Path Dependence through Agglomeration Spillovers: Evidence from the Beet Sugar Industry

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Abstract

This paper presents evidence of path dependence in economic geography by investigating the agglomeration spillovers from US beet sugar factories, which attracted large-scale manufacturing facilities near farmlands. I identify runner-up locations for beet sugar plants from a historical trade journal to estimate the effects of plant openings. The results show that these plant openings had large and long-lasting effects on population and manufacturing activities over one hundred years. The agglomeration spillovers benefited industries not only directly linked through input-output linkages but also extended to broader, less related industries outside the production chain of agricultural processing.

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1. Introduction

This paper examines whether narrow industrial installations create long-run spillovers that eventually lead to larger industrial developments. A large industrial base today may stem from agglomeration spillovers initiated by local firms, potentially driving industrial growth across diverse sectors. Alternatively, spillovers from initial industrial expansion may dissipate over time, leaving little lasting impact over time. In the latter case, the uneven distribution of economic activities would primarily result from natural endowments or location fundamentals, with limited scope for path dependence.

To explore this question, I focus on the sugar beet industry in the United States. Sugar beets are heavy and perishable, requiring processing plants to be located near farmlands (Holmes and Stevens, 2004). The establishment of a large manufacturing plant in such areas has the potential to significantly transform local economies. By examining the long-term effects of one specific industry, this study allows for a detailed investigation of how agglomeration effects unfold through and beyond input-output linkages over a long period of time.

The impact of the beet sugar industry on local economies has long attracted attention. In the United States, the industry was recognized for its distinctive ability to drive local development by integrating agriculture with manufacturing (Michigan Bureau of Labor and Industrial Statistics, 1902). Government officials, academics, or abolitionists who wanted to produce sugar without slavery paid attention to its capacity to stimulate growth in rural areas (Child, 1840; Palmer, 1908; Blakey, 1913; Mapes, 2010).

This paper estimates the long-run effects of beet sugar plant openings on industrial development in the United States using a panel of county censuses over time. Local economic outcomes could be driven by a variety of county characteristics that favor plant openings other than the entry of manufacturing plants itself.

To address this identification challenge, I leverage unique data on plant site selection. The *American Beet Sugar Gazette*, a trade journal, provided a list of cities and towns deemed suitable for factory construction between 1899 and 1912. During this period, the sugar beet industry experienced rapid growth within a narrow window. I compare counties that successfully established beet sugar factories to those identified in the Gazette that ultimately did not. To the extent that the aggregate demand for sugar is finite, the total number of beet sugar plants are limited and they must choose one city over another. Yet, this does not necessarily imply that the runner-up locations were inherently disadvantaged in terms of their potential for industrial growth.

To validate my research design, I compare control counties, treated counties, and counties that never proposed to build sugar beet factories. The comparison of raw differences in population reveals that control counties, despite failing to secure beet sugar factories, exhibited better local population growth trajectories compared to never-proposed counties, which was evident even before the construction of factories began. On the other hand, control counties followed a trend similar to that of treated counties until the beet sugar factories were constructed.

Through a comparison of treated and control counties, I find that the opening of these plants led to a 36 percent increase in population and a threefold (1.1 log points) increase in manufacturing employment over one hundred years. I provide several pieces of suggestive evidence indicating that the large effect size is due to these manufacturing plants being established near farmland at a time when the U.S. economy was still primarily agricultural, and congestion costs from population growth were low.

To better understand the mechanisms driving local industrial development, I analyze a cross-section of counties in 2000. The results show that treated counties are more likely to have industries related to the beet sugar industry, such as animal food, cut stone, plastics, and fertilizers, whereas there were no pre-existing differences in similar industries in 1880. There is no strong evidence that treated and control counties differ in terms of hospitals, museums, crime rates, or the share of college graduates, suggesting that the effect occurs through agglomeration rather than improvements in amenities or public goods.

To dig further into the input-output linkage, I use industry-level employment data between 1870 and 1940 to construct a measure of manufacturing employment weighted by its upstream and downstream linkages to the confectionery industry, excluding the confectionery sector itself. The findings reveal significant effects on downstream industries, such as the food sector, while the evidence for upstream industries, such as stone products, is somewhat weaker.

I then examine whether the agglomeration effects of the beet sugar industry act as a catalyst for broader industrial development by comparing employment growth across various industries based on their linkage distance to the confectionery sector. Beyond the confectionery industry itself, I find that the opening of beet sugar factories led to employment growth not only in industries closely related to confectionery but also in those more distant, such as the motor vehicle industry. Predicting which specific industries would experience significant growth based solely on their input-output linkages to confectionery proved challenging, as there is a weak correlation between industry linkage and the magnitude of employment growth. This suggests that while agglomeration spillovers through input-output linkages do occur, other factors beyond these linkages play a significant role in shaping industrial growth.

The magnitude of employment or population growth observed is greater than the estimates found in some existing studies that examined large-scale government interventions (Kline and Moretti, 2014; Garin, 2019). Using a simple spatial equilibrium model, I demonstrate that the magnitude of local productivity growth from agglomeration is consistent with findings from existing studies. The substantial effect size appears to be driven by a high labor supply elasticity, which could be attributed to housing supply elasticity or high labor mobility in rural areas during the period this study examines.

First, this paper contributes to the literature on path dependence and persistence in economic geography (Krugman, 1991; Rauch, 1993; Arthur, 1994; Davis and Weinstein, 2002; Brakman et al., 2004; Miguel and Roland, 2011; Redding et al., 2011; Bleakley and Lin, 2012; Michaels and Rauch, 2018; Allen and Donaldson, 2022; Smith and Kulka, 2023). Building on studies that examine path dependence through exogenous shifts in infrastructure or wartime destruction, I explore path dependence by analyzing the long-term effects of plant openings. By focusing on a small group of comparable counties, this paper provides a novel setting to test path dependence. While Dell and Olken (2020) examines the long-term effects of sugarcane factories within the broader institutional changes under Dutch colonial rule in Indonesia, this study isolates the impact of sugar beet plant openings, focusing specifically on local firm spillovers in a setting without change in political institutions.

Second, this study relates to local economic spillovers (Glaeser et al., 1992; Greenstone et al., 2010; Kline and Moretti, 2014; Hanlon and Miscio, 2017; Allcott and Keniston, 2018; Kantor and Whalley, 2019; Andrews, 2020; Abebe et al., 2022). By focusing on the impact of a specific, well-defined industry, it sheds light on how local economic spillovers emerge through input-output linkages and also demonstrates how a broad range of industries, even those without direct upstream or downstream connections, can also benefit from agglomeration. These insights have implications for understanding how economic activities diversify into more complex sectors (Hausmann and Klinger, 2006; Neffke et al., 2011).

2. Institutional background

The technology for extracting sugar from beets was first invented in Europe during the 1830s. However, adoption in the U.S. was delayed until the 1890s due to a lack of information about suitable regions for sugar beet cultivation (Ballinger, 1978). Prior to this time, several attempts were made by abolitionists to produce a substitute for cane sugar grown on slave plantations, but all ended in failure (Child, 1840). It was not until the United States Department of Agriculture conducted a national survey of sugar beet soil across the country that the beet sugar industry gained prominence in the early twentieth century. A more detailed discussion on the rise of US beet sugar industry is available in Appendix E.

Although the industry was a relatively small-scale industry in 1890, producing a total of 2,467 tons, the sugar beet industry experienced remarkable growth in subsequent years, reaching 722,054 tons of production in 1915 (Federal Trade Commission, 1917, p.12). During the early stages of industrialization, they played a crucial role in linking agriculture to the burgeoning industrial sector.

Historical records show that the establishment of beet sugar factories resulted in the transformation of rural areas into thriving cities. In Sugar City, Colorado, the population increased by 40 percent after the construction of a sugar beet plant, despite there not being "a single house, barn, or even shack in sight in any direction." Similarly, the sugar beet factory in Rocky Ford, Colorado, led to the construction of hundreds of new buildings and increased the Santa Fe Road's freight income sevenfold (Palmer, 1908). At the time, it was widely accepted that the sugar beet plant brought benefits to various segments of society, including "business and professional men, mechanics, and laborers" (Palmer, 1913).

There were multiple avenues for economic spillovers resulting from the establishment of sugar beet factories. Since suitable temperate areas for sugar beet cultivation had high land values, the sugar companies could not vertically integrate large farmlands (Mapes, 2010, p.53). Instead, smallholders rotated sugar beets with other crops and received training from agriculturalists employed by the companies on how to cultivate the beets. This training also led to discussions on how to improve the cultivation of other crops, such as wheat, rye, barley, and maize. Blakey (1913) claims that every sugar beet factory is "a sort of local agricultural college", enhancing the agricultural efficiency of almost every community it entered.

The ripple effects extended beyond the agricultural sector to include numerous other industries. In addition to requiring various materials and equipment such as bags, thread, valves, pipes, and machinery, the plants also employed a wide range of workers, including chemists, engineers, machinists, carpenters, and blacksmiths. These factories attracted new businesses such as dairies, orchards, and feed yards, as well as professionals like merchants, bankers, and real estate agents, leading to the development of prosperous towns (Grant, 1867; Wiley, 1898; Palmer, 1908; Browne, 1937).

This observation is echoed by Napoléon III, who claimed that the industry improved agricultural techniques, raised land value, increased employment and wages, and enhanced overall prosperity (Napoléon, 1843). Grant (1867) notes that despite government efforts to prevent it, a significant number of agricultural workers were migrating to urban areas in search of employment before the introduction of beet sugar in France. However, he also observes that the emergence of the beet sugar industry created higher-wage employment opportunities in rural areas.

3. Estimating the impact of beet sugar plant openings

3.1 Data and research design

Data. This study examines the local economic impact of sugar beet plant openings using county-level data. To construct treatment indicators, I use a comprehensive list of sugar beet factories from War Food Administration (1946), which documents all sugar beet factories built in the United States from 1838 to 1945. If a city or a town that constructed a beet sugar plant shares boundaries with two different counties, both counties are considered to have sugar beet factories. Figure 1 shows the number of newly constructed beet sugar plants by year.

Variables on population and manufacturing activities are obtained from Haines (2005) and Haines et al. (2019). I examine county population, manufacturing employment, manufacturing wages, and manufacturing value added. Following Kline and Moretti (2014), I exclude non-production workers, who are often white-collar or highly skilled, from manufacturing employment. All dollar values are chained to the consumer price index in 1900. Manufacturing value-added is computed before 1920 by subtracting raw material input from manufacturing output.

Estimating the causal impact of plant openings faces a challenge: factories did not choose locations randomly. Factors like transportation networks, natural resources, local demand, amenities, and skilled labor influenced their decisions, many of which are unknown or unobservable. This study addresses this challenge by using the proposed sugar beet plant locations from the trade journal, *American Beet Sugar Gazette* (*Gazette* hereafter). Published by the American Beet Sugar Gazette Company, this journal served as a forum for the exchange of knowledge on the United States' beet sugar business and was first released in March 1899. Until December 1912, the publication disseminated information about communities striving to establish sugar beet industries (Beet Sugar Gazette Company, 1899). This section of the magazine was previously known as "New Factories" and "Projects for New Factories." Starting from 1911, it was renamed as "New Factory and Equipment" section, which offers comprehensive information on cities and towns that considered sugar beet enterprises, sometimes including the names of the entrepreneurs who invested their capital, planned factory size, and the circumstances that influenced the construction of beet sugar factories.

To construct counterfactual outcomes in which beet sugar plants were not established, I rely on counties that were initially deemed favorable for starting the business but were ultimately not chosen by the beet sugar firms. Springfield, Ohio, for example, appears on this list with the following remark: "There is no reason why the great state of Ohio should not have a sugar factory...The soil is eminently suited to the growing of this crop, the farmers are wide-awake and the capitalists enterprising and resourceful...The city of Springfield is at present making a great effort to secure it." However, Springfield had no sugar beet factories, according to War Food Administration (1946). If the early twentieth-century assessments made by sugar beet experts were credible, it is reasonable to assume that Springfield shared favorable characteristics for sugar beet plant construction, such as soil suitability, farmer expertise, and access to financing, in addition to various unknown or unobservable factors. These runner-up sites will presumably provide a reliable benchmark for what would have occurred if sugar beet factories had not been constructed.

The *Gazette* highlights the importance of coordination between farmers and businessmen in the establishment of a sugar beet plant. Farmers were unwilling to produce sugar beets without the guarantee of compensation for their yields by sugar firms. Similarly, sugar corporations were hesitant to build a new facility without assurances that farmers would produce sugar beets. The establishment of sugar beet plants is more likely to reflect sugar beet-specific factors related to coordination between farmers and entrepreneurs, rather than favorable manufacturing conditions in general, at least among the counties mentioned in the *Gazette* as suitable locations.

The research design may be susceptible to bias if sugar companies deliberately concealed preferred locations to avoid inflating land values before constructing plants. They might also have withheld some potential sites or named unattractive ones to mislead competitors (Slattery and Zidar, 2020). However, the journal's correspondents conducted independent reconnaissance to identify communities seriously considering starting a sugar beet business, rather than relying on companies' site preferences. This reduces concerns about firms' strategic manipulation. In addition to beet sugar corporations, farmers and local officials provided input on the feasibility of establishing factories. If the correspondents and *Gazette* editors deemed a town unsuitable, it would not have been listed. Notably, all counties that established their first sugar beet plant between 1899 and 1912 were on the *Gazette*'s lists.

Research design. I construct treated and control counties based on historical narratives surrounding the emergence of the beet sugar industry. Attempts to establish the beet sugar industry began in 1838 but ended in failure for decades. In the 1890s, the U.S. Department of Agriculture conducted a survey of suitable areas for beet sugar production (US Department of Agriculture, 1891, 1899a). Following this decade long survey, the *Sugar Beet Gazette* published information on suitable plant locations between 1899 and 1912. Although the Gazette continued publication into the 1930s, it stopped sharing suitable locations after 1912. Figure 1 shows that the construction of new beet factories was concentrated within a narrow time frame and gradually tapered off in the subsequent period.

The research design compares counties that built beet factories during the critical period for this emerging industry, between 1899 and 1912, with those deemed suitable at the time but that ultimately did not have factories by 2000. By the turn of the 20th century, there was significant uncertainty about whether the industry would succeed after decades of failures. The counties mentioned in the *Gazette* were considered similar; one group built factories, while the other did not. Comparing them before and after the emergence of the beet sugar industry provides insight into the long-term effects of plant openings.

Counties that built their first beet sugar factory before 1899 or after 1912 are excluded from both the treated and control groups.[1] This is because counties that built factories outside this time frame are arguably less comparable in terms of their risk preferences. *Gazette* continued publication well beyond 1912, but it ceased reporting on suitable locations for sugar beet cultivation after that year. This shift likely signaled the end of the initial sugar beet boom and the industry's transition to a more mature phase. Counties that established beet sugar factories after 1912 entered the industry at a later stage, when the challenges and successes of local beet sugar production were already well-documented. Thus, constructing counterfactual counties for these post-1912 entrants may require a slightly different methodology than solely relying on the *Gazette*. I revisit this issue in the next subsection.

I create a panel of treated and control counties spanning from 1870 to 2000. To ensure a balanced panel, I exclude counties without population estimates for the period between 1870 and 2000. Among the counties that established their first beet sugar plants between 1899 and 1912, I exclude one county[2] from the treated group due to missing population data for 1870. I drop two independent cities in Virginia from the control group. The empirical specification includes state-year fixed effects, and three singleton counties within their respective states are excluded from the regressions[3]. Through this selection process, 263 counties were assigned to the control group and 56 counties to the treated group. County borders were adjusted to align with 1900 definitions (Hornbeck, 2010; Perlman, 2014). The spatial distribution of the treatment and control counties is shown in Figure 2.

3.2 Validity of the research design

Two concerns can be raised about the research design. First, one could argue that it is challenging to claim that treatment is as good as random in this setting, given that allocation to the treatment group essentially depends on a county's ability to successfully complete a plant construction project. One interpretation of the counties on the list that never received a plant is that they were ultimately determined to be least suited to the development of processing manufacturing, or that they had experienced insufficient growth during the intervening period, making them less appealing locations.

[1] I exclude control counties that established beet sugar factories after 1940, using data from Risch et al. (2014).

[2] Finney County, Kansas.

[3] These counties are Essex County, Massachusetts, Monroe County, Mississippi, and Madison County, Tennessee.

In this case, the comparison in this design may overestimate the effect of beet sugar plant openings.

The second concern relates to the exclusion of counties that built sugar beet factories after 1912. One might consider that the research design could additionally exploit the variation in timing of beet sugar plant openings across counties, as certain counties received factories after 1912.

To carefully evaluate these two threats to identification, Figure 3 plots the population trend of control and treated counties, along with counties that were not mentioned in the *Gazette* (never proposed), counties that built sugar beet factories before 1899, and counties that received beet sugar factories after 1912. Panel (a) plots the level of log population, while Panel (b) normalizes log population to the 1900 population of each group, thus visualizing the population trend relative to 1900. Similar figures for the manufacturing employment is shown in Figure A.1. In Figure A.2 and Figure A.3, I also split the never-proposed counties into two groups based on their nearest distance to the treated counties, as counties that are too distant from the control and treated counties will be less comparable. I find that the basic pattern does not change.

Four observations can be made. First, the control and treated counties exhibited similar levels and growth of population until 1900, with divergence occurring thereafter, which may suggest the effect of beet sugar plant openings.

Second, the counties never mentioned in the *Gazette* experienced slower population growth compared to the control counties. By 1880, population levels across never-proposed, control, and treated counties were comparable. However, by 2000, control counties had 0.5 log points less population than treated counties, while never-proposed counties lagged even further behind, with 0.7 log points less population than control counties. This trend indicates that never-proposed areas were already falling behind before the construction of beet sugar factories and continued to do so through 2000. Although control counties were less successful than treated counties in attracting beet sugar plants, they maintained stronger population growth compared to never-proposed counties. If the control counties were the least suited for industrialization, lacking location fundamentals and natural endowments from the outset, we would expect them to perform worse than counties that were never mentioned in the *Gazette*. It seems unlikely that the control counties had disadvantageous location fundamentals that would have hindered industrial development, given their similarity to the treated counties in levels and trends of population and manufacturing employment until 1900.

Third, counties that established sugar beet factories after 1912 initially lagged behind control counties in terms of population growth but largely caught up by 1900. The population growth trend in these counties diverged from both control and treated counties well before 1900. This raises the question of whether including these counties as control or treated groups adds value when estimating the long-term effects of sugar beet plants. A comparison of raw population trends in counties that built factories after 1912 shows that including them may inflate the estimated treatment effect, as their population growth rates are higher than those of both treated and control counties. However, including these counties would introduce pre-existing trends. Including these counties in a difference-in-differences framework assumes that the timing of plant openings is random, which seems difficult to justify in this case. The identifying assumption of this paper is that the sample counties would have followed the same trend without the sugar beet plant openings during a period of uncertainty about the industry's sustainability—an assumption different from randomness in the timing of plant openings. Nevertheless, in Figure A.4, I make several comparisons with never proposed counties and later treated counties using the synthetic differences-in-differences estimator (Arkhangelsky et al., 2021).

Fourth, counties that had established beet sugar factories before 1899 were already more populated than other counties and experienced faster population growth in the latter half of the twentieth century.

3.3 Balance test

This section examines the differences between treated and control counties across a broader range of county characteristics. Table 1 presents regression results of the variables regressed on the treatment indicator with and without state fixed effects. Column (1) presents the mean values, while column (2) measures the unconditional differences between treated and control groups. Column (3) further compares these differences after controlling for state fixed effects. As the likelihood of detecting a significant difference between the treated and control units increases when comparing a large number of variables, columns (4) and (5) document the stepdown p-values adjusted for multiple hypothesis testing (Romano and Wolf, 2005).

The results indicate that treated and control counties share similar characteristics across various metrics in population and manufacturing outcomes. However, several differences emerge in agricultural equipment and irrigated farmlands per county acre.

Treated counties possess significantly more irrigated land, with an unconditional difference of 1.42 farmlands per county acre and a within-state difference of 0.91 farmlands per county acre.

Following Kantor and Whalley (2019), I calculate the distance from each county to the nearest federal agricultural experiment station using data from US Department of Agriculture (1910). Treated counties are significantly closer to agricultural experiment stations, yet the gap narrows when comparing counties within the same state.

I measure agricultural potential for beet sugar cultivation by digitizing USDA records from this period. The USDA experiment is an indicator variable that equals one for counties where the USDA measured sugar quality (US Department of Agriculture, 1891). Purity coefficients and sucrose content in beets, as measured by US Department of Agriculture (1891) between 1890-1900, were crucial for farmers and entrepreneurs considering starting beet sugar factories.[4] Treated counties have slightly higher beet sugar purity (2.18% higher unconditionally, 1.09% higher within states) and sugar in beet percentage (1.04% higher unconditionally, 0.6% higher within states). "Beet belt" refers to counties US Department of Agriculture (1899a) identified as suitable for high-sugar, high-purity sugar beet cultivation, characterized by mean summer temperatures of 69-71°F (Wiley, 1930, p.177). The USDA and Weather Bureau jointly designated this area. The balance in the beet belt indicates that the USDA believed the treated and control counties were similarly suitable after seeing the experiment results. I also find that the treated and control counties had similar levels of potential sugar beet yield, as estimated in the Food and Agricultural Organization's Global Agro-Ecological Zones (GAEZ) model, assuming that farmlands are irrigated and high inputs are used.

In conclusion, although there are some differences in agricultural characteristics, treated and control counties are generally comparable across various manufacturing outcomes and population measures. This study employs a difference-in-differences approach, relying on the parallel trends assumption rather than exact similarity in all characteristics. In the empirical analysis, I will assess pre-treatment trends to assess the validity of the parallel trends assumption.

3.4 Empirical framework

To investigate the effects of sugar beet plant openings, I estimate the following equation:

[4]Evidence suggesting that government research influenced the location of beet sugar factories is presented in Appendix A.6.

$$outcome_{ct} = \sum_{\tau \neq 1900} \gamma_\tau (beet_c \times D_\tau) + \delta_c + \delta_{st} + \varepsilon_{ct} \tag{1}$$

where c and t denote county and census year, respectively. $outcome_{ct}$ is a range of outcome varibles that could measure the local development effects on the agricultural sector, the manufacturing sector, or general population.

$beet_c$ is an indicator that equals one for counties expected to build sugar beet factories between 1899 and 1912 and that actually constructed at least one sugar beet factory during that period. Conversely, it is zero for counties that were proposed but never built a beet sugar factory. D_τ is a time dummy, and γ_τ captures the differences in the dependent variables over time relative to 1900, after county fixed effects (δ_c) and state-by-year fixed effects (δ_{st}). Error terms (ε_{ct}) are clustered by county to account for serial corrleation within counties across time. The identifying assumption of this paper is that, in the absence of the opening of beet sugar factories, the treated and control counties would have followed the same trend in population and manufacturing activities.

4. Results

4.1 Main results

The main results are summarized in Table 2, where the treatment indicator is interacted with a time dummy that equals one after the year 1900. Columns (1) and (2) show a substantial increase in population following the establishment of beet sugar plants. The log population increased by 0.31 to 0.45. This translates to approximately a 36 to 57 percent increase in population, indicating a strong pull factor for migration to these areas.

The impact on manufacturing employment is even more pronounced. Columns (3) and (4) show increases of 1.16 to 1.69 in log manufacturing employment. These coefficients suggest a large expansion of the manufacturing sector, with roughly 219-440 percent increase in employment. Beet sugar plants also positively affected worker wages and overall manufacturing productivity. Columns (5) and (6) indicate increases in manufacturing wages per worker by 1,100 and 1,400 dollars. As shown in Table 1, the baseline manufacturing wage per worker in 1900 was 4,500 dollars. Hence there is roughly 40 percent increase in wage. Columns (7) and (8) show substantial increases in manufacturing value added, with coefficients of 1.54 and 1.87. The effect on wages and value added appears slightly stronger when controlling for state-by-year fixed effects.

Table 1 shows that the average population and manufacturing employment in the sample counties in 1900 were 39,000 and 3,000, respectively. A 36 percent increase in population corresponds to an increase of 14,000 people, while a 219 percent increase in manufacturing employment is associated with an increase of 6,000 workers.

To evaluate the parallel trends assumption and examine the effects over time, I reestimate the equation using a flexible specification where the treatment indicator is interacted with year fixed effects, as shown in Figure 4. The results indicate no evidence of preexisting divergence in the outcome variables before 1900, while the treatment effect grows over time. Although the effect eventually levels off especially in population, it remains persistent through 2000.

Effect size. The impact on population and manufacturing employment is more substantial compared to the effects observed in 'big push' development projects such as the Tennessee Valley Authority, which had no effect on population and only a 10 percent increase in manufacturing employment after a 30-year period (Kline and Moretti, 2014). While the estimated effects in this study are quite large, they align with historical anecdotes demonstrating forty percent population increase in town or sevenfold increase in railroad revenue (Palmer, 1908; Austin, 1928).

How significant was the impact of beet sugar plant openings relative to the size of local economies? The construction and equipment costs for a typical beet sugar factory ranged from 0.5-1 million dollars in 1900 (US Department of Agriculture, 1902a, pp. 26-29), equivalent to 18-36 million dollars in 2022.[5] According to Michigan Bureau of Labor and Industrial Statistics (1902, p. 442), 16 beet sugar factories in Michigan employed a total of 3,954 workers in 1905, suggesting an average of 247 workers per factory. This aligns with earlier observations indicating that beet sugar factories typically employed between 200 to 400 workers (Grant, 1867, p. 76). Table 1 shows that the average number of manufacturing workers in the sample counties in 1900 was 3,297, with an average population of 40,000. Therefore, the entry of a beet sugar plant could account for a 7 percent increase in manufacturing employment before taking into account the spillovers. Although an increase of 200 manufacturing workers in a county may not seem substantial at first glance, the long-term effects of these plant openings on population and manufacturing employment could be significant in predominantly rural areas with

[5] https://www.measuringworth.com/dollarvaluetoday

low initial industrialization.

I provide two suggestive evidence related to this point in the Appendix. First, in Figure A.10, I examine the impact on the share of urban population. The findings suggest that population growth was concentrated in less populated areas, which were more likely to accommodate population increases. Second, Table A.1 reestimates the main results from Table 2 by splitting the sample into Western and Eastern states.[6] The Western states were relatively unsettled, with sparser populations. The increases in population and manufacturing employment are more pronounced in the Western states, likely because moving to less populated areas was less costly, either due to higher housing supply elasticity or greater labor mobility. To further assess the plausibility of the estimated effect, I also employ a simple spatial equilibrium model, as detailed in Section 7.

Robustness. I test the robustness of the main results in several ways. Table C.1 excludes counties that had beet sugar factories in 2000 to determine whether the effect is driven by the historical presence of the factories that no longer exist. Table C.2 excludes counties in certain states where beet sugar production was possible primarily due to political favoritism (Bridgman et al., 2015). Table C.3 calculates alternative standard errors. I cluster standard errors by state instead of counties and calculate Conley standard errors under different assumptions with distance cutoffs up to 100km (60 miles), aligning with the next subsection where I assess potential bias due to spatial spillover. Table C.4 includes controls for the first year a county was mentioned in the *Gazette*, interacting this with time fixed effects.[7] This approach accounts for the possibility that counties attempting to develop the beet sugar sector earlier might systematically differ from those that did so later, particularly in their predisposition to take risks, allowing them to follow distinct time trends. Figure C.1 reestimates the results from Figure 4 based on recent advances in differences-in-differences estimator (De Chaisemartin and d'Haultfoeuille, 2020), although heterogeneity in treatment effects is less of a concern in this study due to the use of a common adoption timing differences-in-differences approach. Figure C.2 examines different types of log transformations for manufacturing employment.

[6] Western states include Kansas, Nebraska, North Dakota, South Dakota, Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming, California, Oregon, and Washington. Eastern states include New York, Pennsylvania, Illinois, Indiana, Michigan, Ohio, Wisconsin, Iowa, Minnesota, Virginia, Texas, and Kentucky.

[7] To address the issue of some fixed effects being omitted due to the small number of new counties appearing in certain years, I group every two years into one period (e.g., 1899-1900, 1901-1902, etc.).

4.2 Spatial spillover

Equation (1) does not explicitly account for spatial spillovers between counties, which could potentially bias the main results, especially given the geographic proximity of treated and control counties. If positive spillovers occur, where benefits from the treated counties extend to nearby control counties, the true effects of the treatment might be underestimated. Conversely, negative spillovers, where treated counties draw resources away from neighboring control counties, could lead to an overestimation of the treatment effects. This would be particularly concerning if, for example, downstream manufacturing plants that would have otherwise located in control counties are instead attracted to treated counties due to the presence of a beet sugar processing plant.

To account for potential spatial spillovers, I introduce five additional indicator variables for the control group based on their proximity to the nearest treated county. These variables categorize counties into distance groups: less than 20 miles, 20-30 miles, 30-40 miles, 40-50 miles, and 50-60 miles from the nearest treated county. The median distance to the county centroid of the treated counties is 60 miles. The main equation is then reestimated to account for spatial effects by including interaction terms between the additional indicators for proximate control counties with time fixed effects equal one for the years after 1900. The control counties in this new specification are those located 60 miles outside the treated counties.

The results, presented in Figure 5, shows how different outcomes—log population, log manufacturing employment, manufacturing wage per worker, and log manufacturing value added—vary with distance from treated counties. If there were any negative spillovers, the results would show that control counties near treated counties experienced population loss, with the negative effect decreases as the distance to the treated counties increases. While there is a slight indication of this pattern between 20 and 40 miles, the coefficients are not statistically significant, and no such pattern is observed for manufacturing outcomes. The population increase can likely be attributed to migration, but probably from areas beyond the control counties. For manufacturing wages, the evidence suggests that any spillovers are more likely positive, contributing to economic benefits in neighboring regions rather than detracting from them. Given these results, concerns about negative spillovers, where resources might be drawn away from control counties, do not appear to be significant in this context.

5. Mechanisms: Agglomeration or amenities?

This section further investigates the mechanisms behind the main findings. Previous research suggests that local economic development can result from public goods provision (Ehrlich and Seidel, 2018), improvements in amenities (Diamond, 2016), or localized agglomeration spillovers (Greenstone et al., 2010; Kline and Moretti, 2014). To explore these different channels, I examine several outcome variables from the year 2000 and run cross-county regressions.

The cross-county specification is analogous to Equation (1). It regresses outcome variables on the treatment variable and state fixed effects without controlling for county fixed effects. To examine the agglomeration spillovers through input-output linkage, I investigate the presence of upstream and downstream industries in the treated counties in 2000 and in 1880. Using County Business Patterns data from 2000, I identify upstream and downstream industries using NAICS codes at the three- or six-digit level. Industry data for 1880 is taken from Hornbeck and Rotemberg (2019).

I identify find upstream and downstream industries based on historical accounts on the beet sugar industry. The sugar beet factory uses limestone to extract juice from sugar beets. Byproducts such as beet tops and pulp were used for producing animal feed (Townsend, 1921, p.49). The lime sludge leftover from the extraction process was used for producing fertilizer, and the beet sugar factory often required rubber belting (Harris, 1919, p. 183).

Figure 6 presents the effects on long-term agglomeration. Panel (a) displays the effects on related industries, showing significant positive impacts in various industries by 2000 but not in 1880. Specifically, the probability of having establishments in the Food (NAICS 311), Other Animal Food (NAICS 311119), Lime & Cement (NAICS 327), Nonmetallic Mineral (NAICS 327), Cut Stone & Stone Product (NAICS 327991), Rubber & Elastic Goods (NAICS 326), Plastics & Rubber (NAICS 326), Other Plastics Product (NAICS 326199), and Chemical Manufacturing (NAICS 325) industries increased significantly. Additionally, fertilizer-related industries (NAICS 325314) also showed notable positive impacts. These results contrast with the 1880 data, where no significant differences were observed. This result provides additional evidence that the result is not driven by pre-existing location fundamentals.

When examining local amenities and public goods provision, I also rely on the County Business Patterns to identify local amenities such as merchandise stores, hospitals, residential care facilities, museums, and drinking establishments. Data on Social

Security recipients, crime rates, and the share of college graduates in 2000 are sourced from Haines (2005). Panel (b) shows that there are no notable differences in local amenities or public goods. These results suggest that the observed economic development is likely driven by spillovers from the sugar beet factories rather than improvements in amenities or local public goods provision.

6. Input-output linkage

6.1 Effects on industries closely linked to the the confectionery industry

This section further investigates how upstream and downstream industries related to beet sugar processing responded to these plant openings, using individual-level census data from 1870 to 1940 (Ruggles et al., 2021). To explore this, I construct a county-level variable for manufacturing employment, weighted by input-output linkages based on an input-output table by Leontief (1936). The upstreamness and downstreamness of each manufacturing industry is computed from the coefficients of the Leontief inverse matrix in the input-output table (Leontief, 1986; Lane, 2021). Due to data limitations, this analysis can only calculate input-output linkages at the three-digit industry level with respect to the confectionery industry. However, the Leontief matrix allows for a more systematic investigation of the role of these input-output linkages.

The procedure for calculating the Leontief inverse matrix is as follows. I use an input-output table based on the U.S. manufacturing census of 1919, developed by Leontief (1936), and map it to the industries in the individual census data. Industry crosswalk is presented in Appendix B. Suppose the input-output matrix $(a_{mn}) \in \mathbb{R}^{M \times M}$ represents the sales amount from industry m to n, where M is the number of manufacturing industries. From this matrix, I construct the technical coefficient matrix $\mathbf{A} = \left(\frac{a_{mn}}{\sum_{m=1}^{M} a_{mn}}\right) \in \mathbb{R}^{M \times M}$ and compute the Leontief inverse matrix $(\mathbf{I} - \mathbf{A})^{-1} := (l_{mn}) \in \mathbb{R}^{M \times M}$. Each element of the Leontief inverse matrix (l_{mn}) captures the percentage increase in industry n production in response to a one percent rise in industry m output, considering both direct and indirect impacts (Leontief, 1986; Lane, 2021). The Leontief inverse matrix represents the total economic impact of demand changes $(\mathbf{A} + \mathbf{A}^2 + \mathbf{A}^3 + \cdots = (\mathbf{I} - \mathbf{A})^{-1})$, including direct $(\mathbf{A})$ and indirect $(\mathbf{A}^2, \mathbf{A}^3, \cdots)$ effects across all sectors.

Based on the Leontief inverse matrix, I calculate the county manufacturing employment weighted by downstreamness: $\sum_{n \neq B} s_{nct} l_{Bn}$, where B represents the confectionery industry, s_{nct} denotes the number of individuals in downstream industry n in county c at year t, and l_{Bn} represents the coefficients in the Leontief inverse matrix that captures downstreamness. Similarly, I compute $\sum_{m \neq B} s_{mct} l_{mB}$ to measure upstreamness-weighted employment. The confectionary industry are excluded from these measures to avoid the mechanical increase from the beet sugar industry. The Leontief inverse matrix shows that the confectionery industry has the strongest downstream impact on the "not specified food industries" sector and the weakest downstream impact on "miscellaneous nonmetallic mineral and stone products." In terms of upstreamness, the "miscellaneous nonmetallic mineral and stone products" industry is the most affected, while the "motor vehicles and motor vehicle equipment" industry is the least affected. The tables displaying the upstream and downstream weights can be found in Appendix B.

Figure 7 shows the results. The outcome variables are log transformed. The treated counties experienced a significant increase in downstream industries, with a 0.9 log point rise in 1940. In contrast, the effect on upstream industries is somewhat less pronounced. To further explore which specific industries saw employment growth in response to the beet sugar plant openings, I investigate an industry-by-industry analysis in the next section.

6.2 Effects on industries distant from the confectionery industry

The opening of beet sugar plants led to increased industrial activities in sectors closely related to the confectionery industry. Another question is whether this agglomeration can stimulate broader industrial growth, extending beyond sectors within the same agricultural production chain through agglomeration economies. I explore whether local manufacturing growth is concentrated in directly affected industries or if a wider array of industries benefits from these agglomeration effects.

To investigate this question, I plot the estimated coefficients based on their distance from the most directly affected industry, as shown in Figure 8. The vertical axis shows the estimated employment growth in each industry based on the regression results from Equation (1), where the outcome variable is the log of manufacturing employment in each industry. The horizontal axis is arranged from left to right according to the sum of the upstreamness and downstreamness coefficients. Figures that are ordered separately by upstreamness and downstreamness are presented in Figure A.6.

Industries closely related to the confectionery sector, positioned on the left side of the chart, tend to exhibit stronger growth, as indicated by the coefficients. These industries, directly connected to the beet sugar production chain, show significant employment growth. Clear examples of downstream industries to the sugar industry, such as food, bakery, canned fruit, dairy, beverage, and grain-mill products, show significant employment growth.

On the other hand, industries that are farther from the confectionery industry, such as tobacco, printing, and motor vehicles, are located on the right side of the plot but still display positive coefficients with confidence intervals above zero.

To more formally test the relationship between industry linkage and employment growth, I regress the estimated employment growth in each industry on the industry linkage coefficients in Table B.2 and Table B.3. The results are presented in Table 3, with the corresponding scatter plot in Figure A.8 and Figure A.9.

Column (1) presents a regression of employment growth on input linkages. Columns (2) and (3) examine the relationship with output linkages and the sum of input and output linkages, respectively. The results show a weak correlation between industry linkages and employment growth. Columns (4) to (6) exclude the confectionery industry, which is an obvious outlier due to its inherent connection to itself. The results still suggest a modest correlation between industry linkage and the scale of employment growth across sectors. I also run a regression on the rank of input-output linkage coefficients in Table A.2 to account for the skewed distribution of these coefficients.

These findings remain consistent in a relatively shorter run when the treatment period is narrowed from 1910-1940 to 1910-1920 by running the same analysis after omitting observations after 1920 (see Figure A.7 and Table A.3).

While closely linked industries saw significant growth, a broader range of manufacturing sectors also gained, indicating that the economic impact of beet sugar factories was more widespread than expected based solely on direct industry linkages.

This finding aligns with observations that beet sugar plants fostered broad-based local growth, 'doubling and quadrupling the value of contiguous farmlands and town lots, and building up flourishing towns where merchants, bankers, real estate agents, and others were universally prosperous' (Palmer, 1908), and attracting new gardens, fields, dairies, poultry yards, orchards, and feed yards (Wiley, 1898). A recent study on the effects of county seats on city outcomes shows that having a county seat stimulates growth beyond the public sector, increasing employment in private industries such as manufacturing, mining, services, and retail (Smith and Kulka, 2023).

7. Unpacking the effect size

The estimated effects on population and manufacturing employment are quite large (36 percent increase in population and threefold increase in manufacturing jobs). To interpret these effects, I use a simple spatial equilibrium model (Moretti, 2011) to disentangle the impact of local productivity growth (shift in local labor demand) and the role of housing supply elasticity (slope of local labor supply).

Production County $c = a, b$ at time $t = 1, 2$ produce manufacturing products traded in the national market. Beet sugar factory is opened in county b at time $t = 2$. The counties have the following production function

$$Y_{ct} = G_{ct} L_{ct}^{\alpha} K_{ct}^{\beta} F_c^{1-\alpha-\beta} \tag{2}$$

where Y_{ct}, L_{ct}, and K_{ct} denotes manufacturing value-added, labor, and capital. F_c indicates exogenous county-level fixed factors that allow the labor demand to shift downward. It is also assumed that $\alpha, \beta, (1 - \alpha - \beta) \in (0, 1)$.

G_{ct} represents the county total productivity that evolves as follows:

$$\ln(G_{c2}) = \ln(G_{c1}) + \lambda B_{c2} + \mu_{c2} \tag{3}$$

where B_{c2} denotes an indicator variable for the presence of a beet sugar factory in a given county c. The beet sugar factories start operations in county b at the start of time $t = 2$, and not in county a. λ denotes the effect of a beet sugar plant opening on local productivity through agglomeration.

μ_{c2} is an unobserved shock. By the identifying assumption in the reduced-form evidence presented in the previous sections, the term μ_{c2} is uncorrelated with the beet sugar factory openings. Capital is perfectly mobile, and the capital price, R_t, is equalized across counties. The inverse labor demand in county c is then

$$\ln(w_{ct}) = \frac{1}{1-\beta} \ln(G_{ct}) - \frac{1-\alpha-\beta}{1-\beta} \ln(L_{ct}) + \ln\left(\frac{\alpha}{1-\beta} \left(F_c^{\frac{1-\alpha-\beta}{\beta}} \frac{\beta}{R_t} \right)^{\frac{\beta}{1-\beta}} \right) \tag{4}$$

where w_{ct} indicates wage.

Preferences Labor supply and housing demand are given by individuals i who choose their residential location c to maximize the indirect utility function,

$$V_{ict} = \frac{w_{ct} M_{ct}}{p_{ct}^{\sigma}} u_{ict} \tag{5}$$

where M_{ct} and p_{ct} denote local amenities and housing price. σ indicates the share of land in the household budget. u_{ict} is an idiosyncratic taste by agent i for location c at time t that is drawn independently from a Fréchet distribution $F(u_{1t}, \cdots, u_{Ct}) = \exp(-\sum_{c=1}^{C} u_{ict}^{-\rho})$ where ρ is a parameter that governs the degree of labor mobility.

Housing and labor supply The inverse housing supply is of the form

$$p_{ct} = \xi L_{ct}^{\theta} \tag{6}$$

By the standard property of the extreme value distribution, the difference in inverse labor supply of county a and b is given by

$$\ln(w_{bt}) - \ln(w_{at}) = \left(\frac{1}{\rho} + \sigma\theta\right) (\ln(L_{bt}) - \ln(L_{at})) \tag{7}$$

Equilibrium and comparative statics The sugar beet factory opening in county b at the beginning of time $t = 2$ increases the county-level productivity by λ. Under the assumption that county a is identical to county b in period $t = 1$, the differences in the growth of equilibrium employment between the two counties from $t = 1$ to $t = 2$ can be expressed as

$$\mathbb{E}[\{\ln(L_{b2}) - \ln(L_{b1})\} - \{\ln(L_{a2}) - \ln(L_{a1})\} | B_{c2}] = \frac{\lambda}{(1-\beta)(\frac{1}{\rho} + \sigma\theta) + (1 - \alpha - \beta)} \tag{8}$$

The above equation demonstrates that the differences-in-difference estimator of opening beet sugar plants on manufacturing employment can be broken down into labor mobility (ρ), housing supply elasticity ($\frac{1}{\theta}$), capital share of output (β), long-run labor demand elasticity ($-\frac{1-\beta}{1-\alpha-\beta}$), share of land in the household budget (σ), and localized productivity gains (λ) resulting from the opening of beet sugar factories.

Calibration The spatial equilibrium model will be calibrated by first determining the county-level productivity increase, λ, and then backing the housing supply elasticity. I derive county-level productivity growth (λ) by substituting the equilibrium employment change into the labor supply curve given in Equation 7. This yields:

$$\lambda = \gamma_w(1-\beta) + \gamma_l(1-\alpha-\beta) \tag{9}$$

where γ_w and γ_l represent the estimated effects of plant openings on manufacturing employment and wages, respectively.

To calibrate the local productivity growth, I adopt the capital share ($\beta = 0.3$) and long-run labor demand elasticity ($-\frac{1-\beta}{1-\alpha-\beta} = -1.5$, $\alpha \approx 0.23$) from Kline and Moretti (2014). Using the empirical estimates from Table 2, this yields the county level productivity growth of 0.72 over one hundred years, which in turn suggests that the ten year productivity growth is about 7 percent on average. Greenstone et al. (2010) document 12 percent productivity growth five years after the plant opens. Abebe et al. (2022) estimates that three years after foreign corporations constructed a plant in Ethiopia, domestic enterprises increased employment and productivity by 11 percent. Kline and Moretti (2014) finds that the Tennessee Valley Authority raised county productivity by 9 percent. The local productivity growth is in line with existing studies.

To evaluate the role of labor supply, which is influenced by housing supply elasticity and labor mobility, I assume that the share of household expenditure on housing (σ) is 0.32, based on the findings of Albouy (2008) and Shapiro (2006). I make several assumptions regarding the labor mobility parameter. First, I consider a case where labor is perfectly mobile ($\rho = \infty$) following Blanchard and Katz (1992). Under this assumption, the housing supply elasticity is 1.15. When labor is slightly less mobile ($\rho = 1/0.15 = 6.66$), the housing supply elasticity increases to 2.5. When labor mobility decreases further ($\rho = \frac{1}{0.35} = 2.85$), as in Hornbeck and Moretti (2018) and Hsieh and Moretti (2019), the housing supply parameter takes a negative value, implying an infinite housing supply elasticity.

For context, the average housing supply elasticity observed in U.S. metropolitan areas between 1970 and 2000 was 1.54. In high-tech clusters like San Francisco and New York, lower elasticities of 0.6-0.8 have been observed (Saiz, 2010). The results in this paper can be explained by either highly mobile labor or higher housing supply elasticity.

8. Conclusion

This paper provides new evidence of path dependence in economic geography, using a unique dataset compiled by industry experts on suitable plant locations. This study compares counties that successfully established sugar beet factories with those where factories were proposed but not built. The findings reveal that the establishment of sugar beet plants had substantial and enduring impacts on industrialization. Downstream industries responded more strongly than upstream industries, but from a broader perspective, a wide range of industries—beyond direct input or output linkages—also benefited from the entry of beet sugar plants. More research is needed to understand what shapes the patterns of agglomeration spillovers beyond input-output linkages.

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Table 1: Balance test

Variables	(1) Mean	(2) (log) difference (raw)	(3) (log) difference (+state FE)	(4) Adjusted p-value (raw)	(5) Adjusted p-value (+state FE)
(log) total population, 1900	39402.28	-0.06 (0.17)	0.13 (0.14)	0.99	0.99
share urban population (pop≥2,500)	0.28	-0.07(0.03)**	-0.04(0.04)	0.45	0.44
share urban population (pop≥25,000)	0.08	-0.03(0.03)	-0.03(0.03)	0.91	0.88
(log) farms, 1900	2211.9	0.11 (0.14)	0.33 (0.10)***	0.94	0.24
(log) farmland acres, 1900	349.56	0.04 (0.11)	0.31 (0.11)***	0.99	0.99
(log) crop revenue per farm acre, 1900 ($)	2.29	0.04 (0.05)	0.06 (0.04)	0.91	0.38
(log) farm value per farm acre, 1900 ($)	31.12	0.09 (0.11)	0.15 (0.08)*	0.91	0.25
(log) farm equipment per farm acre, 1900 ($)	1.3	0.05 (0.05)	0.06 (0.03) **	0.91	0.08
irrigated acre per farm acre, 1900	0.05	0.07 (0.03)***	0.04 (0.01)***	0.08	0.06
(log) mfg. workers, 1900	3297.8	-0.26 (0.29)	-0.07 (0.23)	0.91	0.99
(log) mfg. establishments, 1900	317.84	0.01 (0.20)	0.24 (0.16)	0.99	0.86
mfg. wage per worker ($000), 1900	0.45	-0.02 (0.01)	-0.04 (0.02)**	0.87	0.29
(log) mfg. value added ($000), 1900	3917.22	-0.22 (0.29)	-0.04 (0.26)	0.94	0.99
share literate farmers, 1900	0.94	0.01 (0.01)	0.01 (0.01)	0.91	0.81
distance to agricultural experiment stations (km)	1611.39	-53.85 (26.03)**	-24.33 (21.99)	0.38	0.30
beet sugar purity (percent)	76.28	2.18 (0.73)***	1.09 (0.59)*	0.08	0.10
sugar in beet (percent)	12.31	1.04 (0.35)***	0.6 (0.37)	0.08	0.17
average beet weight (grams)	725.45	29.14 (42.68)	42.23 (45.03)	0.95	0.88
USDA experiment (0/1)	0.76	0.09 (0.06)*	0.1 (0.05)*	0.65	0.25
beet belt (0/1)	0.4	-0.01 (0.07)	-0.06 (0.07)	0.99	0.99
sugarbeet suitability (ton/ha)	9.09	0.34 (0.24)	0.32 (0.23)	0.81	0.29

Notes: Unit of analysis is county (56 treated counties and 263 control counties). Column (1) reports the mean of county characteristics. Columns (2) and (3) document the unconditional (log) differences and the within-state (log) differences. Columns (4) and (5) document the stepdown p-values (Romano and Wolf, 2005) adjusted for multiple hypothesis testing of 21 coefficients on the treatment indicator without (Column (4)) and with (Column (5)) state fixed effects. All reported mean values are in their raw form. All differences represent the raw differences in means unless specified as logged variables. The sources of each variable are explained in Section 3.1 and Section 3.3. *** p<0.01, ** p<0.05, * p<0.1

Table 2: Main results

DV:	log population		log mfg. emp.		mfg. wage per worker		log mfg. value added	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
beet×after 1900	0.45***	0.31***	1.00***	1.10***	0.11***	0.14***	1.54***	1.87***
	(0.17)	(0.12)	(0.21)	(0.19)	(0.04)	(0.04)	(0.33)	(0.35)
Counties	319	319	319	319	319	319	319	319
Observations	4,466	4,466	4,147	4,147	4,147	4,147	4,147	4,147
R-squared	0.81	0.90	0.74	0.80	0.69	0.76	0.57	0.65
County FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y		Y		Y		Y	
State-Year FE		Y		Y		Y		Y

Notes: Regression results from Equation (1). Panel A runs the regression on the entire sample and Panel B and Panel C splits the sample states into Western and Eastern states. The variable beet × after 1900 is an indicator equal to one for treated counties after the year 1900. Error terms are clustered by county. Mean dependent variables are shown in Table 1. *** p<0.01, ** p<0.05, * p<0.1

Table 3: Industry linkage and employment growth

	(1)	(2)	(3)	(4)	(5)	(6)
DV:	Estimated impact on industry employment growth, 1910-40					
upstream	0.011			-0.659		
	(0.034)			(0.560)		
downstream		0.049			2.956	
		(0.043)			(1.851)	
upstream+ downstream			0.015			1.325
			(0.016)			(1.206)
Excluding confectionery industry				Y	Y	Y
Observations	32	32	32	31	31	31
R-squared	0.000	0.003	0.001	0.006	0.113	0.039

Notes: The unit of analysis is an industry, as described in Appendix B. The outcome variable is the estimated coefficient from Figure 8, representing the employment growth in each manufacturing industry in response to the opening of beet sugar plants. The independent variables are the upstreamness or downstreamness coefficients relative to the confectionery industry. Columns (4) to (6) excludes the confectionery industry from the sample. Robust standard errors in parentheses.*** $p<0.01$, ** $p<0.05$, * $p<0.1$

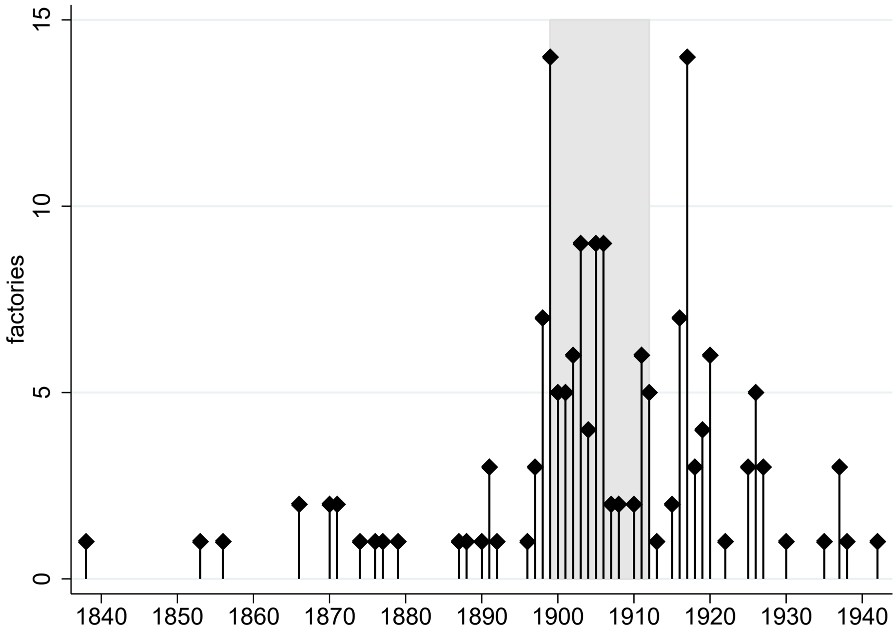


Figure 1: Number of newly established sugar beet factories

Source: The figure illustrates the number of newly established beet sugar factories by year. Data is taken from War Food Administration (1946). The period between 1899 and 1912 is marked in gray.

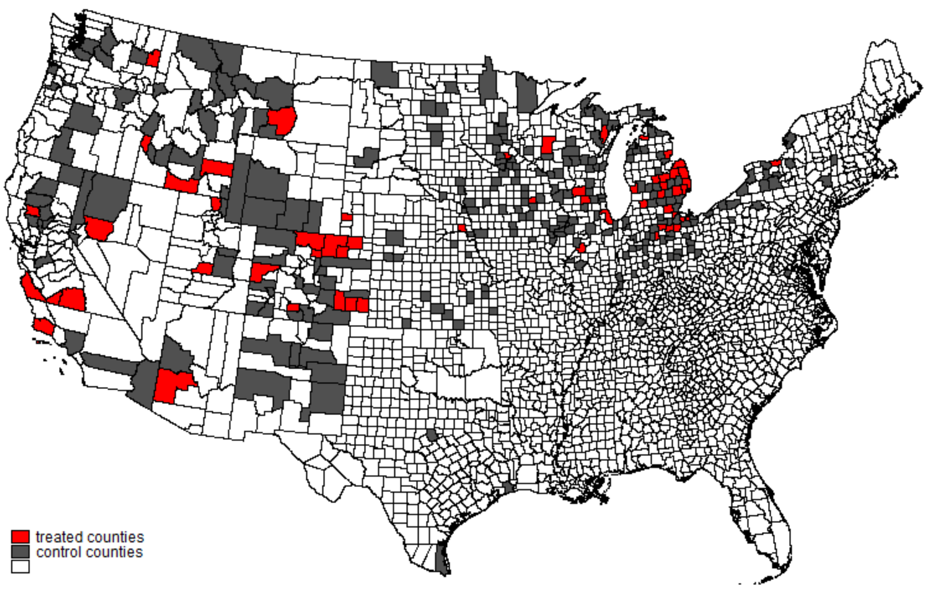
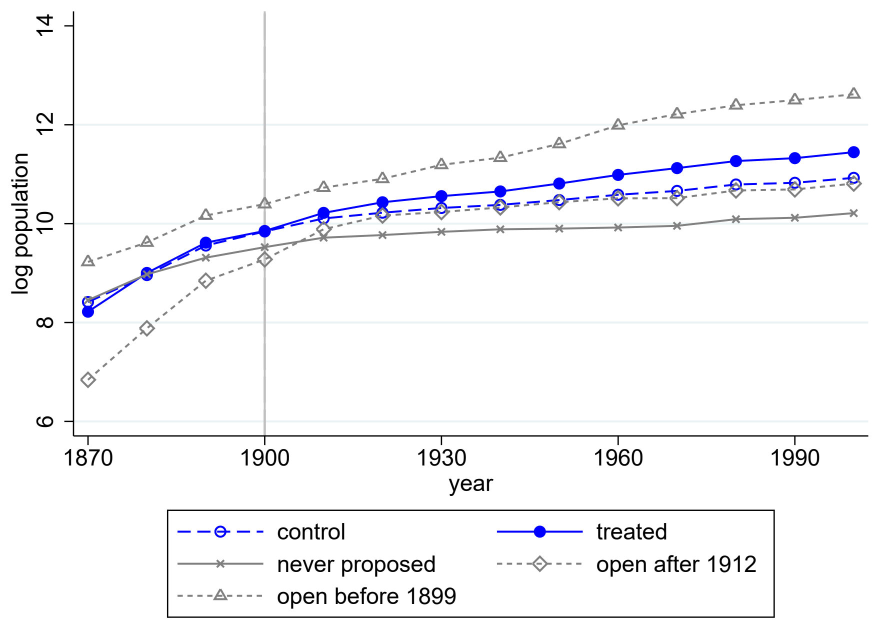


Figure 2: Treated and control counties for sugar beet plant openings

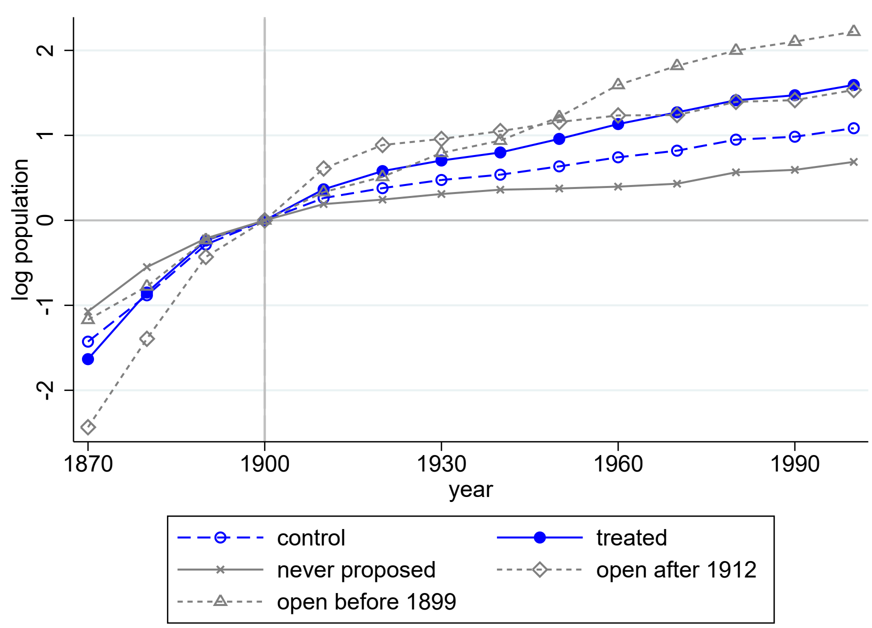
Source: Red counties indicate where sugar beet factories were opened between 1899 and 1912, while grey counties are where sugar beet factories were proposed to be constructed between 1899 and 1912 but ended up with no sugar beet factories. The data was constructed by consulting War Food Administration (1946) and the *Sugar Beet Gazette*.

Figure 3: Graphical analysis of the research design

(a) log population (level)



(b) log population (relative to 1900)



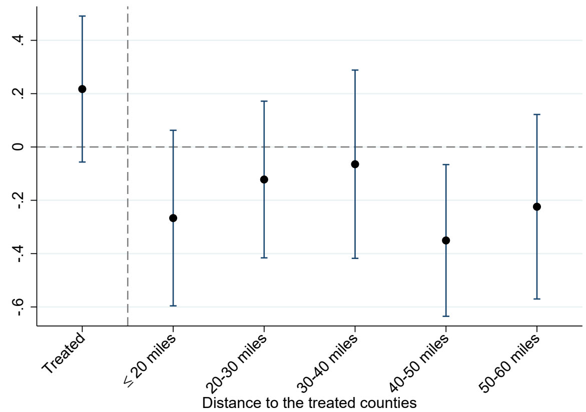
Note: Average log population of counties. Counties not mentioned in the *Gazette* (marked by X) are categorized as "never proposed." Counties that established sugar beet factories before 1899 are denoted by hollow triangles, while those that received beet sugar factories after 1912 are represented by hollow diamonds.

Figure 4: Main results: flexible estimates

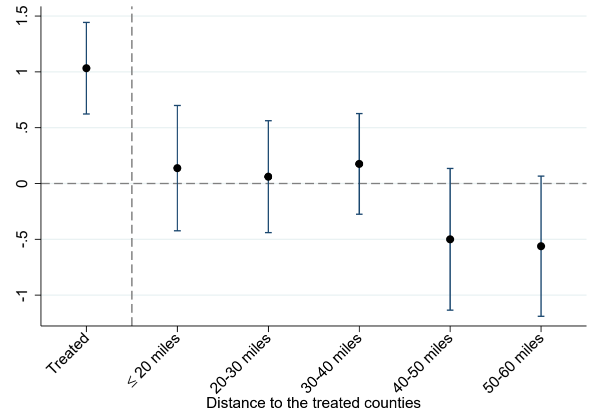
Note: Regression results from Equation (1), with the outcome variables are shown in each panel name. All regressions control for county fixed effects and state by year fixed effects. All results are based on a balanced panel of 319 treated and control counties. The dashed lines in Figures (b) indicate 95 percent confidence intervals, based on robust standard errors clustered by county.

Figure 5: Spatial spillover

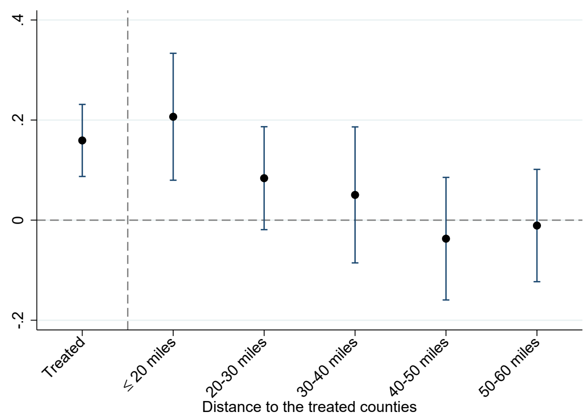
(a) log population



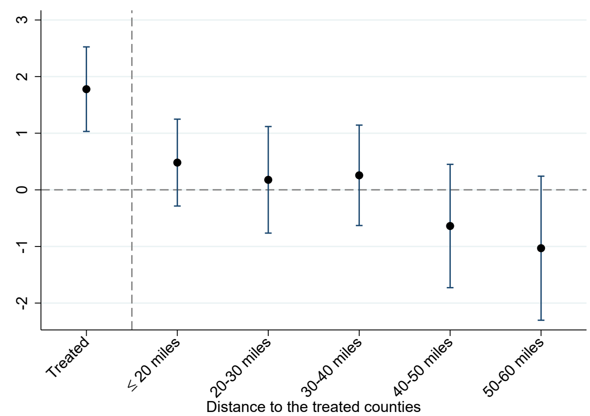
(b) log mfg. employment



(c) mfg. wage per worker



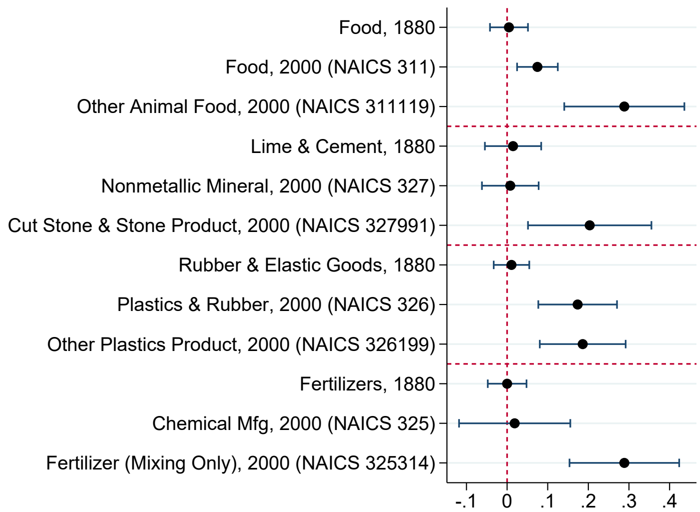
(d) log mfg. value added



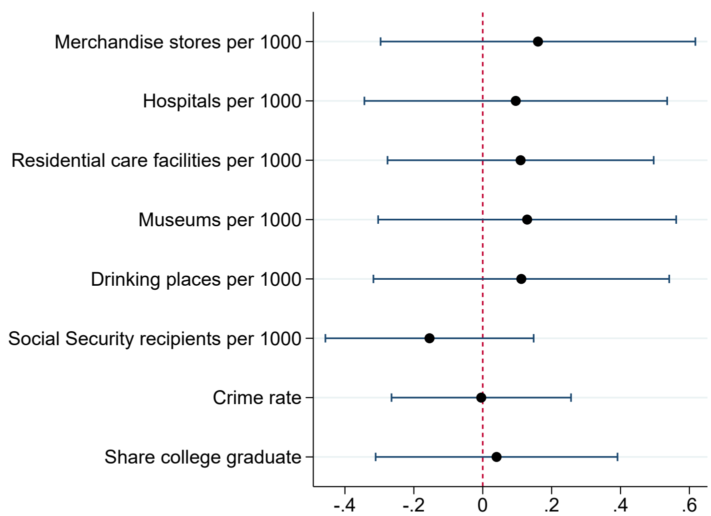
Note: The panel names represent the outcome variables. The regressions include the outcome variables as dependent variables, with the treatment indicator for the factory openings and additional indicator variables based on the distance to the nearest treated county (grouped into ranges: below 20 miles, 20-30 miles, 30-40 miles, 40-50 miles, and 50-60 miles), interacted with time fixed effects (set to one for years after 1900) as the independent variables. All regressions include county and state-by-year fixed effects. Standard errors are clustered at the county level. Error bars represent 95 percent confidence intervals.

Figure 6: Effects on the long-run agglomeration and amenities

(a) Agglomeration



(b) Amenities

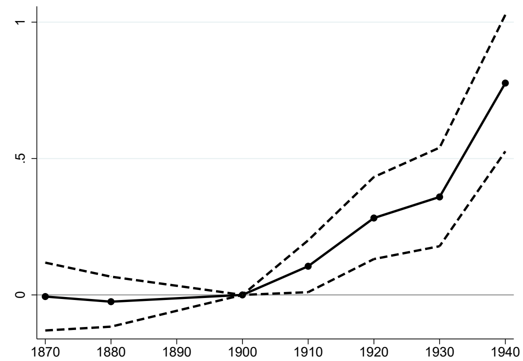


Note: Figures (a) and (b) the cross-county regression analogous to Equation (1), where the outcome variables are regressed on the treatment indicator and state fixed effects. The outcome variables in Panel (a) are indicator variables representing the presence of each industry. The outcome variables in Panel (b) are standardized, with a mean of zero and a standard deviation of one. The error bars display the 95% confidence intervals from robust standard errors.

Figure 7: Upstream and downstream industries

(a) log upstream mfg. emp.

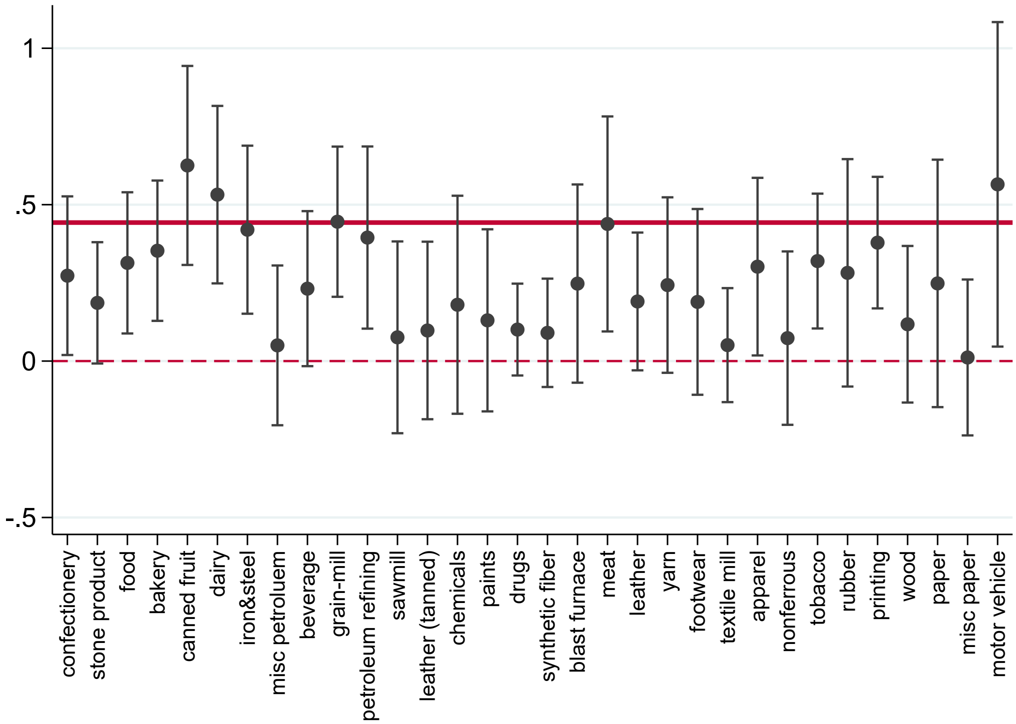
(b) log downstream mfg. emp.



Note: Regression results from Equation (1) where the outcome variables are log manufacturing employment weighted by its upstreamness and downstreamness to the confectionery industry. All regressions control for county and state by year fixed effects. All results are based on a balanced panel of 319 treated and control counties. The dashed lines indicate 95 percent confidence intervals, based on robust standard errors clustered by county.

Figure 8: Industry-specific estimates

(a) Industry-specific coefficients



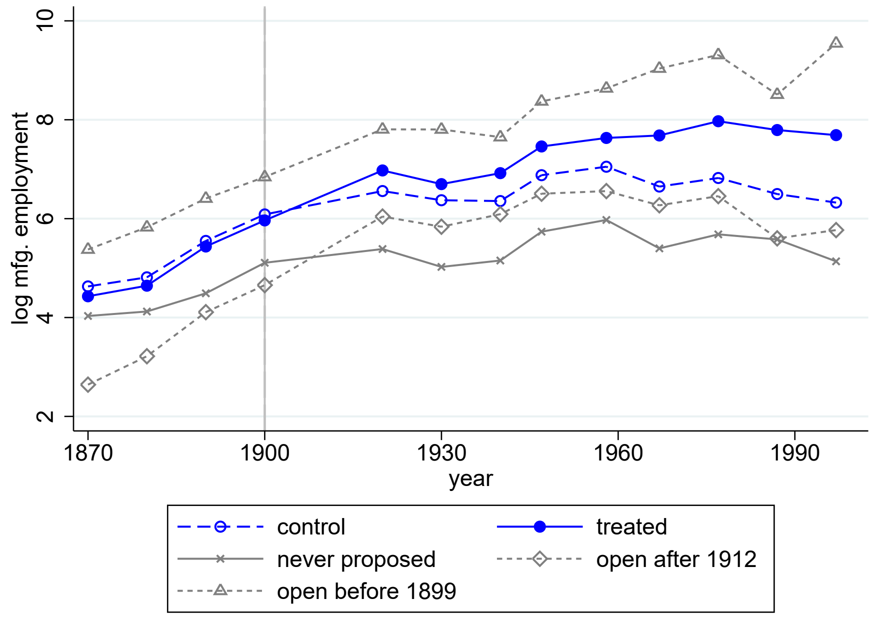
Note: Ordered from left to right by the sum of upstream and downstream coefficients, the estimated coefficients with 95 percent confidence intervals indicate the effect of beet sugar plant openings on local employment growth between 1910 and 1940. The solid red line represents the aggregate manufacturing employment growth. The full industry name, industry code, and the sum of upstream and downstream coefficients are provided in Table B.4

A. Additional results

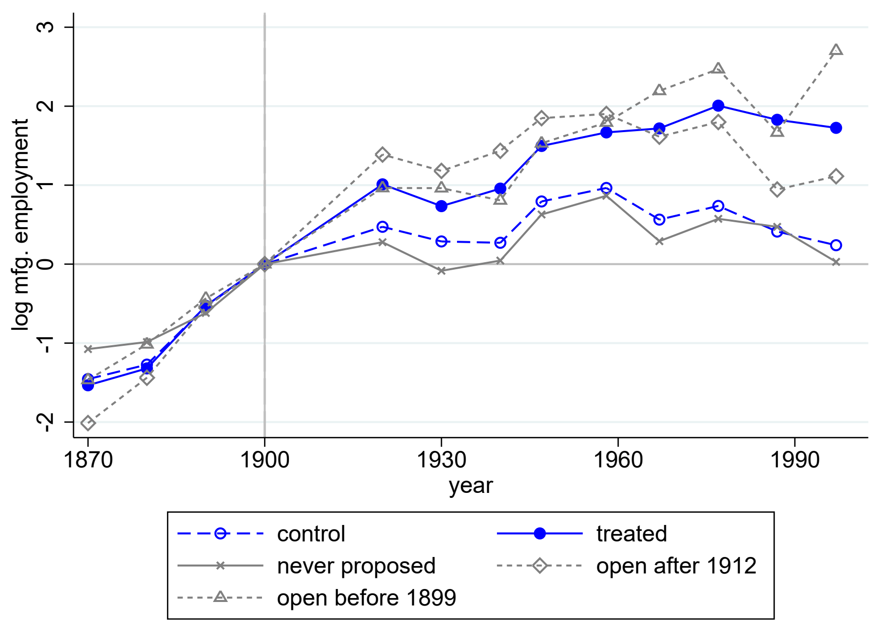
A.1 Validity of the research design

Figure A.1: Graphical analysis of the research design: manufacturing employment

(a) log mfg. employment (level)



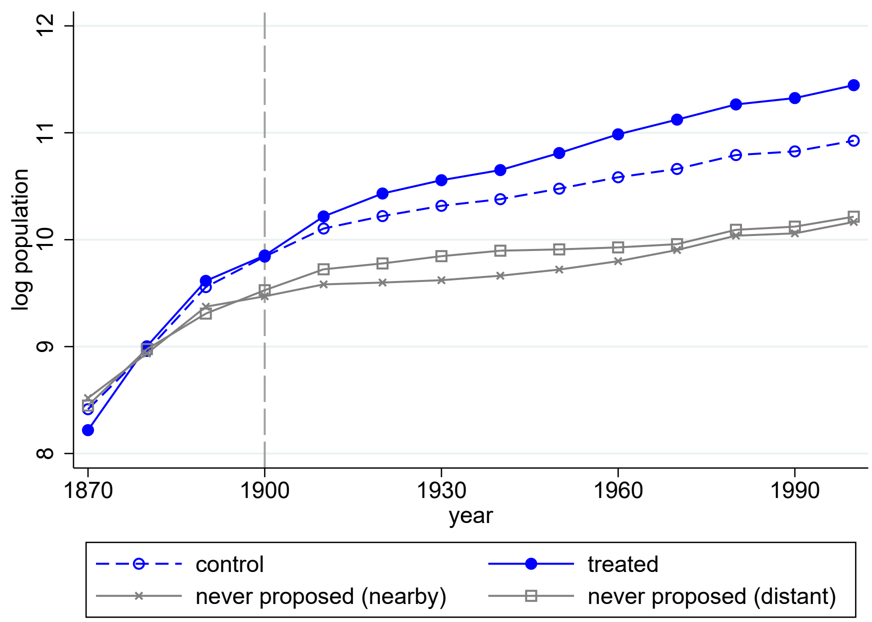
(b) log mfg. employment (relative to 1900)



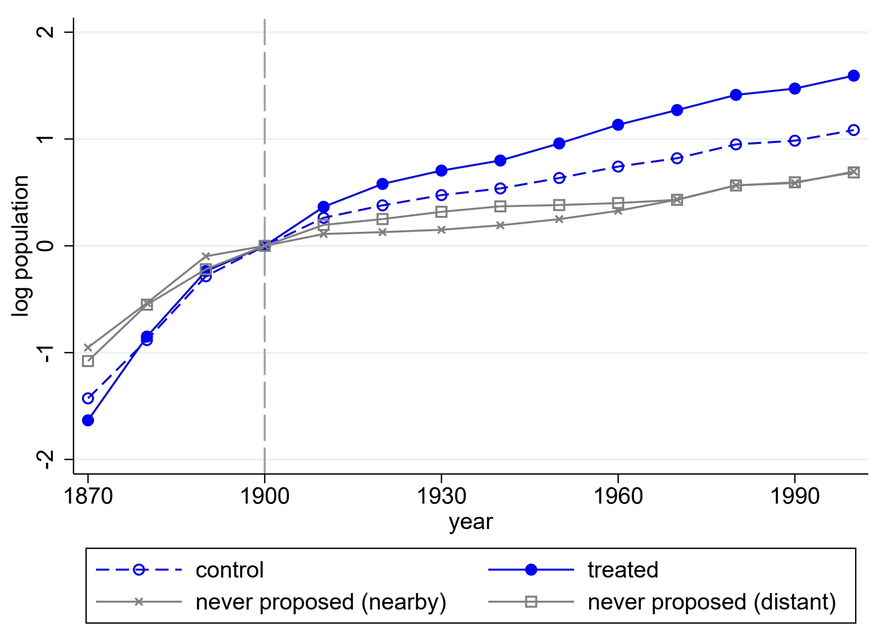
Note: Average log manufacturing employment of counties. Counties not mentioned in the *Gazette* (marked by X) are categorized as "never proposed." Counties that established sugar beet factories before 1899 are denoted by hollow triangles, while those that received beet sugar factories after 1912 are represented by hollow diamonds.

Figure A.2: Graphical analysis of the research design: Population trends by treatment status and proximity to treated counties

(a) log population (level)



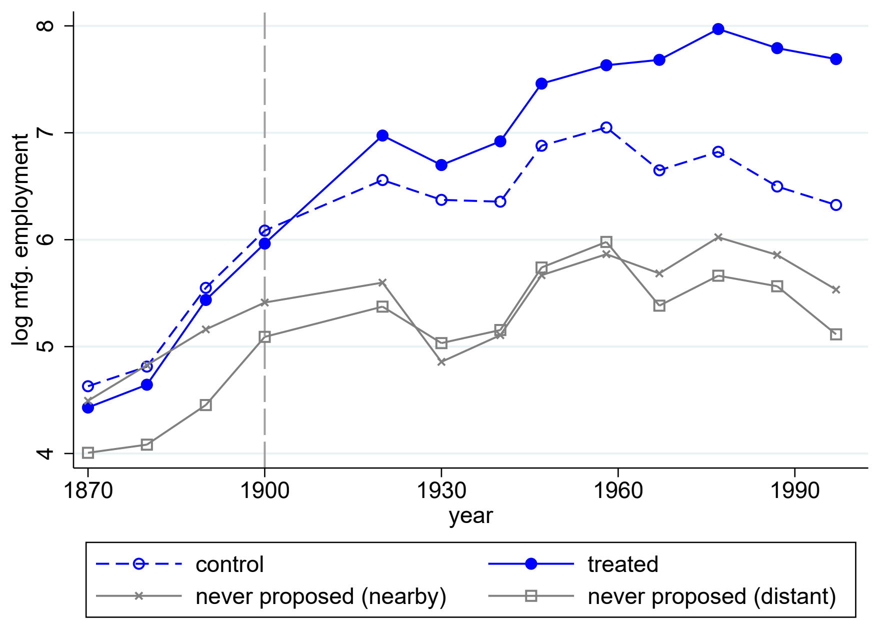
(b) log population (relative to 1900)



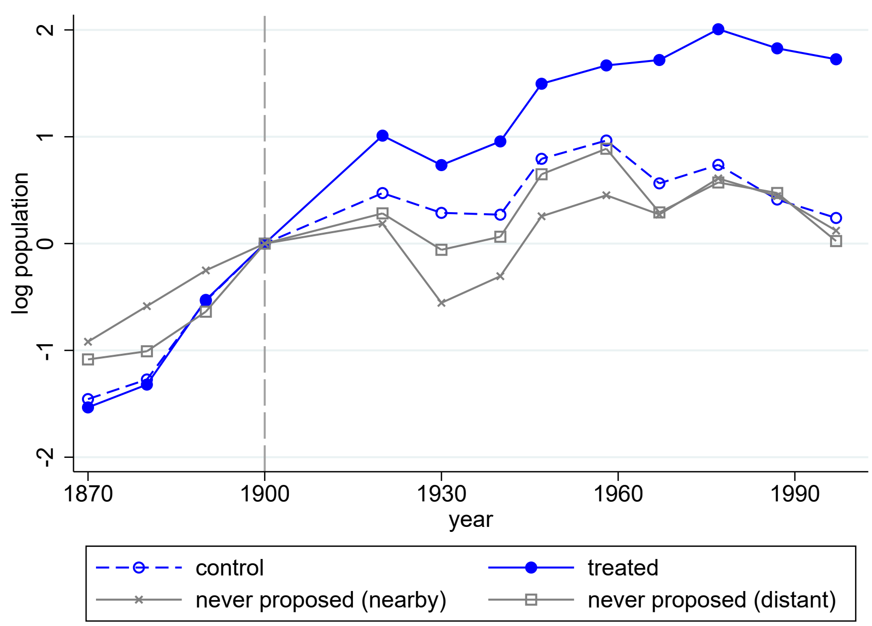
Note: Average log population of counties. Counties not mentioned in the *Gazette* are categorized as either nearby or distant based on whether their nearest distance to the treated county's centroid is less than 50 miles. Never-proposed counties within 50 miles of the treated counties are marked with X, while never-proposed counties beyond 50 miles are marked with hollow squares.

Figure A.3: Graphical analysis of the research design: Manufacturing employment trends by treatment status and proximity to treated counties

(a) log mfg. employment (level)



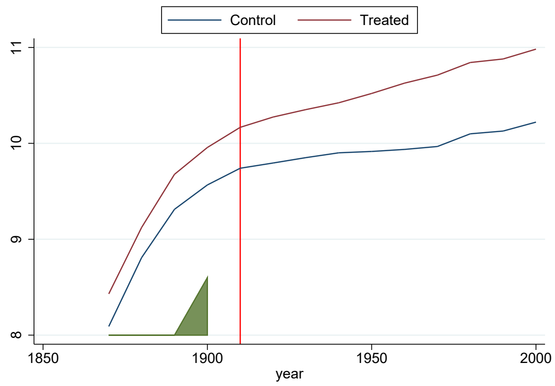
(b) log mfg. employment (relative to 1900)



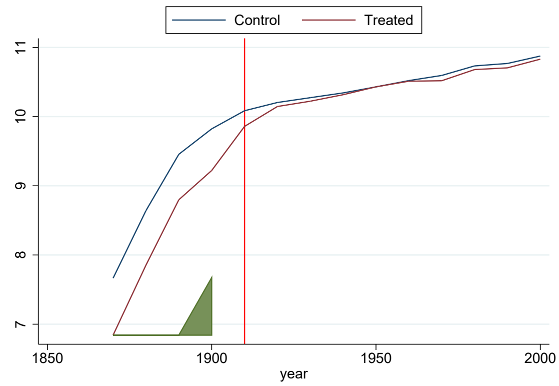
Note: Average log manufacturing employment of counties. Counties not mentioned in the *Gazette* are categorized as either nearby or distant based on whether their nearest distance to the treated county's centroid is less than 50 miles. Never-proposed counties within 50 miles of the treated counties are marked with X, while never-proposed counties beyond 50 miles are marked with hollow squares.

Figure A.4: Synthetic differences-in-difference results

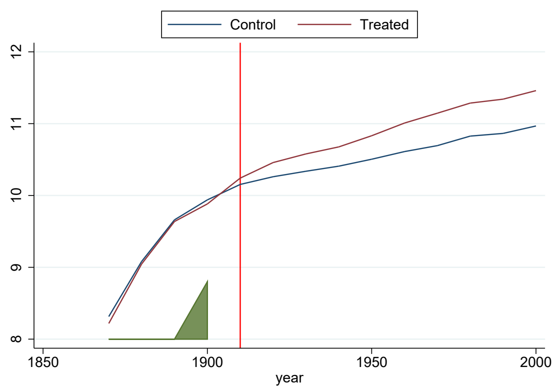
(a) Never proposed counties (Control) v. Control counties (Treated)



(b) Control counties (Control) v. Opening after 1912 (Treated)



(c) Main result

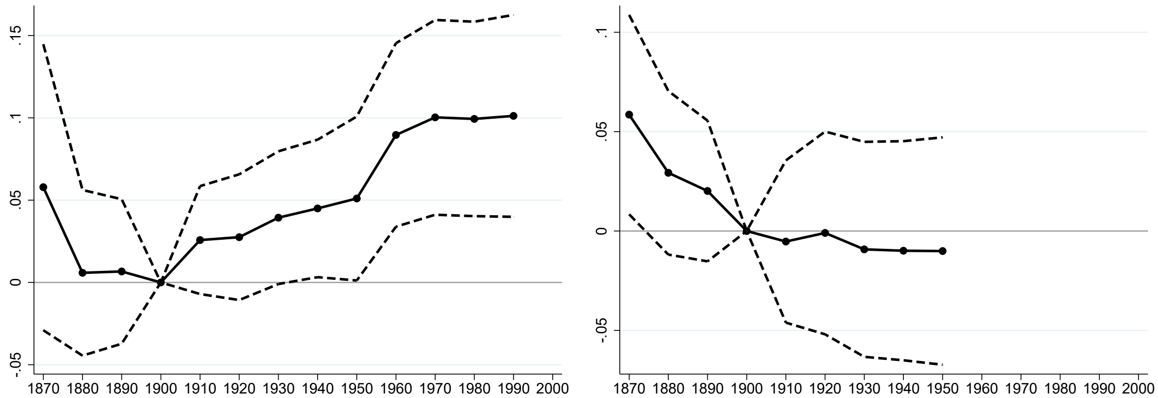


Note: Synthetic differences-in-difference estimator. The outcome variable is log population. Panel (a) compares counties mentioned in the *Gazette* but did not build sugar beet factories (control counties in the research design, labeled as *Treated* in the figure) with counties that were not mentioned in the *Gazette* (Control). Panel (b) compares these control counties (Control) with counties that opened sugar beet factories after 1912 (Treated). Panel (c) is the comparison of the control and treated counties in the research design of this study. The estimated Average treatment effect on the treated (ATT) is 0.23 (0.04)*** in panel (a), 0.54 (0.15)*** in panel (b), and 0.40(0.12)*** in panel (c). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

A.2 Impact on urban population

Table 2 documents that the opening of beet sugar plants led to significant population increases. I further divide county population into the number of people living in cities or towns with populations greater than 2,500 or 25,000 using Haines (2005). I then construct the share of the population in cities greater than 2,500 or 25,000 for each county.

Figure A.10 document the regression results from estimating Equation (1) using the share of urban population as outcome variables. The effects of plant openings on the share of the population in cities greater than 2,500 showed an increase of approximately 15 percentage points by 1990. Although the effects on cities with populations greater than 25,000 are only available until 1950, the coefficient size is much smaller compared to the effects on cities with populations greater than 2,500. This result is consistent with historical evidence indicating that sugar beet plants primarily led to population increases in less populated areas rather than in already densely populated urban cities (Austin, 1928).



(a) Share of urban population (pop>2,500) (b) Share of urban population (pop>25,000)

Figure A.5: Effects on urban population

Note: Figures (a) and (b) present the regression results from Equation (1), with the outcome variables being the share of the urban population. Panel (a) examines the share of the population in cities with more than 2,500 residents, while Panel (b) examines the share of the population in cities with more than 25,000 residents. All regressions control for county fixed effects and state by year fixed effects. All results are based on a balanced panel of 319 treated and control counties. The dashed lines indicate 95 percent confidence intervals, based on robust standard errors clustered by county.

A.3 Regional heterogeneity

Table A.1: Main results: Regional heterogeneity

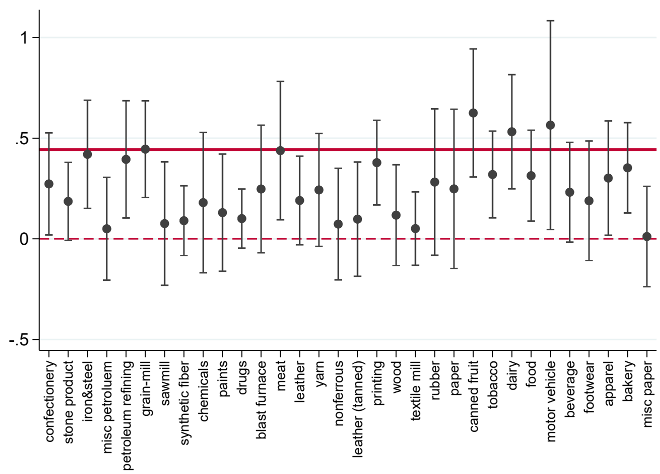
DV:	log population		log mfg. emp.		mfg. wage per worker		log mfg. value added	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				Panel A: Western states				
beet×after 1900	0.72***	0.75***	1.69***	1.88***	0.12**	0.17***	2.65***	3.16***
	(0.19)	(0.21)	(0.30)	(0.32)	(0.06)	(0.06)	(0.55)	(0.62)
Counties	127	127	127	127	127	127	127	127
Observations	1,778	1,778	1,651	1,651	1,651	1,651	1,651	1,651
R-squared	0.84	0.89	0.70	0.77	0.57	0.64	0.56	0.65
				Panel B: Eastern states				
beet×after 1900	0.04	-0.03	0.30*	0.48**	0.13***	0.11***	0.52*	0.85***
	(0.11)	(0.11)	(0.17)	(0.19)	(0.04)	(0.04)	(0.27)	(0.32)
Counties	192	192	192	192	192	192	192	192
Observations	2,688	2,688	2,496	2,496	2,496	2,496	2,496	2,496
R-squared	0.86	0.88	0.68	0.73	0.79	0.81	0.50	0.56
County FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y		Y		Y		Y	
State-Year FE		Y		Y		Y		Y

Notes: Regression results from Equation (1). Panel A and Panel B splits the sample states into Western and Eastern states. The variable beet × after 1900 is an indicator equal to one for treated counties after the year 1900. Error terms are clustered by county. Mean dependent variables are shown in Table 1. *** p<0.01, ** p<0.05, * p<0.1

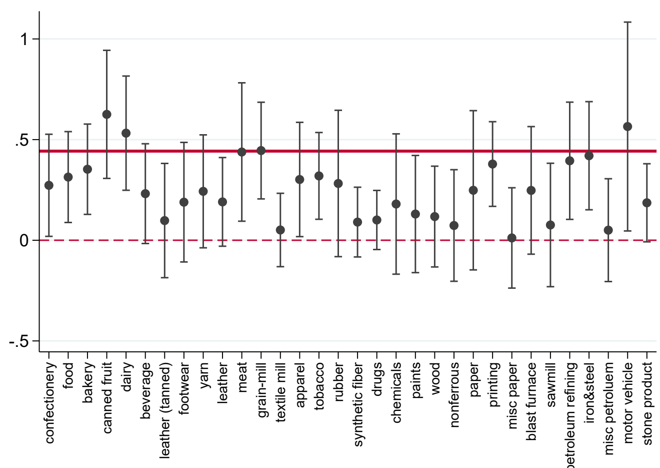
A.4 Industry-specific estimates

Figure A.6: Industry-specific estimates: 1910-40

(a) Industry-specific coefficients (sorted by upstreamness)



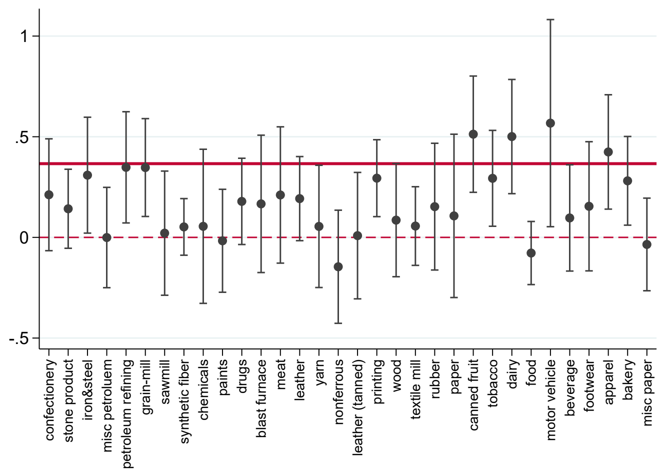
(a) Industry-specific coefficients (sorted by downstreamness)



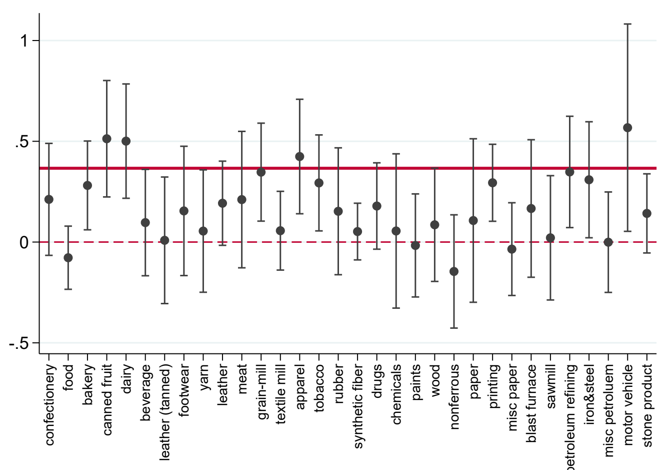
Note: Ordered from left to right by the sum of upstream and downstream coefficients, the estimated coefficients with 95 percent confidence intervals indicate the effect of beet sugar plant openings on local employment growth between 1910 and 1940. The solid red line represents the aggregate manufacturing employment growth. The full industry name, industry code, and the sum of upstream and downstream coefficients are provided in Table B.2 and Table B.3.

Figure A.7: Industry-specific estimates: 1910-20

(a) Industry-specific coefficients (sorted by upstreamness)



(a) Industry-specific coefficients (sorted by downstreamness)

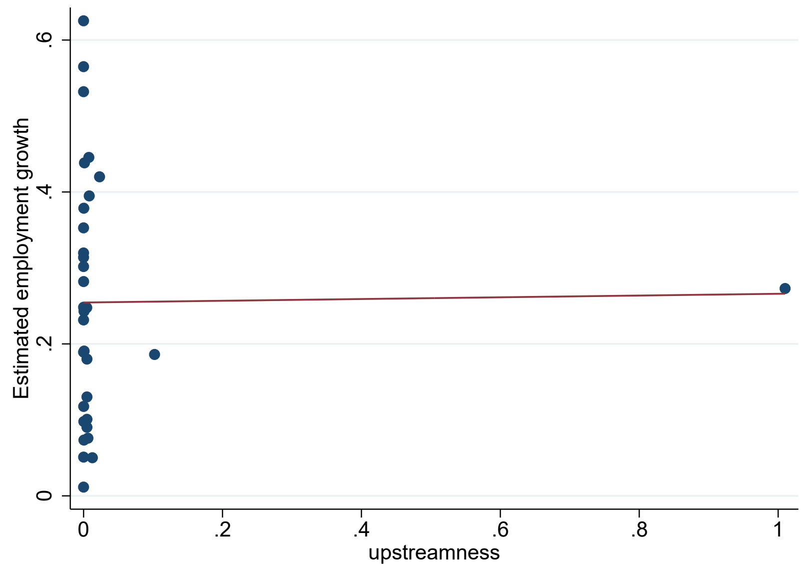


Note: Ordered from left to right by the sum of upstream and downstream coefficients, the estimated coefficients with 95 percent confidence intervals indicate the effect of beet sugar plant openings on local employment growth between 1910 and 1920. The solid red line represents the aggregate manufacturing employment growth. The full industry name, industry code, and the sum of upstream and downstream coefficients are provided in Table B.2 and Table B.3.

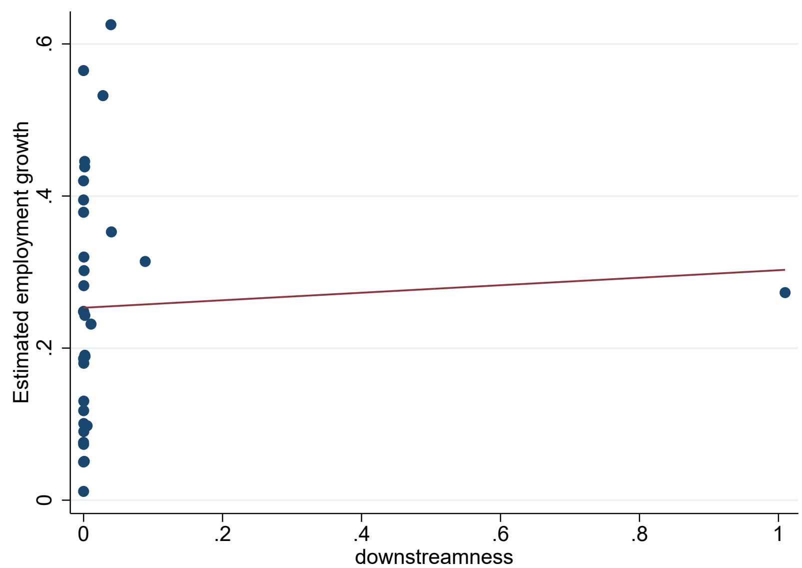
A.5 Industry linkage and employment growth

Figure A.8: Industry-specific estimates: Including the confectionery industry

(a) Industry-specific coefficients (sorted by upstreamness)



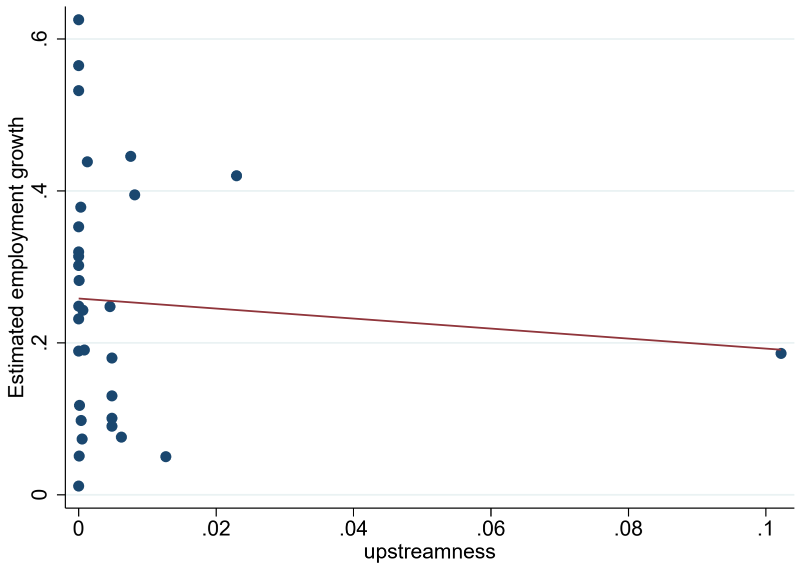
(a) Industry-specific coefficients (sorted by downstreamness)



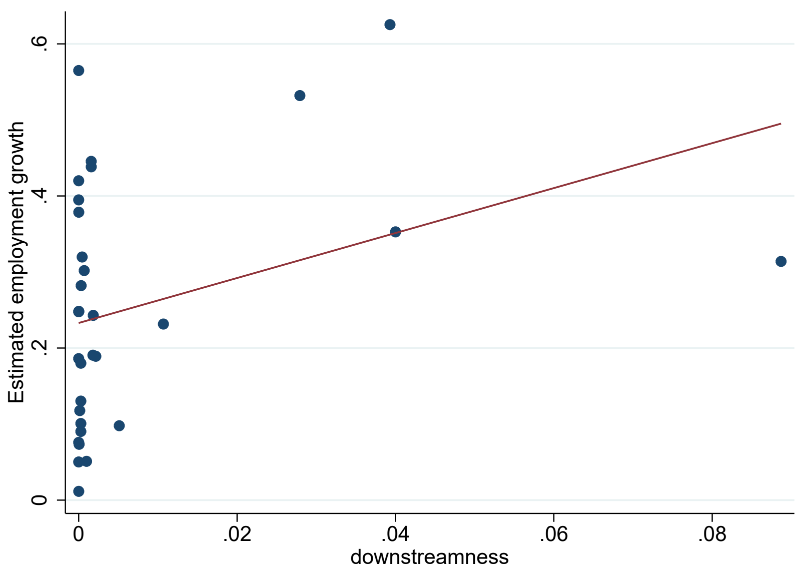
Note: Relationship between industry employment growth during 1910-40 and upstream or downstream linkage to the confectionery industry. Outcome variables are from Figure 8 and independent variables are from Table B.2 and Table B.3. The outlier on the right side of the scatterplot is the confectionery industry

Figure A.9: Industry-specific estimates: Excluding the confectionery industry

(a) Industry-specific coefficients (sorted by upstreamness)



(a) Industry-specific coefficients (sorted by downstreamness)



Note: Confectionery industry is excluded. Relationship between industry employment growth during 1910-40 and upstream or downstream linkage to the confectionery industry. Outcome variables are from Figure 8 and independent variables are from Table B.2 and Table B.3.

Table A.2: Industry linkage and employment growth: Regression on ranks of input-output linkage, 1910-40

	(1)	(2)	(3)	(4)	(5)	(6)
DV:	Estimated impact on industry employment growth, 1910-40					
rank(upstream)	-0.004			-0.005		
	(0.003)			(0.004)		
rank(downstream)		0.004			0.004	
		(0.003)			(0.004)	
rank(upstream+ downstream)			0.003			0.004
			(0.003)			(0.004)
Observations	32	32	32	31	31	31
R-squared	0.061	0.039	0.071	0.071	0.050	0.040

Notes: The unit of analysis is an industry, as described in Appendix B. The outcome variable is the estimated coefficient from Figure 8, representing the employment growth in each manufacturing industry in response to the opening of beet sugar plants between 1910-40. The independent variables are the ranks of upstreamness or downstreamness coefficients relative to the confectionery industry, where higher ranks indicate stronger linkage coefficients. Columns (4) to (6) excludes the confectionery industry from the sample. Robust standard errors in parentheses.*** p<0.01, ** p<0.05, * p<0.1

Table A.3: Industry linkage and employment growth: Regression on ranks of input-output linkage, 1910-20

	(1)	(2)	(3)	(4)	(5)	(6)
DV:	Estimated impact on industry employment growth, 1910-20					
rank(upstream)	-0.004			-0.005		
	(0.004)			(0.004)		
rank(downstream)		0.001			0.001	
		(0.004)			(0.004)	
rank(upstream+ downstream)			0.001			0.001
			(0.004)			(0.004)
Observations	32	32	32	31	31	31
R-squared	0.046	0.006	0.005	0.057	0.004	0.004

Notes: The unit of analysis is an industry, as described in Appendix B. The outcome variable is the estimated coefficient from Figure 8, representing the employment growth in each manufacturing industry in response to the opening of beet sugar plants between 1910-20. The independent variables are the ranks of upstreamness or downstreamness coefficients relative to the confectionery industry, where higher ranks indicate stronger linkage coefficients. Columns (4) to (6) excludes the confectionery industry from the sample. Robust standard errors in parentheses.*** p<0.01, ** p<0.05, * p<0.1

A.6 US Department of Agriculture experiments

Section 2 and Section 3.3 introduced the US Department of Agriculture's nationwide experiments aimed at assessing the suitability of sugar beets across the country (US Department of Agriculture, 1891). This subsection explores whether the provision of such information influenced the emergence of a new industry.

To identify general trends, I regress an indicator variable (multiplied by 100) for the establishment of beet sugar factories between 1890 and 1942 against several independent variables, controlling for latitude-longitude and state fixed effects. Columns (1) and (2) examine the outcome variable using an indicator variable that equals one hundred for counties where the USDA measured sugar quality. The results suggest that USDA experiments are associated with a higher probability of beet sugar plant openings, even after controlling for sugar beet suitability under high input and irrigation conditions as provided by the Global Agro-ecological Zones model. This correlation could imply that information provision mattered for the sugar beet industry, or it might simply reflect the fact that experiments were conducted in areas where the sugar beet industry was likely to thrive.

Columns (3) to (5) instead control for the actual outcome of the experiments, specifically the quality of sugar. This quality was assessed using two measures: sugar content in beets and the purity coefficient. Thus, the sample in these columns is restricted to counties where USDA experiments were conducted. Conditional on the presence of USDA experiments, higher sugar quality was associated with a greater likelihood of plant openings. Further investigation into this government research is left for future research.

Table A.4: USDA experiments

	(1)	(2)	(3)	(4)	(5)
Dep var:	Beet sugar plants opening 1890-1942				
USDA experiment	4.91***	4.56***			
	(1.66)	(1.53)			
FAO beet suitability		1.55**			1.54*
		(0.59)			(0.85)
Sugar in beet			1.13***		1.18**
			(0.41)		(0.47)
Purity coefficient				0.36**	0.05
				(0.15)	(0.11)
lat-lon	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
Observations	2,807	2,807	1,207	1,138	1,138
R-squared	0.14	0.15	0.21	0.22	0.22

Notes: The unit of observation is the county. The dependent variable is an indicator (multiplied by 100) for the opening of beet sugar factories between 1890 and 1942. The USDA experiment indicator represents the presence of USDA experiments testing beet sugar quality in a county. FAO beet suitability refers to the potential yield of sugar beets under high input and irrigation conditions. Sugar in beets and purity coefficient denote the quality of sugar from beets as described in (US Department of Agriculture, 1891). *** $p<0.01$, ** $p<0.05$, * $p<0.1$

A.7 Effects on agriculture

(a) log farmvalue

(b) log farm output

Figure A.10: Effects on agriculture

Note: Figures (a) and (b) present the regression results from Equation (1), with the outcome variables being log farm value in Panel (a) and log farm output in Panel (b). All regressions control for county fixed effects and state by year fixed effects. The dashed lines indicate 95 percent confidence intervals, based on robust standard errors clustered by county.

B. Coefficients of the Leontief inverse matrix

Table B.1: Manufacturing industry crosswalk

Industry name	Ind1950 code	Ind1950 industry name
flour and grist mill products	409	Grain-mill products
canning and preserving	408	Canning and preserving fruits, vegetables, and seafoods
bread and bakery products	416	Bakery products
sugar, glucose, and starch	417	Confectionery and related products
liquors and beverage	418	Beverage industries
tobacco manufactures	429	Tobacco manufactures
slaughtering and meatpacking	406	Meat products
butter, cheese, etc	407	Dairy products
other food industries	426	Not specified food industries
blast furnaces	336	Blast furnaces, steel works, and rolling mills
steel works and rolling mills	336	Blast furnaces, steel works, and rolling mills
other iron and steel and electric manufactures	337	Other primary iron and steel industries
automobiles	376	Motor vehicles and motor vehicle equipment
brass, bronze, copper, etc	338	Primary nonferrous industries
non-metal minerals	326	Miscellaneous nonmetallic mineral and stone products
refined petroleum	476	Petroleum refining
coal	477	Miscellaneous petroleum and coal products
coke	477	Miscellaneous petroleum and coal products
chemicals	466	Synthetic fibers
chemicals	467	Drugs and medicines
chemicals	468	Paints, varnishes, and related products
chemicals	469	Miscellaneous chemicals and allied products
lumber and timber products	307	Sawmills, planing mills, and mill work
other wood products	308	Miscellaneous wood products
paepr and wood pulp	456	Pulp, paper, and paperboard mills
other paper products	458	Miscellaneous paper and pulp products
printing and publishing	459	Printing, publishing, and allied industries
yarn and cloth	439	Yarn, thread, and fabric mills
clothing	448	Apparel and accessories
other textile products	446	Miscellaneous textile mill products
leather tanning	487	Leather: tanned, curried, and finished
leather shoes	488	Footwear, except rubber
other leather products	489	Leather products, except footwear
rubber manufactures	478	Rubber products

Notes: The first column lists the manufacturing industry names from Leontief (1936), while the second and third columns correspond to the manufacturing industries in the individual-level census data (Ruggles et al., 2021).

Table B.2: Upstreamness coefficients

ind1950 Code	Upstream Weight	Industry Name
417	1.01	Confectionery and related products
326	0.102	Miscellaneous nonmetallic mineral and stone products
337	0.023	Other primary iron and steel industries
477	0.0127	Miscellaneous petroleum and coal products
476	0.00816	Petroleum refining
409	0.00757	Grain-mill products
307	0.00622	Sawmills, planing mills, and mill work
466	0.004841	Synthetic fibers
469	0.004841	Miscellaneous chemicals and allied products
468	0.004841	Paints, varnishes, and related products
467	0.00484	Drugs and medicines
336	0.004555	Blast furnaces, steel works, and rolling mills
406	0.001262	Meat products
489	0.000828	Leather products, except footwear
439	0.000609	Yarn, thread, and fabric mills
338	0.000498	Primary nonferrous industries
487	0.000359	Leather: tanned, curried, and finished
459	0.000307	Printing, publishing, and allied industries
308	0.000123	Miscellaneous wood products
446	7.51e-05	Miscellaneous textile mill products
478	6.28e-05	Rubber products
456	9.96e-06	Pulp, paper, and paperboard mills
408	0	Canning and preserving fruits, vegetables, and seafoods
429	0	Tobacco manufactures
407	0	Dairy products
426	0	Not specified food industries
376	0	Motor vehicles and motor vehicle equipment
418	0	Beverage industries
488	0	Footwear, except rubber
448	0	Apparel and accessories
416	0	Bakery products
458	0	Miscellaneous paper and pulp products

Notes: Upstreamness coefficients are calculated from Leontief inverse matrix (Leontief, 1986) based on Leontief (1936).

Table B.3: Downstreamness coefficients

ind1950 Code	Downstream Weight	Industry Name
417	1.009545	Confectionery and related products
426	0.088695	Not specified food industries
416	0.040011	Bakery products
408	0.03931	Canning and preserving fruits, vegetables, and seafoods
407	0.027933	Dairy products
418	0.010702	Beverage industries
487	0.005128	Leather: tanned, curried, and finished
488	0.002168	Footwear, except rubber
439	0.001842	Yarn, thread, and fabric mills
489	0.0018	Leather products, except footwear
406	0.00159	Meat products
409	0.001582	Grain-mill products
446	0.000993	Miscellaneous textile mill products
448	0.000697	Apparel and accessories
429	0.000441	Tobacco manufactures
478	0.000312	Rubber products
466	0.000275	Synthetic fibers
467	0.000275	Drugs and medicines
469	0.000275	Miscellaneous chemicals and allied products
468	0.000275	Paints, varnishes, and related products
308	0.000137	Miscellaneous wood products
338	5.5e-05	Primary nonferrous industries
456	1.8e-05	Pulp, paper, and paperboard mills
459	1.3e-05	Printing, publishing, and allied industries
458	9e-06	Miscellaneous paper and pulp products
336	3e-06	Blast furnaces, steel works, and rolling mills
307	3e-06	Sawmills, planing mills, and mill work
476	3e-06	Petroleum refining
337	3e-06	Other primary iron and steel industries
477	3e-06	Miscellaneous petroleum and coal products
376	2e-06	Motor vehicles and motor vehicle equipment
326	1e-06	Miscellaneous nonmetallic mineral and stone products

Notes: Downstreamness coefficients are calculated from Leontief inverse matrix (Leontief, 1986) based on Leontief (1936).

Table B.4: Sum of upstream and downstreamness coefficients

ind1950	Upstream Weight +Downstream Weight	Industry name
417	2.01909	Confectionery and related products
326	.1022117	Miscellaneous nonmetallic mineral and stone products
426	.0886948	Not specified food industries
416	.0400114	Bakery products
408	.0393102	Canning and preserving fruits, vegetables, and seafoods
407	.0279325	Dairy products
337	.022979	Other primary iron and steel industries
477	.012687	Miscellaneous petroleum and coal products
418	.0107016	Beverage industries
409	.0091533	Grain-mill products
476	.0081583	Petroleum refining
307	.0062199	Sawmills, planing mills, and mill work
487	.005487	Leather: tanned, curried, and finished
469	.0051157	Miscellaneous chemicals and allied products
468	.0051157	Paints, varnishes, and related products
467	.0051157	Drugs and medicines
466	.0051157	Synthetic fibers
336	.004558	Blast furnaces, steel works, and rolling mills
406	.0028528	Meat products
489	.0026278	Leather products, except footwear
439	.0024504	Yarn, thread, and fabric mills
488	.0021679	Footwear, except rubber
446	.0010679	Miscellaneous textile mill products
448	.0006973	Apparel and accessories
338	.0005535	Primary nonferrous industries
429	.0004406	Tobacco manufactures
478	.0003745	Rubber products
459	.0003195	Printing, publishing, and allied industries
308	.0002598	Miscellaneous wood products
456	.0000277	Pulp, paper, and paperboard mills
458	9.19e-06	Miscellaneous paper and pulp products
376	1.99e-06	Motor vehicles and motor vehicle equipment

Notes: Sum of upstream and downstreamness coefficients are calculated from Leontief inverse matrix (Leontief, 1986) based on Leontief (1936).

C. Robustness checks

C.1 Self-sustaining agglomeration

I examine whether a historical presence of a beet sugar plant openings leads to a permanent effect. Several counties in the baseline samples had beet sugar factories by 2000. To conduct a clearer test of self-sustaining agglomeration forces, I also run the regression after excluding eleven treated counties that still had beet sugar factories by 2000, as identified in Risch et al. (2014). The results, presented in Table C.1, are quantitatively similar to those in Table 2.

Table C.1: Main results: Excluding counties with beet sugar factories today

DV:	log population		log mfg. emp.		mfg. wage per worker		log mfg. value added	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
beet × after 1900	0.33**	0.23**	0.85***	0.94***	0.11***	0.11***	1.34***	1.57***
	(0.17)	(0.10)	(0.22)	(0.18)	(0.04)	(0.04)	(0.33)	(0.34)
Observations	4,312	4,312	4,004	4,004	4,004	4,004	4,004	4,004
R-squared	0.81	0.90	0.74	0.80	0.69	0.76	0.57	0.65
County FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y		Y		Y		Y	
State-Year FE		Y		Y		Y		Y

Notes: Regression results from Equation (1). The variable beet × after 1900 is an indicator equal to one for treated counties after the year 1900. Error terms are clustered by county. Mean dependent variables are shown in Table 1. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

C.2 New Deal Sugar Cartel

The effects of opening beet sugar plants on local economies could be primarily due to protection from international trade provided by the New Deal Sugar Cartel (Krueger, 1988). This cartel, established in 1934, tied sugar beet quotas for farmers to the acres of sugar beets cultivated prior to the Great Depression. Bridgman et al. (2015) document that California, Colorado, and Utah were given disproportionately large beet sugar production quotas compared to states like Minnesota or North Dakota. This was because innovations in crop storage technology and the rise of alternative profitable crops raised the opportunity cost of producing sugar beets in the West.

To address this channel, I drop counties in California, Colorado, and Utah from the analysis and re-estimated the effect on manufacturing employment. The results are presented in Table C.2.

Table C.2: Main results: Excluding counties from California, Colorado, and Utah

DV:	log population		log mfg. emp.		mfg. wage per worker		log mfg. value added	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
beet × after 1900	0.23	0.25*	0.74***	0.94***	0.17***	0.15***	1.24***	1.63***
	(0.21)	(0.14)	(0.26)	(0.22)	(0.03)	(0.04)	(0.37)	(0.39)
Observations	3,808	3,808	3,536	3,536	3,536	3,536	3,536	3,536
R-squared	0.80	0.90	0.72	0.79	0.72	0.78	0.54	0.63
County FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y		Y		Y		Y	
State-Year FE		Y		Y		Y		Y

Notes: Regression results from Equation (1). The variable beet × after 1900 is an indicator equal to one for treated counties after the year 1900. Error terms are clustered by county. Mean dependent variables are shown in Table 1. *** p<0.01, ** p<0.05, * p<0.1

C.3 Standard errors accounting for spatial correlation

Table C.3: Main results: Conley standard errors

DV:	log population		log mfg. emp.		mfg. wage per worker		log mfg. value added	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
beet×after 1900	0.45	0.31	1.00	1.10	0.11	0.14	1.54	1.87
Standard errors:								
Clustered by county	(0.17)	(0.12)	(0.21)	(0.19)	(0.04)	(0.04)	(0.33)	(0.35)
Clustered by state	(0.27)	(0.15)	(0.32)	(0.25)	(0.05)	(0.03)	(0.45)	(0.40)
Conley std. error (40km cutoff)	(0.17)	(0.12)	(0.22)	(0.19)	(0.04)	(0.04)	(0.33)	(0.35)
Conley std. error (70km cutoff)	(0.19)	(0.11)	(0.23)	(0.20)	(0.04)	(0.04)	(0.31)	(0.34)
Conley std. error (100km cutoff)	(0.21)	(0.11)	(0.25)	(0.21)	(0.04)	(0.03)	(0.33)	(0.36)
Counties	319	319	319	319	319	319	319	319
Observations	4,466	4,466	4,147	4,147	4,147	4,147	4,147	4,147
R-squared	0.81	0.90	0.74	0.80	0.69	0.76	0.57	0.65
County FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y		Y		Y		Y	
State-Year FE		Y		Y		Y		Y

Notes: Regression results from Table 2. The variable beet × after 1900 is an indicator equal to one for treated counties after the year 1900. Error terms are clustered by county. Mean dependent variables are shown in Table 1. Error terms are clustered by county or calculated according to Conley (1999) under different distance cutoffs. *** p<0.01, ** p<0.05, * p<0.1

C.4 Controlling for the timing the first proposed year

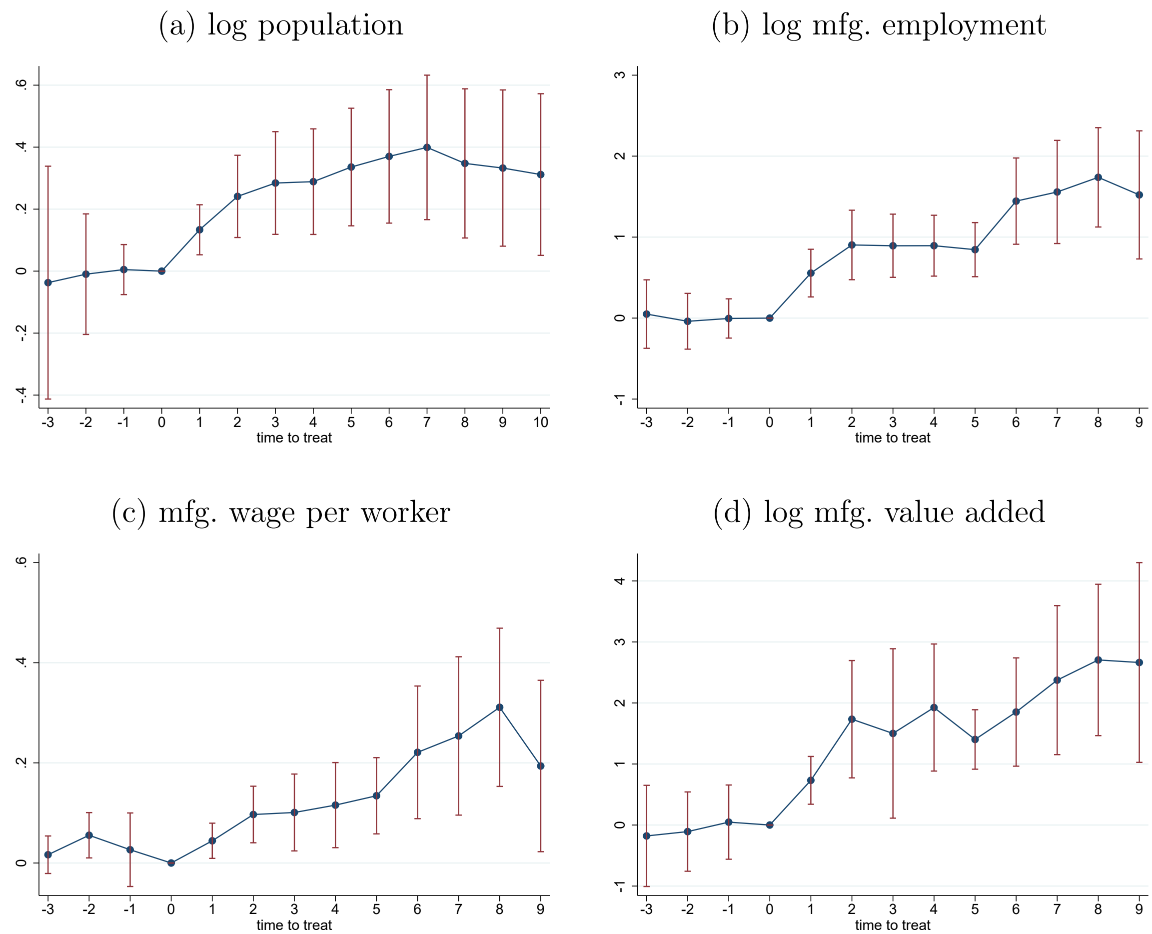
Table C.4: Main results: Controlling for the first proposed year

DV:	log population		log mfg. emp.		mfg. wage per worker		log mfg. value added	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
beet × after 1900	0.48***	0.30***	1.05***	1.11***	0.10***	0.14***	1.62***	1.89***
	(0.16)	(0.11)	(0.21)	(0.19)	(0.04)	(0.04)	(0.33)	(0.36)
Observations	4,466	4,466	4,147	4,147	4,147	4,147	4,147	4,147
R-squared	0.82	0.90	0.74	0.80	0.70	0.76	0.57	0.65
County FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y		Y		Y		Y	
State-Year FE		Y		Y		Y		Y
Proposed year-Year FE	Y	Y	Y	Y	Y	Y	Y	Y

Notes: Regression results from Equation (1). The variable beet × after 1900 is an indicator equal to one for treated counties after the year 1900. Error terms are clustered by county. Mean dependent variables are shown in Table 1. *** p<0.01, ** p<0.05, * p<0.1

C.5 Alternative differences-in-difference estimator

Figure C.1: Alternative differences-in-difference estimator



Note: This is the replication of Figure 4 using De Chaisemartin and d'Haultfoeuille (2020)'s differences-in-difference estimator. Panel name indicates outcome variables. All regressions control for county fixed effects and state by year fixed effects. All results are based on a balanced panel of 319 treated and control counties. The dashed lines in Figures (b) indicate 95 percent confidence intervals, based on robust standard errors clustered by county.

C.6 Log transformation

When examining agricultural or manufacturing outcomes, I add one to the outcome variables before taking their logarithms. This transformation, or the inverse hyperbolic sine transformation, has known issues, as the log of one-plus transformation places arbitrary weights on the intensive and extensive margins depending on how outcome variables are scaled.

Following Chen and Roth (2022), I test the robustness of the manufacturing employment results by explicitly assigning a value of 29.5 to observations with zero manufacturing employment. This value is chosen by comparing county-level census data with individual-level census data. In the sample counties of this study in 1900, there are three counties with zero manufacturing employment. According to the individual-level census, these three counties have 0, 4, and 55 manufacturing workers, respectively. Thus, I assign a mean value of 29.5 manufacturing workers to counties that have zero manufacturing employment according to the county-level census. Figure C.2 documents the regression results from the same regression as in Figure 4, but with the adjusted manufacturing employment.

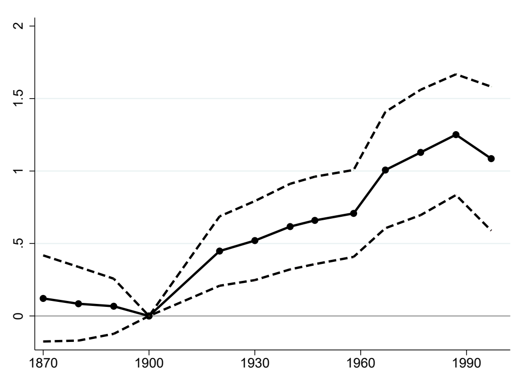


Figure C.2: Effects on log manufacturing employment

D. Factory location

This study uses the data from War Food Administration (1946) to identify the location of beet sugar plants (see Figure F.6). To assess the reliability of this data, I cross-referenced it with other sources (Beet Sugar Gazette Company, 1908; Federal Trade Commission, 1917; Townsend, 1921; American Sugar Refining Company, 1930). Samples of data are displayed in Figure F.7 and Figure F.8. Although the time coverage of these other data sources is shorter than that of War Food Administration (1946), they are consistent with each other during the periods of overlap.

E. Historical background on the invention of beet sugar

Andreas Margraff, a Prussian chemistry professor, first discovered that sugar could be produced from beets in 1747. However, mass production of this new technology was not possible at the time, and it remained an academic concept. It was not until the late 18th century, during the Haitian revolution, which disrupted cane sugar production, that interest in beet sugar production resurfaced. In 1797, Franz Achard, a Huguenot refugee from France who had been a student of Magraff, published his discoveries on an improved process of beet sugar production. He produced his first sample in 1799 (Child, 1840). The British government, concerned about the profits from the sugar business in its colonial possessions, attempted to bribe Achard to prevent him from sharing his knowledge, but he refused and continued his work (US Beet Sugar Association, 1936).

Napoleon's continental blockade in 1812 significantly reduced the shipment of cane sugar from tropical colonies. In response, Napoleon encouraged the production of sugar from beets by subsidizing the sugar beet industry and establishing chemical schools. Despite some obstacles after the trade barrier was lifted in 1815, the sugar beet industry expanded across several European countries, including the Netherlands, Austria, Germany, Russia, Belgium, Poland, Italy, and Sweden. By 1867, about 27.87 percent in the world sugar market were produced from beets (Goessmann, 1870, p. 44).

Sugar consumption in the United States increased dramatically between 1865 and 1914, with annual per capita consumption rising from 18.17 pounds to 89.14 pounds (Federal Trade Commission, 1917, p.17). While sugarcane is the most commonly used raw material for sugar production, sugar beets also play a significant role in the sugar industry. In fact, beet sugar accounts for between 55 and 60 percent of domestic sugar production in the United States since the mid-2000s (US Department of Agriculture, 2018), and 30 percent of global sugar supply (Dohm et al., 2014).

The technology to extract sugar from beets was first invented and commercialized in Europe.[8] Attempts to establish a sugar beet plant in the United States date all the way back to the nineteenth century. By 1880, the United States consumed more sugar than any other major advanced economies, excluding Britain (Bannister, 1890). David Lee Child, an abolitionist, had a trip to France, Belgium, and Germany in 1836 to examine the sugar beet industry in the hopes of finding an alternative for slave-produced cane sugar. Due to the expanding slave emancipation movement, it was anticipated that the production of sugar from the colonies would decrease in the face of an ever increasing demand for sugar. Child (1840) compared the productivity of Louisiana's cane sugar industry to that of France's beet sugar industry, concluding that the sugar beet sector is more efficient in terms of labor intensity, soil fertilization, and economic benefit to local economies. It was believed in France at the time that the rise in employment brought on by the beet sugar production had reduced urban migration because it boosted employment in rural areas and encouraged farmers to have better education to comprehend the sugar beet growing process. In 1838 Northampton, Massachusetts, Child himself established a sugar beet factory, but it stopped operating in 1841.

The quest for a viable sugar beet industry in the United States drew interest not only from abolitionists but also from members of the Church of Jesus Christ of Latter-day Saints, who proposed building a sugar beet plant in Salt Lake City. With ample funds at their disposal, they invested in heavy English equipment and expensive French beet seedlings. However, their plans were thwarted by the unsuitable soil, which was too saline to produce sugar of high quality. They built a sugar beet plant in 1853, only to see it grind to a halt in 1855 (Kaufman, 2009). Over the next few decades, fourteen sugar beet factories sprouted up in Massachusetts, Utah, California, Illinois, Wisconsin, Maine, and Delaware. Yet, with the exception of the one in Alvarado, California, none of these factories managed to last more than a decade, let alone achieve commercial success (War Food Administration, 1946).

These failures stood in stark contrast to the enthusiasm and optimism that characterized early nineteenth-century American sugar beet promoters. James Pedder of the Philadelphia Beet Sugar Society, after visiting France to study beet sugar, confidently

[8]Appendix E provides a more detailed account of this process.

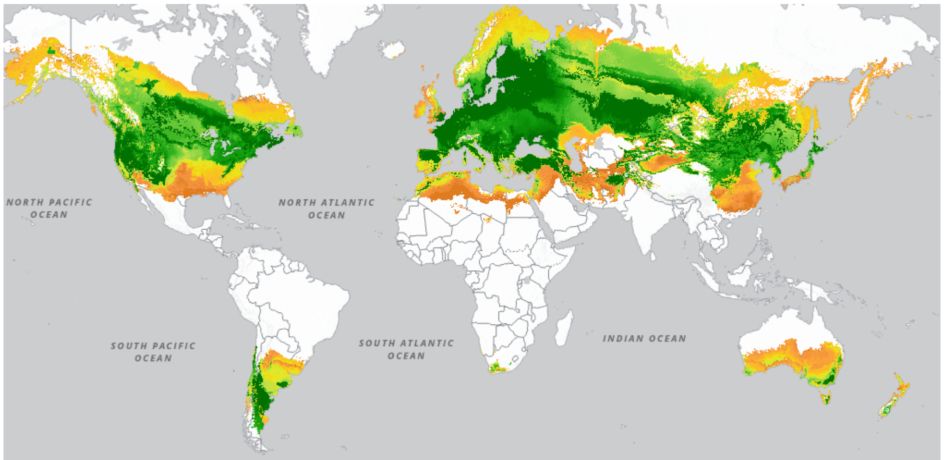
declared that “America is destined to take the lead in the production of silk and sugar, as she has already done in cotton, rice and tobacco.” (Pedder, 1836, p. 40) Similarly, Grant (1867) argued that "beet sugar could be successfully transplanted from France to the United States."

One of the main reasons for the failures was a lack of understanding regarding the suitable regions for growing sugar beets in the US. Harvey Wiley, later the first commissioner of the US Food and Drug Administration, was appointed chief chemist at the US Department of Agriculture (USDA hereafter) after studying sugar chemistry during his time in Germany from 1878 to 1881. In his 1890 publication, where he discusses the optimal soil and climate conditions for sugar beet cultivation, he warns against the dangers of constructing large and expensive sugar beet factories without first studying the local climatic and soil conditions (Wiley, 1890, p. 6). While German immigrants brought considerable knowledge to the US, they often failed to choose the best regions for growing high-quality beets (Ballinger, 1978, p. 9). The knowledge of where to cultivate them was deeply ingrained throughout Europe and had to be rediscovered through trial and error in the United States. Due to the high cost of constructing sugar beet plants, there was a high level of investment uncertainty, making it more difficult for farmers and businesses to enter this new industry.

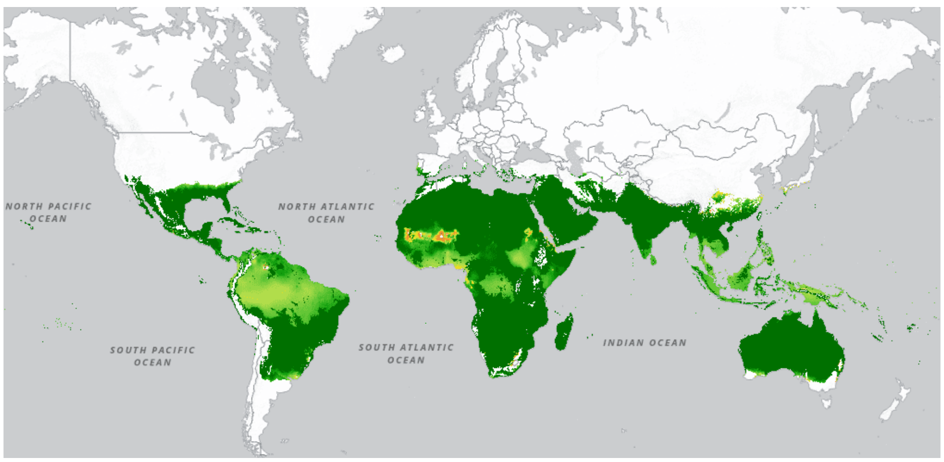
In 1890, the USDA began collaborating with state agricultural experiment stations to conduct systematic experiments to evaluate the suitability of sugar beets in various regions of the United States. The USDA plant scientists’ experiments formed the foundation of the industry (US Department of Agriculture, 1902b, p. 596). The USDA distributed sugar beet seeds with written instructions, gathered sugar beets at the end of the year, and assessed the sugar quality of each sample. Based on the experiment results, the USDA issued a map drawing the beet belt with their new data, showing the areas that were thought to be especially favorable for growing sugar beets (see Figure F.2a and Figure F.2b). The experiment records show the grower’s name, location, sugar beet crop variety, and quality of sugar. The sucrose in beet or purity coefficients are plotted in Figure F.9a and Figure F.9b, respectively, with the figures showing the county-level mean of beet sugar quality surveyed by the USDA. Higher purity or higher sucrose indicates sweeter sugar. The experiments that began in 1890 allowed them to "determine with some degree of accuracy the localities where sugar-beet is destined to be most successful." (US Department of Agriculture, 1899b, p. 6).

Between 1888 and 1897, the research and development phase saw the import of improved sugar beet seeds from Europe, the adaptation of labor-intensive European cultivation methods to the labor-scarce environment of the United States, the expansion of US factory scales, and the on-the-job training of sugar beet factory workers by European immigrants or those who studied in Europe. Federal and state governments offered bounties to entice additional investment, tariffs on imported sugar, tariff reductions on sugar beet machinery equipment in 1890, conducted systematic experiments to examine the suitability, and sent agents to encourage farmers and businessmen to promote beet sugar industry, all of which contributed to the industry's growth.It is difficult to pinpoint the primary factors that contributed to the growth of the beet sugar industry (Arrington, 1967). Economists at the time raised doubt about the importance of sugar tariffs (Blakey, 1912; Magnuson, 1918; Taussig, 1912).

F. Appendix figures



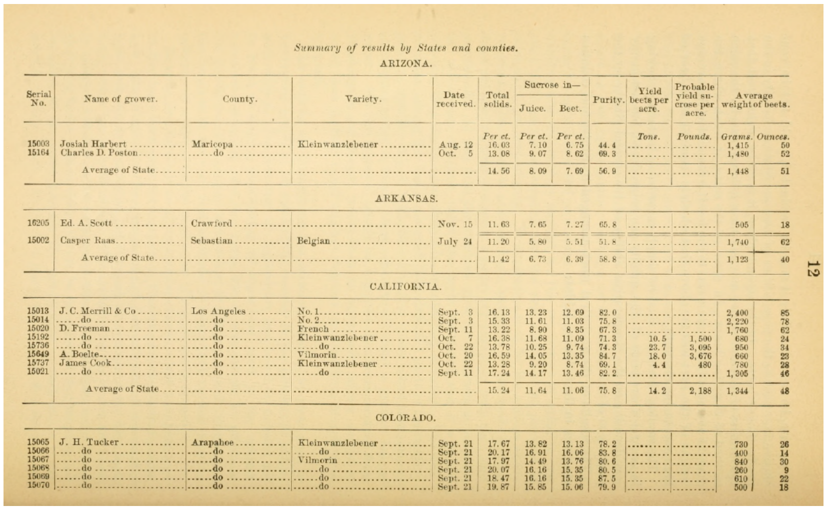
(a) Sugar beet suitability



(b) Sugar cane suitability

Figure F.1: Sugar beet and sugar cane suitability

Source: Panels (a) and (b) are taken from the Global Agro-Ecological Zones (v4) by the Food and Agricultural Organization. Greener areas indicate higher suitability, orange areas indicate lower suitability, and white areas are unsuitable.



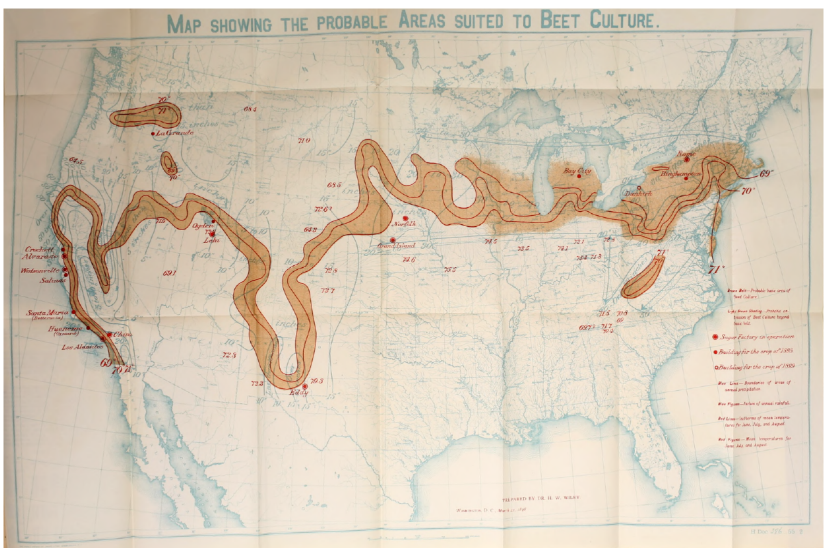
Summary of results by States and counties.

ARIZONA.

Serial No.	Name of grower.	County.	Variety.	Date received.	Total solids.	Sucrose in— Juice.	Sucrose in— Beet.	Purity.	Yield beets per acre.	Probable yield sucrose per acre.	Average weight of beets.	
					Per ct.	Per ct.	Per ct.		Tons.	Pounds.	Grams.	Ounces.
15003	Josiah Harbert	Maricopa	Kleinwanzlebener	Aug. 12	16.03	7.10	6.75	44.4			1,415	50
15164	Charles D. Poston	do		Oct. 5	13.08	9.07	8.62	69.3			1,480	52
	Average of State				14.56	8.09	7.69	56.9			1,448	51
	ARKANSAS.											
16205	Ed. A. Scott	Crawford		Nov. 15	11.63	7.65	7.27	65.8			505	18
15002	Casper Raas	Sebastian	Belgian	July 24	11.20	5.80	5.51	51.8			1,740	62
	Average of State				11.42	6.73	6.39	58.8			1,123	40
	CALIFORNIA.											
15013	J. C. Merrill & Co	Los Angeles	No. 1	Sept. 3	16.13	13.23	12.69	82.0			2,400	85
15014	do	do	No. 2	Sept. 3	15.33	11.61	11.03	75.8			2,220	78
15020	D. Freeman	do	French	Sept. 11	13.22	8.90	8.35	67.3			1,760	62
15192	do	do	Kleinwanzlebener	Oct. 7	16.38	11.68	11.09	71.3	10.5	1,500	680	24
15736	do	do	do	Oct. 22	13.78	10.25	9.74	74.3	23.7	3,095	950	34
15649	A. Boelte	do	Vilmorin	Oct. 20	16.59	14.05	13.35	84.7	18.0	3,676	660	23
15737	James Cook	do	Kleinwanzlebener	Oct. 22	13.28	9.20	8.74	69.1	4.4	480	780	28
15021	do	do	do	Sept. 11	17.24	14.17	13.46	82.2			1,305	46
	Average of State				15.24	11.64	11.06	75.8	14.2	2,188	1,344	48
	COLORADO.											
15065	J. H. Tucker	Arapahoe	Kleinwanzlebener	Sept. 21	17.67	13.82	13.13	78.2			730	26
15066	do	do	do	Sept. 21	20.17	16.91	16.06	83.8			400	14
15067	do	do	Vilmorin	Sept. 21	17.97	14.49	13.76	80.6			840	30
15068	do	do	do	Sept. 21	20.07	16.16	15.35	80.5			260	9
15069	do	do	do	Sept. 21	18.47	16.16	15.35	87.5			610	22
15070	do	do	do	Sept. 21	19.87	15.85	15.06	79.9			500	18

12

(a) Measurement of sugar quality



(b) Beet belt

Figure F.2: Study of beet sugar industry by USDA

Source: Panel (a) is taken from US Department of Agriculture (1891), and (b) from US Department of Agriculture (1899a).

(a) Beet belt (intersected on 1900 county polygon)

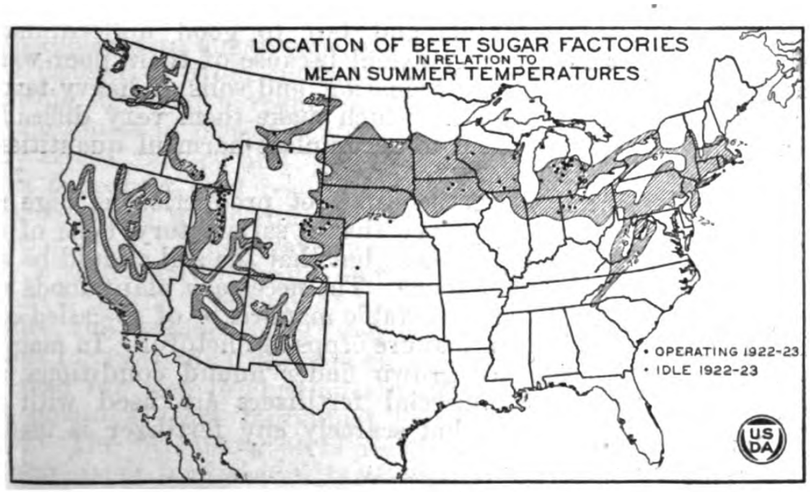


Fig. 18.—Sugar beets thrive best in localities where the temperature during the summer (average of June, July, and August) does not vary greatly from 70° F. Nearly all of the beet-sugar factories in the United States are located between the isotherms of 67 and 72° F. summer temperature. Owing to great variations in altitude in the Western States, the shaded area includes a wide range of climatic conditions in these States.

(b) Beet belt as of 1923

Figure F.3: Beet belt

Source: Panel (a) is the beet belt ((US Department of Agriculture, 1899a)) intersected with the 1900 county shape file. Panel (b) is the updated beet belt US Department of Agriculture (1923). Red line that highlights the temperature is done by author. The red line that highlights the temperature is added by the author.

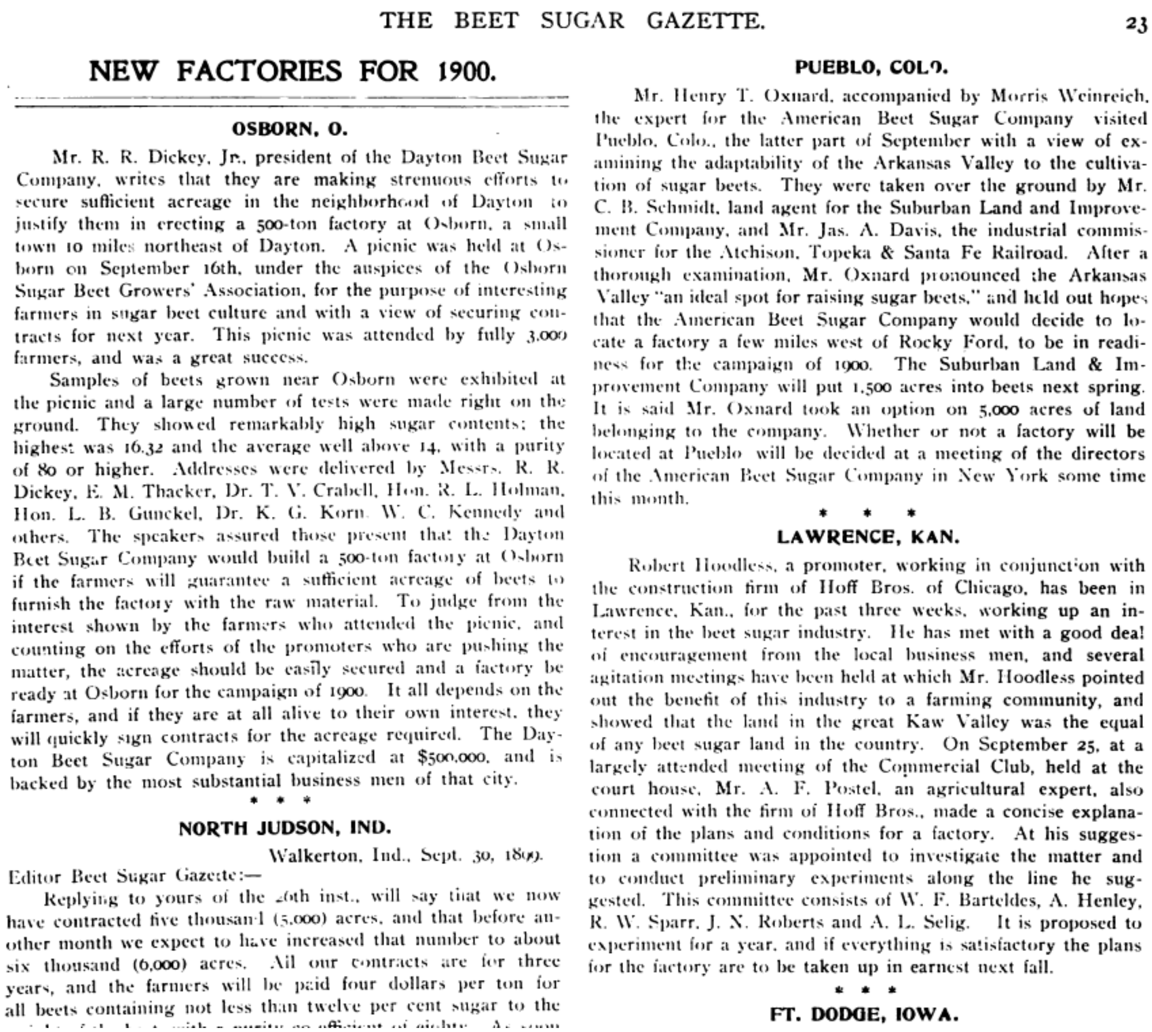
SPRINGFIELD, O.

A company was recently organized at Dayton, O., for the purpose of starting a beet sugar factory at some convenient place in that state. The prime mover in the project is Mr. R. R. Dickey, Jr., vice-president of the Globe Iron Works of Dayton, and he is ably assisted by Mr. John S. Harshman, president of the Ohio Beet Sugar Association.

There is no reason why the great state of Ohio should not have a beet sugar factory. In fact, there is every reason why it should not only come into line, but soon occupy a place in the front rank of beet sugar producing states. The soil is eminently suited to the growing of this crop, the farmers are wide-awake, and the capitalists enterprising and resourceful.

A friendly rivalry has started between several cities as to which one should be selected for a site for the new factory. The city of Springfield is at present making a great effort to secure it. A meeting of business men was held recently in the Board of Trade rooms of that city and a committee appointed to look into the matter and make a report on it. Mr. Dickey and others having declared their readiness to subscribe stock, the question seems to turn, as usual, on the prospects of securing the necessary contracts for acreage to be planted to beets. It is stated that about 3,000 acres are in sight and there are strong hopes of securing the requisite 5,000 in a short time. The plans contemplate a factory of 500 tons capacity.

Figure F.4: American Sugar Industry and Beet Sugar Gazette, September 1899



THE BEET SUGAR GAZETTE. 23

NEW FACTORIES FOR 1900.

OSBORN, O.

Mr. R. R. Dickey, Jr., president of the Dayton Beet Sugar Company, writes that they are making strenuous efforts to secure sufficient acreage in the neighborhood of Dayton to justify them in erecting a 500-ton factory at Osborn, a small town 10 miles northeast of Dayton. A picnic was held at Osborn on September 16th, under the auspices of the Osborn Sugar Beet Growers' Association, for the purpose of interesting farmers in sugar beet culture and with a view of securing contracts for next year. This picnic was attended by fully 3,000 farmers, and was a great success.

Samples of beets grown near Osborn were exhibited at the picnic and a large number of tests were made right on the ground. They showed remarkably high sugar contents; the highest was 16.32 and the average well above 14, with a purity of 80 or higher. Addresses were delivered by Messrs. R. R. Dickey, E. M. Thacker, Dr. T. V. Crabell, Hon. R. L. Holman, Hon. L. B. Gunckel, Dr. K. G. Korn, W. C. Kennedy and others. The speakers assured those present that the Dayton Beet Sugar Company would build a 500-ton factory at Osborn if the farmers will guarantee a sufficient acreage of beets to furnish the factory with the raw material. To judge from the interest shown by the farmers who attended the picnic, and counting on the efforts of the promoters who are pushing the matter, the acreage should be easily secured and a factory be ready at Osborn for the campaign of 1900. It all depends on the farmers, and if they are at all alive to their own interest, they will quickly sign contracts for the acreage required. The Dayton Beet Sugar Company is capitalized at $500,000, and is backed by the most substantial business men of that city.

* * *

NORTH JUDSON, IND.

Walkerton, Ind., Sept. 30, 1899.

Editor Beet Sugar Gazette:—

Replying to yours of the 26th inst., will say that we now have contracted five thousand (5,000) acres, and that before another month we expect to have increased that number to about six thousand (6,000) acres. All our contracts are for three years, and the farmers will be paid four dollars per ton for all beets containing not less than twelve per cent sugar to the

PUEBLO, COLO.

Mr. Henry T. Oxnard, accompanied by Morris Weinreich, the expert for the American Beet Sugar Company visited Pueblo, Colo., the latter part of September with a view of examining the adaptability of the Arkansas Valley to the cultivation of sugar beets. They were taken over the ground by Mr. C. B. Schmidt, land agent for the Suburban Land and Improvement Company, and Mr. Jas. A. Davis, the industrial commissioner for the Atchison, Topeka & Santa Fe Railroad. After a thorough examination, Mr. Oxnard pronounced the Arkansas Valley "an ideal spot for raising sugar beets," and held out hopes that the American Beet Sugar Company would decide to locate a factory a few miles west of Rocky Ford, to be in readiness for the campaign of 1900. The Suburban Land & Improvement Company will put 1,500 acres into beets next spring. It is said Mr. Oxnard took an option on 5,000 acres of land belonging to the company. Whether or not a factory will be located at Pueblo will be decided at a meeting of the directors of the American Beet Sugar Company in New York some time this month.

* * *

LAWRENCE, KAN.

Robert Hoodless, a promoter, working in conjunction with the construction firm of Hoff Bros. of Chicago, has been in Lawrence, Kan., for the past three weeks, working up an interest in the beet sugar industry. He has met with a good deal of encouragement from the local business men, and several agitation meetings have been held at which Mr. Hoodless pointed out the benefit of this industry to a farming community, and showed that the land in the great Kaw Valley was the equal of any beet sugar land in the country. On September 25, at a largely attended meeting of the Commercial Club, held at the court house, Mr. A. F. Postel, an agricultural expert, also connected with the firm of Hoff Bros., made a concise explanation of the plans and conditions for a factory. At his suggestion a committee was appointed to investigate the matter and to conduct preliminary experiments along the line he suggested. This committee consists of W. F. Barteldes, A. Henley, R. W. Sparr, J. N. Roberts and A. L. Selig. It is proposed to experiment for a year, and if everything is satisfactory the plans for the factory are to be taken up in earnest next fall.

* * *

FT. DODGE, IOWA.

Figure F.5: American Sugar Industry and Beet Sugar Gazette, 1900

1906

VISALIA, CALIF. Erected by Pacific Sugar Corp. Machinery moved from Rome, New York, and St. Louis Park, Minn. Capacity, 350 tons. Machinery moved to Hooper, Utah in 1919.

BRUSH, COLO. Erected by Morgan County Construction Co. Original capacity, 600 tons. Present capacity, 1,600 tons. Present owner, Great Western Sugar Co.

FT. MORGAN, COLO. Erected by Morgan County Construction Co. Original capacity, 600 tons. Equipped with Steffens process. Present capacity, 1,600 tons. Present owner, Great Western Sugar Co.

SWINK, COLO. Erected by Holly Sugar Co. Original capacity, 1,200 tons. Equipped with Steffens process. Present capacity, 2,200 tons. Present owner, Holly Sugar Corp.

NAMPA, IDAHO. Erected by Western Idaho Sugar Co. Capacity, 750 tons. Machinery moved to Spanish Fork, Utah in 1916.

GARDEN CITY, KANS. Erected by U. S. Sugar and Land Co. Original capacity, 1,000 tons. Equipped with Steffens process and steam pulp dryer. Present capacity, 1,200 tons. Present owner, Garden City Co.

CHARLEVOIX, MICH. Erected by West Michigan Sugar Co. Capacity, 600 tons. Machinery moved to Ottawa, Ohio in 1912.

CHASKA, MINN. Erected by Carver County Sugar Co. Machinery moved from East Tawas, Mich. Original capacity, 600 tons. Equipped with fire pulp dryer. Present capacity, 1,700 tons. Present owner, American Crystal Sugar Co.

BILLINGS, MONT. Erected by Billings Sugar Co. Original capacity, 1,200 tons. Equipped with Steffens process and pulp dryer. Present capacity, 3,500 tons. Present owner, Great Western Sugar Co.

REMOVED: Rome, N. Y.; St. Louis Park, Minn.; East Tawas, Mich.
TOTAL: 92-26-66

1907

LAS ANIMAS, COLO. Erected by American Beet Sugar Co. Capacity, 700 tons. Dismantled in 1942.

WAVERLY, IOWA. Erected by Iowa Sugar Co. Machinery originally erected at Bay City, Mich. in 1898. Original capacity, 400 tons. Equipped with fire pulp dryer. Present capacity, 700 tons. Present owner, Waverly Sugar Co.

REMOVED: Bay City, Mich.
TOTAL: 94-27-67

1908

CORCORAN, CALIF. Erected by Pacific Sugar Corp. Machinery originally erected at Crockett, Calif. Capacity, 600 tons. Machinery moved to Preston, Idaho in 1922.

Figure F.6: Beet sugar plant opening records

Source: Beet sugar opening records from War Food Administration (1946).

BEET SUGAR FACTORIES

OF THE

UNITED STATES AND CANADA

It is the aim of the publishers to keep this list up to date and reliable. Factory managers will therefore, confer a favor by promptly notifying us of any change in name or capacity.

NAME OF COMPANY AND FACTORIES	LOCATION OF FACTORIES	DAILY SLICING CAPACITY TONS BEETS
CALIFORNIA		
Alameda Sugar Co.	Alvarado . . . . . . Cal.	800
Los Alamitos Sugar Co.	Los Alamitos . . . "	700
Spreckles Sugar Co.	Spreckles . . . . . . "	3,000
Union Sugar Co.	Betteravia . . . . . "	600
American Beet Sugar Co., main office, 32 Nassau St., New York. Pacific Coast, office, 604 Mission St., San Francisco.	Chino . . . . " Oxnard . . . . "	900 2,000
Pacific Sugar Corporation, main office, Los Angeles, Cal.	Visalia. . . . . "	400
Alta, Cal., Beet Sugar Co.	Hamilton City . . "	700
	Total. 8	9,100
COLORADO		
American Beet Sugar Co., western office, 1530 Sixteenth St., Denver, Colo. . . .	Rocky Ford. . . .Colo Lamar. . . . . " Las Animas . . . Colo	1,100 600 700
MICHIGAN—Cont.		
German-American Sugar Co. . . .	Bay City, Sta. A. "	650
Mt. Clemens Sugar Company. . .	Mt. Clemens. . . . "	600
Menominee River Sugar Co. . . .	Menominee . . . . "	1,200
St. Louis Sugar Co.	St. Louis . . . . .Mich.	600
The Continental Sugar Co., main office, Cleveland, Ohio: Blissfield Works.	Blissfield. . . . . . . "	600
West Michigan Sugar Co.	Charlevoix. . . . . . "	600
	Total 16	11,550
MINNESOTA		
Carver County Sugar Co.	Chaska . . . . . . Minn.	600
MONTANA		
The Great Western Sugar Co. . .	Billings. . . . . . Mont.	1,200
NEBRASKA		
American Beet Sugar Co.	Grand Island . . Neb.	350

(a) Beet sugar plant locations, 1920

1897.

Los Alamitos Sugar Co., Los Alamitos, Cal.

Pecos Valley Beet Sugar Co., Carlsbad, N. Mex. (Operated unsuccessfully for two years. It was closed and later destroyed by fire.)

First Beet Sugar Co., Rome, N. Y. (On account of bad management and lack of beets died after two years.)

1898.

California Beet Sugar & Refining Co., Crockett, Cal. (Removed to Corcoran, Cal., in 1909.)

Oregon Sugar Co., La Grande, Oreg. (Removed to Burley, Idaho, in 1911.)

Ogden Sugar Co., Ogden, Utah.

Michigan Sugar Co. (old), Bay City, Mich. (Removed to Waverly, Iowa, in 1907.)

Minnesota Sugar Co., St. Louis Park, Minn. (Burned in 1905.)

Binghamton Sugar Co., Binghamton, N. Y. (Removed to Blackfoot, Idaho, in 1904.)

American Beet Sugar Co., Oxnard, Cal.

(b) Beet sugar plant locations, 1930

Figure F.7: Factory locations in 1920 and 1930

Source: Panel (a) is from Beet Sugar Gazette Company (1908). Panel (b) is from Federal Trade Commission (1917).

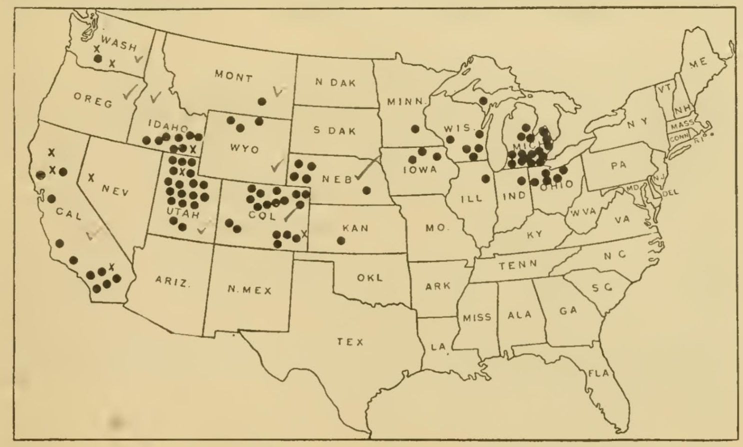
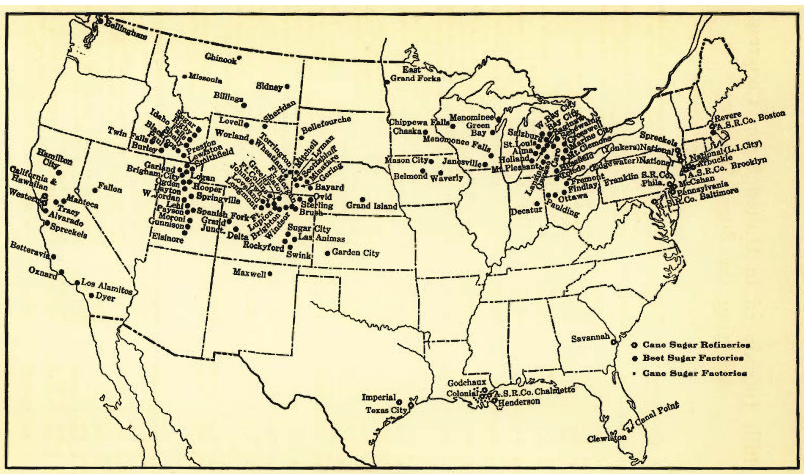


FIG. 1.—Outline map showing by black dots the locations of beet-sugar mills that were in operation during the 1920–21 campaign. Mills that were standing idle during the 1920–21 campaign are indicated by an × mark.

(a) Beet sugar plant locations, 1920

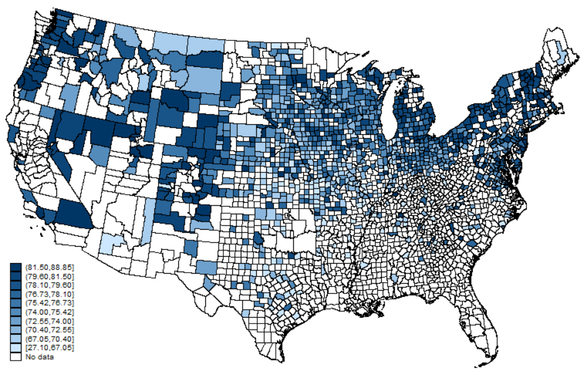


Map Showing Beet and Cane Sugar Factories and Cane Sugar Refineries in the United States
December 31. 1930

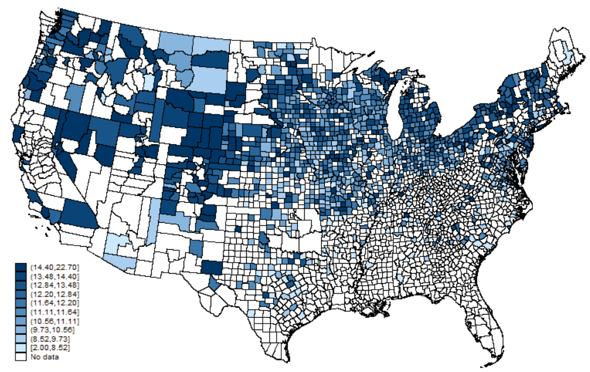
(b) Beet sugar plant locations, 1930

Figure F.8: Factory locations in 1920 and 1930

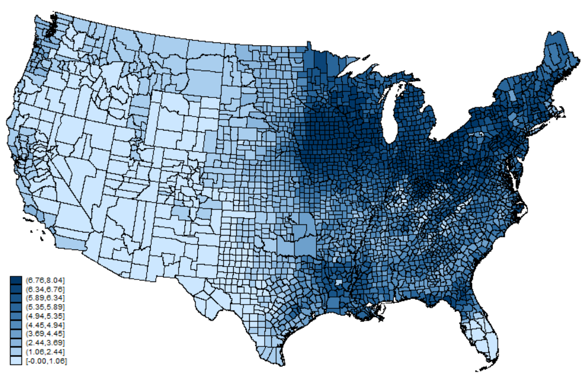
Source: Panel (a) is from Townsend (1921). Panel (b) is from American Sugar Refining Company (1930). Hollow circles in Panel (b) indicate sugar cane plants.



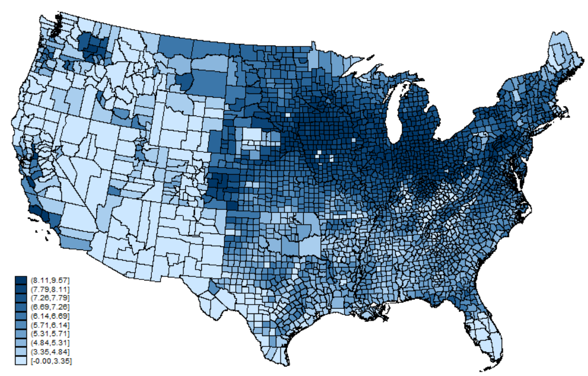
(a) Purity coefficients (percent)



(b) Sugar in beets (percent)



(c) potential yield (ton/ha), rain-fed with high input



(d) potential yield (ton/ha), irrigation with high input

Figure F.9: Sugar beet suitability

Notes: Purity coefficients and sucrose in beets are county-level mean of USDA experiment results between 1890-1900 (US Department of Agriculture, 1891). Potential yield (ton/ha) data are taken from Global Agro-ecological Zones at Food and Agriculture Organization (2012).

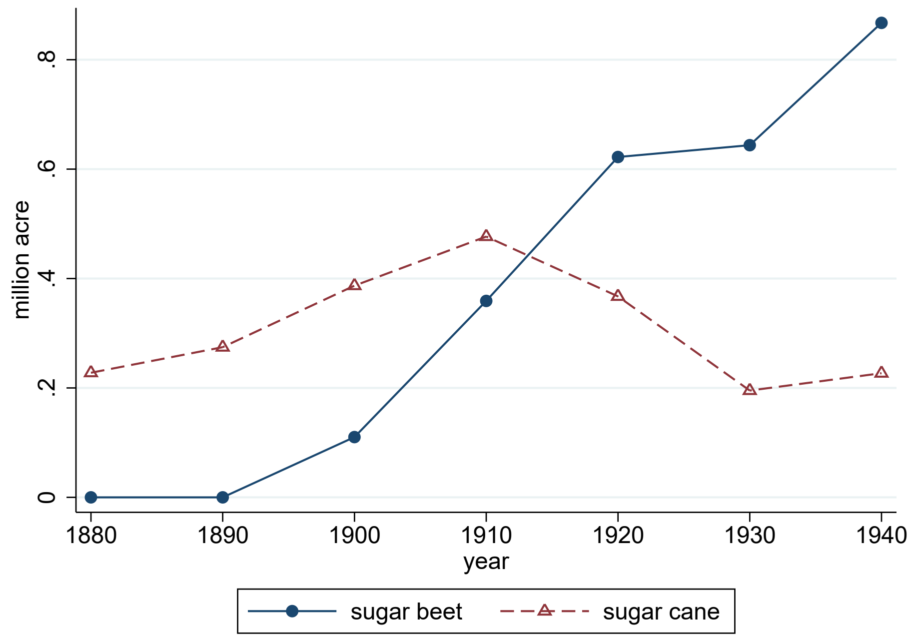


Figure F.10: Farmland acres cultivated for sugar beet and sugarcane

Source: Data is taken from Haines et al. (2019).