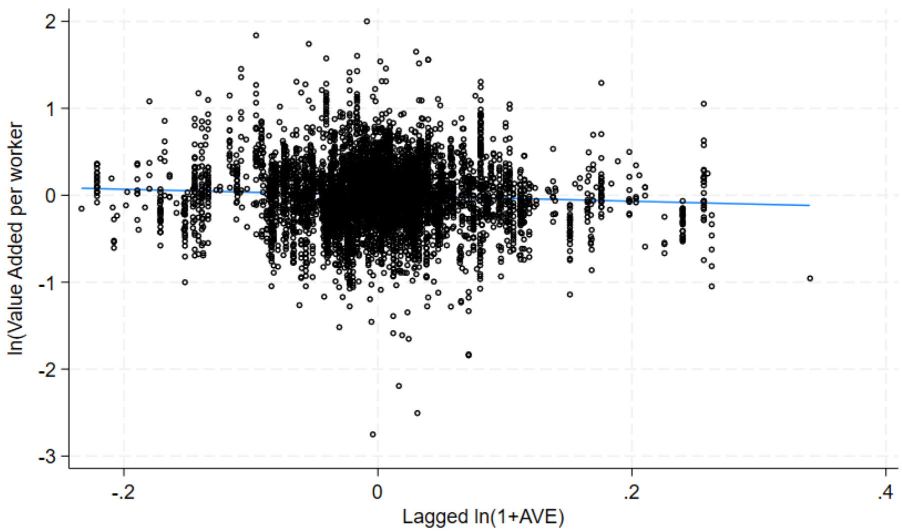
Notes: Figure 2 shows the average tariff rate (x 100) in ad valorem equivalent terms (AVE) for US imports (tariff revenue divided by the total value of imports) by SIC 2-digit industry.

Figure 3: Relationship between change in AVE and Realized Protection, Product Level Data 1870-1900



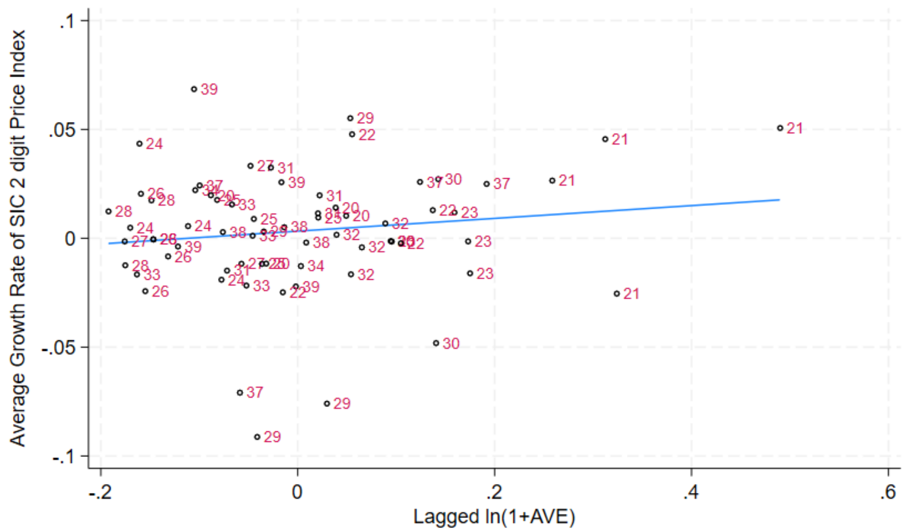
Notes: Figure 3 plots the relationship between the actual one-year change in ln(1+AVE) and the predicted changes in ln(1+AVE) at the product level. The predicted changes come from an initial regression at the product level of the change in product level ln(1+AVE) on time dummies and the product level Greenland-Lopresti measure of "realized protection" as defined in the text.

Figure 4: Relationship between Labor Productivity and the Average Tariff, 1880-1909, State Level Data



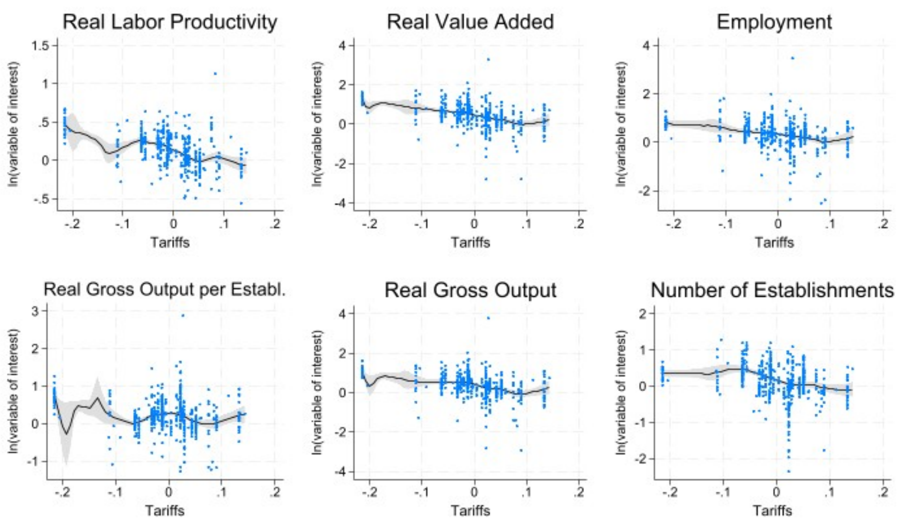
Notes: Figure 4 plots the relationship between the ten-year lag of $\ln(1 + \text{AVE})$ and real labor productivity. The sample covers up to 82 industries at the SIC 3-digit level. There are up to 48 states/territories/territories in the sample and we have four census years, 1880, 1890, 1900, and 1909. Real labor productivity is measured as industry value added in 1870 USD divided by the total number of workers using data from the US Census of Manufactures. Value added is deflated using 2 -digit industry price indexes. See text for further details. Data for productivity and tariffs are residualized after controlling for state-industry fixed effects and year fixed effects.

Figure 5: Relationship between the Average Annual Growth Rate of SIC 2- Digit Price Indexes and the Average Tariff by SIC 2-digit Industry



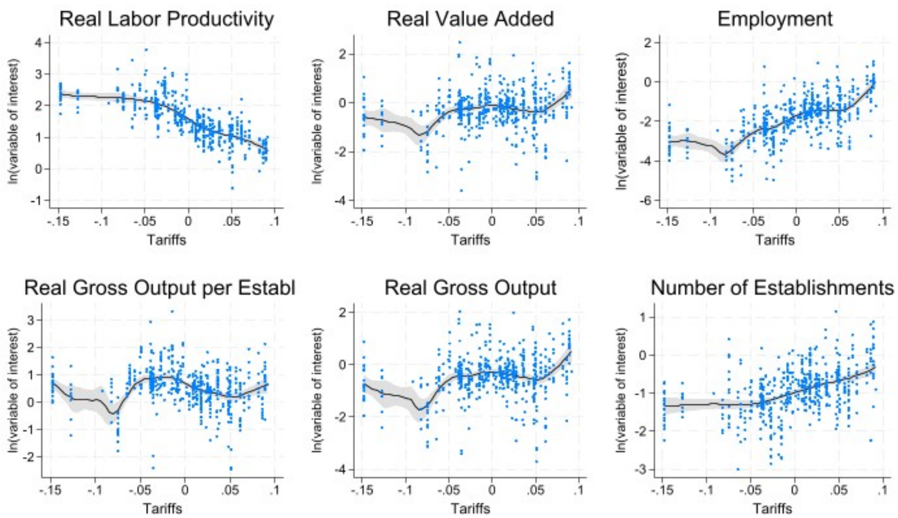
Notes: Figure 5 plots the relationship between the initial level of $\ln(1 + \text{AVE})$ and the subsequent average annual growth rate of the SIC 2-digit price index over the following census periods. The sample and regressions are for 20 industries at the SIC 2-digit level over four census years, 1880, 1890, 1900, and 1909. We control for the log of the initial level of the price index in each period and a full set of period dummies.

Figure 6: Non-parametric Estimates of the Relationship between the Main Variables of Interest and the Average Tariff in SIC 26 and SIC 27: Paper and Publishing, 1870-1909



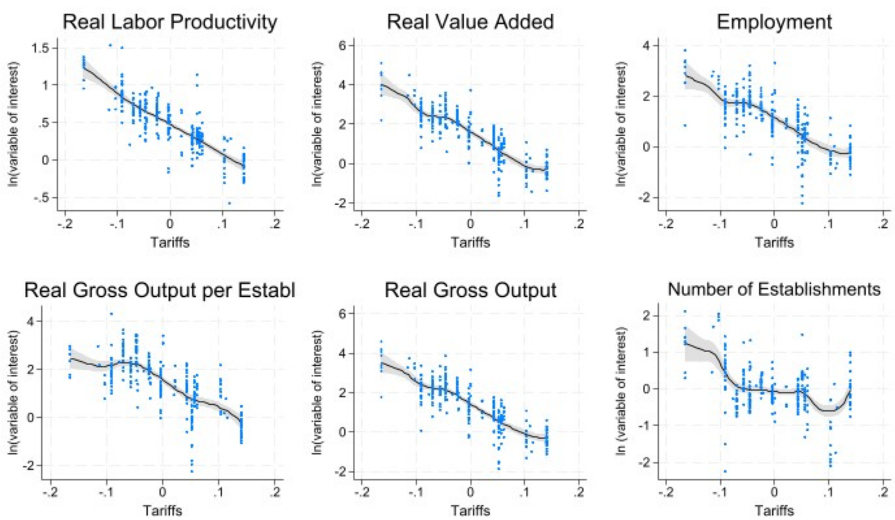
Notes: Figure 6 plots the non-parametric part of the equation (10) which estimates a relationship between the initial level of $\ln(1 + \text{AVE})$ and the main variables of interest using Robinson's (1988) double residual semi-parametric estimator and control function approach to instrumental variable estimation. The sample covers industries in at the SIC 3-digit level in two broad SIC 2-digit categories: paper, and printing and publishing. There are 48 states/territories in the sample, and we have four census years, 1880, 1890, 1900, and 1909. See text for further details.Tariffs and other variables are residualized after controlling for state-by-industry fixed effects and year fixed effects.

Figure 7: Non-parametric Estimates of the Relationship between the Main Variables of Interest and the Average Tariff in SIC 28 and SIC 29: Chemical, and Petroleum and Coal, 1870-1909



Notes: Figure 7 plots the non-parametric part of the equation (10) which estimates a relationship between the initial level of $\ln(1 + \text{AVE})$ and the main variables of interest using Robinson's (1988) double residual semi-parametric estimator and control function approach to instrumental variable estimation. The sample covers industries in at the SIC 3-digit level in two broad SIC 2-digit categories:chemicals, and petroleum and coal. There are 48 states/territories in the sample, and we have four census years, 1880, 1890, 1900, and 1909. See text for further details.Tariffs and other variables are residualized after controlling for state-by-industry fixed effects and year fixed effects.

Figure 8: Non-parametric Estimates of the Relationship between the Main Variables of Interest and the Average Tariff in SIC 37: Transportation Equipment, 1880-1909



Notes: Figure 8 plots the non-parametric part of the equation (10) which estimates a relationship between the initial level of $\ln(1 + \text{AVE})$ and the main variables of interest using Robinson's (1988) double residual semi-parametric estimator and control function approach to instrumental variable estimation. The sample covers industries at the SIC 3-digit level in the broad SIC 2-digit category: transportation equipment. There are 48 states/territories in the sample, and we have four census years, 1880, 1890, 1900, and 1909. See text for further details.Tariffs and other variables are residualized after controlling for state-by-industry fixed effects and year fixed effects.

APPENDIX FOR ONLINE PUBLICATION

Did Tariffs Make US Manufacturing Great? New Evidence from the Gilded Age

Table of Contents

A Robustness Tests

A.1 Exogeneity of Instrumental Variable: Specific Tariff Share (STS) and Industry Characteristics

We begin by discussing the relationship between the share of total tariff revenue generated by specific tariffs (STS) and industry characteristics. Here we want to alleviate concerns about our identification strategy stemming from the possibility that policy makers might have levied specific tariffs based on the past performance of industries. For example, it could be argued that industries with low growth might have lobbied legislators for protection from foreign competition in the form of specific tariffs. We estimate the following specification

$$STS_{kt} = (\textbf{Industry Characteristics}_{kt})'\beta + \mu_k + \delta_t + \varepsilon_{kt} \tag{9}$$

where STS is the share of total tariff revenue generated by specific tariffs, k indexes industries, **Industry Characteristics** is a vector of explanatory variables, and t indexes the census years (1870, 1880, 1890, 1900, and 1909). The vector **Industry Characteristics** includes the share of gross output, the share of workers, the level of labor productivity, and labor productivity growth over the previous decade. Each industry characteristic is defined at the SIC 3-digit level and the shares are calculated relative to the US total of the relevant variables.

Table B1 presents the estimation results. In columns 1 and 2, we use a linear panel data two-way fixed effects estimator. This is a conservative estimator because the dependent variable is a fractional variable defined over the interval [0, 1]. Therefore, we also use the fractional response estimator developed by Papke and Wooldridge (1996) in columns 3 and 4 treating the data as a pooled cross-sectional data set, and the fractional panel fixed effects estimator developed by Papke and Wooldridge (2008) in columns 5 and 6. Standard errors are clustered at the SIC 3-digit level.

For each estimator, we estimate two specifications. One includes the share of gross output, the share of workers, and labor productivity in the vector **Industry Characteristics**. The other adds the average labor productivity growth rate in the previous decade to the vector of industry characteristics.

In all specifications, we control for year fixed effects, and in all but columns 3 and 4, for industry fixed effects. The results show that irrespective of the specification and the estimator, there is no *systematic* relationship between the share of specific tariff revenues and the relative size (share of workers) and economic performance (gross output, labor productivity, labor productivity growth) of industries. These results support our assumption that the share of total tariff revenue generated by specific tariffs is not related to past industrial performance, consistent with our assumption that realized protection is exogenous.

A.2 Semi-parametric Regressions

Our baseline regressions assume that the main variable of interest - the ad valorem equivalent of tariffs - enters the regression specification linearly. We relax this assumption and estimate the following semi-parametric regression:

$$\ln(y_{kst}) = f(\ln(1 + \text{AVE}_{k,t-10})) + \mu_{ks} + \delta_t + \xi_{kst} \quad (10)$$

where y is an outcome variable of interest such as real labor productivity (real net output divided by the total number of workers), k indexes industries, s indexes states, and t indexes the census years (1880, 1890, 1900, and 1909). Unlike the original specification, we allow the ad valorem equivalent of tariffs to enter non-parametrically which is captured by the function $f(.)$. The remaining controls are the same as in equation (1).

We estimate a version of (10) that adjusts for an endogenous treatment variable using the Robinson (1988) semi-parametric estimator using a control function approach. Standard errors are clustered at the state SIC 3-digit industry level. Since our main interest is the behavior of the instrumented ad valorem equivalent of tariffs, we present only the figures showing the estimates of the non-parametric part of (10): the relationship between $\ln(y)$ and instrumented $f(\ln(1 + \text{AVE}_{k,t-10}))$.

Figures B1 through B6 show the non-parametric estimates with 95 per cent confidence intervals for the main dependent variables of interest: labor productivity (real value added per worker), real gross output per establishment, real value added, real gross output, workers, and establishments. In general, we see that the relationship between the dependent variables of interest and tariffs is consistent with the sign of the estimated coefficients in Table 2, Panels B and C: negative when the dependent variables are labor productivity and real gross output per establishment and positive for the others.

As for the relationship between labor productivity and tariffs, the non-parametric estimates show this is negative. However, a closer visual inspection reveals some parts of the distribution exhibit a slight positive relationship. We have tested whether a parametric linear, quadratic, or cubic model respectively would fit the data using the Härdle and Mammen (1993) test. All three options were rejected at the 5 per cent significance level (test statistics equal 2.82, 3.12, and 3.44 respectively). Overall, these results suggests that the relationship between tariffs and labor productivity is somewhat complex because of heterogeneity but overall the relationship is probably negative and very unlikely to be positive.

A.3 Robustness of Standard Error Estimators

We have reported cluster robust standard errors throughout this study. We have also accompanied our results with Anderson-Rubin F-statistics which are robust to weak instruments. The validity of these estimators rely on their asymptotic properties. Therefore, as an additional robustness check, we report here cluster robust standard errors calculated using the wild bootstrap procedure. Wild bootstrap is advantageous when the assumptions of asymptotic theory might be violated, such as with weak instruments, a small number of clusters, or very unbalanced clusters. In our analysis, some of the instruments might be considered weak (Table 4 and 6 in particular) and some of the clusters are of uneven size. Furthermore, the wild bootstrap offers asymptotic improvement because with the increasing sample size, the bootstrapped distribution converges to the actual one faster than the distributions on which asymptotic theory depends.[36] We have performed the wild bootstrap using the Stata command *boottest* developed by Roodman et al. (2019) with 999 replications. The results are presented in Figures B5 and B6. We see that, overall, the results are qualitatively unchanged and the statistical significance reported in Tables 4 through 6 is largely intact.

A.4 Panel Data with Endogeneity and Sample Selection

Our data set of state-industry pairs between 1870 and 1909 is an unbalanced panel. In this section we will discuss in detail why it is unbalanced and explore a model that deals with sample selection. We find that our baseline results are highly robust to sample selection.

The unbalanced nature of our data set has several sources. First, new US states and territories enter the data set; second, additional industries enter or exit the data; third, existing industries enter or exit new states/territories. The entry of new states reflects the time period we study which saw the closing of the frontier and former territories forming new US states. For example, Oklahoma, a former Indian reservation, became a Territory in 1890 and entered the Union as a state in 1907. North and South Dakota were, originally, organized as one territory in 1861 before they were admitted as US states in 1889. New states in the data set imply additional state-industry pairs. These additional state-industry pairs are due to the closing of the American continental territory.

Industries also entered and exited our data set across all states in a given sample year. These exits happened mostly in 1909 and were largely due to changes in the industry classification system of the 1909 census. A new law, in effect for that census year, limited the scope of the census to industries in which establishments operated under the Census's defined "factory" system. In this definition, establishments confined to producing for wholesale trade were included whilst those producing for individual customers or customers in local areas were not (Washington, D.C.: United States Bureau of the Census, Department of Commerce, 1913, page 19). As a result, we observe the disappearance from the sample in industrial categories such as SIC 349 - Miscellaneous Fabricated Products (e.g. tin smithing), SIC 313 - Boot and Shoe Cut Stock (e.g. production of shoe making parts), SIC 223 - Broadwoven Fabric Mills, Wool (e.g. weaving of wool and mohair products), or SIC 208 - Beverages. It stands to reason that these classification changes were hardly related to American tariff policy.

[36] For a discussion of wild bootstrap properties, see Djogbenou, MacKinnon and Nielsen (2019) and Roodman et al. (2019)

Entries over time occurred due to the emergence of new industries that had not previously been classified in any state. These entries of new industries were mostly the result of the second industrial revolution during which an entire set of new industries emerged: for example electrical equipment products (SIC 36), automobiles, or electrical streetcars (both in SIC 37 category). The character of this technological process, especially its hardly predictable nature (Mowery and Rosenberg, 1998), makes it difficult to see how the emergence of these industries would be systematically related to tariff policy. Indeed, it would be challenging to argue that the breakthrough innovations of Thomas Edison, George Westinghouse, or Alexander Graham Bell were due to their systematic consideration of US tariff policies.

A final reason for entries (and some exits) into our panel data set over time is that industries that already operated in other states appeared (or exited) in new states or territories. It is legitimate to be concerned that the unobservables which could partially determine whether a firm (or several firms within any given industry) would operate in a particular state and the error term in equation (1) could be correlated. However, it is unlikely these factors were highly correlated with tariff policy since most entries were in western and central states. These places were already protected by geography from foreign competition, so tariffs were probably not decisive here.

To allay concerns about selection not already addressed by our IV strategy and the inclusion of fixed effects, we estimate a sample selection model for panel data with an endogenous variable. The main regression equation is the same as equation (1)

$$\ln(y_{kst}) = \beta_1 \ln(1 + \text{AVE}_{kt-10}) + \mu_{ks} + \delta_t + \varepsilon_{kst}. \tag{11}$$

We instrument $\ln(1 + \text{AVE}_{kt-10})$ with the same instrumental variable as defined by equation (7) in Section 4. The selection equation is defined using a latent variable s^*_{kst}

$$s^*_{kst} = \mathbf{X}'_{st}\beta + \mu_k + \delta_t + \psi_{kt}. \tag{12}$$

We also define

$$s_{kst} = 1[s^*_{kst} > 0] = 1[\mathbf{X}'_{st}\beta + \mu_k + \delta_t + \psi_{kt} > 0], \tag{13}$$

where 1[.] is an indicator function, $\mathbf{X}_{st}$ is a vector of explanatory variables in state s at time t which determine the location of industry k, and s_{kst} is a selection indicator which equals one if $g(y_{kst})$ is observed and zero otherwise. We follow Klein and Crafts (2012) who analysed the location of US industries across US states in the period directly relevant to this study, to choose the explanatory variables in the selection equation (13). The variables include a state's share of its total land area allocated to farm land, state level coal prices, market potential, and distance to New York City.[37] We use the estimation procedure developed by Semykina and Wooldridge (2010) to account for the presence of endogeneity and selection in panel data. Standard errors are clustered at the state SIC 3-digit industry and are again estimated using the wild bootstrap with 999 replications using the Stata *boottest* command developed by Roodman et al. (2019).

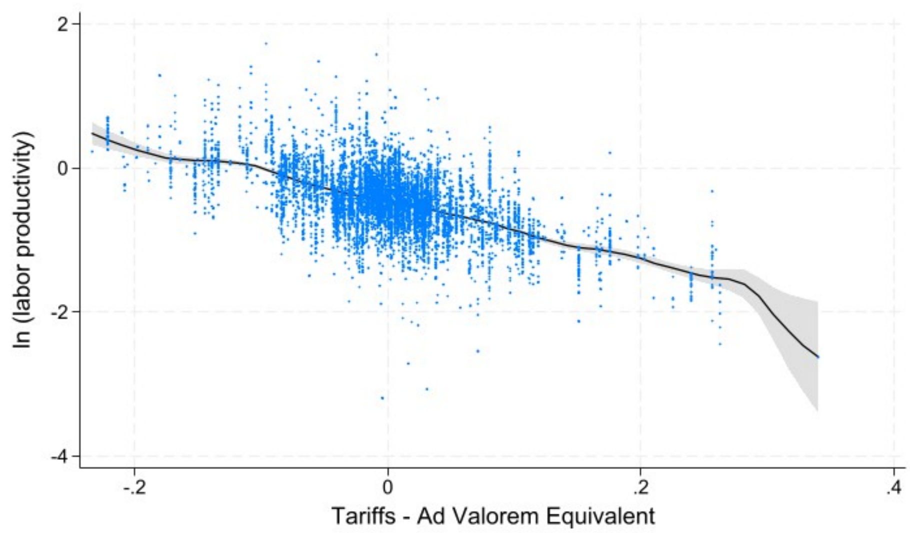
The results are presented in Table B7. As regards to the coefficients on tariffs, the signs do not change from our baseline, and the qualitative pattern of statistical significance remains largely unchanged. The only notable change is the coefficient on tariffs in the model for real gross output with state-year fixed effects which lost its 10 percent statistical significance (p-value is 0.11). Overall, the results confirm the robustness of the findings in the Table 2.

[37]The data come from Klein and Crafts (2012) for all variables except the share of farm land in 1870 and coal prices in 1870. Coal prices at the state level were calculated using 1870 US average coal price from Carter et al. (2006), series Cc327 and the ratio of state coal prices to US average in 1880. The share of farm land was calculated using state-level data on total land area and the total area of farm land from Carter et al. (2006), series Cf8-64, and Da159-224.

B Additional Tables & Figures

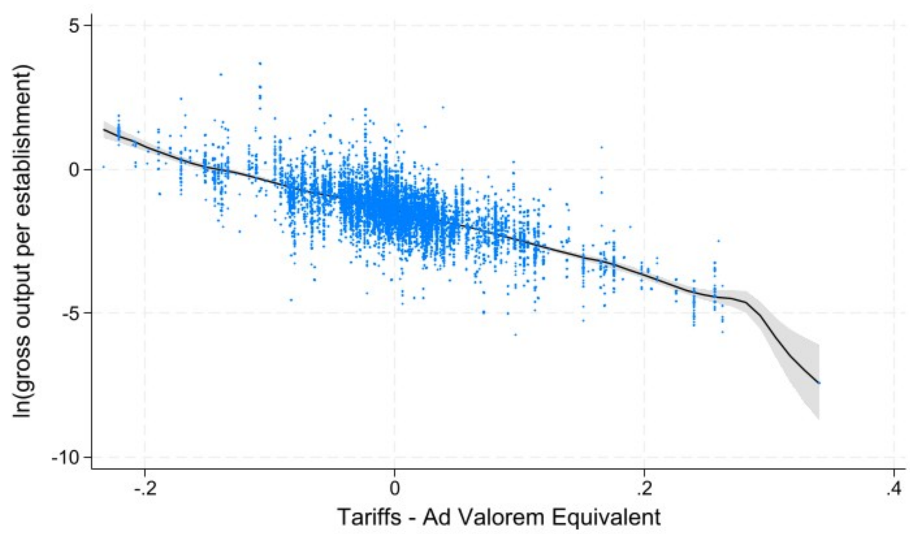
B.1 Additional Figures

Figure B1: Non-parametric Estimates of the Relationship between the Labor Productivity and the Average Tariff, 1880-1909



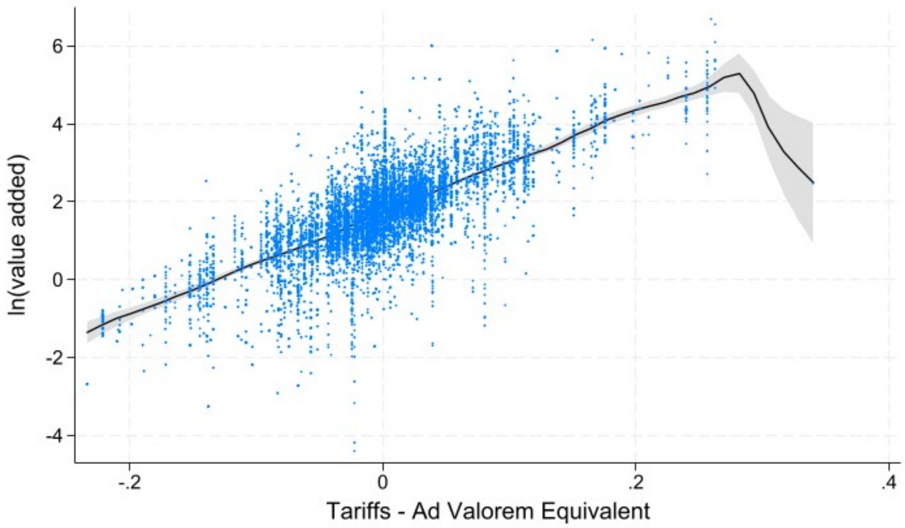
Notes: Figure B1 plots the non-parametric part of equation (10) which estimates a relationship between the initial level of ln$(1 + AVE)$ and the subsequent real labor productivity using Robinson's (1988) double residual semi-parametric estimator and control function approach to instrumental variable estimation. The sample covers up to 82 industries at the SIC 3-digit level and 48 states/territories and we have four periods, 1880, 1890, 1900, and 1909. Real labor productivity is measured as industry value added divided by the total number of workers using data from the US Census of Manufactures. Value added is deflated using 2 digit industry price indexes. See text for further details. Tariff and labor productivity data are also residualized after controlling for state-by-industry fixed effects, and year fixed effects.

Figure B2: Nonparametric Estimates of the Relationship between the Real Gross Output per Establishment and the Average Tariff, 1880-1909



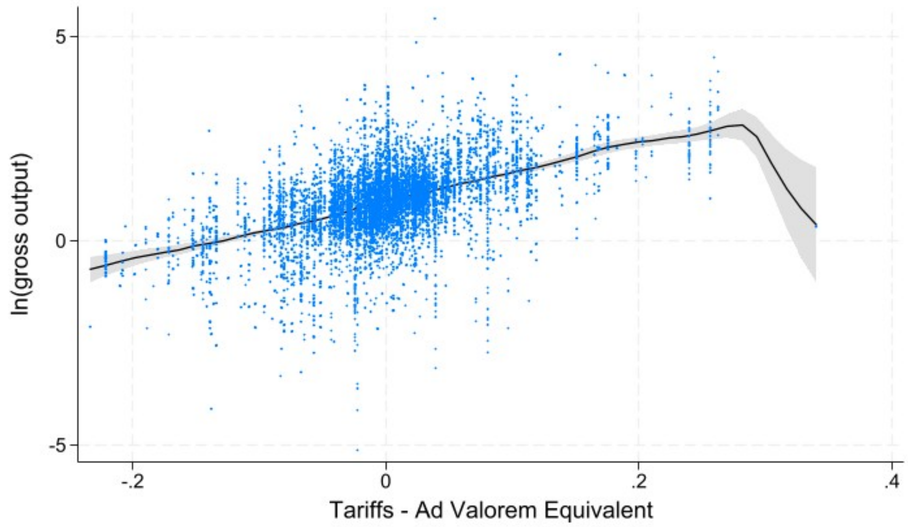
Notes: Figure B2 plots the non-parametric part of equation (10) which estimates a relationship between the initial level of ln$(1 + AVE)$ the subsequent real gross output per establishment using Robinson's (1988) double residual semi-parametric estimator and control function approach to instrumental variable estimation. The sample covers up to 82 industries at the SIC 3-digit level and 48 states/territories and we have four periods, 1880, 1890, 1900, and 1909. Gross output is deflated using 2 digit industry price indexes. See text for further details. Tariff and gross output per establishment data are also residualized after controlling for state-by-industry fixed effects, and year fixed effects.

Figure B3: Non-parametric Estimates of the Relationship between the Real Value Added and the Average Tariff, 1880-1909



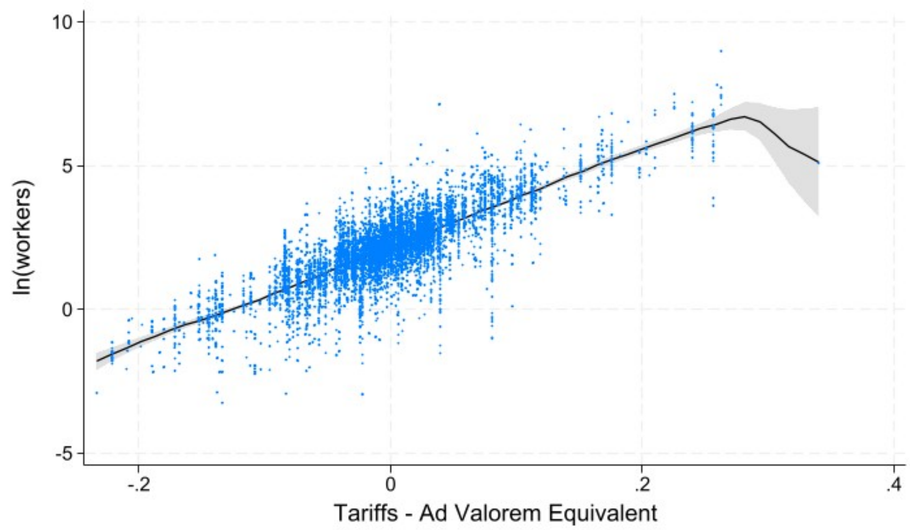
Notes: Figure B3 plots the non-parametric part of equation (10) which estimates a relationship between the initial level of ln$(1 + AVE)$ the subsequent real value added using Robinson's (1988) double residual semi-parametric estimator and control function approach to instrumental variable estimation. The sample covers up to 82 industries at the SIC 3-digit level and 48 states/territories and we have four periods, 1880, 1890, 1900, and 1909. Real labor productivity is measured as industry value added divided by the total number of workers using data from the US Census of Manufactures. Value added is deflated using 2 digit industry price indexes. See text for further details. Tariff and real value added data are also residualized after controlling for state-by-industry fixed effects, , and year fixed effects.

Figure B4: Nonparametric Estimates of the Relationship between the Real Gross Output and the Average Tariff, 1880-1909



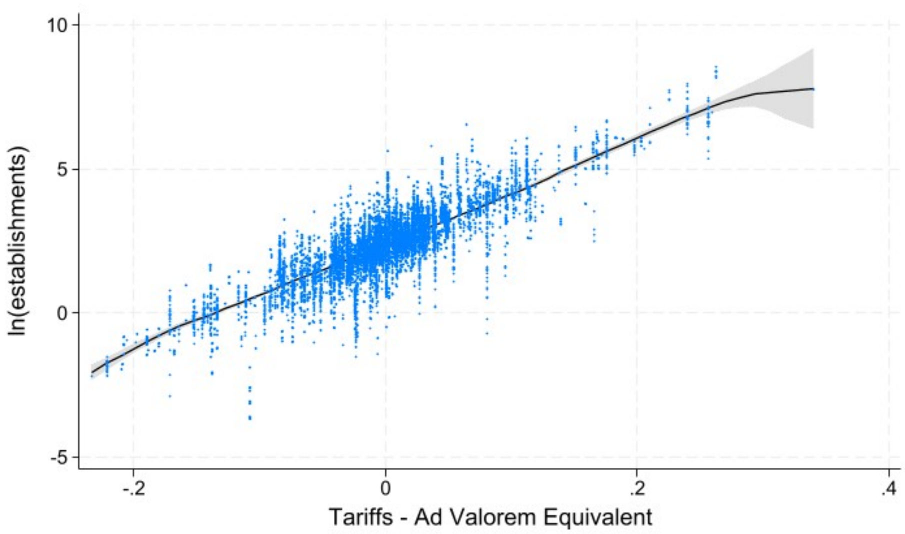
Notes: Figure B4 plots the nonparametric part of equation (10) which estimates a relationship between the initial level of ln$(1 + AVE)$ the subsequent real gross output using Robinson's (1988) double residual semi-parametric estimator and control function approach to instrumental variable estimation. The sample covers up to 82 industries at the SIC 3-digit level and 48 states/territories and we have four periods, 1880, 1890, 1900, and 1909. Gross output is deflated using 2 digit industry price indexes. See text for further details. Tariff and gross output data are also residualized after controlling for state-by-industry fixed effects, and year fixed effects.

Figure B5: Nonparametric Estimates of the Relationship between the Employment and the Average Tariff, 1880-1909



Notes: Figure B5 plots the non-parametric part of equation (10) which estimates a relationship between the initial level of ln$(1 + AVE)$ the subsequent employment using Robinson's (1988) double residual semi-parametric estimator and control function approach to instrumental variable estimation. The sample covers up to 82 industries at the SIC 3-digit level and 48 states/territories and we have four periods, 1880, 1890, 1900, and 1909. See text for further details. Tariff and employment data are also residualized after controlling for state-by-industry fixed effects, and year fixed effects.

Figure B6: Nonparametric Estimates of the Relationship between the Number of Establishments and the Average Tariff, 1880-1909



Notes: Figure B6 plots the non-parametric part of equation (10) which estimates a relationship between the initial level of ln$(1 + AVE)$ the subsequent employment using Robinson's (1988) double residual semi-parametric estimator and control function approach to instrumental variable estimation. The sample covers up to 82 industries at the SIC 3-digit level and 48 states/territories and we have four periods, 1880, 1890, 1900, and 1909. See text for further details. Tariff and establishment data are also residualized after controlling for state-by-industry fixed effects, and year fixed effects.

B.2 Additional Tables

Table B1: Relationship Between the Share of Revenues Generated by Specific Tariffs (STS) and Industry Characteristics, SIC 3-Digit Industries, US 1870-1909.

	Linear Panel Two-Way FE	Linear Panel Two-Way FE	Fractional Estimator	Fractional Estimator	Fractional Panel FE	Fractional Panel FE
Share of gross output	-0.008	0.005	-4.089	-5.015	-3.620	-2.087
	[1.651]	[1.655]	[5.978]	[5.875]	[3.815]	[4.532]
Share of workers	-1.541	-1.467	-0.970	0.547	-1.585	-3.139
	[2.759]	[2.832]	[8.433]	[9.722]	[7.305]	[8.626]
Labor productivity	-0.000	-0.000	0.000	0.000	-0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Labor productivity growth rate		0.169		-0.342		0.468
		[0.295]		[1.311]		[1.075]
N	316	311	316	313	316	313
R^2	0.84	0.84	.	.	.	.

Notes: Table B1 shows results for regressions with the share of revenues generated by specific tariffs as the dependent variable. The data set is a panel of SIC 3-digit industries in 1870, 1880, 1890, and 1900. The coefficients in the first and second column were estimated using a linear two-way fixed effects estimator (fixed effects cover industries and years). The coefficients in the third and fourth columns were estimated with a pooled fractional response estimator, and coefficients in the fifth and sixth columns were estimated using a fractional response panel data estimator. We use a correlated random effects approach to calculate the fixed effects in the last two columns. Shares of gross output and workers respectively were calculated relative to the total gross output in US manufacturing and total number of workers in US manufacturing respectively in the relevant years. Labor productivity growth rates are calculated between t and $(t-10)$ for the decades 1870-1900 and between t and $t-9$ for 1900-1909. Standard errors were clustered at the level of SIC 3-digit industries and are reported in the parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table B2: Tariffs, Input Tariffs, and Various Industry Outcomes

	Value Added per Worker	Gross Output per Establ.	Real Value Added	Real Gross Output	# Workers	# Establs.
Panel A: OLS Regressions						
$\ln(1+AVE_{t-10})$	-0.29***	0.56***	-0.77***	-0.51**	-0.48**	-1.08***
	[0.10]	[0.20]	[0.23]	[0.24]	[0.24]	[0.22]
$\ln(1+AVE_{t-10})$ input tariffs	-5.30***	-2.90***	-3.07***	-2.83***	2.23***	0.06
	[0.29]	[0.60]	[0.68]	[0.74]	[0.69]	[0.62]
Year FEs	Y	Y	Y	Y	Y	Y
SIC 3 x State FEs	Y	Y	Y	Y	Y	Y
N	5527	5527	5527	5527	5527	5527
N SIC x States	1596	1596	1596	1596	1596	1596
R^2	0.79	0.81	0.86	0.86	0.86	0.81
Panel B: IV Regressions						
$\ln(1+AVE_{t-10})$	-2.05	-3.74	13.06*	7.12	15.10**	10.86
	[1.97]	[5.10]	[6.78]	[5.94]	[7.25]	[6.70]
$\ln(1+AVE_{t-10})$ input tariffs	-0.92	-15.01***	3.50	3.44	4.42	18.45***
	[1.83]	[3.29]	[5.04]	[4.03]	[5.42]	[4.57]
Year FEs	Y	Y	Y	Y	Y	Y
SIC 3 x State FEs	Y	Y	Y	Y	Y	Y
N	5527	5527	5527	5527	5527	5527
N SIC x States	1596	1596	1596	1596	1596	1596
Kleibergen-Paap F-stat	4.04	4.04	4.04	4.04	4.04	4.04
Anderson-Rubin F-stat	1.49	17.90	4.49	2.20	6.20	31.14
Anderson-Rubin F-stat p-value	0.23	0.00	0.01	0.11	0.00	0.00

Notes: Table B2 shows the relationship between the levels of several outcomes for state-level SIC 3 digit industries in four census years (1880, 1890, 1900, and 1909) and the level of $\ln(1 + AVE)$ at a ten-year lag for industry tariffs and industry input tariffs. The dependent variables are measured at the state-industry level. Estimation is by OLS or two stage least squares as indicated. Excluded instrument is the average of the predicted change in $\ln(1 + AVE)$ at the product level within an SIC industry. For the input tariffs, a similar procedure is followed but using input weights to make the instrument. Predictions are generated with a regression of the one-year product level change in $\ln(1 + AVE)$ on the Greenland-Lopresti measure of realized protection using product level changes in import unit values and the share of specific tariff revenue for the item. Period fixed effects are included in all specifications. Standard errors are clustered at the state-SIC 3-digit industry level.

Table B3: Tariffs and Long Differences of Various Industry Outcomes

	Value Added per Worker	Gross Output per Establ.	Real Value Added	Real Gross Output	# Workers	# Establs.
Panel A: OLS Regressions						
Δ ln(1+AVE$_{t-10}$)	-0.36***	0.35*	-0.88***	-0.67***	-0.52**	-1.01***
	[0.09]	[0.19]	[0.20]	[0.21]	[0.21]	[0.18]
Year FEs	Y	Y	Y	Y	Y	Y
N	5128	5128	5128	5128	5128	5128
N SIC x States	1962	1962	1962	1962	1962	1962
R^2	0.02	0.03	0.02	0.01	0.02	0.09
Panel B: IV Regressions						
Δ ln(1+AVE$_{t-10}$)	-6.26**	-21.15**	7.88	-1.79	14.14*	19.37**
	[3.13]	[8.52]	[7.33]	[6.72]	[8.36]	[8.66]
Year FEs	Y	Y	Y	Y	Y	Y
N	5128	5128	5128	5128	5128	5128
N SIC x States	1962	1962	1962	1962	1962	1962
Kleibergen-Paap F-stat	14.31	14.31	14.31	14.31	14.31	14.31
Anderson-Rubin F-stat	5.28	8.49	1.21	0.07	3.33	5.57
Anderson-Rubin F-stat p-value	0.02	0.00	0.27	0.79	0.07	0.02

Notes: Table B3 shows the relationship between the inter-census year changes of several outcomes for state-level SIC 3 digit industries and the inter-census year change in $\ln(1 + AVE)$ at a 10 year lag for industry tariffs. Estimation is by OLS or two stage least squares as indicated. Excluded instrument is the average of the predicted change in $\ln(1 + AVE)$ at the product level within an SIC industry. Period fixed effects are included in all specifications. Standard errors are clustered at the state-SIC 3-digit industry level.

Table B4: Tariffs and Average Annual Growth Rates of Various Industry Outcomes

	Value Added per Worker	Gross Output per Establ.	Real Value Added	Real Gross Output	# Workers	# Establs.
Panel A: OLS Regressions						
$\ln(1+AVE_{t-10})$	-0.04***	0.08***	-0.05**	-0.03	-0.01	-0.08***
	[0.01]	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]
ln(level of dep. variable_{t-10})	-0.09***	-0.10***	-0.09***	-0.09***	-0.09***	-0.08***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Year FEs	Y	Y	Y	Y	Y	Y
SIC 3 x State FEs	Y	Y	Y	Y	Y	Y
N	6783	6783	6783	6783	6783	6783
N SIC x States	1961	1961	1961	1961	1961	1961
R^2	0.59	0.56	0.62	0.61	0.59	0.55
Panel B: IV Regressions						
$\ln(1+AVE_{t-10})$	-0.32*	-1.05*	1.07*	0.31	1.45**	1.74**
	[0.18]	[0.56]	[0.57]	[0.58]	[0.66]	[0.68]
ln(level of dep. variable_{t-10})	-0.09***	-0.10***	-0.09***	-0.09***	-0.09***	-0.07***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Year FEs	Y	Y	Y	Y	Y	Y
SIC 3 x State FEs	Y	Y	Y	Y	Y	Y
N	6783	6783	6783	6783	6783	6783
N SIC x States	1961	1961	1961	1961	1961	1961
Kleibergen-Paap F-stat	16.56	14.59	15.09	14.96	15.88	17.34
Anderson-Rubin F-stat	4.07	4.13	3.33	0.27	4.71	6.51
Anderson-Rubin F-stat p-value	0.04	0.04	0.07	0.60	0.03	0.01

Notes: Table B4 shows the relationship between the average annual growth rate of several outcomes for state-level SIC 3 digit industries for four census periods (1870-1880, 1880-1890, 1890-1900, and 1900-1909) and $\ln(1 + AVE)$ in the initial years 1870, 1880, 1890, and 1900. Estimation is by OLS or two stage least squares as indicated. Excluded instrument is the average of the predicted change in $\ln(1 + AVE)$ at the product level within an SIC industry. Predictions are generated with a regression of the one-year product level change in $\ln(1 + AVE)$ on the Greenland-Lopresti measure of realized protection using product level changes in import unit values and the share of specific tariff revenue for the item. Period and state-SIC 3-digit industry fixed effects are included in all specifications. Standard errors are clustered at the state-SIC 3-digit industry level.

Table B5: Robustness of Standard Error Estimates: Wild Bootstrap, Part 1: Industry SIC 2-Digit Groups 20-32, US 1870-1909

SIC category Main Variables of interest	Coefficient on $\ln(1+AVE)$	standard error	t-statistics	p-value	Bootstraped t-statistics	Bootstraped p-value
SIC Group 20 & 21						
Real VA/L	-0.60	0.50	-1.19	0.24	1.21	0.23
Gross Output per Establ.	5.31	0.81	6.53	0.00	-7.70	0.00
Real Value Added	-3.71	0.98	-3.77	0.00	3.98	0.00
Real Gross Output	-0.78	1.02	-0.76	0.45	0.77	0.42
Number of Workers	-3.11	0.97	-3.20	0.00	3.25	0.00
Number of Establishments	-6.09	0.98	-6.24	0.00	7.71	0.00
SIC Group 22 & 23						
Real VA/L	-4.73	2.76	-1.71	0.09	-1.81	0.08
Gross Output per Establ.	-7.38	5.93	-1.24	0.21	-1.30	0.22
Real Value Added	15.08	6.88	2.19	0.03	2.65	0.02
Real Gross Output	12.56	6.14	2.05	0.04	2.42	0.04
Number of Workers	19.82	6.41	3.09	0.00	4.70	0.00
Number of Establishments	19.94	7.53	2.65	0.01	3.51	0.00
SIC Group 24 & 25						
Real VA/L	2.56	0.94	2.73	0.01	3.27	0.00
Gross Output per Establ.	-0.03	1.66	-0.02	0.98	-0.02	0.99
Real Value Added	38.05	5.98	6.36	0.00	15.13	0.00
Real Gross Output	37.83	6.00	6.30	0.00	14.31	0.00
Number of Workers	35.49	5.49	6.46	0.00	14.03	0.00
Number of Establishments	37.86	5.84	6.48	0.00	18.77	0.00
SIC Group 26 & 27						
Real VA/L	-1.81	0.31	-5.81	0.00	-6.68	0.00
Gross Output per Establ.	0.20	0.61	0.32	0.75	0.32	0.76
Real Value Added	-3.12	0.88	-3.54	0.00	-4.21	0.00
Real Gross Output	-2.40	0.86	-2.77	0.01	-3.08	0.00
Number of Workers	-1.31	0.79	-1.66	0.10	-1.78	0.09
Number of Establishments	-2.60	0.65	-3.98	0.00	-4.63	0.00
SIC Group 28 & 29						
Real VA/L	-8.01	2.94	-2.73	0.01	3.22	0.00
Gross Output per Establ.	-6.28	4.11	-1.53	0.13	1.57	0.13
Real Value Added	-2.66	4.06	-0.65	0.51	0.66	0.50
Real Gross Output	-2.99	4.27	-0.70	0.49	0.69	0.48
Number of Workers	5.35	4.67	1.15	0.25	-1.17	0.25
Number of Establishments	3.29	3.14	1.05	0.30	-1.10	0.28
SIC Group 32						
Real VA/L	-0.22	0.64	-0.35	0.73	-0.35	0.75
Gross Output per Establ.	2.81	1.15	2.44	0.02	2.86	0.00
Real Value Added	1.67	1.23	1.36	0.18	1.44	0.17
Real Gross Output	1.88	1.18	1.59	0.11	1.68	0.10
Number of Workers	1.90	1.39	1.36	0.17	1.40	0.18
Number of Establishments	-0.93	0.95	-0.99	0.33	-1.01	0.31

Notes: Table B5 presents wild-bootstrapped standard errors with t-statistics and corresponding p-values for our empirical models in Tables 4 through 6. Standard errors are clustered at the state SIC 3-digit industry level for the SIC 2-digit industry groups 20-32. Bootstrapping was done with 999 replications.

Table B6: Robustness of Standard Error Estimates: Wild Bootstrap, Part 2: Industry SIC 2-Digit Groups 33-39, US 1870-1909

SIC category Main Variables of interest	Coefficient on $\ln(1 + AVE)$	standard error	t-statistics	p-value	Bootstraped t-statistics	Bootstraped p-value
SIC Group 33 & 34						
Real VA/L	-3.31	1.22	-2.72	0.01	-2.88	0.02
Gross Output per Establ.	-4.17	3.28	-1.27	0.21	-1.25	0.26
Real Value Added	8.26	2.91	2.84	0.00	2.59	0.02
Real Gross Output	5.95	2.85	2.09	0.04	1.96	0.07
Number of Workers	11.57	3.78	3.06	0.00	2.88	0.01
Number of Establishments	10.11	3.23	3.13	0.00	2.81	0.03
SIC Group 35 & 36						
Real VA/L	3.12	4.13	0.75	0.45	-0.83	0.42
Gross Output per Establ.	1.36	8.45	0.16	0.87	-0.16	0.88
Real Value Added	-12.94	9.26	-1.40	0.17	2.05	0.06
Real Gross Output	-15.48	10.49	-1.48	0.14	2.33	0.04
Number of Workers	-16.06	11.56	-1.39	0.17	2.04	0.06
Number of Establishments	-16.85	10.87	-1.55	0.12	3.00	0.01
SIC Group 37						
Real VA/L	-4.31	1.08	-3.98	0.00	-3.43	0.00
Gross Output per Establ.	-5.32	2.82	-1.89	0.06	-2.25	0.06
Real Value Added	-13.56	3.32	-4.09	0.00	-3.92	0.00
Real Gross Output	-11.97	3.18	-3.76	0.00	-3.72	0.00
Number of Workers	-9.26	3.02	-3.07	0.00	-3.10	0.01
Number of Establishments	-6.65	3.40	-1.96	0.05	-1.74	0.13
SIC Group 38						
Real VA/L	8.44	3.67	2.30	0.02	-2.64	0.01
Gross Output per Establ.	-48.65	14.75	-3.30	0.00	3.55	0.00
Real Value Added	38.46	16.96	2.27	0.03	-3.50	0.00
Real Gross Output	36.92	16.19	2.28	0.02	-3.50	0.00
Number of Workers	30.02	16.58	1.81	0.07	-2.40	0.03
Number of Establishments	85.57	21.39	4.00	0.00	-11.39	0.00
SIC Group 39						
Real VA/L	0.48	5.35	0.09	0.93	-0.09	0.94
Gross Output per Establ.	36.39	13.40	2.72	0.01	-5.66	0.00
Real Value Added	72.91	26.97	2.70	0.01	-6.54	0.00
Real Gross Output	77.25	28.45	2.72	0.01	-6.55	0.00
Number of Workers	72.43	27.92	2.59	0.01	-5.45	0.00
Number of Establishments	40.85	16.49	2.48	0.01	-4.80	0.00

Notes: Table B6 presents wild-bootstrapped standard errors with t-statistics and corresponding p-values for our empirical models in Tables 4 through 6. Standard errors are clustered at the state SIC 3-digit industry level for the SIC 2-digit industry groups 33-39. Bootstrapping was done with 999 replications.

Table B7: Panel Data with Endogenous Variable and Sample Selection

Main Variables of interest	Coefficient on $\ln(1 + AVE)$	N	t-statistics	p-value	AR t-statistics	AR p-value
IV Regressions						
Real VA/L	-4.38	6788	-2.16	0.03	-2.79	0.01
Gross Output per Establ.	-11.09	6788	-2.18	0.03	-2.53	0.02
Real Value Added	14.88	6788	2.45	0.01	2.58	0.02
Real Gross Output	9.46	6788	1.77	0.08	1.74	0.12
Number of Workers	19.26	6788	2.82	0.00	3.26	0.01
Number of Establishments	20.54	6788	3.04	0.00	3.46	0.01
IV Regressions - State x Year Fixed Effects						
Real VA/L	-3.56	6788	-1.93	0.05	-2.34	0.02
Gross Output per Establ.	-10.69	6788	-2.23	0.03	-2.57	0.02
Real Value Added	15.17	6788	2.52	0.01	2.67	0.02
Real Gross Output	9.65	6788	1.83	0.07	1.80	0.11
Number of Workers	18.73	6788	2.81	0.00	3.23	0.01
Number of Establishments	20.33	6788	3.12	0.00	3.53	0.00

Notes: Table B7 presents regression results for a panel data model of sample selection with an endogenous variable as discussed in Section A.4. 'AR' stands for Anderson-Rubin. Wild-bootstrapping with 999 replications was used to estimate t-statistics and p-values.