Temporary Shocks and Persistent Effects in Urban Economies: Evidence from British Cities after the U.S. Civil War*

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Abstract

Can a temporary economic shock to an important local industry influence long-run city population? To answer this question I study the large temporary shock to British cities caused by the U.S. Civil War (1861-1865), which reduced cotton supplies to Britain's important cotton textile industry. I show that this event temporarily reduced the growth rate of cities specialized in cotton textile production, relative to other English cities, and led to a persistent change the trajectory of city population growth.

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1 Introduction

Trade allows cities and regions to specialize in industries in which they have a comparative advantage. As a consequence of specialization, local economies can become reliant on a few major traded industries; auto manufacturing in Detroit, the high-tech sector in Silicon Valley, and entertainment in Los Angeles are just a few modern examples. One consequence of concentrated production is that locations may be strongly affected by temporary industry-specific economic shocks. Can temporary economic shocks to an important local industry influence the long-run population size of a city?

This study takes advantage of a unique historical event in order to help answer this question. The experiment is provided by the large exogenous shock to the British cotton textile industry generated by the U.S. Civil War (1861-1865). The cotton textile industry was Britain's largest manufacturing sector during the 19th century and was entirely reliant on imported supplies of raw cotton, most of which came from the U.S. South. The Civil War sharply disrupted these supplies, leading to a deep depression in the industry that saw hundreds of thousands of operatives put out of work or working short-time.

This empirical setting has three features that are particularly important for my study. First, the shock to the cotton textile sector was temporary. Following the end of the Civil War, raw cotton imports quickly returned to their original growth path, as did national cotton textile production. Raw cotton prices returned to pre-war levels within ten years after the end of the Civil War. Thus, within a decade, the initial causes for the economic shock had completely disappeared.

The second key feature of the empirical setting is that, prior to the Civil War, there was substantial variation across British cities in the share of employment in the cotton textile industry. Most of Britain's cotton textile employment was concentrated in cities in the Northwest region. Within these cities the cotton textile industry often provided 20-30% of employment. These initial agglomeration patterns, which date to the 18th century, were driven by historical features such as the availability of water power (Crafts & Wolf (2013)). These features had little direct effect on the industry in the period I study. However, the initial pattern of geographic specialization meant that there was substantial variation in the impact of the cotton shortage across locations. As a result, I am able to compare outcomes in the affected cotton textile cities to those in other British cities, where the direct impact of the U.S. Civil War was limited. To further strengthen the analysis, I compare the cotton textile cities to a set of other British cities that were heavily reliant on textile production, but based on wool, linen, or silk, rather than cotton. While these cities were economically similar to the cotton textile cities, they were not negatively impacted by the cotton shortage.[1]

The third important feature of this empirical setting is that the policy response to this event was limited, despite the magnitude of the event. The main government response came in the form of relief for truly destitute unemployed workers and some government-sponsored public works projects. This weak response was a result of the strong free-market ideology that dominated British policy during this period, as well as the small size of the central government. As a result, this setting provides a particularly clean experiment in which to observe how the economy responds to a large temporary shock.

To study the impact of the event on city size, I draw on new data describing the population of British cities from 1841-1901. These data, together with the initial variation in cotton textile employment, allow me to analyze the impact of the shock on city size using a difference-in-difference estimation strategy. I find that the cotton textile cities – those with more than 10% of workers in the cotton textile sector prior to the war – suffered a reduction in decadal population growth of 8-14 percentage points over the 1861-1871 decade, relative to other cities in Britain. This is one-third to one-half of the average decadal growth rate (20-22 percent) in the cotton textile cities over the two decades prior to the war. After 1871, the growth rate returned to, but not above, pre-war levels. Thus, the Civil War had a

[1] If anything, the non-cotton textile industries show modest positive effects during the Civil War period due to the lack of competition from cotton textile products.

temporary effect on population growth and a permanent effect on the level of population in the cotton textile cities. This result holds whether I compare the cotton cities to all other British cities, or only to other textile-producing cities. The effect on city population persists at least through 1901, with no sign of diminishing. While the cotton textile cities suffered, I show that non-cotton cities that were both economically similar and geographically close experienced more rapid population growth during the Civil War decade.

To strengthen these findings, I generate additional results by treating all of the cotton cities as a single economic unit and applying synthetic control methods (Abadie & Gardeazabal (2003), Abadie *et al.* (2010), Abadie *et al.* (2014)). This methodology offers two potential advantages. First, it allows me to treat all of the cotton cities as a single observation unit, so it will be robust to concerns that the cotton district was really a single regional economy (despite substantial heterogeneity across cotton cities). Second, it provides a data-driven approach to choosing the set of comparison cities. Applying the synthetic control approach yields results that are similar to those obtained in the difference-in-difference analysis.

I also provide evidence on the migration response to the cotton shortage. To infer internal migration patterns, I use information on the location of birth of each city resident provided in the Census of Population. For each city, the Census reports the number of city residents born in each county in the country. Using these data, it is possible to provide estimates of net internal migration patterns over the course of a decade. These data suggest that roughly 21,000 residents moved out of the cotton textile region during the Civil War period, equal to 0.7% of the regional population or 1.4% of the employed population. At the same time, in-migration to the cotton textile region, which was substantial prior to the war, nearly disappeared. I discuss several reasons why these are likely to be lower-bound estimates of the migration response. Further analysis shows that migrants leaving the cotton textile region flowed to nearby cities that were economically similar to the cotton textile cities.

This study contributes to a debate in the existing literature over the fundamental determinants of city size. Some papers in this literature find that even large temporary shocks to cities have little impact on their long-run size (Davis & Weinstein, 2002, 2008), suggesting the existence of a unique steady state and a strong role for locational fundamentals. Others find evidence that temporary advantages or disadvantages can have persistent impacts (Bleakley & Lin (2012), Redding *et al.* (2011), Kline & Moretti (2013)), a result that can be explained by models of random city growth (Simon (1955) Gabaix (1999)) or those characterized by increasing returns and multiple equilibria (Krugman (1991)). This paper finds clear evidence that temporary shocks to city economies can have persistent impacts on city size, consistent with models featuring random growth or multiple equilibria.

This study differs from previous work on the determinants of city size in two important ways. First, this is the first study to consider the impact of a trade shock. This difference matters because such events occur regularly in open economies. Economic shocks also lend themselves to policy interventions, ranging from trade policies to temporary government bail-outs of the affected industry. Second, this is the first study in this vein to analyze migration patterns. My results suggest that the availability of economically-similar nearby locations that were not affected by the shock played a role in drawing workers away from the cotton textile cities and generating the persistent effects that I observe.

This study is also related to a growing literature analyzing the impact of trade on local labor markets (Topalova, 2007, 2010; Autor *et al.*, 2012, 2013; Kovak, 2013; Dix-Carneiro & Kovak, 2014). These studies, which tend to focus on changes that are plausibly permanent, suggest that trade can have substantial localized effects. My study differs from previous work in this area because the event I consider was widely seen as temporary. Thus, I provide evidence that even temporary changes in trade flows can have substantial short and long-run consequences for local economies.

A related strand of literature focuses on the impact of cyclical recessions on local labor markets. In a seminal paper, Blanchard & Katz (1992) find that workers migrate away from a state in response to a negative productivity shock, allowing the state to return to normal employment levels in 5-7 years. My findings regarding migration are similar to these results.[2]

Methodologically, this paper is similar to studies that consider particular temporary events and then trace out the impacts on local labor markets.[3] For example, Carrington (1996) studies the impact of the construction of the Trans-Alaska Pipeline and Black *et al.* (2005) considers the impact of the coal boom and bust on coal producing counties of the U.S. in the 1970s and 1980s. My paper differs from these studies in that I consider long-run outcomes while they focus primarily on contemporaneous responses.

The next section introduces the empirical setting, followed by the data, in Section 3, the analysis, in Section 4, and conclusions in Section 5.

2 Empirical setting

The cotton textile industry was a large and important sector of the British economy in the second half of the 19th century. Cotton textile production was Britain's largest manufacturing sector (by employment), cotton textile products were Britain's most valuable export, and raw cotton was the country's most important import. In 1861, just prior to the U.S. Civil War, the industry employed 456,646 workers, equal to 2.3% of the total population of England & Wales, or 9.5% of manufacturing employment.[4] Most of these workers were employed in large factories in the industrial cities of Northwest England.

The shortage of cotton caused by the U.S. Civil War generated a shock that was both large and temporary. Figures 1 and 2 illustrate the size of the shock as well as its temporary nature. The left-hand panel of Figure 1 describes raw cotton imports into Britain. We can see that the Civil War caused a sharp drop in the level of imports. At the same time, a

[2] More recent studies in this vein include Notowidigdo (2013) and Yagan (2014).

[3] Because I consider how the initial distribution of industry employment interacts with an industry shock occurring at the national level, there is a natural parallel between my analysis and the literature following Bartik (1991).

[4] This figure includes only those employed in cotton textile manufacturing and excludes other closely related industries such as cotton textile printing (12,556 workers) and cotton textile dying (4,772 workers). Thus, it understates the industry's true importance.

gap between imports from the U.S. and total imports opened up, as other suppliers such as India and Egypt increased production. After the war, raw cotton imports rapidly returned to their original level. The right-hand panel of Figure 1 shows the import price. The price increases sharply during the Civil War. The price remained above the pre-war for some years after the war, as U.S. output recovered following the end of slavery, but by 1876 the price had returned to the level observed in the year before the war.

The temporary nature of the changes in import quantities and prices may seem surprising given the massive changes triggered by the War, most importantly the end of slavery, which led to a substantial reorganization in the U.S. cotton economy. The fact that this did not have a major effect on import supplies or prices after the mid-1870s is due in large part to the fact that new suppliers – particularly India – entered the market during the high-price years of the Civil War and remained as suppliers thereafter. Contributing to this, new inventions allowed British manufacturers take advantage of these new supplies (Hanlon (2015)), while expanding rail networks opened up new productive regions.[5] The result was that new sources filled in for reduced U.S. supply and import levels rebounded rapidly following the end of the war.

In terms of expectations, historical sources suggest that through most of 1861 contemporaries failed to anticipate the magnitude of the disruption that would take place in the following years.[6] This feature is reflected in cotton prices, which showed only a mild increase in 1861. By 1862, the seriousness of the disruption was becoming clearer, and there were ex-

[5] The new cotton textile technologies developed during the Civil War were primarily aimed at improving the ability of British manufacturers to use low-quality cotton, particularly cotton from India. While these technologies benefited suppliers like India, they would not have affected the relative locational advantages of different cities within England. Relative to other countries, the development of these new technologies probably benefited the cotton textile producers in England, where Indian cotton was a more important input than it was in other major textile producing countries, particularly the producers in the Northern U.S. This feature is reflected in Figure 2, which shows that British cotton textile output continued to grow strongly in the decades after the war.

[6] For example, J.C. Ollerenshaw (1870, p.112), remarked in his presentation to the Manchester Statistical Society that, "The American War commenced on April 5th, 1861, but for many months it had little effect on commerce - being generally regarded as merely temporary..." A striking illustration of the extent of the failure to anticipate the magnitude of the impending conflict comes from the initial Union Army enlistment contracts, which were for only 90 days; it was assumed that the war would be over before they expired.

pectations that the end of slavery may permanently affect supplies of U.S. cotton. However, manufacturers and workers remained confident that other raw cotton suppliers would come into the market to meet the demand for cotton products, allowing the industry to return to its original levels of growth and prosperity. Thus, by the middle of the war, British producers expected that there may be permanent shifts in their sources of supply, but in general they anticipated only a temporary impact on the industry as a whole, expectations that were to prove largely correct.

Figure 2 shows domestic raw cotton consumption (left panel), the best available measure of output in the industry, and employment in the cotton textile industry (right panel). The left-hand panel suggests that overall industry production dropped by as much as half during the war, but rebounded rapidly thereafter. The right-hand panel shows that cotton textile employment growth slowed down substantially during 1861-1871 and then slowly recovered.

An important feature of this setting is that the cotton textile industry was heavily geographically concentrated. Most cotton production took place in cities in the Northwest region of England, comprised of the counties of Lancashire and Cheshire. According to the 1861 British Census, 82% of the cotton textile workers in England and Wales were located in these two Northwest counties. In 1851, cotton textile production accounted for 29% of employment in these counties. This pattern of concentration dates back to the late 18th century, and perhaps earlier. Using data from reports generated by the introduction of the Factory Acts in 1838, Crafts & Wolf (2013) show that this pattern of geographic concentration was related to the availability of water power, the ruggedness of terrain (which decreased the cost of land), proximity to a port (Liverpool), access to markets in other nearby cities, and the area's history of textile innovation in the 18th and early 19th century. While the Northwest region also benefited from access to local coal deposits, many other regions did as well, and Crafts & Wolf find that this had little impact on the location of the industry by 1838. By 1850 the importance of initial advantages due to water power and cheap land had largely ceased to matter. Access to markets in nearby cities was also unlikely to have been an important factor in 1850, given that nearby markets provided only a small fraction of industry demand. Thus, of the initial conditions that drove the location of the industry, only access to the port of Liverpool still mattered during the period I study, though this advantage was also of declining importance due to the spread of rail and canal networks and the falling cost of rail transport.

As a result of the initial distribution of the cotton textile industry, the impact of the cotton shortage was concentrated in cities in the Northwest region of England. This is highlighted in Figure 3, which shows the number of unemployed able-bodied workers seeking relief from local Poor Law Boards, as a fraction of the total 1861 population, during the Civil War years. Poor Law Boards were the primary vehicle for government relief during this period, so relief rates can reveal the severity of the shock across locations. The figure describes relief rates for able-bodied workers for three areas: the cotton producing region in the Northwest of England, the nearby wool textile region of Yorkshire, and all other English counties for which data are available.

A final useful feature of this empirical setting is that I can compare outcomes in the cotton textile cities of Northwest England to outcomes in a set of similar textile-producing cities with industries based on wool, linen, silk and lace, rather than cotton. Many of these other textile cities were also geographically proximate to the Lancashire cotton cities, in nearby Yorkshire County.[7] Despite using different inputs, these other textile industries shared many similarities with the cotton textile industry, including their technology, other inputs such as coal and machinery, labor forces, employment practices, and organization.[8] Unlike the cotton

[7]Wool textiles was the second most important textile industry in England during this period. The two branches of this industry, Woolen and Worsted, employed 209,276 workers in 1861, equal to about 1% of the total population of England and just over 4% of the industrial workforce. For historical reasons that were likely similar to those that operated in Lancashire, though not as well studied, the industry was heavily concentrated in Yorkshire. The 1861 census shows that 72% of the woolen textile workers and 90% of the worsted textile workers in England and Wales were located in Yorkshire County. Wool textile production accounted for 30% of employment in the industrialized West Riding region of Yorkshire. Other cities, such as Derby, Norwich and Coventry specialized in silk, while Nottingham was a center for lace production.

[8]Much of this similarity was driven by the adoption of innovations generated in the cotton textile industry by manufacturers in other textile industries.

textile industry, these other textile industries experienced little direct negative impact from the U.S. Civil War. In fact, they benefited from substitution away from more expensive cotton textiles.[9]

3 Data

The main data set used in this analysis describes the population of English cities every ten years, starting in 1841. These new data were collected and digitized from British Census of Population abstracts. Because these data are used to analyze patterns of overall city population, it is important that I work with consistent geographic areas. To obtain geographically consistent series, I take advantage of the fact that in each census report the Census Office took the city boundaries for a set of major cities in a specific year and then went back to previous census returns and used the more geographically disaggregated data to reconstruct the population within those boundaries over several previous decades as best they could. These reconstructed city population data are available in two series, with the first spanning 1841-1891 and 46 cities and the second covering 1851-1901 and 55 cities.[10] Thus, two or three observations are available prior to the U.S. Civil War, and it is possible to track impacts up to 35 years after the end of the war.[11]

The Census of Population data also include information on the county of birth of the residents of each city in each census year from 1851-1891. These data can be used to estimate

[9] A graph describing employment in these other textiles is available in the Appendix. Imports of other inputs such as raw wool, flax, or silk were largely unaffected by the Civil War because the U.S. was not a major supplier of these commodities. While there was some effect on demand from the U.S., due to tariffs imposed to help fund the war effort, the U.S. was a much smaller market at the time than it is today. Also, exports to European markets increased during the Civil War decade, particularly exports to France following a new trade agreement in 1860.

[10] The 1891 Census reports population for 57 major cities based on the city's 1891 boundaries for the years 1841-1891. Of these, I am able to identify the share of cotton textiles in total employment in 1851 for 46 cities. The 1901 Census reports population for 79 cities for 1851-1901 based on 1901 city boundaries. Of these, I can identify the 1851 cotton textile employment share for 55 cities.

[11] The 1861 observations were collected before the beginning of the U.S. Civil War and there is little chance that these could have been substantially affected by expectations of the onset of the conflict. Thus, I treat 1861 as a pre-war observation.

the net flows of workers into a city from each English county over the course of each decade. Specifically, if I observe a substantial change in the residents of a city reporting a location of birth in a different county then I infer that migration took place from that county into the city. However, it is important to keep in mind that this method may understate migration flows. If people move from city A to B but were born in a third location, then they will not be captured in estimates of the migration flows from A to B during a period. Also, these data will miss migration that is internal to a county, such as movements from textile cities to cities with economies based on other types of industries. These factors are likely to lead me to underestimate the role of migration in affecting city population growth during the Civil War period.[12] Thus, I think of the results obtained using the migration data as providing a lower bound to the true migration response.

To identify cotton cities, I use occupation data from the Census of Population for 1851. The Census of Population asked every city resident for their occupation, so it provides a complete picture of local employment in the cities. Responses, which include occupations such as "Cotton spinner" or "Iron founder", generally correspond closely to industries. Using these, I am able to calculate employment in cotton textile production as a share of total private-sector employment in each city. This provides the key explanatory variable used in the analysis.[13]

Using these data I construct two measures of the importance of cotton textile employment. The first measure, $CotTOWN_c$ is an indicator variable for locations with more than 10% of private sector employment in cotton textile production. Ten percent is chosen as a cutoff to ensure that the cotton textile industry was an important part of the local economy

[12]When comparing these migration responses to short-run migration responses in other contexts, such as recessions, it is important to keep in mind that there are two other factors that will cause my findings to understate short-run migration responses. First, my data will capture only net migration between locations. Second, if migration takes place but return migration occurs before a new census was collected, this short-term migration will not be captured.

[13]The geographic units in these data do not always correspond exactly to those used in the city population data, though they are generally close. Further details about how the city-industry data are matched to the city population data are available in the Appendix.

in those cities identified as treated by the cotton shock. In the data, all of the cities identified with the cotton textile industry have cotton textile employment shares above 15%, while in all other cities the cotton textile industry employs less than 7% of the workforce.[14] I use this discrete measure in the main analysis for two reasons. First, it will be robust to moderate amounts of measurement error in my estimates of a city's cotton textile employment share. Second, within the major cotton textile producing cities, the share of employment in cotton textiles was not a particularly good predictor for the incidence of the shock. This is because within these cities there was specialization in different types of cotton textiles, such as finer threads or coarser fabrics, and in different parts of the production process, such as spinning vs. weaving, which played an important role in generating variation in the local impact of the cotton shortage. In robustness exercises, I will also consider an alternative indicator of the incidence of the shock in a city, $CotSHR_c$, which is the share of the city's private sector workers employed in the cotton textile industry. Additionally, I define an indicator variable $OtherTEX_c$ which identifies the set of non-cotton textile cities, those with more than ten percent of employment in textile industries other than cotton (e.g., wool, linen, silk).[15] All of these measures are based on city employment data from 1851.

Figure 4 provides a map showing the location of each city in the main analysis database (covering 1841-1891). The cotton textile cities are clustered in the Northwest region of England. Just to the east of this cluster is a set of non-cotton textile cities. These are the wool-producing cities located in Yorkshire county.

I also draw on data on the number of able-bodied workers receiving relief from local Poor Law Boards which were digitized by Southall *et al.* (1998). Southall entered data for January and July of 1860, 1863, and 1866 for a sample of Poor Law Unions (PLUs) across England. To analyze these data, I average the two observations in each year and then calculate the

[14]There is a discrete jump in cotton textile employment shares between Wigan, with 17%, to Warrington, with 7%, so choosing any alternative cutoff in this range will not affect the results.

[15]There are no cities with more than ten percent of employment in cotton textiles and more than ten percent in other textile industries.

change in relief seekers in 1863 or 1866, relative to 1860, as a share of the population of the PLU from the 1861 Census.[16] The geographic boundaries of the PLUs do not correspond exactly to the city data used in the main analysis, but in general they are fairly similar.

4 Analysis

This section begins with preliminary work establishing the link between a city's cotton textile employment share and the impact of the Civil War on city employment, as revealed by data on Poor Law Board relief. I then turn to the main results, which describe the impact of the Civil War on city size both during war and in the decades following. Finally, I look at the migration response.

4.1 Workers seeking relief

As a first step, I need to establish that cities which specialized in cotton textile production were disproportionately affected by the Civil War. To do so, I compare the increase in able-bodied workers seeking relief from local Poor Law Boards in a Poor Law Union to a measure of the importance of cotton textile employment in the Union. I compare the increase in the average across the observations in 1863 relative to the average level in 1860, as a share of the Union's 1861 population. The regression specification is,

$$\frac{ABRS_c^{1863} - ABRS_c^{1860}}{POP_c} = a_0 + a_1 CotTOWN_c + e_c$$

where $ABRS_c^t$ is the number of able-bodied relief seekers in city c in year t, POP_c is city population in 1861, and $CotTOWN_c$ is an indicator variable for cities with more than 10% of private sector employment in cotton textile production. In some specifications, I replace $CotTOWN_c$ with $CotSHR_c$, the share of cotton textile workers in private sector employment.

[16] I include both indoor and outdoor relief.

We may be worried about spatial correlation in these regressions. To help address this, I have also calculated results where I cluster standard errors by county. This delivers smaller confidence intervals and more statistically significant results than robust standard errors, suggesting that there is negative spatial correlation in the data.[17] Negative spatial correlation is a common finding throughout this analysis. To be conservative, I report the larger robust standard errors only.

Results are shown in Table 1. Columns 1-2 use the discrete indicator of cotton cities as the explanatory variable. Column 1 looks at the relationship across all PLUs for which data are available, while Column 2 considers only those PLUs that correspond to cities used in the analysis of city population patterns presented in the next section.[18] Columns 3-4 report results from similar regressions, but using a continuous measure of cotton textile employment share as the main explanatory variable.

These results suggest that cities with a larger initial cotton textile industry experienced a substantial increase in relief seekers during the Civil War relative to other areas of England. While the pattern is clear, the magnitude of the increase is more difficult to interpret because it depends on the particular institutional features of the Poor Law during this period. In particular, this magnitude should not be interpreted relative to modern unemployment insurance claims because the unpleasant nature of receiving relief meant that families would generally avoid seeking relief until they were truly destitute.[19]

It is also possible to look at whether the increase in relief seekers caused by the Civil War persisted in the years after the war. This is done using data on the number of relief seekers in 1866. The results, shown in Table 2, are calculated using the same specification as those

[17] I do not calculate spatially correlated standard errors in the results in Tables 1 and 2 (as I will do for later results) because it is difficult to obtain the geographic coordinates of the center of the historical PLUs. Instead I have considered standard errors clustered by county.

[18] Note that not all cities used in analysis of city population patterns are included in the PLUs reported in Southall's data.

[19] There is also evidence that a substantial amount of the relief in response to the cotton shortage was provided by charities, which would not be captured in these data. This would cause the results in Table 1 to understate the magnitude of the increase in relief-seekers.

in Table 1. These show no evidence that there were more relief seekers in 1866 in cotton textile cities than in 1860. This suggests that either the negative employment effects in the cotton textile cities had been completely reversed by 1866 or that the local economies had adjusted through spatial migration. Later, I present migration results which suggest that spatial adjustment played an important role in generating this rapid recovery.

4.2 City size effects

I now turn to the main analysis, which considers the impact of the Civil War on city size and the geographic location of economic activity. A good starting point is to look at the average growth rates in the cotton cities and all of the other cities over each decade in the 1841-1891 period. This is done in Table 3 using 46 cities. There are ten cotton cities, defined as those with more than 10 percent of the working population employed in the cotton textile industry in 1851. There are eight other textile cities, defined as those with more than 10 percent of the working population employed in other textile industries.[20] These definitions will be used throughout the paper.

The first pattern to take away from Table 3 is that, relative to all other cities, or to just other textile cities, the cotton cities in the Northwest of England suffered slower growth in the 1861-1871 period. This was a reversal of the previous trend of faster growth in cotton cities. After 1871, growth in the cotton cities rebounded, but did not overshoot, suggesting that population in these cities did not catch-up after the shock, at least through 1891.

Figure 5 allows us to compare population trends in the cotton cities to the other textile cities over the study period graphically. This figure presents the sum of log population for the cotton and other textile cities across the entire 1841-1891 period.[21] This graph shows that there was little change in the population growth rate in the other textile cities over this

[20]All of these have less than 10 percent employed in cotton textiles.

[21]Using the sum of log population here ensures that the patterns are not dominated by the large cities. It also matches my empirical approach.

period, so that a trend-line based on the 1841-1861 period predicts population through 1891 reasonably well. For the cotton cities, the trend is fairly constant in the 1841-1861 period, but slows substantially between 1861-1871. There is also weak evidence that population growth remained lower in the cotton textile cities after 1871 than would have been predicted based on the initial growth trend. Note that Figure 5 has been constructed to allow comparison with a well-known graph from Davis & Weinstein (2002) describing the population of Hiroshima and Nagasaki before, during, and after World War II (their Figure 2). A quick visual comparison highlights the differences between their results and the patterns that I observe.

Next, I explore these patterns using a regression approach. The baseline regression specification is,

$$ln(POP_{ct}) - ln(POP_{ct-1}) = \alpha + \sum_{t>1861} \beta_t \left(CotTOWN_c * Shock_t\right) + \gamma_c + \lambda_t + e_{it} \tag{1}$$

where POP_{ct} is the population of city c in period t, $CotTOWN_c$ is an indicator variable for the cotton cities, $Shock_t$ is an indicator variable for decade t, γ_c is a full set of city fixed effects, and λ_t is a full set of time effects.

The main coefficient of interest in these regressions is β_{1871}, which will reflect the impact of the shock on growth in cotton textile towns during the Civil War decade. We will also want to look at the estimates of β_{1881}, β_{1891}, etc., for evidence of a higher growth rate in cotton towns in the years after 1871, which would suggest a rebound toward the original population growth path.

In interpreting these coefficients, particularly β_{1871}, it is important to keep in mind that, because all cities are operating within a connected economic system, a negative shock to the cotton textile cities may generate positive effects for the non-cotton cities. Thus, the β coefficients will reveal changes in relative growth rates between cotton and non-cotton cities generated by the shock, which will be composed of both the negative effects in the cotton cities and any positive impact of the shock on non-cotton cities. This is not a problem given that the goal of this study is to establish whether there was a persistent relative change in city sizes resulting from the shock.[22]

Spatial correlation is a potential concern in this setting. To deal with this, I estimate standard errors robust to spatial correlation up to 100km based on Conley (1999).[23] These spatial-correlation-robust standard errors are generally lower than the heteroskedasticity-robust standard errors, suggesting that errors are negatively spatially correlated.[24] Thus, I present both robust standard errors and spatially correlated standard errors in the main results. While serial correlation can be an issue in panel data settings (Bertrand *et al.* (2004)), it is less likely to be a major concern for the current study given that, in terms of observations (but not years covered), the time-series dimension of the data is short relative to the number of cross-sectional units. To provide an alternative method for assessing the statistical significance of the results that does not require specific assumptions about the structure of the error term, I also report results from permutation tests at the bottom of each of the main regression tables.

Table 4 describes results generated for different time periods using the specification in Equation 1. Heteroskedasticity-robust standard errors are reported in single parentheses, while spatial-correlation-robust standard errors are in double parentheses. The first column reports results from a placebo test using only data from 1841-1861, prior to the war. These results show that the cotton cities did not exhibit statistically significant differential growth patterns during this pre-period. The second column compares the decades just before and

[22]To be specific, the null hypothesis I address is that the temporary shock had no impact on the population in the cotton textile cities relative to other comparable English cities. This is different from the null hypothesis that the temporary shock caused the population of the cotton textile cities to differ from what it would have been in the absence of any shock. My empirical methodology will address the first of these hypotheses, but would not necessarily address the second.

[23]To implement this approach, I follow Hsiang (2010). I have experimented with allowing correlation over different distances. Reasonable alternative distances do not affect the confidence intervals. I have also experimented with allowing limited serial correlation based on the method from Newey & West (1987) and found that this does not substantially change the results.

[24]Negative spatial correlation is consistent with my results since, as we will see, I find that negative shocks to some cities benefit other nearby cities.

just after the war. There is clear evidence that population growth in the cotton cities fell in the 1861-1871 period relative to other cities. Column 3 expands the pre-period to include 1841-1851. The results in both Columns 2 and 3 are statistically significant at the standard 95% confidence level. In Column 4, I includes the full set of data from 1841-1891 and estimate separate impacts for the 1871-1881 and 1881-1891 periods. Here, we are looking for evidence that the cotton cities experienced faster growth after 1871, which might have allowed them to catch-up to their previous growth path. The results provide no evidence that any such recovery took place, at least before 1891. This suggests that reduced growth in 1861-1871 generated a persistent effect on the level of population in the cotton cities. Finally, Column 5 uses an alternative data set covering 1851-1901 to extend the results one additional decade after the war. The permutation tests, reported at the bottom of the table, indicate that the negative impacts estimated for the 1861-1871 decade are all statistically significant at the 95% level.

The results in Table 4 include the full set of cities for which sufficient data are available. A potential concern here, as in all difference-in-difference analysis, is whether the set of control cities provides a reasonable comparison group for the treated cities. Specifically, I must assume that in the absence of the shock, the growth path of the control cities, controlling for their initial growth rate, provides a valid counterfactual for the growth path of the treated cities. We may worry that there is substantial variation in the underlying characteristics of the cities which lead to this assumption being violated. Seaports, for example, may not be a good counterfactual for inland industrial cities. One way to strengthen the results against this concern is to confine the analysis to a subset of cities that are more similar to the treated cities, though this comes at the cost of working with a reduced sample size. To do so, I compare the cotton textile cities to other textile-producing cities with economies based on wool, linen, silk, or other textile products that were not negatively affected by the cotton shortage.

How economically similar were the other textile cities to the cotton textile cities? To measure the economic similarity of cities I calculate the correlation across employment shares in 19 analysis industries (treating textiles as one industry) between city pairs using city-industry employment data for 1851. I then look at the average, maximum, and minimum correlation across all pairs of cities in a particular group or pair of groups. Table 5 describes these results. The first row looks across all pairs of cotton textile cities. The second looks across pairs of non-cotton textile cities. In the third row I look at all pairs comprised of one cotton textile city and one non-cotton textile city. The fourth row does the same for pairs of cotton textile cities matched with each non-textile city.

The results in Table 5 show that the cotton textile and non-cotton textile cities were economically very similar; the average correlation across pairs of cotton and non-cotton textile cities is 0.878. This is nearly as high as the correlation between pairs of cotton textile cities (0.965) and is higher than the correlation between pairs of other textile cities (0.850). In other words, the non-cotton textile cities are, on average, more similar to the cotton textile cities than they are to each other. The figures in the last row show that the cotton textile cities are much less similar to the non-textile cities, with an average correlation of only 0.128. These correlations suggest that the non-cotton textile cities provide a reasonable control group for the cotton textile cities.

Table 6 presents results calculated by comparing the 10 cotton textile cities to the 8 other cities where (non-cotton) textile production formed an important part of the economy. The format mirrors the results in Table 4. This table shows that I obtain similar but even stronger results when comparing the cotton textile cities to the subset of economically similar cities in which non-cotton textile industries provided a major portion of local employment.

In terms of magnitudes, the results in Tables 4-6 suggest that the cotton textile cities experienced a reduction in their decadal growth relative to other cities in the range of 8-14 percentage points during the Civil War period, with no evidence of higher growth leading to catch-up after 1871.

The results presented above are estimated using a single discrete cutoff to identify the cotton textile cities. An alternative is to use a continuous measure based on the share of cotton textile production in local employment prior to the war (1851). Table 7 presents results using explanatory variables constructed using these continuous measures. Columns 1-2 use data from all cities in England for 1841-1891 and 1851-1901, respectively. Columns 3-4 use data from only textile cities over a similar time period. All of these results are similar to those presented previously; the negative effect on city population growth in 1861-1871 is statistically significant in all specifications, while none of them show evidence of faster population growth in the decades after 1871.[25]

In the Appendix, I present additional estimates that can be used to assess the sensitivity of my results to changes in the estimation approach or in the underlying data. In one set of results I include estimate effects for both cotton towns and other textile towns in the same regression. These results show that cotton towns experienced slower growth in the 1861-1871 decade, while they also provide some evidence that growth in the other textile towns accelerated in the decades after the Civil War. To check the sensitivity of my results to changes in the set of included cities, I estimate additional results using only cities in the Northwest Counties and Yorkshire. This helps ensure that my results are not driven by differential growth trends among cities in this region. These estimates suggest an even larger reduction in growth in the cotton textile towns during the Civil War decade. Additionally, I calculate results using all cities except Manchester and London, which are outliers in terms of city population. Dropping these cities has little impact on the estimated effects. I also provide results obtained using propensity score matching, which provides an alternative approach to dealing with concerns about the comparability of treatment and control cities. These results are very similar to those reported in the main text.

An alternative econometric approach to estimating the effect of this event is to use the

[25]Table 7 presents only a subset of the specifications shown in Tables 4 and 6. However, I have applied the continuous measure of local cotton textile employment to any of the specifications shown in Table 4 and 6 and these also deliver results that are similar to those obtained using the discrete indicator for cotton textile cities.

synthetic control method. Implementing this method involves combining all of the cotton cities into a single composite cotton region.[26] The composite cotton region is then matched to a synthetic control constructed using a weighted combination of the available control units, where the weights are constructed so that the synthetic control matches the composite cotton region as closely as possible across a set of observable pre-treatment characteristics subject to the constraint that the weights are non-negative.

The synthetic control method offers two potential advantages in this setting. First, it provides a transparent data-driven choice of control units and allows us to easily test how well the synthetic control unit is matching the treatment cities across the set of available features. Second, by treating the cotton cities as a single unit, it can help address concerns that the cotton cities should be thought of as a single regional economy rather than a set of independent city observations (despite substantial heterogeneity across the cotton cities). The downside of the synthetic control method in this setting is that an analysis based on region-level data involves relatively few observations, reducing the power of the exercise. Given these advantages and disadvantages I view this method as complementary to the difference-in-difference approach.

I implement the synthetic control method using city population data from 1841-1891, aggregated to 9 regions, with one region, the Northwest, comprised of the cotton cities.[27] I consider two outcome variables, the log of population and the population growth rate. The synthetic control is constructed by matching on industry employment shares in 1851 for 19 industries as well as the outcome variable in the pre-treatment period. Appendix Table 17 describes the balance between the actual cotton region values for the matching

[26] An alternative to aggregating the cotton cities to one composite cotton region is simply to run the analysis on county-level data and combine Lancashire and Cheshire into one cotton textile county. However, this approach generates misleading results because it ignores the substantial heterogeneity across cities within these counties. In addition to the cotton textile cities, these counties also include important ports such as Liverpool, rapidly growing industrial cities that had no cotton textile production such as Barrow-in-Furness, as well as many smaller rural cities.

[27] The regions are the Southwest, Southeast, London, East, West Midlands, East Midlands, Yorkshire, and the North, plus the cotton cities in the Northwest.

variables and the values for the synthetic control. The synthetic control generally matches the actual values well, with the main exception being the share of textile employment, which is impossible to match given that textile employment is higher in the cotton region than anywhere else in the country.

Figure 6 describes the results obtained using the synthetic control method. The top panel of the figure describes results obtained with log population as the outcome variable. The top-left panel compares the actual log population in the cotton region to the synthetic control. Starting in 1871 the actual population of the cotton region falls below the level that we should expect given the synthetic control. The top-right panel describes the gap between the actual and synthetic control values for the cotton region (black line). To provide a sense of the significance of these results, I also conduct a permutation exercise in which synthetic controls are constructed for each of the control regions. The grey lines in the top-right panel of Figure 6 describe the gaps obtained when applying the synthetic control method to each of the control regions.[28] We can see that the estimated gap for the cotton region lies below all of the placebo gaps, consistent with a statistical significance level of roughly 83.3 percent.

The bottom panel of Figure 6 describes similar results obtained for city growth rates. The bottom-left figure suggests that the cotton region experienced substantially slower growth in 1861-1871 than the synthetic control would lead us to expect. It is interesting to see that growth in the cotton region falls in 1861-1871, while growth in the synthetic control jumps. This reflects the displacement of workers from one region to the other, a feature that will be revisited later. The bottom-right figure shows that the (negative) gap between actual growth and growth based on the synthetic control in 1861-1871 was larger in the cotton region than the gap obtained when applying the synthetic control approach to any other region. Given that there are 8 placebo gaps for which reasonable synthetic controls can be constructed,

[28]This permutation test follows Abadie *et al.* (2010). The gaps for two regions, London and the East, are dropped from this figure following their advice, because the mean squared predicted error in the pre-treatment period is more than 20 times larger than that of the cotton region, indicating that the synthetic control for these regions does not perform well in this specification.

this is consistent with a statistical significance level of roughly 87.5 percent.

The results described thus far suggest that the Civil War led to a permanent change in the population of cotton textile cities relative to other cities in England. These effects are due to a combination of losses in the cotton textile cities and gains among other cities. In the Appendix (Figures 10 and 11) I explore the impact of these changes on the distribution of city sizes using standard log rank - log size graphs. These graphs suggest that Zipf's law holds reasonably well in all years, but that cotton textile towns move down in the city size-rankings after 1861. This movement is summarized in Figure 7, which shows the city size distribution for mid-sized cities in 1861 and 1871, covering every cotton city except Manchester. We can see that, between 1861 and 1871, all but one of the cotton textile cities fell in the city size ranking (represented by an upward movement in the graph). Despite this, the overall relationship between city size and city rank remained close to linear.

Next, I look at the characteristics of the cities that experienced population gains as a result of this event. After dropping the cotton textile cities from my data set, I use the remaining data to consider two factors that may predict accelerated growth in the remaining cities: economic similarity to the cotton cities, as measured by the size of the city's non-cotton textile industry, and geographic proximity to the cotton textile district.[29] The regression specification is,

$$\Delta \ln(POP_{c1871}) - \Delta ln(POP_{c1861}) = b_0 + b_1 DIST_c + b_2 TEX_c + b_3(DIST_c * TEX_c) + e_c$$

where $\Delta \ln(POP_{ct})$ is the change in log population in city c from decade $t-1$ to t, $DIST_c$ is the city's geographic proximity to the cotton textile region, and TEX_c is the share of non-cotton textile production in city employment in 1851.

The results are presented in Table 8. Columns 1-2 suggest that geographic proximity and

[29]Liverpool is also dropped from this analysis, since the economy of that city was heavily reliant on the cotton textile industry, despite the fact that little actual textile production took place within the city.

economic similarity to the cotton textile cities are correlated with accelerated city growth during the U.S. Civil War, but these results are very weak. However, when these factors are interacted, in Column 4, there is evidence that cities that were both geographically proximate and economically similar to the cotton textile cities experienced accelerated population growth during the Civil War decade.

4.3 Migration patterns

To provide further support for these results, I turn to data on migration patterns. A good starting point for considering migration flows is Figure 8. The left-hand panel of Figure 8 plots the number of residents of other English counties who were born in the Northwestern counties (the cotton textile region) in each year. This figure shows that the Civil War period was characterized by a sharp increase in residents of other counties who were born in the Northwest, suggesting that out-migration took place during this period. The number of people born in the Northwest but living in other counties increased by around 21,000 from 1861-1871, equal to a movement of about 0.7% of the 1861 population or 1.4% of the 1861 working population of the Northwest counties. This is substantially larger than the increase of around 1,600 from 1851-1861. For comparison, the growth in population in the cotton textile cities shown in Figure 5 in 1861-1871 was lower than the growth in 1851-1861 by about 48,000 people.

Much of this out-migration flowed to the economically-similar cities in nearby Yorkshire County. The right-hand panel of Figure 8 describes the change in the number of Northwest residents reporting Yorkshire as their location of birth and the change in the number of Yorkshire residents reporting the Northwestern counties as their location of birth, in each decade. Here I have put the series in logs so that they are easier to compare. These series show that net migration from Lancashire to Yorkshire increased during the Civil War period. At the same time, migration into Lancashire from Yorkshire almost completely ceased. Also, though the original patterns of migration resume after 1871, there is no evidence that these populations return to their original positions in the post-war period, suggesting that the migration flows that occurred during the Civil War were not reversed in later decades.

Next, I examine some of the factors that may predict the destination of migration flows out of the Northwest region. Motivated by previous work on this topic, I consider three potential factors: the geographic proximity of destination cities, the economic similarity of these cities, and a history of past migration flows. The specification is,

$$\begin{aligned} \Delta \ln(NWborn_{c1871}) - \Delta \ln(NWborn_{c1861}) &= \alpha_0 + \alpha_1 DIST_c + \alpha_2 TEX_c \\ &+ \alpha_3 PASTmig_c + e_{ct} \end{aligned} \quad (2)$$

where Δ indicates a difference operator between decade t and $t-1$, and $NWborn_{ct}$ is the count of Northwest-born residents in city c and decade t so, for example, $\Delta \ln(NWborn_{c1871})$ is a measure of the migration flow from the Northwest region into city c over the 1861-1871 decade. The explanatory variables are the distance and economic similarity measures, $DIST_c$ and TEX_c, which are defined as before, and the count of current residents in city c who were born in the Northwest counties, $PASTmig_c$.[30] Thus, this specification looks at whether these factors are related to the increase in migration flows that occurred during the Civil War decade.

Results are shown in Table 9. Columns 1-3 describe regressions including each of the migration determinants separately, while all factors are included in Column 4. These results provide evidence that geographic proximity was the most important determinant of out-migration flows from the cotton textile districts. In interpreting these results, it is useful to know that the city distance variable varies from 0.67-0.97. Given this, the results in Column

[30] Including previous migration patterns in this specification is suggested by previous work such as Bartel (1989) and Altonji & Card (1991).

1 suggest that growth in Northwest-born residents in the nearest cities increased by 21% during the Civil War period, while growth in the most distance cities increased by 12%.[31]

The location-of-birth data can also be used to look for evidence of changes in inflows of workers into the cotton textile towns, though data are available for only five cotton textile cities, so these results must be interpreted with caution. In the five cities for which data are available, Table 10 shows that population growth from 1861-1871 was reduced by roughly 10,000 persons compared to growth in 1851-1861. The population of these cities born in other regions grew by 4,800 in 1851-1861 but fell by 3,580 in 1861-1871, representing a reversal of 8,400. This suggests that a reduction in in-migrants from other locations can explain a substantial fraction of the reduction in population growth during the Civil War decade.

Overall, the results in this section suggest that the cotton shortage had a substantial effect on migration patterns. I find evidence of both an increase in flows of Northwest-born people into other regions and a reduction in the migration of workers from elsewhere into the cotton textile cities. Of these, there is some evidence that the latter played a somewhat more important role.

5 Conclusions

This paper draws on a unique historical setting in order to provide well-identified evidence of the persistent effect of a temporary shock to city economies. My results show that the economic shock caused by the Civil War had a persistent negative effect on the population of cotton textile cities, relative to other English cities, lasting at least until 1901, with no signs of diminishing.

My findings contrast with some previous results, such as Davis & Weinstein (2002), who study the impact of WWII bombing on Japanese cities. One explanation for these differences

[31] These values are calculated by taking the maximum and minimum distance values, multiplying by the estimated distance coefficient from Column 1 of Table 9, and then subtracting off the estimate on the constant term.

is geography. England is characterized by relatively mild topography and modest climatic variation. As a result, for each cotton city there were comparable nearby locations that were not adversely affected by the temporary shock. Migrants took advantage of the availability of these alternatives during the Civil War period, and these population movements were not reversed after the war. In contrast, comparable alternative locations may not have been available for the Japanese cities studied by Davis and Weinstein as a result of that country's mountainous topography (Head & Mayer (2004)). Together, these results suggest that city size may be characterized by a unique equilibrium when variation in locational fundamentals is sufficiently large, but that temporary shocks can have persistent effects on city size when the variation in locational fundamentals is small.

One of the contributions of this study is to show that temporary *trade* shocks can have long-term effects. This result is interesting because economies are regularly exposed to temporary shocks of this type. Without access to additional data, such as wages, it is not possible to assess the welfare effects of this geographic reallocation in my setting. This is a fruitful area for future research.

Previous work by Autor *et al.* (2012) and others has found no large migration in response to permanent trade shocks (though they do not completely rule out such a response). Other studies by Topalova (2007), Dix-Carneiro & Kovak (2014), and Yagan (2014) also suggest limited migration responses. Given these findings, it is surprising to see clear evidence of a substantial migration in response to a temporary shock in my setting. One potential explanation for this is that the event I consider was more severe. Another potential explanation, suggested by the results of Autor *et al.* (2012), is that government transfer payments, which are much larger in modern economies than they were in my setting, may reduce the incentives to move in search of work.[32]

[32] A third alternative explanation is that migration costs were lower in 19th century Britain than in the U.S. today, but this seems improbable.

References

Abadie, Alberto, & Gardeazabal, Javier. 2003. The Economic Costs of Conflict: A Case Study of the Basque Country. *The American Economic Review*, **93**(1), pp. 113–132.

Abadie, Alberto, Diamond, Alexis, & Hainmueller, Jens. 2010. Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California's Tobacco Control Program. *Journal of the American Statistical Association*, **105**(490), 493–505.

Abadie, Alberto, Diamond, Alexis, & Hainmueller, Jens. 2014. Comparative politics and the synthetic control method. *American Journal of Political Science*.

Altonji, Joseph, & Card, David. 1991. The Effects of Immigration on the Labor Market Outcomes of Less-Skilled Natives. *In:* Abowd, John M, & Freeman, Richard B (eds), *Immigration, Trade and the Labor Market*. Chicago: University of Chicago Press.

Autor, David H., Dorn, David, Hanson, Gordon H., & Song, Jae. 2012 (July). *Trade Adjustment: Worker Level Evidence*. Working Paper.

Autor, David H, Dorn, David, & Hanson, Gordon H. 2013. The China Syndrome: Local Labor Market Effects of Import Competition in the United States. *American Economic Review*, **103**(6), 2121–2168.

Bartel, Ann. 1989. Where Do the New US Immigrants Live? *Journal of Labor Economics*, **7**, 371–391.

Bartik, Timothy J. 1991. *Who Benefits from State and Local Economic Development Policies?* Kalamazoo, MI: W.E. Upjohn Institute for Employment Research.

Bertrand, M, Duflo, E, & Mullainathan, S. 2004. How Much Should We Trust Differences-in-Differences Estimates? *The Quarterly Journal of Economics*, **119**(1), pp. 249–275.

Black, Dan, McKinnish, Terra, & Sanders, Seth. 2005. The Economic Impact Of The Coal Boom And Bust. *The Economic Journal*, **115**(503), 449–476.

Blanchard, Olivier Jean, & Katz, Lawrence F. 1992. Regional Evolutions. *Brookings Papers on Economic Activity*, 1 – 61.

Bleakley, Hoyt, & Lin, Jeffrey. 2012. Portage: Path Dependence and Increasing Returns in U.S. History. *Quarterly Journal of Economics*, **127**(May), 587–644.

Carrington, William J. 1996. The Alaskan Labor Market during the Pipeline Era. *Journal of Political Economy*, **104**(1), pp. 186–218.

Conley, T.G. 1999. GMM Estimation with Cross Sectional Dependence. *Journal of Econometrics*, **92**(1), 1 – 45.

Crafts, Nicholas, & Wolf, Nikolaus. 2013 (August). *The Location of the UK Cotton Textile Industry in 1838: a Quantitative Analysis*. University of Warwick Working Paper.

Davis, Donald R, & Weinstein, David E. 2002. Bones, bombs, and break points: The geography of economic activity. *American Economic Review*, **92**(5), 1269–1289.

Davis, Donald R, & Weinstein, David E. 2008. A search for multiple equilibria in urban industrial structure. *Journal of Regional Science*, **48**(1), 29–65.

Dix-Carneiro, Rafael, & Kovak, Brian. 2014 (July). *Trade Reform and Regional Dynamics: Evidence from 25 Years of Brazilian Matched Employer-Employee Data*. Working Paper.

Gabaix, X. 1999. Zipf's law for cities: An explanation. *Quarterly Journal of Economics*, **114**(3), 739–767.

Gabaix, Xavier, & Ibragimov, Rustam. 2011. Rank- 1/2: a simple way to improve the OLS estimation of tail exponents. *Journal of Business & Economic Statistics*, **29**(1), 24–39.

Hanlon, W. Walker. 2015. Necessity is the Mother of Invention: Input Supplies and Directed Technical Change. *Econometrica*, **83**(1), 67–100.

Head, Keith, & Mayer, Thierry. 2004. The Empirics of Agglomeration and Trade. *Handbook of Regional and Urban Economics*, **4**, 2609–2669.

Hsiang, Solomon M. 2010. Temperatures and cyclones strongly associated with economic production in the Caribbean and Central America. *Proceedings of the National Academy of Sciences*, **107**(35), 15367–15372.

Kline, Patrick, & Moretti, Enrico. 2013. Local Economic Development, Agglomeration Economies, and the Big Push: 100 Years of Evidence from the Tennessee Valley Authority. *Quarterly Journal of Economics*.

Kovak, Brian K. 2013. Regional Effects of Trade Reform: What is the Correct Measure of Liberalization? *American Economic Review*, **103**(5), 1960–1976.

Krugman, Paul. 1991. Increasing Returns and Economic Geography. *Journal of Political Economy*, **99**(3), pp. 483–499.

Mitchell, B.R. 1988. *British Historical Statistics*. Cambridge, UK: Cambridge University Press.

Mitchell, BR, & Deane, P. 1962. *Abstract of British Historical Statistics*. London: Cambridge University Press.

Newey, Whitney K., & West, Kenneth D. 1987. A Simple, Positive Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix. *Econometrica*, **55**(3), pp. 703–708.

Notowidigdo, Matthew J. 2013 (March). *The Incidence of Local Labor Demand Shocks*. Working Paper.

Redding, Stephen J, Sturm, Daniel M, & Wolf, Nikolaus. 2011. History and Industry Location: Evidence from German Airports. *Review of Economics and Statistics*, **93**(3), 814–831.

Simon, H. 1955. On a Class of Skew Distribution Functions. *Biometrika*, **42**, 425–440.

Southall, HR, Gilbert, DR, & Gregory, I. 1998 (Jan.). *Great Britain Historical Database : Labour Markets Database, Poor Law Statistics, 1859-1939*. [computer file]. UK Data Archive [distributor] SN: 3713.

Topalova, Petia. 2007. *Trade Liberalization, Poverty and Inequality: Evidence from Indian Districts*. University of Chicago Press. Chap. Globalization and Poverty, pages 291–336.

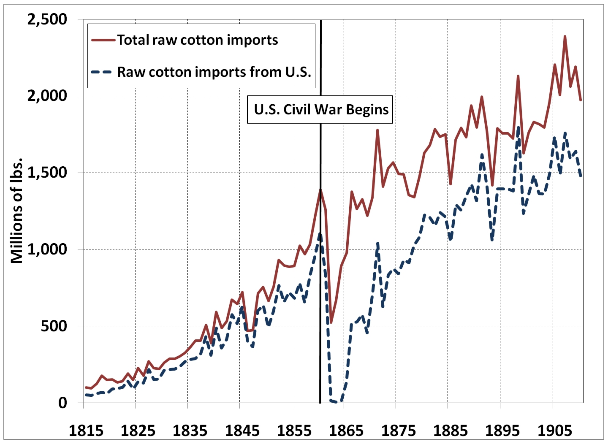
Topalova, Petia. 2010. Factor Immobility and Regional Impacts of Trade Liberalization: Evidence on Poverty from India. *American Economic Journal: Applied Economics*, **2**(4), 1 – 41.

Yagan, Danny. 2014 (January). *Moving to Opportunity? Migratory Insurance Over the Great Recession.* Working Paper.

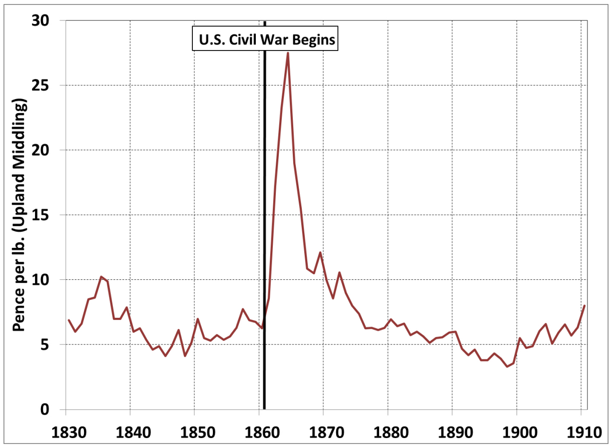
6 Figures

Figure 1: The impact of the U.S. Civil War on British cotton imports and prices

British raw cotton import quantities



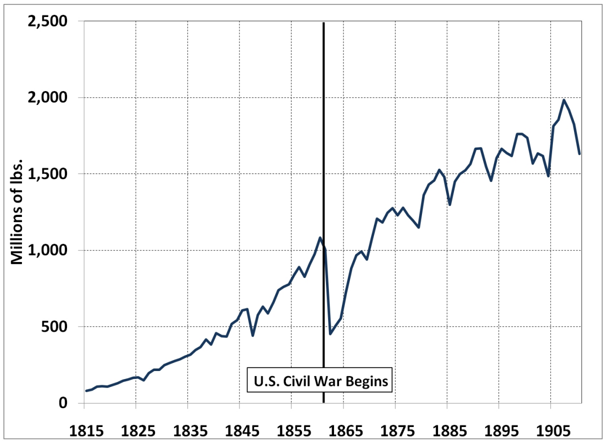
Cotton prices on the Liverpool market



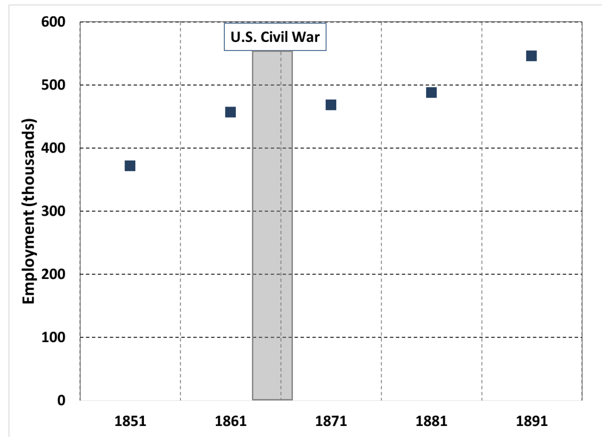
Import data from Mitchell (1988). Price data, from Mitchell & Deane (1962), are for the benchmark Upland Middling variety.

Figure 2: Domestic raw cotton consumption and cotton textile employment in Britain

Domestic raw cotton consumption

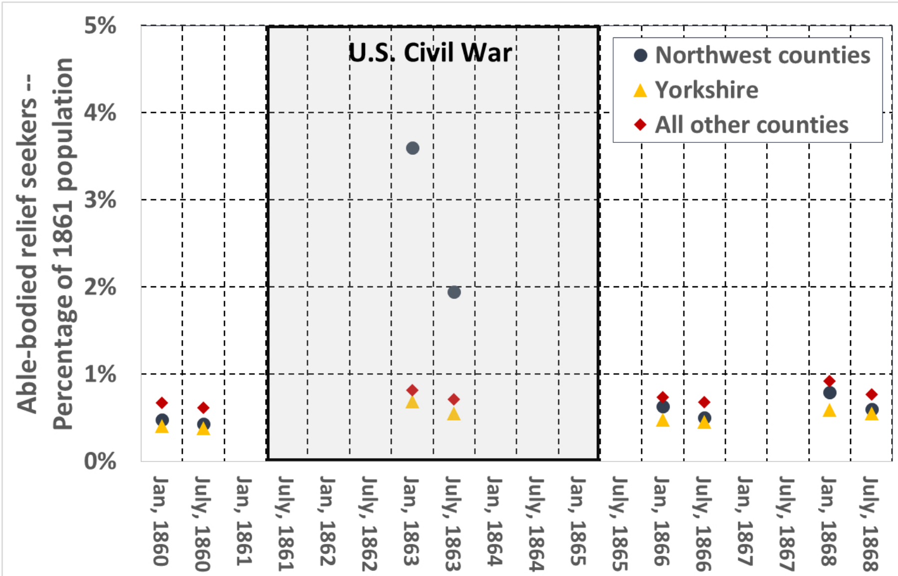


Cotton textile industry employment



Domestic raw cotton consumption data, from Mitchell & Deane (1962), are the best available measure of industry production. Industry employment data is from the Census of Population and covers all of England and Wales.

Figure 3: Able-bodied relief-seekers as a share of 1861 population



Data from Southall *et al.* (1998).

Figure 4: Map of England showing the cities included in the main analysis data

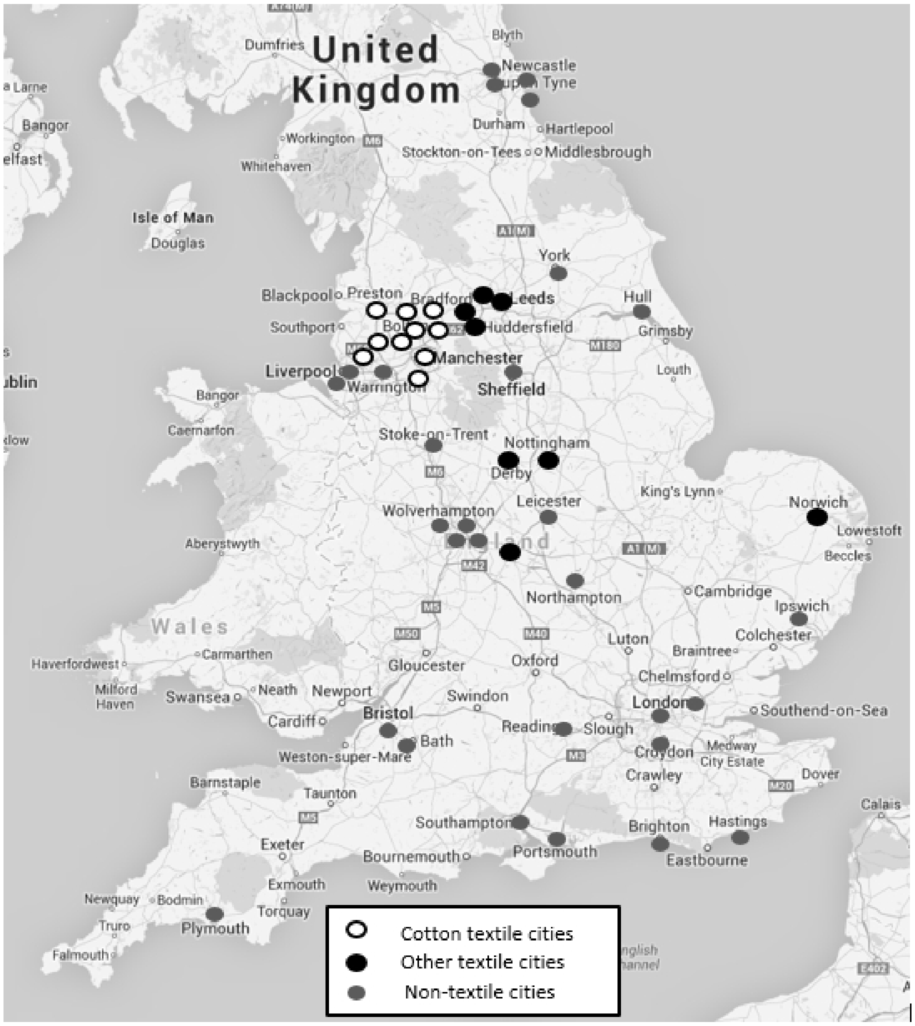


Figure 5: Population growth in cotton and other textile cities

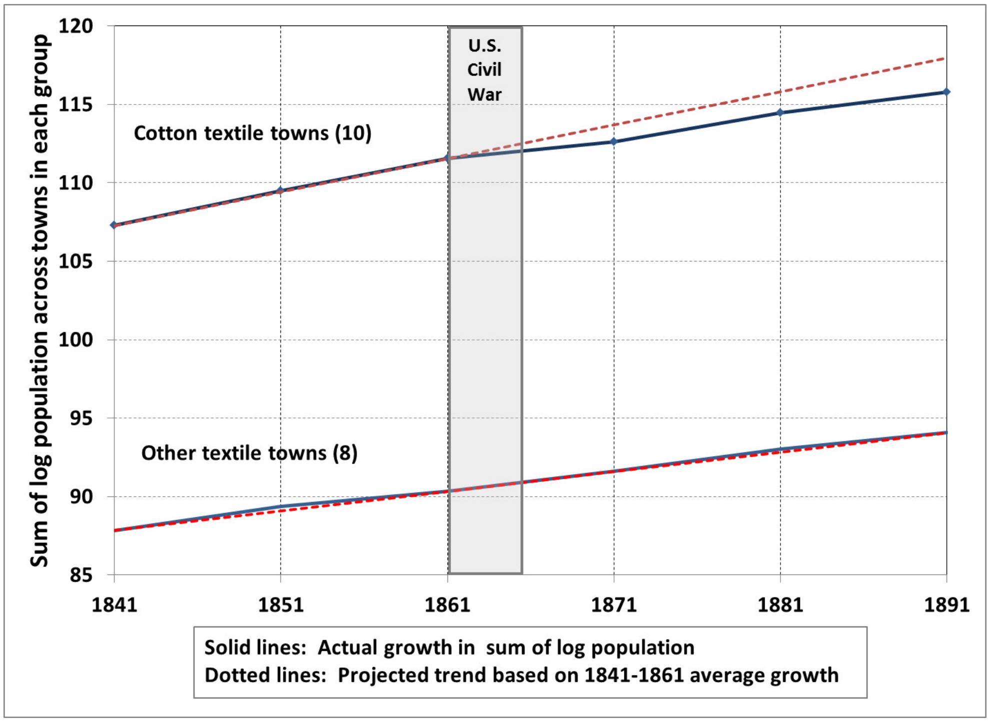
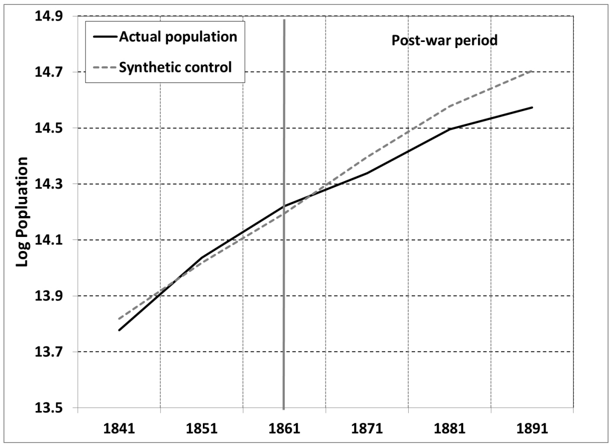


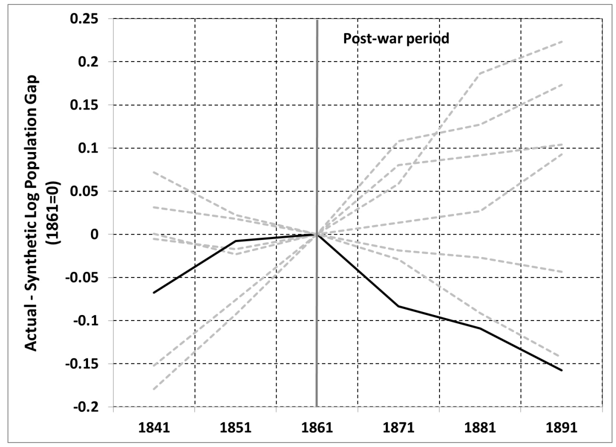
Figure 6: Synthetic control results

Panel A: Results for log population

Cotton region actual population and synthetic control

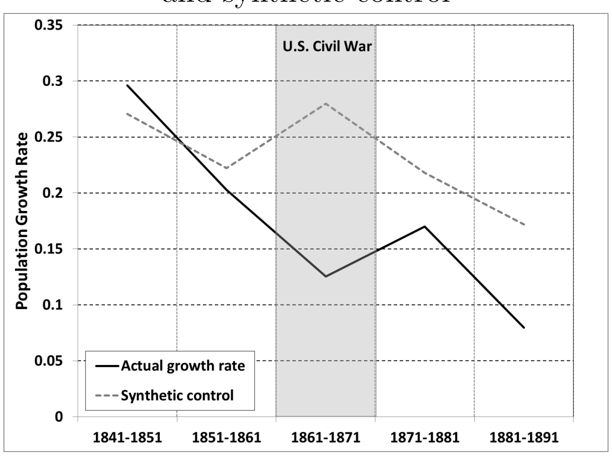


Comparing cotton region population gap to alternative permutations

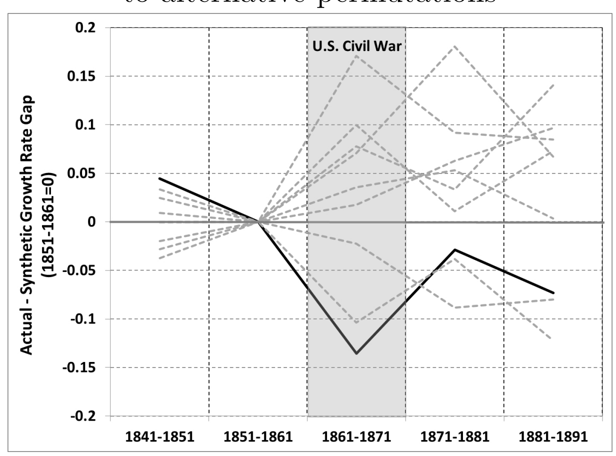


Panel B: Results for population growth

Cotton region actual growth and synthetic control

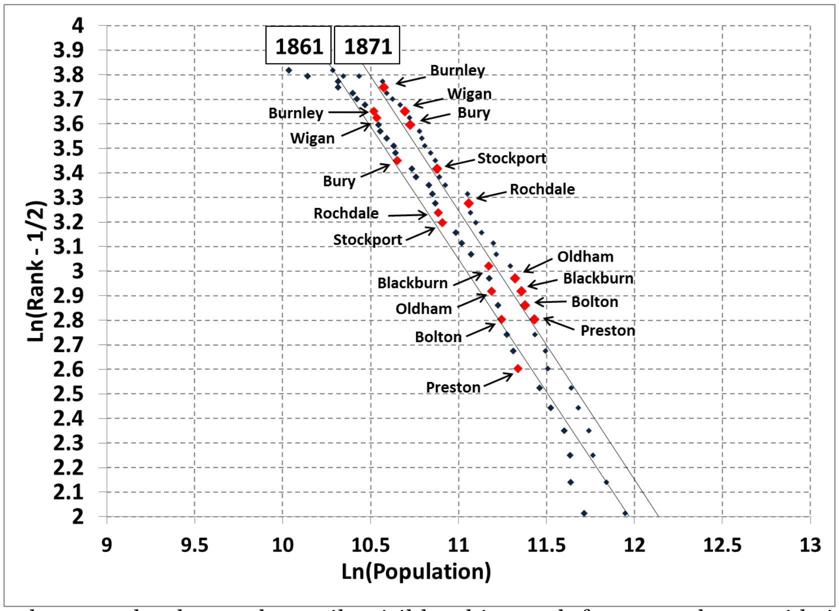


Comparing cotton region growth gap to alternative permutations



Top panel: Synthetic control based on matching industry employment shares in 1851 and region population in the pre-shock period (1841-1861). Synthetic control weights are Yorkshire (0.461) and London (0.505). Bottom panel: Synthetic control based on matching industry employment shares in 1851 and population growth in the two pre-shock decades, 1841-51 and 1851-61. Synthetic control weights are Yorkshire (0.652) and the Southeast (0.348).

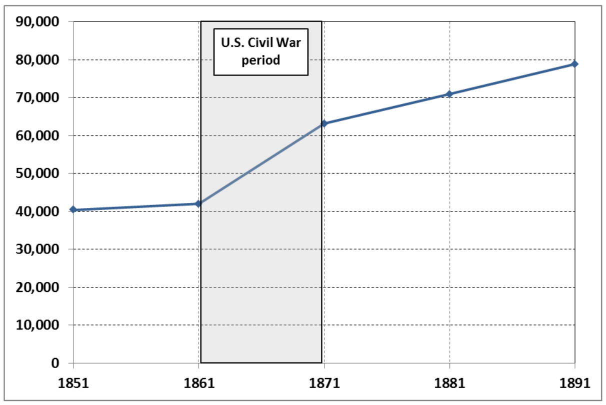
Figure 7: Log rank vs. log size graph for mid-sized cities in 1861 and 1871



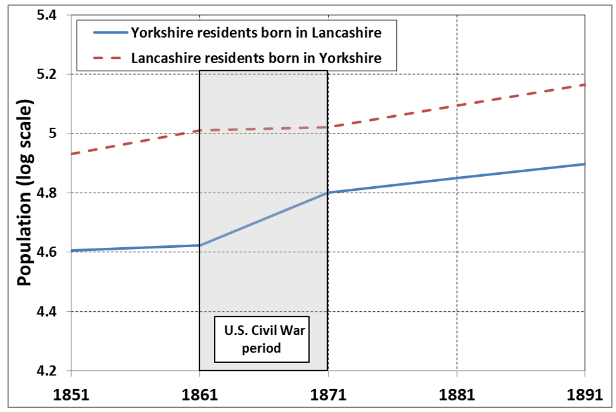
In order to make the results easily visible, this graph focuses only on mid-sized cities. All of the cotton textile cities except Manchester, the second largest city in England, fall into this range. The y-axis plots Ln(Rank-0.5) as suggested by Gabaix & Ibragimov (2011).

Figure 8: Evidence on migration patterns

Residents of other English counties that were born in the Northwest region



Residents of the Northwest and Yorkshire born in the other region



Data collected from Census of Population reports.

7 Tables

Table 1: Increase in relief seekers in cotton textile cities during the Civil War

DV: Increase in able-bodied relief seekers from 1860 to 1863 as a share of 1861 city population				
	(1)	(2)	(3)	(4)
Cotton city indicator	0.0198***	0.0273***		
	(0.00393)	(0.00588)		
Cotton emp. shr			0.0565***	0.0627***
			(0.0113)	(0.0142)
Constant	0.00117***	0.00238**	0.000741*	0.00275
	(0.000286)	(0.000844)	(0.000400)	(0.00171)
Observations	156	22	156	22
R-squared	0.404	0.519	0.509	0.556

*** p<0.01, ** p<0.05, * p<0.1 based on heteroskedasticity-robust standard errors shown in parentheses. Regressions are run on a cross-section of PLUs. Columns 1 and 3 include all PLUs for which data are available from Southall *et al.* (1998). Columns 2 and 4 include only those PLUs that correspond to cities that are available in the main analysis dataset.

Table 2: Relief seekers in cotton textile cities in 1866 relative to 1860

DV: Increase in able-bodied relief seekers from 1860 to 1866 as a share of 1861 city population				
	(1)	(2)	(3)	(4)
Cotton city indicator	0.000200	-0.000195		
	(0.000392)	(0.000640)		
Cotton emp. shr			0.000515	-0.00102
			(0.00101)	(0.00161)
Constant	-0.000166	0.000893**	-0.000166	0.00101**
	(0.000254)	(0.000426)	(0.000254)	(0.000412)
Observations	156	22	156	22
R-squared	0.001	0.005	0.001	0.026

*** p<0.01, ** p<0.05, * p<0.1 based on heteroskedasticity-robust standard errors shown in parentheses. Regressions are run on a cross-section of PLUs. Columns 1 and 3 include all PLUs for which data are available from Southall *et al.* (1998). Columns 2 and 4 include only those PLUs that correspond to cities that are available in the main analysis dataset.

Table 3: Average decadal population growth in cities

	1841-1851	1851-1861	1861-1871	1871-1881	1881-1891
All cities (47)	25.1%	22.2%	19.1%	20.2%	15.0%
Cotton cities (10)	22.3%	20.4%	10.9%	18.3%	13.0%
Other textile cities (8)	19.0%	12.2%	16.2%	17.5%	13.3%
Non-textile cities(29)	25.8%	22.7%	21.3%	20.8%	15.5%

Table 4: Regressions of population growth in cotton vs. all English cities

	DV: City population growth rate in each decade				
	(1)	(2)	(3)	(4)	(5)
Years included:	1841-1861	1851-1871	1841-1871	1841-1891	1851-1901
Cotton cities in 1851-1861	0.0115				
	(0.0346)				
	((0.0290))				
Cotton cities in 1861-1871		-0.0812***	-0.0754**	-0.0754**	-0.0799***
		(0.0272)	(0.0289)	(0.0291)	(0.0271)
		((0.0237))	((0.0237))	((0.0219))	((0.0160))
Cotton cities in 1871-1881				0.00465	0.00151
				(0.0324)	(0.0312)
				((0.0218))	((0.0189))
Cotton cities in 1881-1891				0.00371	-0.00454
				(0.0367)	(0.0377)
				((0.0225))	((0.0182))
Cotton cities in 1891-1901					-0.0462
					(0.0417)
					((0.0175))
City FEs	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes	Yes
Observations	94	94	141	235	275
Cities	47	47	47	47	55
	Permutation test of Cotton cities × 1861-1871 coefficient				
P-value:		0.046	0.043	0.047	0.020

*** p<0.01, ** p<0.05, * p<0.1 based on heteroskedasticity-robust standard errors shown in parentheses. HAC standard errors robust to spatial correlation up to 100km in double parentheses. All specifications include a full set of city fixed effects and year effects. The regressions in columns 1-4 use data from the 1891 census covering 1841-1891. The results in column 5 are based on a slightly different data set from the 1901 census covering 1851-1901. Permutation tests are based on 10000 replications with random reassignment of cotton city indicators across all locations. Permutation test p-values report the fraction of placebo regressions with results as negative as the coefficient estimated on the true data.

Table 5: Measuring the economic similarity across groups of cities

Summary statistics for industry employment share correlations for city pairs of each type			
	Mean	Min	Max
Pairs of cotton cities	0.965	0.899	0.999
Pairs of non-cotton textile cities	0.850	0.491	0.997
Cotton and non-cotton textile cities	0.878	0.430	0.995
Cotton and non-textile cities	0.128	-0.080	0.566

Correlations are for 44 cities where full city-industry data are available and the city is in either the 1841-1891 analysis database or the 1851-1901 analysis database.

Table 6: Regressions of population growth in cotton vs. other textile cities

	DV: City population growth rate in each decade				
	(1)	(2)	(3)	(4)	(5)
Years included:	1841-1861	1851-1871	1841-1871	1841-1891	1851-1901
Cotton cities	0.0486				
in 1851-1861	(0.0566)				
	((0.0277))				
Cotton cities		-0.135**	-0.110***	-0.110**	-0.126**
in 1861-1871		(0.0521)	(0.0381)	(0.0385)	(.0523)
		((0.0394))	((0.0348))	((0.0403))	((0.0443))
Cotton cities				-0.0499	-0.0628*
in 1871-1881				(0.0294)	(0.0346)
				((0.0237))	((0.0155))
Cotton cities				-0.0611*	-0.0765*
in 1881-1891				(0.0333)	(0.0373)
				((0.0286))	((0.0164))
Cotton cities					-0.0974**
in 1891-1901					(0.043)
					((0.0259))
City FEs	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes	Yes
Observations	36	36	54	90	90
Cities	18	18	18	18	18
	Permutation test of Cotton cities × 1861-1871 coefficient				
P-value:		0.0048	0.0047	0.006	0.0106

*** p<0.01, ** p<0.05, * p<0.1 based on heteroskedasticity-robust standard errors shown in parentheses. HAC standard errors robust to spatial correlation up to 100km are in double parentheses. All specifications include a full set of city fixed effects and year effects. The regressions in columns 1-4 use data from the 1891 census covering 1841-1891. The results in column 5 are based on a slightly different data set from the 1901 census covering 1851-1901. Permutation tests are based on 10000 replications with random reassignment of cotton city indicators across all locations. Permutation test p-values report the fraction of placebo regressions with results as negative as the coefficient estimated on the true data.

Table 7: Results using the cotton textile employment share as the key explanatory variable

DV: City population growth rate in each decade				
	All English cities		**Textile cities only**	
	(1)	(2)	(3)	(4)
Years included:	1841-1891	1851-1901	1841-1891	1851-1901
City cotton employment share	-0.144**	-0.165**	-0.204**	-0.247**
× 1861-1871	(0.0706)	(0.0673)	(0.0886)	(0.113)
	((0.0532))	((0.0389))	((0.0758))	((0.080))
City cotton employment share	0.0458	0.0296	-0.0761	-0.111
× 1871-1881	(0.0778)	(0.0756)	(0.0775)	(0.0869)
	((0.0533))	((0.0442))	((0.0302))	((0.0332))
City cotton employment share	0.0588	0.0307	-0.0672	-0.108
× 1881-1891	(0.0963)	(0.104)	(0.104)	(0.120)
	((0.0584))	((0.0463))	((0.0708))	((0.044))
City cotton employment share		-0.0902		-0.191
× 1891-1901		(0.123)		(0.143)
		((0.0416))		((0.0529))
City FEs	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes
Observations	235	275	90	90
Cities	47	55	18	18
	Permutation test of Cotton cities × 1861-1871 coefficient			
P-value:	0.0899	0.0415	0.0213	0.019

*** p<0.01, ** p<0.05, * p<0.1 based on heteroskedasticity-robust standard errors shown in parentheses. HAC standard errors robust to spatial correlation up to 100km are in double parentheses. All specifications include a full set of city fixed effects and year effects. Column 1 uses data from all English cities included in the 1841-1891 data set. Column 2 uses data from all English cities included in the 1851-1901 data set. Column 3 uses data from textile cities (cotton and non-cotton) included in the 1841-1891 data set. Column 4 uses data from textile cities included in the 1851-1901 data set. The cotton textile employment share is calculated using city-industry data from 1851. Permutation tests are based on 10000 replications with random reassignment of cotton textile employment shares across all locations. Permutation test p-values report the fraction of placebo regressions with results as negative as the coefficient estimated on the true data.

Table 8: Factors predicting increased growth during the Civil War among non-cotton cities

DV: Growth in city population 1861-1871 relative to 1851-1861				
	(1)	(2)	(3)	(4)
Distance (std)	0.0266		0.0113	0.0392
	(0.0201)		(0.0207)	(0.0232)
	((0.0125))		((0.00831))	((0.0117))
Non-cotton textile employment share (std)		0.0382	0.0330	-0.0412
		(0.0272)	(0.0308)	(0.0384)
		((0.0266))	((0.0283))	((0.0268))
Distance x Non-cotton textile employment share				0.0787**
				(0.0335)
				((0.0243))
Constant	-0.00712	-0.00712	-0.00712	-0.0426*
	(0.0196)	(0.0190)	(0.0193)	(0.0244)
	((0.0147))	((0.0133))	((0.0139))	((0.0170))
Observations	35	35	35	35
R-squared	0.052	0.106	0.113	0.233

*** p<0.01, ** p<0.05, * p<0.1 based on heteroskedasticity-robust standard errors shown in parentheses. HAC standard errors robust to spatial correlation up to 100km are in double parentheses. Regressions are run across 35 non-cotton cities, with Liverpool excluded. The distance variable is $exp(-dist_c)$ where $dist$ is the distance, as the crow flies, from city c to Manchester in thousands of kilometers. The non-cotton textile employment share is based on data from 1851. Both the distance and textile employment share variables are standardized.

Table 9: Factors affecting the migration destination of the Northwest-born population

DV: Decadal growth in share of Northwest-born residents in city population in 1861-1871 compared to 1851-1861				
	(1)	(2)	(3)	(4)
Distance	0.298***			0.238*
	(0.104)			(0.141)
	((0.0895))			((0.110))
Non-cotton textile emp. share		0.173**		-0.00273
		(0.0810)		(0.0956)
		((0.102))		((0.0741))
Initial NW pop.			26.52***	8.754
			(7.668)	(12.33)
			((8.293))	((2.988))
Observations	48	48	48	48
R-squared	0.198	0.067	0.147	0.206

*** p<0.01, ** p<0.05, * p<0.1 based on heteroskedasticity-robust standard errors shown in parentheses. HAC standard errors robust to spatial correlation up to 100km in double parentheses. Data cover 48 cities from 1851-1871. Liverpool is excluded because, even though it did not produce cotton textiles, its economy was dependent on the cotton textile industry. The distance variable is $exp(-dist_c)$ where $dist$ is the distance, as the crow flies, from city c to Manchester in thousands of kilometers. The non-cotton textile employment share is based on data from 1851. Both the distance and textile employment share variables are standardized. Initial NW pop. is the share of NW-born residents in total city population in 1851.

Table 10: Residents of five cotton textile cities born in other locations

	All city residents		**Residents born in other regions**	
Year	Population	Change in Population	Population	Change in Population
1851	227,026		38,959	
1861	253,483	26,457	43,781	4,822
1871	269,588	16,105	40,201	-3,580
Difference:		-10,352		-8,402

The cities included in the data are Bolton, Carlisle, Lancaster, Preston and Stockport. Manchester is excluded from the data due to changing city boundaries.

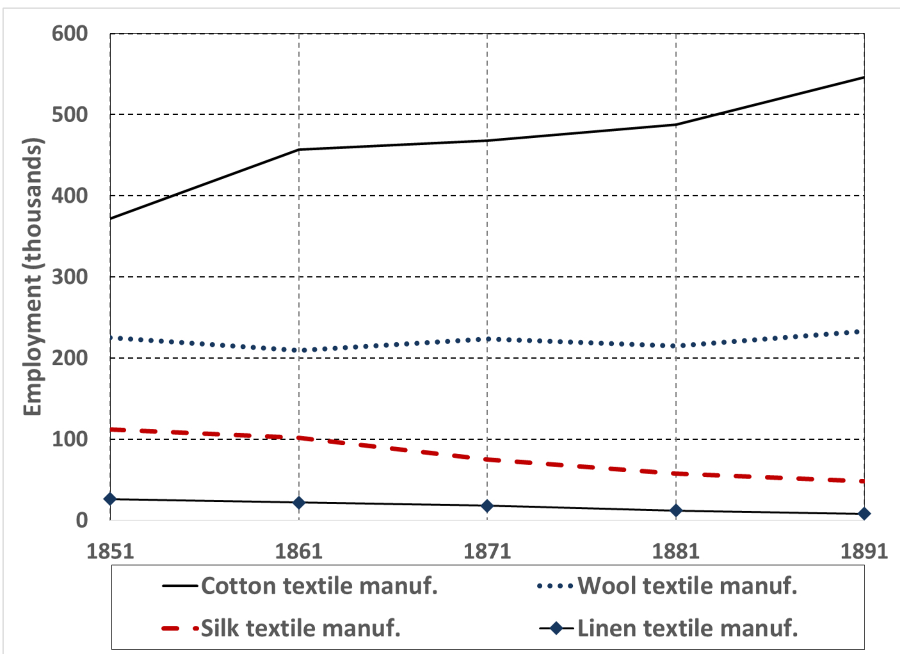
A Appendix (for online publication only)

This appendix provides some additional information about the empirical setting, data construction, and results.

A.1 Additional details on the empirical setting

Figure 9 shows employment in the cotton textile industry relative to other textile industries from 1851-1891. Wool textiles employment increased during the 1861-1871 decade and then remained flat. The smaller linen and silk industries were broadly declining in England & Wales over this period.

Figure 9: Employment in different textile industries in Britain, 1851-1891



Industry employment data is from the Census of Population and covers all of England and Wales.

A.2 Additional details on the data

Tables 11 and 12 describe, respectively, the textile cities and non-textile cities included in the main analysis database, which spans 1841-1891. Table 13 describes the additional cities that are included in the analysis database spanning 1851-1901. One city from the 1841-1891 database, Hastings, was not reported in the 1851-1901 data.

Table 11: Cities included in the analysis: textile cities

City	Population in 1851	Share of employment in cotton textiles	Share of employment in non-cotton textiles
Blackburn	52,187	0.61	0.01
Bolton	65,302	0.44	0.05
Burnley	26,848	0.33	0.01
Bury	35,571	0.28	0.03
Manchester	420,718	0.23	0.09
Oldham	52,820	0.52	0.06
Preston	70,309	0.49	0.03
Rochdale	41,513	0.19	0.15
Stockport	53,835	0.58	0.02
Wigan	31,941	0.17	0.01
Bradford	110,390	0.01	0.58
Coventry	36,579	0.00	0.50
Derby	43,178	0.01	0.33
Halifax	55,268	0.01	0.42
Huddersfield	56,964	0.03	0.31
Leeds	172,270	0.00	0.34
Norwich	68,713	0.01	0.16
Nottingham	98,911	0.02	0.25

Cotton textile cities are listed in bold font. Non-cotton textile cities are listed in italics.

Table 12: Cities included in the 1841-1891 analysis database: non-textile cities

City	Population in 1851	Share of employment in cotton textiles	Share of employment in non-cotton textiles
Aston Manor	6,426	0.00	0.00
Bath	54,240	0.00	0.02
Birkenhead	34,275	0.00	0.00
Birmingham	242,260	0.00	0.01
Brighton	66,465	0.00	0.01
Bristol	137,382	0.01	0.02
Croydon	20,307	0.00	0.01
Gateshead	25,568	0.00	0.01
Hastings*	16,966	0.00	0.01
Hull	87,822	0.06	0.02
Ipswich	32,914	0.00	0.02
Leicester	63,487	0.02	0.08
Liverpool	375,955	0.01	0.02
London	2,363,221	0.00	0.04
Newcastle	87,784	0.00	0.03
Northampton	26,657	0.00	0.02
Plymouth	90,401	0.00	0.02
Portsmouth	72,096	0.00	0.01
Reading	25,871	0.00	0.03
Sheffield	135,310	0.00	0.01
South Shields	28,974	0.00	0.02
Southampton	35,305	0.00	0.02
Sunderland	64,720	0.00	0.02
Walsall	27,062	0.00	0.00
Warrington	21,381	0.07	0.00
West Brom	34,591	0.00	0.00
West Ham	18,817	0.00	0.01
Wolverhampton	49,985	0.00	0.01
York	40,675	0.00	0.03

*Hastings is available in the 1841-1891 database but is not available in the 1851-1901 database.

Table 13: Additional non-textile cities included in the 1851-1901 analysis database

City	Population in 1851	Share of employment in cotton textiles	Share of employment in non-cotton textiles
Canterbury	18,522	0.00	0.03
Chester	27,766	0.00	0.02
Dudley	37,962	0.00	0.01
Exeter	38,851	0.00	0.04
Gloucester	25,105	0.00	0.02
Lincoln	17,536	0.00	0.02
Oxford	29,499	0.00	0.02
Tynemouth	29,170	0.00	0.02
Worcester	30,813	0.00	0.02

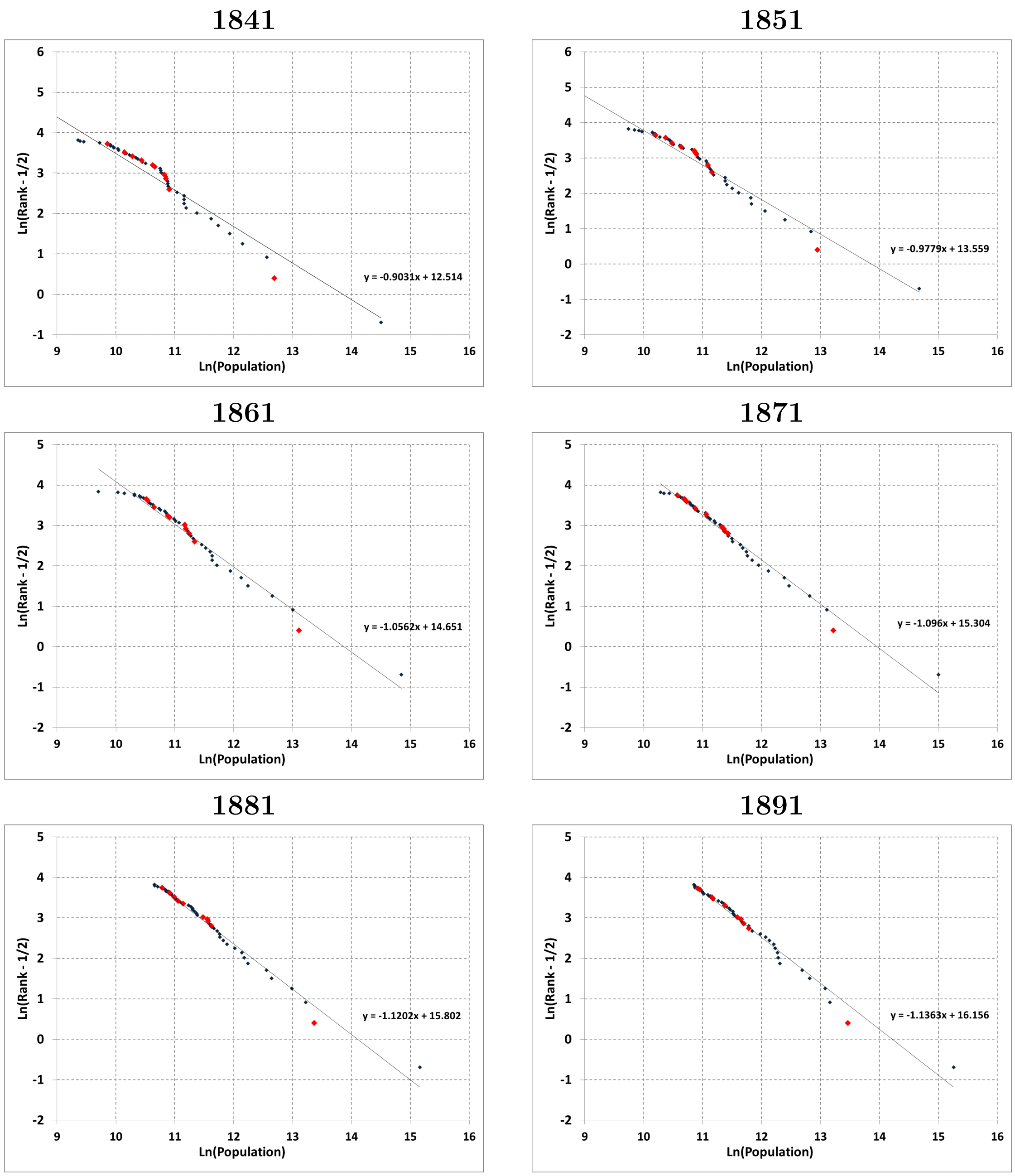
In order to identify which of these cities were major cotton textile producers, the city population data were merged with city occupation data from the Census of Population occupation reports. City cotton textile employment share is based on two occupational categories, "Cotton Manufacture" and "Packer and Presser, Cotton", with the first category capturing nearly all of the cotton textile employment.

For most of the cities in the data, occupation data is available at the city level. While these data are available based on each city's 1851 boundaries, which will not match the 1891 boundaries used in the city population data perfectly, these data are likely to provide a close approximation of the importance of cotton textile production in an area.

For 13 cities, city-level occupation data was not reported in 1851 but can be found using district-level occupation data from the 1851 census. The district and city populations are generally similar, so this is a reasonable way to assess city industrial composition. The exception is Aston Manor, where the city population (6,400) is much smaller than the district population (35,812), but because there is very little cotton textile employment in the district ensures there is sure to be little in the city.

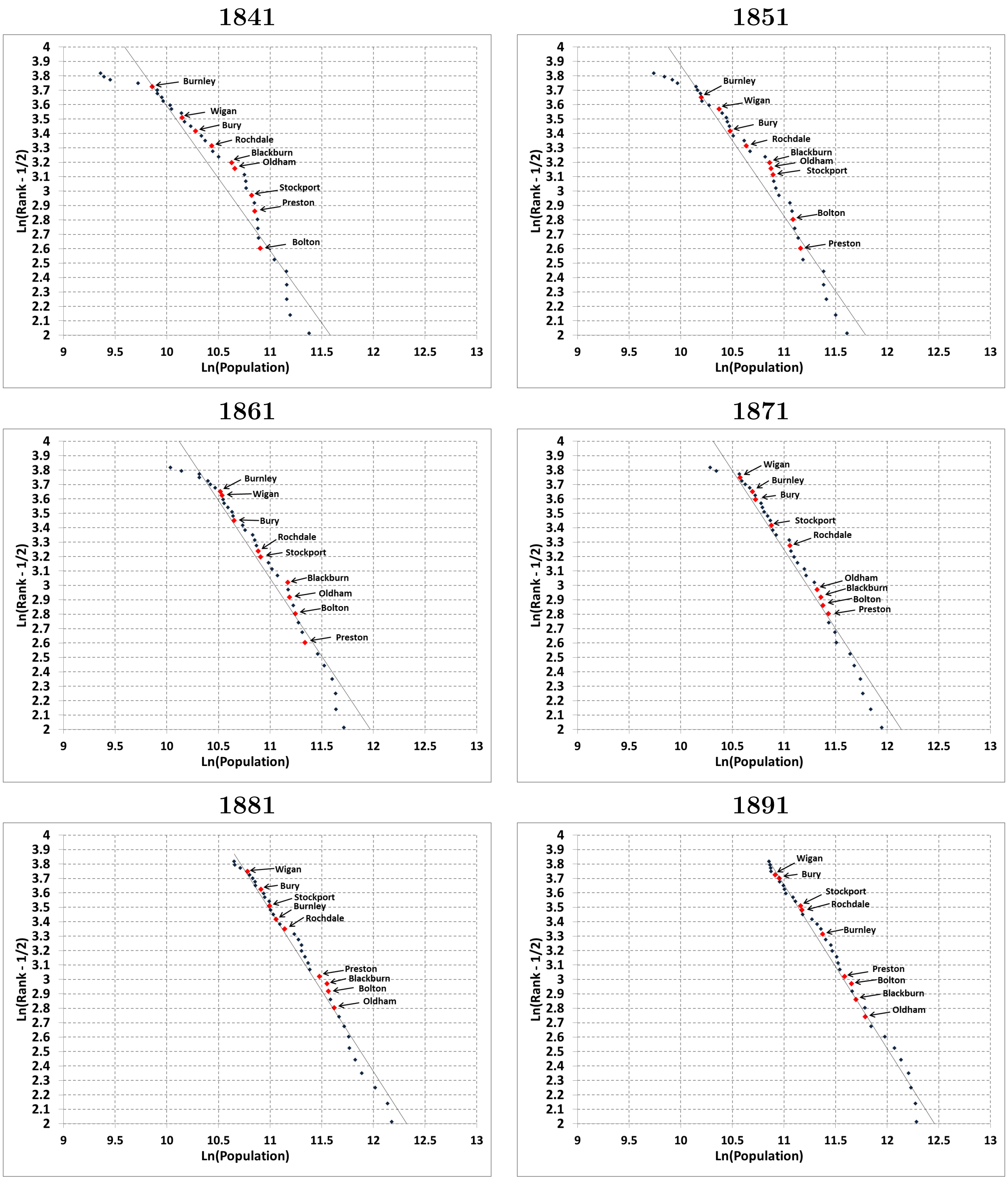
A.3 Additional analysis results

Figure 10: Log(Rank) - Log(Size) graphs, 1841-1891



Graphs comparing Ln(Rank-1/2) to Ln(Size). Using Rank-1/2 follows Gabaix & Ibragimov (2011).

Figure 11: Log(Rank) - Log(Size) graphs zoomed in to mid-sized cities, 1841-1891



Graphs comparing Ln(Rank-0.5) to Ln(Size). Using Rank-0.5 follows Gabaix & Ibragimov (2011).

Table 14: Estimating separate effects for cotton and other textile cities

	DV: City population growth rate in each decade			
	Using 10% cutoff to identify cotton cities		**Using city cotton textile employment shares in 1851**	
	(1)	(2)	(3)	(4)
Cotton city	-0.0700**	-0.0759***	-0.126*	-0.146**
× 1861-1871	(0.0298)	(0.0270)	(0.0739)	(0.0677)
	((0.0183))	((0.0158))	((0.0460))	((0.0396))
Cotton city	0.00989	0.00525	0.0648	0.0495
× 1871-1881	(0.0370)	(0.0356)	(0.0823)	(0.0776)
	((0.0191))	((0.0191))	((0.0466))	((0.0463))
Cotton city	0.0104	-5.46e-05	0.0813	0.0528
× 1881-1891	(0.0413)	(0.0419)	(0.101)	(0.107)
	((0.0227))	((0.0185))	((0.0582))	((0.0487))
Cotton city		-0.0424		-0.0717
× 1891-1901		(0.0435)		(0.127)
		((0.0176))		((0.0427))
Other textile city	0.0467	0.0517	0.157	0.222
× 1861-1871	(0.0362)	(0.0437)	(0.132)	(0.164)
	((0.0409))	((0.0458))	((0.143))	((0.157))
Other textile city	0.0451	0.0481	0.165*	0.231**
× 1871-1881	(0.0356)	(0.0371)	(0.0878)	(0.0874)
	((0.0173))	((0.00654))	((0.0784))	((0.0319))
Other textile city	0.0577	0.0576	0.194*	0.255***
× 1881-1891	(0.0379)	(0.0362)	(0.111)	(0.0695)
	((0.0251))	((0.0186))	((0.102))	((0.0603))
Other textile city		0.0489		0.213**
× 1891-1901		(0.0323)		(0.0848)
		((0.0199))		((0.0806))
City FEs	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes
Observations	235	275	235	275
Cities	47	55	47	55
Years included:	1841-1891	1851-1901	1841-1891	1851-1901

*** $p<0.01$, ** $p<0.05$, * $p<0.1$ based on heteroskedasticity-robust standard errors shown in parentheses. HAC standard errors robust to spatial correlation up to 100km are in double parentheses. All specifications include a full set of city fixed effects and year effects. In Columns 1-2 "Cotton" is based on an indicator variable for whether a city's cotton textile employment share is above 10% and "Other textile city" is an indicator variable for whether the city's employment share in all other textile industries is above 10%. In Columns 3-4, "Cotton" is the city's cotton textile employment share and "Other tex." is the city's employment share in all other textile industries. Columns 1 and 3 use data from 1841-1891 while Columns 2 and 4 use data from 1851-1901. The cotton textile employment share is calculated using city-industry data from 1851.

Table 15: Additional sensitivity checks

	DV: City population growth rate in each decade			
	Using only cities in the Northwest and Yorkshire		Dropping Manchester and London	
	(1)	(2)	(3)	(4)
Cotton city × 1861-1871	-0.125***	-0.143***	-0.0760**	-0.0851***
	(0.0324)	(0.0396)	(0.0310)	(0.0286)
	((0.0189))	((0.0236))	((0.0196))	((0.0166))
Cotton city × 1871-1881	-0.0447	-0.0607	0.00842	0.000893
	(0.0385)	(0.0428)	(0.0346)	(0.0337)
	((0.0321))	((0.0335))	((0.0202))	((0.0196))
Cotton city × 1881-1891	-0.0202	-0.0424	0.00712	-0.00561
	(0.0462)	(0.0455)	(0.0393)	(0.0410)
	((0.0210))	((0.0282))	((0.0240))	((0.0191))
Cotton city × 1891-1901		-0.0849*		-0.0521
		(0.0437)		(0.0450)
		((0.0230))		((0.0182))
City FEs	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes
Observations	95	95	225	265
Cities	19	19	45	53
Years included:	1841-1891	1851-1901	1841-1891	1851-1901

*** p<0.01, ** p<0.05, * p<0.1 based on heteroskedasticity-robust standard errors shown in parentheses. HAC standard errors robust to spatial correlation up to 100km are in double parentheses. All specifications include a full set of city fixed effects and year effects. Columns 1-2 use only data from the Northwest counties (Lancashire & Cheshire) and Yorkshire. Columns 3-4 use data for all cities except London and Manchester, which are substantial outliers in terms of city population. Columns 1 and 3 use data from 1841-1891 while Columns 2 and 4 use data from 1851-1901. The cotton textile employment share is calculated using city-industry data from 1851.

Table 16: Results obtained using propensity score matching

	DV: Change in city growth rate between 1851-1861 and 1861-1871			
	Cities in 1841-1891 data		**Cities in 1851-1901 data**	
	(1)	(2)	(3)	(4)
Cotton city indicator	-0.120***	-0.162**	-0.0877*	-0.155**
	(0.0254)	(0.0685)	(0.0458)	(0.0651)
Observations	47	47	55	55
Matching variables:	Population 1861 Growth 1841-51 Growth 1851-61	Population 1861 Growth 1841-51 Growth 1851-61 Tex. emp. share in 1851	Population 1861 Growth 1851-61	Population 1861 Growth 1851-61 Tex. emp. share in 1851

*** p<0.01, ** p<0.05, * p<0.1 Results use propensity score matching to three nearest neighbors. Matching is based on city population in 1861, city population growth from 1841-1851 and city population growth from

Table 17: Synthetic control balance across matching variables

	Log Population results		Pop. growth results	
	Actual	Synthetic	Actual	Synthetic
Growth -- 1851	--	--	0.2960	0.2704
Growth -- 1861	--	--	0.2029	0.2220
Population	1,373,570	1,656,090	--	--
Industry employment shares...				
Construction	0.053	0.065	0.0526	0.0645
Chemicals and oils	0.013	0.018	0.0128	0.0176
Apparel	0.109	0.141	0.1093	0.1406
Food and drinks	0.047	0.056	0.0470	0.0556
Earthenware and bricks	0.006	0.008	0.0062	0.0079
Leather goods	0.006	0.014	0.0057	0.0142
Machinery and metals	0.065	0.093	0.0648	0.0928
Mining related	0.012	0.013	0.0118	0.0132
Misc. manufacturing	0.032	0.047	0.0316	0.0471
Professionals	0.010	0.020	0.0098	0.0198
Paper manufacturing	0.010	0.020	0.0097	0.0202
General services	0.149	0.206	0.1490	0.2065
Shipbuilding	0.007	0.005	0.0065	0.0047
Shopkeepers	0.018	0.012	0.0185	0.0122
Textiles	0.338	0.172	0.3380	0.1724
Trade and business service:	0.060	0.056	0.0602	0.0565
Transportation services	0.063	0.049	0.0626	0.0487
Vehicle manufacturing	0.002	0.004	0.0023	0.0038
Utilities	0.002	0.002	0.0016	0.0019