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ABSTRACT

Industrialization and urbanization are seen as interdependent processes of modern economic development. However, the exact nature of their causal relationship is still open to considerable debate. This paper uses firm-level data from the manuscripts of the decennial censuses between 1850 and 1880 to examine whether the adoption of the steam engine as the primary power source by manufacturers during industrialization contributed to urbanization. While the data indicate that steam-powered firms were more likely to locate in urban areas than water-powered firms, the adoption of the steam engine did not contribute substantially to urbanization.

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I. Introduction

Industrialization and urbanization are seen as interdependent processes of modern economic development. In the United States, industrialization began in the early nineteenth century as manufacturing re-organized from artisanal shops to non-mechanized factories in a handful of industries; however, in the second half of the nineteenth century, manufacturing activity rose in scale, became more mechanized and spread to numerous industries. The rise of a manufacturing sector, especially in the second half of the nineteenth century, coincided with a significant growth in urban population. As the domestic labor force in manufacturing doubled from 10% to 20% between 1850 and 1880, so too did the share of the population in urban places, from 15% to 30%.

One of the major developments associated with industrialization was the shift in primary power sources for manufacturing from hand and water power to steam power, particularly in large factories. This shift towards greater use of steam power by manufacturers is believed to be explained by a sharp decline in the relative user cost of steam compared to other power sources. According to Atack's (1979) estimates, the annual costs per horsepower of steam fell below that of water power in the 1840s. By 1870, steam power capacity in manufacturing was greater than that of water-power (Fenichel (1979) and Rosenberg and Trajtenberg (2004)). While rigorous comparisons of hand and steam power costs do not exist, the relative cost of using hand power may have risen as wages were increasing over this period (see Margo (2000)).

In a recent paper, Rosenberg and Trajtenberg (2004) argue that the adoption of the steam engine by manufacturers, and in particular the Corliss engine, was responsible for the rapid rise in urbanization.[1] By releasing firms from the locational limitations of topography and climate and offering them the freedom to locate in cities, they argue that the deployment of the Corliss steam engine served as a catalyst for the relocation of firms from rural locations to cities. While the idea that the steam engine contributed to urbanization is not new, and indeed many early promoters of the steam engine proclaimed locational freedom as one of its major benefits, Rosenberg and Trajtenberg's paper represents the first serious empirical estimate of this hypothesis.[2] In sum, they show that counties which adopted a higher stock of Corliss steam-engines as of 1870 exhibited faster population growth in subsequent decades.

This paper evaluates the role of the steam engine, as well as other primary power sources, on the location of manufacturing firms using establishment-level data from the manuscript censuses of manufactures for the period between 1850 and 1880. Since the data from the manuscript censuses contain information on power sources of establishments and whether these establishments were in rural or urban places, it is possible to estimate more precisely whether the adoption of the steam engine contributed to urbanization. Although the census data do not distinguish between Corliss and other types of steam engines, there is little reason to believe that the locational impact of steam engines was isolated to the Corliss type.

The analysis of the manuscript census data show that steam-powered employees were on

1 Rosenberg and Trajtenberg believe that the Corliss steam engine was a general purpose technology that was responsible for triggering economic growth in the late nineteenth century. They argue that the steam engine, by fostering urbanization, allowed the economy to capture significant benefits of agglomeration economies. However, previous studies that use the growth accounting framework suggest a limited role of general purpose technologies on economic growth. For example, Crafts (2004) and Crafts and Mills (2004) find that the impact of the steam engine on UK economic growth was rather modest. A social savings calculation suggests that the steam engine's contribution to growth was about 0.05% per year between 1870 and 1910.

2 For example, the *Scientific American*, in their May 12, 1849 issue, wrote: "A water-mill is necessarily located in the country afar from the cities, the markets, and the magazines of labor, upon which it must be dependent. Water appears to run very cheaply, but it always rents for a high price, and the [capital] cost of dams, races, water wheels etc. is on the average quite as great as that of a steam engine and equipage... A man sets down his steam-engine where he pleases - that is, where it is most to his interest to plant it, in the midst of the industry and markets, both for supply and consumption of a great city - where he is sure of always having hands near him, without loss of time in seeking for them, and where he can buy his raw materials and sell his goods, with adding the expense of double

average almost five and a half times more likely to locate in cities than water-powered employees between 1850 and 1880. However, when compared to employees that did not use inanimate power as their primary power source, such as hand-power, steam-powered employees were on average 0.55 times less likely to locate in cities. At any given point in time, the differences in predicted probabilities of urbanization for steam powered employees were negligible. However, when the calculations factor into account the changes in the distribution of primary power sources over time, the shift in power source from hand and water-power into steam-power may have contributed to about 8-10% increase in the rate of urbanization.

Rather than the adoption of steam-power, the shift from artisanal to factory organization of production in manufacturing may have been the single most important contributor to urbanization in the second half of the nineteenth century. Factory workers, who did not use inanimate power, as well as steam-powered and water-powered factory workers were on average two to three times more likely to locate in cities than their non-factory counterparts. Factory production is estimated to have increased urbanization by about 27% at any given point time. Finally, employees in firms with a higher intensity of female labor were much more likely to locate in urban areas whereas employees with a higher intensity of child labor were less likely to do so.

II. Data

This paper uses the Atack-Bateman-Weiss (ABW) sample of manufacturing firms drawn from the manuscripts of the decennial censuses for 1850, 1860, 1870 and 1880 to examine whether the adoption of the steam engine contributed to urbanization. In addition to the typical census type information on output, raw materials, capital, labor, and wages, the data provide

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transportation." See Hunter (1985, p.104).

information on primary power source. For 1850-1870, the census enumerators collected information on whether an establishment used one of five types of power sources: water, steam, hand, animal, and combination. However, information on the level of horsepower was only sporadically reported for a meaningful analysis of this variable. For 1880, the census schedules provide information on the level of primary horsepower generated by water and steam, but do not contain information on other types of power sources.

The ABW data contain information on the location of firms at the county level and whether its location is urban or rural. An area was defined as urban if it was an incorporated town or city which contained a population of at least 2,500. However, it is important to note that, unlike the modern definition which uses the county as the smallest geographic unit of analysis for determining whether a place is rural or urban, the most likely unit of geographic observation was the minor civil division during this period. Thus, it is possible to infer from the data whether an establishment was located in the rural or urban part of the county. Finally, the establishments are categorized by standard industrial code (sic) at the 3-digit industry level.

To eliminate potential outliers in the data, the samples were restricted to establishments with positive values of output, employment and capital. Firms with capital-labor ratios below $50 per worker were omitted. The data were restricted to manufacturing industries defined by modern 3-digit industries ranging from 200 to 399; however, 351 (steam engine) was deleted. For the 1880 data, the so-called "special agent" industries are under-represented in the random sample. In a number of industries, such as cotton, wool, silk, iron and steel, etc., experts rather than regular enumerators were chosen to gather information. However, these manuscript schedules collected by "special agents" have never been located. Several strategies are deployed to ensure that the data analysis is robust to the under-enumeration of these industries.[3]

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3 The articles by Atack, Bateman and Margo (2002, 2003, 2004) carefully address many of the important data

Table 1 demonstrates that the manufacturing employment of the establishments in the ABW sample became increasingly more urbanized between 1850 and 1880. Over this period, the share of employment in urban locations rose from 40% to 71%. However, the growth in urbanization of the manufacturing labor force was not monotonic as the share of urban employment fell between 1860 and 1870. Unfortunately, it is difficult to know whether this decline was caused by the Civil War or whether it is related to sampling problems with the 1870 data, such as an under-enumeration of firms in the South. From a regional perspective, little discernible patterns emerge in the ABW data except for the possible emergence of north-south divergence in urbanization rates by 1880.

Table 2 reports the share of urban manufacturing employment by 2-digit industries. The ABW data indicate that the share of manufacturing employment in urban locations varied significantly by industries. Employees in tobacco, apparel, printing and miscellaneous industries were much more likely to locate in cities whereas those in food and lumber-wood industries were more likely to reside in rural places. For employment in some industries such as textiles and primary metals, locational patterns shifted somewhat over time and became more concentrated in cities by 1880. The industry data also indicate that the drop in urbanization between 1860 and 1870 was heavily concentrated in a few industries such as apparel, lumber-wood, paper, and chemicals.

III. Did the Steam Engine Contribute to the Growth of Cities?

To assess whether the adoption of the steam engine led firms to locate in urban areas, we select a discrete choice model where the dependent variable takes on a value of 1 if a firm is located in an urban area and 0 if it is located in a rural area. More specifically, the regression

issues, including those related to "special agent" industries, that pertain to the ABW data.

estimates are based on the logit model of the following form:

$$(1)\ \ ln[P_i/(1 - P_i)] = a + ß_1\ Location_i + ß_2\ Industry_i + ß_3\ Factory_i + ß_4\ Women_i + ß_5\ Children_i + ß_6\ Steam_i + ß_7\ Water_i + ß_8\ Steam{*}Factory_i + ß_9\ Water{*}Factory_i + u_i$$

where P_i is the probability that a firm *i* is located in an urban area and $(1-P_i)$ is the probability that it is located in a rural area. To estimate the impact of primary power sources on location, we construct dummy variables for steam-powered and water-powered firms; the omitted category is dominated by hand-powered firms, but also include a small number of firms that use some combination of various power sources.

To control for other factors that influence firm location decisions, we include as independent variables a factory dummy variable, which equals one if a firm employed more than 15 laborers, the share of women employees, the share of children employees (for 1880 only), and interactions between steam and water power dummy variables with the factory dummy variable.[4] In addition, to account for unmeasured industry and location specific effects, the regressions contain 3-digit industry and county-level locational fixed-effects, respectively.

The regression sample means are reported in Table 3. Between 1850 and 1880, the proportion of workers in factories rose steadily from 61.3% to 77.9%. Over the same time period, the share of steam-powered employees rose from 20.7% to 52.2% whereas the share in water-power fell from 31.7% to 6.3%. Similarly, the share of steam-powered factory workers rose from 17.0% to 46.2% whereas that of water-powered factory workers fell from 21.4% to 3.1%. The intensity of female labor in manufacturing declined from 23.3% to 16.6%, but this decline may be an artifact of changes in reporting criterion. In 1850 and 1860, the data contain female workers of all ages; however, in 1870 and 1880, the data only include female workers over fifteen years of age. In 1880, about 4% of the manufacturing employment in the ABW

4 Employment is defined as one plus men, women and child employees.

sample was comprised by children.

The logistic regressions reported in this paper are weighted by employment. However, there are differing strategies for interpreting the logistic regression coefficients. One standard strategy involves reporting the coefficients in odds-ratios, (P/(1-P)), by simply taking the exponent or anti-logarithm of the logit regression coefficients. The odds-ratio has the simple interpretation in that a coefficient greater (less) than one means that manufacturing employment is more (less) likely to locate in an urban rather than a rural location. The second strategy involves translating the effects on logged odds into the effects on probabilities. This latter strategy provides a more concrete estimate of the independent variable's effect on urbanization.

Table 4 reports the logistic regression coefficients in terms of odds-ratios. The results indicate that steam-powered employees were more likely to locate in urban locations than water-powered employees, but were less likely to do so compared to employees in the omitted category.[5] Compared to water-powered employees, steam-powered employees were 8.7 times more likely to locate in cities in 1850, but that figure declined to an average of 4.3 for the decades between 1860 and 1880. On the other hand, when compared to the employees in the omitted category, steam-powered employees were on average 0.64 times less likely to locate in cities between 1850-1870. In 1880, the odds fell even more sharply to 0.29, but this decline may be in part due to a change in reporting procedure for primary power data.[6]

Factory employees, those who worked for establishments with greater than 15 employees, were on average twice as more likely to locate in cities than those in smaller establishments. Except for 1850, steam-powered factory employees were also more likely to

5 The omitted category consists of establishments that used hand, animal, and combination of power sources as well as those that failed to report their sources of primary power.

6 In order to determine whether the results of the paper are sensitive to the under-enumeration of "special agent" industries for 1880, the analysis was repeated accordingly. First, "special agent" industries were re-weighted to match the published aggregates. Second, the "special agent" industries were omitted from the sample. In both

locate in cities. The interaction between steam-power and factory dummy variables indicate that employees in steam-powered factories were 1.7 and 1.2 times more likely to locate in cities in 1860 and 1870, and 3.5 times more likely in 1880. Surprisingly, employees in water-powered factories, except for 1860, were even more likely to locate in cities than those of steam-powered factories. In 1850, employees in water-powered factories were 2.8 times more likely to locate in cities than those in other firms; the odds-ratio fell to 1.2 in 1860, but rose again to 2.2 and 3.6 in 1870 and 1880, respectively.

For 1880, a second logistic regression, equation (5), was estimated using levels of horsepower of steam and water power and their interactions with a factory dummy. For this specification, the odds of locating in cities declined to 0.75 and 0.72 for a unit increase in steam and water power per worker, respectively; however, their factory interaction was significant for steam but not for water power. The lack of significance may be due the positive correlation between horsepower intensities in steam and water power and factory organization.

Employees in firms with a higher intensity of women workers were much more likely to locate in cities. Except for 1850, when the coefficient was not significant, an increase in the intensity of women workers increased the probability of locating in cities from 1.3 to 9.6 times between 1860 and 1880. On the other hand, employees of firms that utilized children more intensely in 1880 were more likely to locate in rural locations.

While the odds-ratios provide an intuitively useful way of interpreting the logit model, an alternative strategy of estimating out-of-sample predictions in probabilities provides a means of estimating the changes in the probability of the dependent variable associated with a change in the independent variable. However, since the relationships between the independent variables and the dependent variable in probability are non-linear and non-additive, the simple partial

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instances, the logit regression estimates were essentially identical to those reported in the paper.

derivative, especially for dichotomous dummy variables, is a poor estimate of the effects on probability. Instead, to derive a more accurate estimate, it is necessary to calculate the predicted differences in probabilities associated with a dummy variable group or a standard deviation change of a continuous independent variable (see Sample (2000), Hamilton (2004)).

This paper employs two types of counter-factual experiments based on predicted probabilities. The first method is analogous to using the standard partial equilibrium framework where predicted changes in probability of the dependent variable is estimated for a change in an independent variable holding all other variables constant. This method estimates the contribution of the steam engine (or other independent variables) on urbanization at any given point in time assuming that all other factors are held constant. The second method takes into account the changing distribution of primary power sources over time. As shown in Table 3, there has been a systematic shift in primary power sources from hand and water to steam power over time. This method estimates the changes in the level of urbanization over time that can be attributed to the changing distribution of primary power sources.

To estimate the predicted probabilities based on the first method outlined above, it is necessary to select a starting point for calculating the out-of-sample predictions. While there is no standard choice, a useful one is the probability associated with the sample mean. For example, the sample mean of the share of urban manufacturing employment in 1880 as reported in Table 3 is P_0=0.71; the logit for this probability, L_0, is equal to 0.8954 ($\ln(P_0/(1-P_0))=\ln(0.71/0.29)$). To compute the impact of an independent variable on urbanization, the logistic regression coefficient in logit (logarithm of the odds-ratios reported in Table 3) is added to the initial logit value. If the independent variable is a dummy variable, then $L_1=L_0 + ß_i$; if the independent variable is continuous, then $L_1=L_0 + ß_i*SD_i$, where SD is the standard deviation. The probability associated with this new logit L_1 is then equal to $P_1=1/(1+e^{-L1})$. The difference in predicted probabilities, P_1 minus P_0, measures the independent variable's impact on urbanization.

The computations on predicted probabilities indicate that the adoption of factory production and female intensive labor force contributed positively to urbanization, but that the adoption of inanimate primary power sources, both steam and water power, led to a decrease in urbanization. While the reported estimates are based on the 1880 logit coefficients, similar results are obtained for other years. Factory production based on animate power sources increased the share of urban manufacturing employment by 10%, but if steam and water-powered factories are included, then the impact factories increased to 27%. Like factory production, one standard deviation increase in the intensity of the female labor force increased urbanization by about 11%.

Surprisingly, the adoption of the steam engine contributed to a significant decline in the probability of urban employment. The steam power dummy variable contributed to a decline in urban employment by 29.5%. However, the net effect of the steam engine, when one includes the effect of steam-powered factories, was negligible. The adoption of water power led to an even more significant decline in the share of urban employment. The water power dummy variable accounted for a 55.6% decline in the share of urban employment; however, if the impact of water-power factories was added, water-power on net contributed to a 31.3% decline in urban manufacturing employment. When the exercise was repeated for equation (5) using levels of horsepower, a standard deviation increase in horsepower per worker led to a decline in urban employment by 9% and 11% for steam and water, respectively.

The second counter-factual experiment asks how much of the changes in urbanization over time can be attributed to the change in the distribution of power sources from hand and water-power to steam-power. Using the 1850 estimated logit coefficients, it is possible to estimate the predicted changes in the rate of urbanization if the 1880 mean distribution of employment in water-powered shops, steam-powered shops, non-powered factory, water-powered factory, and steam-powered factory is used, holding all other variables at the 1850 sample means. By this estimation, the shift in the distribution of power sources, which also takes into account the changes in the organization of production, may have increased urbanization by about 8% between 1850 and 1880. Alternatively, if the 1880 logit coefficients are used on the 1850 employment distribution, then the change in the rate of urbanization is about 10%.

Despite the lengthy set of controls, the logit coefficient estimates on the steam engine variable are likely to be biased upwards due to omitted factors that are positively correlated with use of steam and location in an urban area. If the choice of power sources is endogenous, then there may be an endogeneity bias in the regression estimates since urban firms were more likely to adopt steam engines rather than water wheels as their primary power source. On the other hand, measurement error in the use of steam may bias the results in the opposite direction, although this bias is likely to be mitigated by the use of dummies rather than horsepower. Finally, to determine whether there may be an additional bias caused by the fact that establishments in some industries may reside solely in urban or rural locations within a county, the regressions were repeated without county fixed-effects and the results were essentially unchanged.

Decomposing Industry Fixed-Effects

The data presented in Table 2 indicate that some industries were much more likely to locate in urban areas than others. Table 5 examines the role of industry fixed-effects by estimating logit regressions based on dummy variables for 2-digit industries. The omitted industry was stone, clay and glass (sic 32), as well as a few other manufacturing industries (sic 29, sic 30, sic36, sic 38) whose sample sizes were very small. While there were considerable variations in the data, the logit regressions show that firms in some industries such as lumber and wood, chemicals, leather, and transportation were relatively more likely to locate in rural areas; on the other hand, firms in printing, miscellaneous and apparel manufactures were generally more likely to locate in urban areas.

The examination of the industrial patterns of urbanization show that industries that were more likely to locate in rural areas were generally intensive in raw materials derived from agriculture and forests. On the other hand, the industries that were more likely to locate in urban areas were mostly labor intensive such as printing, miscellaneous and apparel, and to a lesser extent tobacco and textiles industries. It is also interesting to note that some industries such as lumber and wood that relied on intensive use of inanimate power were more likely to locate in rural rather than in urban areas.

IV. Conclusion

Modern economic development has been associated with industrialization and urbanization. In the United States, while cities existed prior to the nineteenth century, the rapid rise of urbanization coincided with industrialization that took hold and grew over the course of the nineteenth century. This paper examines whether the growing importance of the steam engine as a primary power source by manufacturers during the second half of the nineteenth century was responsible for the rise of urbanization during industrialization.

The analysis of establishment data from the manuscript censuses shows that, contrary to the findings of Rosenberg and Trajtenberg (2004), the steam engine did not serve as a catalyst for the relocation of manufacturers from rural areas to large urban centers. While steam-powered employees were much more likely to locate in cities when compared to water-powered employees, the net impact of urbanization caused by steam power at any given point time was negligible. Over time, the shift in primary power sources from hand and water to steam power may have contributed to an increase of about eight to ten percent increase in the rate of urbanization but the actual figure is likely to be considerably less. Rather than steam power, the data indicate that the shift from artisan to factory production contributed significantly to urbanization. Regardless of whether the factory used steam, water or hand power, factory production increased the likelihood of firms and employment locating in cities.

One of the most important developments associated with industrialization was the rise of the labor market. While it is difficult to infer the causes of urbanization from the analysis presented in this paper, one intriguing theory that is broadly consistent with the data is based on labor market transactions costs. When the labor market is composed of heterogeneous firms and workers who must search and match for production, economic agents have an incentive to agglomerate in cities since search costs are likely to decline with the density of the labor market.[7] The data show that factories that employed a larger workforce and industries that were labor intensive all tended to locate in cities rather than in rural areas.

7 See Kim (1989) and Helseley and Strange (1990).

Table 1

Share of Urban Manufacturing Employment by Region:
Data from the Census Manuscripts
(percentage)

	1850	1860	1870	1880
United States	40.4%	51.5%	44.2%	71.0%
New England	38.7	39.6	29.6	68.7
Middle Atlantic	43.9	67.2	60.4	78.4
East North Central	31.5	35.5	33.7	71.0
West North Central	50.8	43.1	37.1	64.8
South Atlantic	41.8	58.4	13.2	62.5
East South Central	33.0	27.5	58.0	48.5
West South Central	7.3	15.4	24.4	29.2
Mountain	-	-	-	-
Pacific	72.7	30.4	52.2	51.3

Sources: See Atack and Bateman (1999).

Table 2

Share of Urban Manufacturing Employment by Industry:
Data from the Census Manuscripts
(percentage)

	1850	1860	1870	1880
All Manufactures	40.4%	51.5%	44.2%	71.0%
20 Food	35.3	48.8	45.1	64.0
21 Tobacco	73.5	71.3	44.5	88.0
22 Textiles	31.9	47.3	38.7	81.1
23 Apparel	72.3	82.3	69.2	89.4
24 Lumber	18.8	24.4	15.5	31.7
25 Furniture	50.3	54.1	53.0	69.9
26 Paper	42.1	67.9	27.6	75.1
27 Printing	83.7	82.3	72.3	98.2
28 Chemicals	35.3	54.2	22.1	52.1
29 Petroleum	-	-	-	-
30 Rubber	-	-	-	-
31 Leather	36.7	41.9	34.9	68.8
32 Stone	48.0	52.5	44.4	49.5
33 Primary	12.3	55.7	49.0	73.3
34 Fabricated	51.9	63.3	52.7	72.5
35 Machinery	78.3	63.8	69.4	65.9
36 Electrical	-	-	-	-
37 Transportation	30.2	42.3	29.5	83.0
38 Instruments	44.0	-	-	95.5
39 Miscellaneous	81.6	76.0	71.3	88.5

Sources: Atack and Bateman (1999).

Table 3

Regression Sample Means Weighted by Employment, 1850-1880

	1850	1860	1870	1880
Urban	0.404	0.515	0.442	0.710
Factory	0.613	0.644	0.702	0.779
Women	0.233	0.222	0.164	0.166
Children	-	-	-	0.043
Steam	0.207	0.251	0.415	0.522
Water	0.317	0.269	0.189	0.063
Steam*Factory	0.170	0.187	0.342	0.462
Water*Factory	0.214	0.188	0.143	0.031
Number of Firms	4,402	4,700	3,912	5,654
Number of Emp.	44,375	51,709	47,552	87,599

Sources: Atack and Bateman (1999).

Table 4

Determinants of Urban Location of Manufacturing Employment, 1850-1880
(Logit regression reported in odds-ratio with z-statistics in parentheses)

	1850 (1)	1860 (2)	1870 (3)	1880 (4)	1880+ (5)
Factory	2.132* (24.6)	2.020* (25.3)	3.296* (36.7)	1.732* (20.7)	2.237* (37.0)
Women/Labor	0.993 (-0.2)	2.606* (21.7)	1.314* (5.7)	9.590* (47.9)	7.891* (44.0)
Children/Labor	-	-	-	0.931 (-0.8)	0.719* (-3.7)
Steam	0.664* (-7.1)	0.581* (-12.5)	0.659* (-8.4)	0.290* (-33.4)	0.749* (-26.8)
Water	0.076* (-38.8)	0.167* (-35.4)	0.122* (-21.1)	0.074* (-39.5)	0.719* (-27.5)
Steam*Factory	0.635* (-6.8)	1.662* (9.6)	1.189* (3.1)	3.533* (29.6)	1.183* (12.6)
Water*Factory	2.826* (14.1)	1.163* (2.5)	2.196* (7.5)	3.643* (16.3)	1.032 (1.7)
Fixed effects					
County	yes	yes	yes	yes	yes
Industry	yes	yes	yes	yes	yes
Pseudo R^2	0.13	0.11	0.08	0.15	0.14
# of Est.	4,351	4,679	3,833	5,535	5,533
# of Emp.	42,004	51,059	46,256	83,849	83,547

* $P<0.05$.

Table 5

Decomposing Industry Fixed-effects
(Logit regression reported in odds-ratio)

Urban Employment	1850	1860	1870	1880
Factory	2.26*	2.06*	3.14*	1.68*
Women/Labor	0.81*	1.77*	1.01	3.03*
Children/Labor	-	-	-	0.29*
Steam	1.11	0.70*	0.75*	0.41*
Water	0.12*	0.17*	0.13*	0.09*
Steam*Factory	0.67*	1.22*	1.16*	3.25*
Water*Factory	4.72*	1.19*	2.35*	3.26*
20 Food	1.64	1.68*	2.03*	2.58*
21 Tobacco	3.42	2.17*	0.98*	6.31*
22 Textiles	0.67*	1.33*	0.88	4.43*
23 Apparel	2.91*	2.51*	2.34*	4.93*
24 Lumber	0.65*	0.55*	0.38*	0.64*
25 Furniture	1.47*	1.28*	1.69*	2.86*
26 Paper	1.46*	2.56*	0.44*	2.79*
27 Printing	6.75*	4.01*	3.71*	62.5*
28 Chemicals	0.81*	1.07	0.32*	1.16*
29 Petroleum	-	-	-	-
30 Rubber	-	-	-	-
31 Leather	0.69*	0.59*	0.72*	2.12*
32 Stone	+	+	+	+
33 Primary	0.18*	1.15*	1.12	2.64*
34 Fabricated	1.40*	1.76*	1.40*	2.13*
35 Machinery	1.10*	1.87*	1.50*	1.94*
36 Electrical	-	-	-	-
37 Transportation	0.51*	0.72*	0.55*	4.91*
38 Instruments	-	-	-	-
39 Miscellaneous	5.36*	2.52*	2.91*	9.17*
Fixed effects				
County	yes	yes	yes	yes
Pseudo R^2	0.16	0.14	0.15	0.22
Observations	41,869	51,013	45,800	82,303

+ Omitted category.
* P<0.05.

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