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NEW TECHNOLOGIES, PRODUCTIVITY, AND JOBS: THE (HETEROGENEOUS) EFFECTS OF ELECTRIFICATION ON US MANUFACTURING

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New Technologies, Productivity, and Jobs: The (Heterogeneous) Effects of Electrification on US Manufacturing
Martin Fiszbein, Jeanne Lafortune, Ethan G. Lewis, and José Tessada
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ABSTRACT

We use city-industry data from 1890 to 1940 to identify the impact of electricity on manufacturing. We exploit cross-industry variation in pre-electricity energy intensity combined with geographic variation in proximity to early hydroelectric power plants. Labor productivity gains from the arrival of electricity were rapid and long-lasting. Electricity was labor-saving, induced capital deepening, and a hollowing out of the labor skills distribution. We document significant heterogeneity in electricity's effects: in sector-county pairs where the average firm was initially large, we find no significant expansion in employment, while in markets with relatively small firms, output and employment increased.

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1 Introduction

Technological progress has perennially been a source of optimism and a source of worry for those who fear its impact on employment. As Acemoglu and Restrepo (2019) formalize, new technologies can both destroy jobs and have reinstatement effects, and the overall impact depends on the strength of those forces. This paper investigates the many-sided impacts of one of the major technological transformations of modern times: the electrification of manufacturing production. David (1989, 1990), and Jovanovic and Rousseau (2005) argue that the scope of the transformation was comparable to that of the spread of computers. Furthermore, while Gordon (2016) argued that electricity created sweeping productivity gains, the anxiety of workers who feared losing jobs to "mechanization" were contemporaneously echoed in Jerome (1934)'s classic study. In this study, we also investigate a role for product-market structure –namely, whether firms are big or small– mediating these competing forces, as it determines whether productivity gains translate more into mark-up increases or higher labor demand (see Autor et al., 2020b; De Loecker et al., 2016). Like today, big firms' rising power was seen as a potential threat to welfare (Lamoreaux, 2019), though how this interacted with technological change has not been previously studied in this era.

To examine how electricity adoption affected manufacturing production during the Second Industrial Revolution, we use a rich dataset of manufacturing industries in the largest urban centers from 1890 to 1940. We estimate the effects of electricity combining sector- and city-level variation while controlling for sector and city fixed effects in each period. With this approach, our estimates result from comparing outcomes across (i) industries with different levels of energy intensity within a given city, and (ii) cities with different access to hydropower within a given industry. In other words, our approach allows us to remove the direct effects of both geography (including any direct "natural advantage" of hydropower-suitable sites) and industry. We examine outcomes over several decades, exploring the manufacturing sector's dynamic response as electricity usage increases.

We start by showing that the two sources of variation used in our empirical strategy have strong predictive power: electricity adoption was significantly influenced by pre-determined energy intensity at the sector level and by electricity rates by access to hydropower at the city level. The importance of variation in proximity to large hydropower stations is in line with the results of Severnini (2014), who argues that transmission of power over long distances was infeasible early on. The importance of pre-electrification power intensity is consistent with the findings of Woolf (1984) who shows that that electricity substituted for other forms of power. We then use the *interaction* of these sources of variation to study the impacts of electricity adoption on manufacturing production and job mix. To reiterate, we use the interaction conditional on city- and industry-trends, not distance to hydropower per se. Among other things, this sweeps out the influence of any geographic features that have a common influence on all industries, including access to water.[1]

Using this novel approach, we find that productivity gains from electricity adoption were rapid and long-lasting. Being close to a hydroelectric plant led to differentially faster productivity growth in energy-intensive industries. By the early 1900s, having one power plant within 70 km increases the labor productivity of an industry at the 75th percentile of energy-intensity by 5 percent compared to one at the 25th percentile. The magnitude more than doubles by 1920 and remains stable until 1940. Our findings are robust to considering different measures of access to hydropower and to controlling for initial conditions. We show that these differences only started to appear once electricity spread to manufacturing firms – i.e., there are no "pre-trends" – suggesting that our measure does not capture other advantages of their geographical location. We also show that they can be reconciled with the existing literature (Crafts, 2002; David, 1990) that had argued productivity gains lagged electricity adoption by several decades.[2]

Growth in productivity fueled by electricity adoption was not, however, tied to an expansion of employment. Energy-intensive sectors in cities with access to hydropower exhibit faster output growth than those without access but have similar growth in employment—a labor-saving pattern. We also find that electricity adoption induced capital deepening, consistent with the presence of complementarities between electricity and capital. These results echo the historical account of new technologies in the Second Industrial Revolution in Goldin and Katz (2009).

Examining labor market effects in more detail, we find that electricity favored labor hollowing out –a decline of middle-skill jobs at the expense of high- and low-skill jobs. This hollowing-out pattern is consistent with previous studies and with the notion that electricity adoption enabled the reorganization of factory production (e.g., Devine, 1983; Gray, 2013; Katz and Margo, 2014). While Jerome (1934) suggests that electricity could destroy low-skill jobs, our findings suggest that for this level of skill, reinstatement effects were larger than job destruction effects.[3] When looking at a proxy for the task content of occupations, we see that polarization appears to have been accompanied by an expansion of non-routine cognitive tasks and a fall in routine activities (manual and cognitive), something similar to what has been observed as the modern impact of computerization.[4]

[1] The relevant geography for using water as a direct source of power was, in any case, quite different than for its use in electricity generation. Furthermore, by the beginning of the electrification era, water was only a minor – and declining – source of power in manufacturing.

[2] The lag has traditionally been attributed to the costs and challenges of reorganizing the factory to take advantage of purchased electricity (e.g., Devine, 1983). While these impediments may have been real, our findings suggest adoption was also slow in most places due to the high cost of electricity itself, as immediate productivity gains are concentrated in places with access to hydropower. Woolf (1984) also argued that cost was a key driver of electrification in manufacturing.

[3] As we build uniform sectors for the whole sample period, the appearance and disappearance of industries in the raw data do not explain our results.

[4] Given that we look at employment at the sector level, our results could represent a lower bound for employment flows if those happen within sector. We do not observe gross job flows either.

We then study the effects of electricity on employment by occupational categories. We show that an increase in production workers entirely explains the increase in the share of low-skill workers and that the destruction of medium-skill jobs corresponds to a collapse of craftsmen occupations. This result is consistent with the notion that production line methods favored by electricity replaced artisanal methods and required instead simple manual tasks performed by low-skill workers. We also find that electricity adoption was associated with an overall increase in the number of distinct occupations.

We then argue that market structure can explain why productivity gains from electricity were not tied to overall output growth at the city-sector level. To make our argument precise, we introduce a simple model where the impact of improved energy depends on market structure, expanding the model of Autor et al. (2020b) to include multiple factors of production (energy – the source of technological advance– and labor). In markets with small firms, cheaper energy is predicted to increase output and employment. In markets with large firms, the resulting inelastic product demand curves (by Marshall's second law of demand) are predicted to induce firms to increase mark-ups instead of output in response to the same fall in energy prices, leading labor demand to increase by less (or even decrease). To test our hypothesis, we assess whether electricity had heterogeneous effects by the average firm size before the diffusion of electricity. We find electricity adoption had negative (though not usually significant) effects on employment in city-sector cells with above-median firm size and positive effects on output and employment in cells with below-median firm size. This result is robust to several different ways to approximate market structure, including tradability. Thus, the reinstatement effects of technological change appear to be tied to market structure, as the model predicts.[5]

Our paper contributes to the literature on the role of electricity in the process of economic growth. Our empirical strategy is closely related to the contributions of Gaggl et al. (2019, 2016), who exploit geographic variation in access to hydropower to show that electricity induced reallocation of labor from agriculture to manufacturing. We combine that source of variation with cross-sectoral variation, allowing us to control for the direct effects of local "geographic advantage" –hopefully lending credibility to our approach– as well as, for the first time, being able to examine impacts within, not just across sectors.

Beyond the analysis of productivity effects, our cross-county cross-sector approach also provides interesting findings in our detailed examination of labor market effects. The hollowing out pattern in the distribution of labor skills we find within sector complements the across sector findings of Gray (2013) and Katz and Margo (2014). The most novel aspect of our contribution is to link market structure, a previously neglected aspect with broad, important implications.

[5] Our analysis is thus consistent with the only study that has shown strong negative employment effects of electricity (Morin, 2019), which focused on the cement sector, one of the most concentrated ones in the US.

Indeed, our insights on the impacts of new technologies on labor markets may go beyond the context of the Second Industrial Revolution in the US. The burgeoning literature on the contemporary impacts of industrial robots mostly points to negative effects on employment, though not in all cases (see Acemoglu et al., 2020; Acemoglu and Restrepo, 2020; Aghion et al., 2020; Dauth et al., 2019; Graetz and Michaels, 2018), suggesting that the relationship between new technologies and jobs may not be unique. Our analysis of electrification shows the labor market impacts of new technologies may depend on product market structure. Our results on labor hollowing out have points in common with studies on recent trends toward polarization in labor markets (Autor et al., 2003; Goos and Manning, 2007), and, as previously mentioned, our arguments about the role of market structure echo those of De Loecker et al. (2016), De Loecker et al. (2020), and Autor et al. (2020a).

The rest of the paper is organized as follows. Section 2 discusses the related literature in more detail and frames our contributions. Section 3 describes the data that we use and our empirical strategy. Section 4 shows that electricity adoption was significantly influenced both by pre-determined energy intensity at the sector level, and access to hydropower at the city level. Section 5 presents our analysis of the impacts of electricity on manufacturing productivity, employment, capital deepening, and different types of labor. Section 6 studies the role of market structure. The last section concludes.

2 Related Literature

A large literature studies the effects of electricity on productivity. According to the usual narratives, its impact on productivity was sizable, though lagged by over two decades from establishing the first power plants.[6] Using growth accounting methods, Crafts (2002) finds a sizable contribution of electricity to total factor productivity but only starting in 1920. David (1990) and David and Wright (2003) argue that adoption required time as innovations diffused progressively across different activities and types of firms. Goldfarb (2005) suggests that multiple adaptations were needed and that this delayed productivity gains. Jovanovic and Rousseau (2005) and Atkeson and Kehoe (2007) analyze the slow adoption process of electricity and other general-purpose technologies and their delayed effects on productivity. The idea of a slow adoption process echoes contemporaneous studies noted that growth in energy use in manufacturing was below expectations and much slower than in transportation (Daugherty, 1933; Thorp, 1929). Along these lines, we find significant lags in the impacts of electricity when using cross-industry variation alone, but earlier, significant and sizeable impacts when using cross-industry cross-city variation. This suggests that the existence

[6]A notable exception is Ristuccia and Solomou (2014) who find no productivity gains from electricity diffusion in the UK, Germany, France, and Japan using time series data, nor across industrial sectors in the UK.

of rapid productivity gains, though only in areas with access to cheap electricity thanks to hydropower. This echoes the argument by David and Wright (2003) that the UK lagged the US in productivity growth over 1920 due to the gap in the availability of cheap purchased electric power for industrial districts.

Historical narratives argue that electricity enabled a radical transformation in the organization of production. Devine (1983) describes the differences between the organization of steam-powered factories and electricity-powered factories. With steam power, many machines had to be connected to the same power source using a system of belts and shafts. With electricity, each machine could eventually have its own drive, which brought about energy savings and a considerable increase in flexibility for organizing the factory floor layout. This created space for efficiency gains and paved the way for *Taylorism* and continuous-process methods. Du Boff (1967) argues that electricity allowed for smaller machine size and lower fixed costs of using energy. We find evidence of labor hollowing out and increased occupational diversity in energy-intensive firms with access to hydropower. This is consistent with the notion that electricity favored continuous process methods and reshaped labor demands accordingly.[7]

Our results on the role of market structure provide a distinct addition to the literature. While our simple model shows why the impact of technology in the labor market depends on product demand elasticity, this insight has been absent in the literature. The relevance of market structure in our analysis echoes the contemporaneous concerns about "bigness" in the period we study. Increased capitalization required by technological change and the Great Merger Movement between 1895 and 1904 led to increased concentration. Concerns about this process gave rise to anti-trust policies, but these did not reduce concentration in the short run (Adelman, 1951; Lamoreaux, 2019; Nutter and Einhorn, 1969; Smythe, 2010).

Our model and results complement the analysis of Smythe (2001), who shows a positive correlation between a merger in an industry during the Great Merger Movement and the rate of electricity adoption a decade later. Our results suggest that beyond accelerating adoption, concentration influenced the impacts of electricity on labor demands. Furthermore, we find that in sector-cities with larger average firms, electricity adoption favored further market concentration.

Our analysis complements a number of recent studies that examine the impacts of electrification in developing countries in more recent periods (e.g., Dinkelman, 2011; Fried and Lagakos, 2019; Lipscomb et al., 2013). Thus, our results may be of broad interest for developing countries today. At the same time, our study's context has some distinguishing features, as the technology was new and complementary inputs had yet to be developed. Finally, our analysis complements other studies

[7] However, we do not observe that more complex firms were more likely to adopt electricity nor that electricity increased the presence of women, clerical workers, or managerial positions, casting doubt on the link between electricity and Taylorism.

of electrification in the US that are focused on the effects of electrification for households and rural areas (e.g., Lewis, 2013; Lewis and Severnini, 2019). A distinctive aspect of our study is the focus on manufacturing activities in the US during the Second Industrial Revolution. While electricity is commonly considered to have played a fundamental role in that major historical transformation, ours is among a small set of rigorous, detailed quantitative studies on the topic.

3 Data and Empirical Strategy

3.1 Data

Our data set combines information on energy intensity, access to hydropower, electricity adoption, industrial output, employment, and other outcomes for a panel of consistently defined countries and industrial sectors between 1890 and 1940.

We use data at the city-industry level from decennial Censuses of Manufactures 1890–1940. While not much micro-level data is available for historical Census of Manufactures in the United States for the period we are interested in (the samples by Atack et al., 2008, end in 1880), summary tables by industry and city (or county, depending on the year) are available in the published paper versions for Census years and some intercensal periods. This is an extended version of the data digitized by Lafortune et al. (2019) from the Censuses of Manufactures, now restricting it to the post-1890 period and adding 1940 to capture long-term impacts of electricity diffusion. The key outcomes of interest are electricity and energy use, capital, labor, and output. Value of products and costs are available for the full period, which allows us to define value-added as our measure of output (Y). We use the total number of workers as our measure of employment (N) and compute labor productivity as value-added per worker or Y/N. We present summary statistics for these outcomes in Appendix Table A.1.

Energy-intensity, as proxied by horsepower use, is available at the city-industry level from 1910 to 1930. We use the prime movers as our definition of horsepower when measuring energy intensity (HP/Y) but we add to it the rented horsepower when calculating the fraction of horsepower that is electric in the industry. We also obtained aggregate industry measures of horsepower use from 1890 to 1930. Unfortunately, electricity usage by city-industry is only available in 1920. In 1930, we have the electricity rented by firms which is a significant portion, but not all, electricity used by firms at that moment.

The geographic coverage of the Manufacturing Census differs by year. The population threshold above which cities were included in each year changed over time. In 1890, the 165 largest cities were included. In 1900, there were 209 cities included since only cities with more than 20,000 inhabitants were detailed in the reports. In 1910 and 1920, only cities with more than 50,000 inhabitants were included. In 1930, the process was more complex and involved restricting cities to those that had a significant amount of manufacturing workers (10,000 was a typical cut-off but it depended on other factors). Due to this change of geography, and because, with rare exception, cities are within county boundaries, we make "county" the unit of analysis, matching each city to the county they corresponded to.[8] We merged counties over time to ensure that borders were very similar between years, as described in Lafortune et al. (2019).

The map in Figure 1 shows the counties that enter into our sample (using 1920 county boundaries). The areas in our analysis are the largest metropolitan areas of the period (including counties whose population was 5 to 6 times that of an average US county). The close relationship between our analysis at the national level and that at the local level (without adding county-level fixed effects) suggests that the focus on big cities does not strongly alter the results.

Industry classifications changed significantly over the period. We use detailed information provided by the Census Bureau on the change in industry definitions over this period to generate groups that are consistent over the full period. This means that we loose some details in how fine our industries are defined but we are sure that we have the same industries included in each group in each period. Industries were matched across census tabulations using tabulated crosswalks in years after 1900, and by hand before that. Appendix Table C.16 gives our final set of industry crosswalks. We generate a balanced sample at the aggregate level from 1890 to 1940 with 156 industries consistently defined over the period. As a result of this procedure, new industries are bundled with the closest original sector or are kept together with the sector where they were originally included. Similarly, disappearing industries are grouped following the same idea. This guarantees that we observe all the activity reported in manufacturing despite the change in the number of industries reported by each Census.[9]

At the industry-city level, some industries disappear since there is also a minimum "cell size" to be included (often, at least 3 establishments). However, even with these reporting restrictions, there is "balancedness" in the sense that the industries detailed for each city often repeat, allowing us to use panel methods as detailed in the empirical methods section. In the industry by area analysis, we exclude the residual "All other industries" cells, as they are not comparable across years or areas. Merged all together, we obtain a panel including 16,279 industry-city-year observations. This includes a total of 178 areas (more in some years than in others) and 150 industries. We capture around a quarter of all manufacturing output in our database.

[8]The only significant exception to this is New York City, which spans multiple counties and whose county composition changes over time. We therefore construct New York City to cover the five "boroughs" (counties) that make it up at the end of the period. This aggregates together Brooklyn and New York City, which reported as separate cities in earlier years.

[9]It also means that (potentially endogenous) changes in the number of industries observed do not drive our results, particularly about employment levels.

We identify access to early hydropower using the Census of Central Electric Light and Power Stations and Street and Electric Railways of 1912. This edition of the Census provides a map of all hydroelectric central stations reporting water power of at least 1,000 horsepower. We digitized this map geocoding each power plant. Given the absence of historical literature determining the length of distribution that was possible over the years, we employ our own data to determine how far away from these power plants one needs to be to obtain benefits. Appendix Figures A.1 and A.2 show that there appears to be a benefit to being close to a power plant in terms of electricity prices and electricity usage until one is further than 70 km. We thus use as our main measure whether there are any hydro power plants were within a radius of 70 km of the centroid of the county. We also measured the distance of each centroid to the closest power plant on the map. We present this map in Figure 1. As an alternative measure, we use the 44 hydroelectric power stations identified in the 1900 Census of Manufactures and identify the county where each of them was located. This data, however, is of lower quality given the lack of exact geographic location and the unclear definition the Census of Manufactures employed to classify these stations.

We also use data on electricity prices. Our preferred source is the Census of Manufacturing 1947 which provides, for each county, the total cost of electricity and the number of KWh consumed by manufacturing firms. This is the only source we found with reliable price information for the manufacturing sector. Our analysis suggests, in line with Severnini (2014), that even by 1947 prices remained very local, as the distribution network was not yet well developed. We also show results using the National Electric Light Association (NELA) Rate Book from 1921 and 1935, which provide information on residential rates for a subset of cities in our sample.

For labor related outcomes, we exploit data from the Census of Population with IPUMS micro-data from 1900 to 1940 full counts (Ruggles et al. (2019)). We obtain information regarding the number of workers and their characteristic by county and industry. Since the Census of Population data uses IND1950 as an industry classification, we generate a cross-walk between the Census of Manufacturing and the Census of Population. Given that our classification is finer than that provided in the Census, sometimes one IND1950 is matched to multiple industries in our database, as shown in Appendix Table C.16.[10]

3.2 Empirical strategy

Using our detailed data at the sector-county every decade in the period 1890-1940, we use a difference-in-difference estimator to exploit variation in energy intensity across industries and variation in access to cheap electricity across locations. This approach is essentially the cross-country cross-industry design pioneered by Rajan and Zingales (1998), discussed in detail by (Ciccone and

[10] As mentioned earlier, we observe sector level outcomes, thus flows between finer industries within a sector are not observed, neither are gross job flows at the sector level.

Papaioannou, 2016), though in our case geographic variation is across cities rather than countries. We run regressions for outcomes at different points in time, focusing on observed patterns before and after the arrival of electricity—this time variation is an additional layer that in intuitive terms implies we adopt a triple-difference approach.

We estimate the following equation:

$$\Delta log(y)_{ict} = \gamma_t \cdot HP_{i,0} \cdot Prox_c + \theta_{it} + \theta_{ct} + \varepsilon_{ict}, \tag{1}$$

where i denotes an industry, c a county and t a time period. We estimate the regression separately for each year. This lets all the coefficients estimated in this model change by year. We control for fixed effects by industry (θ_{it}) and by county(θ_{ct}) separately, for each year in our sample. $\Delta log(y)_{ict}$ corresponds to outcomes related to either growth in employment or output or productivity between year t and year 1890, which pre-dates the diffusion of electricity in manufacturing. In some specifications, we also include a control for the 1890 value of the outcome variable at the industry-city level, thus allowing for differential trends across years by initial levels. Regressions are weighted by the number of establishments in each sector-county cell.

Our parameter of interest is γ_t, which measures the differential impact of the arrival of electricity on a given sector given its location. $HP_{i,0}$ measures the initial horsepower usage per worker of the industry in 1890 at the *national* level. This attempts to compare sectors with high versus low energy needs *before* the widespread adoption of electricity. As discussed below, this is a strong predictor of electricity adoption.

We interact sector-level energy intensity with a city-level proxy for access to electricity: the availability of a hydroelectric plant in a near vicinity. The generation of electricity was developed before the technological innovations that allowed its distribution over long distances. Moreover, electricity was much cheaper when produced by hydroelectric power than through (mostly thermal) alternatives. Using information on the geographic location of all large hydroelectric plants in 1912, we define $Prox_c$ as the distance to the nearest station or the number of stations within a 70km radius. We also obtained a list of all large hydroelectric plants in 1900 and assigned a value of one to counties that had a plant in 1900. Thus, this interaction allows us to add another "difference" to the empirical strategy comparing two counties that differed in their access to hydroelectric power.

While locations with early hydroelectric potential may confer some direct geographic advantage city effects control for the direct effects of any geographic advantage as it affects city growth rates.[11] The threat to identification here is that power plants may have located in areas that were anticipated

[11] Though water was used as an alternative power source historically, it was a minority source on the decline as electricity was spreading. According to the Census of Manufactures, steam power accounted for 78% of power use at the dawn of electrification in 1890, while water accounted for only 21%, a number which fell to 13% by 1900. In any case, the impact of local water sources or any other relevant geographic features are controlled for with our unrestricted city trends. See U.S. Department of Interior, United States Census Office (1902).

(for reasons *other than* the availability of electric power) to increase their growth rate, not overall, but in historically power-intensive industries relative to less power-intensive industries. But this is unlikely to be the primary driver of power plant location: in the early 20th century manufacturing continued to rely on other power sources (water, but mainly steam) and was not the main source of growth in demand for purchased electricity (see, e.g., Bureau of Census, 1910; Bureau of the Census, 1902, p. cccxxix). We formally test the existence of pre-trends by using outcomes measured in 1880 as placebo and show that there were no benefit to being in those locations before 1900.

4 Energy intensity, access to hydropower, and electricity adoption

This section establishes the building blocks of our empirical strategy to identify the impacts of electricity adoption on manufacturing production. Our strategy is based on combining two sources of variation in electricity adoption: cross-sectoral variation in energy intensity (before the diffusion of electricity) and cross-county variation in access to hydropower.

We start by showing that energy-intensity before the arrival of electricity is a good predictor of electricity-intensity once electricity has been implemented. We do that by regressing electricity use in 1920 (this is the only year in our county-industry data where we have all the required data to compute these values) on the industry-level energy intensity in 1890, previous to the diffusion of electricity in manufacturing.[12] We include county-level fixed effects to capture any factor related to the location of these industries across the United States. [13] The results are presented in Table 1. In the first column, we use electric horsepower per worker as our measure of electricity use while in the next column, we employ electric horsepower per value added. Finally, the last column focuses on the percentage of horsepower that were electrified.

We find a strong and robust relationship between how energy intensive an industry was in 1890 (either by using horsepower per worker or per output) and the intensity in the use of electricity of that industry in subsequent years. A one percent increase in horsepower per output in 1890 is associated with 60 percent higher electric horsepower per worker, 65 percent higher electricity per output and 77 percent higher fraction of horsepower being electrified in 1920. A one percent increase in horsepower per worker in 1890 is associated with 35 percent higher electricity per worker, 39 percent higher electricity per output and 58 percent higher fraction of electrified horsepower in 1920. The results are very statistically significant.

We now address the concern that these results may not reflect the role of energy-intensity but rather some other industry-level characteristic that was correlated with energy-intensity and

[12]This section does not include a control for the outcome variable in 1890 since we do not have electricity at the city-industry level for that year.

[13]However, results are almost identical when excluding these controls. Results available upon request.

with electricity adoption. First, note that our measure of energy-intensity does not just capture established versus new industries. Appendix Table A.2 shows the list of sectors that were more and less energy-intensive before the arrival of electricity. While some of the most energy-intensive industries are the ones that led the Second Industrial Revolution (e.g., iron and steel, electrical machinery), others are more traditional industries (e.g., flouring, vinegar).

We explore the relationship of energy adoption and various of industry-level characteristics (early adoption, capital intensity, human capital intensity, complexity) in Appendix Table A.3. The first panel shows that the few industries that started employing electricity in 1890 were not those that ended up using it more intensively. Early adoption of electricity is actually associated with lower electricity intensity in subsequent years.

One could be worried that energy-intensity is simply a proxy for "heavy industries." We explore this using measures of capital intensity in Panel B. We find that capital-labor ratios in 1890 are negatively correlated with electricity intensity in 1920, although capital output ratios in 1890 are positively correlated with electricity intensity in 1920. This suggests that energy-intensity was more correlated with higher capital-output ratios than capital-labor ratios. Overall, the results suggest that our measure of energy-intensity is not the same as capital intensity.

Panel C turns to variables related to human capital. Lafortune et al. (2019) suggest that the Second Industrial Revolution led to skill becoming complementary with capital and the arrival of electricity could have played a role in that transformation. This would suggest that higher skill ratios would have been essential for the adoption of electricity. However, the results presented in this panel do not support this hypothesis, which is not surprising since electricity is one of the last changes to occur during the Second Industrial Revolution. We first use the average literacy of workers who report working in that industry in the Census of Population in 1900. We find no evidence that industries that were more literate in 1900 at the national level had higher electricity intensity in 1920. If anything, the results suggest a negative relationship between literacy and electricity intensity.

The results above could be imperfect since we have to merge two industry categories, introducing noise in the analysis. The next set of results use the number of white-collars per blue-collars in the Census of Manufactures in 1890. This has the advantage of being in our database and thus can be generated for all industries in our classification directly. However, it is less clearly a measure of skill than literacy, since blue-collar workers may have also been "skilled." The results presented in Table 1 show that a similar conclusion as when using literacy can be drawn: industries with fewer high-skill workers are less likely to have adopted electricity, contrary to our hypothesis.

We finally include measures of industry complexity since some authors argue that the arrival of electricity was particularly relevant for allowing a better division of labor through a change in floor organization. We find no evidence that proxies of complexity such as the number of occupations employed in an industry or the Herfindahl index of occupations are positively correlated with more use of electricity.

In sum, the results show that energy intensity in 1890 (*before* the diffusion of electricity in manufacturing) is a good predictor of electricity intensity a few decades later, and that this does to simply mask a pattern related to other variables.

When did the difference by energy intensity arise and was it long lasting? To answer this question, we must rely on cross-industry variation only, since we do not have measures of electricity usage at the industry-city level for years other than 1920. Thus, our sample consists of 156 industries, and we cannot control for differences in location patterns across industries. We regress our three measures of electric intensity at the industry-year level on our measure of energy intensity in 1890 separately for each year. To show the results graphically, we predicted what the electric intensity was for the industries at the 10th, 50th and 90th percentile of initial energy-intensity. This is presented in Figure 2 where the dependent variable is in difference of log for each outcome. The pattern of the industry at the median is reflective of the typical "S-shape" adoption curve of new technology. From our data, in 1890, the average industry used less than 0.005 electric horsepower per worker in a given year, that number jumped to 0.07 in 1900 and then to 0.5 in 1910, virtually being multiplied by 100 over 20 years. It then increased to 0.6 in 1920 to then continue growing at a slower rate in the following decades, reaching 1.8 by 1940. This is visible in our graph as a change between 6 and 8 log points between 1890 to 1940 but much more rapid between 1890 to 1910 than after. This figure shows that initial energy intensity strongly influenced adoption of electricity as early as 1900 with the gap increasing until 1930. By 1940, initial energy-intensity is not a good predictor of electricity per worker or per output but remains one for the fraction of horsepower electrified. Coefficients used to obtained the predicted measures for each year are presented in Appendix Table A.4. Thus, the results suggests that energy intensive industries became more electricity intensive from 1900 onward and that this relationship became stronger as electricity spread more widely.

We now turn to show that cross-county differences in access to hydropower were also a key determinant of electricity adoption. This is the second building block of our empirical strategy. We measure this using proximity to large hydroelectric plants. In Table 2, we show how the presence of hydroelectric power plants in 1912 or 1900 are correlated with lower electricity prices, obtained from our preferred measure which employs manufacturing rates for 1947. We explore the correlation between the level (in the first three columns) and the logarithm (in the last 3 columns) of the rates and 3 different measures of proximity to a hydroelectric plant. Our first measure is the number of power plants within a 70km radius of the centroid of the county in 1912. Our second is the inverse distance of the centroid of the country to the nearest hydroelectric power plant in 1912. Finally, our last measure is a dummy for the presence of a large hydroelectric power plant in 1900.

The results in Table 2 show that our three measures of proximity are all significantly correlated with lower manufacturing electricity prices in 1947. Appendix Figure A.1 Panel A displays the effects of distance to 1912 hydropower stations on 1947 prices. The results show that being further than 70km from hydropower is associated with an increase of 0.8-1 cents per KW/h—over one standard deviation and about half of the mean price for that period. In Appendix Table A.5, we use two alternative measures of electricity prices. In Panel A, we use residential rates for 1920 while in Panel B, we use residential rates for 1935. This table shows in general a negative correlation between proximity and electricity prices but it is only significant for the earliest power plants. Residential electricity prices were likely to be different from those paid by manufacturing firms which may explain the difference. We also consider these measures in Appendix Figure A.1 Panels B and C. Overall, these results indicate that electricity prices paid by manufacturing firms were likely to be significantly lower when they were located closer to a large power plant.

Having established that both industry-level energy intensity and county-level access to hydropower were relevant determinants of electricity adoption, we now show that the interaction between these two factors is also a strong predictor of electricity adoption even controlling for industry and city fixed effects. We do this in Table 3, where each panel corresponds to a different way of measuring proximity. In the first panel, we use the number of power plants within a 70km radius of the centroid of the county. We find that industries that were more energy-intensive in 1890 and were located in counties with a power plant had substantial increases in electricity intensity (i.e., electric horsepower per output or per worker) by 1920.

The next panel uses the inverse of the distance to the nearest power plant in 1912. We find again a strong relationship between the interaction between the inverse distance and the energy intensity of the industry in 1890. This suggests that energy-intensive industries became particularly more electricity-intensive in places that were closer to a hydroelectric power plant in 1912. Finally, the last panel uses a more demanding specification using a simple dummy for whether the county had one of the 44 power stations already in existence in 1900. This is a very small number of counties but where the location of the power plant may have been particularly driven by topological characteristics that favored the production of hydro-electricity. We find again a strong "first stage" in that industries that were more energy intensive in 1890 that were located in one of these counties was observed to be more electricity intensive in 1920, when defined as electric horsepower by output or by workers.

We are unable to run this first stage in other years because of data availability. However, in 1930, we have rented electric power as one of our available measure. While this does not correspond fully to all electric horsepower since many industries produced their own electricity over this period, we have tried using it as an outcome and have found that the first stage, while a bit weaker, does continue to exist in 1930 with that proxied measure of electricity-intensity.[14]

In the above regression, we weight our regressions by the number of establishments represented for each industry-county cell in our sample. We do this for two reasons. First, while we do not have firm-level data, we wish our results to be representative of the impact of electricity on an average firm. Second, the variables for sector-county cells with less establishments are likely to be noisier, so weighting can increase the precision of the estimates. This is particularly true since the number of establishments is the criteria that the Census of Manufactures used to determine whether a cell would or would not be included in the report. Thus, by weighting by the number of establishments, we also give more weight to observations that are more continuously in our sample, ensuring that our fixed effects strategy is well identified.

Weighting by the number of establishments is only valid if our interaction does not influence the number of establishments present in the sample. To check for this, we run as an outcome variable three different measures of "size" of a cell against our interaction on a sample that includes every single industry ever present in our sample for every single county ever included in our sample. We continue to include county and industry fixed effects. The results of these regressions are presented in Appendix Table A.6. The first column shows the impact of our interaction on the cell being in the sample in that year. The second column uses as an outcome variable the number of establishments imputing as "0" as cell that is not in our sample while the third does the same thing with the number of workers in that cell.

Overall, the results suggest that industries that were more energy-intensive and that were close to a power plant were not more likely to be in the sample, nor more likely to have more establishments or more workers. In 1900, we actually find a significant impact of the interaction on the likelihood of being in the sample but the impact is negative suggesting that those cells were less likely to be in the sample. We find a significant and positive impact between our variable of interest and the number of workers (including 0s for missing cells) but the significance disappears in other years. Similarly, we find no significant correlation between our interaction and the number of establishments in any years. This suggests that we can use the number of establishments as a weighting variable since our variable of interest does not seem to be correlated with it. While energy intensity and access to hydropower affected various outcomes of interest, they did not significantly change the likelihood of being sampled. Furthermore and consistent with our argument, we find that the results are similar qualitatively when we omit our weights but much noisier.[15]

[14]Results not presented but available upon request.

[15]Results available upon request.

5 Impacts on productivity and jobs

5.1 Productivity Growth and Employment

Having shown that our interaction between early energy-intensity and proximity to power plants generated sufficient variation in electricity-intensity, we now turn to exploring the impact of electricity on productivity. Given that we only have a "first stage" for 1920, we focus exclusively on the reduced form approach.

Figure 3 shows the estimates of the estimation of equation (1) for three outcomes: labor productivity, output, and employment. The first figure thus shows how the interaction between proximity to hydropower and energy-intensity impacted the growth in productivity of industry-county cells over the period. First, the figure demonstrates that in 1880, industries that had higher horsepower intensity did not growth differentially in counties that were close to a power plant compare to those that were further away. This is indicative that our measure does not capture something that was permanently influencing the growth of these industry-county cells but rather a change that occurred immediately after electricity began to diffuse to the manufacturing sector. We see that, even as early as 1900, there was clearly a higher labor productivity growth in industries that were energy-intensive in 1890 who had a power plant close to them by 1912 than amongst these same industries in different locations or amongst other industries within the same county. Similar to our pattern of electricity adoption, magnitudes are such that they suggest that growth benefits increased until 1920 and that the growth advantage remained fairly constant for the following decades. To get a sense of the magnitudes, having one power plant within 70 km increases the labor productivity of an industry that was at the 75th percentile of energy needs by 4 percent compared to one at the 25th percentile as early as 1900. The magnitude increases to around 11 percent by 1920 and remained at that level until 1940. In 1920, this, combined with the first stage presented in Table 3, implies that having one more percent in electric horsepower per value-added leads to 1.5 percent higher labor productivity. In Appendix Figure A.3, we show the same estimations but this time controlling for labor productivity in 1890. We find a similar pattern with slightly smaller magnitudes. This suggests that the growth may have been larger in part because there industries in these counties may have had lower than average productivity in 1890. Nevertheless, in either version, our results suggest strong, large and very robust impacts of electricity-intensity on labor productivity.

The next table explores the robustness of these results. The first two columns of Table 4 show how different our results may be when restricting the sample to industry-county cells that were present in all of the 5 years we include. This is to make sure that the early impact on productivity we documented before is not driven by changes in samples between years. The next two columns use the inverse distance to the closest power plant to check whether our results are robust to how we measure exactly proximity. Finally, the last two columns use our other proxy of closeness to a power plant which is whether the county had a power plant in 1900. The first two columns suggest that the time pattern we observed in Figure 3 is not because of changes in which cell were included since the results show significant and strong initial productivity growth gains as before, despite losing, in some years, more than half of the sample. The next column shows that our results are robust to changing the way in which we measure proximity to the 1912 power plants. The results suggest, as before, that productivity growth would have been larger in county and cells that were able to electrify more intensively as early as 1900. It again shows that by 1920, there is no doubt that productivity gains were strong and very robust. Furthermore, we also repeated our main analysis for 1920 but changing the definition of "close" to 10km intervals. The coefficients on the interaction of each measure of proximity and initial energy intensity are presented in Appendix Figure A.4 for 1920. Our results show the same type of discontinuity around 70km suggesting that exactly at the distance from a power plant where firms stopped benefiting from lower electricity prices, productivity gains also disappeared. Finally, the last two columns change more dramatically our definition of proximity by using the very few hydropower plants in existence in 1900. In those columns, we observe much noisier results but we still see that the magnitudes suggests that by as early as 1920, productivity gains existed. Thus, overall, our robustness analysis confirms that firms that became more electricity-intensive earlier observed labor productivity gains relatively quickly.

Why do we find this result while the previous literature – which tends to look at the industry level (e.g., David (1989)) – does not? We explore this in Appendix Table A.7 where we contrast the results we obtained with those that we would have observed had we done a cross-industry comparison instead of a "double difference" type of approach. In the first two columns, we report the impact we would have measured on productivity by comparing industries, at the national level, that had high energy demands in 1890 to those who had lower ones. The next two columns repeat the same analysis but this time using our industry-county data and adding county fixed effects. We find that our results are very different from those obtained through a cross-industry comparison. In particular, the results in Table A.7 are more aligned with the existing literature. They suggest no or, in the case of the county-level analysis, negative initial impact of electrification on labor productivity. The benefits of the new technology are only visible in 1930 or 1940 in this table, which is 20 to 40 years later than our cross-industry cross-county analysis would suggest. This is consistent with the previous literature, and appears to indicate that not all firms in industries that were highly demanding in energy were able to gain in terms of productivity from electrification; these gains depended on the access these firms had to hydropower plants.

Finally, we explore the reasons behind this increased labor productivity in the two bottom graphs of Figure 4, by looking at output and employment separately. It shows that the increased productivity stem from slightly increased production without any gains in employment. The coefficients for output are not significant in 1900 and 1930 but overall suggest sizeable increases in output when a cell is close to a hydropower plant and was intensive in energy before the arrival of electricity. For employment, we observe the coefficients hovering around zero, without allowing us to reject significant decreases in employment in cells that were benefited more significantly by electricity until at least 1920. This would suggest that electricity may have initially replaced some workers with more or better machines. Including controls for 1890 outcomes shows larger increases in output but also sometimes significant increases in employment, as can be seen in the last two graphs of Appendix Figure A.3.

5.2 Capital Deepening and Labor Hollowing Out

The previous section suggests that electrification led to growth in labor productivity, driven by an increase in output that was significantly larger than the small change in labor demand. To better understand these effects, we now examine how electricity modified factor demands by manufacturing firms. This section shows that electricity adoption induced increases in energy-intensity and capital-intensity, as well as a hollowing out in the skills distribution of the manufacturing labor force.

First, we consider the effects of energy intensity and access to hydropower on horsepower per worker and capital per worker. The results are displayed in Table 5. We find that sector-city cells with higher propensity to electricity adoption exhibit lower levels of energy intensity when we do not control for 1890 value. None of the coefficients is significant in this case. However, with controls, we find that more intensive electricity adoption is correlated with higher levels of energy intensity, significantly so for 1920. This is consistent with them having access to cheaper energy and increasing their demand in response to it. Moreover, electricity appears to be complementary to capital since cells with higher propensity to adopt electricity also increased their capital per worker. This suggests that electricity complemented capital which may explain why increases in labor were relatively muted if the complementarity of electricity with labor was smaller.

We now turn to further investigate how electricity adoption affected labor demand. First, we examine which types of workers were displaced.[16] We rely on micro-level data from the Census of Population, which records workers' industries and occupations, and (following the classification proposed by Katz and Margo, 2014)consider three broad occupational groups: high-, medium- and low-skill. The results, displayed in the first three panels of Figure 4, indicate that electricity adoption induced hollowing out of the labor force—a reduction of middle-skill jobs in favor of low- and high-skill employment, although not significantly so for the latter. While in Lafortune et al. (2019), no indication that the changing relationship between capital and skill was masking polarization was found, we do see a strong pattern in the case of electricity.

[16] We also divided workers by "blue-" versus "white-collar" workers as defined in the Census of Manufacturing. Results are unclear which is consistent with electricity having a non-monotonic relationship with skills.

Our findings match the overall trend documented by Katz and Margo (2014) and echo their interpretation of changes in occupational structure as driven by technological change in the Second Industrial Revolution. This suggests that the results presented by Gaggl et al. (2016) are not only due to sectoral shifts but rather suggests that electricity adoption led to polarization within industries.

We break down occupational groups into finer sub-groups to understand better the reasons behind this pattern. For low-skill occupations, we consider four groups: transportation workers, service workers, apprentices, and production workers. The latter includes operative and kindred workers not elsewhere classified and laborers not elsewhere classified, the two largest occupational groups in our sample, preventing us from obtaining a better picture of that sub-group. For medium-skill, we use OCC1950 division between clerks and salesmen, and then divide the remaining occupations into craftsmen and machine operators. Historical narratives suggest that craftsmen were more likely to be replaced by machines powered by electricity, while machine operators were plausibly complementary to machines technological changes in the period; we also expect craftsmen occupations to be more prevalent in small firms and machine operators in large ones. For high-skill workers, we consider the OCC1950 division into professionals, technical and kindred workers on one side, and managers on the other.

Figure 5 presents the results. The increase in the fraction of employees concentrated in low-skill occupations is entirely due to a large increase in production workers, consistent with the notion that electricity increased line production tasks performed by low-skill workers. The share of apprentices fell significantly by 1940, although in terms of magnitude this is irrelevant for low skill workers overall. When looking at medium skill workers, we find that the "hollowing out" of the occupational distribution is due to the collapse of craftsmen. The share of craftsmen within manufacturing employment was substantially lower in cells that benefited more from electricity in all years although less strongly after 1920. Clerical workers had lower employment shares in those cells in 1940. Electricity may thus have induced the replacement of some clerical tasks like accounting or secretarial activities. We also see a significantly lower relative size of the sales workforce in manufacturing in 1930 and 1940. Finally, machine operators first benefit from the arrival of electricity, increasing significantly their share of workforce in 1910 but then falls to zero. The reason behind this shift may be found in the last panel of Figure 5, which shows that the share of high-skill workers is not due to more managers but rather to more professional and technical workers. Thus, while medium-skill workers may have initially been well suited to work with electric machinery, by 1930 firms may have started to require more skilled workers, such as engineers.[17]

While we do not have task contents for the period in question, we matched the 1950 occupational

[17] We found no evidence that the share of female workers or literate workers was affected by electricity, suggesting that occupations changed more than demographic characteristics of workers.

categories of IPUMS with the 1977 Dictionary of Occupations classification as provided by Autor et al. (2003). We then computed the average task component for each industry-county-year cell in our data for five categories: non-routine manual, routine manual, non-routine interactive, routine cognitive and non-routine analytical. Results are reported in Appendix Table A.9. We observe that industry-county cells that benefited more from electricity saw an increase in the non-routine cognitive task component of the occupations they employed. This is visible for all years except 1910 and for both interactive and analytical tasks. On the other hand, electricity appears to have decreased the intensity of routine tasks, although initially, routine manual tasks appear to have increased. Finally, non-routine manual tasks also decreased. This suggests that electricity had a similar impact as the arrival of computers on the labor market Autor et al. (2003) and is in line with the results of Gray (2013).

Finally, we provide some suggestive evidence that electricity-induced productivity gains may have partly operated through reorganization of factory production processes. Specifically, we look at how electricity adoption affected occupational diversity, as measured by the number of distinct occupations in each sector-city cell. The results in the last panel of Figure 4 show the relationship was positive and large after 1910 until 1930. This is consistent with the hypothesis of Acemoglu and Restrepo (2019) that new technologies can create new "tasks". [18]

Overall, our results suggest that electricity replaced craftsmen and clerical workers with line production workers and professionals. This is consistent with manufacturing production becoming more concentrated in larger firms, something we explore in the next section.

6 The role of market structure

The previous section suggests that electricity increased productivity as output growth significantly outpaced the null employment growth. In the language of Acemoglu and Restrepo (2019), this would imply that this technology had displacement effects that were fully compensated by reinstatement effects. In this section, we show the role that market structure can play in rationalizing these findings and show additional empirical results that confirm our theoretical predictions.

6.1 Model

We first set up a model that links labor demand, energy prices and firm/market characteristics. This model adds multiple factors of production in the model of Autor et al. (2020b) to show that

[18] We found no evidence that the Herfindahl index of occupations increased, suggesting that the increase in occupations was driven by occupations that had a small share of total employment.We do not find the increase in occupations was driven by the appearance of electricity-related occupations such as electricians.

a decrease in the price of one factor may have differential impact on the demand for the other depending on the structure.

Firms in city c and industry i at time t have a production function given by

$$Y_{cit} = A_{ct} z (\alpha_i E_{cit}^{\rho} + (1-\alpha_i) L_{cit}^{\rho})^{1/\rho}$$

where E is energy and L is labor and ρ represents the substitution parameter between both inputs where $-\infty < \rho < 1$. We assume firms have constant return to scale. As α increases, the industry is more energy intensive. Productivity is allowed to depend on county-level characteristics (A_{ct}) and on firm characteristics (z). The price of energy is r_{ct} and the price of labor is w_{ct}. We will thus follow the literature on skill-biased technological change as modelling electricity as a fall in the price of one of the inputs in the production function.

Define $\Delta_{ict} = (1-\alpha_i)^{\frac{1}{1-\rho}} w_{ct}^{\frac{-\rho}{1-\rho}} + \alpha_i^{\frac{1}{1-\rho}} r_{ct}^{\frac{-\rho}{1-\rho}}$, the CES aggregate of the factor costs. We can show that firms have constant marginal costs equal to $\Delta_{ict}^{\frac{\rho-1}{\rho}} / A_{ct} z$.

We now follow Autor et al. (2020b) in defining the market in which firms are operating. We assume an industry with monopolistic competition and firm-level heterogeneity in productivity (z_i), each producing a differentiated variety. Individual demand for a good ω from industry i is of the type

$$q(p_\omega) = p_\omega^{-\sigma_i} d(p_\omega)$$

Each firm produces one good/variety ω. The function $d(\cdot)$ is assumed to satisfy additional conditions. In particular, there exists a "choke price" $\bar{p}$ such that $d(p) = 0 \forall p \geq \bar{p}$. Secondly, $d(\cdot)$ must be such that Marshall's Second Law is satisfied which implies that the absolute elasticity of demand must be decreasing in the quantity demanded. This implies specifically that $d(p_\omega) > 0$, $d'(p_\omega) < 0$, $d \log d(p)/d \log p < \sigma - 1$ and $d^2 \log d(p)/d \log p^2 < 0$.

Firms who want to enter into the market need to pay an entry cost $\kappa > 0$. Once this fixed cost has been paid, firms draw their productivity level z from a known distribution with pdf $\lambda(z)$. The firm will thus maximize its profits by selecting the price that maximizes

$$\left(p_\omega - \Delta_{ict}^{\frac{\rho-1}{\rho}} / A_{ct} z \right) q(p_\omega)$$

This will imply that firms will produce until:

$$q(p_\omega) + \left(p_\omega - \Delta_{ict}^{\frac{\rho-1}{\rho}} / A_{ct} z \right) q'(p_\omega) = 0$$

Defining the mark-up as

$$m(p_\omega, \sigma_i) = \frac{-\sigma_i + p_\omega d'(p_\omega)/d(p_\omega)}{1 - \sigma_i + p_\omega d'(p_\omega)/d(p_\omega)}$$

we obtain that

$$\log p_\omega = \log m(p_\omega, \sigma_i) + \frac{\rho - 1}{\rho} \log \Delta_{ict} - \log A_{ct} - \log z$$

Autor et al. (2020b) shows that prices will be decreasing in marginal costs. We will extend this result to show that prices will fall in response to a fall in the price of electricity.

First, we can show that $\frac{\partial m}{\partial p_\omega} < 0$. Using that

$$\frac{\partial \log p_\omega}{\partial \log r} = \frac{-1}{1 - \frac{\partial \log m}{\partial \log p_\omega}} \frac{1-\rho}{\rho} \frac{\partial \log \Delta_{ict}}{\partial \log r}$$

$$\frac{\partial \log p_\omega}{\partial \log r} = \frac{1}{1 - \frac{\partial \log m}{\partial \log p_\omega}} \frac{\alpha^{\frac{1}{1-\rho}} r^{\frac{\rho}{1-\rho}}}{\Delta_{ict}} > 0$$

Finally, we can show that

$$\frac{\partial \log q}{\partial \log r} = \frac{\sigma_i - p_\omega d'(p_\omega)/d(p_\omega)}{1 - \frac{\partial \log m}{\partial \log p_\omega}} \frac{1-\rho}{\rho} \frac{\partial \log \Delta_{ict}}{\partial \log r}$$

$$\frac{\partial \log q}{\partial \log r} = \frac{-\sigma_i + p_\omega d'(p_\omega)/d(p_\omega)}{1 - \frac{\partial \log m}{\partial \log p_\omega}} \frac{\alpha^{\frac{1}{1-\rho}} r^{\frac{\rho}{1-\rho}}}{\Delta_{ict}} < 0$$

A decrease in the price of electricity thus leads firms to produce more and to decrease prices. Mark-ups will also increase.

Our focus, however, will be in the impact of lower electricity prices on productivity and hiring. (Unconditional) labor demand is given by

$$\log L_{ict} = \log q(p_\omega, w_{ct}, r_{ct}) - \log z - \log A - \frac{1}{\rho - 1} \log(\alpha_i) - \frac{1}{\rho - 1} \log w_{ct} - \frac{1}{\rho} \log \Delta_{ict}$$

which implies that

$$\frac{\partial \log L}{\partial \log r} = \left(-\frac{1}{\rho} + \frac{\sigma_i - p_\omega d'(p_\omega)/d(p_\omega)}{1 - \frac{\partial \log m}{\partial \log p_\omega}} \frac{1-\rho}{\rho} \right) \frac{\partial \log \Delta_{ict}}{\partial \log r}$$

or

$$\frac{\partial \log L}{\partial \log r} = \left(\frac{1}{1-\rho} + \frac{-\sigma_i + p_\omega d'(p_\omega)/d(p_\omega)}{1 - \frac{\partial \log m}{\partial \log p_\omega}} \right) \frac{\alpha^{\frac{1}{1-\rho}} r^{\frac{\rho}{1-\rho}}}{\Delta_{ict}}$$

The impact of a fall in r will thus be undetermined since the substitution effect (the first term) may or may not dominate the scale effect (second term).

Finally, labor productivity will increase in response to a fall in electricity price since combining the above equations give us

$$\frac{\partial \log(Y/L)}{\partial \log r} = \left(\frac{1}{1-\rho} \right) \frac{\alpha^{\frac{1}{1-\rho}} r^{\frac{\rho}{1-\rho}}}{\Delta_{ict}} > 0$$

It is easy to show that all these impacts will be larger for sectors where α_i is larger.

PROPOSITION 1. The impact of a decrease in electricity price on labor will be more negative on labor the larger the firm's productivity (z).

PROOF. See Appendix B.

Thus, our model suggests that labor demand will decrease in response to a fall in electricity prices when the output response will be more muted. This will happen when the firm is more productive. This is a direct corollary of Marshall's Second Law. More productive firms will produce more for their market. This will imply that they will face a more inelastic demand. In response to a fall in their marginal costs because of electricity prices, they will thus increase less their output, leading to the substitution effect of r to be larger relative to the substitution effect.

A similar result would be obtained if we modelled the arrival of electricity not simply as cheaper electricity but also as a skill-biased technological change that increases the marginal productivity of energy relative to labor. However, modeling electricity as a TFP shock would not produce the same results as it would not lead to a substitution pattern between labor and energy.

Finally, we could model labor in a richer fashion by adding multiple types of skills. What would differ then is that the substitution effect may lead to an increase in the demand for some types of workers and a decrease in the demand for others. Looking at how the labor demand for each type of workers respond to changes in energy demands would be indicative of the type of substitutability or complementarity that one would observe between energy and that type of labor.

6.2 Evidence on the heterogeneous effects of electricity adoption

Our findings on the impacts of electricity adoption on levels of productivity and employment are consistent with a setup in which firms were relatively large and faced less elastic demand functions and energy was complementary to capital, low- and high-skill workers but substitute to middle-skill employees. Our model suggests that these patterns would be strongly influenced by the productivity of the firm (and thus their size). This section presents evidence that supports the relevance of the basic idea captured in the model.

How can we measure the degree of "biggness" of an industry in a given city in our data? The ideal would involve computing mark-ups but our data does not provide us with information regarding quantities produced, only the value of the products. We are thus unable to distinguish between firms that sell large quantities from those that sell at high prices. We also do not have information regarding the distribution of firms in a given sector-city cell. What we can compute is the average size of a firm in a given cell, as value-added per firm or number of workers per firm. We hypothesize that cells where these numbers are larger would be an indication of higher productivity. We thus measure this in 1890 and classify each cell as competitive (non-competitive) if the value is below (above) the median. About a third of the sector-county pairs in our subsequent years did not exist in 1890 and thus are eliminated from the rest of the analysis. This generates sizeable differences as average firms in "large" cells have 9 times as large workforce and output as those in "small" cells.

What type of indication can we have that cells with large average firms face less elastic demand curves? We use Atack et al. (2008) state level sample and compute mark-ups for each firm in that sample (since quantity of output and value of output are separately available in that sample). We find that there is a very strong and statistically significant relationship between the average size of a firm and the average mark-up observed in the state-industry cell.[19] Thus, our measure is correlated with demand elasticity. Nevertheless, too few cells are available in that sample to allow us to directly measure market competitiveness in the Atack data and contrast the impact of electricity by that division in our Census of Manufacturing setting.

One may also be worried that our measure of market structure is actually a measure of returns to scale. We studied this in a companion paper Lafortune et al. (2020) and actually find that the less competitive sector-cities cells have slightly lower, and not bigger, returns to scale than those we classify as competitive.[20] This would match the argument given by some historians that "bigness" in the turn of the twentieth century was driven by collusive practices more than by technological advantage (for a discussion of competitive behavior and anti-trust responses over this period, see Lamoreaux (2019)).

Table 6 shows the impacts of access to cheaper electricity on productivity, output and labor hiring, depending on whether the country sector-city cell had above the median or below the median firm size as measured by output per firm. All regressions here include a control for 1890 outcome.

[19]Results are available on request.

[20]See Appendix Figure A.5.

We observe two completely different patterns depending on whether the cell was more or less large in 1890. In cells that had large firms, we observe large and immediate increases in labor productivity, more muted changes in output and large decreases in labor hiring until 1940. On the other hand, in cells that had small firms in 1890, we observe no change in labor productivity until 1930, with large increases in output and hiring. This supports our hypothesis that the impact of a new technology appears to have been radically different depending on the elasticity of demand curve faced by the firms.

We show, in Appendix Table A.10 that these results are extremely similar if one does not include controls for 1890 outcomes. We then show, in Appendix Table A.11 that results are also very similar when separating large and small cells using the 1890 average firm size in terms of employees instead of output. The output results appear slightly noisier but the difference between the two types of cells remains very striking.

One may be worried that our definition of large and small cells is correlated with other characteristics that make adoption of electricity more worthwhile. To verify that this is not the case, we try to construct a "technology-driven" measure of size. As a first approximation, we can think of industries in tradeable industries facing much more elastic demand curves than those in non-tradeable sectors. To measure the degree of tradability of an industry, we regress in the 1940 Census the employment of a given manufacturing sector in a given county against the total wage income of that county and allow that coefficient to vary by industry. This is inspired by Hong and McLaren (2016) who compute this using modern data. The idea is that the local size of more tradeable sectors should be less dependent on the level of income of the county where they are located than sectors that are less tradeable.[21] We thus use the coefficients of this regression for each industry and rank them. We call a "tradeable sector" one whose coefficient was below the median. Table A.12 shows that output and employment responded much more positively in sectors that were tradeable than in those that were not. This would be consistent with our hypothesis that firms that faced more elastic demand curves would respond to lower electricity prices by increasing output and employment.

This is however a very coarse division and only at the industry-level. To pursue this idea at the county-industry level, we combine a ranking of tradability by industry called the "Hoover index" (Kim, 1995) at the two-digit level calculated in 1880 with the inverse of the cost of reaching every person in the US from a given county, available from Donaldson and Hornbeck (2016). The intuition is that an industry-city cell will be larger if it is in a tradeable industry and if it can reach at low cost many customers. If the good is not easily tradeable or the city is isolated from other markets, it is likely that the cell will be producing less and thus facing a more elastic demand curve.

[21] The less data-intensive approach in Hong and McLaren (2016) is better suited for our data compared to other similar measures in the literature, but follows the same basic idea.

In Appendix Tables A.13 and A.14, we expand this analysis in two different ways. In the first, we divide the Hoover index by the average transportation a city faces and divide the sample by the median value. Large firms in this context are thus those in geographically concentrated industries and centrally located cities. In the second, we denote as large any industry-city cell where the Hoover index is above the median in terms of tradability or the transportation costs are below the median, those with low tradability and high transportation costs are then classified as small. In both cases, we observe patterns that are, in general, in agreement with our previous results, in particular for output and labor. We see that cells that should be, for technological reasons, larger and thus facing less elastic demand, appear to have seen larger increase in labor and output than those that were less technological.

Next, we examine whether the labor hollowing out effect discussed earlier was also stronger in larger or smaller firms. Table 7 presents these results contrasting cells with large (in the odd columns) to small firms (even columns) for each outcome. We observe that only in cells that had large average firms in 1890 did we observe a consistent pattern of polarization. These are exactly the cells where labor growth was null or negative. On the other hand, in cells with smaller average firms, we observe limited impact on skill mix (though there also appears to be some reallocation to lower skill jobs in small firms in 1900). Thus, only when electricity appeared to have led to no positive impact on employment did middle-skill workers decreased their relative share of employment.

Finally, we explore, in Appendix Table A.15, whether electricity adoption led to even more market concentration, measured through the change in log number of firms in the cell. Cells where firms were on average larger before the arrival of electricity are in the odd columns and smaller in the even ones. We observe that in cells that had larger average firms in 1890, if anything, the number of firms *decreases*. Output and employment growth were more timid in this case and this would imply that the average firm got larger. On the other hand, in cells that had smaller average firms in 1890, we observe the opposite: significant growth in the number of firms. Thus, not only did the impact of electricity differ by the initial size in the city-industry cell, it also appears to have strengthened this initial pattern, with cells that had larger firms becoming even larger.

7 Conclusion

This paper uses a new approach to study the impact of electricity's spread on production, exploiting cross-industry cross-county variation in how accessible and beneficial the arrival of electricity may have been to the manufacturing sector. Using this approach, we find that electricity increased labor productivity of manufacturing firms but not employment. Thus, fears about "technological unemployment", as stated by Keynes (2008), may have been warranted, mirroring the today's concerns about automation (Acemoglu and Restrepo (2020)). We also find evidence that more electrification led to labor polarization, not only because of sectoral shifts as detailed by Gaggl et al. (2016), but even within a given sector. The previous literature, in contrast, found that productivity gains significantly lagged the spread of electricity, a result that also appears in our data using a simpler, cross-industry approach. Thus, it appears that immediate productivity gains were *localized* to areas with cheap access to power.

Our main conclusions highlight the important role of initial market conditions in shaping the impact of a new technology. Consumers and workers appear to gain from cheap electricity when this occurs in a market where firms face high elasticity of demand. On the other hand, larger firms used cheap electricity to shed workers, particularly those in the middle of the distribution, and increase mark-ups. This is a relevant lesson for industrial revolutions of the past, present and future. Public policy should be particularly concerned about "biggness" when faced with new technological changes that may be competing with labor hiring.

Finally, our results raise the question of whether electricity generated agglomeration economies within given geographical areas. Our empirical strategy abstracts from this by focusing on variation across industry within a given geographical area. Klein and Crafts (2011) argue that natural comparative advantages influenced the location of manufacturing firms until the end of the 19th century when market access and market size became the only determinants. Hanlon and Miscio (2017) find that there were cross-industry agglomeration effects in British cities at the end of the 19th century, early 20th century. More specific to electricity, Severnini (2014) argues that dams built before 1950 in the United States, compared to those built after where alternative producing technologies were more readily available, generated strong agglomeration economies that lasted beyond the initial construction period. We leave this question to further research.

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8 Tables and Figures

Figure 1: Location of hydropower plants with 1,000 or more horsepower in 1912 and counties included in our sample (1920 county boundaries shown)

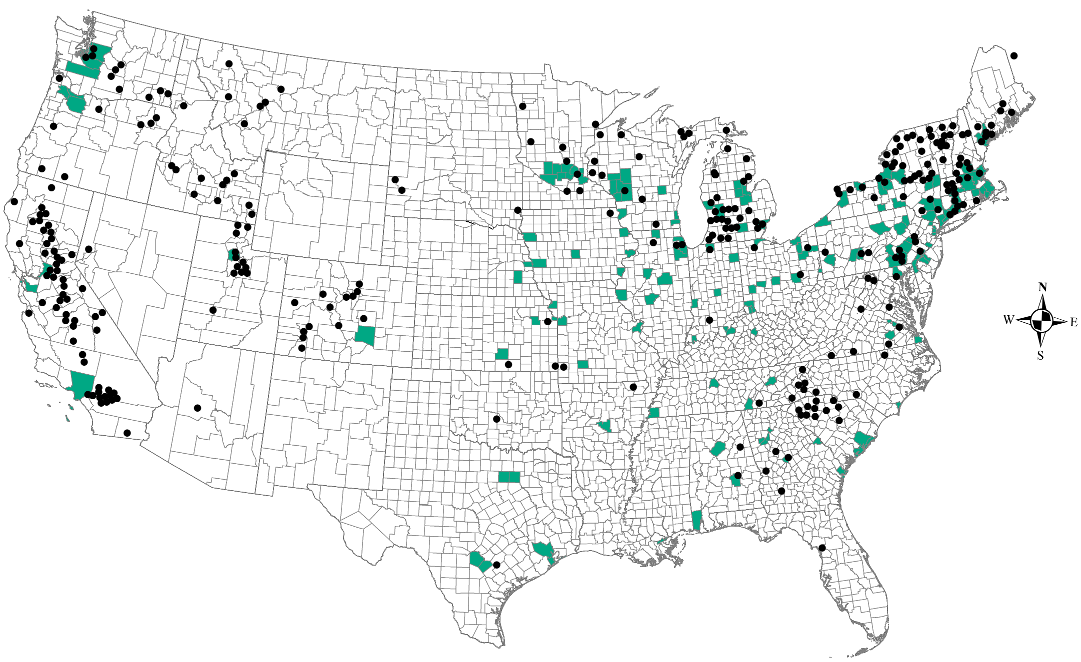


Figure 2: Difference in predicted electricity adoption depending on initial energy-intensity

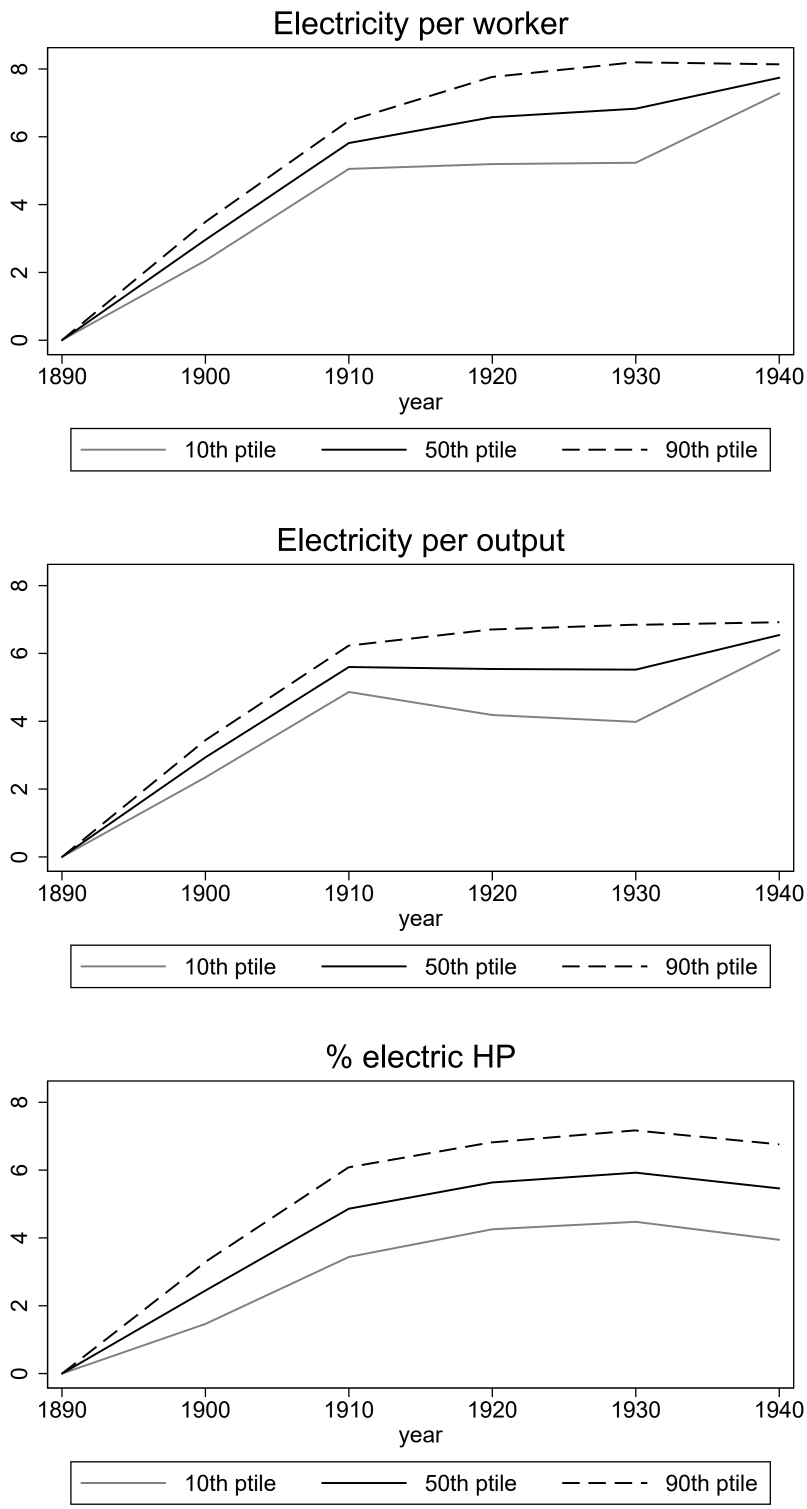


Figure 3: Impact of electricity on productivity, employment and output

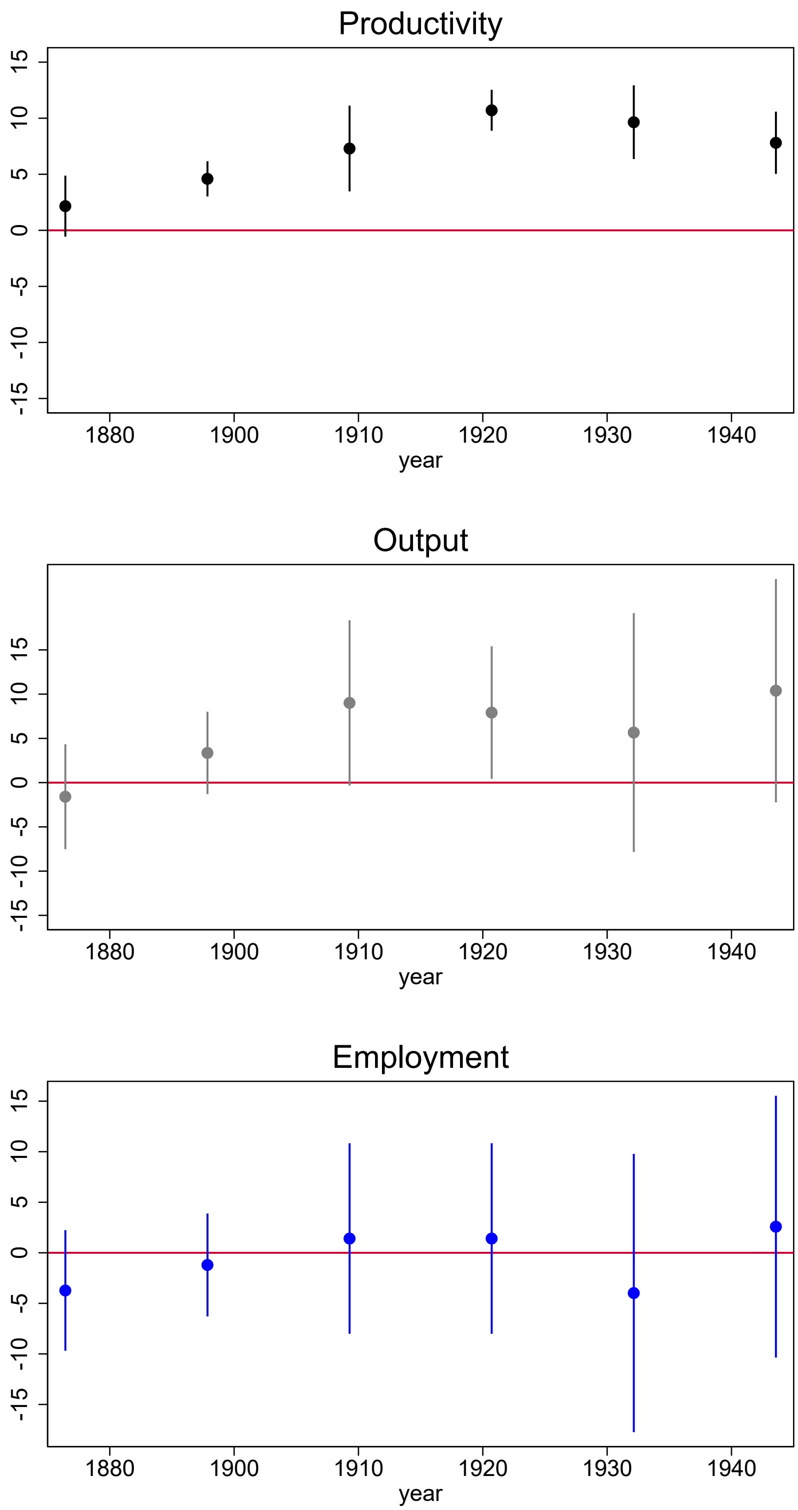


Figure 4: Impact of electricity on labor market outcomes

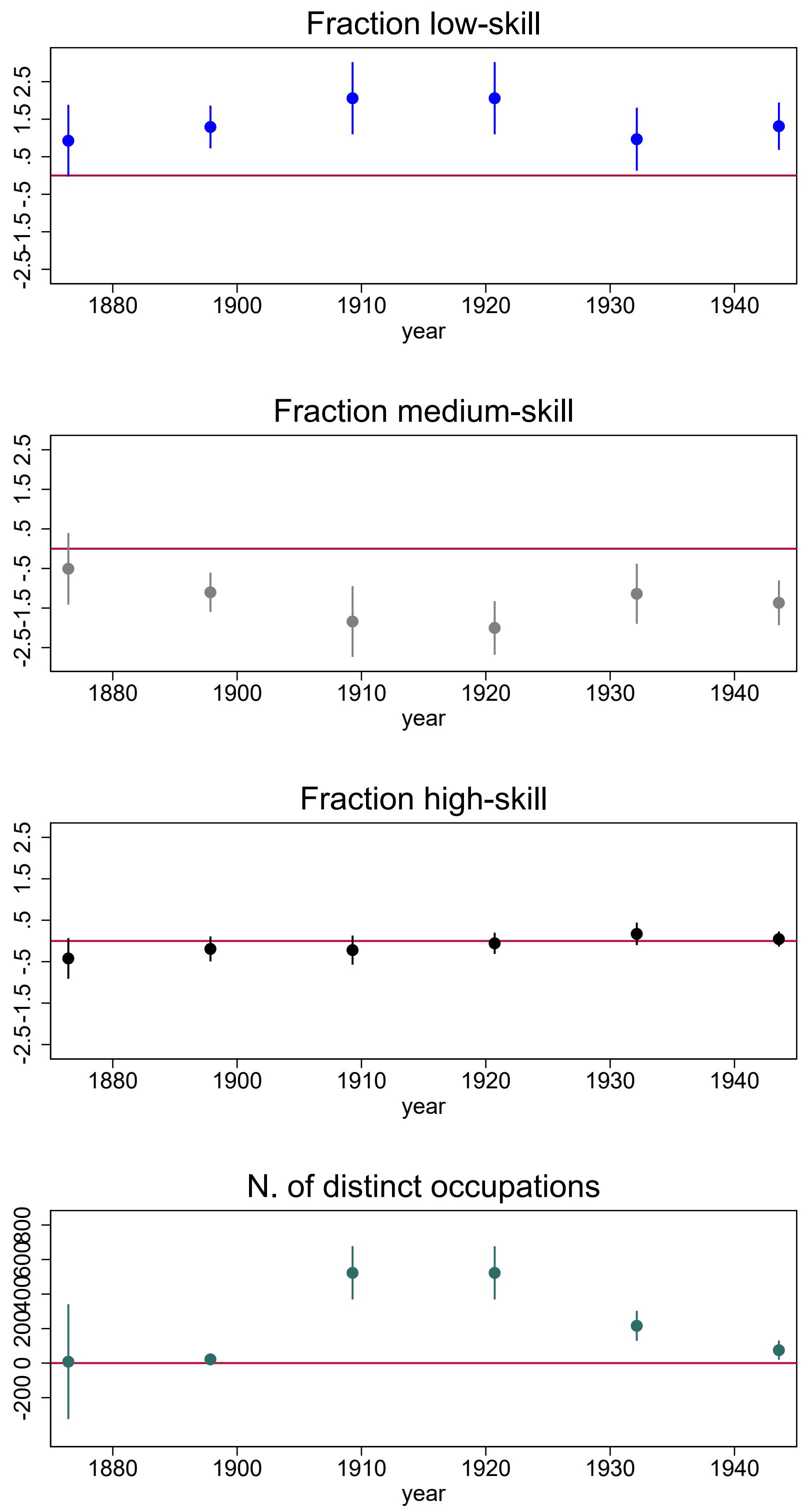


Figure 5: Impact of electricity on occupational shares-by sub-groups

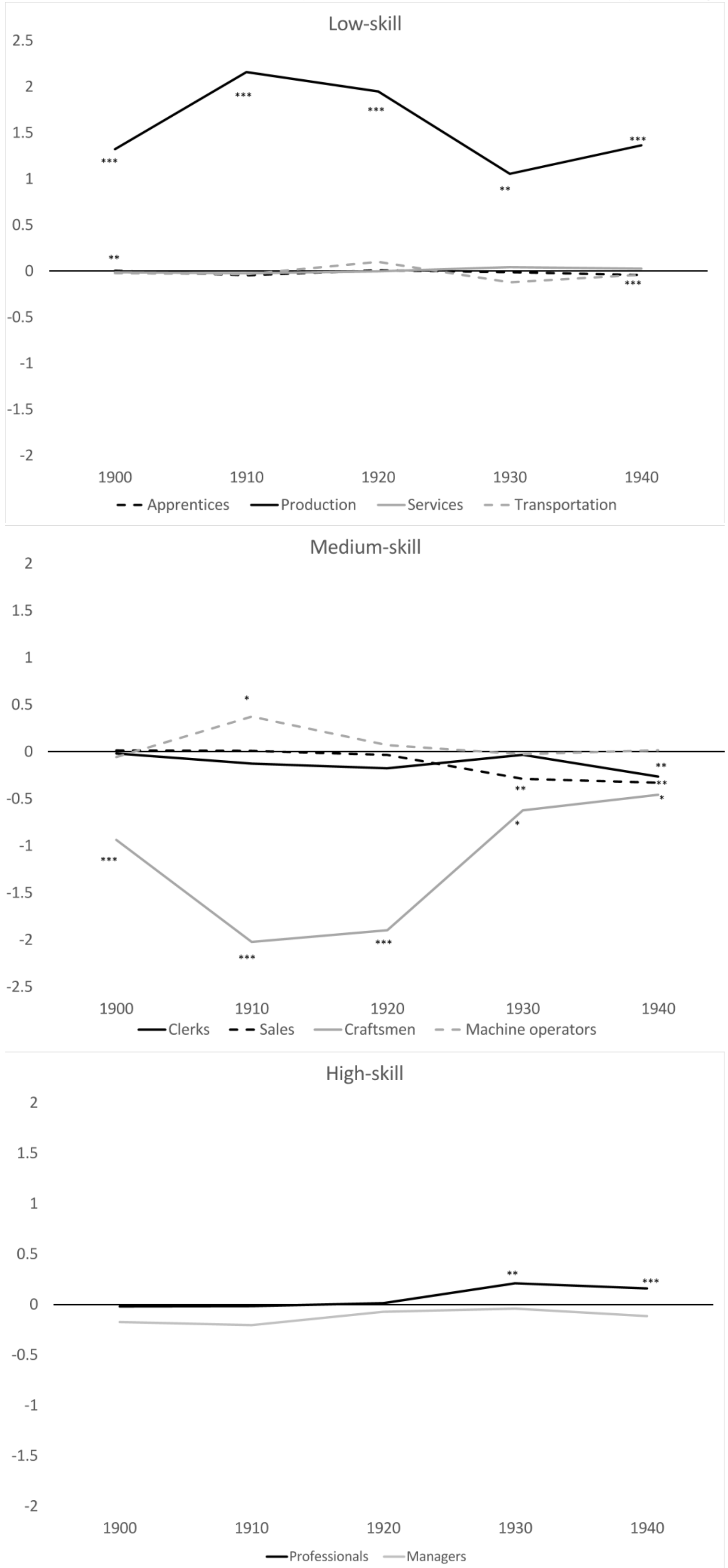


Table 1: Predicting Electricity Use in 1920

	Electricity per Worker	Electricity per Output	% elec. HP
	(1)	(2)	(3)
	Panel A: Using HP/Y as measure of energy intensity		
ln HP/Y1890	0.595***	0.641***	0.767***
	(0.054)	(0.054)	(0.054)
r2	0.138	0.155	0.128
N	2,633	2,637	2,637
	Panel B: Using HP/N as measure of energy intensity		
ln HP/N1890	0.345***	0.390***	0.584***
	(0.075)	(0.076)	(0.077)
r2	0.103	0.118	0.080
N	2,633	2,637	2,637

Each observation corresponds to an industry-county cell in 1920. Standard errors are presented between parentheses. Coefficients presented are those from a regression of log electricity per worker, log electricity per output and percent of horsepower electrified on industry-level log horsepower per worker in 1890 in Panel A and log horsepower per output in 1890 in Panel B. Weights are the number of establishments in a cell. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 2: Correlations between 1947 manufacturing electricity prices and hydroelectric plants

	Levels			Logarithms		
Plant within 70km	-0.010***			-0.567***		
	(0.003)			(0.159)		
Inverse distance		-0.038*			-2.103*	
		(0.020)			(1.158)	
Plant in 1900			-0.008**			-0.535**
			(0.004)			(0.237)
r2	0.212	0.160	0.066	0.160	0.126	0.085
N	2,433	2,433	2,433	2,421	2,421	2,421

Each observation corresponds to an industry-county cell. Clustered standard errors by county are presented between parentheses. Coefficients presented are those from a regression of electric prices in level (columns (1)-(3)) and in log (columns (4)-(6)) on each measure of proximity to an electric power plant. Weights are the number of establishments in a cell. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: Relationship between access and need for electricity and use of electricity

	Electricity per Worker (1)	Electricity per Output (2)	% elec. HP (3)
	Number of 1912 power plants within 70km		
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	14.593***	8.044***	1.504
	(1.880)	(1.875)	(1.024)
r2	0.859	0.867	0.475
N	2,581	2,583	2,583
	Distance to 1912 power plants		
$\frac{\text{ln HP/Y1890} \times \text{inv. distance}}{100}$	68.023***	48.661***	3.723
	(12.627)	(12.599)	(6.881)
r2	0.859	0.867	0.475
N	2,581	2,583	2,583
	Had a power plant in 1900		
$\frac{\text{ln HP/Y1890} \times \text{ had early plant}}{100}$	18.120***	10.097**	4.638*
	(4.558)	(4.546)	(2.476)
r2	0.858	0.866	0.476
N	2,581	2,583	2,583

Each observation corresponds to an industry-county cell in 1920. Standard errors are presented between parentheses. Coefficients presented are those from a regression of log electricity per worker, log electricity per output and percent of horsepower electrified on industry-level log horsepower per worker in 1890 interacted with proximity to a hydroelectric power in each panel. Weights are the number of establishments in a cell. Fixed effects for county and industry are included. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Robustness checks for impact on productivity

	Balanced panel		Using inv. distance		Using plants in 1900	
	(1)	(2)	(3)	(4)	(5)	(6)
			1900			
$\frac{\text{ln HP/Y1890} \times \text{proximity}}{100}$	7.405***	3.933***	17.824***	6.688	0.853	0.497
	(1.526)	(1.325)	(5.571)	(4.954)	(1.942)	(1.721)
r2	0.599	0.714	0.299	0.448	0.297	0.448
N	449	449	4,263	4,263	4,263	4,263
			1910			
$\frac{\text{ln HP/Y1890} \times \text{proximity}}{100}$	7.086*	3.132	19.849	-0.967	-0.256	2.558
	(3.807)	(3.685)	(12.734)	(12.073)	(5.124)	(4.818)
r2	0.344	0.408	0.229	0.318	0.227	0.318
N	449	449	1,599	1,599	1,599	1,599
			1920			
$\frac{\text{ln HP/Y1890} \times \text{proximity}}{100}$	15.115***	11.991***	46.053***	27.081***	6.234**	7.843***
	(2.091)	(1.583)	(6.784)	(5.183)	(2.461)	(1.862)
r2	0.771	0.871	0.600	0.768	0.593	0.767
N	449	449	2,633	2,633	2,633	2,633
			1930			
$\frac{\text{ln HP/Y1890} \times \text{proximity}}{100}$	12.378***	10.726***	27.659***	17.937**	3.342	3.585
	(2.771)	(2.199)	(10.025)	(7.686)	(3.083)	(2.357)
r2	0.666	0.791	0.581	0.754	0.578	0.754
N	449	449	1,178	1,178	1,178	1,178
			1940			
$\frac{\text{ln HP/Y1890} \times \text{proximity}}{100}$	11.738***	7.515***	44.287***	22.717***	1.627	1.892
	(2.372)	(1.649)	(8.922)	(6.376)	(2.537)	(1.797)
r2	0.622	0.821	0.508	0.751	0.499	0.749
N	449	449	1,599	1,599	1,599	1,599
1890 Control	No	Yes	No	Yes	No	Yes

Each observation corresponds to an industry-county cell in a given year. Standard errors are presented between parentheses. Coefficients presented are those from a regression of log output per worker on industry-level log horsepower per worker in 1890 interacted with a dummy indicating whether the centroid of the county was within 70km of a hydroelectric power plant in 1912 in the first two columns, with the inverse distance between the centroid and the closest hydroelectric power plant in 1912 in columns (3) and (4) and with a dummy for having a hydroelectric plant in one's county in 1900 in the last two columns. Weights are the number of establishments in a cell. Fixed effects for county and industry are included. The first two columns include only industry-county cells that are in every single year of our panel data. Even columns include values of the dependent variable in 1890 as control. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: Impact on energy and capital intensity

	Δ ln HP/N		Δ ln K/N	
	(1)	(2)	(3)	(4)
			1900	
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$			4.410***	2.755***
			(1.282)	(0.968)
			1910	
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	-10.466	4.453	8.267***	5.382***
	(6.665)	(3.761)	(2.124)	(1.530)
			1920	
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	-4.583	13.380***	10.548***	7.551***
	(4.615)	(1.888)	(1.671)	(1.057)
			1930	
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	-4.501	3.671		
	(7.635)	(2.469)		
1890 Control	No	Yes	No	Yes

Each observation corresponds to an industry-county cell in a given year. Standard errors are presented between parentheses. Coefficients presented are those from a regression of log horsepower per worker (first two columns) and log capital per worker (last two columns) on industry-level log horsepower per worker in 1890 interacted with a dummy indicating whether the centroid of the county was within 70km of a hydroelectric power plant in 1912. Weights are the number of establishments in a cell. Fixed effects for county and industry are included. Even columns include values of the dependent variable in 1890 as control. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: Heterogeneity by initial firm size-productivity, output and hiring

	Δ ln Y/N		Δ ln Y		Δ ln N	
	Large	Small	Large	Small	Large	Small
	(1)	(2)	(3)	(4)	(5)	(6)
			1900			
$\frac{\ln HP/Y1890\times \text{ plants within 70km}}{100}$	4.620***	-2.051	0.955	16.109***	-5.878***	19.157***
	(0.846)	(1.578)	(1.944)	(2.824)	(1.924)	(3.471)
F-test of equality	15.27***		919.67***		43.25***	
N	1,725	1,597	1,725	1,597	1,725	1,597
			1910			
$\frac{\ln HP/Y1890\times \text{ plants within 70km}}{100}$ m	2.048	0.319	10.238***	10.227	5.256	9.163
	(2.380)	(5.138)	(3.742)	(8.357)	(3.727)	(8.020)
F-test of equality	0.08		0.00		0.17	
N	893	460	893	460	899	463
			1920			
$\frac{\ln HP/Y1890\times \text{ plants within 70km}}{100}$	8.661***	0.373	10.934***	20.014**	-2.297	22.115***
	(0.966)	(1.622)	(3.465)	(7.823)	(3.306)	(7.602)
F-test of equality	12.83***		0.99		7.93**	
N	1,188	741	1,188	741	1,188	741
			1930			
$\frac{\ln HP/Y1890\times \text{ plants within 70km}}{100}$	10.264***	7.108**	9.862	37.458***	-3.765	32.204**
	(1.747)	(3.522)	(6.302)	(13.125)	(6.193)	(12.778)
F-test of equality	0.44		2.58		4.61*	
N	533	310	533	310	533	310
			1940			
$\frac{\ln HP/Y1890\times \text{ plants within 70km}}{100}$	3.290**	5.946**	18.111***	38.687***	12.109**	33.967***
	(1.529)	(2.543)	(6.035)	(10.643)	(5.939)	(10.045)
F-test of equality	0.49		1.83		2.19	
N	729	383	729	383	729	383
1890 "Y" Control	Yes	Yes	Yes	Yes	Yes	Yes

Each observation corresponds to an industry-county cell in a given year. Standard errors are presented between parentheses. Coefficients presented are those from a regression of log output per worker (columns (1) and (2)), log output (columns (3) and (4)) and log workers (columns (5) and (6)) on industry-level log horsepower per worker in 1890 interacted with a dummy indicating whether the centroid of the county was within 70km of a hydroelectric power plant in 1912. Weights are the number of establishments in a cell. Fixed effects for county and industry are included. Values of the dependent variable in 1890 are included in all regressions In odd columns, industry-county cells that had in 1890 above median output per establishment are included while those below the median are included in even columns. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 7: Heterogeneous impact on labor markets

	Fraction of high-skilled		Fraction of medium-skilled		Fraction of low-skilled		Number of dist. occ.	
	Large	Small	Large	Small	Large	Small	Large	Small
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1900								
$\frac{\ln HP/Y1890\times \text{ plants within 70km}}{100}$	0.409	-0.818***	-0.951***	-1.496***	0.540	2.313***	43.293***	12.918
	(0.264)	(0.297)	(0.313)	(0.551)	(0.383)	(0.622)	(15.365)	(14.321)
F-test of equality	8.66**		0.80		6.16*		1.77	
1910								
$\frac{\ln HP/Y1890\times \text{ plants within 70km}}{100}$	0.032	-0.834	-2.627***	-0.183	2.595***	1.018	425.706***	245.209*
	(0.263)	(0.510)	(0.555)	(1.004)	(0.601)	(1.081)	(103.314)	(125.820)
F-test of equality	1.80		3.31		1.18		0.59	
1920								
$\frac{\ln HP/Y1890\times \text{ plants within 70km}}{100}$	0.019	0.084	-2.742***	0.386	2.722***	-0.470	149.504***	49.492*
	(0.195)	(0.381)	(0.452)	(0.918)	(0.444)	(0.939)	(23.324)	(29.070)
F-test of equality	0.02		7.42**		7.84**		3.42	
1930								
$\frac{\ln HP/Y1890\times \text{ plants within 70km}}{100}$	0.099	-0.301	-2.324***	-0.201	2.225***	0.501	425.105***	206.248**
	(0.253)	(0.684)	(0.614)	(1.116)	(0.657)	(1.315)	(72.172)	(88.660)
F-test of equality	0.29		1.68		0.93		1.44	
1940								
$\frac{\ln HP/Y1890\times \text{ plants within 70km}}{100}$	0.010	-0.200	-2.456***	-1.266	2.431***	1.445	123.680***	116.514
	(0.154)	(0.252)	(0.463)	(0.798)	(0.490)	(0.898)	(41.976)	(77.790)
F-test of equality	0.30		1.06		0.63		0.00	

1.2Each observation corresponds to an industry-county cell in a given year. Standard errors are presented between parentheses. Coefficients presented are those from a regression of fraction of workers in high-level occupations (columns (1) and (5)), medium level occupations (columns (2) and (6)) and low level occupations (columns (3) and (7)) and the number of distinct occupations (columns (4) and (8)) on industry-level log horsepower per worker in 1890 interacted with a dummy indicating whether the centroid of the county was within 70km of a hydroelectric power plant in 1912. Weights are the number of establishments in a cell. Fixed effects for county and industry are included. In the first four columns, industry-county cells that had in 1890 above output per establishment are included while those below the median are included in the next four columns.* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

A Additional figures and tables

Figure A.1: Impact of closeness to hydropower plants on energy prices, by distance

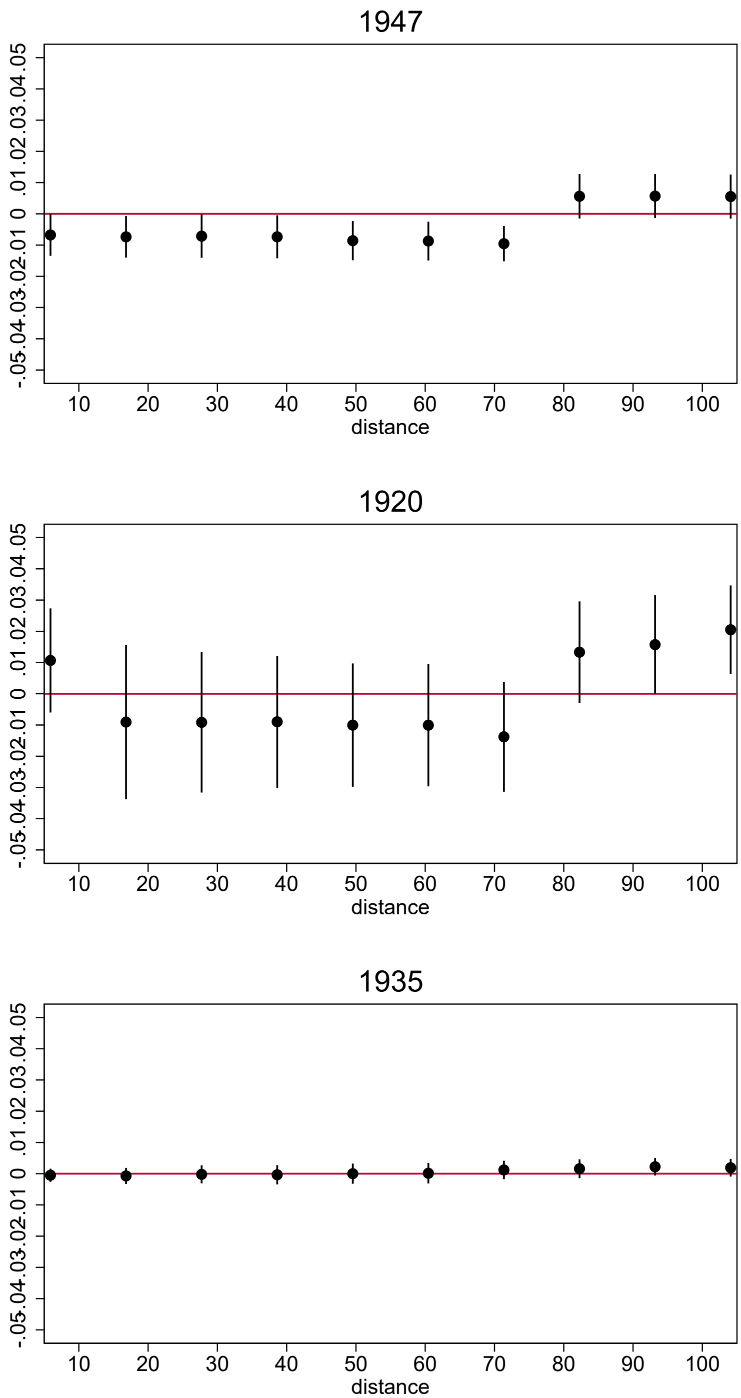


Figure A.2: Impact of closeness to hydropower plants on energy use, by distance

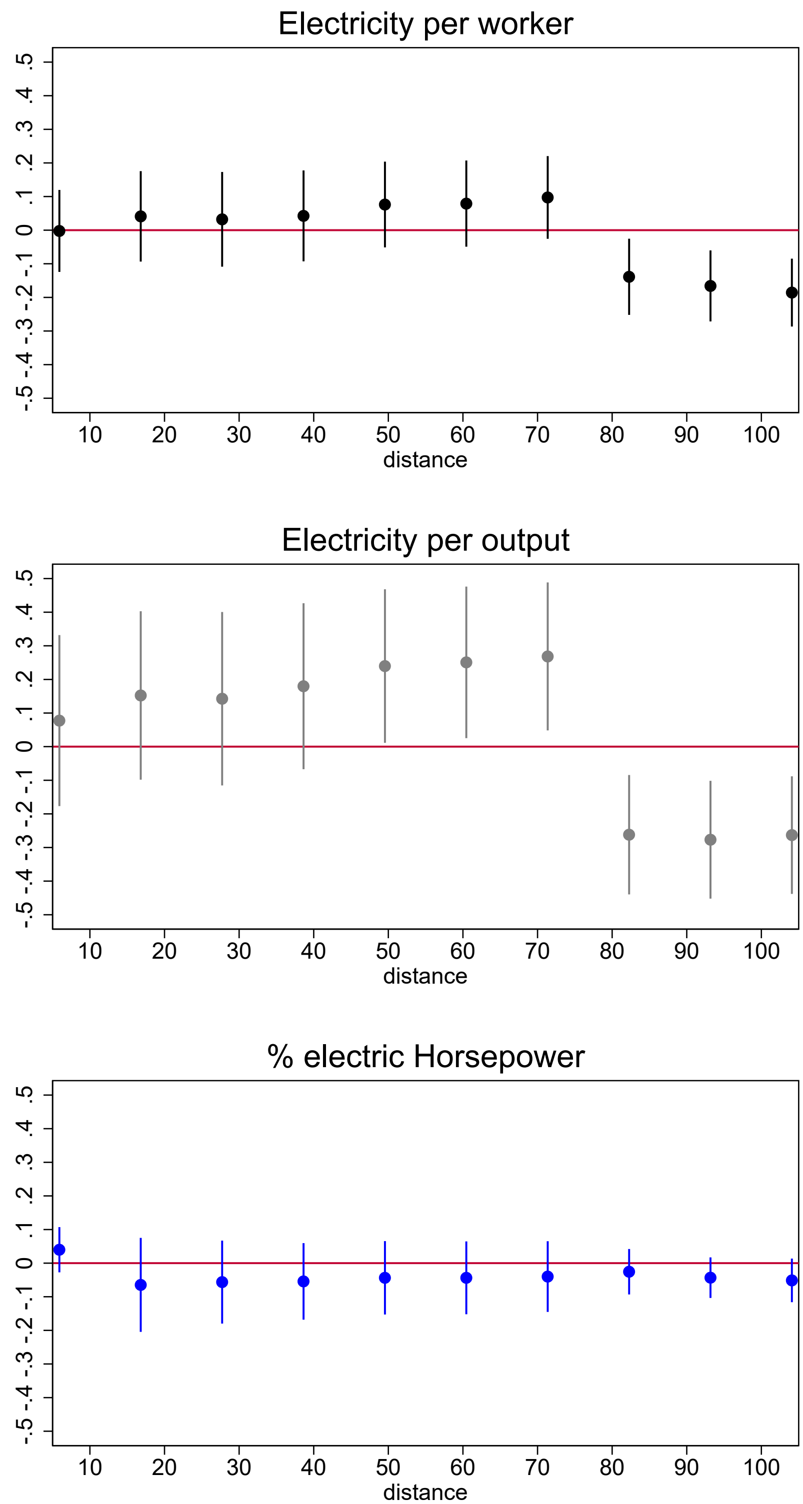


Figure A.3: Impact of electricity on productivity, employment and output, including 1890 controls

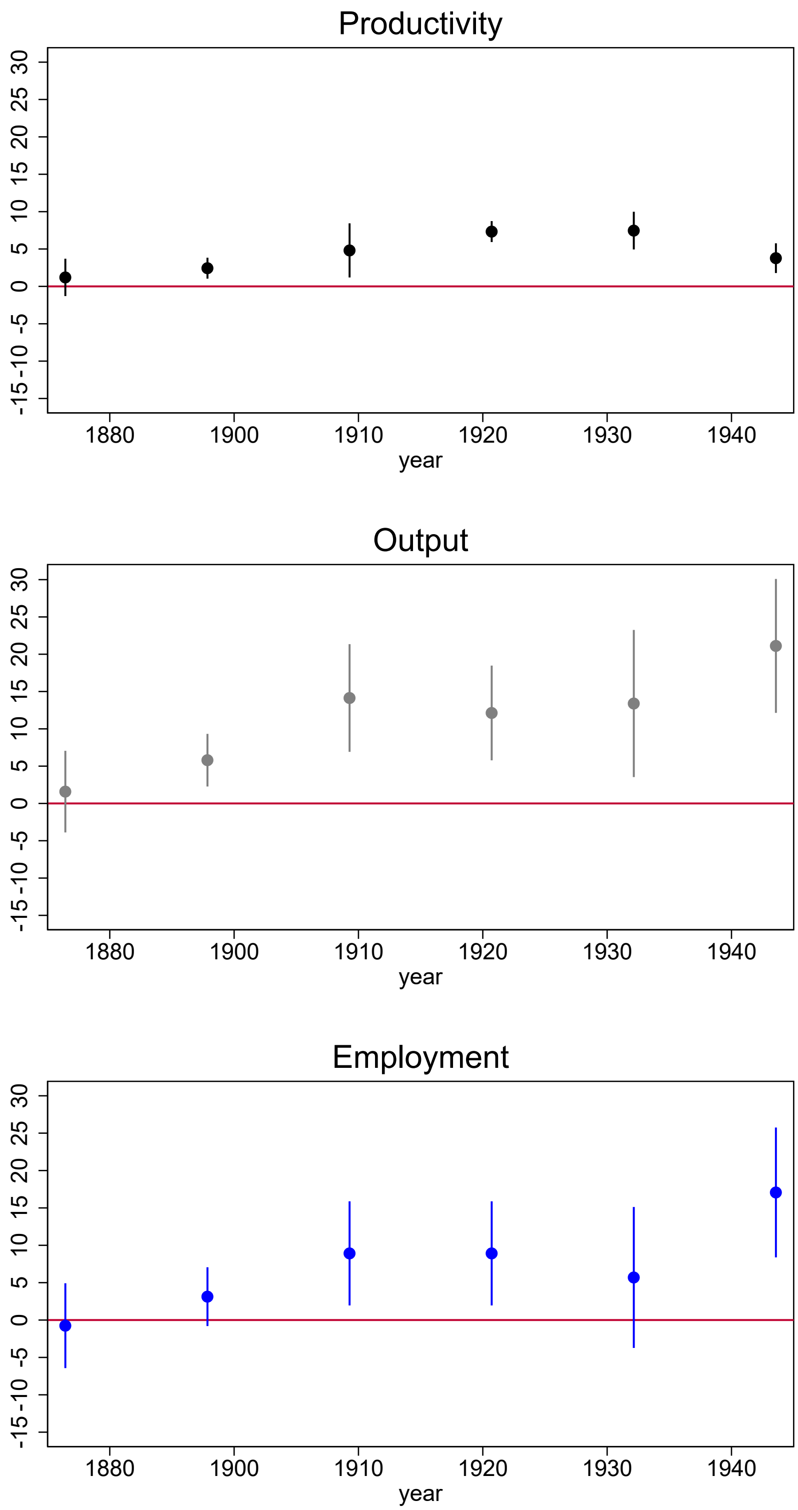


Figure A.4: Impact of closeness to hydropower plants on productivity, output and employment, by distance, 1920

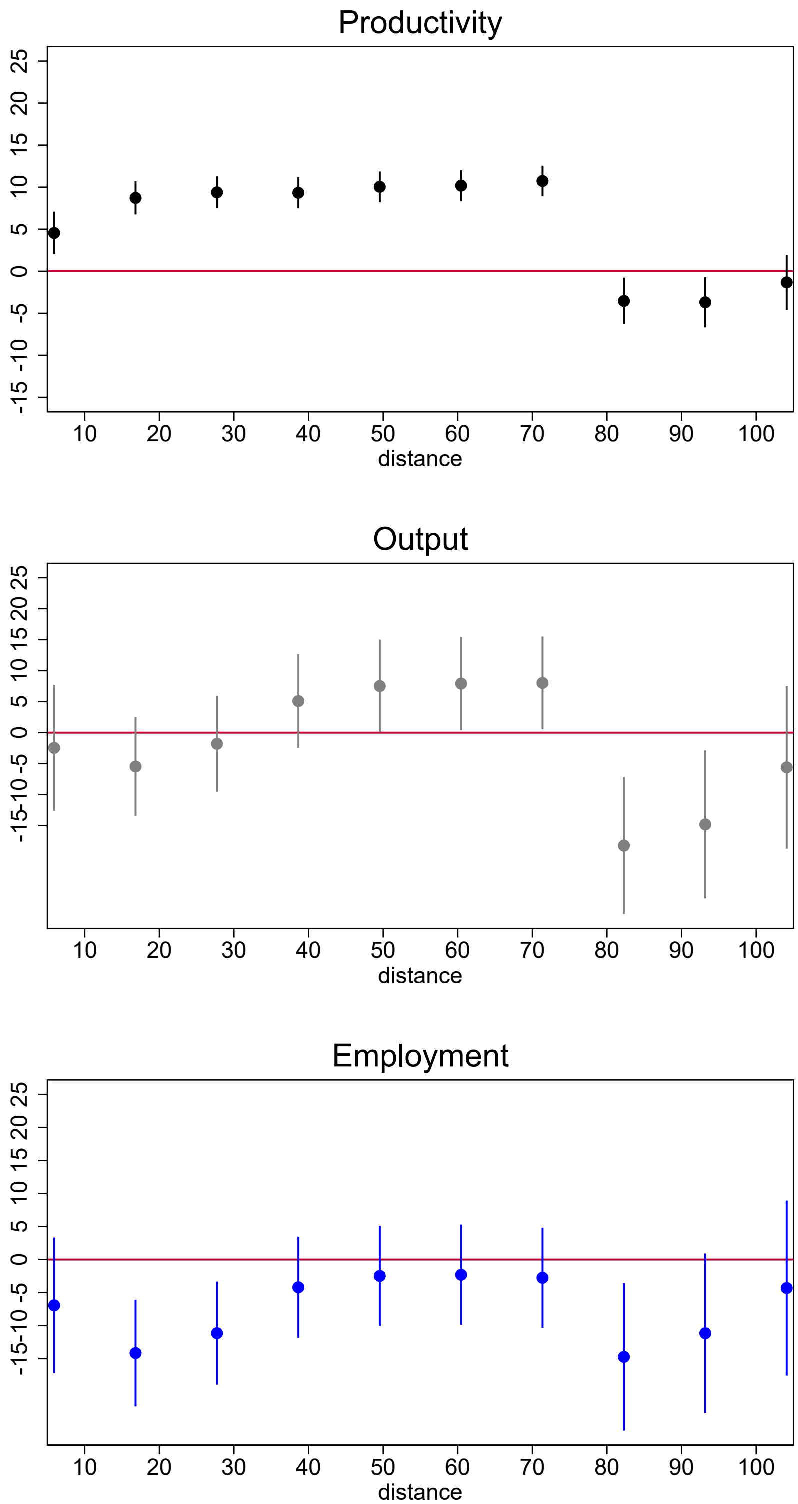
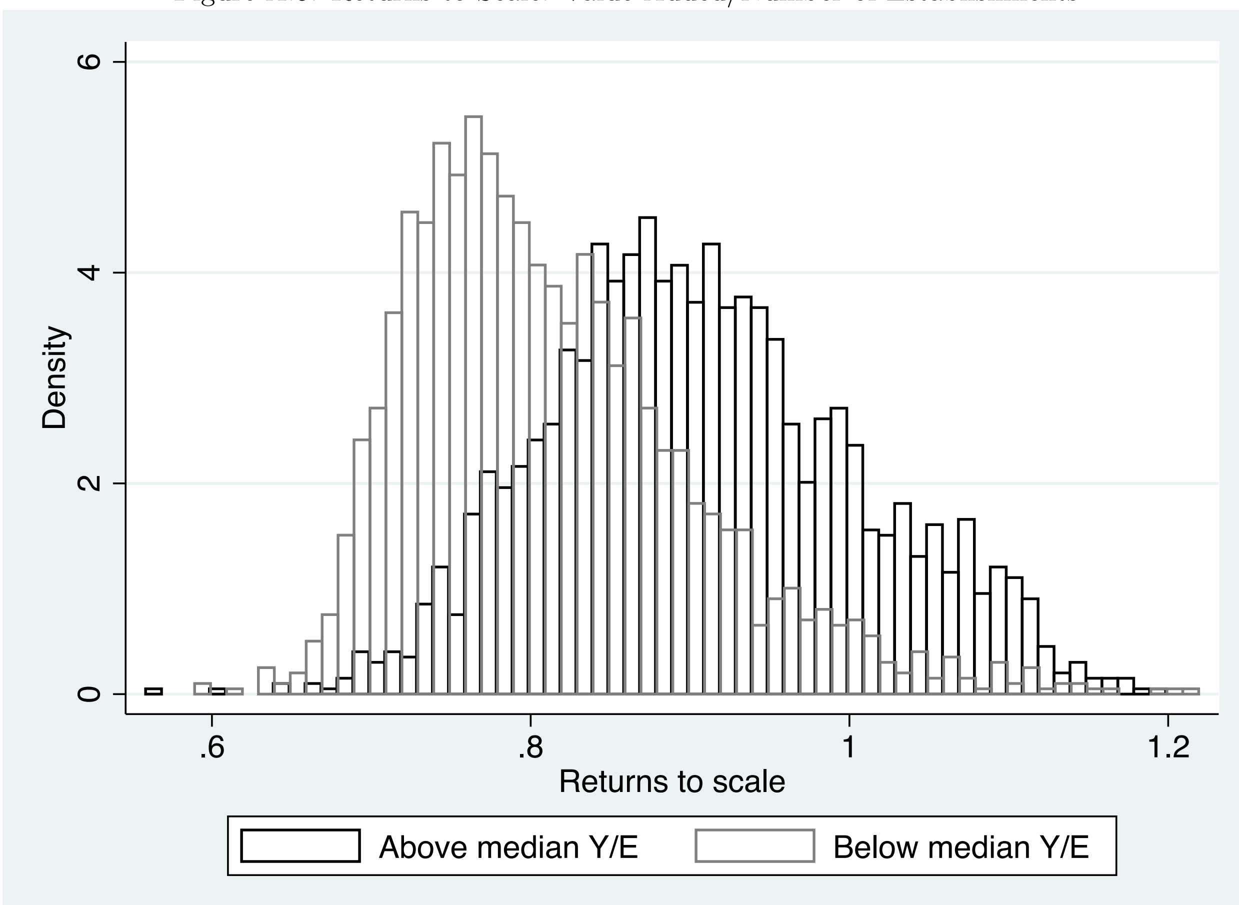


Figure A.5: Returns to Scale: Value Added/Number of Establishments



Notes: The calculation of returns to scale is done as in Lafortune et al. (2020) for 1890-1930. Industry-city cells are divided by whether their average firm size (in terms of value added) was above the median or below the median in 1890.

Table A.1: Summary statistics, county-industry database

Variable	N	Mean	St. Dev.
Log Electricity per worker	2,828	0.014	1.114
Log Electricity per output	2,830	-7.928	1.045
Log (% elec. HP)	2,830	-0.320	0.575
Was in sample	169,830	0.098	0.297
Number of establishments	169,830	3.938	78.671
Number of establishments (if cell exists)	16,600	40.293	248.711
Number of workers	169,830	88.5	1556.45
Number of workers (if cell exists)	16,600	905.802	4903.617
Δ ln Y/N	11,696	0.435	0.611
Δ ln Y	11,708	1.828	2.442
Δ ln N	11,719	1.396	2.460
Δ ln HP/N	5,610	1.926	2.529
Δ ln K/N	8,827	0.710	0.916

Table A.2: Large sectors in top, bottom 5% of HP/Y, 1890

Most Horsepower Intensive		Least Horsepower Intensive	
(4)	Flour	(63)	Turpentine and Rosin
(52)	Paper Goods	(146)	Feathers/Plumes/Artificial Flowers
(96)	Iron and Steel	(33)	Fur Goods
(124)	Electrical Machinery	(30)	Clothing
(18)	Cotton Goods	(58)	Photoengraving
(95)	Mineral Grinding	(36)	Awnings, Tents & Sails
(21)	Dyeing and Finishing Textiles	(90)	Plaster & Wallboard
(15)	Vinegar	(82)	Leather
(110)	Iron & Steel Forgings	(17)	Tobacco products

See Appendix Table C.16 for detailed sector descriptions, using reference number.

Table A.3: Predicting Electricity Use in 1920

	Electricity per Worker	Electricity per Output	% elec. HP
	(1)	(2)	(3)
	Panel A: Early Adopters		
ln EHP1890/HP1890	-0.870***	-0.874***	-0.916***
	(0.031)	(0.032)	(0.032)
r2	0.307	0.312	0.291
N	2,633	2,637	2,637
	Panel B: Capital Intensive Industries		
ln K/N1890	-0.631***	-0.669***	-0.616***
	(0.084)	(0.085)	(0.086)
r2	0.115	0.130	0.078
N	2,633	2,637	2,637
ln K/Y1890	2.281***	2.371**	3.055***
	(0.208)	(0.211)	(0.209)
r2	0.137	0.151	0.132
N	2,633	2,637	2,637
	Panel C: Human Capital Measures		
Average literacy	-27.574***	-24.669**	-23.617***
	(1.738)	(1.783)	(1.807)
r2	0.178	0.171	0.119
N	2,633	2,637	2,637
White-Collars/Blue-Collars	-1.188***	-1.258***	-1.420***
	(0.073)	(0.074)	(0.074)
r2	0.181	0.200	0.179
N	2,633	2,637	2,637
	Panel D: Complexity Measures		
Distinct Occ.	-0.057***	-0.057***	-0.053***
	(0.003)	(0.003)	(0.003)
r2	0.218	0.226	0.164
N	2,633	2,637	2,637
HHI Occ. 1900	0.620**	0.010	0.066
	(0.272)	(0.277)	(0.279)
r2	0.098	0.109	0.059
N	2,633	2,637	2,637
1890 Control	No	No	No

Each observation corresponds to an industry-county cell in 1920. Standard errors are presented between parentheses. Coefficients presented are those from a regression of log electricity per worker (columns (1) and (2)), log electricity per output (columns (3) and (4)) and percent of horsepower electrified (columns (5) and (6)) on industry-level characteristics in each panel. Weights are the number of establishments in a cell. Even columns include values of the dependent variable in 1890 as control. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.4: Predicting Electricity Use, with Energy Intensive Industries in 1890

	Δ Electricity per Worker		Δ Electricity per Output		Δ % elec. HP	
	(1)	(2)	(3)	(4)	(5)	(6)
			1900			
ln HP/Y1890	0.389**	0.415***	0.374**	0.392***	0.623***	-0.126
	(0.153)	(0.120)	(0.155)	(0.121)	(0.152)	(0.147)
r2	0.040	0.414	0.037	0.417	0.098	0.419
N	156	156	156	156	156	156
			1910			
ln HP/Y1890	0.484***	0.516***	0.467***	0.489***	0.902***	0.007
	(0.127)	(0.052)	(0.127)	(0.047)	(0.119)	(0.058)
r2	0.086	0.847	0.080	0.875	0.273	0.882
N	156	156	156	156	156	156
			1920			
ln HP/Y1890	0.876***	0.913***	0.860***	0.885***	0.874***	-0.073***
	(0.168)	(0.103)	(0.170)	(0.104)	(0.116)	(0.021)
r2	0.150	0.686	0.143	0.682	0.269	0.984
N	156	156	156	156	156	156
			1930			
ln HP/Y1890	1.010***	1.044***	0.976***	0.999***	0.919***	-0.035**
	(0.199)	(0.157)	(0.196)	(0.152)	(0.116)	(0.016)
r2	0.143	0.473	0.138	0.486	0.288	0.990
N	156	156	156	156	156	156
			1940			
ln HP/Y1890	0.292*	0.326***	0.279*	0.302***	0.959***	-0.025
	(0.152)	(0.091)	(0.147)	(0.086)	(0.120)	(0.021)
r2	0.023	0.655	0.023	0.671	0.292	0.986
N	156	156	156	156	156	156
1890 Control	No	Yes	No	Yes	No	Yes

Each observation corresponds to an industry cell in a given year for each panel. Standard errors are presented between parentheses. Coefficients presented are those from a regression of log electricity per worker (columns (1) and (2)), log electricity per output (columns (3) and (4)) and percent of horsepower electrified (columns (5) and (6)) on industry-level log horsepower per output in 1890. Even columns include values of the dependent variable in 1890 as control. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.5: Correlations between electricity prices and hydroelectric plants, alternative sources

	Levels			Logarithms		
	Panel A: 1920 residential rates					
Plants within 70km	-6.889			-0.191		
	(4.434)			(0.117)		
Inverse distance		9.802			0.247	
		(25.765)			(0.680)	
Plant in 1900			-13.954***			-0.407**
			(4.537)			(0.170)
r2	0.043	0.005	0.104	0.038	0.004	0.118
N	2,637	2,637	2,637	2,637	2,637	2,637
	Panel B: 1935 residential rates					
Plants within 70km	0.600			0.051		
	(0.743)			(0.061)		
Inverse distance		-3.091			-0.149	
		(3.088)			(0.282)	
Plant in 1900			-2.848***			-0.262***
			(0.735)			(0.070)
r2	0.002	0.010	0.104	0.000	0.004	0.136
N	2,519	2,519	2,519	2,519	2,519	2,519

Each observation corresponds to an industry-county cell. Clustered standard errors by county are presented between parentheses. Coefficients presented are those from a regression of electric prices in level (columns (1)-(3)) and in log (columns (4)-(6)) on each measure of proximity to an electric power plant. Weights are the number of establishments in a cell. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.6: Impact on sample selection, number of establishments and employment

	Was in sample (1)	Number of establishments (2)	Number of workers (3)
		1900	
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	-0.583***	20.753	1634.135**
	(0.211)	(51.953)	(756.838)
r2	0.565	0.148	0.132
N	28,182	28,182	28,182
		1910	
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	-0.107	35.074	1487.680
	(0.163)	(38.174)	(991.409)
r2	0.343	0.117	0.094
N	28,182	28,182	28,182
		1920	
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	-0.242	53.150	1944.715
	(0.198)	(118.152)	(2372.600)
r2	0.400	0.063	0.068
N	28,182	28,182	28,182
		1930	
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	-0.224	35.908	359.902
	(0.147)	(44.233)	(1019.819)
r2	0.290	0.083	0.070
N	28,182	28,182	28,182
		1940	
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	-0.263	32.239	584.890
	(0.167)	(40.592)	(976.493)
r2	0.320	0.082	0.064
N	28,182	28,182	28,182

Each observation corresponds to an industry-county cell in a given year. Standard errors are presented between parentheses. Coefficients presented are those from a regression of dummy for whether was in the sample (column (1)), number of establishments (columns (2)) and number of workers (columns (3)) on industry-level log horsepower per worker in 1890 interacted with a dummy indicating whether the centroid of the county was within 70km of a hydroelectric power plant in 1912. Fixed effects for county and industry are included. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.7: Comparing productivity results with cross-industry methodology

	National level		County-level data	
	(1)	(2)	(3)	(4)
			1900	
ln HP/Y1890	0.015	0.015	-0.055***	-0.047***
	(0.013)	(0.013)	(0.004)	(0.004)
r2	0.008	0.009	0.135	0.291
N	156	156	4,263	4,263
			1910	
ln HP/Y1890	0.017	0.015	-0.028***	-0.019**
	(0.015)	(0.014)	(0.009)	(0.009)
r2	0.009	0.034	0.128	0.172
N	156	156	1,599	1,599
			1920	
ln HP/Y1890	0.016	0.018	-0.051***	-0.053***
	(0.016)	(0.016)	(0.006)	(0.004)
r2	0.006	0.029	0.293	0.638
N	156	156	2,633	2,633
			1930	
ln HP/Y1890	0.034*	0.034*	-0.025***	-0.027***
	(0.020)	(0.020)	(0.009)	(0.008)
r2	0.019	0.019	0.268	0.470
N	156	156	1,178	1,178
			1940	
ln HP/Y1890	0.013	0.012	0.015*	0.012
	(0.023)	(0.023)	(0.008)	(0.008)
r2	0.002	0.008	0.081	0.148
N	156	156	1,599	1,599
1890 Control	No	Yes	No	Yes
County Effects?			Yes	Yes

Each observation corresponds to an industry in the first two columns and to an industry-county cell in a given year in the last two columns. Standard errors are presented between parentheses. Coefficients presented are those from a regression of log output per worker on industry-level log horsepower per worker in 1890. Weights are the number of establishments in a cell in the last columns. Fixed effects for county are included in the last two columns. Even columns include values of the dependent variable in 1890 as control. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.8: Impact on labor markets-from Census of population

	High (1)	Medium (2)	Low (3)	N. of dist. occ. (4)
			1900	
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	-0.011	-0.896***	0.908***	21.800**
	(0.165)	(0.247)	(0.288)	(9.795)
			1910	
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	-0.093	-1.572***	1.665***	522.432***
	(0.211)	(0.423)	(0.458)	(78.687)
			1920	
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	-0.007	-1.714***	1.721***	105.528***
	(0.144)	(0.331)	(0.327)	(15.580)
			1930	
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	0.133	-0.904**	0.771*	216.174***
	(0.185)	(0.390)	(0.430)	(44.271)
			1940	
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	-0.002	-1.727***	1.717***	75.178***
	(0.104)	(0.306)	(0.332)	(28.376)
1890 "Y" Control	No	No	No	No

Each observation corresponds to an industry-county cell in a given year. Standard errors are presented between parentheses. Coefficients presented are those from a regression of fraction of workers in high-level occupations (first column), medium level occupations (column (2)) and low level occupations (column (3)) and the number of distinct occupations (last column) on industry-level log horsepower per worker in 1890 interacted with a dummy indicating whether the centroid of the county was within 70km of a hydroelectric power plant in 1912. Weights are the number of establishments in a cell. Fixed effects for county and industry are included. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.9: Impact on tasks-from Census of population

	Non-routine manual (1)	Routine manual (2)	Non-routine interactive (3)	Routine cognitive (4)	Non-routine analytical (5)
			1900		
$\frac{\text{ln HP/Y1890} \times \text{plants within 70km}}{100}$	-0.073	-1.534	10.331***	-9.547***	4.244***
	(0.597)	(1.002)	(3.120)	(3.136)	(1.395)
			1910		
$\frac{\text{ln HP/Y1890} \times \text{plants within 70km}}{100}$	-3.203***	3.545***	-2.793	4.624	1.850
	(1.001)	(1.337)	(3.831)	(3.827)	(1.954)
			1920		
$\frac{\text{ln HP/Y1890} \times \text{plants within 70km}}{100}$	-2.233***	-1.731*	5.244*	-6.725***	2.401
	(0.781)	(1.000)	(2.674)	(2.567)	(1.554)
			1930		
$\frac{\text{ln HP/Y1890} \times \text{plants within 70km}}{100}$	-2.028	-1.689	6.546**	-3.260	4.843***
	(1.511)	(1.381)	(3.075)	(3.589)	(1.811)
			1940		
$\frac{\text{ln HP/Y1890} \times \text{plants within 70km}}{100}$	0.620	-3.117***	4.861**	-4.320*	2.850***
	(0.801)	(0.922)	(1.927)	(2.353)	(1.086)
1890 "Y" Control	No	No	No	No	No

Each observation corresponds to an industry-county cell in a given year. Standard errors are presented between parentheses. Coefficients presented are those from a regression of average tasks content of workers in a given industry-county-year on industry-level log horsepower per worker in 1890 interacted with a dummy indicating whether the centroid of the county was within 70km of a hydroelectric power plant in 1912. Weights are the number of establishments in a cell. Fixed effects for county and industry are included. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.10: Heterogeneity by market competitiveness-productivity, output and hiring, without 1890 controls

	Δ ln Y/N		Δ ln Y		Δ ln N	
	Large	Small	Large	Small	Large	Small
	(1)	(2)	(3)	(4)	(5)	(6)
			1900			
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	8.392***	-3.837**	-0.338	16.177***	-8.730***	20.015***
	(0.916)	(1.671)	(2.028)	(3.155)	(2.004)	(3.591)
F-test of equality	44.89***		20.00***		52.94***	
N	1,725	1,597	1,725	1,597	1,725	1,597
			1910			
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	6.904***	-2.688	8.756**	4.432	1.871	6.636
	(2.490)	(5.228)	(3.841)	(8.971)	(3.871)	(8.484)
F-test of equality	2.37		0.19		0.24	
N	893	460	893	460	899	463
			1920			
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	14.520***	-5.198**	10.139***	9.660	-4.380	14.835*
	(1.210)	(2.289)	(3.448)	(8.124)	(3.276)	(7.951)
F-test of equality	42.79***		0.00		4.79*	
N	1,188	741	1,188	743	1,188	741
			1930			
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	15.030***	2.476	5.656	32.891**	-9.374	30.415**
	(2.325)	(4.636)	(6.374)	(13.786)	(6.270)	(13.399)
F-test of equality	3.96*		2.39		5.30*	
N	533	310	533	310	533	310
			1940			
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	8.866***	0.781	11.699*	35.610***	2.833	34.829***
	(1.967)	(3.855)	(6.256)	(11.917)	(6.189)	(11.397)
F-test of equality	2.52		2.21		4.09*	
N	729	383	729	383	729	383
1890 "Y" Control	No	Yes	No	Yes	No	Yes

Each observation corresponds to an industry-county cell in a given year. Standard errors are presented between parentheses. Coefficients presented are those from a regression of log output per worker (columns (1) and (2)), log output (columns (3) and (4)) and log workers (columns (5) and (6)) on industry-level log horsepower per worker in 1890 interacted with a dummy indicating whether the centroid of the county was within 70km of a hydroelectric power plant in 1912. Weights are the number of establishments in a cell. Fixed effects for county and industry are included. In odd columns, industry-county cells that had in 1890 above median output per establishment are included while those below the median are included in even columns. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.11: Heterogeneity by market competitiveness-productivity, output and hiring, using employees per firm as measure of firm size

	Δ ln Y/N		Δ ln Y		Δ ln N	
	Large	Small	Large	Small	Large	Small
	(1)	(2)	(3)	(4)	(5)	(6)
			1900			
$\frac{\ln HP/Y1890 \times \text{ plants within 70km}}{100}$	3.972***	-2.359	1.474	16.076***	-4.325**	19.389***
	(0.817)	(1.593)	(1.882)	(2.899)	(1.888)	(3.547)
F-test of equality	13.86***		17.97***		38.03***	
N	1,726	1,596	1,726	1,596	1,726	1,596
			1910			
$\frac{\ln HP/Y1890 \times \text{ plants within 70km}}{100}$	7.100***	-0.463	12.994***	6.703	3.724	8.349
	(2.696)	(4.051)	(3.841)	(7.812)	(3.725)	(7.652)
F-test of equality	1.46		0.44		0.25	
N	886	467	886	467	892	470
			1920			
$\frac{\ln HP/Y1890 \times \text{ plants within 70km}}{100}$	8.721***	-1.440	9.825***	15.751**	-3.062	19.009***
	(0.967)	(1.593)	(3.442)	(7.560)	(3.273)	(7.289)
F-test of equality	19.52***		0.44		6.80**	
N	1,166	763	1,166	765	1,166	763
			1930			
$\frac{\ln HP/Y1890 \times \text{ plants within 70km}}{100}$	10.416***	5.219	8.118	32.686**	-4.903	30.223**
	(1.715)	(3.800)	(6.283)	(13.168)	(6.190)	(12.706)
F-test of equality	1.21		2.11		4.53*	
N	526	317	526	317	526	317
			1940			
$\frac{\ln HP/Y1890 \times \text{ plants within 70km}}{100}$	3.787**	6.397**	17.069***	41.939***	10.225*	37.168***
	(1.500)	(2.772)	(6.140)	(10.871)	(6.081)	(10.106)
F-test of equality	0.50		2.78		3.45	
N	704	408	704	408	704	408
1890 "Y" Control	Yes	Yes	Yes	Yes	Yes	Yes

Each observation corresponds to an industry-county cell in a given year. Standard errors are presented between parentheses. Coefficients presented are those from a regression of log output per worker (columns (1) and (2)), log output (columns (3) and (4)) and log workers (columns (5) and (6)) on industry-level log horsepower per worker in 1890 interacted with a dummy indicating whether the centroid of the county was within 70km of a hydroelectric power plant in 1912. Weights are the number of establishments in a cell. Fixed effects for county and industry are included. Values of the dependent variable in 1890 are included in all regressions. In odd columns, industry-county cells that had in 1890 above median workers per establishment are included while those below the median are included in even columns. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.12: Heterogeneity by tradability-productivity, output and hiring

	Δ ln Y/N		Δ ln Y		Δ ln N	
	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)
			1900			
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	-0.185	3.702***	16.715***	2.620	17.175***	-2.092
	(1.124)	(0.913)	(3.099)	(2.175)	(3.186)	(2.507)
N	1,730	2,533	1,730	2,533	1,730	2,533
			1910			
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	6.172**	4.178*	25.976***	9.050*	18.641***	3.949
	(3.011)	(2.319)	(5.706)	(4.883)	(5.399)	(4.737)
N	608	991	608	991	615	1,002
			1920			
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	16.824***	3.681***	49.327***	-0.283	33.409***	-5.702
	(1.419)	(0.815)	(5.703)	(3.935)	(5.548)	(3.747)
N	1,006	1,627	1,008	1,629	1,006	1,627
			1930			
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	17.106***	3.428**	45.510***	2.156	29.193***	-1.861
	(2.354)	(1.480)	(8.766)	(6.261)	(8.599)	(5.935)
N	445	733	445	733	445	733
			1940			
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	-0.202	4.531***	59.311***	10.096*	59.868***	5.089
	(2.449)	(1.064)	(8.366)	(5.523)	(8.282)	(5.286)
N	555	1,044	555	1,044	555	1,044
1890 "Y" Control	Yes	Yes	Yes	Yes	Yes	Yes

Each observation corresponds to an industry-county cell in a given year. Standard errors are presented between parentheses. Coefficients presented are those from a regression of log output per worker (columns (1) and (2)), log output (columns (3) and (4)) and log workers (columns (5) and (6)) on industry-level log horsepower per worker in 1890 interacted with a dummy indicating whether the centroid of the county was within 70km of a hydroelectric power plant in 1912. Weights are the number of establishments in a cell. Fixed effects for county and industry are included. Values of the dependent variable in 1890 are included in all regressions In odd columns, industries with Hoover index above 0.2 are presented while those with indices smaller than this value are included in even columns. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.13: Heterogeneity by market competitiveness-productivity, output and hiring, using tradability divided by trade costs

	Δ ln Y/N		Δ ln Y		Δ ln N	
	Large	Small	Large	Small	Large	Small
	(1)	(2)	(3)	(4)	(5)	(6)
			1900			
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	-0.874	4.350***	0.306	14.606***	1.251	9.667***
	(1.140)	(1.052)	(3.001)	(2.553)	(3.256)	(2.913)
F-test of equality	11.21***		13.19***		3.69	
N	2,106	2,157	2,109	2,161	2,106	2,157
			1910			
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	6.625**	3.267	4.476	23.847***	-2.127	19.814***
	(3.186)	(2.087)	(5.855)	(5.203)	(5.635)	(4.872)
F-test of equality	0.78		6.12*		8.68**	
N	829	770	829	770	838	779
			1920			
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	6.308***	10.886***	2.836	33.905***	-3.806	22.338***
	(1.427)	(0.883)	(6.285)	(4.117)	(5.919)	(4.045)
F-test of equality	7.83**		17.58***		13.47***	
N	1,263	1,370	1,265	1,372	1,263	1,370
			1930			
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	-0.581	14.343***	3.516	28.006***	3.502	13.670**
	(3.032)	(1.424)	(10.660)	(6.260)	(9.882)	(6.183)
F-test of equality	22.38***		4.04*		0.76	
N	574	604	574	604	574	604
			1940			
$\frac{\text{ln HP/Y1890} \times \text{ plants within 70km}}{100}$	-0.290	5.614***	15.352	20.223***	15.146	14.473**
	(2.092)	(1.393)	(9.638)	(5.810)	(9.353)	(5.670)
F-test of equality	5.07*		0.18		0.00	
N	774	825	774	825	774	825
1890 "Y" Control	Yes	Yes	Yes	Yes	Yes	Yes

Each observation corresponds to an industry-county cell in a given year. Standard errors are presented between parentheses. Coefficients presented are those from a regression of log output per worker (columns (1) and (2)), log output (columns (3) and (4)) and log workers (columns (5) and (6)) on industry-level log horsepower per worker in 1890 interacted with a dummy indicating whether the centroid of the county was within 70km of a hydroelectric power plant in 1912. Weights are the number of establishments in a cell. Fixed effects for county and industry are included. Values of the dependent variable in 1890 are included in all regressions. In odd columns, industry-county cells that had in 1890 above median Hoover index divided by transportation costs are included while those below the median are included in even columns. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.14: Heterogeneity by market competitiveness-productivity, output and hiring, using as competitive industry-city cells with below median Hoover index and above median trade costs

	Δ ln Y/N		Δ ln Y		Δ ln N	
	Large	Small	Large	Small	Large	Small
	(1)	(2)	(3)	(4)	(5)	(6)
			1900			
$\frac{\ln HP/Y1890\times \text{ plants within 70km}}{100}$	-0.495	5.181***	-0.094	18.516***	0.354	12.850***
	(0.871)	(1.512)	(2.340)	(3.321)	(2.546)	(3.911)
F-test of equality	13.29***		22.98***		8.28**	
N	3,092	1,171	3,096	1,174	3,092	1,171
			1910			
$\frac{\ln HP/Y1890\times \text{ plants within 70km}}{100}$	4.668*	4.605**	6.168	26.190***	1.276	20.963***
	(2.699)	(2.029)	(4.891)	(6.129)	(4.825)	(5.534)
F-test of equality	0.00		6.56**		6.81**	
N	1,159	440	1,159	440	1,167	450
			1920			
$\frac{\ln HP/Y1890\times \text{ plants within 70km}}{100}$	4.230***	12.891***	0.457	38.393***	-3.984	24.866***
	(1.081)	(1.049)	(4.952)	(4.727)	(4.750)	(4.587)
F-test of equality	32.74***		30.39***		218.96***	
N	1,847	786	1,850	787	1,847	786
			1930			
$\frac{\ln HP/Y1890\times \text{ plants within 70km}}{100}$	-0.762	15.791***	-2.077	28.122***	-1.871	12.366*
	(1.974)	(1.880)	(7.644)	(7.256)	(7.295)	(6.951)
F-test of equality	36.43***		8.09**		1.97	
N	828	350	828	350	828	350
			1940			
$\frac{\ln HP/Y1890\times \text{ plants within 70km}}{100}$	-0.204	6.180***	4.349	16.674**	4.271	10.179
	(1.496)	(1.821)	(7.074)	(6.474)	(6.853)	(6.357)
F-test of equality	8.19**		1.65		0.40	
N	1,144	455	1,144	455	1,144	455
1890 "Y" Control	Yes	Yes	Yes	Yes	Yes	Yes

Each observation corresponds to an industry-county cell in a given year. Standard errors are presented between parentheses. Coefficients presented are those from a regression of log output per worker (columns (1) and (2)), log output (columns (3) and (4)) and log workers (columns (5) and (6)) on industry-level log horsepower per worker in 1890 interacted with a dummy indicating whether the centroid of the county was within 70km of a hydroelectric power plant in 1912. Weights are the number of establishments in a cell. Fixed effects for county and industry are included. Values of the dependent variable in 1890 are included in all regressions. In odd columns, industry-county cells that had in 1890 above median Hoover index or below median trade costs while those that had below median Hoover and above median trade costs are included in even columns. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.15: Heterogeneous impact on log number of establishments

	Large (1)	Small (2)	Large (3)	Small (4)
			1900	
$\frac{\ln HP/Y1890\times \text{ plants within 70km}}{100}$	-9.255***	9.110***	-4.375**	6.733***
	(1.700)	(2.299)	(1.849)	(2.203)
F-test of equality	40.43***		14.54***	
			1910	
$\frac{\ln HP/Y1890\times \text{ plants within 70km}}{100}$	-0.582	2.791	-3.528	4.726
	(2.875)	(5.999)	(3.188)	(5.907)
F-test of equality	0.22		1.29	
			1920	
$\frac{\ln HP/Y1890\times \text{ plants within 70km}}{100}$	-6.941***	0.133	-16.218***	0.150
	(2.436)	(5.644)	(2.726)	(5.649)
F-test of equality	1.21		6.42*	
			1930	
$\frac{\ln HP/Y1890\times \text{ plants within 70km}}{100}$	3.355	35.753***	-5.210	35.729***
	(4.636)	(10.566)	(5.430)	(10.599)
F-test of equality	6.22**		9.62**	
			1940	
$\frac{\ln HP/Y1890\times \text{ plants within 70km}}{100}$	-4.728	29.435***	-7.313	29.750***
	(4.183)	(9.398)	(4.672)	(9.143)
F-test of equality	9.34**		10.81***	
1890 "Y" Control	No	No	Yes	Yes

Each observation corresponds to an industry-county cell in a given year. Standard errors are presented between parentheses. Coefficients presented are those from a regression of log number of establishments on industry-level log horsepower per worker in 1890 interacted with a dummy indicating whether the centroid of the county was within 70km of a hydroelectric power plant in 1912. Weights are the number of establishments in a cell. Fixed effects for county and industry are included. Values of the dependent variable in 1890 are included in even columns. In the first two columns, industry-county cells that had in 1890 above output per establishment are included while those below the median are included in the next two columns. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

B Proofs

Proof of Proposition 1.

Whether a fall in electricity prices will increase or decrease unconditional labor demand depends entirely on whether the substitution effect dominates the scale effect. The first effect is independent on characteristics linked to productivity. Thus, the impact of a fall in electricity prices will depend on the latter variables only in so it affects the scale of production.

We thus need to determine the sign of

$$\frac{\partial^2 \log q}{\partial \log r \partial \log z} = \frac{\partial^2 \log d}{\partial \log p^2} \frac{\partial \log p_w}{\partial \log z} \frac{\partial \log p_w}{\partial \log r} + \left(-\sigma_i + \frac{\partial \log d}{\partial \log p_w} \right) \frac{\partial^2 \log p_w}{\partial \log r \partial \log z}$$

For this, we will need to obtain how the price response to a fall in electricity price depends on z.

We find that

$$\frac{\partial^2 \log p}{\partial \log r \partial \log z} = \frac{\frac{\partial^2 \log m}{\partial \log p^2} \frac{\partial \log p_w}{\partial \log r} \frac{\partial \log p_w}{\partial \log z}}{1 - \frac{\partial logm}{\partial logp}}$$

Combining the two derivatives, we conclude that

$$\frac{\partial^2 \log q}{\partial \log r \partial \log z} > 0$$

as long as $\frac{\partial^3 \log d}{\partial \log p^3}$ is not too negative. In that case, more productive firms will respond less strongly to a fall in electricity in terms of output. This will make their effect on labor demand be more negative.

C Industry classification

Table C.16: Industries included in each industry group

Industry 1 (Industry 1950: 406)

Slaughtering and meat packing, not including retail butchering; Slaughtering, wholesale, not including meat packing; Sausage; Slaughtering and meat packing, wholesale; Meat packing, wholesale; Sausage, meat puddings, headcheese, etc., and sausage casings, not made in meat-packing establishments; Poultry, killing and dressing, not done in slaughtering and meatpacking establishments; Slaughtering and meat packing; Sausage casings—not made in meat-packing establishments; Sausages, prepared meats, and other meat products—not made in meat-packing establishments; Poultry killing, dressing, and packing, wholesale; Slaughtering and meat-packing, wholesale; Sausage, meat puddings, headcheese, etc, and sausage casings, not made in meat-packing establishments, sausage; Sausage, not made in slaughtering and meat-packing establishments; Sausage, meat puddings, headcheese, etc, and sausage casings, not made in meat-packing establishments, sausage casings; Poultry dressing and packing, wholesale; Custom slaughtering, wholesale

Industry 2 (Industry 1950: 497)

Cheese; Butter; Butter, reworking; Cheese and butter (factory); Condensed and evaporated milk; Butter, cheese, and condensed milk; Cheese, butter, and condensed milk; Cheese and butter, urban dairy product; Condensed milk; Creamery butter

Industry 3 (Industry 1950: 408, 416, 417, 419)

Food preparations, not elsewhere classified, breadstuff preparations, cereals, and breakfast foods. Macaroni, vermicelli and noodles; Confectionery; Bread and other bakery products; Pickled fruits and vegetables and vegetable sauces and seasonings; Bread and other bakery products (except biscuit, crackers, and pretzels); Ice cream; Food preparations, not elsewhere classified, except breadstuff preparations, cereals, and breakfast foods-for animals and fowls; Pickles, preserves, and sauces, pickles and sauces; Food preparations, not elsewhere classified, except macaroni, vermicelli and noodles-for human consumption; Food preparations, not elsewhere classified, except breadstuff preparations, cereals, and breakfast foods; Feeds, prepared, for animals and fowls; Food preparations, not elsewhere classified; Canning and preserving, fruits and vegetables, canned vegetables; Food preparations; Fish, canning and preserving; Food preparations, not elsewhere specified; Canning and preserving, fruits and vegetables; Canning and preserving, fruits and vegetables, canned fruits; Fruits and vegetables, canning and preserving; Food preparations, not elsewhere classified, except macaroni, vermicelli and noodles and peanut butter and sweetening sirups-for human consumption; Coffee and spice, roasting and grinding, coffee; Food preparations, not elsewhere classified, except breadstuff preparations, cereals, and breakfast foods-for human consumption; Confectionery and ice cream; Oysters, canning and preserving; Cereal preparations; Confectionery and ice cream, confectionary; Lard, not made in slaughtering and meat-packing establishments; Coffee and spice, roasting and grinding; Chewing gum; Food preparations, not elsewhere classified, breadstuff preparations, cereals, and breakfast foods; Food preparations, not elsewhere classified, all other food preparations; Canning and preserving: Fruits and vegetables: pickles, jellies, preserves, and sauces; Canned and dried fruits and vegetables (including canned soups)

Industry 4 (Industry 1950: 409)

Flouring and grist mill products; Flour and other grain-mill products; Flour-mill and gristmill products

Industry 5 (Industry 1950: 419)

Rice, cleaning and polishing; Rice cleaning and polishing

Industry 6 (Industry 1950: 417)

Sugar, refining, not including beet sugar; Sugar refining, cane; Sugar and molasses, refining; Cane-sugar refining; Sugar, beet; Beet sugar; Sugar and molasses, beet; Cane sugar-except refineries; Sugar and molasses, not including beet sugar; Sugar, cane; Sugar, cane, not including products of refineries

Industry 7 (Industry 1950: 417)

Chocolate and cocoa products; Chocolate and cocoa products, not including confectionery

Industry 8 (Industry 1950: 418)

Mineral and soda water: except mineral and carbonated waters; Mineral and soda waters; Beverages; Nonalcoholic beverages; Mineral and soda water: mineral and carbonated waters

Industry 9 (Industry 1950: 418)

Alcohol, ethyl, and distilled liquors; Liquors, malt; Liquors, distilled; Liquors, vinous; Wines; Liquors, rectified or blended; Malt liquors

Industry 10 (Industry 1950: 418)

Malt

Industry 11 (Industry 1950: 409)

Baking powders and yeast; Baking and yeast powders; Baking powder, yeast, and other leavening compounds; Baking powders, yeast, and other leavening compounds

Industry 12 (Industry 1950: 419)

Oleomargarine; Oleomargarine and other butter substitutes; Oleomargarine—not made in meat-packing establishments; Oleomargarine, not made in meat-packing establishments

Industry 13 (Industry 1950: 419)

Corn sirup, corn sugar, corn oil, and starch; Glucose; Starch; Glucose and starch

Industry 14 (Industry 1950: 419)

Flavoring extracts; Flavoring extracts and flavoring syrups; Flavoring extracts and flavoring syrups, not elsewhere classified; Cordials and syrups; Cordials and flavoring syrups

Industry 15 (Industry 1950: 419)

Vinegar and cider

Industry 16 (Industry 1950: 419)

Ice, manufactured; Ice, artificial

Industry 17 (Industry 1950: 429)

Tobacco, chewing, smoking, and snuff; Tobacco, cigars, and cigarettes; Tobacco manufactures; Tobacco, chewing and smoking, and snuff; Cigars; Tobacco, cigars and cigarettes; Cigarettes; Cigars and cigarettes; Tobacco (chewing and smoking) and snuff; Tobacco: Chewing and smoking, and snuff

Industry 18 (Industry 1950: 439)

Cotton goods; Cotton thread; Cotton small wares; Cotton, compressing; Cotton, ginning; Cotton yarn; Cotton broad woven goods; Cotton goods, including cotton small wares; Cotton lace; Cotton, cleaning and rehandling; Cotton narrow fabrics; Lace goods

Industry 19 (Industry 1950: 439)

Silk and rayon manufactures; Rayon narrow fabrics; Silk throwing and spinning—contract factories; Rayon throwing and spinning—contract factories; Silk and silk goods, including throwsters; Rayon broad woven goods—regular factories or jobbers engaging contractors; Silk broad woven goods—regular factories or jobbers engaging contractors; Rayon yarn and thread, spun or thrown—regular factories or jobbers engaging contractors; Silk and silk goods; Silk broad woven goods—contract factories; Silk goods; Silk and silk goods, finished products; Silk narrow fabrics; Silk yarn and thread, spun or thrown—regular factories or jobbers engaging contractors; Rayon broad woven goods—contract factories; Silk and silk goods, throwsters and winders

Industry 20 (Industry 1950: 448)

Woolen, worsted, felt goods, and wool hats; Wool scouring; Men's and boys' hats and caps (except felt and straw); Finishing of men's and boys' hats of fur-felt, wool-felt, and straw; Clothing, women's, factory product; Clothing, women's, contract work, except suits, skirts, and cloaks, shirt waists and dresses, except house dresses; Women's, children's and infants' underwear and nightwear of cotton and flannelette woven fabrics; Hat and cap, except felt and straw men's; Millinery and lace goods, except trimmed hats and hat frames; Wool pulling; Fur hats; Clothing, women's, except suits, skirts, and cloaks, shirt waists and dresses, except house dresses, undergarments and petticoats and wrappers and housedresses; Collars and cuffs, paper; Furnishing goods, men's; Woolen and worsted goods; Embroideries; House dresses, uniforms, and aprons—made in inside factories or by jobbers engaging contractors; Clothing, women's, contract work, undergarments and petticoats; Clothing, women's, regular factory products, except suits, skirts, and cloaks and shirt waists and dresses, except house dresses; Embroideries, other than Schiffli-machine products—contract factories; Woolen goods; Men's and boys' underwear—made in contract factories; Hat and cap materials; Millinery and lace goods; Women's and misses' clothing, not elsewhere classified—made in contract factories; Trimmings (not made in textile mills), stamped art goods, and art needlework—contract factories; Coats, suits, and skirts (except fur coats)-made in contract factories; Clothing, women's; Men's neckwear—made in contract factories; Women's and misses' dresses (except house dresses)—made in contract factories; Wool hats; Children's and infants' wear not elsewhere classified-made in contract factories; Clothing, women's, except suits, skirts and cloaks, shirt waists and dresses, except house dresses; House dresses, uniforms, and aprons—made in contract factories; Robes, lounging garments, and dressing gowns; Straw goods, not elsewhere specified

Industry 21 (Industry 1950: 437)

Dyeing and finishing textiles; Dyeing and finishing textiles, exclusive of that done in textile mills; Dyeing and finishing cotton, rayon, silk, and linen textiles; Dyeing and cleaning; Dyestuff and extracts; Dyeing and finishing woolen and worsted

Industry 22 (Industry 1950: 436)

Hosiery and knit goods; Knitted underwear; Knitted outerwear (except knit gloves)—contract factories; Hosiery—seamless; Knitted outerwear (except knit gloves)—regular factories or jobbers engaging contractors; Knit goods; Knitted gloves; Knitted cloth; Hosiery—full-fashioned

Industry 23 (Industry 1950: 437)

Cloth, sponging and refinishing; Cloth sponging and miscellaneous special finishing; Cloth sponging and refinishing

Industry 24 (Industry 1950: 438)

Carpets and rugs, other than rag; Carpets, rag; Carpet yarn, woolen and worsted; Carpets, rugs, and mats made from such materials as paper fiber, glass, jute, flax, sisal, cotton, cocoa fiber, and rags; Mats and matting, from cocoa fiber, grass, and coir; Mats and matting, grass and coir; Mats and matting; Carpets and rugs, wool; Carpets and rugs, wool, other than rag; Carpets and rugs, rag

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Industry 25 (Industry 1950: 438)

Oilcloth, enameled; Asphalted-felt-base floor covering; Oilcloth; Artificial leather and oilcloth; Oilcloth, floor; Oilcloth and linoleum, floor; Artificial leather; Oilcloth and linoleum; Linoleum; Linoleum, asphalted-felt-base and other hard-surface floor coverings, not elsewhere classified

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Industry 26 (Industry 1950: 449)

Felt goods; Haircloth; Felt goods, wool, hair, or jute; Felt goods, wool, hair, and jute (except woven felts and hat bodies and hats)

Industry 27 (Industry 1950: 446)

Upholstering materials; Batting, padding, and wadding: upholstery filling; Excelsior; Upholstering materials, not elsewhere specified; Upholstering materials, not elsewhere classified

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Industry 28 (Industry 1950: 446)

Processed waste and recovered wool fibers—contract factories; Waste; Cotton waste; Wool shoddy; Shoddy; Oakum; Processed waste and recovered wool fibers—regular factories or jobbers engaging contractors

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Industry 29 (Industry 1950: 449)

Cordage and twine; Cordage and twine and jute and linen goods; Linen goods; Jute goods; Bags, other than paper; Jute and jute goods; Bags, other than paper, not made in textile mills; Jute goods (except felt); Bags, other than paper, not including bags made in textile mills; Textile bags—not made in textile mills; Thread, linen; Bagging, flax, hemp, and jute

Industry 30 (Industry 1950: 448)

Gloves and mittens; Clothing (except work clothing), men's, youths', and boys', not elsewhere classified; Clothing, men's, contract work, men's and youths' and boys'; Clothing, men's, buttonholes; Dress and semidress gloves and mittens: cloth, cloth and leather combined; Trousers (semidress), wash suits, and washable service apparel; Clothing, men's, factory product, buttonholes; Clothing, men's; Leather gloves and mittens; Clothing, men's, custom work and repairing; Work shirts; Men's and boys' suits, coats, and overcoats (except work clothing)—made in contract factories; Clothing, men's, contract work, boys'; Clothing, men's, regular factory products, men's, youths'; Clothing men's, factory products buttonholes; Collars, men's; Clothing, men's, regular factory products, boys'; Clothing, men's, contract work; Shirts; Men's and boys' shirts (except work shirts), collars, and night-wear made in inside factories or by jobbers engaging contractors; Clothing, men's, including shirts; Clothing, men's, contract work, except men's and youths'; Men's and boys' suits, coats, and overcoats (except work clothing)—made in inside factories or by jobbers engaging contractors; Clothing, men's, regular factory products; Clothing, men's, contract work, men's, youths'; Clothing, men's, regular factory products, except men's, youths' and boys'; Clothing men's, factory products; Gloves and mittens, cloth; Work clothing (except work shirts), sport garments (except leather), and other men's and boys' apparel, not elsewhere classified; Clothing, men's, contract work, men's and youths'; Clothing, men's, factory product; Men's and boys' shirts (except work shirts), collars, and night-wear—made in contract factories; Work gloves and mittens: cloth, cloth and leather combined; Gloves and mittens, leather; Clothing, men's, regular factory products, except men's, youths', and boys'; Clothing, men's, regular factory; Clothing, leather and sheep-lined; Raincoats and other waterproof garments (except oiled cotton)

Industry 31 (Industry 1950: 448)

Corsets; Corsets and allied garments

Industry 32 (Industry 1950: 489)

Saddlery and harness; Pocketbooks, purses, and card cases; Trunks and valises; Women's pocketbooks, handbags, and purses; Leather goods not elsewhere classified; Suitcases, brief cases, bags, trunks, and other luggage; Belts (apparel), regardless of material; Pocketbooks; Leather goods, not elsewhere classified; Trunks, suitcases, and bags; Leather goods; Belting other than leather and rubber, not made in textile mills; Whips; Leather board; Small leather goods; Bellows; Saddlery, harness, and whips; Belting and hose, woven, other than rubber; Leather goods, not elsewhere specified; Leather-boards

Industry 33 (Industry 1950: 449)

Fur goods; Fur coats and other fur garments, accessories, and trimmings

Industry 34 (Industry 1950: 478)

Tires and inner tubes; Suspenders, garters, and other elastic woven goods, made from purchased webbing; Belting and hose, rubber; Rubber goods other than tires, inner tubes, and boots and shoes; Rubber and elastic goods; Suspenders, garters, and elastic woven goods; Rubber tires, tubes, and rubber goods, not elsewhere specified; Rubber products not elsewhere classified; Belting and hose, linen; Rubber goods, not elsewhere specified; Belting and hose, woven and rubber; Reclaimed rubber; Suspenders, garters, and other goods made from purchased elastic material; Belting and hose, other than leather; Rubber tires and inner tubes

Industry 35 (Industry 1950: 449)

House-furnishing goods, not elsewhere specified, mops and dusters; House-furnishing goods, not elsewhere specified; Curtains, draperies, and bedspreads—made in regular factories or by jobbers engaging contractors; Curtains, draperies, and bedspreads—contract factories; House-furnishing goods, not elsewhere classified; Aluminum ware, kitchen, hospital, and household (except electrical appliances); Housefurnishings (except curtains, draperies, and bedspreads); Aluminum products (including rolling and drawing and extruding), not elsewhere classified; Aluminum manufactures; House-furnishing goods, not elsewhere specified, comforts, quilts, feather pillows, and beds; House furnishing goods, not elsewhere specified; House-furnishing goods, not elsewhere specified, except comforts, quilts, feather pillows, and beds and mops and dusters; House-furnishing goods, not elsewhere specified, except mops and dusters

Industry 36 (Industry 1950: 449)

Awnings, tents, and sails; Canvas products (except bags); Awnings, tents, sails, and canvas covers

Industry 37 (Industry 1950: 449)

Regalia, and society badges and emblems; Flags and banners; Regalia and society banners and emblems; Clothing, horse; Nets and seines; Miscellaneous fabricated textile products not elsewhere classified; Nets and selnes; Flags, banners, regalia, society badges, and emblems; Horse blankets, fly nets, and related products; Regalia, badges, and emblems

Industry 38 (Industry 1950: 308)

Charcoal; Lumber and timber products; Boxes, wooden packing; Wooden boxes except cigar boxes; Sawmills, veneer mills, and cooperage-stock mills, including those combined with logging camps and with planing mills; Boxes, wooden, except cigar boxes; Lumber and timber products, not elsewhere classified; Wood distillation; Charcoal, not including production in the lumber and wood distillation industries; Logging camps and logging contractors (not operating sawmills); Boxes, wooden packing, except cigar boxes; Plywood mills; Hardwood distillation and charcoal manufacture; Lumber and other mill products from logs or bolts; Wood distillation, not including turpentine and rosin; Wood distillation and charcoal manufacture

Industry 39 (Industry 1950: 307)

Window shades; Venetian blinds; Planing-mill products (including general millwork), not made in planing mills connected with sawmills; Lumber, planing mill products, including sash, doors, and blinds; Planing mills not operated in conjunction with sawmills; Lumber, planing-mill products, not including planing mills connected with sawmills; Window shades and fixtures; Window and door screens and weather strip; Window and door screens and weather strips

Industry 40 (Industry 1950: 309)

Mattresses and spring beds; Mattresses and spring beds, not elsewhere specified; Mattresses and bed springs, not elsewhere classified; Mattresses and bedsprings

Industry 41 (Industry 1950: 309)

Hammocks; Furniture, including store and office fixtures; Furniture, including cabinetmaking, repairing, and upholstering; Refrigerators; Office furniture; Laboratory, hospital, and other professional furniture; Public-building furniture; Show cases; Upholstered household furniture; Furniture, wood and rattan and willow; Furniture, except wood, other than rattan and willow; Partitions, shelving, cabinet work, and office and store fixtures; Furniture, rattan and willow and metal; Furniture, chairs; Refrigerators, domestic (mechanical and absorption), refrigeration machinery and equipment, and complete air-conditioning units; Household furniture, except upholstered; Furniture, metal furniture and store and office fixtures; Furniture, factory products; Furniture and refrigerators; Refrigerators, mechanical; Furniture, rattan and willow, store and office fixtures; Furniture, cabinet making, repairing and upholstering; Furniture, rattan and willow; Furniture, metal; Furniture; Furniture, wood, other than rattan and willow; Furniture, metal and store fixtures; Furniture, factory product; Refrigerators and refrigerator cabinets, exclusive of mechanical refrigerating equipment; Furniture, store and office fixtures

Industry 42 (Industry 1950: 466, 467)

Chemicals; Perfumery and cosmetics; Druggists' preparations, not including prescriptions; Celluloid and celluloid goods; Drug grinding; Drugs and medicines (including drug grinding); Perfumes, cosmetics, and other toilet preparations; Druggists' preparations; Foundry supplies; Insecticides, fungicides, and related industrial and household chemical compounds; Patent medicines and compounds, patent and proprietary medicines; Patent medicines and compounds; Druggists' preparations; Plastic materials; Coal-tar products; Rayon and allied products; Perfumes, cosmetics, and other toilet preparations; Sulphuric, nitric, and mixed acids; Compressed and liquefied gases—not made in petroleum refineries or in natural-gasoline plants; Patent medicines and compounds and druggists' preparations; Compressed and liquefied gases; Patent medicines and compounds , patent and proprietary compounds, not elsewhere specified; Foundry supplies; Chemicals, not elsewhere classified; Chemicals not elsewhere classified; Patent or proprietary medicines and compounds; Patent medicines and compounds, except patent and proprietary medicines; Coal-tar products, crude and intermediate

Industry 43 (Industry 1950: 308)

Baskets, and rattan and willow ware; Baskets and rattan and willow ware, not including furniture; Baskets and rattan and willow ware; Whalebone and rattan; Baskets for fruits and vegetables; Rattan and willow ware (except furniture) and baskets other than vegetable and fruit baskets

Industry 44 (Industry 1950: 308)

Boxes, cigar; Boxes, cigar, wooden; Cigar boxes: wooden, part wooden

Industry 45 (Industry 1950: 308)

Rules, ivory and wood; Wood products not elsewhere classified; Woodenware, not elsewhere specified; Wood turned and shaped and other wooden goods, not elsewhere classified; Cooperage; Wood, turned and carved; Kindling wood; Cooperage and wooden goods, not elsewhere specified; Cooperage, except hogsheads and barrels; Wooden goods, not elsewhere specified; Wood work - Miscellaneous; Cooperage, hogsheads and barrels

Industry 46 (Industry 1950: 308)

Caskets, coffins, burial cases, and other morticians' goods; Coffins, burial cases, and undertakers' goods

Industry 47 (Industry 1950: 308)

Cork products; Cork, cutting

Industry 48 (Industry 1950: 308)

Matches

Industry 49 (Industry 1950: 308)

Wood preserving; Wood, preserving

Industry 50 (Industry 1950: 308)

Lasts; Lasts and related products

Industry 51 (Industry 1950: 309)

Looking-glass and picture frames; Mirror and picture frames; Mirror frames and picture frames

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Industry 52 (Industry 1950: 456)

Pulp, from fiber other than wood; Paper; Paper and wood pulp; Pulp goods; Pulp mills; Pulp, wood; Pulp goods (pressed, molded); Wood pulp; Fabricated plastic products, not elsewhere classified; Paper and paperboard mills; Pulp (wood and other fiber)

Industry 53 (Industry 1950: 458)

Converted paper products not elsewhere classified; Die-cut paper and paperboard, and converted cardboard; Envelopes; Stationery goods, not elsewhere specified; Cardboard, not made in paper mills; Cardboard; Card cutting and designing; Paper goods, not elsewhere classified; Stationery goods, not elsewhere classified; Paper goods, not elsewhere specified; Coated and glazed paper; Pencil cases; Greeting cards (except hand-painted); Card board

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Industry 54 (Industry 1950: 458)

Bags, paper; Bags, paper, exclusive of those made in paper mills; Paper bags, except those made in paper mills

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Industry 55 (Industry 1950: 457)

Boxes, fancy and paper; Boxes paper, not elsewhere classified, shipping containers; Boxes, paper, not elsewhere classified; Boxes, paper and other, not elsewhere specified; Paperboard containers and boxes not elsewhere classified; Boxes paper, not elsewhere classified, cartons; Boxes paper, not elsewhere classified, set-up paper boxes; Fiber cans, tubes, and similar products; Boxes paper, not elsewhere classified, all others

Industry 56 (Industry 1950: 458)

Paper hangings; Wall paper; Wallpaper; Wall paper, not made in paper mills

Industry 57 (Industry 1950: 459)

Printing and publishing, newspapers and periodicals; Engraving and diesinking; Printing and publishing, music; Printing and publishing, newspaper and periodical; Bookbinding and blank book making; Printing, tip; Printing and publishing; Printing and publishing, book and job, job printing and book publishing and printing; Type founding; Labels and tags; Printing and publishing, book and job; Engraving on metal (except for printing purposes); Lithographing and engraving; Engraving, steel, including plate printing; Type founding and printing materials; Printing and publishing, newspaper and periodical, printing, publishing, and job printing; Machine and hand typesetting (including advertisement typesetting); Engravers' materials; Paper patterns; Engraving, wood; Printing and publishing, book and job, book publishing and printing, linotype work and typesetting; Engravers materials; Periodicals: publishing without printing; Bookbinding and blank-book making; Printing and publishing, book and job , book publishing and printing; Printing materials; Printing and publishing, book and job, job printing; Newspapers: publishing without printing; Printing and publishing, book and job ; Engraving (steel, copperplate, and wood); plate printing; Printing and publishing, book and job, except job printing; Printing-trades machinery and equipment; Books: publishing without printing; Periodicals: publishing and printing; Printing and publishing, music ; Printing and publishing, book and job, book publishing without printing and linotype work and typesetting; Printing materials, not including type or ink; Lithographing and photo-lithographing (including preparation of stones or plates and dry transfers); Books: printing without publishing; General commercial (job) printing; Lithographing; Newspapers: publishing and printing; Printing and publishing, book and job, book publishing and printing, linotype work and typesetting; Bookbinding and related industries; Books: publishing and printing; Engraving (other than steel, copperplate)

Industry 58 (Industry 1950: 459)

Photolithographing and photoengraving; Photo-engraving, not done in printing establishments; Photo-engraving; Photoengraving, not done in printing establishments (including preparation of plates); Gravure, rotogravure, and rotary photogravure (including preparation of plates); Photolithographing and engraving

Industry 59 (Industry 1950: 459)

Stereotyping and electrotyping; Stereotyping and electrotyping, not done in printing establishments; Electrotyping and stereotyping, not done in printing establishments

Industry 60 (Industry 1950:459)

Paint and varnish; Varnishes; Paints and varnishes; Colors and pigments; Paints; Varnish; Dyestuffs and extracts; Paints, varnishes, and lacquers; Tanning materials, natural dyestuffs, mordants and assistants, and sizes; Tanning materials, natural dyestuffs, mordants, assistants, and sizes; Dyestuffs and extracts—natural

Industry 61 (Industry 1950: 469)

Oil, not elsewhere specified; Fish and other marine oils, cake, and meal; Oil, lubricating; Essential oils; Oil, essential; Oil, cake, and meal, linseed; Oil, cottonseed and cake; Oil and cake, cottonseed; Oil, resin; Oil, linseed; Oil, not elsewhere specified, composite; Linseed oil, cake, and meal; Oil, castor; Oil, lard; Oils, not elsewhere classified; Oil, not elsewhere specified, vegetable, animal, and mineral oils; Oil, cake, and meal, cottonseed; Lard, refined; Oils, essential; Soybean oil, cake, and meal; Oil, vegetable, essential; Oil, not elsewhere specified, vegetable; Oil, cottonseed, cake; Cottonseed oil, cake, meal, and linters; Oil, not elsewhere specified, except vegetable and composite; Oil, illuminating, not including petroleum refining; Oil, not elsewhere specified, composite oils; Vegetable and animal oils, not elsewhere classified

Industry 62 (Industry 1950: 469)

Soap and candles; Soap; Candles; Soap and glycerin

Industry 63 (Industry 1950: 477)

Turpentine and rosin; Wood naval stores; Tar and turpentine; Gum naval stores (processing but not gathering or warehousing)

Industry 64 (Industry 1950: 469)

Fertilizers

Industry 65 (Industry 1950: 469)

Explosives; Gunpowder; High explosives

Industry 66 (Industry 1950: 469)

Salt

Industry 67 (Industry 1950: 469)

Bone black, carbon black, and lampblack; Bone, ivory, and lamp black; Bone, carbon, and lamp black; Bone black, carbon black, and lamp black

Industry 68 (Industry 1950: 469)

Ink, printing; Ink, printing; Ink, writing; Printing ink; Ink, writing; Ink; Writing ink

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Industry 69 (Industry 1950: 469)

Firearms; Firearms and ammunition; Ammunition and related products; Ammunition

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Industry 70 (Industry 1950: 469)

Cleaning and polishing preparations, blackings, and dressings; Cleansing and polishing preparations; Blacking, stains, and dressings; Blacking; Cleansing and polishing preparations, except metal polish and cleansing preparations; Blacking and cleansing and polishing preparations; Cleaning and polishing preparations; Cleansing and polishing preparations, except metal polish; Cleansing and polishing preparations, metal polish; Cleansing and polishing preparations, cleansing preparations; Cleansing and polishing preparations, polishing preparations

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Industry 71 (Industry 1950: 469)

Glue, not elsewhere specified; Glue and gelatin; Glue

Industry 72 (Industry 1950: 477)

Grease and tallow (except lubricating greases); Grease and tallow; Grease and tallow, not including lubricating greases

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Industry 73 (Industry 1950: 476)

Petroleum, refining; Gas, illuminating and heating; Axle grease; Lubricating greases; Lubricating oils and greases—not made in petroleum refineries; Petroleum refining; Lubricating oils and greases, not made in petroleum refineries; Gas, manufactured, illuminating and heating

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Industry 74 (Industry 1950: 469)

Fireworks; Fire-works

Industry 75 (Industry 1950: 469)

Bluing

Industry 76 (Industry 1950: 469)

Mucilage, paste, and other adhesives, except glue and rubber cement; Mucilage and paste; Mucilage, paste and other adhesives, not elsewhere specified

Industry 77 (Industry 1950: 477)

Coke; Coke, not including gas-house coke; Beehive coke; Oven coke and coke-oven byproducts

Industry 78 (Industry 1950: 318)

Paving materials; Paving and paving materials; Paving materials: Asphalt, tar, crushed slag, and mixtures; Paying blocks and paying mixtures: asphalt, creosoted wood, and composition

Industry 79 (Industry 1950: 318)

Roofing materials; Roofing and roofing materials; Roofing, built-up and roll; asphalt shingles; roof coating (except paint); Roofing, built-up and roll; asphalt shingles; roof coatings other than paint

Industry 80 (Industry 1950: 477)

Fuel, artificial; Fuel Briquettes and boulets; Fuel briquets; Fuel, manufactured

Industry 81 (Industry 1950: 478)

Rubber boots and shoes (including rubber-soled footwear with fabric uppers); Boots and shoes, rubber

Industry 82 (Industry 1950: 487)

Leather, tanned, curried, and finished; Leather: tanned, curried, and finished-regular factories or jobbers engaging contractors; Leather: Tanned, curried, and finished; Leather: tanned, curried, and finished—contract factories; Leather, patent and enameled; Leather, morocco; Leather, dressed skins; Leather, tanned and curried

Industry 83 (Industry 1950: 4689)

Belting, leather; Belting and hose, leather; Industrial leather belting and packing leather; Packing hose

Industry 84 (Industry 1950: 488)

Boots and shoes, other than rubber; Boot and shoe cut stock; Boots and shoes; Boots and shoes, factory product; Boot and shoe cut stock, not made in boot and shoe factories; Boot and shoe findings; Boots and shoes, custom work and repairing; Boot and shoe findings, exclusive of those produced in boot and shoe factories; Boot and shoe uppers; Boot and shoe cut stock, exclusive of that produced in boot and shoe factories; Boots and shoes, not including rubber boots and shoes; Boots and shoes, including cut stock and findings; Boots and shoes, other than rubber, stitching and crimping; Boots and shoes, other than rubber, regular factory products; Boots and shoes, stitching and crimping; Boots and shoes, regular factory products; Boots and shoes, other than rubber, except regular factory products; Boot and shoe findings, not made in boot and shoe factories; ; Boots and shoes, other than rubber, contract work; Footwear (except rubber); Boot and shoe cut stock and findings; Boots and shoes, contract work

Industry 85 (Industry 1950: 316)

Glass; Tableware, pressed or blown glass, and glassware not elsewhere classified; Glass containers; Flat glass

Industry 86 (Industry 1950: 316)

Glass, cutting, staining, and ornamenting; Mirrors; Mirrors, framed and unframed, not elsewhere specified; Mirrors, framed and unframed; Glass products (except mirrors) made from purchased glass; Mirrors and other glass products made of purchased glass; Glass, cutting, staining, and ornamenting, decalcomania work on glass; Glass, cutting, staining, and ornamenting, except decalcomania work on glass

Industry 87 (Industry 1950: 317)

Lime and cement; Cement; Lime

Industry 88 (Industry 1950: 318, 319)

Pottery, including porcelain ware; Pottery, terra-cotta and fire-clay products; Masonry, brick and stone; Pottery, terra cotta, and fire-clay products; Porcelain electrical supplies; Brick and tile, terra-cotta, and fire-clay products, except building bricks and terra-cotta products; Artificial stone; Brick and tile, terra-cotta, and fireclay products; Whiteware; Concrete products; Brick and tile, terra-cotta, and fire-clay products, building brick; Brick and tile; Clay products (other than pottery) and nonclay refractories; Brick and tile, terra-cotta, and fire-clay products, stove lining and terra-cotta products; Artificial stone products; Crucibles; Clay refractories, including refractory cement (clay); Roofing tile; Concrete products; Brick and hollow structural tile; Clay and pottery products; Terra cotta; Clay products (except pottery) not elsewhere classified; Sand-lime brick, block and tile; Nonclay refractories; Pottery products not elsewhere classified; Brick and tile, terra-cotta, and fire-clay products, fire brick; Floor and wall tile (except quarry tile); Vitreous-china plumbing fixtures; Pottery; Sand-lime brick; Sewer pipe and kindred products; Hotel china; Brick and tile, terra-cotta, and fire-clay products, terra-cotta products

Industry 89 (Industry 1950: 319)

China firing and decorating, not done in potteries; China decorating; China decorating, not including that done in potteries; China firing and decorating (for the trade)

Industry 90 (Industry 1950: 317)

Plastering and stuccowork; Wall plaster and composition flooring; Wallboard and wall plaster (except gypsum), building insulation (except mineral wool), and floor composition; Wall plaster, wall board, insulating board, and floor composition; Mineral wool; Statuary and art goods (except stone and concrete)—factory production; Wall plaster; Gypsum products; Statuary and art goods, factory product; Statuary and art goods

Industry 91 (Industry 1950: 326)

Monuments and tombstones; Mantels, slate, marble, and marbleized; Monuments, tombstones, cut-stone, and stone products not elsewhere classified; Marble and stone work; Marble and stone work, monuments and tombstones; Marble, granite, slate, and other stone products, other marble and stone work, except slated; Marble, granite, slate, and other stone products; Marble and stone work, except monuments and tombstones

Industry 92 (Industry 1950: 326)

Emery and other abrasive wheels; Emery wheels and other abrasive and polishing appliances; Emery wheels; Sand and emery paper and cloth; Abrasive wheels, stones, paper, cloth, and related products; Hones, whetstones, and similar products; Sand paper, emery paper, and other abrasive paper and cloth

Industry 93 (Industry 1950: 326)

Asbestos products (except steam packing and pipe and boiler covering); Asbestos products, not including steam packing; Steam packing; Steam and other packing, pipe and boiler covering, and gaskets, not elsewhere classified; Steam and other packing; pipe and boiler covering; Asbestos products, other than steam packing or pipe and boiler covering

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Industry 94 (Industry 1950: 326)

Graphite, ground and refined; Graphite and graphite refining; Natural graphite, ground and refined; Graphite ground and refined

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Industry 95 (Industry 1950: 326)

Minerals and earths, ground or otherwise treated; Kaolin and ground earths; Kaolin and other earth grinding

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Industry 96 (Industry 1950: 326)

Iron and steel, steel works and rolling mills; Iron and steel: Steel works and rolling mills; Iron and steel; Iron and steel, blast furnaces; Steel castings; Blast-furnace products; Tin and terne plate; Iron and steel: Blast furnaces; Steel works and rolling mills; Iron and steel, tempering and welding; Ferroalloys; Tin plate and terneplate

Industry 97 (Industry 1950: 346)

Gas machines and gas and water meters, gas meters and water meters; Ironwork, architectural and ornamental; Gas machines and meters; Plumbers' supplies; Construction and similar machinery (except mining and oil-field machinery and tools); Hardware, except locks and builder's hardware; Vault lights and ventilators; Foundry and machine-shop products, machine shop and foundry combined; Steam engines, turbines, and water wheels; Signs and advertising novelties, signs, electric and others; Signs, advertising displays, and advertising novelties; Foundry and machine shop products; Foundry and machine-shop products, boiler shops; Hardware, locks; Bridges; Lightning rods; Steam fittings, regardless of material; Pumps, not including steam pumps; Steam fittings and heating apparatus; Foundry and machine-shop products, except machine shops; Steel barrels, kegs, and drums; Registers, car fare; Hardware; Locomotives, not made by railroad companies; Enameled-iron sanitary ware and other plumbers' supplies (not including pipe and vitreous and semivitreous china sanitary ware); Signs and advertising novelties; Mining machinery and equipment; Foundry and machine-shop products, except foundries; Vending, amusement, and other coin-operated machines; Hardware, saddlery; Oil-field machinery and tools; Mechanical power-transmission equipment; Plumbers supplies; Hardware not elsewhere classified; Pumps (hand and power) and pumping equipment; Locomotives, not made in railroad repair shops; Steel barrels, drums and tanks, portable; Engines, steam, gas, and water; Gray-iron and semisteel castings; Blowers; exhaust and ventilating fans; Foundry and machine-shop products, not elsewhere classified; Hardware, vehicle hardware; Cast-iron pipe; Steam fittings and steam and hot-water heating apparatus; Textile machinery and parts; Signs and advertising novelties, electric and other signs; Iron and steel, processed; Steam fittings and steam and hot-water heating apparatus, radiators and cast-iron heating boilers

Industry 98 (Industry 1950: 338)

Gold and silver, reducing and refining, not from the ore; Tinsmithing, coppersmithing, and sheet-iron working; Smelting and refining, not from the ore; Smelting and refining, lead; Secondary smelting and refining of nonferrous metals, not elsewhere classified; Sheet-metal work not specifically classified; Copper, tin, and sheet-iron products; Tinware, not elsewhere specified; Zinc, smelting and refining; Gold, silver, and platinum, reducing and refining, not from the ore; Smelting and refining, metals other than gold, silver, or platinum, not from the ore; Smelting and refining, copper; Lead, smelting and refining; Smelting and refining, zinc; Cooper, tin, and sheet-iron work; Primary smelting and refining of nonferrous metals; Silversmithing; Copper, smelting and refining; Smelting and refining; Secondary smelting and refining, gold, silver, and platinum; Tin cans and other tinware not elsewhere classified; Zinc; Tin cans and other tinware, not elsewhere classified; Copper, tin, and sheet-iron work, including galvanized iron work, not elsewhere classified

Industry 99 (Industry 1950: 337)

Wire; Wire, drawn from purchased bars or rods; Wire drawn from purchased rods

Industry 100 (Industry 1950: 337)

Iron and steel, nails and spikes, cut and wrought, including wire nails; Nails, spikes, etc. not made in wire mills or in plants operated in connection with rolling mills; Iron and steel, nails and spikes, cut and wrought, including wire nails, not made in steel works or rolling mills; Nails, spikes, etc., not made in wire mills or in plants operated in connection with rolling mills; Iron, steel, nails, spikes, cut and wrought, including wire nails, not made in steel works or rolling mills

Industry 101 (Industry 1950: 337)

Wirework, including wire rope and cable; Wirework, not elsewhere specified; Wirework not elsewhere classified; Wirework, not elsewhere classified

Industry 102 (Industry 1950: 337)

Cutlery (except aluminum, silver, and plated cutlery) and edge tools; Machine-tool and other metalworking-machinery accessories, metal cutting and shaping tools, and machinists' precision tools; Metal working machinery and equipment, not elsewhere classified; Tools, not elsewhere specified; Cutlery and edge tools; Machine tools; Tools, not elsewhere specified, except machinists'; Tools (except edge tools, machine tools, files, and saws); Cutlery and tools, not elsewhere specified; Cutlery and edge tools, except razors; Cutlery (not including silver and plated cutlery) and edge tools; Cutlery and edge tools, razors; Tools, not elsewhere specified, machinists'; Tools, not including edge tools, machine tools, files, or saws; Machine-tool accessories and small metal-working tools, not elsewhere classified; Tools, not elsewhere specified, shovels, spades, scoops, hoes, and carpenters' tools, not elsewhere classified

Industry 103 (Industry 1950: 346)

Files

Industry 104 (Industry 1950: 346)

Saws

Industry 105 (Industry 1950: 346)

Stoves, ranges, water heaters, and hot-air furnaces (except electric); Gas and oil stoves; Gas stoves; Heating and cooking apparatus, except electric, not elsewhere classified; Stoves, gas and oil; Stoves and hot-air furnaces; Stoves and furnaces, including gas and oil stoves; Stoves and hot air furnaces, stoves and ranges; Oil burners, domestic and industrial; Stoves and ranges (other than electric) and warm-air furnaces; Stoves and hot air furnaces, hot-air furnaces

Industry 106 (Industry 1950: 346)

Japanning; Enameling; Stamped ware; Enameling, japanning, and lacquering; Stamped and pressed metal products (except automobile stampings); Automobile stampings; Enameling and enameled goods; Enameling and japanning; Stamped and enameled ware, not elsewhere specified; Vitreous enameled products, including kitchen, household, and hospital utensils; Stamped ware, enameled ware, and metal stamping, enameling, japanning, and lacquering; Enameled goods

Industry 107 (Industry 1950: 346)

Galvanizing; Galvanizing and other coating processes; Galvanizing and other coating—carried on in plants not operated in connection with rolling mills; Galvanizing and other coating not done in plants operated in connection with rolling mills

Industry 108 (Industry 1950: 346)

Iron and steel, doors and shutters; Doors, shutters, and window sash and frames, metal; Doors, window sash, frames, molding, and trim (made of metal)

Industry 109 (Industry 1950: 346)

Bolts, nuts, washers, and rivets, not made in plants operated in connection with rolling mills; Iron and steel, bolts, nuts, washers, and rivets; Bolts, nuts, washers, and rivets made in plants not operated in connection with rolling mills; Iron and steel, bolts, nuts, washers, and rivets, not made in rolling mills; Iron and steel, bolts, nuts, washers, and rivets, not made in steel works or rolling mills

Industry 110 (Industry 1950: 346)

Iron and steel, forgings; Horseshoes, not made in steel works or rolling mills; Forgings, iron and steel—made in plants not operated in connection with rolling mills; Iron and steel forgings; Iron and steel forgings, not made in steel works or rolling mills; Forgings, iron and steel, not made in plants operated in connection with rolling mills; Horseshoes, factory product; Horse-shoes

Industry 111 (Industry 1950: 346)

Iron and steel, wrought pipe; Wrought pipe, welded and heavy riveted, not made in plants operated in connection with rolling mills; Iron and steel, pipe, wrought; Iron and steel pipe, wrought; Wrought pipes, welded and heavy riveted—made in plants not operated in connection with rolling mills

Industry 112 (Industry 1950: 346)

Springs, steel, except wire, not made in plants operated in connection with rolling mills; Springs, steel, car and carriage, not made in steel works or rolling mills; Springs, steel (except wire)—made in plants not operated in connection with rolling mills; Springs, steel, car and carriage

Industry 113 (Industry 1950: 346)

Screws; Screws, machine; Screw-machine products and wood screws; Screws, wood

Industry 114 (Industry 1950: 346)

Safes and vaults

Industry 115 (Industry 1950: 347)

Bronze castings; Nonferrous-metal products not elsewhere classified; Lead, bar, pipe, and sheet; Brass castings and brass finishing; Alloying; and rolling and drawing of nonferrous metals, except aluminum; Bells; Brass, bronze, and copper products; Lead, bar, pipe and sheet; Brass and bronze products; Brass; Babbitt metal and solder; Brass castings; Nonferrous-metal foundries (except aluminum); Brass and copper, rolled; Brassware; Brass, bronze and copper products, brass and bronze products; Brass, bronze and copper products, copper and all other products; Nonferrous-metal alloys and products, not including aluminum products

Industry 116 (Industry 1950: 388)

Watch and clock materials, except watchcases; Watches and watch movements; Clocks; Watch and clock materials; Clocks and watches, including cases and materials; Watch and clock materials and parts, except watchcases; Watches; Watchcases; Watch cases; Clocks, watches, and materials and parts (except watchcases); Clocks, clock movements, time-recording devices, and time stamps

Industry 117 (Industry 1950: 399)

Costume jewelry and costume novelties (jewelry other than fine jewelry); Jewelry; Jewelers' findings and materials; Jewelry (precious metals)

Industry 118 (Industry 1950: 399)

Lapidary work

Industry 119 (Industry 1950: 346)

Silverware and plated ware; Silverware; Plated and britannia ware; Silversmithing and silverware; Plated ware

Industry 120 (Industry 1950: 346)

Electroplating, plating, and polishing; Electroplating

Industry 121 (Industry 1950: 358)

Calcium lights; Lamps and reflectors; Gas and lamp fixtures; Gas and electric fixtures, lamps and reflectors; Gas and electric fixtures; lamps, lanterns, and reflectors; Gas and electric fixtures; Gas and electric fixtures, electric fixtures; Gas and electric fixtures, except electric fixtures; Lighting fixtures; Lamps and reflectors, all other lamps; Lamps and reflectors, reflectors; Lamps and reflectors, automobile lamps

Industry 122 (Industry 1950: 347)

Tin and other foils, not elsewhere specified; Collapsible tubes; tinfoil; Tin and other foils (except gold and silver foil); Tin foil; Tin and other foils, not including gold foil; Tinfoil

Industry 123 (Industry 1950: 347)

Gold and silver, leaf and foil; Gold leaf and foil; Gold and silver leaf and foil

Industry 124 (Industry 1950: 367)

Electrical machinery, apparatus, and supplies; Phonographs and graphophones; Electric light and power; Insulated wire and cable; Generating, distribution, and industrial apparatus, and apparatus for incorporation in manufactured products, not elsewhere classified; Electric lamps; Batteries, storage and primary (dry and wet); Electrical apparatus and supplies; Electrical measuring instruments; Electrical products not elsewhere classified; Automotive electrical equipment; Electrical appliances; Wiring devices and supplies; X-ray and therapeutic apparatus and electronic tubes; Radios, radio tubes, and phonographs; Communication equipment; Phonographs; Beauty-shop and barber-shop equipment; Carbon products for the electrical industry, and manufactures of carbon or artificial graphite

Industry 125 (Industry 1950: 357)

Agricultural implements; Agricultural machinery (except tractors); Windmills; Windmills and windmill towers; Tractors

Industry 126 (Industry 1950: 357)

Typewriters and supplies; Typewriters and supplies, carbon paper; Office and store machines, not elsewhere classified; Typewriters and supplies, typewriters and parts; Carbon paper and inked ribbons; Typewriters and supplies, except typewriters and parts and carbon paper; Typewriters and parts

Industry 127 (Industry 1950: 357)

Scales and balances

Industry 128 (Industry 1950: 358)

Washing machines and clothes wringers; Washing machines, clothes wringers; Washing machines, wringers, driers, and ironing machines, for household use; Laundry equipment, domestic

Industry 129 (Industry 1950: 358)

Sewing machines and attachments; Sewing machines, domestic and industrial; Sewing machines, cases, and attachments; Sewing-machine cases

Industry 130 (Industry 1950: 376)

Carriage and wagon materials; Carriages and wagons, including repairs; Wheelbarrows; Automobiles, including bodies and parts; Carriages, wagons, sleighs, and sleds; Carriages and wagons; Automobile bodies and parts; Motor vehicles, not including motorcycles; Motor-vehicle bodies and motor-vehicle parts; Carriages and wagons,including repairs, repair work only; Carriages and wagons,including repairs, cars and wagons; Carriage, wagon, sleigh, and sled materials; Automobiles; Carriages and wagons and materials; Automobile trailers (for attachment to passenger cars); Motor vehicles, motor-vehicle bodies, parts and accessories; Transportation equipment not elsewhere classified

Industry 131 (Industry 1950: 379)

Cars and general shop construction and repairs by steam-railroad companies; Car and general construction and repairs, steam-railroad repair shops; Cars, street-railroad, not including operations of railroad companies; Cars, electric-railroad, not including operations of railroad companies; Cars, railroad and street, and repairs, not including establishments operated by steam railroad companies; Cars and general shop construction and repairs by steam railroad companies; Cars, electric and steam railroad, not built in railroad repair shops; Cars and general shop construction and repairs by street railroad companies; Cars and general shop construction and repairs by street-railroad companies; Cars, street railroad, not including operations of railroad companies; Car and general construction and repairs, electric-railroad repair shops; Cars, steam-railroad, not including operations of railroad companies; Cars, steam railroad, not including operations of railroad companies; Cars and car equipments-railroad, street, and rapid-transit; Cars and general shop construction and repairs by electric-railroad companies

Industry 132 (Industry 1950: 377)

Bicycles and tricycles; Aeroplanes, seaplanes, and airships, and parts; Bicycles, motorcycles, and parts; Motorcycles, bicycles and parts; Aircraft and parts, including aircraft engines; Motorcycles, bicycles, and parts; Aircraft and parts

Industry 133 (Industry 1950: 378)

Shipbuilding, including boat building; Shipbuilding; Shipbuilding, wooden, including boat building, yards where work on new vessels was done; Shipbuilding, wooden, including boat building, yards engaged entirely on repair work; Shipbuilding, wooden, including boat building, boats under 5 tons; Boat building and boat repairing; Shipbuilding, iron and steel; Shipbuilding, steel, repair work only, small boats, and masts, spars, oars, and rigging; Shipbuilding, steel, new vessels; Shipbuilding, steel, new vessels, small boats, and masts, spars, oars, and rigging; Shipbuilding, steel; Ship and boat building, steel and wooden, including repair work; Shipbuilding and ship repairing; Ship and boat building, wooden; Shipbuilding, steel, repair work only; Shipbuilding, wooden, including boat building; Shipbuilding, wooden, including boat building, masts, spars, oars, and the rigging of vessels

Industry 134 (Industry 1950: 386)

Instruments, professional and scientific; Surgical appliances; Artificial limbs; Surgical and medical instruments; Surgical supplies and equipment not elsewhere classified; orthopedic appliances; Instruments, professional and scientific, medical and surgical; Surgical and orthopedic appliances, including artificial limbs; Surgical appliances and artificial limbs; Instruments, professional and scientific, except medical and surgical; Professional and scientific instruments (except surgical and dental)

Industry 135 (Industry 1950: 387)

Photographic materials, motion-picture films not exposed, and motion-picture projection films; Photographic apparatus, except cameras and motion-picture machines; Photographic apparatus and materials; Photographic materials; Photographic apparatus; Photographic apparatus and materials and projection equipment (except lenses); Photographic apparatus, cameras and motion-picture machines; Photographic materials, except motion-picture films; Photographic materials, motion-picture films; Photographic materials, except motion-picture films not exposed, and motion-picture projection films

Industry 136 (Industry 1950: 386)

Optical goods; Optical instruments and lenses; Ophthalmic goods: lenses and fittings

Industry 137 (Industry 1950: 386)

Dentists' materials; Dental goods; Dental equipment and supplies; Dental goods and equipment

Industry 138 (Industry 1950: 399)

Musical instruments, piano and organ materials; Musical instruments, organs and materials; Muscial instruments: Organs; Musical instruments: Pianos; Musical instruments and parts and materials, not elsewhere classified; Musical instruments and materials, not specified; Musical instruments, pianos; Musical instruments, pianos and organs and materials; Musical instruments, parts, and materials not elsewhere classified; Musical instruments, pianos and materials; Pianos; Organs; Musical instruments, organs; Musical instrument parts and materials: Piano and organ; Piano and organ parts and materials

Industry 139 (Industry 1950: 399)

Toys and games; Games and toys (except dolls and children's vehicles); Dolls (except rubber); Toys (not including children's wheel goods or sleds), games, and playground equipment

Industry 140 (Industry 1950: 399)

Carriages and sleds, children's; Children's vehicles

Industry 141 (Industry 1950: 399)

Sporting and athletic goods; Sporting goods; Sporting and athletic good not elsewhere classified; Sporting and athletic goods, not including firearms or ammunition; Billiard tables and materials; Billiard tables, bowling alleys, and accessories; Billiard and pool tables, bowling alleys, and accessories

Industry 142 (Industry 1950: 399)

Pens, steel; Pens, gold; Pencils (except mechanical) and crayons; Pens, fountain and stylographic; Pens, fountain, stylographic and gold; Artists' materials; Pencils, lead; Pens, fountain and stylographic; pen points, gold, steel, and brass; Pens, mechanical pencils, and pen points; Pencils, lead (including mechanical)

Industry 143 (Industry 1950: 399)

Stencils and brands; Hand stamps, stencils and brands; Hand stamps; Hand stamps, stencils, and brands; Hand stamps and stencils and brands

Industry 144 (Industry 1950: 399)

Buttons

Industry 145 (Industry 1950: 399)

Jewelry and instrument cases; Jewelry cases and instrument cases

Industry 146 (Industry 1950: 399)

Feathers and plumes; Artificial feathers and flowers; Artificial flowers; Feathers, plumes, and manufactures thereof; Feathers, plumes, and artificial flowers; Artificial and preserved flowers and plants; Artificial flowers, feathers and plumes

Industry 147 (Industry 1950: 399)

Brooms and brushes; Brooms; Brushes; Brooms, from broom corn; Brushes, other than rubber; Brushes, except toilet; Brushes, toilet; Brooms, except from broom corn; Brushes, other than toilet

Industry 148 (Industry 1950: 399)

Furs, dressed; Furs, dressed and dyed

Industry 149 (Industry 1950: 399)

Umbrellas and canes; Umbrellas, parasols, and canes

Industry 150 (Industry 1950: 399)

Pipes (tobacco); Pipes, tobacco; Tobacco pipes and cigarette holders

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Industry 151 (Industry 1950: 399)

Soda water apparatus; Soda fountains, beer dispensing equipment, and related products; Soda-water apparatus

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Industry 152 (Industry 1950: 399)

Models and patterns; Models and patterns (except paper patterns); Models and patterns, not including paper patterns

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Industry 153 (Industry 1950: 399)

Hair work; Hairwork

Industry 154 (Industry 1950: 399)

Needles, pins, hooks and eyes, and snap fasteners; Needles and pins; Hooks and eyes; Needles, pins, hooks and eyes, and slide and snap fasteners; Needles, pins, hooks and eyes; Needles, pins, and hooks and eyes

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Industry 155 (Industry 1950: 399)

Fire extinguishers, chemical

Industry 156 (Industry 1950: 399)

Ivory and bone work; Combs; Fancy and miscellaneous articles, not elsewhere classified, paper and wood novelties; Fancy articles, not elsewhere specified; Fancy and miscellaneous articles, not elsewhere classified; Theatrical scenery and stage equipment; Ivory, shell, and bone work, not including combs and hairpins; Fancy articles, not else where specified; Ivory, shell, and bone work, not including buttons, combs, or hairpins; Miscellaneous fabricated products not elsewhere classified; Fancy and miscellaneous articles, not elsewhere classified, except beadwork, celluloid and metal novelties; Fancy and miscellaneous articles, not elsewhere classified, metal novelties; Fancy and miscellaneous articles, not elsewhere classified, except metal and paper novelties; Theatrical scenery; Combs and hairpins, not made from metal or rubber; Fancy and miscellaneous articles, not elsewhere classified, except beadwork, celluloid, metal and paper novelties; Fancy and miscellaneous articles, not elsewhere classified, metal and wood novelties; Fancy and miscellaneous articles, not elsewhere classified, beadwork and celluloid novelties; Fancy and miscellaneous articles, not elsewhere classified, paper novelties; Fancy and miscellaneous articles, not elsewhere classified, metal and paper novelties; Fancy and miscellaneous articles, not elsewhere classified, wood novelties; Fancy and miscellaneous articles, not elsewhere classified, except paper and wood novelties; Fancy and miscellaneous articles, not elsewhere classified, except metal and wood novelties; Combs and hairpins, except those made from metal or rubber; Lamp shades