Immigration, Industrial Revolution and Urban Growth in the United States, 1820-1920:

Factor Endowments, Technology and Geography

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Industrial revolution is associated with a major technological change in manufacturing which substituted the work of skilled artisans who crafted the entire product with factories that used division of labor of relatively unskilled workers along an assembly-line. This paper explores whether the massive influx of unskilled immigrants between 1840 and 1920, by significantly increasing the ratio of unskilled to skilled labor endowment, contributed to the growth of factories in the United States. Using an identification strategy based on the assumed exogenous increase in immigration caused by the potato famine in Europe in the mid-nineteenth century, I find that firms in counties which had a higher share of foreign-born were significantly more likely to be organized as factories between 1860 and 1880.

I. Introduction

The century between 1820 and 1920 defined America as a nation of immigrants or a "melting pot." During this century, more than 33 million people entered the ports of the United States. Immigrants from Europe came in massive waves until the era of open immigration ended with the passage of the 1921 Emergency Quota Act (Figure 1).[1] By the end of the first three decades of immigration, the census of 1850 finds that almost 10% of Americans was foreign-born. The share of the foreign-born population fluctuated around 13-15% between 1860 and 1920, but immigrants and their children represented 30-40% of the white population (Figure 2). With the passage of the Immigration Act of 1965, immigration rose steadily during the last three decades. However, this recent wave of immigration pales in comparison to that of the earlier waves in duration and in terms of the share of aggregate population (Figure 3).

What impact did immigration have on the American economy during the era of mass immigration? Goldin (1994) and Hatton and Williamson (1998) find that immigrants and natives were substitutes; immigration lowered native wages and displaced natives from the northeastern United States where immigrants largely settled.[2] Studies on immigrant assimilation generally find that immigrants earned lower wages on arrival but provide different assessments on their rates of assimilation. While Hannon (1982), Eichengreen and Gemery (1986) and Hanes (1996) find that wage growth among immigrants was slower than native-born workers, Blau (1980), Hatton (1997), and Minns (2000) find that immigrants experienced faster wage growth than native-born and caught up to native-born level of earnings within 20 or 25 years. For the

1 The movement to restrict immigration in the U.S. started in the late nineteenth century. Between 1897 and 1917, the House and the Senate passed numerous bills on literacy tests which finally became law in 1917. When literacy tests proved to be ineffective in curbing immigration, the Congress moved toward a quota system. See Hingham (1955) and Goldin (1994).

2 Friedberg and Hunt (1995) provide an excellent summary of the literature, especially of works on the impact of immigration on the second half of the twentieth century. Most studies on recent immigration find that immigrants and natives are substitutes. Some studies such as Borjas (1999) and Borjas, Freeman and Katz (1997) find large negative impact whereas Card (2001) finds small impact. On the other hand, Ottaviano and Peri (2005a, 2000b)

antebellum period, Ferrie (1999) finds that immigrants were geographically, occupationally and financially mobile.[3] However, from an aggregate perspective, because American real wages rose steadily between 1820 and 1920, many scholars such as Goldin (1994) point to the absorptive capacity of the American economy (Figure 4).[4]

In this paper, I explore whether immigration had a more fundamental impact on the American economy between 1860 and 1920. In particular, I investigate whether immigration during this period had a significant impact on the growth and spread of factory organization in manufacturing. Between 1820 and 1840, when factory production was still in its infancy in America, immigration may have hindered the spread of factories as many skilled European artisans sought refuge from the spread of European factory production by moving to America. Immigration after 1840, however, is likely to have contributed to the growth of factories as it significantly increased the unskilled to skilled labor endowment ratio in America. Because factory production utilized unskilled workers intensely, the dramatic increase in unskilled to skilled labor endowment ratio is likely to have had a significant impact on the growth of factory production in the United States.[5]

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argue that immigrants and natives are complements and that immigrants had a positive impact on native wages.

3 Ferrie (1999) provides a richly detailed study of the immigrant experience by constructing a sample of immigrants from passenger ship lists who entered through New York City in the 1840s and located in the census of populations in 1850 and 1860. By 1850, most immigrants reached their intended destinations (New York, Ohio, and Pennsylvania) and only 17% remained in the vicinity of New York City. Relative to the native population, immigrants were initially disproportionately represented as skilled artisans and unskilled laborers. About a quarter of immigrants moved downwards in occupational status, but the dominant tendency was to move upwards. The Irish, compared to the British and Germans, were least mobile both geographically and occupationally.

4 Data on real wages were constructed from various sources such as Coombes (1926), Aldrich and Week's series from Long (1960), Rees (1961), Lebergott (1964), and Margo (2000). The nominal values were converted to real wages using the BLS CPI from the *Historical Statistics of the United States* (1975). Aldrich, Weeks, Rees, and Lebergott series are the average earnings in all manufacturing, Coombes series is the average earnings of unskilled workers in manufacturing, and Margo series is the average earnings of common laborers in the Northeast. The ratio of skilled to unskilled wages seems to have fluctuated without any visible trend between 1820 and 1860 based on the ratio of wages of artisans and common laborers in the Northeast (Margo (2000)) but seems to have narrowed between 1890 and 1940 (Goldin and Katz (1999), Goldin and Margo (1992)). Also see Williamson and Lindert (1980).

5 Beginning with Habakkuk (1962), there is extensive literature on skilled-biased technology in American history.

The industrial revolution, which began in England and spread to other countries in Europe and to the United States, is fundamentally linked with the rise of factories and the decline of skilled artisans in manufacturing (Mokyr (2002)). While there are many theories on the rise of factories, this paper emphasizes the importance of the unskilled intensity of factory production.[6] It is widely believed that factories substituted skilled artisans with the division of labor of unskilled workers who specialized in a limited number of tasks (Sokoloff (1984), Atack (1987), Goldin and Katz (1998), Atack, Bateman and Margo (2005)).[7] In the United States, in the early industrial period (1820-1840), factories in New England utilized the unskilled labor of women and children (Goldin and Sokoloff (1982)); however, in the second industrial revolution (1860-1920), unskilled immigrant laborers were the dominant factory manufacturing labor force.

The pace and the skill composition of immigrants differed greatly between the early and late industrial period in the United States (Tables 1 and 2). In the early period of industrialization

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For Habakkuk, labor scarcity rather than immigration of unskilled workers caused the early adoption of mechanized factory production in America as compared to Britain. For Rosenberg (1972), the American system of manufacturing was biased toward resource intensive technologies due to its abundant resources. Goldin and Katz (1998) interpret the works of James and Skinner (1985) and Cain and Patterson (1986) as providing evidence for the existence of technology-unskilled complementarity in the nineteenth century U.S. manufacturing. These works indicate that physical capital, raw material and unskilled labor were complements and that they substituted for skilled artisans. To the contrary, Williamson and Lindert (1990) argue that physical capital was a complement to skilled rather than to unskilled labor during this period (also see Temin (1966) and David (1975)). In this paper, I highlight the role of the relative supplies of skilled and unskilled workers as in Goldin and Katz (1998) and Acemoglu (1998). The empirical estimation in this paper is motivated by Acemoglu's model which predicts that an increase in the supply of unskilled (skilled) workers increases the technologies used by unskilled (skilled) workers. Thomas (1954) and Erickson (1957) believed that immigration contributed to the growth of factories in the U.S. Acemoglu (1998) suggests that the increase in the supply of unskilled workers from villages in Ireland to English cities, as documented by Williamson (1990), may have played a role in the rise of factories in England as well. Finally, Lewis (2003, 2006) finds that immigration had an impact on the direction of American technology in the second half of the twentieth century.

6 Mokyr (1999, 2002) provides an excellent summary of the literature on the British industrial revolution. Mokyr (2002) examines three main classes of explanations for the rise of factories: fixed costs and physical economies of scale, information costs and incentives and labor effort. However, he argues that the most compelling explanation for the rise of factories is based on ideas developed by Demsetz (1988) and Becker and Murphy (1992), namely that "division of labor is limited by the size of the knowledge set necessary to execute and operate best-practice techniques." While workers possessed different skill endowments, factories served as a repository of technical knowledge and reduced the costs of transmitting this knowledge to individual workers.

7 According to Atack, Bateman and Margo (2004), the factory system through division of labor shortened the period of skill acquisition and contributed to the de-skilling of workers. Thus, the factory system was well adapted to utilize the abundance of unskilled immigrant workers. Consistent with the de-skilling hypothesis or the intense utilization of

between 1820 and 1840, the pace of immigration was modest and most of the immigrants were skilled artisans and were relatively wealthy. In the transition period between the early to late industrialization, the rate of immigration rose dramatically and a great majority of immigrants were unskilled farmers, laborers and servants. Although the pace of immigration fluctuated and the sources of immigrants shifted from northwestern to central and southeastern Europe by the second industrial revolution, a majority of immigrants remained unskilled workers. Thus, immigration between 1846 and 1920 significantly increased the unskilled to skilled labor endowment ratio in the United States.

One major issue is whether factory jobs "pulled" immigrants to the United States or whether immigrants endogenously changed the direction of American technology toward factory organization of production. My principal identification strategy rests on the exogeneity or the "push" factor of immigration between 1847-1854, a period which marked the first major wave of mass immigration. Many scholars agree that the most important cause of immigration during this period was the potato famine in Ireland and in other European countries (Ó Gráda and O'Rourke (1997), Cohn (2000), Hatton and Williamson (2005)). The potato famine, caused by *p. infestans*, a fungus-like disease that turns the potato into inedible black mush, reduced the acreage of potato in Ireland from 2.1 million acres in 1845 to a mere 0.3 million in 1847 causing massive deaths and emigration (Ó Gráda (1999), Mokyr (1985)).

The instruments used in this paper are the share of foreign-born population in 1850 and the growth in the foreign-born population between 1850 and 1860.[8] Because a large share of

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unskilled workers, Atack, Bateman and Margo find that average wages of firms fell with increases in firm size.

8 The growth in the foreign-born population between 1850 and 1860 is likely to capture the large inflow of German immigration between 1852 and 1854 sparked by the political repression following the unsuccessful 1848 revolution (Atack and Passell (1994)). In addition, as compared to studies such as Altonji and Card (1991) and others which use historic shares of foreign-born as instruments, the historic level of the share of foreign-born in 1850 and the growth of foreign-born population between 1850 and 1860 are much more likely to be exogenous.

immigration prior to the antebellum period occurred during the famine period, the share of foreign-born population in 1850 should be highly correlated with the share of immigrants induced by the potato famine. The total numbers of immigrants between 1846 and 1850 equaled that of the entire period between 1820 and 1845; in addition, the Irish foreign-born represented almost 43% of all foreign-born population in 1850 (Gibson and Lennon (1999)).[9] The growth in the foreign-born population between 1850 and 1860 should also be correlated with the famine-induced immigration as the number of immigrants between 1851 and 1854 were one and a half times greater than the number between 1855 and 1860.

Data on the occupation of immigrants during the mid-nineteenth century provide little evidence for the proposition that these first wave of immigrants was "pulled" by factory jobs in the United States. Cohn (1992), based on data from passenger lists from ships which arrived in New York between 1836-1853, finds that a majority of English immigrants were unskilled and less than 5% of them possessed prior industrial experience.[10] Relative to the English population, immigrants were over-represented as farmers and laborers but under-represented in almost all other occupational categories (Table 3). For a sample of immigrants who came in the 1840s, Ferrie (1999) finds that the majority of the Irish came as unskilled laborers, the British as unskilled laborers and skilled artisans and Germans as farmers and skilled artisans.

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9 It is important to note that immigration data between 1820 and 1860 were incomplete and subject to both under- and over-enumeration. No data were collected for immigrants arriving from Canada, Mexico and Pacific ports and the data included transients bound for territories outside of the U.S. and double counted merchants and visitors who made more than one return voyage from Europe. Of these factors, the most important factor was the under-enumeration of the immigration flow through Canada. Between 1810-1839, a large share of immigrants to the United States arrived at St. Lawrence ports (see McClelland and Zeckhauser (1982)). Before 1865, about half of UK immigrants, especially the poor, may have come through Canada because the fare to Canadian maritime ports was less than half of that to American ports (Ferrie (1999)).

10 There is considerable anecdotal evidence that most skilled immigrants were artisans rather than factory managers, mechanics or operatives. As the rise of factory production in Europe displaced artisans in Europe, they moved to America. Thus, the arrival of skilled artisans may have delayed the onset of industrial revolution in American cities. However, as factory production gained momentum in the United States, there is evidence that skilled artisans became managers and foremen of factories suggesting complementarities between immigrant artisans and laborers.

While the long-run ebb and flow of immigration was due to the combination of "push" and "pull" factors, one additional exogenous factor which significantly increased the share of unskilled immigrants is related to major advances in transportation. First, advances in internal transportation due to railroads provided easy access to major ports for most European populations (Hatton and Williamson (2005)). Second, the advances in steamship technology made the trans-Atlantic travel shorter, safer, and easier to get in and out of secondary ports in the Mediterranean (Cohn (2005), Keeling (1999)). Third, the passenger costs relative to per capita income fell significantly between 1820 and 1860 (Galenson (1984)).

My second identification strategy utilizes the fact that most immigrants entered the United States through New York and used domestic transportation networks to reach their intended destinations. Between 1850 and 1914, 70% of immigrants arrived via the ports in New York (Keeling (1999)) and many immigrants moved immediately from the port of entry to internal destinations (Ferrie (1999)). Distance from New York City and access to water transportation in 1850 are likely to capture the influence of transportation costs on immigrant settlement patterns. It is important to note that New York City became the dominant mercantile port and later the port of entry for immigrants long before it became an industrial city (Albion (1939)). However, distance from New York City and access to water transportation in 1850 may also be correlated with access to markets for manufacturers.

To determine whether immigrants contributed to the growth and spread of unskilled-biased technology embodied in factory-assembly production, I use data of manufacturing firms drawn from the manuscripts of the decennial censuses between 1850 and 1880 which have been merged with county-level information from the censuses of populations from the same respective years. Data analysis suggests that immigration between 1850 and 1920 may have had a

fundamental impact on the direction of American technology. The data reveal that firms in counties with a higher share of foreign-born were much more likely to be organized as factories and were generally larger. In addition, firms in these counties were also more productive and were likely to pay higher average wages to their workers. Standard tests of the instruments indicate their general validity and that the 2SLS estimates are generally similar to those of ordinary regression estimates.

The paper is organized as follows. Section II presents the model and empirical strategy for estimating the impact of unskilled/skilled endowment ratio on unskilled-biased technology as embodied in factory assembly production. Section III discusses data used in this study. Section IV estimates the impact of immigration on factory organization. Section V examines the link between immigrant diversity and division of labor. Section VI concludes with a summary of the findings.

II. Framework for Studying Endowments and Endogenous Technological Change

Industrial development in the United States exhibited three major production technologies: artisan shops (1790-1820), factory-assembly (1820-1920), and factory-continuous (1920-). Prior to the industrial revolution, skilled artisans produced the entire product with the help of apprentices and family members. With the industrial revolution, factories hired numerous unskilled workers who specialized in few tasks based on division of labor and few skilled workers who operated machines and supervised workers. In the first half of the twentieth century, however, the factory-continuous method began to replace the factory-assembly system in a number of industries (Goldin and Katz (1998), Jerome (1924)). Unlike the earlier factories, the new factory-continuous system was intensive in skilled rather than unskilled workers. With

the advent of electric motors, mechanization replaced the division of labor of unskilled workers.

Whereas Goldin and Katz (1998) examine the shift in production from factory-assembly to the factory-continuous methods, I examine the shift from artisan shop to the earlier factory system based on unskilled division of labor.[11] The empirics of this paper is motivated by Acemoglu's (1998) model of endogenous technological change. The model assumes that there are two types of workers, skilled (H) and unskilled (L), who supply labor inelastically. The consumption good is produced from two complementary production processes, one using skilled and the other using unskilled. Firm level technology, A_h or A_l, is determined by technology employed by the firm where skilled and unskilled workers are assumed to use different technologies. The main result of Acemoglu's model is summarized by the following equation: $A_h/A_l = f(p, H/L)$ where $p=p_h/p_l$. In this model, an increase in the relative supply of a skill type will lead to an improvement in the technologies that uses that particular skill type. Thus, an exogenous increase in the supply of skilled (unskilled) workers will lead to an improvement in technologies which utilize skilled (unskilled) workers.[12]

In this paper, I assume that the adoption of the factory method of production signifies the increase in the use of unskilled intensive technology and also assume that the share of foreign-born population (FB/(FB+NB)) is a useful measure of the relative supply of unskilled to skilled workers (L/H). The share of foreign-born population is subject to two important sources of measurement errors: (1) not all foreign-born workers are unskilled and (2) not all native-born

11 Goldin and Katz (1998) suggest that the growth in the supply of skilled labor due to the sudden growth in high school educated workers may have fueled skilled-biased technology toward the factory-continuous batch production. In addition, the supply of unskilled workers fell dramatically during this period as immigration slowed to a trickle.
12 The intuition of the model is as follows: when there are more unskilled workers, then the market for unskilled-complementary technologies, such as factories, is larger. As a result, more resources will be devoted to the invention of unskilled-complementary technologies. In this model, Acemoglu (1998) shows that the impact on wages is dynamic. Initially, the shift in supply of unskilled workers will lower unskilled wages; however, as the "directed technology effect" shifts the relative demand of unskilled workers and the wages of unskilled workers will rise over

workers are skilled. However, these measurement errors, to the extent that they are important, are both likely to bias the estimates downwards.

To investigate whether immigration influenced the adoption of factory production in U.S. manufacturing, I estimate the following equations:

(1) $\text{Factory}_{ijc} = \alpha_0 + \alpha_1 \text{Fgn-Born}_c + \alpha_2 F_{ijc} + d_j + d_s + u_{ijc}$

(2) $\ln[\text{Firmsize}]_{ijc} = \alpha_0 + \alpha_1 \text{Fgn-Born}_c + \alpha_2 F_{ijc} + d_j + d_s + u_{ijc}$

where Factory_{ijc} is equal to 1 if firm size is greater than 15 workers and 0 otherwise, firm size is defined as one plus the number of male, female and child employees, and i, j, c, s indexes firm, industry, county and state, respectively. The independent variables are the share of foreign-born population in county c, firm-level (F_{ijc}) characteristics such as the capital-labor ratio, the share of male workers and whether a firm used steam-power or water-power rather than hand-power. Goldin and Katz (1998) believe that the shift from artisan to a factory system probably involved an increase in capital-labor intensity. Since firms in some industries may be more likely organized as factories because of industry-specific differences in fixed cost or because they are located in certain regions with access to specialized raw materials, the regressions include 3-digit industries (d_j) and state fixed-effects (d_s).

In addition, I estimate whether firms in counties with higher levels of immigrant workers were more productive and paid higher wages using the following equations:

(3) $\ln[\text{Wage}]_{ijc} = \alpha_0 + \alpha_1 \text{Fgn-Born}_c + \alpha_2 F_{ijc} + d_j + d_s + u_{ijc}$

(4) $\ln[\text{LP}]_{ijc} = \alpha_0 + \alpha_1 \text{Fgn-Born}_c + \alpha_2 F_{ijc} + d_j + d_s + u_{ijc}$

where wage and labor productivity (LP) are average wages and output per worker of firms, respectively. To the extent that immigration leads to the adoption of superior factory-assembly

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time.

production technologies based on division of labor, workers in immigration abundant counties should be more productive and earn higher wages.

III. Data

The data used in this paper come from Atack-Bateman-Weiss (ABW) sample of manufacturing firms drawn from the manuscripts of the decennial censuses for 1850, 1860, 1870 and 1880 which has been merged with county-level information from the respective U.S. decadal censuses of population.[13] The ABW data set contains information on manufacturing firms such as output, capital, labor, raw materials, wages, and primary power source and are categorized by the standard industrial code at the 3-digit industry level. The county-level census data contain a rich array of information such as population, foreign-born population and various economic and demographic characteristics. The samples were restricted to firms with positive values of output, employment and capital. To eliminate potential outliers in the data, I also excluded firms whose gross output was less than $500 and those with extremely low and high wages (see Atack, Bateman and Margo (2004) and Kim (2006)).

Table 4 presents data on county population characteristics from the censuses of population. The number of counties in the U.S. grew from 1623 to 2613 and the average population of these counties also rose steadily from 14,290 to 19,208. The foreign-born share of the population rose from 5.9% to 11.5% between 1850 and 1870 and then fell slightly to 10.7% in 1880. The average urban share of the county population rose from 3.8% to 8.1% between 1850 and 1880. From a regional perspective, the share of foreign-born was the highest in the Pacific and Mountain counties followed by Middle Atlantic, East North Central, New England

13 The firm-level manuscript data were constructed by Jeremy Atack, Fed Bateman and Thomas Weiss. I thank

and West North Central counties and was the lowest in the southern counties. The share of natives who were born out of state was lowest in the counties in New England, Middle Atlantic, South Atlantic and West South Central and rose markedly in counties in the Western regions.

Table 5 presents the summary statistics of the ABW sample of manufacturing firms drawn from the manuscript censuses between 1850-1880.[14] A factory is defined as a firm whose size is greater than 15 employees. Firm size is defined as the sum of male, female and child labor; male-intensity is defined male labor divided by firm size which includes children in 1850 and 1860. The data show that factory organization of production and the size of firms in the ABW sample rose from 11 to 17 percent and 10.1 to 15.4 employees per firm between 1850 and 1880, respectively. The average nominal wages, labor productivity and capital intensity rose between 1850 and 1870 and then fell slightly in 1880. The share of firms that used steam-power increased whereas those that used water-power decreased over time; the level of male-intensity in manufacturing remained constant. Finally, the average percentage of foreign-born of the matched data rose slightly from 13% to 16% over time.

IV. Immigrants and Factories

This section presents the impact of immigration on factory organization in the United States between 1860 and 1880. It reports the probit and OLS estimates and their respective IV-

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Michael Haines for kindly providing me with the merged data set.

14 Economic historians have raised a number of issues concerning the data from these earlier censuses. First, entrepreneurial labor often went unreported (Sokoloff (1984b)). Second, there is uncertainty as to whether capital is composed of both fixed and working capital. Based on the 1832 McLane Report, Sokoloff (1984a) finds that working capital (inventory and accounts receivable) was a major component of published capital stock in these early years. Third, gender and age were not reported consistently over time. In 1850 and 1860, males and females of all ages were reported separately; in 1870 and 1880, the children were reported separately along with adult males and females. Finally, in 1880, the so-called "special agent" industries – which include cotton, wool, silk, iron and steel –

probit and IV estimates of equations (1)-(4) using the identification strategy outlined in the introduction. The strategy employs two sets of instruments: (1) share of foreign born in 1850 and the change in the share of foreign-born between 1850 and 1860, and (2) distance from New York City and whether a county had access to water transportation in 1850. All of the standard errors are clustered by counties.

Tables 6 and 7 report the probit and OLS estimates of equations (1)-(4) with and without firm-level control variables. Since the results are similar for both specifications, we focus our discussion on the coefficients with the firm-level control variables. The probit regression indicates that counties with a higher share of foreign-born were significantly more likely to have firms organized as factories. Based on stata's dprobit command which calculates marginal changes in probability for infinitesimal changes in the independent variable (discrete change for dummy variables), the estimated marginal impacts of foreign-born on the factory variable were 0.17, 0.31 and 0.43 for 1860, 1870 and 1880 respectively. The marginal impact on factory organization was relatively strong for steam-power dummy (0.16 to 0.31), moderately important for water-power dummy (0.01 to 0.10) but surprisingly weak for capital-labor intensity (0.001 to 0.01) and negative for male-intensity (-0.13 to -0.24).

The OLS regression estimates on firm size indicate similar patterns. In this case, one standard deviation increase in the county foreign-born population increased firm size by between 19% to 22% in 1860, 1870 and 1880. Firm size is also positively correlated with capital intensity, male intensity, steam and water powered firms.[15] The regressions on wages and labor productivities show that firms in counties with a higher share of foreign-born paid higher

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are under-represented in the sample. While these are important concerns, the empirical findings reported in this paper are not sensitive to these concerns.

15 Atack, Bateman and Margo (2005) explore the relationship between capital intensity and factory organization.

average wages and were characterized by higher labor productivity.[16] One standard deviation increase in the share of county foreign-born population increased wages and labor productivities by 7% to 22%. In terms of firm level characteristics, wages and productivity were positively correlated with capital intensity and steam-power use, but negatively correlated with male labor intensity and the utilization of water power.

The first-stage regressions for the IV specification are presented in Table 8. As expected, the percentage of foreign-born in 1850 was highly correlated with the percentages of foreign-born in 1860, 1870 and 1880, respectively. A little more surprising is the fact that the change in the growth of foreign-born in 1850 to 1860 are positively correlated with the shares of foreign-born in the later decades. Also as expected, the share of foreign-born populations in 1860, 1870 and 1880 were all negatively correlated with the distance from New York City but were positively correlated with whether a county possessed access to water transportation in 1850. Finally, the two sets of instruments are strong candidates according to Staiger and Watson's (1997) rule of thumb: the first stage F-statistics, testing the hypothesis that coefficients on the instruments are jointly zero, are significantly higher than 10.

The instrumental variables regressions reported in Tables 9-12 continue to support the thesis that immigration advanced American technology toward factory production.[17] For both the

16 Edin, Fredricksson and Åslund (2003) find that ethnic enclaves in Sweden increased the wages of unskilled workers: a standard deviation in concentration increased their wages by 13%. Their evidence, based on individual level data, suggests that ethnic enclaves provide network effects or provide human capital externalities. My analysis suggests that ethnic enclaves also improve the productivity of firms by lowering the costs of matching heterogeneous workers and firms. Ottaviano and Peri (2005a) find a positive correlation between wages and employment density of U.S.-born workers and linguistic diversity suggesting that a diversity of skills enhances the productivity of a city.

17 There is considerable anecdotal evidence that immigrants played a major role in industrial America. The clothing industry in New York City provides an illustrative example. In the early nineteenth century, clothing was made by artisan tailors assisted by journeymen tailors and apprentices. In New York City, the majority of the 357 clothing entrepreneurs in the Longworth directory in 1816 were artisan tailors. As Feldman (1960, p.90) writes: "The shops were not mechanized and only a few inexpensive tools were needed. Skill, not machinery, was the prerequisite to success for a custom tailor shop." The changes in the organization of the clothing industry coincide with the influx of immigrants into New York City. Between 1830 and 1850, wholesale manufacturers began to utilize division of

IVprobit estimates on factory organization and the IV estimates on firm size, the IVprobit or the IV estimates are relatively similar to those of the probit or the OLS estimates except for 1880 when the IV estimates are significantly smaller. However, the IVprobit and IV estimates are higher than the probit or the OLS estimates when the instruments used are the two transportation related variables for 1860 and 1870. For average firm-level wages and productivities, the IV estimates are similar or greater than the OLS estimates, especially when the instruments used are distance from New York City and water transportation access in 1850. The differences are also significantly greater in 1880 than in the earlier years. Overidentification tests generally indicate the validity of the instruments.

Rather than the unskilled to skilled labor endowment ratio, an alternative thesis for the rise of factories rests on urbanization. If factories arose in urban areas to take advantage of agglomeration economies such as knowledge spillovers, then the direction of causality might run from urban economies to factories and immigrants as firms and workers concentrated in cities to take advantage of these economies. Since immigrants were much more likely to locate in cities than native workers, it may be extremely difficult to separate out the urban agglomeration-effect from the unskilled labor-endowment effect.[18] Nevertheless, it will be useful to examine the

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labor where few skilled workers were employed as cutters and semi- and unskilled workers were recruited to sew. Most of the early sewing women were natives, but they were quickly displaced by immigrant workers during the period of heavy immigration in the 1840s. Prior to 1850, most firms operated "inside shops" composed of specialized cutting departments for coats, pants, vests, and trimmings. Sewing was contracted to outside workers. According to Feldman (1960, 97)), "Brooks employed 78 people on the premises and more than 1,500 outside. Lewis and Hanford in 1849 employed 72 people inside and 3,600 outside." With the introduction of the sewing machine, a good portion of the sewing operation moved inside the shop. Division of labor increased within sewing as workers specialized by plain sewing, stitching, finishing process, embroidering, etc. (See Feldman (1960), Pope (1905), Waldinger (1986), and Burrows and Wallace (1999), and Stott (1990)). Parmet (1981, p.90) writes that "As unskilled immigrants could quickly learn to operate sewing machines, highly skilled custom workers lost their primary market advantage. Moreover, because men could more readily use the foot-power sewing machine, women lost additional advantage. Though women predominated in the industry as late as 1850, they were in the minority ten years later."

18 It is well known that immigrants are much more likely to concentrate in cities than natives (Carpenter (1927), Ward (1972), Bartel (1989). In 1870, 26.5% of the foreign-born resided in cities with populations greater than 100,000 as compared to 8.1% of the native-born; in 1920, the figures were 47.7% and 22.6% respectively (Gibson

impact of urbanization on factory organization.

Table 13 reports the probit factory and OLS firm size regressions when the share of urban population variable of two different threshold sizes - 2,500 and 25,000 - are included in the regressions. The regressions show that firms in more urbanized counties were much more likely to be organized as factories; however, the regressions also indicate that the foreign-born variable remains highly significant although the size of the coefficient declines somewhat. Thus, even after accounting for urbanization, firms in counties with a higher share of foreign-born population were larger and were more likely to be factories. Surprisingly, firms in the very largest cities were less likely to be organized as factories than in the smaller sized cities. The coefficient on the share of urban population of large cities of 25,000 or greater was smaller and much less significant than that of the coefficient on the share of urban population of cities 2,500 or greater.

V. Immigrant Diversity and Division of Labor

The immigrants who arrived in the U.S. between 1820 and 1920 came from a historically unprecedented number of different nations and backgrounds. These immigrants not only increased the unskilled to skilled endowment ratio, they also significantly increased the diversity of the industrial labor force. While the vast majority of immigrants was classified in the unskilled category, immigrant workers possessed a great diversity in prior work experiences and physical attributes. Thus, immigration, by increasing the diversity of the workforce, extended the

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and Lennon (1999). While there are no empirical estimates on native urban displacement by immigrants during this period, Hatton and Williamson (1998) find that 100 foreign-born in-migrants displaced 40 native-born by out-migration in the Northeast region and Collins (1997) finds a displacement rate of about 4.8 blacks for every 100 foreign-born. It is particularly difficult to separate out the urban-agglomeration effect and the labor endowment-effect because the two factors may be intimately related. Kim (2006) argues that factories became concentrated in cities to take advantage of labor matching economies, but without immigrants, manufacturing firms were less likely

potential for division of labor in society, especially in factories.

Since data on foreign-born by nationality are available for 1870 and 1880, it is possible to investigate whether immigrants from different nations impacted the organization of production differently. The regression estimates reported in Table 14 indicate that the shares of foreign-born from most European countries, such as Ireland, Germany, England and Wales, and Scandinavia, and from British America (Canada) were positively correlated with factory organization and firm size as well as wages and productivity. However, firms in counties with higher shares of foreign-born from Italy were less likely to organize as factories. Interestingly, native in-migration was not associated with factory organization or firm size, but were associated with higher wages and productivity. The regression estimates also indicate that ethnic diversity contributed to factory organization and firm size and was positively correlated with wages and productivity in 1880 but not in 1870.[19]

Table 15 presents the occupational distribution of the foreign-born by national origins in manufacturing, mining and mechanical industries for 1870 and 1890.[20] Although the data cannot distinguish artisans from factory occupations, they indicate significant clustering of occupation by nationalities. In 1870, the Germans specialized in many food related industries as brewers, distillers, butchers and confectioners, but they also specialized in other occupations such as basket-, cabinet-, cigar-, and piano-makers. The Irish were highly specialized in gas-works and

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to be organized as factories.

19 Immigrant diversity is measured using the following standard index of diversity: Diversity = $1/\Sigma_i (FB_{ij}/Pop_j)^2$ where FB_{ij} is foreign-born population from country i in county j and Pop_j is total population in county j. The data contain information on foreign-born from 25-27 countries.

20 The census occupational categories probably understate the extent of ethnic division of labor. Even within occupational categories, there was considerable ethnic specialization. For example, Bodnar, Simon and Weber (1982; 62-63) write: "Italians coming to Pittsburgh had considerable experience in nonagricultural and skilled blue-collar work. These experiences enabled them to secure a variety of occupations while the successful operation of the kin network at the same time funneled Italians into clusters within certain industries. Nearly 60 percent of all adult male Italians were classified as laborers in the 1900 census. Oral interviews and the Pittsburgh Survey of 1907 uncovered several distinct groupings of Italian day laborers. Italians in the steel industry dominated carpentry, repair,

other heavy industries and were employed in manual occupations such as bleachers (textiles), brass-founders, iron-foundry operatives, iron-furnace operatives among others. The English and Welsh were concentrated in textiles, iron and steel, and in certain machine manufacturing. The Scandinavians were highly specialized in a few occupations: sail and awning makers and those related to the lumber industry.

While there were some changes in the definitions of occupations between 1879 and 1890, the data indicate that occupational clustering by nationalities persisted over time. There is considerable overlap in the occupational categories in which Germans, Irish, British, and Scandinavians were over-represented in both 1870 and 1890. However, there were some major changes as well. Some of these changes were due to the arrival of new immigrant groups such as the Italians. Italians were over-represented in the boot and shoe, charcoal, coke and lime, confectioners, distillers and rectifiers industries among a few others.

Despite the fact that close to one third of the workers in manufacturing and mechanical industries were women in 1890, the data on occupation by sex reveal limited scope for division of labor for women in manufacturing.[21] Compared to men's, women's occupations were highly specialized in a few industries. German women were over-represented as bakers; Irish women were mostly servants and were not well-represented in manufacturing; British and Canadian (French-speaking) women were most prevalent in textile related occupations. Of the female workers, only the Italian women were specialized in a variety of industries. Consequently, the data suggest that industrialization based on the unskilled labor of native women and children in the United States is likely to have been much more muted and confined to a few industries.

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and rail shops."

21 While female labor specialization may have been influenced by discrimination, Goldin's (1990) work suggests that discrimination against female workers in nineteenth century manufacturing was likely to have been relatively unimportant.

VI. Conclusion

Ever since Habakkuk (1962), the idea of skilled or unskilled-biased technology has generated significant interest in economics. In recent years, a number of scholars have found evidence of technology-skilled complementarities between computer-based technologies and college educated labor (Autor, Levy and Murnane (2003), Berman, Bound, and Griliches (1994), Autor, Katz and Krueger (1998), Beaudry and Green (2005), among others).[22] Goldin and Katz (1998) present evidence that technology-skilled complementarity originated with the shift in manufacturing from factory-assembly to factory-batch or continuous production methods and that this shift may have been caused by the rapid rise in American high school education in the early twentieth century (Goldin and Katz (2000), Goldin (2001)).

This paper examines whether immigration, by significantly increasing the unskilled to skilled labor endowment ratio, contributed to the growth and spread of factory production in the second industrial period in the U.S. between 1860 and 1920. The empirical model is motivated by Acemoglu (1998) and Goldin and Katz (1998). Acemoglu's endogenous model of technological change predicts that an increase in unskilled to skilled labor endowment will lead to higher productivity of unskilled technology. As noted by Goldin and Katz (1998) and many others, the form of unskilled technology in manufacturing was embodied in the form of a factory system based on division of labor.

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22 In an open economy model of trade, a change in factor endowment can have two kinds of impacts: change in mix of production caused by the Rybczynski's theorem and a biased-technological change. Kim (1999) and Hanson and Slaughter (2002) examine the impact of resource endowments on industry-mix. Lewis (2005, 2006) finds that local labor supply shocks identified with a component of foreign immigration had little impact on the local industry mix but had significant impact in local factor intensity in production. These endogenous changes in technology were also associated with little or no effect on relative wages. To the extent that differences in local factor endowments may cause differences in local technologies, the literature on factor biased-technology provides evidence for the idea that different localities, regions and nations may have different technologies of production (Treffler (1995)).

Based on the analysis of firm level data merged with county level information for the period between 1850 and 1880, I find that immigration had a significant impact on the shift in manufacturing from artisans to factories. Instrumental variable estimates indicate that firms in counties with a significantly higher share of foreign-born population were much more likely to organize as factories than as artisans. The diversity of immigrants also seem to have contributed to the rise of a factory system based on division of labor.

In the United States, the factory system of production arose in rural New England between 1820 and 1840 to take advantage of that region's abundance in unskilled native women and children.[23] However, because the supply of native unskilled workers was limited and too homogenous, the industrial revolution in the Unites States would have been much more muted without immigrants. Immigrants not only significantly increased the unskilled to skilled labor endowment, but they also increased the diversity of skills and worker attributes important for division of labor in factories. In addition, immigration and division of labor significantly contributed to urbanization.[24]

What lessons and insights emerge from history for understanding the impact of immigration on the American economy today? The experience of the era of mass immigration points to the great absorptive capacity of the American economy. While immigration may lower

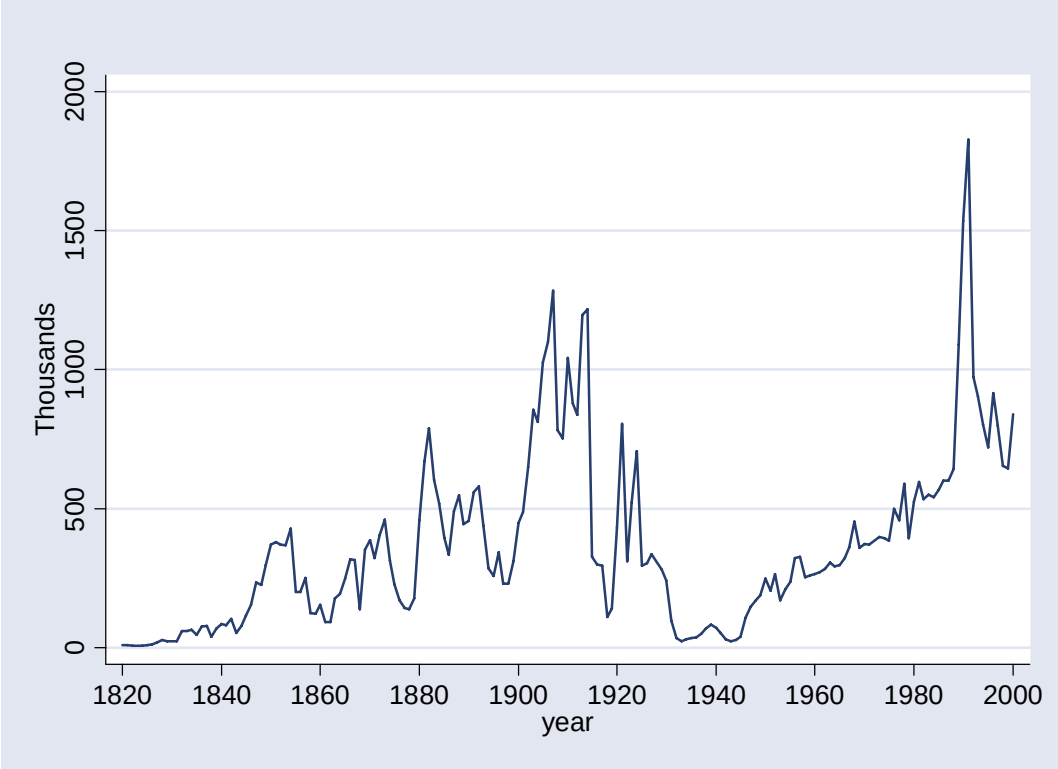
23 Legal factors may have also lowered the costs of locating in rural locations during this period. Steinfeld (1991, 2001) argues that early American labor was "unfree" in the sense that employers possessed significant legal rights over workers. In particular, workers who breached their employment contracts were subject to criminal sanctions or forfeiture of back wages. Consequently, the employer's legal position reduced the level of turn-over in the labor market. In the 1850's, with the rise in the idea of "free labor" in America, employers lost much of their legal leverage over employees. As workers could terminate their employment any time, the change in the legal environment likely increased worker turn-over and raised the cost of recruiting workers in rural areas. Interestingly, Hamilton (2000) suggests that changes in the ability of a master to enforce apprentice contracts in North America may have contributed to the shift in manufacturing from artisans to factory production in the 1820s.

24 Why did immigrants concentrate in cities? Most likely, immigrants concentrated in cities to take advantage of ethnic externalities (Borjas (1995)). Immigrant networks greatly facilitated the transmission of knowledge concerning labor market conditions and skill requirements of their specialized occupations and skills (Munshi (2003)). Ethnic networks fostered division of labor by immigrant groups (see Earnst (1949), Rischin (1962), Stott

the wages of natives in the short run, the long-run impact of immigration is likely to have been much more positive as indicated by the secular rise in long-run real wages (Figure 4). In this paper, I suggest that the source of this great absorptive capacity of the American economy lies in its ability to develop and implement technologies which favor changing factor endowment conditions. In addition, history teaches us that these induced technological changes have had a major impact on the geographic landscape of the American economy.

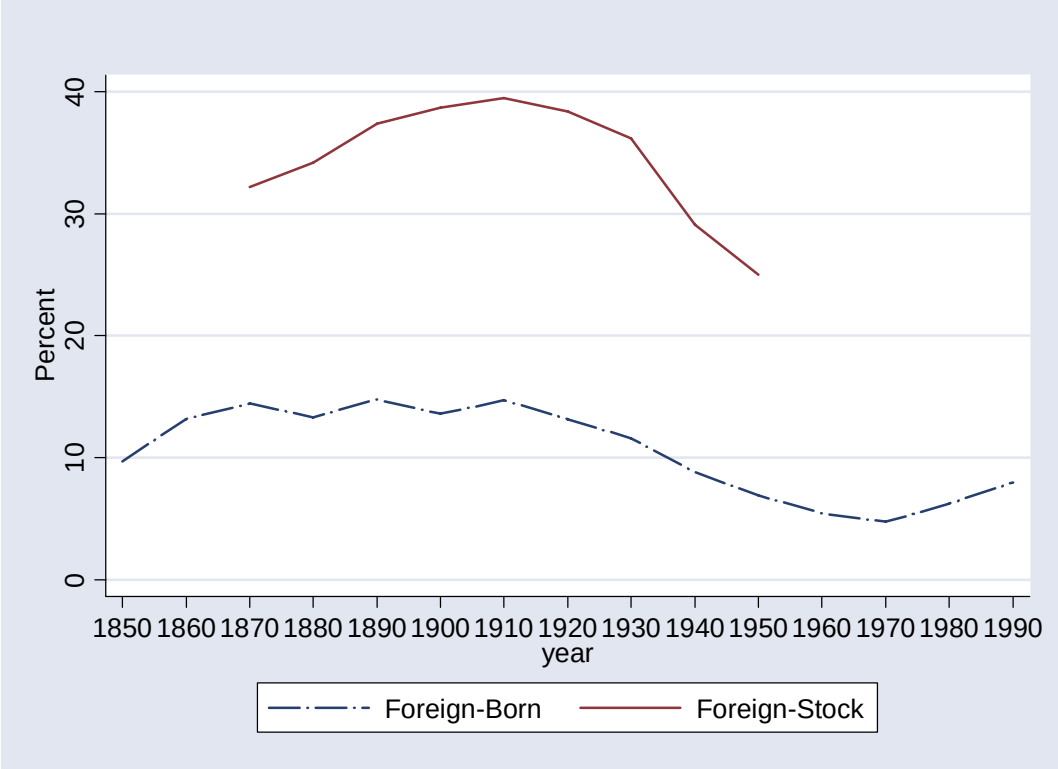
Figure 1: Annual Immigration Flows, 1820-2000

(1990), Ward (1989), Barrett (1987) and Bodnar (1977) to list a few). Also see Kim (2006).



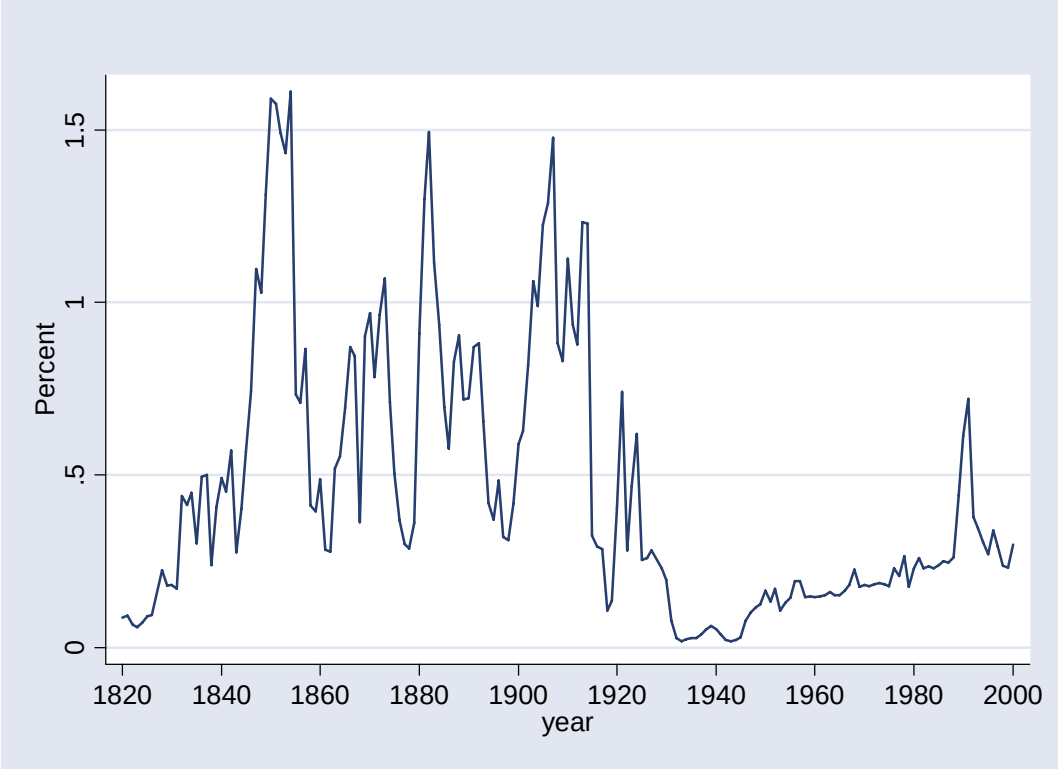
Sources: Historical Statistics of the U.S. and Statistical Abstract of the U.S.

Figure 2: Foreign-Born and Foreign-Stock as Shares of Population, 1850-1990



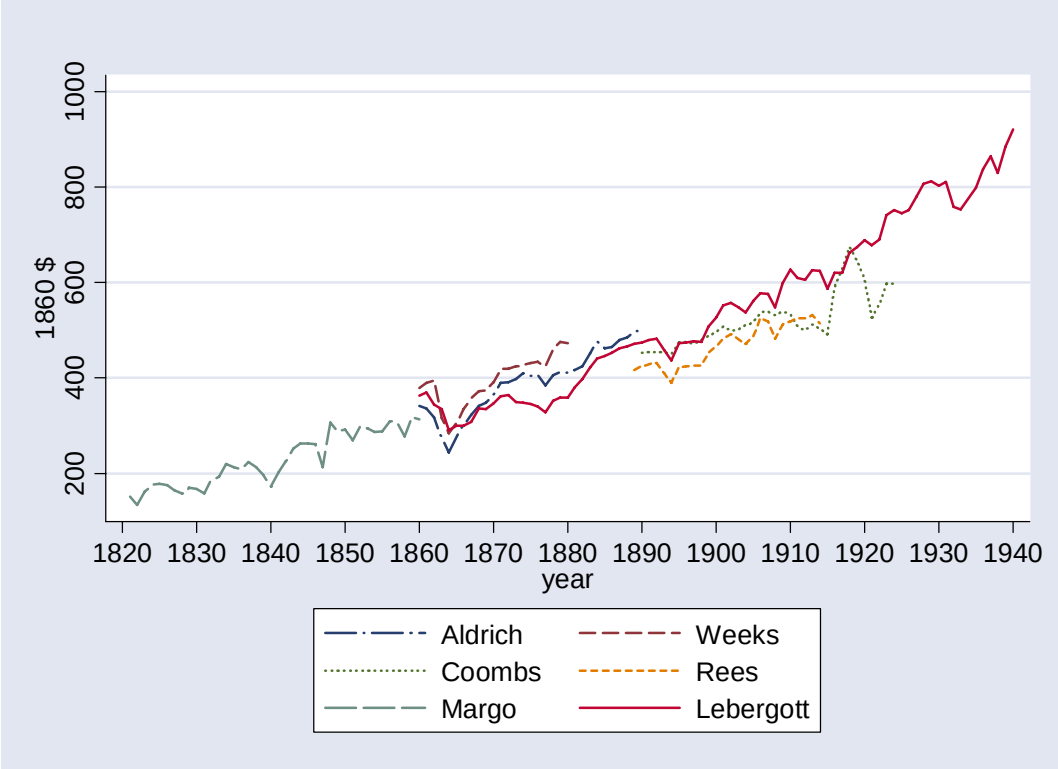
Note: Foreign-stock or immigrants and their children is measured as foreign-born plus the native born of foreign or mixed parentage. Foreign-stock is for only the white population.
Sources: Gibson and Lennon (1999) and Hutchinson (1956).

Figure 3: Annual Immigration as a Percentage of Population, 1820-2000



Sources: Historical Statistics of the U.S. and Statistical Abstract of the U.S.

Figure 4: Real Annual Wages, 1820-1940



Note: Aldrich, Weeks, Rees and Lebergott series are average earnings in all manufacturing; Coombes series is the average earnings of unskilled workers in manufacturing.
Sources: Coombes (1926), Long (1960), Rees (1961), Lebergott (1964), and Margo (2000).

Table 1

Sources of Immigration, 1820-1930

Years	Average Yearly Total (Per 1000 Population)	Great Britain	Ireland	Other NW Europe	Germany	Central & Eastern Europe	Southern Europe
1820-1831	14,538 (1.3)	22%	45%	12%	8%	0%	2%
1832-1846	71,916 (4.3)	16	41	9	27	0	1
1847-1854	334,506 (14.0)	13	45	6	32	0	0
1855-1964	160,427 (5.2)	25	28	5	33	0	1
1865-1873	327,464 (8.4)	24	16	10	34	1	1
1874-1880	260,754 (5.6)	18	15	14	24	5	3
1881-1893	525,102 (8.9)	14	12	16	26	16	8
1894-1899	276,547 (3.9)	7	12	12	11	32	22
1900-1914	891,806 (10.2)	6	4	7	4	45	26
1915-1919	234,536 (2.3)	5	2	8	1	7	21
1920-1930	412,474 (3.6)	8	5	8	9	14	16

Source: Cohn (2006).

Table 2

Occupation of Immigrants, 1820-1898

Occupation	1820-1831	1832-1846	1847-1854	1855-1864	1865-1873	1874-1880	1881-1893	1894-1898
Percent with no listed occp.	61%	56%	54%	53%	54%	47%	49%	38%
Immigrants with Occupation by Category								
Professional	3%	1%	0%	1%	1%	2%	1%	1%
Commercial	28	12	6	12	6	4	3	4
Skilled	30	27	18	23	24	24	20	25
Farmers	23	33	33	23	18	18	14	12
Laborers	14	24	41	37	44	40	51	37
Servants	2	2	2	4	7	8	9	18
Misc.	0	0	0	0	1	5	3	3
Unskilled	39	59	76	64	69	66	74	67

Source: Cohn (2006).

Table 3

Occupational Structure of English Immigrants, 1836-1853

Occupation	1836-1845 (Percentage of total male immigrants)	1846-1853 (Percentage of total male immigrants)	1836-1845 (Ratio of percentage in the immigrant sample to the percentage of that group in the English population)	1846-1853 (Ratio of percentage in the immigrant sample to the percentage of that group in the English population)
Farmers	16.3%	17.8%	0.58	2.95
Laborers	44.0	53.1	5.37	6.90
Servants	2.9	1.7	0.32	0.27
Total Preindustrial	28.0	20.4	0.94	0.72
Building trades	4.5	2.7	0.56	0.46
Mining	7.8	4.4	2.36	0.85
Food	3.4	1.8	0.81	0.50
Metal	1.8	1.9	0.62	0.86
Clothing	5.0	4.8	0.68	0.77
Woodworking	1.8	1.5	0.72	0.82
Miscellaneous	0.3	0.7	0.20	0.35
Mechanics	3.4	2.6	-	-
Total Industrial	4.3	4.1	0.28	0.35
Textiles	2.5	0.9	0.30	0.18
Iron and Steel	0.8	2.2	0.16	0.54
Miscellaneous	1.1	1.0	0.55	0.65
Total Tertiary	4.4	2.9	0.45	0.31
Clerical	0.6	1.1	0.27	0.57
Commercial	2.7	1.2	0.55	0.22
Professional	1.1	0.5	0.44	0.32
Number of Males	925	1481	925	1481

Note: The information is based on samples randomly drawn from the passenger lists of ships which arrived in New York City between 1836 and 1853.
Source: Cohn (1992).

Table 4

U.S. County Population Characteristics by Region, 1850-1880

Counties	1850	1860	1870	1880
U.S. Total				
Number of Counties	1623	2079	2291	2613
Population	14290	15122	16830	19208
Urban (%)	3.8	4.7	7.5	8.1
Foreign Born (%)	5.9	9.6	11.5	10.7
Native Born Out of State (%)	29.4	-	33.0	31.6
Mfg Labor (%)	1.8	2.2	2.4	1.9
New England				
Number of Counties	64	67	67	67
Population	42627	46795	52059	59859
Urban (%)	18.4	22.1	26.2	30.6
Foreign Born (%)	9.2	11.0	13.6	14.2
Native Born Out of State (%)	13.5	-	12.9	13.7
Mfg Labor (%)	7.7	9.1	11.2	11.6
Middle Atlantic				
Number of Counties	142	146	147	148
Population	41540	51089	59937	70924
Urban (%)	8.4	12.8	20.2	24.2
Foreign Born (%)	11.1	13.0	13.5	11.9
Native Born Out of State (%)	10.9	-	9.7	9.0
Mfg Labor (%)	4.5	4.6	6.0	6.1
East North Central				
Number of Counties	351	402	411	423
Population	12887	17231	22201	26493
Urban (%)	3.5	5.9	14.4	14.1
Foreign Born (%)	11.1	16.2	17.1	15.7
Native Born Out of State (%)	48.3	-	34.4	26.7
Mfg Labor (%)	1.8	2.5	3.4	3.0
West North Central				
Number of Counties	158	350	419	562
Population	5572	6186	9204	10956
Urban (%)	1.3	2.3	4.8	5.6
Foreign Born (%)	6.4	14.7	19.7	18.0
Native Born Out of State (%)	56.7	-	62.0	58.7
Mfg Labor (%)	0.9	1.2	1.4	1.0
South Atlantic				
Number of Counties	394	459	470	484
Population	11876	11688	12454	15697
Urban (%)	3.1	3.5	3.7	4.6
Foreign Born (%)	1.4	1.4	1.1	1.0
Native Born Out of State (%)	8.5	-	10.0	11.4
Mfg Labor (%)	1.3	1.5	1.4	1.5

Table 4 - continued

U.S. County Population Characteristics by Region, 1850-1880

Counties	1850	1860	1870	1880
East South Central				
Number of Counties	290	305	330	351
Population	11597	13184	13347	15912
Urban (%)	1.7	2.3	3.2	3.0
Foreign Born (%)	1.0	1.6	1.3	1.0
Native Born Out of State (%)	20.1	-	19.4	15.3
Mfg Labor (%)	1.1	1.1	1.1	0.9
West South Central				
Number of Counties	176	236	255	357
Population	5342	7405	7961	9340
Urban (%)	2.8	2.1	2.4	3.1
Foreign Born (%)	5.6	6.9	6.7	6.0
Native Born Out of State (%)	40.1	-	41.8	38.7
Mfg Labor (%)	0.5	0.7	1.5	0.5
Mountain				
Number of Counties	14	32	98	119
Population	5209	5466	3218	5488
Urban (%)	4.2	4.5	5.9	8.0
Foreign Born (%)	9.6	22.4	31.2	25.5
Native Born Out of State (%)	44.2	-	63.6	58.8
Mfg Labor (%)	0.2	1.4	2.6	1.0
Pacific				
Number of Counties	34	82	94	102
Population	3114	5415	7182	11255
Urban (%)	2.2	3.7	5.0	8.3
Foreign Born (%)	16.1	26.1	26.2	25.2
Native Born Out of State (%)	73.3	-	56.2	50.0
Mfg Labor (%)	3.6	4.9	3.3	1.9

Source: ICPSR Study Number 2896 (Michael Haines)

Table 5

Summary Statistics, 1850-1880:
Mean (Standard Deviation)

All Firms	1850	1860	1870	1880
Factory	0.11 (0.313)	0.09 (0.287)	0.13 (0.332)	0.17 (0.379)
Firm size (log)	1.53 (0.955)	1.21 (1.088)	1.37 (1.190)	1.78 (1.095)
Annual wage (log)	5.50 (0.422)	5.68 (0.438)	5.70 (0.689)	5.48 (0.763)
Labor productivity (log)	6.08 (0.806)	6.36 (0.844)	6.59 (0.870)	6.31 (0.836)
K/L ratio (log)	5.81 (1.146)	6.32 (1.113)	6.44 (1.160)	6.23 (1.142)
Share of male labor	0.93 (0.189)	0.95 (0.161)	0.93 (0.196)	0.91 (0.210)
Steam power	0.10 (0.297)	0.17 (0.378)	0.25 (0.436)	0.30 (0.459)
Water power	0.25 (0.432)	0.26 (0.437)	0.19 (0.394)	0.15 (0.352)
Number of firms	5,421	7,474	5,554	7,136
Counties	1850	1860	1870	1880
Foreign-born (%)	0.059 (0.101)	0.096 (0.133)	0.115 (0.152)	0.107 (0.132)
Number of Counties	1618	2079	2290	2569

Note: Factory is equal to 1 if a firm employed more than 15 workers and 0 otherwise. Firm size is defined as one plus number of male, female, and child workers. Male intensity is defined as male workers divided by firm size. Male labor category contains male children in 1850 and 1860 but not in 1870 and 1880. Steam power is equal to 1 if a firm used steam and 0 otherwise; same for water power. Sample selection criteria was same as that of Atack, Bateman and Margo (2004): Gross output greater than $500; for 1850 and 1860, average monthly wage greater than $4.76 but less than $190.5; and, for 1870 and 1880, average monthly wage greater than $5.20 but less than $208. For source notes, see Atack and Bateman (1999).

Table 6

Foreign-born and Factory Organization and Firm Size in U.S. Manufacturing, 1860-1880

	Factory						Firm Size (log)					
	Probit	Probit	Probit	Probit	Probit	Probit	OLS	OLS	OLS	OLS	OLS	OLS
	1860	1860	1870	1870	1880	1880	1860	1860	1870	1870	1880	1880
Fgn-born (%)	2.64*	2.47*	2.77*	2.74*	2.19*	2.37*	1.64*	1.41*	1.76*	1.47*	1.80*	1.67*
	(0.24)	(0.24)	(0.33)	(0.33)	(0.28)	(0.29)	(0.18)	(0.13)	(0.19)	(0.17)	(0.19)	(0.17)
Ln(K/L)	-	0.01	-	0.03	-	0.07*	-	-0.01	-	0.002	-	0.01
		(0.03)		(0.03)		(0.02)		(0.02)		(0.01)		(0.01)
Men/L	-	-1.90*	-	-1.49*	-	-1.33*	-	-2.14*	-	-1.44*	-	-1.12*
		(0.20)		(0.15)		(0.11)		(0.14)		(0.12)		(0.08)
Steam	-	1.14*	-	1.24*	-	1.28*	-	0.91*	-	1.07*	-	1.07*
		(0.09)		(0.09)		(0.06)		(0.05)		(0.05)		(0.05)
Water	-	0.21*	-	0.60*	-	0.46*	-	0.09*	-	0.27*	-	0.41*
		(0.10)		(0.11)		(0.10)		(0.04)		(0.06)		(0.05)
Constant	-1.20	1.72*	-0.28	-0.84*	-0.45	0.76	1.39*	2.55*	1.57*	2.03*	4.78*	4.64*
	(0.95)	(0.78)	(0.84)	(0.88)	(0.90)	(0.93)	(0.17)	(0.24)	(0.20)	(0.23)	(0.14)	(0.17)
Fixed-effects												
Industry	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
State	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Pseudo or R-squared	0.27	0.35	0.22	0.32	0.28	0.29	0.30	0.42	0.30	0.43	0.23	0.38
Observations	7374	7334	5443	5411	7087	7087	7454	7413	5548	5515	7136	7136

Note: Robust standard errors in parentheses. * Significant at the 5% level.
Factory is equal to 1 if a firm employed more than 15 workers and 0 otherwise.

Table 7

Foreign-born and Wages and Labor Productivity in U.S. Manufacturing, 1860-1880

	Wages (log)						Labor Productivity (log)					
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
	1860	1860	1870	1870	1880	1880	1860	1860	1870	1870	1880	1880
Fgn-born (%)	0.52*	0.52*	1.50*	1.41*	1.83*	1.69*	0.92*	0.92*	1.27*	1.15*	1.61*	1.43*
	(0.07)	(0.07)	(0.10)	(0.10)	(0.21)	(0.21)	(0.12)	(0.14)	(0.13)	(0.13)	(0.22)	(0.22)
Ln(K/L)	-	0.06*	-	0.20*	-	0.22*	-	0.25*	-	0.27*	-	0.29*
		(0.01)		(0.01)		(0.01)		(0.01)		(0.01)		(0.01)
Men/L	-	0.67*	-	0.43*	-	0.58*	-	0.40*	-	0.40*	-	0.41*
		(0.04)		(0.05)		(0.04)		(0.07)		(0.08)		(0.05)
Steam	-	0.01	-	0.07*	-	0.01	-	0.13*	-	0.09*	-	-0.03
		(0.02)		(0.03)		(0.02)		(0.03)		(0.03)		(0.02)
Water	-	-0.05*	-	-0.13*	-	-0.19*	-	0.02	-	-0.06	-	-0.14*
		(0.02)		(0.03)		(0.03)		(0.04)		(0.05))		(0.04)
Constant	5.98*	4.79*	5.24*	2.72*	-	3.46*	9.35*	7.18*	7.38*	3.14*	4.83*	5.19*
	(0.07)	(0.08)	(0.14)	(0.14)		(0.12)	(0.11)	(0.13)	(0.11)	(0.16)	(0.12)	(0.14)
Fixed-effects												
Industry	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
State	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Pseudo or R-squared	0.40	0.44	0.25	0.35	0.32	0.43	0.20	0.27	0.14	0.25	0.24	0.36
Observations	7454	7413	5548	5515	7136	7136	7326	7287	5417	5387	7112	7112

Note: Robust standard errors in parentheses. * Significant at the 5% level.

Table 8

First Stage Regressions

Foreign-born (ratio)	1860 (1)	1860 (2)	1860 (3)	1860 (4)	1870 (1)	1870 (2)	1870 (3)	1870 (4)	1880 (1)	1880 (2)	1880 (3)	1880 (4)
1850 Foreign-born population ratio	0.91* (224.6)	-	0.90* (220.1)	-	0.74* (155.9)	-	0.73* (149.0)	-	0.62* (147.8)	-	0.61* (147.4)	-
Growth in Foreign-born (1860-1850)	-	0.04* (17.3)	0.005* (5.90)	-	-	0.05* (21.7)	0.01* (10.6)	-	-	0.01* (12.7)	0.006* (12.7)	-
Log (Distance)	-	-	-	-0.06* (34.2)	-	-	-	-0.03* (4.97)	-	-	-	-0.04* (33.6)
Access to water transportation in 1850	-	-	-	0.06* (21.1)	-	-	-	0.03* (8.45)	-	-	-	0.05* (23.2)
Staiger and Watson F-statistics	*50492*	*298*	*25456*	*819*	*24292*	*473*	*12502*	*691*	*21836*	*162*	*11201*	*844*
R-squared	0.94	0.54	0.94	0.51	0.86	0.59	0.93	0.59	0.90	0.59	0.90	0.68
Observations	6695	6726	6727	6727	4600	4600	4600	4654	6868	6868	6868	6973

Note: Robust standard errors in parentheses. * Significant at the 5% level.
Regressions include all the exogenous variables including state and 3-digit industry fixed-effects.
Growth in foreign-born is defined as $(\text{Foreign-born}_{1860} - \text{Foreign-born}_{1850})/\text{Population}_{1850}$.
Distance measures square miles from Kings County, New York and is constructed using data on county longitude and latitude from http://www.census.gov/tiger/tms/gazetteer. Distance between two points, A and B, is calculated using the following approximate formula: $[(69.1*(\text{longitudeA}-\text{longitudeB}))^2 + (53.0*(\text{latitudeA}-\text{latitudeB}))^2]^{1/2}$.

Table 9

IV Estimation of Foreign-born and Factory Organization of U.S. Manufacturing, 1860-1880

1860	Probit	IV Probit #1	IV Probit #2	IV Probit #3	IV Probit #4
Fgn-born (%)	2.47*	2.36*	1.22	2.35*	2.92*
	(0.24)	(0.30)	(1.60)	(0.30)	(0.57)
Wald test of Exogeneity, p>chi^2	-	0.07	0.39	0.06	0.47
1870	Probit	IV Probit #1	IV Probit #2	IV Probit #3	IV Probit #4
Fgn-born (%)	2.74*	2.74*	0.41	2.74*	2.58*
	(0.33)	(0.32)	(3.93)	(0.32)	(0.62)
Wald test of Exogeneity, p>chi^2	-	0.05	0.52	0.05	0.48
1880	Probit	IV Probit #1	IV Probit #2	IV Probit #3	IV Probit #4
Fgn-born (%)	2.37*	1.65*	1.00	1.65*	1.92*
	(0.29)	(0.32)	(4.25)	(0.32)	(0.61)
Wald test of Exogeneity, p>chi^2	-	0.06	0.82	0.06	0.96

Note: Although not reported for space considerations, the regressions include all the exogenous variables including state and 3-digit industry fixed-effects. Factory is equal to 1 if a firm employed more than 15 workers and 0 otherwise. IV estimation was conducted using ivprobit in Stata version 9.
Standard errors in parentheses. * Significant at the 5% level.
IV Probit #1's instrument is share of foreign-born population in 1850.
IV Probit #2's instrument is the growth in foreign-born population between 1850 and 1860.
IV Probit #3's instruments are share of foreign-born population in 1850 and the growth in foreign-born population between 1850 and 1860.
IV Probit #4's instruments are distance from King's county and whether the county possessed access to water transportation in 1850.

Table 10

IV Estimation of Foreign-born and Firm Size (log) of U.S. Manufacturing, 1860-1880

1860	OLS	IV Reg #1	IV Reg #2	IV Reg #3	IV Reg #4
Fgn-born (%)	1.41*	1.35*	0.51	1.34*	2.04*
	(0.13)	(0.11)	(0.52)	(0.11)	(0.23)
Overid test					
Sargan P-value	-	-	-	0.10	0.00
1870	OLS	IV Reg #1	IV Reg #2	IV Reg #3	IV Reg #4
Fgn-born (%)	1.47*	1.52*	1.22*	1.52*	1.97*
	(0.17)	(0.15)	(0.89)	(0.15)	(0.28)
Overid test					
Sargan P-value	-	-	-	0.74	0.00
1880	OLS	IV Reg #1	IV Reg #2	IV Reg #3	IV Reg #4
Fgn-born (%)	1.67*	1.24*	1.12	1.24*	1.42*
	(0.17)	(0.16)	(0.98)	(0.16)	(0.32)
Overid test					
Sargan P-value	-	-	-	0.90	0.01

Note: Although not reported for space considerations, the regressions include all the exogenous variables including state and 3-digit industry fixed-effects. Factory is equal to 1 if a firm employed more than 15 workers and 0 otherwise. Standard errors in parentheses. * Significant at the 5% level.
IV Reg #1's instrument is share of foreign-born population in 1850.
IV Reg #2's instrument is the growth in foreign-born population between 1850 and 1860.
IV Reg #3's instruments are share of foreign-born population in 1850 and the growth in foreign-born population between 1850 and 1860.
IV Reg #4's instruments are distance from King's county and whether the county possessed access to water transportation in 1850.

Table 11

IV Estimation of Foreign-born and Average Wages (log) of U.S. Manufacturing, 1860-1880

1860	OLS	IV Reg #1	IV Reg #2	IV Reg #3	IV Reg #4
Fgn-born (%)	0.52*	0.48*	0.27*	0.48*	0.80*
	(0.07)	(0.04)	(0.20)	(0.04)	(0.09)
Overid test					
Sargan P-value	-	-	-	0.29	0.88
1870	OLS	IV Reg #1	IV Reg #2	IV Reg #3	IV Reg #4
Fgn-born (%)	1.41*	1.48*	0.67	1.47*	2.01*
	(0.10)	(0.09)	(0.54)	(0.09)	(0.17)
Overid test					
Sargan P-value	-	-	-	0.13	0.03
1880	OLS	IV Reg #1	IV Reg #2	IV Reg #3	IV Reg #4
Fgn-born (%)	1.69*	1.96*	1.68*	1.95*	2.79*
	(0.21)	(0.11)	(0.66)	(0.11)	(0.22)
Overid test					
Sargan P-value	-	-	-	0.67	0.49

Note: Although not reported for space considerations, the regressions include all the exogenous variables including state and 3-digit industry fixed-effects. Factory is equal to 1 if a firm employed more than 15 workers and 0 otherwise. Standard errors in parentheses. * Significant at the 5% level.
IV Reg #1's instrument is share of foreign-born population in 1850.
IV Reg #2's instrument is the growth in foreign-born population between 1850 and 1860.
IV Reg #3's instruments are share of foreign-born population in 1850 and the growth in foreign-born population between 1850 and 1860.
IV Reg #4's instruments are distance from King's county and whether the county possessed access to water transportation in 1850.

Table 12

IV Estimation of Foreign-born and Labor Productivity (log) of U.S. Manufacturing, 1860-1880

1860	OLS	IV Reg #1	IV Reg #2	IV Reg #3	IV Reg #4
Fgn-born (%)	0.92*	0.90*	0.81*	0.90*	1.79*
	(0.14)	(0.10)	(0.44)	(0.10)	(0.20)
Overid test					
Sargan P-value	-	-	-	0.84	0.001
1870	OLS	IV Reg #1	IV Reg #2	IV Reg #3	IV Reg #4
Fgn-born (%)	1.15*	1.29*	-0.02*	1.28*	1.86*
	(0.13)	(0.13)	(0.76)	(0.13)	(0.24)
Overid test					
Sargan P-value	-	-	-	0.08	0.49
1880	OLS	IV Reg #1	IV Reg #2	IV Reg #3	IV Reg #4
Fgn-born (%)	1.43*	1.79*	2.39*	1.80*	2.42*
	(0.22)	(0.13)	(0.75)	(0.13)	(0.25)
Overid test					
Sargan P-value	-	-	-	0.42	0.10

Note: Although not reported for space considerations, the regressions include all the exogenous variables including state and 3-digit industry fixed-effects. Factory is equal to 1 if a firm employed more than 15 workers and 0 otherwise. Robust standard errors in parentheses. * Significant at the 5% level.
IV Reg #1's instrument is share of foreign-born population in 1850.
IV Reg #2's instrument is the growth in foreign-born population between 1850 and 1860.
IV Reg #3's instruments are share of foreign-born population in 1850 and the growth in foreign-born population between 1850 and 1860.
IV Reg #4's instruments are distance from King's county and whether the county possessed access to water transportation in 1850.

Table 13

Urbanization, Factory Production and Firm Size, 1860-1880

1860	Factory Probit	Factory Probit	Firm Size OLS	Firm Size OLS
Fgn-born (%)	1.69* (0.47)	2.42* (0.41)	0.68* (0.19)	1.16* (0.18)
Urban>2,500	0.37* (0.18)	-	0.41* (0.09)	-
Urban>25,000	-	0.02 (0.13)	-	0.15* (0.08)
1870	Factory Probit	Factory Probit	Firm Size OLS	Firm Size OLS
Fgn-born (%)	1.00* (0.43)	2.32* (0.43)	0.38 (0.24)	1.08* (0.25)
Urban>2,500	0.86* (0.17)	-	0.56* (0.08)	-
Urban>25,000	-	0.19 (0.13)	-	0.20* (0.08)
1870	Factory Probit	Factory Probit	Firm Size OLS	Firm Size OLS
Fgn-born (%)	0.97* (0.40)	1.90* (0.36)	0.76* (0.24)	1.31* (0.22)
Urban>2,500	0.58* (0.12)	-	0.38* (0.07)	-
Urban>25,000	-	0.19 (0.10)	-	0.15* (0.06)

Note: The regressions include all the exogenous variables including state and 3-digit industry fixed-effects. Factory is equal to 1 if a firm employed more than 15 workers and 0 otherwise. Robust standard errors in parentheses. *Significant at the 5% level.

Table 14

Ethnic Diversity and Factories, 1870-1880

	Factories		Firm Size (log)		Wages (log)		Labor Productivity (log)	
	Probit 1870	Probit 1880	OLS 1870	OLS 1880	OLS 1870	OLS 1880	OLS 1870	OLS 1880
Native Born Out of State	0.39 (0.90)	0.04 (0.37)	0.16 (0.19)	0.15 (0.18)	0.48* (0.14)	0.52* (0.13)	0.56* (0.17)	0.66* (0.16)
English & Wales	2.69 (2.05)	5.15* (1.88)	-0.03 (1.38)	1.59 (1.30)	1.48* (0.69)	2.18* (0.87)	0.78 (1.15)	1.63* (0.94)
British America	5.51* (1.58)	3.10* (1.12)	1.74* (0.89)	1.12 (0.80)	0.85 (0.43)	1.24* (0.34)	-0.14 (0.46)	1.38* (0.38)
Ireland	4.65* (1.25)	4.72* (1.26)	3.60* (0.62)	3.67* (0.71)	2.31* (0.38)	3.51* (0.41)	1.90* (0.39)	2.72* (0.48)
Germany	6.78* (1.29)	3.49* (0.94)	2.20* (0.53)	1.93* (0.67)	1.68* (0.32)	2.73* (0.30)	0.60 (0.38)	2.39* (0.38)
Italy	7.14 (11.1)	-32.7* (14.5)	-4.76 (4.95)	-28.9* (8.25)	-7.73* (3.08)	19.5* (6.51)	-6.34* (2.88)	28.7* (7.55)
Scandinavia	4.69* (1.64)	4.72* (1.22)	1.50* (0.62)	3.10* (0.79)	1.34* (0.56)	1.99* (0.35)	-0.10 (0.57)	1.35* (0.41)
Diversity	11.9* (4.42)	4.50 (3.88)	4.10* (1.60)	1.52 (3.02)	0.76 (0.94)	4.33* (1.02)	-2.38* (0.97)	3.63* (1.23)

Note: The regressions include all the other explanatory variables as in Table 7 except that the foreign-born variable has been replaced by shares of population of native born out of state and shares of foreign-born populations born of various European nations. Robust standard errors in parentheses. * Significant at the 5% level.

Table 15

Occupations in Which Foreign-born Workers are Overly Represented by National Origins:
Manufacturing, Mining and Mechanical Industries, 1870
(Average of All Gainful Workers = 100)

Germans
bakers (587), basket-makers (424), brewing and malting (901), butchers (446), cabinet-makers (412), cigar-makers (491), confectioners (397), coopers (320), distillers and rectifiers (360), engravers (315), gun and locksmiths (382), piano (596), tailors (307), upholsterers (439), wood-turners and carvers (416)

Irish
bleachers (294), brass founders and workers (304), gas-workers (517), iron-foundry operatives (263), marble and stone cutters (319), paper-mill operatives (246), plumbers and gas fitters (269), print-work operatives (381), quarrymen (392), rolling mill operatives (264), roofers and slaters (232), rubber-factory operatives (264), sewing machine factory operatives (252), steam-boiler makers (362), woolen-mill operatives (274)

English and Welsh
bleachers, dyers and scourers (519), carpet-makers (403), cotton-mill operatives (375), iron and steel work operatives (351), iron-furnace operatives (340), knitting and hosiery mill operatives (627), machine and allied trades including engineers and foremen (309), machinists (392), mining (797), pattern making (356), pottery making (471), print-work operatives (635), rolling-mill operatives (653), silk-mill operatives (550), steam-boiler makers (436), steam-engine makers (461), tool and cutlery making (469), woolen-mill operatives (465)

Scandinavian
awning makers (563), lumbermen and raftsmen (229), saw-mill operatives (284), wood choppers (121)

British American
brick and tile (575), cotton mill operatives (454), fishermen and oystermen (383), lumbermen and raftsmen (710), oil (306), rubber factories (380), saw mill operatives (684), shingle and lath makers (455), ship-carpenters (445), ship-caulkers (325), and tool and cutlery making (427), woodchoppers (582), woolen-mill operatives (357)

Occupations in Which Foreign-born Workers are Overly Represented by National Origins:
Manufacturing and Mechanical Industries, 1890
(Average of All Gainful Workers = 100)

Germany
Male: bakers (515), basket-makers (303), bottlers (318), brewing and malting (813), butchers (295), cabinet-makers (427), chemical works (234), confectioners (235), coopers (233), copper workers (250), gun and locksmiths (335), lead and zinc workers (218), leather (202), meat and fruit packers, canners, preservers (232), piano (259), seamstresses (285), silk mill operatives (256), sugar makers and refiners (519), tailors (381), tobacco and cigar factory operatives (251) trunk, valise, etc. makers (264), upholsterers (207). *Female*: bakers (348).

Ireland
Male: bleachers (341), brass workers (229), candle, soap, tallow makers (236), carpet makers (286), chemical works (289), copper (210), gas-workers (669), hat and cap (208), iron and steel (247), leather etc. (338), marble and stone cutters (262), mason (201), meat and fruit packers, canners, preservers (269),oil (252), paper-mill operatives (256), print-work operatives (313), roofers and slaters (216), rubber-factory operatives (385), steam-boiler makers (268), sugar (209), wire (206), woolen-mill operatives (224). *Female*: none.

Great Britain
Male: bleachers, dyers and scourers (459), brass (216), carpet-makers (404), copper (247), cotton-mill operatives (340), engravers (245), glove (316), gold and silver (250), hosiery and knitting (271), iron and steel work operatives (278), machinists (266), marble and stone cutters (357), masons (206), metal works (246), mill and factory operatives (339), model and pattern making (309), potters (399), print-work operatives (386), roofers and slaters (224), sail, awning and tent (204), ship and boat (213), silk-mill operatives (386), steam-boiler makers (287), tool and cutlery making (274), woolen-mill operatives (422). *Female*: cotton mill operatives (261), mill and factory (323), potters (502), silk mill (228), woolen-mill (281).

Canada
Male - English speaking: builders and contractors (247), carpenters and joiners (215), rubber-factory operatives (253), sail, awning and tent (220), saw and plane mill (273), ship and boat (479). *Female - English speaking*: clock and watch makers (244), rubber-factory operatives (327).
Male - French speaking: boot and shoe (324), box (258), brick and tile (1,118), cotton mill (2,799), door, sash and blind (206), gold and silver (243), hosiery and knitting (532), leather etc. (203), mill and factory operative (934), paper mill (478), print works (377), saw and planing (405), ship and boat (280), tool and cutlery making (298), woolen-mill (736). *Female - French speaking*: cotton mill (1654), hosiery and knitting (281), mill and factory operative (736), woolen-mill (442).

Scandinavia
Sweden and Norway - Male: agricultural implements (467), cabinet (279), sail, awning and tent (250), saw and plane mill (341), tailors (250), wire (348). *Female*: none. *Denmark - Male*: agricultural implements (288), brick and tile (262), butter and cheese (243), cabinet (243), sail, awning and tent (269). *Female*: none.

France
Male: bakers (361), basket (205), bleachers, dyers and scourers (496), butchers (280), cabinet (224), charcoal, coke and lime (373), clock and watch (359), confectioners (308), copper (227), distillers and rectifiers (328), engravers (384), glass (717), glove (656), gun and locksmiths (291), lead and zinc workers (205), meat and fruit packers, canners, preservers (205), silk-mill operatives (838). *Female*: artificial flower (739), bakers (254), bleachers, dyers and scourers (851), confectioners (211), glass (271), lace and embroidery (413), silk-mill (238).

Italy
Male: boot and shoe (268), charcoal, coke and lime (476), confectioners (771), distillers and rectifiers (308), hat and cap (256), marble and stone (464), print works (234), silk mill (509). *Female*: artificial flower (3788), bakers (348), bleachers, dyers and scourers (232), confectioners (2554), paper mill (416), sewing machine operators (276), silk mill (319), Tailoresses (726), tobacco and cigar factory (421)

Source: Hutchinson (1956).
Note: Only those with figures greater than 200 have been listed.

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