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INDUSTRIALIZATION AND URBANIZATION IN NINETEENTH CENTURY AMERICA

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ABSTRACT

During the nineteenth century the United States urbanized – the share of the population living in urban areas increased – and industrialized – the share of the labor force in manufacturing increased. Our survey of the literature and analyses of census data suggests that a key reason was the development of a nationwide transportation system, especially the railroad. Coupled with changes in manufacturing technology and organizational form, the “transportation revolution” increased demand for manufacturing labor in urban locations. Labor supply responded and because of agglomeration economies, population density and the size and number of urban places increased. Although our focus is on the US experience, a causal role for transportation is likely for other economies that experienced historical industrialization and urbanization.

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1. Introduction

The story of nineteenth century development in the United States is one of dynamic tension between extensive growth as the country was settled by more people, bringing more land and resources into production and the intensive growth from enhancing the productivity of specific locations. Key elements in that intensive growth are the movement of population out of agriculture and into other activities. These activities included not only trade (with its closely associated exchange and movement of goods and people) which concentrated in marketplaces but also and increasingly over the century, manufacturing. This paper seeks to clarify the interaction of these forces with particular attention to the growth of population centers and their increasing colocation with manufacturing. At its inception, America's first industrial revolution was predominantly rural. It would become increasingly urban over the course of the nineteenth century, not only as economic activity agglomerated around early nuclei but also because changes in technology diminished the importance and value of certain initial conditions and freed manufacturing to relocate to more centralized and concentrated locations. We document the increasingly urban character of manufacturing over the century, and we sketch an economic framework for its interpretation.

In 1800 83 percent of the American labor force was engaged in agricultural production, mostly for household consumption with any surplus of most crops directed towards local markets (Carter et al., 2006, Ba814 and Ba817). There were some American products where the principal market lay overseas, like tobacco and cotton, but these were the rare exception. Most basic manufactured goods were also made in the home although some might be purchased from local artisans. Household production was driven both by a lack of the necessary cash to buy in the market and the distance to readily accessible marketplaces.

Population densities in the United States were very low, especially when compared with those in western Europe or the Far East. There were few towns and cities of any size. In 1800, for example, the US population of 5.3 million was spread out across over 860,000 square miles of territory, giving the country an average population density of 6.1 per square mile—barely over the 1890 census threshold of "settled" (density > 6.0).[1] Moreover, the Louisiana Purchase of 1804 approximately doubled the land area of the US, adding so much sparsely populated territory that despite the US population growing by 36 percent between 1800 and 1810, density fell to just 4.3 persons per square mile (far short of one family) and did not surpass the 1800 level until sometime in the 1820s (Carter et al., 2006). Just 33 communities nationwide in 1800 would have met the conventional Census definition of "urban" – population of 2,500 or more – comprising 6.1 percent of the population.[2] Only two cities (Philadelphia and New York) where

[1] Figures on population density, urbanization rates, and the number and size of urban places mentioned throughout the paper are from U.S. Census Bureau 1993; Gibson, 1998; or Carter et al., 2006. The 1890 Census report (U.S. Department of the Interior Census Office., 1895) categorized areas of under 2 persons per square mile as "unsettled"; those with between 2 and 6 as "frontier" and those over 6 as "settled." This classification was tremendously influential on historians and has been used to date and mark the closing of the frontier (Turner, 1894).

[2] Included on the map in Figure 1 but not in the total of 33 urban places and cities are St. Louis and New Orleans, both on the Mississippi River, but not part of the US proper in 1800 (they became part of the US following the Louisiana purchase).

1.9 percent of the US population lived, were of any real size and would have met the population cutoff to qualify as one of largest 100 cities as of 1900 (that is, a population of 38,000 or more, see Gibson, 1998).

Figure 1 about here

Moreover, the location of the few urban places in 1800 reflected the primitive nature of overland transportation, which was extremely limited and costly, even when it occurred on "improved" surfaces like turnpikes or graded and paved roads in or near the few population centers. Shipping goods by wagon over indifferent or bad roads – the vast majority -- cost as much as 70 cents per ton-mile in 1816 (Taylor, 1951), ruling out all but the least bulky, most valuable commodities. Personal travel overland was equally difficult, expensive, and time-consuming. While a horse might carry a rider 20-30 miles in a day, horses were costly, and most trips were made on foot. If a wagon were needed, a trip to and from market could easily take several days (Rothenberg, 1981). Much transportation, therefore, of goods or people in the early nineteenth century occurred along the Eastern seaboard or on navigable internal waterways. Figure 1 maps the locations of urban places and geographic variation in population density in 1800.

The few relatively large agglomerations on the coast – Boston or New York, for example – were located where "natural advantage" provided harbors with ocean access. Further inland, water transportation had to stop where rivers draining to the Atlantic Ocean crossed the Eastern "fall line," again creating points of agglomeration and concentrated settlement – so-called "portage" sites (Bleakley and Lin, 2012).[3] However, as noted, the number of such places and the share of the population living in them were very small at the start of the nineteenth century – the vast majority of the population was rural, and sparsely settled at that.

Over the nineteenth century, the American economy grew dramatically in the aggregate and per capita coincident with a pronounced shift of labor out of agriculture (Gallman and Rhode, 2019). By 1900, the share of the labor force in farming had decreased 43 percentage points during the preceding century. And, as the labor force shifted out of agriculture, the nation became more urban with almost 40 percent of the American population living in places of 2,500 population or more and average population density increased. Moreover, fully a quarter of the population lived in the nation's 100 largest cities (population of 38,000 or more). These cities are mapped in Figure 2, along with the geographic variation in population density:

Figure 2 about here

[3] At the point where a navigable river crossed the fall line there were physical obstacles – falls, rapids, boulders, and the like – that prevented further travel. Boatmen would have to disembark and then have the boat moved further up the river to a safe place, which usually required removing any goods to lighten the load. This created natural stopping places – portage sites – for trade. See Bleakley and Lin (2012) for a full discussion. We have marked the eastern fall line on Figures 1 and 2. Also visible in Figure 1 are cities like Albany, Hudson, and Schenectady that were located on the Hudson River, which originates upstate and eventually drains into the Atlantic Ocean at New York harbor.

Many cities were deep in the interior, far from either coast and the eastern fall line or, in the case of the Midwest, the Great Lakes. Some had limited or no access to navigable waterways (for example, Indianapolis or Salt Lake City).

An important component of the shift of labor out of agriculture was into manufacturing. When the nineteenth century began, the "Industrial Revolution" was well underway in Britain but barely in its infancy in the United States (United States. Congress House., 1791). By 1900, the United States was the world's leading producer of manufactures, with labor productivity twice as high as that in Britain, the nation where industrialization had first taken hold (Broadberry and Irwin, 2004, Table 3; Broadberry and Irwin, 2006). Critical to American industrial ascendancy were radical changes in the nature of the manufacturing process and the rise of the factory. Home manufactures declined precipitously, and many local artisans were displaced by the factory system. Compared with artisan shops, factories employed more workers per establishment and used machinery powered by an inanimate source to produce a large volume of output that was sold in increasingly distant markets. Early in the nineteenth century waterpower was the preferred inanimate source, but by the end of the period, steam power predominated.

To make this transition work, inputs had to be purchased and product shipped all over the nation using a dramatically expanded and improved transportation network – the so-called "Transportation Revolution" (Taylor, 1951). While the transportation revolution encompassed significant improvements and expansion of water transportation, the most important innovation was the development of a nationwide railway network. The diffusion of railways began in earnest in the 1840s and was essentially complete by the end of the century, dramatically increasing "market access" to manufacturing establishments (Taylor, 1951; Fogel, 1964; Atack, 2013; Donaldson and Hornbeck, 2016). It was associated with profound changes in the cost of transportation both within and between modes. Wagon haulage experienced the smallest change with per ton-mile rates perhaps halving to 15 cents where there were surfaced rather than dirt roads. Water rates, which were already low relative to overland rates, declined perhaps 30 percent on downstream passage; 66 percent transatlantic and 85 percent upstream to fractions of a cent per ton mile thanks in part to steam power. And, in railroading, productivity growth drove down shipping rates by 80 percent to the point where shipping by rail was cost competitive with rivers on a ton-mile basis but for much quicker and more direct delivery.

Our basic explanation of the urbanization of manufacturing in nineteenth century America is very simple –the transportation revolution (especially the railroad) fueled the growth in the number and size of urban places. Coupled with the changes in manufacturing production, this incentivized establishments to urbanize. While it would be incorrect to say that such agglomeration could occur almost anywhere, sources of natural advantage in the early nineteenth century such as coastal access or portage, were much less important by 1900, as shown in Figure 2.

Over the past several decades, American economic historians have assembled empirical evidence that allows this explanation to be refined in ever greater detail. Some involves the digitization and processing of published data from the various nineteenth century census volumes, as well as archival evidence from the original manuscript census returns. It also involves digitization and GIS processing of historical maps of various kinds, part of the ongoing "big data" revolution in economic history. Similar efforts are underway for other countries experiencing historical industrialization and urbanization. We mention these briefly in the conclusion but focus mainly on research on the United States along with suggestions for improvement and further analysis moving forward.

2. From Artisan Shop to Factory: Manufacturing in Nineteenth Century America

At the start of the nineteenth century the American population was overwhelmingly rural and agricultural. Because internal transportation costs were very high, it was prohibitively expensive for most rural farm households to purchase manufactured goods from abroad. Instead, rural farm households made much of what they needed at home, such as clothing or “homespun”. As Albert Gallatin, the US Secretary of the Treasury, observed "by far the greater part of goods made of cotton, flax, or wool are manufactured in private families, mostly for their own use …about two thirds of the clothing . . . worn and used by the inhabitants of the United States who do not reside in cities, is the product of family manufactures" (Gallatin, 1810, 427).

What rural families could not make for themselves they either did without or bought from local artisans, who worked on their own or perhaps with a partner or an apprentice or two. The capital requirements of those businesses were minimal – a building, some simple tools, and “working capital” in the form of partially finished goods and raw materials. Depending on local demand, such enterprises might form the nucleus for agglomeration, but typically at a very modest scale well below the standard census definition of “urban.” For example, an early traveler through Maine described the process as follows: “the place … at which a village begins is either a sea-harbour [sic] or other landing, where country produce is exchanged … or it is a cataract on a river … capable of affording a mill seat. In such a situation, the first fabric that is raised is a solitary sawmill … a flour mill is erected near the sawmill. Sheep being brought upon the farms, a carding machine and fulling mill follow … the mills becoming every day more and more a point of attraction, a blacksmith, a shoemaker, a taylor [sic] and various other artisans and artificers successively assemble…" (Kendall, 1809, quoted in Hunter 1979).

Two other features of the early artisan shop – hand labor and non-specialization -- are important to note. To a first approximation, the artisan shop relied entirely on "hand labor' – that is, it was non-mechanized. Human muscle worked the tools of the trade—hammers, chisels, knives, drills, and so on -- rather than inanimate power source. Artisan production was also "non-specialized", first and foremost in the performance of production tasks –that is, there was little or no division of labor. This is obvious for sole proprietors – if the artisan worked alone there could be no division of labor. Only as more workers were added – for example, an apprentice – might some division of labor take place. Artisan shops also tended to be relatively non-specialized in goods produced within their broad industrial category. Blacksmiths, who could be found almost anywhere in early nineteenth century America, were the classic example (Atack and Margo, 2019). They fashioned a huge array of products out of metal – pots, pans, tools, horseshoes, rakes and other agricultural implements, for starters -- and repaired metal objects that needed fixing. Although most farmers possessed some rudimentary blacksmithing skills (like the knowledge to heat metal in order to bend it), more refined tools and objects were best acquired from the village smithy or repaired there.

Home production of manufactures declined sharply over the nineteenth century (Tryon, 1917) and production outside the home shifted from the hand labor of the artisan shop to the "machine labor" of the factory. Visiting novelists such as Charles Dickens and Anthony and Frances Milton Trollope took note (Trollope, 1832; Dickens, 1850; Trollope, 1863) and use of the word "factory" grew fourfold over the century Patents on new and improved machinery destined for the factory floor accelerated (Sokoloff, 1988; Khan, 2005; 2014). The transition was so important that, in 1880, Carroll D. Wright penned a census monograph on the topic (United States. Census Office. and United States. Census Office., 1883). And by the end of the century, the Census Bureau essentially equated manufacturing with factory production and stopped collecting data on hand trades (Atack and Margo, 2019).

Compared with the artisan shop, factories were larger in the number of workers employed, often dramatically so. Factories had more workers because they engaged in division of labor. Indeed, by the late nineteenth century, the extent of division of labor was so complete that, in the larger factories, a worker might be assigned only a single task in making a product (Atack et al., 2016). This intense division of labor produced a vast increase in the diversity of occupational titles that were included in the handwritten census surveys and eventually in the appearance of occupational dictionaries to make sense of the distinctions (United States. Department of Labor. Employment Service., 1939).

Factories also differed from artisan shops in using more capital per worker and per unit of output (Atack et al., 2004). Some of this can be attributed to differences in fixed capital such as structures and in working capital. However, a key reason for the greater capital intensity in factory production was the widespread use of machinery invented specifically to substitute for human actions – for example, drilling or polishing – and powered by an inanimate source. Initially, waterpower was the inanimate source but was displaced over the century by dramatic increases in the use of steam power, until the very end when electricity started to become available in some cities. This was compounded by the lack of suitable waterpower sites in advantageous locations as settlement moved west.

Waterpower has a long history stretching back to antiquity whereas steam as a viable source was a more recent development, tracing its origins to the early eighteenth century in England for simple tasks like pumping. The defining feature of waterpower is that it is site specific; the establishment had to locate at the source to use it. Such waterpower sites varied widely in their efficacy and in their accessibility to population and to markets (Leblanc, 1969) Some could reliably support only a single establishment or were distant from input or product markets. Others might be close to major population centers, abundant in water flow, and could support multiple establishments. Once an establishment, or more likely several, settled at a particular site, it could attract population and complementary services, leading to a rise in density and, eventually, a town or city. Even where waterpower was thought to be abundant (as, for example, at Lowell on the Merrimack) though, it was limited by natural forces—the flow and the fall (United States. Census Office., 1885; Hunter, 1979).[4] Improved storage via reservoirs and delivery systems of canals and dams might ameliorate these limitations but only in "lumps" and with diseconomies of scale. Even so, nature still ultimately prevailed.[5] Moreover, as density

[4] It took the development of electrical generation at the end of the nineteenth century to make any serious use of the nation's greatest hydro power, Niagara (See Hunter and Bryant, 1991, especially pp. 254ff).

[5] Increased power could often be secured by changing wheel type—for example, from a traditional waterwheel to a water turbine, with small (but perhaps important further marginal improvements) through better turbine design (Hunter, 1979, chapters 7 and 8). But ultimately stream flow and fall determined the waterpower potential. When this limit was reached, supplementary power had to be used. This was usually from steam. For example, Swain (United States. Census Office., 1885, 71-2) describes how Pepperell on the Saco River could only reliably draw 2000hp on its contractual mill rights for 8 months of the year and so installed

rose, competition for the water itself increased to supply public water or for sanitation. By contrast, the central feature of steam power is that the steam engine itself was manufactured (often elsewhere) and could be placed (if not moved) virtually anywhere. Wherever the establishment was, so too could be a steam engine. It was also readily expansible without necessarily replacing everything. For example, additional boilers could provide more steam, or an upgrade may allow for increased steam pressures. Indeed, in practical terms the only real limit was the ability to deliver fuel. Initially, this was wood but increasingly and then exclusively coal, a much more energy dense fuel.[6]

The shift from the hand labor of artisan shop to the machine labor of the factory led to substantial increases in labor productivity in manufacturing. A lengthy literature in economic history has examined these changes in productivity within a production function or growth accounting framework using published or archival data from the various nineteenth century federal censuses of manufacturing. A fair summary is that the literature supports quantitatively significant roles for capital deepening in general and greater relative use of steam power in particular; increases in the division of labor; and total factor productivity growth. However, the

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1500hp of back-up steam power to supplement its waterpower for the balance of the year. Similarly, mills at Lowell were increasingly forced to install some steam capacity even though they all preferred to use their waterpower when it was available because its operating costs were substantially lower—much of the capital costs thereof having long since been amortized.

[6] The power of steam comes not from the fuel but from the water that is converted to steam. A given volume of water produces far more power as steam than by the force of gravity.

relative importance of these different sources of growth is subject to ongoing debate, largely because of measurement problems with the census data (a selective list of references is Atack, 1977; Sokoloff, 1984a; Sokoloff, 1984b; Atack et al., 2004; Atack et al., 2008; Margo, 2015; Atack and Margo, 2019).

Without question, the most detailed and arguably most convincing evidence on the role of machine labor is an unusual late nineteenth century federal document, the so-called "Hand and Machine Labor" study conducted by the US Department of Labor in the mid-1890s (United States. Department of Labor., 1899). This study, which compiled data at the production task level for approximately 600+ highly specific manufactured goods (for example, circular saw blades with a specific number of teeth), was motivated by Congressional concern over the employment effects of machine production. For each good, agents for the Commissioner of Labor collected data at the task level on making the product by hand labor (artisanal) methods and on making the product by machine labor (factory) methods. These data included details about the individual workers performing the task, the tools they used, whether inanimate power was employed, and, crucially, the amount of time to complete the task, among many other pieces of information. The HML staff also constructed a crosswalk allowing consistent comparisons to be made between hand and machine labor at the production task level.

Although the HML data have been known to economic historians for a long time, it is only recently that advances in computing have allowed them to be digitized and organized in a way that facilitates systematic analysis (Atack et al., 2019). Atack, Margo, and Rhode (2020) use the HML production task data to measure the overall difference in productivity between hand and machine labor and the role of inanimate power in explaining this difference. For tasks that were the same between hand and machine labor except for the possible use of powered machinery in the latter, machine labor completed these approximately seven times more quickly than hand labor. Approximately a third of the higher productivity of machine labor can be attributed to greater use of inanimate power *per se*; the remainder, according to the authors, is due to several sources, of which the much finer degree of division of labor under machine labor is likely the most important factor (Atack et al., 2016).[7]

In theory, the processes of industrialization and urbanization in nineteenth century America could have proceeded independently. In fact, they did not – as the country urbanized, manufacturing became more urban. In recent decades American economic historians have digitized published and archival census data, producing public-use data sets that contain much useful information for studying nineteenth century urbanization and industrialization (Atack and Bateman, 1999; Haines and Inter-university Consortium for Political and Social Research, 2010). More recently, as we discuss in section 3, GIS software has provided the tools to digitally process historical maps which can then be linked to census data to explore various hypotheses (Atack, 2013). We use the census data in two ways.

First, we document change over time through county level correlations between the urban population share and the employment-to-population rate in manufacturing. We can compute these correlations for most census years in the nineteenth century from the published census

[7] Unfortunately, an important limitation of the HML study is that it contains no information on the location of the surveyed establishments within the United States – in particular, whether these were rural or urban.

beginning in 1820.[8] The number of observations increases over time reflecting the expansion of the land territory of the United States as well as the creation of new counties in old and new areas. Table 1 reports these correlations with counties both equally weighted as well as by their total population. Correlation levels are always higher if we weight counties by total population, which, in effect, grants more importance to those parts of the country that were more densely settled overall. However, regardless of the weighting scheme, the correlations are positive. They are quite low early in the nineteenth century but there is a strong upward trend indicating that, by the end of the century, counties that were urbanized were highly likely to be industrialized.

Table 1 about here

While this correlation analysis tells us that counties that were more urbanized were more industrialized by the end of the century, this is not the same as saying that manufacturing establishments were becoming more urban. Here, we need data on the urban/rural status of manufacturing establishments, which is not available over the entire period. To gain some insight, we use the establishment samples from the original manuscript returns of the 1850-1880 federal censuses of manufacturing collected and digitized by Jeremy Atack, Fred Bateman, and Thomas Weiss (Atack and Bateman, 1999). For simplicity we focus on the earliest (1850) and

[8] The first census of manufactures was conducted in 1810 but is thought to be so defective that it has been little used by anyone though some information—presumably based upon the returns, was summarized by Tench Coxe (Coxe, 1814). There was no census of manufactures in 1830 (see Wright, 1900).

latest (1880) of these to establish the trend.[9] We present estimates of percent urban which treat establishments equally, as well as estimates weighted by measures of establishment size -- employment, capital invested, value of raw materials used, and value added (gross value of outputs – value of raw materials). These estimates are shown in Panel A of Table 2.

Table 2 about here

In 1850, about a quarter of manufacturing establishments were in urban places.[10] This is above the percentage of the population that was urban (15.4 percent), but still low in an absolute sense. By 1880, the urban share had increased to 48 percent, just under half of all establishments. When we weight by establishment size, the percent urban increases. In other words, larger establishments were more likely to be urban in both years but even taking this into account, manufacturing became substantially more urbanized between 1850 and 1880. For

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[9]Other than 1820 (Sokoloff, 1982), 1850 through 1880 are the only years for which establishment level data survive from the nineteenth century federal manufacturing censuses. Data on urban manufacturing was reported separately starting with the 1880 census, but the Atack-Bateman-Weiss samples are more flexible, allowing us, for example, to delete outliers from the calculation (see the notes to Table 2).

[10] It is possible that the percent urban in manufacturing is overstated in these nineteenth century censuses because of under-enumeration of rural establishments. Rural establishments were more difficult to find in the first place, and more costly for census enumerators to visit. If this is the case, we would expect relatively more under-enumeration earlier in the century than later, which would imply that the upward trend in urbanization in Table 2 is biased downwards.

example, by 1880, just under three-quarters (73 percent) of manufacturing labor was urban, compared with 41 percent in 1850.

In Panel B of Table 2, we divide up urban establishments into three categories – urban establishments that used hand labor (non-powered), those using steam power, and those using waterpower. The figures shown in Panel B are the proportions in these categories and thus add up to the overall percent urban. Between 1850 and 1880 the urban share of establishments grew by 23 percentage points, and most of this growth – 16.3 percentage points, or about 71 percent – is accounted for by the increase in share of non-powered establishments that chose to locate in urban places. However, the remaining 30 percent is accounted for entirely by the increase in the share of establishments that were both urban and used steam power. Importantly, when we weight by employment, the importance of growth in steam use is magnified – of the 32.4 percentage point increase in the urban share of manufacturing employment between 1850, 28 percentage points, or 86 percent is accounted for by steam powered establishments. By (strong) contrast, urban waterpower establishments accounted for small fractions of all establishments (1.6 percent) and employment (4.6 percent) in 1850; there was no change in the former, and a decline in the latter, by 1880.

3. Explaining the Urbanization of Nineteenth Century American Manufacturing

As the labor force shifted out of agriculture in the nineteenth century, the American population became more urban and so did manufacturing. Why did manufacturing become more urban? Boustan, Bunten, and Hearcy (in Cain et al., 2018, vol. 2, chapter 22), hereafter BBH, suggest a simple model derived from Rosen (1979) and Roback (1982) that can serve as a broad interpretive frame. More densely populated areas command higher land rents in equilibrium. For workers to be willing to live in denser—more expensive—areas, nominal wages must be higher or amenities better than in the countryside. Because urban land and urban labor is more expensive, for firms to be willing to locate in urban places, labor productivity must be higher or some component of production costs other than labor and land less expensive. BBH are not able to construct an urban rent premium series for the nineteenth century. However, they construct urban and rural wage series, which show a substantial and growing urban wage premium over the nineteenth century.[11] Because the manufacturing labor force became more urban over time, t, the urban demand for manufacturing labor must have grown faster than supply, implying that urban places were becoming more profitable locations to conduct manufacturing over time.[12]

Urban economists, of course, have long suggested a broad set of reasons why firms might find it advantageous to locate in urban places – agglomeration economies. Thicker markets for goods and factors of production, especially if the urban place is connected to a broader transportation network, enhance market access and lower search costs associated with matching

[11] It is worth noting that the wage data that BBH use for the nineteenth century portion of the series pertain to average wages at the establishment level in manufacturing. It is possible that the increase in the urban wage premium could be due to compositional shifts rather than a growing productivity gap. Further work on this issue would certainly be welcome.

[12] See Higgs (2011, ch. 3), and Kim (2006) for very similar arguments. The alternative explanation, that denser areas became more attractive places to live because of improving amenities, does not square with the abundant evidence on higher morbidity and mortality rates in urban versus rural locations in the nineteenth century until possibly late in the century with improvements in urban water and sewage systems; see, for example, BBH, Ferrie and Troesken (2008), and Costa (2015).

factor supply to factor demand. Denser populations serve as conduits for the spread of new ideas and innovations. The challenge is to link the generalities to concrete historical manifestations and then sort out which were more important quantitatively in the American case.[13]

As we noted previously, at the start of the nineteenth century urban areas, both small and large, were places of commerce, not of production. Larger cities on the eastern seaboard, such as Boston, Philadelphia, and New York, were port cities, with the bulk of the labor force engaged in trade and related activities. The same was true in the interior for portage sites (Bleakley and Lin, 2012). As discussed above, manufacturing outside of the home early on was concentrated in artisan shops which might, but did not need to be, located in a village or town. Moreover, some industrial activities, such as flour milling, were overwhelmingly rural even late in the century—in part because they satisfied local needs, or were part-time complementary activities, and their power requirements of a few horsepower were easily satisfied by local waterpower sites.[14]

As the conventional story goes, the transition from hand to machine labor began in the Northeast around 1820. The correlations in Table 1 show it was a predominantly rural affair at the outset. Consider the iconic symbol of early industrialization, the New England textile mill.

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[13] An alternative is a structural estimation of a dynamic spatial equilibrium model that builds in agglomeration economies. Such a model has been estimated for English cities covering the second half of the nineteenth century (see Hanlon and Miscio (2017)) but, to our knowledge, has not been attempted for the United States.

[14] Just 10 percent of the flour mills in the 1880 establishment sample were located in urban areas, compared 46 percent of establishments overall.

Such mills were among the very first factories in the United States, but they were initially located in the countryside, not in the city. They drew their labor-- young women from area farms—and provided marginal New England farmers with "a new source of profit and support from the increased industry of his wife and daughters" (United States. Dept. of the Treasury. and United States. Congress House., 1791).[15] Early industrialization in the Northeast could take advantage of the generous availability of cheap waterpower in the region. But as population moved from east to west, the availability of suitable sites declined precipitously (Atack et al., 1980).

Consider in the abstract, therefore, the decision problem faced by prospective manufacturer to use waterpower in production. To do so requires locating at an existing site that can be expanded or else developing a new usable site. Whether this is beneficial depends on the productivity gains associated with waterpower, compared with, on net, differences in production costs associated with locating at the site versus remaining unpowered and locating somewhere else, including perhaps in a city or town. Moreover, other margins, such as the number of

[15] Contemporaries even lauded how American factory locations differed from the "dark Satanic mills" of industrializing Britain and the evils of urban living. As the American Society for the Encouragement of Domestic Manufactures put it "We have… none of those great manufacturing cities; nor do we wish for such. Our fabrics will not require to be situated near mines of coal, to be worked by fire or steam, but rather on chosen sites, by the fall of waters and the running stream, the seats of health and cheerfulness, where good instruction will secure the morals of the young, and good regulations will promote, in all, order, cleanliness, and the exercise of the civil duties" (American Society for the Encouragement of Domestic Manufactures., 1817, 14).

workers (and therefore the extent of division of labor) are choice variables as well. As Panel B of Table 2 show, the fraction of manufacturing establishments that both used waterpower and were urban was quite small in 1850.

What changed? One prominent hypothesis is that the development of cheap, reliable steam engines freed manufacturing to mechanize and urbanize. The basic idea, a very old one, is that the steam engine lifted a key locational constraint associated with waterpower.[16] Manufacturing establishments that utilized waterpower had to locate near a suitable site. They had no choice. Moreover, even if the site could support multiple establishments, there were significant limits to its scalability. By contrast, an establishment that utilized steam power was "footloose" – theoretically, it could locate anywhere, although proximity to the fuel source (coal) lowered user costs which favored locating near transportation.[17] Technical progress in machinery meant that more establishments demanded more power and could benefit from using steam, encouraging a feedback mechanism between steam and urbanization.[18] The time series patterns shown in Panel

[16] See Alfred Chandler (1972).

[17] The principal benefit of coal is energy density—BTUs per pound or volume. However, whereas wood in early America was available almost everywhere, coal was to be found in just a few locations and so had to be shipped relatively long distances. Supplying this coal was a major driving force behind improvements in transportation. Some canals (such as the Chesapeake and Ohio and the Delaware and Raritan) and railroads (such as the Reading), for example, focused on bringing coal to consumers.

[18] Use of steam power in US manufacturing was not common until the second half of the nineteenth century. The first systematic survey of steam power in the United States was

B of Table 2 would seem consistent with this story – establishments that used steam power and which were urban increased their share of total establishments and total employment, and of urban establishments and urban employment, between 1850 and 1880.

A small literature in American economic history has developed in recent years to evaluate the role of the steam engine in nineteenth century urbanization in general and that of manufacturing specifically. Initially, this literature favored the hypothesis that the development of steam power promoted urbanization, but a critical backlash emerged downplaying the role of steam in favor of a role for immigration. In our view, the literature asks good questions, but the empirical analysis is dated and in need of fresh work. Accordingly, we provide some additional regression evidence (see below) that should be viewed cautiously but suggests to us that, once the transportation revolution is considered steam may have more explanatory power than previously thought and therefore is worthy of closer scrutiny in future work.

The modern literature begins with a well-known paper by Rosenberg and Trajtenberg (2004), hereafter RT, who focus on a particular version of the steam engine, the Corliss (named after its inventor). The Corliss engine was more efficient than its predecessors (that is, used less coal per hour of horsepower) and it could be built to larger horsepower sizes, which meant more workers could be accommodated per machine and a greater division of labor therefore accomplished (Atack et al., 2008). RT collected data from a late 1860s Congressional document

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conducted in 1838. It estimated there were 1,860 stationary engines with a total capacity of just over 36.3 thousand horsepower (U.S Congress. House, 1839, 371). In Britain, the horsepower capacity of stationary steam engines was already 165 thousand by 1830 (see Crafts, 2004a, especially 526; Also Crafts, 2004b).

that identified a subset of purchasers of Corliss engines (Corliss, 1870). The purchasers are assigned to their counties of residence, which generates a partial measure of the stock of the Corliss engines. The empirical analysis is restricted to counties in 11 northeastern states, for which waterpower sites were in sufficient supply to be a viable alternative to steam. They also assemble data for the same counties on watermills in use in manufacturing; these data pertain to 1880 because RT claimed to be unable to find similar data for 1870. In their first set of regressions (RT, Table 1), the measures of the stock of Corliss engines (as of 1869) and watermills (as of 1880) are regressed on county level variables as of 1850, plus state fixed effects. OLS and Poisson regression are used. Their key finding is that the stock of Corliss engines in 1869 is positively and significantly related to county population in 1850, but no such pattern is evident for watermills.

Next, RT (in their Table 2) regress the county growth rate in population from 1870 to 1900 on the initial stock of Corliss engines (as of 1869), watermills (as of 1880), other county level covariates, plus state fixed effects. They find a positive and significant coefficient of the initial stock of Corliss engines, but no such effect for watermills. The steam coefficient, they claim, is robust to variations in the regression specification, including lagged growth rates in county population or the level of population (that is, convergence) in 1870. RT also report 2SLS coefficients from instrumental variables regressions in which the initial stock of Corliss regressions is predicted from their Table 1 regressions (in effect, first stage regressions). They continue to find positive and significant effects of Corliss engines on county population growth.[19]

In a comment on RT, Abrams, Li, and Mulligan (Abrams et al., 2008, hereafter ALM) argue that RT's findings on the role of steam power are not robust. ALM show that plausible and relatively minor variations in the sample of counties changes the magnitude and statistical significance of the 2SLS coefficient of the stock of Corliss engines on county population growth.[20] ALM also show that adding a dummy variable for large port cities (for example, New York, Philadelphia) to RT's Table 1 regressions predicting the stock of Corliss engines produces a significant positive coefficient and further erodes the magnitude and significance of the 2SLS Corliss coefficient.

In our view, neither RT's original paper or the ALM comment satisfactorily address endogeneity or robustness issues. In RT's case, the argument why the righthand side variables in their Table 1 are valid instruments for the IV analysis in Table 2 amounts to the variables are pre-determined. ALM's inclusion of a port city dummy shows that these cities did seem to attract more Corliss engines, but for the variable to be a valid instrument, it would need to be

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[19] RT also provide background information on the Corliss petitioners in the 1869 congressional document, and on what the engines were used for. They note, for example, that Corliss engines were used to power urban waterworks, providing another connection between steam power and urbanization.

[20] ALM also point out that watermill data do exist for manufacturing in 1870 (RT claim otherwise); however, RT's results are not substantively changed by substituting the 1870 watermill data for 1880.

excludable, which ALM do not justify (and does not seem plausible to us). A limitation with both RT and ALM is the asymmetric treatment of watermills – both assume watermills to be exogenous. But, if steam power is a choice variable on the part of establishments, which it certainly was, so too was waterpower.

Like ALM, Kim (2005) is skeptical of Rosenberg and Trajtenberg's claim that the steam engine was a positive force for urbanization. Kim focuses on the likelihood that a manufacturing establishment located in an urban area, using the 1850-80 establishment samples (Atack and Bateman, 1999). His baseline analyses are a set of logit regressions by census year. The key independent variables in the regression are dummies for whether the establishment used steam or waterpower, which are interacted with dummies for factory status (employment greater than 15 workers). Kim also controls for the gender and age mix of employment and county and industry (three-digit SIC codes) fixed effects. Establishments are weighted by employment prior to estimation. With these controls Kim finds that steam powered establishments were less likely to locate in urban areas relative to non-powered unless they also met the definition of a factory; however, the same is true of water-powered establishments. Overall, Kim interprets his regressions as providing very little in the way of direct support of the hypothesis that the diffusion of steam led to urban growth; however, shifts in the distribution of employment from water to steam do suggest a positive but small "shift-share" role. In our view, however, what Kim's regressions show is that the shift of manufacturing establishments towards urban areas included non-powered as well as steam-powered establishments, a pattern that is evident in Panel B of our Table 2. Because Kim's regressions are OLS – or equivalently, Kim does not develop an identification strategy for the choice of power type, factory status, and their interaction – they do not provide sufficient reason, in our view, to reject diffusion of steam power as a key causal factor.

Returning momentarily to our literature review, another hypothesis invokes a role for foreign immigration. The United States attracted a steady flow of immigrants, primarily from Europe, during the nineteenth century but especially after 1850 and again late in the century. Immigrants disproportionately settled in cities, fueling urban growth, and expanding the pool of available labor therein, because immigrants had higher labor force participation than natives. The influx of immigrants, so the argument goes, lowered the relative price of labor in cities, encouraging manufacturing establishments to relocate and engage in greater division of labor, thereby expanding on average in size (measured by employment). Table 3, which we constructed using the complete count federal censuses for 1870-1900, is suggestive; it shows that immigrants were more urban than the general population where they were more likely to work in manufacturing.[21]

Table 3 about here

Kim (2007) attempts econometrically to assesses the role of immigration using the 1880 establishment level data from Atack and Bateman (1999). His key independent variable is the

[21] See also Sequeira, Nunn, and Qian (2020), hereafter SNQ. The main focus of the SNQ paper is on the long run effects of nineteenth century immigration to the US (e.g. 1880 – 2000) but the authors also note that immigrants were more likely to settle in urban places and that immigration expanded (and sometimes altered the skill mix of) the local labor pool. They also emphasize the importance of the railroad as the main way that immigrants traveled around the country, deciding where to settle.

foreign-born share in the county in which the establishment is located which he instruments for using the foreign-born share in the county in 1850, growth in the foreign-born share between 1850 and 1860, and distance to the eastern seaboard and a dummy for the availability of water transportation. His dependent variables are a dummy for factory status, the log of establishment employment, the average (nominal) wage of the establishment, and labor productivity (value added per worker). The IV estimates show positive and significant effects of the percent foreign born in the county on all variables. To take advantage of the productivity gains associated with division of labor, Kim concludes, manufacturers had strong incentives, especially after the Civil War, to locate in urban areas, where they could find this immigrant labor pool, thereby economizing on search and matching costs. Over time prospective immigrants became aware of this tendency, increasing the likelihood of their settling in cities where the jobs were. But, as with Kim (2005), whether one is convinced by the empirical analysis turns on the identification strategy; it is unclear *a priori* whether one should accept the exclusion restriction, for example, for distance to the eastern seaboard or the water transportation dummy.

One factor that is either missing from or not well integrated in the literature just reviewed is an explicit consideration of the transportation revolution (Taylor, 1951). Starting in the 1820s with canals (for example, the Erie Canal) and then accelerating with the arrival of the railroad in the 1840s, the transportation revolution linked the hinterland to existing major (and minor) population centers including the established ports; facilitated westward expansion, regional growth, and regional specialization; and expanded access to raw materials. The famous study by Fogel (Fogel, 1964; see also Fishlow, 1965) demonstrated that the social savings of the railroad – the reduction in transportation costs compared with the next best alternative -- was relatively modest, but this mainly reflects the geography of the United States, with its comparatively dense network of inland waterways and a lengthy coastline with direct access to ocean shipping.

In recent years, American economic historians have been revisiting the economic impact of the transportation revolution, based on econometric analyses of county level variation derived from GIS processing of nineteenth century maps (Atack, 2013). This includes treatment effects of the railroad on urbanization and local population growth.[22] Thus far, the direct evidence for the former is limited to a study of the American Midwest in the 1850s by Atack, Bateman, Haines and Margo (2010a), hereafter ABHM, who use GIS processing of historical maps to create a county-level dummy variable for rail access (=1 if a there was railroad within the county boundaries, zero otherwise). Their analysis focuses on 278 counties in 7 Midwestern states for which county boundaries were fixed between 1850 and 1860. None of the counties in their sample had rail access in 1850, but access grew substantially between 1850 and 1860. ABHM began with difference-in-difference (DID) estimates of the effect of gaining rail access by 1860 on the proportion of the county population living in urban places and on population density. From DID they proceeded to an instrumental variables strategy that predicted rail access based on a "straight line" IV derived from 60 cartographic/geologic surveys authorized by Congress and conducted between 1824 and 1838 for possible transportation improvements.[23] Both DID

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[22] For causal evidence on the effects of transportation improvements in the twentieth century on urban growth, see Duranton and Turner (2012).

[23] Specifically, ABHM locate the geographic starting and endpoints of the surveys and draw straight lines between them. If a county lies on the straight line, the "Congressional Survey" IV = 1, 0 otherwise. The survey IV has a strong first stage (see Atack et al., 2010a).

and 2SLS estimates show a significantly positive and relatively larger effect of gaining rail access on the urban population share, but a more modest, albeit positive, impact on population density.[24] At present, it is unknown whether the particular identification strategy used by ABHM can be adapted for other parts of the United States as these gained rail access over the nineteenth century or whether alternative strategies are needed.[25]

Donaldson and Hornbeck (2016), hereafter DH, is another recent study that explores the economic effects of the railroad using geographic variation. The main variable of interest in DH is land values in agriculture and how these responded to increases in “market access” prompted by the diffusion of the railroad.[26] DH’s measure of the treatment effect of the railroad, therefore, is quite different from ABHM who use a dummy variable for whether a railroad exists

[24] ABHM’s point estimates from the 2SLS regressions are larger in magnitude than the OLS DID estimates but, because of the size of the 2SLS standard errors, are not significantly different from OLS.

[25] One possibility is the straight line IV used by Perlman (2017). This is a straight line IV which is based on the location of urban places in 1830, which pre-date the diffusion of the railroad. Perlman’s IV covers a broader geographic area than the analogous straight-line variable used in the ABHM paper and thus may be more broadly useful in future work.

[26] The basic idea in DH is that market access is that all counties are linked geographically via available transportation. Through a complex programming application of GIS software, DH compute the least cost way of transport from one county to another in 1870 and 1890; if, between 1870 and 1890 rail access is introduced into the least cost route at any point, this enhances market access.

in the county. DH's main finding is that the expansion of market access arising from railroad diffusion between 1870 and 1890 significantly raised agricultural land values; important for this paper, they also estimate a significant positive effect of increases in market access on the local county population; because their regression sample holds county boundaries fixed by design, this is equivalent to increases in population density.   DH do not, however, investigate directly if railroad-induced increases in market access lead to increased urbanization per se, so this remains an open question for future research.

These limitations aside, the ABHM and DT results can be rationalized in terms of our framework by recognizing that the diffusion of the railroad did not increase access at every point along the network but rather where the train stopped – to pick up or drop off freight or passengers (or both).   The stops became natural points of agglomeration.   Pre-existing villages and towns grew once they were connected to the network.   Manufacturing establishments moved there to have ready access to the growing network through which they could obtain raw materials more cheaply and reliably as well as sell their goods to a broader market. There may also be a role for the transportation revolution in fostering another traditional agglomeration economy associated with urbanization – readier access to innovations and new ideas. It has long been known that patenting was more common in urban areas (Higgs, 1971, ch. 3). Perlman (2017) finds that improvements in market access (in the DH sense) increased patenting rates and that much of this increase can be explained by agglomeration (that is, population density).   That said, for most urban places, pure agglomeration economies were highly localized, and so most places were still quite small in population size, even by 1900 (Hodgson 2018). But for others, the economies were more substantial, so the number and size of cities increased, to the point where, as we noted previously, a quarter of the population resided in the nation's 100 largest cities by 1900.

Did the transportation revolution impact the changes in manufacturing production discussed earlier? Here as elsewhere, the literature has been limited so far but suggestive. Atack, Haines, and Margo (2011) use the 1850-80 establishment samples to show that increasing rail access led to increases in share of establishments meeting the consensus definition of a factory (16 or more employees), which they interpret, *a la* Adam Smith, that the transportation revolution fostered division of labor. However, they do not explore whether the changes in factory status in response to increased transportation access varied between urban and rural establishments, or with the use of inanimate power. To encourage further work along these lines, Table 4 presents difference-in-difference (DID) estimates of rail access using the 1850 and 1880 samples. The dependent variables are dummies for different combinations of factory, urban, and power status – for example, the likelihood that an establishment was a steam-powered factory located in an urban area. The regressions include a dummy variable for rail access, a year dummy for 1880, the interaction between the two (the coefficient of this variable is the DID estimate), and fixed effects for three-digit industry code and county.[27] We present results for equally weighted observations and weighted by employment.

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[27] The measure of rail access in Table 4 is whether or the entire land area of the county is within 10 miles of a railroad, or a 20-mile roundtrip, which is generally viewed as the maximum distance that could be traveled by wagon in a day. This is a much more exacting measure of rail access than used by ABHM, who only measured if a railroad crossed into a county's boundaries. As can be seen from Table 4, the spread of the railway network is still strongly evident; when the

Table 4 about here

As can be seen, gaining rail access is positively and significantly associated with increases in the share of establishments that were small and non-powered (that is, artisan shops) and for steam powered establishments regardless of size, but no effects for non-powered factories or establishments using waterpower.[28] When we weight the data by employment, we see a large positive and significant effect for steam-powered factories, but no effects for the other types of establishments.

We see the results in Table 4 as suggestive evidence that the transportation revolution did alter the overall urban-rural mix by increasing the frequency of steam powered establishments in general and, evidently, pushing smaller, non-powered firms to favor denser areas. That said, when we weight by employment, the strongest effect was to encourage the shift towards machine labor in its classic form – the steam powered factory. No attempt has been made to find an instrumental variable for rail access in Table 4, as this goes well beyond the strategy adopted in

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data are weighted by employment, nearly half (49.6 percent) of establishments were located in such counties in 1880, compared with 16.7 percent in 1850.

[28] Hornbeck and Rotemberg (2019) use county-industry level data from the 1860-1900 manufacturing censuses to estimate the impact of increased market access on manufacturing productivity and average firm characteristics. They find a positive effect on the number of establishments, but not average establishment size (measured by workers/firm). This may reflect changes in composition – for example, an increase in small, non-powered establishments and in steam powered factories, as we find in Table 4 – which cannot be addressed using county level aggregates.

Atack, Bateman, Haines, and Margo (2010b). It is an open question, therefore, whether, for example, the substantive patterns in Table 4 with respect to railroad access are causal.

4. Concluding Remarks

America industrialized over the course of the nineteenth century. Initially, industrialization was not an urban affair, but over time, manufacturing and urbanization became tightly connected, as the nature of manufacturing shifted from the hand labor of the artisan shop to the machine labor of the factory. We have related this change to the transportation revolution, the growing use of steam power, and other key historical changes of that epoch. Our argument is that the tighter connection was largely demand driven – establishments became more urban because urban locations were more profitable, despite a higher cost of land and labor. To explain the increased manufacturing demand for urban locations, economic historians have previously hypothesized causal roles for the steam engine and immigration – the former allowed establishments using inanimate power to locate almost anywhere, unlike waterpower, and the latter, by expanding the pool of less skilled labor, lowered the cost of increases in the division of labor. We have privileged the role for the transportation revolution, particularly the railroad, which encouraged urbanization and, importantly, expanding market access for both outputs and inputs, such as coal that was complementary to the diffusion of steam power.

Although the focus of this paper has been on the American experience in the nineteenth century, our explanation is likely relevant to other historical industrial revolutions because the improvements in transportation, the diffusion of steam power and, more broadly, the urbanization of manufacturing, occurred outside the United States to varying degrees. There are now numerous studies of the impact of historical railway development outside of the United

States. A fair summary of this literature is that railway development promoted historical urban growth and industrialization almost everywhere in Europe and in Japan; see, for example, Kotavaara, Antikainen, and Rusanen (2011); Tang (2014); Berger and Enlo (2017); Hornung (2015); Bogart, You, Alvarez, Satchell, and Shaw-Taylor (2020); and Berger (2019). Evidence on steam power analogous to our results in Table 4 is scantier but in a recent paper, Yamasaki (2017) finds strong causal (IV) evidence that the diffusion of rail accelerated the shift to urban manufacturing in Japan in the late nineteenth and early twentieth century, particularly for larger, steam-powered establishments. Comparing and contrasting the American experience of historical urbanization-cum-industrialization with those in other countries is, in our view, a fruitful area for further research.

Over the twentieth century new forces emerged that decoupled manufacturing and cities. The spread of automobiles, trucks, and good roads, the adoption of electrical power, and the mechanization of farming are thought to have encouraged the decentralization of manufacturing activity. By the 1970s, the correlation of manufacturing employment and urbanization—which Table 1 documented rose sharply between 1820 and 1900 – had returned to its 1820 levels. Understanding and integrating these changes into a coherent narrative over the full sweep of the nineteenth and twentieth centuries, is yet another important topic for future research.

Table 1: County-Level Correlations: Urbanization and Manufacturing Employment to Population Ratios, 1820-1900

Year	Percent in Places 2,500 or more population	Percent in Places 25,000 or more population	Percent in Places 2,500 or more population	Percent in Places 25,000 or more in population	Number of Counties
	Unweighted		Weighted by Pop		
1820	0.283	0.172	0.450	0.328	761
1840	0.357	0.147	0.575	0.371	1,240
1850	0.420	0.266	0.717	0.545	1,620
1860	0.341	0.202	0.655	0.477	1,773
1870	0.361	0.322	0.703	0.574	2,290
1880	0.671	0.490	0.810	0.712	2,567
1890	0.706	0.522	0.856	0.778	2,638
1900	0.681	0.465	0.814	0.709	2,779

Source: Correlations are computed from county level data from (Haines and ICPSR, 2010), see text.

Table 2: Percent Urban in Manufacturing, 1850 and 1880: Evidence from the Atack-Bateman Manufacturing Establishment Samples

Panel A: Percent Urban (Places of Population 2,500 or more)

Weighted by	Equal	Employment	Capital	Value of Raw Materials	Value Added
1850	24.9%	40.9%	46.2%	49.5%	42.5%
1880	47.9	73.3	70.7	75.1	73.8

Source: Atack and Bateman (1999). An observation (establishment) is considered urban if it is reported in the census to be located in an identifiable urban place of population 2,500 or more when enumerated. We use the Atack-Bateman national samples; 1880 sample is reweighted to correct for under-representation of so-called “special agent” industries (see, for example, Atack, Bateman, and Margo (2008). To be included in the table, establishments had to report positive values of gross outputs, inputs, employment, raw materials, and value added (= value of gross outputs – value of raw materials). In 1850 employment is the sum of male and female workers; in 1880, employment is the sum of adult male, adult female, and child workers. Establishments with extremely high or low imputed rates of return to capital invested or extremely high reported labor input are assumed to be outliers, and are dropped from the calculation; see Atack Bateman, and Margo (2008). N (establishments) = 5,037 in 1850 and 7,196 in 1880.

Table 2 (continued)

B. Percent Urban, by Type of Power

	Urban = 1 & Hand Labor = 1	Urban =1 & Steam Power = 1	Urban =1 & Waterpower = 1	Urban = 1 & Hand Labor = 1	Urban = 1 & Steam Power = 1	Urban = 1 & Waterpower = 1
Weight	Equal	Equal	Equal	Employment	Employment	Employment
1850	20.8%	2.5%	1.6%	27.1%	9.2%	4.6%
1880	37.1	9.2	1.6	32.3	37.2	3.8

Source: See Panel A. Urban & Hand Labor = 1 if establishment was urban and reported no use of steam or waterpower. Urban & Steam Power =1 if establishment was urban and reported use of steam power and no use of waterpower. Urban & Waterpower = 1 if establishment was urban and reported use of waterpower (this includes establishments using both water and steam power).

Table 3: The Nexus of Immigration, Manufacturing, and Urban Employment, 1870-1900

	1870	1880	1900
Total Labor Force	12,412,105	17,984,764	24,457,404
Manufacturing Percent	10.7	12.0	11.6
Urban Percent	28.0	29.1	37.8
Immigrant Percent	22.8	20.7	19.5
All Manufacturing	1,327,673	2,152,150	2,841,683
Urban Percent	63.1	60.2	71.3
Immigrant Percent	38.0	33.6	32.3
All Urban	3,476,493	5,238,320	9,234,847
Manufacturing Percent	24.1	24.7	22.0
Immigrant Percent	43.4	36.7	31.0
All Immigrants	2,835,950	3,730,597	4,776,229
Manufacturing Percent	17.8	19.4	19.2
Urban Percent	53.3	51.6	59.9
Urban & Manufacturing	837,405	1,294,899	2,027,440
Immigrant Percent	45.5	39.1	36.7
Urban & Immigrant	1,510,467	1,924,850	2,863,202
Manufacturing Percent	25.2	26.3	26.0
Immigration & Manufacturing	503,959	724,039	917,826
Urban Percent	75.6	69.9	80.9

Sources: computed from IPUMS complete count census data for 1870, 1880, and 1900 (Ruggles et al., 2020). 1890 data are unavailable.

Table 4: Difference-in-Difference Estimates: Effects of Gaining Rail Access Between 1850 and 1880 on Different Types of Manufacturing Establishments

Dependent variable	Sample Mean, 1850	Sample Mean, 1880	DID Coefficient	Sample Mean, 1850	Sample Mean, 1880	DID coefficient
Establishment Weight	Equal	Equal	Equal	Employment	Employment	Employment
Non-powered & non-factory & urban=1	0.173	0.285	0.153* (0.078)	0.116	0.088	0.011 (0.032)
Non-powered & factory & urban=1	0.024	0.034	0.011 (0.012)	0.134	0.138	-0.006 (0.060)
Steam powered & non-factory & urban=1	0.011	0.038	0.037* (0.011)	0.013	0.019	0.007 (0.00)
Steam powered & factory & urban= 1	0.010	0.045	0.059* (0.025)	0.090	0.407	0.224* (0.081)
Water powered & non-factory & urban=1	0.012	0.010	0.015 (0.013)	0.008	0.003	0.009 (0.005)
Water powered & factory & urban=1	0.002	0.005	-0.004 (0.013)	0.029	0.022	-0.03 (0.046)
Rail Access = 1	0.083	0.355		0.167	0.496	

Source: Atack and Bateman (1999). In this table we use the state samples for 1850 and 1880 as these have more observations than the national samples used in Table 2. Independent variables are dummies for rail access, year = 1880, rail access x year = 1880, 3-digit industry code, and county. Rail access = 1 if 100 percent of the county area was within 10 miles of a railroad, 0 otherwise. Standard errors, shown in parentheses, are clustered at the county level. DID coefficient: coefficient of rail access x year = 1880. Factory =1 if 16 or more workers are employed at the establishment. To be included in the regressions, establishments must meet the sample screens in Table 2 (for example, positive value added). 1880 observations are reweighted to correct for under-representation of special agent industries; see Atack, Bateman, and Margo (2008). N (establishments) = 7,380 in 1850 and 12,403 in 1880.

Figure 1
Urban places, population density and the eastern fall line, 1800

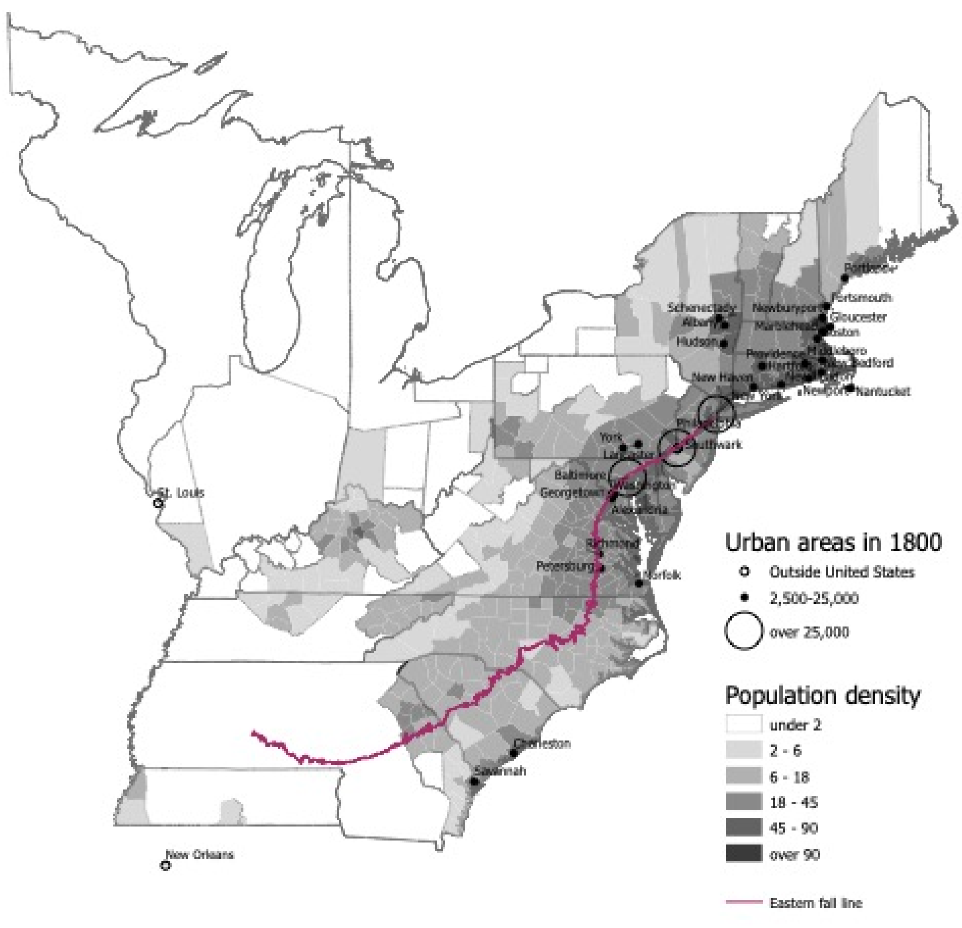
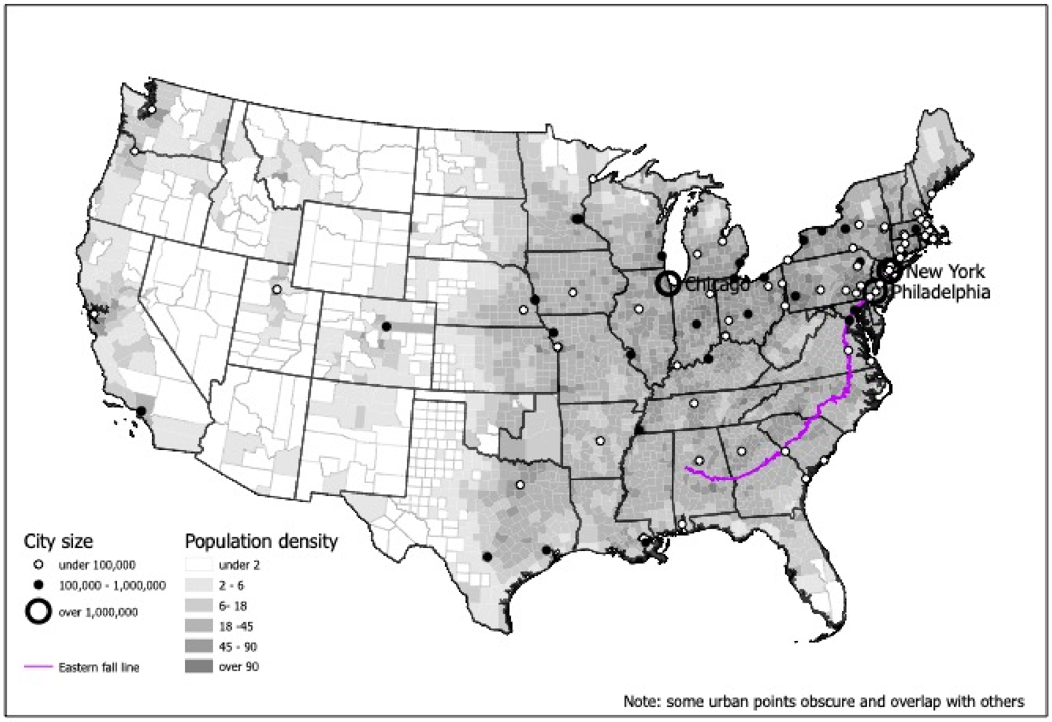


Figure 2
The 100 largest urban places, population density and the eastern fall line, 1900



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