One Hundred Years of Manufacturing: Long-run Consequences of the Indiana Gas Boom

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January 2026

Abstract

I examine the long-run consequences of a temporary, localized energy boom on local manufacturing development. Exploiting the 1886 discovery of natural gas in eastern Indiana, I use decadal U.S. census data on manufacturing activity to document how fifteen years of cheap natural gas spurred manufacturing growth in the region that persisted for nearly a century—despite the gas supply's collapse in 1901. Comparing gas-rich counties with similar non-gas counties, I show that gas counties experienced both immediate and sustained manufacturing growth. Initially driven by glass and iron industries, this growth survived the collapse of gas supply, and later expanded to machinery and automobiles, suggesting the presence of agglomeration forces in manufacturing that offset the loss of the initial advantage. This early industrial boom in the gas region was driven by a unique geological circumstance that complicated the transportation of gas to distant markets and pushed gas producers to attract manufacturers to the region with offers of cheap energy. To underscore the importance of this transportability constraint, I contrast Indiana with the Appalachian gas region, which faced no such limitations and exported most of its gas to distant urban markets. Appalachian gas counties experienced only modest excess manufacturing growth. The comparison highlights that even a temporary resource boom, when used as an input in local production, can create enduring advantages for local manufacturing industries.

Word count: 2742

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1 Introduction

Are resource discoveries a blessing or a curse? Despite extensive research, there is no consensus. Resource booms have fueled early industrialization, but they can also create Dutch Disease dynamics that crowd out manufacturing. Some discoveries produce lasting growth; others end in ghost towns. This paper helps better explain why outcomes differ: when resources are used locally as manufacturing inputs—rather than sold as tradable commodities— even short-lived resource discoveries can generate long-lasting industrialization.

I study this mechanism through a major 1880s natural gas discovery in rural Indiana that, because of a unique geological circumstance, could only be used locally. Unable to sell gas to out-of-state manufacturing hubs, the region instead attracted manufacturers away from those pre-existing centers with offers of cheap, clean energy. Although the gas was depleted within two decades, the temporary manufacturing advantage spurred a swift transition out of agriculture, turning the area into a manufacturing center and sustaining decades of industrial growth.

Discovered in 1886, the Indiana gas field was the largest reservoir known at the time and had an unusual structure: it was a single contiguous 2,500-square-mile reservoir shared by more than 300,000 residents in the small communities above it. That shared ownership created a Tragedy of the Commons: towns rushed to drill for gas in a race to consume before their neighbors, and no collective efforts were taken to invest in the construction of costly long-distance pipelines—so the gas stayed local. Unable to pipe gas to distant markets, communities tried to attract manufacturers by advertising their cheap fuel, often by burning huge gas torches day and night—wasting gas and hastening the field's depletion. Efforts to ban this practice were slowed by legal challenges, and enforcement was weak. Paradoxically, the Tragedy of the Commons problem that caused widespread waste also kept the gas in local use, pushing the region into energy-intensive manufacturing and giving it a certain resilience when the field was eventually depleted—an unusual case where one market failure partly offset another.

I compare Indiana's gas region to the only other major natural gas region at the time, the Appalachian Basin. In Appalachia, gas fields were numerous, small, and geographically dispersed, so collective ownership problems were limited and a Tragedy of the Commons dynamic did not emerge. This enabled a dense network of long-distance pipelines to develop, allowing gas to be piped to large distant markets rather than used locally; as a result, the region saw only modest local manufacturing growth. Comparing the two regions helps isolate the effect of gas discoveries per se—common to both regions—from the effect of gas non-transportability—specific to Indiana.

Using county-level census data together with data I collected from archival Mineral Resources of the United States reports, state geological surveys, and historical gas and oil drilling data from the U.S. Geological Survey, I show that during the Indiana Gas Boom, counties in Indiana's gas region shifted out of agriculture faster and more intensively, and saw more than twice the manufacturing growth of comparable nearby counties. In contrast, in the Appalachian Basin—where gas was shipped to distant markets rather than used locally—gas-producing counties experienced much smaller manufacturing growth relative to similar nearby counties. A triple difference-in-differences design confirms that the effects of gas discoveries on manufacturing were significantly larger in Indiana than in Appalachia.

To show that energy abundance fueled Indiana's manufacturing boom, I reconstruct historical gas prices from archival Mineral Resources reports and compare them to coal prices. Indiana's gas was more than 30% cheaper than coal during the Gas Boom. By contrast, gas prices converged with coal prices in western Pennsylvania (then the center of Appalachian gas production) because gas was piped to energy-intensive markets as a substitute for coal rather than used locally.

The Indiana Gas Boom differed from other major U.S. resource booms. Unlike southern petroleum discoveries that encouraged trade-oriented extraction (Michaels, 2011), Indiana used its gas locally. Its boom–bust pattern resembled western mining booms (Dunn and Siodla, 2024; Jacobsen and Parker, 2016), yet Indiana proved more resilient than these towns after depletion: instead of becoming ghost towns, Indiana towns sustained the manufacturing base built during the boom and emerged as industrial centers. In this sense, Indiana's industrialization more closely resembles earlier industrialization patterns, where proximity to coal fostered manufacturing growth (Fernihough and O'Rourke, 2020; Ranestad and Sharp, 2023), than later mining patterns whereby mining towns increasingly exported their resources rather than use them locally.

The Indiana Gas Boom has a clear start and end, resembling an unintended place-based policy that temporarily lowered local manufacturing costs. This speaks to a growing literature showing that short-lived manufacturing advantages during initial phases of industrialization can have persistent effects. This literature includes papers on import protection (Juhász, 2018; Hanlon, 2020) and on large-scale public investment programs (Garin and Rothbaum, 2025; Mitrunen, 2025; Kline and Moretti, 2014). Such persistence is typically weaker or absent in non-manufacturing sectors such as agriculture (Kline and Moretti, 2014; Hornbeck and Keskin, 2015).

The paper also contributes to research on path dependence in economic geography (Bleakley and Lin, 2012; Severnini, 2023; Ciccone and Nimczik, 2022), Midwestern development during the Second Industrial Revolution (Irwin, 2003; Wright, 1990), and the history of U.S. gas and oil discoveries (Clay and Tarr, 2015), where the Indiana Gas Boom has received relatively little attention (Glass, 2000; Waples, 2012; Blanchard, 2021).

2 A Tale of Two Gas Regions

The U.S. natural gas industry effectively began in 1882 near Pittsburgh. After a brief boom-bust cycle, newly discovered gas fields expanded rapidly beyond western Pennsylvania into the broader Appalachian region starting in the late 1890s.[1] Meanwhile, about 400 kilometers west of Appalachia, a parallel gas region emerged in eastern Indiana following the 1886 discovery of the Trenton Gas Field (Figures 1 and 2).[2]

Unlike the Appalachian gas fields, Indiana's gas field was a contiguous 2,500-square-

[1] Gradually, geologists learned to better predict the location of Appalachian gas wells, so that by the late 1890s, rich gas fields were found in West Virginia, leading to decades of energy abundance. A breakthrough came with the application of the anticlinal theory in seeking new gas fields. First developed in 1883-1885, the anticlinal theory holds that oil and gas migrates underground into the porous parts of the geological rock to form reservoirs. The actionable insight was that these reservoirs are typically to be found at highest parts of the underground porous rock sections just beneath the seal—the solid, non-porous rock that does not allow the gas and oil to rise further. Consequently, gas and oil wells should be dug on the crests of anticlines. The anticlinal theory gradually came to be used to successfully predict the location of gas fields in West Virginia.

[2] Two years before this, abundant gas was found in Findlay, western Ohio, encouraging further drilling efforts in the surrounding region. This led to the discovery of the Trenton Gas Field.

mile area of gas-bearing rock (Figure 3). Its size and contiguity encouraged local consumption, as drilling was cheap and reliable: if one well failed, another nearby often succeeded. The low barrier to entry produced many small local firms drawing from the same reservoir (Figure 4), creating a Tragedy of the Commons and making the coordination required for costly long-distance pipeline construction difficult to achieve. Consequently, Indiana never developed a cross-state pipeline network.[34]

In Appalachia, on the other hand, the scattered gas fields were harder to find, raising initial search and extraction costs and drawing more established firms into the region. Rather than supplying gas to local communities, these companies mostly invested in expensive long-distance pipelines to pipe gas to increasingly distant out-of-state centers of demand (Figure 5).

[3]For a better understanding of why a dense pipeline network failed to develop in Indiana, consider the dynamics surrounding the only long-distance gas pipeline ever constructed on the Indiana gas field. Long-distance pipe-laying was still largely experimental at the time, yet by 1891 the world's longest pipeline was being built, linking the northwest corner of Indiana's gas region to Chicago. The effort to pipe gas from Indiana to Chicago met hostility from local manufacturers who relied on the shared reservoir for energy. Local manufacturers responded to the Chicago pipeline by lobbying for laws banning the sale of gas out of state. When the Supreme Court struck this down as unconstitutional, they instead lobbied for a subtler law: a "safety" statute capping pipeline pressure at 300 psi, seeking to limit the use of compression stations to pipe the gas out of the region through long-distance pipelines. Nevertheless, when gas continued to be piped to Chicago, local manufacturers turned to the state inspector for natural gas, alleging—without evidence—that the gas wasbeing piped at pressures greater than 300 psi, though this was evidently not the case.(Geology and Resources, 1886-1902) Although all attempts to prevent the piping of gas to Chicago failed, the shared nature of the gas supply in Indiana created a hostile climate toward efforts to pipe the region's gas, possibly discouraging would-be investors interested in constructing long-distance pipelines to large, distant markets. Meanwhile, a steady decline in well pressure across the Trenton Gas Field which began soon after the completion of the pipeline to Chicago—the result of waste and over-extraction practiced by the many communities of the gas region—forced the firm piping gas to Chicago to increasingly rely on expensive compression stations, thereby chipping away at the profits from selling gas to Chicago. Together, these explain why so little of the Indiana gas ended up being piped to Chicago, despite the pipeline's early completion. Other than the early long-distance pipeline to Chicago, no other long-distance pipelines were connected to the Trenton gas field, probably due to hostility from local communities and manufacturers, as well as due to the rapidly declining gas pressure of the reservoir, and to an inability to obtain full control over the reservoir so as to prevent its inevitable depletion.

[4]Gas was piped to nearby communities outside the gas region, in Indiana and western Ohio, but these communities were quite small, and the piping of gas to them did not threaten the supply of gas for local manufacturers in the same way that the potential piping of gas to Chicago would have done.

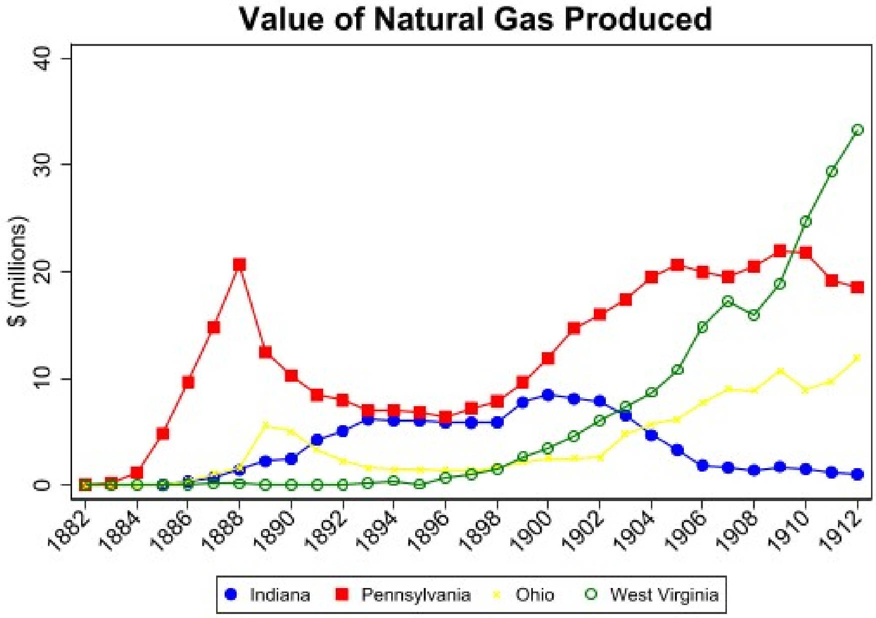

FIGURE 1: VALUE OF NATURAL GAS BY STATE

I reconstruct the state-level aggregate value of natural gas from the annual Mineral Resources of the United States reports and adjust for inflation using 1880 as the base year. I measure the value of natural gas as total sales reported by gas extraction firms. Commercial extraction began in western Pennsylvania in the early 1880s and then spread temporarily to western Ohio and Indiana. West Virginia entered later, becoming a major producer only around the turn of the twentieth century. Although large gas fields were discovered across southern and western states during the first decade of the 1900s, I do not include them here because they are less relevant to my purpose: comparing the Appalachian Basin region—West Virginia, eastern Ohio, and western Pennsylvania—with the Indiana Gas Region.

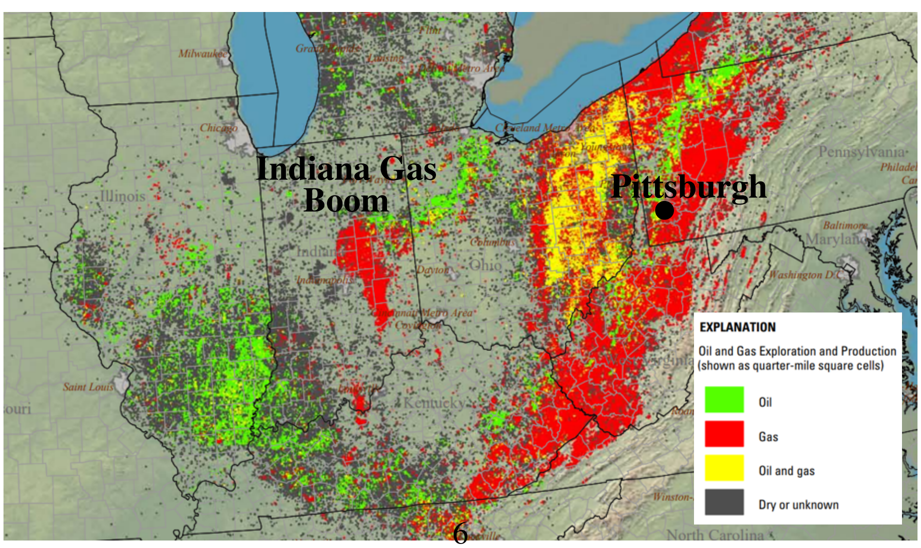

FIGURE 2: GAS AND OIL EXPLORATION MAP

Map of historical oil and gas exploration (U.S. Geological Survey 2024). The Trenton Gas Field is clearly visible in east-central Indiana, while the Lima-Indiana oil field stretches to its northeast. The Appalachian Basin is also clearly visible, showing that eastern Ohio was rich with oil, while western Pennsylvania was rich with both oil and natural gas, and West Virginia rich predominantly with gas.

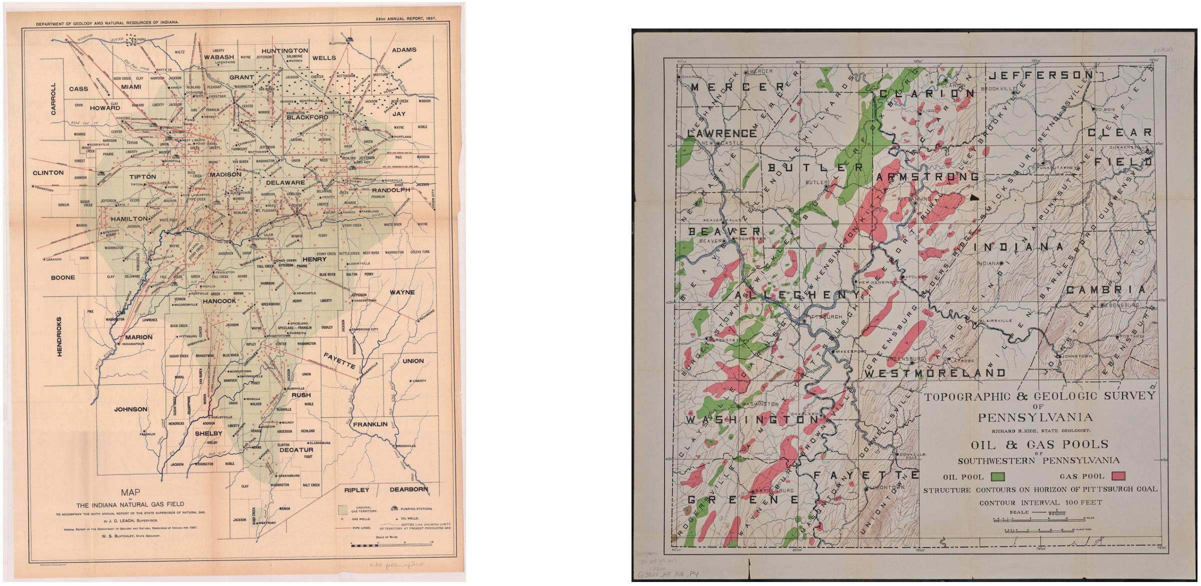

FIGURE 3: MAPS OF GAS FIELDS

The lefthand map is taken from Indiana Geological Survey for 1897. In it, one can see the contiguous Indiana gas region stretching across numerous counties in the region. The righthand map was created by the Pennsylvania Geological Survey in 1916. The belt-shaped reservoirs trend along the regional anticlines, as is clearly indicated on the map.

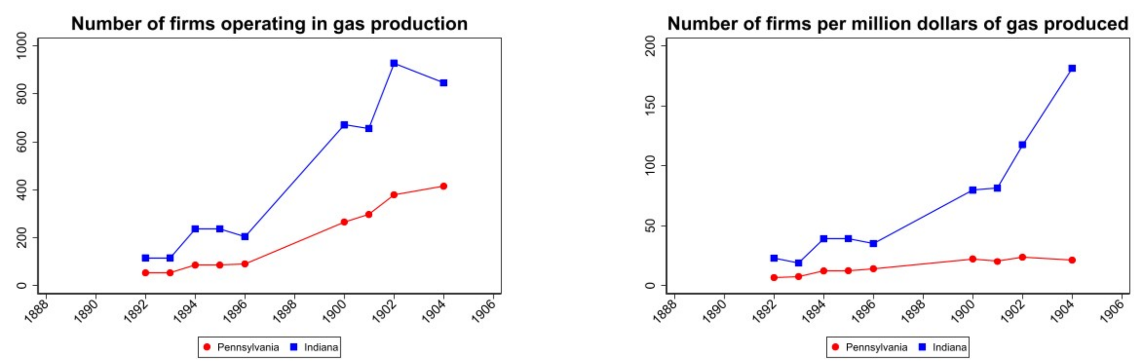

FIGURE 4: NUMBER OF GAS PRODUCING FIRMS BY STATE

The Mineral Resources of the United States reports record the number of gas-extraction firms operating in Indiana, Pennsylvania, and Ohio; they do not report West Virginia. I omit Ohio from the figure because it contains two distinct gas fields: a western Ohio field that operated only briefly in the 1880s, and an eastern Ohio field that continues the western Pennsylvania fields and is therefore part of the Appalachian Basin gas region. Because western Pennsylvania was the primary Appalachian Basin natural-gas producer in the 1890s, it is the appropriate comparison with Indiana here. During the Indiana Gas Boom, the Indiana gas region had far more firms than the Appalachian gas region ever did. These firms were typically small and local: dividing the number of firms by the aggregate value of gas produced (in 1880 prices) shows that Indiana's proliferation of gas firms was driven by small, low-value firms.

Locally constrained consumption pushed Indiana gas prices below that of Appalachian gas and also made gas cheaper relative to coal. I reconstruct historical gas prices using the estimated value of displaced coal, data on the aggregate value of gas consumed, and coal prices, all from the Mineral Resources reports (Equation 1).[5] Because coal is measured in tons and gas in millions of cubic feet, the reconstructed gas price is the per-unit value of gas that yields the same energy output as one ton of coal.

$$\widetilde{\text{Price Gas}}_{\$/\text{TC}} = \left(\frac{\text{Value Gas Consumed}_{\$}}{\text{Value Coal Replaced}_{\$}}\right) \times \text{Price Coal}_{\$/\text{TC}} \tag{1}$$

Because coal and gas were near-perfect manufacturing substitutes, their prices nearly converged in Pennsylvania (Figure 6). In Indiana, on the other hand, gas was used locally, whereas the price of coal – being a traded good – is determined nationally, net of transportation costs. This explains why in Indiana, where gas was constrained to local use, the price differential was large.

Finally, I reconstruct a state-level time series of natural gas supply (Figure 7), showing that gas in Indiana had begun to decline by 1901.[6] I also collect data from annual reports

[5]Unlike coal or oil, gas production was inferred from well pressure, which fluctuated seasonally and even daily. Measuring consumption of gas posed similar obstacles: pipelines connected wells to households and manufacturing establishments, where there were few reliable methods to track actual use. Although meters were introduced in 1891, they proved impractical for large consumers, particularly energy-intensive manufacturers. Consequently, neither producers nor consumers had accurate knowledge of the volume of natural gas consumed, leading to unconventional pricing arrangements. In Indiana, households typically paid flat monthly rates, while manufacturers often paid fixed, goods-specific charges tied to output—for example, a glass producer might pay a predetermined fee for the estimated flow needed to make a particular glass product (as a result, actual prices per cubic foot of gas were not systematically recorded until 1906). Fortunately, beginning in 1892, the Mineral Resources of the United States reports included state-level estimates of the value of coal displaced by natural gas. These estimates were based on surveys: glass, iron, and steel manufacturers were asked to report the amount of coal they replaced after switching to gas, along with the resulting cost savings. Deriving these figures for Indiana was more complex. Before the gas boom, the Indiana gas region's manufacturing sector was small, so there was little evidence of coal use in manufacturing. The Mineral Resources reports addressed this by combining their data on coal-gas substitution in Pennsylvania with rough estimates of local coal-gas substitutability provided by knowledgeable individuals in Indiana's gas region. The reports estimated how much coal would counterfactually have been consumed to achieve the same manufacturing output that is produced using natural gas, and then multiplied those counterfactual coal quantities by prevailing local coal prices.

[6]The geological surveys of the state of Indiana describe the collapse of gas supply in 1901 as a turning point, after which local firms stopped relying on natural gas and instead transitioned to coal-based fuels. Although compression stations were built in the following years to make the most of the remaining gas supply,

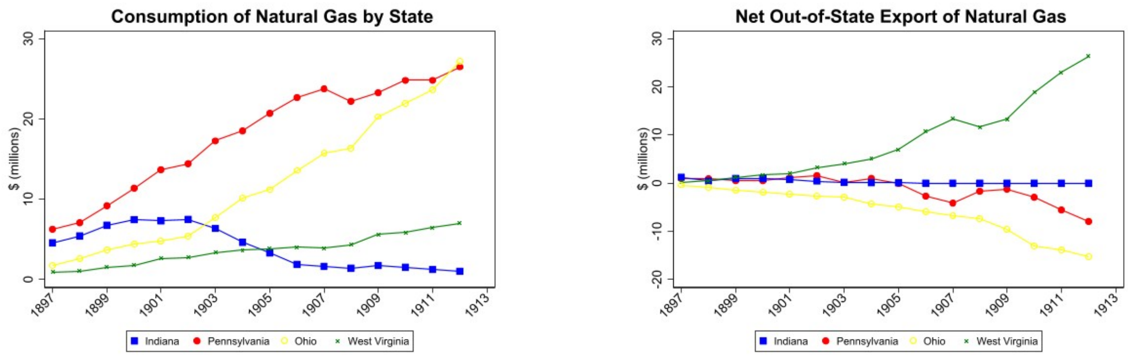

FIGURE 5: NATURAL GAS CONSUMPTION AND EXPORTS BY STATE

I reconstruct state-level net exports and consumption of natural gas using the annual Mineral Resources of the United States reports, adjusting for inflation to 1880 dollars. Several patterns stand out. First, West Virginia was a net exporter of gas, while Pennsylvania and Ohio were net importers. Historically, they imported most of the gas they consumed from the West Virginia fields. West Virginia remained an exporter and never became a large consumer. In terms of consumption, Ohio and Pennsylvania were the largest consumers, briefly rivaled by Indiana during the Indiana Gas Boom. During that boom, Indiana was self-sufficient—neither importing nor exporting a significant share of its gas. After the end of the Indiana Gas Boom, Indiana remained only a very minor consumer.

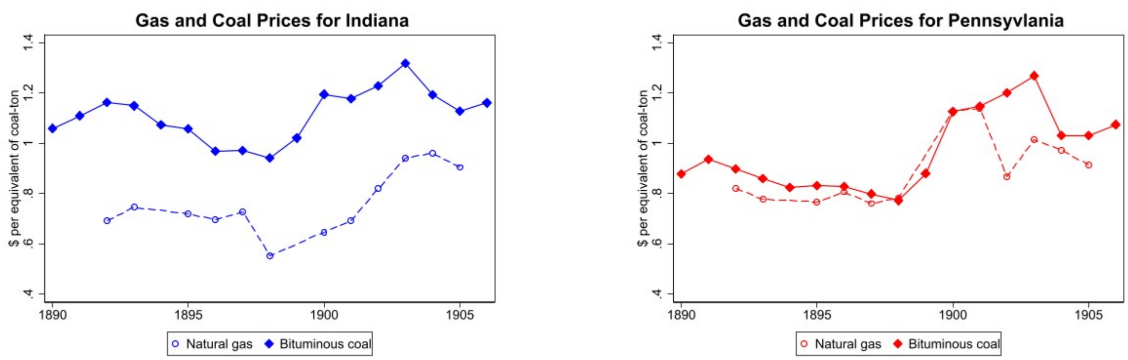

FIGURE 6: NATURAL GAS AND BITUMINOUS COAL PRICES

This figure shows, separately for Indiana and Pennsylvania, the price per ton of bituminous coal and the price of natural gas per energy equivalent of one ton of bituminous coal. I include only Indiana and Pennsylvania, omitting Ohio and West Virginia, for two reasons. First, the key variable for reconstructing gas prices—the value of coal replaced by gas—was recorded in the Mineral Resources of the United States reports for Indiana, Pennsylvania, and Ohio, but not for West Virginia. Second, I exclude Ohio because it contains two distinct gas fields: a western Ohio field that operated only briefly in the 1880s, and an eastern Ohio field that continues the western Pennsylvania fields and is therefore part of the Appalachian Basin gas region. Because western Pennsylvania was the primary Appalachian Basin natural gas producer in the 1890s, it is the appropriate comparison with Indiana here. Because bituminous coal and natural gas were near-perfect substitutes for smithing and manufacturing, the figure shows how, in Indiana, the discovery of natural gas led to a local energy-price advantage, giving the Indiana gas region a comparative advantage in energy costs. In Pennsylvania, where gas was primarily piped to large cities such as Pittsburgh, coal and natural-gas prices converge. Prices are adjusted for inflation to 1880 dollars.

of the Directory of the Iron and Steel Association to construct Figure 8, which presents a time series of iron and steel manufacturers in the Indiana gas region for 1882–1908.[7]

Figure 8 highlights three key points: First, there was no iron or steel manufacturing in the region before the Indiana Gas Boom. Second, during the boom, all iron and steel producers relied on natural gas. Third, when gas supplies collapsed in 1901, the number of manufacturing towns fell and surviving firms shifted from natural gas to coal-based fuels.

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gas was nonetheless used from then on for domestic purposes only, before running out altogether. From a manufacturing perspective, the Indiana Gas Boom ended in 1901. The first challenge in reconstructing the time series—obtaining natural gas prices—I discussed above. Then, because the value of gas consumed equals the quantity consumed times its price, I can deduce the quantity of gas supply for 1892-1905 by dividing the value of gas consumed by the selling price of gas. Starting in 1906, however, the Mineral Resources reports stopped recording the value of coal replaced, and began to systematically record annual cubic feet of gas produced by state. The challenge, therefore, is converting from energy-equivalent units of tons of coal—which I use in 1892-1905— to cubic feet of gas. Thankfully, in the 1895 geological survey of the state of Indiana, the state supervisor for natural gas discusses how to convert cubic feet of gas to units of coal: "Less than seven cubic feet of gas will do the work of one pound of Pittsburgh coal, or less than 14,000 cubic feet of gas are practically equal to one ton of Pittsburgh coal."

[7] The Iron and Steel Association, a lobbying group for iron and steel producers in the United States, submitted annual reports to the U.S. Congress that contained detailed lists of all iron and steel manufacturers in the United States, including details such as the year of opening, type of product, and type of fuel being used. The reports sometimes also document the geographic relocation of firms, as well as their activity status – whether they are open or closed per year of the report. Based on these, I show in Figure 10 a constructed a time series of iron and steel manufacturers in the Indiana gas region for 1882-1908. There exists a difficulty working with the firm-level data, as it is difficult to track firms over time—across reports—due to changing names of firms and ownership structures, such as consolidations or break-ups of firms. Instead, I aggregate the data to the town level, and track the number of towns in the Indiana gas region that saw iron or steel production for the relevant period, by type of fuel being used.

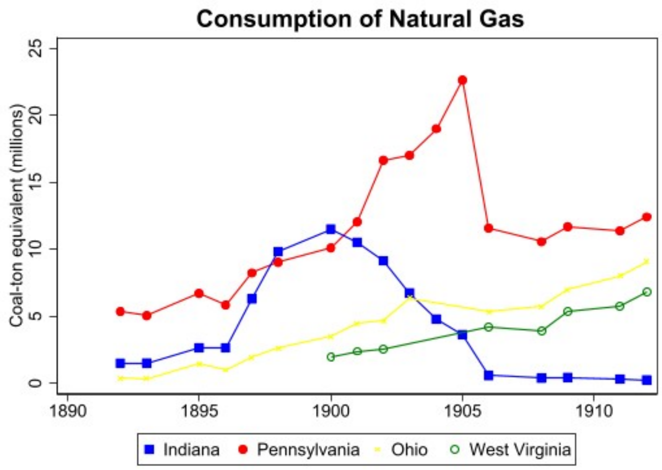

FIGURE 7: QUANTITY OF NATURAL GAS CONSUMED

This figure shows the reconstructed annual quantity of natural gas consumed by state, measured in energy equivalent units of tons of bituminous coal. The source data were collected from the Mineral Resources of the United States reports. Several points are noteworthy. First, the center of Appalachian Basin natural gas consumption was always Pennsylvania, where Pittsburgh is located. Indiana temporarily rivaled Pennsylvania in gas consumption, but this ended with the decline of Indiana's gas supply in 1901. After the turn of the century, Ohio—and even West Virginia—saw increasing natural gas consumption as networks of long-distance pipelines became integrated and gradually brought natural gas to many towns in the region (which, by then, was produced predominantly in West Virginia).

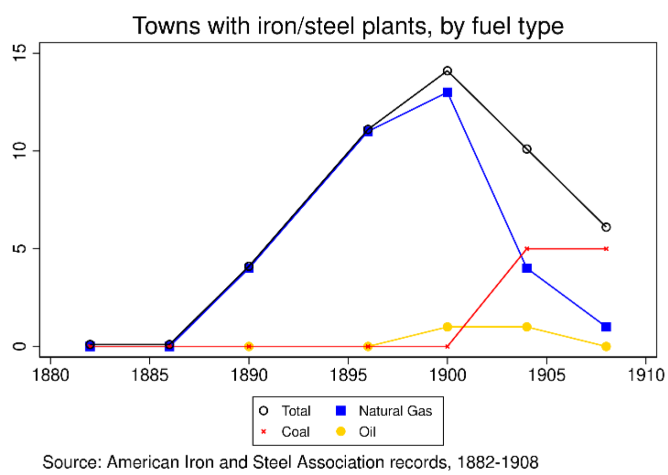

FIGURE 8: IRON PRODUCERS' TRANSITION AWAY FROM NATURAL GAS

This figure reports the towns in the Indiana Gas Region where iron producers were located. The data on iron producers come from the American Iron and Steel Association records, which report firm-level data on iron and steel producers. However, firms change names and ownership structures over time, making it difficult to construct a reliable panel dataset. Instead, I report iron and steel manufacturing at the town level. Several points are noteworthy in this figure. First, before the Indiana Gas Boom, which began in 1886, there was no iron production in the Indiana gas region. Second, virtually all iron producers relied on natural gas for the duration of the Gas Boom, which lasted until 1901. Third, when gas supply collapsed after 1901, iron firms either shut down, relocated, or switched to coal-based fuels.

3 County-level Data

County-level data come from full-count decennial U.S. Census of Population samples for 1860–1950 (Ruggles et al., 2024), supplemented with Census of Manufactures and Agriculture data compiled by Haines (Haines, 2010). For later years—when full-count population data are not public—I use County Business Patterns data digitized by Fabian Eckert (Eckert, Fort, et al., 2021) (Eckert, Lam, et al., 2022). Historical railway data are from the work of Jeremy Atack (Atack, 2016), market-access measures from Richard Hornbeck's work (Hornbeck and Rotemberg, 2024), and additional county variables for 1960–2010 from IPUMS NHGIS. Gas- and oil-rich counties are identified using state and national geological surveys and a historical U.S. Geological Survey drilling database (Skinner et al., 2022).[8]

4 Empirical Strategy and Results

I begin by analyzing effects of the Indiana Gas Boom, for which I construct treatment and comparison groups to satisfy the parallel-trends assumption. The treatment group includes all counties in the Indiana gas field, excluding those with significant oil discoveries and the one highly urbanized county.[9] This yields fifteen similarly agricultural treated counties, all with railroad connectivity by 1880. The comparison group consists of similarly agricultural counties in Indiana and neighboring Ohio, Michigan, and Illinois, excluding counties without railroad connectivity in 1880, with fewer than 40% of residents living on farms, or

[8]This data has been collected by the U.S. Geological Survey and is composed of several non-public datasets on historical oil and gas wells. Data on well drilling is aggregated to square miles. I further aggregate these data to count the total number of oil and gas wells drilled in each county, in each decade. The number of gas and oil wells drilled by decade is a rough measure for local abundance of gas and oil, as there is large variation in the richness of wells. Unfortunately, accurate data on gas and oil flows does not exist systematically for my period of interest. I therefore use the number of wells drilled as an imperfect proxy for local resource abundance. The reasoning is that, in places with succesful gas and oil drilling, drilling will persist so long as the region continues to discover abundant reserves. Once an area dries out, drilling in that area will gradually cease.

[9]This county had over 33% of its population living in towns in 1880, and had double the population that year of all other counties in the gas region.

with any history of major gas or oil discoveries.[10]

For robustness checks, I restrict the comparison group to counties above the 80th percentile in market access to better match the treatment group. I also implement a "doughnut" strategy by excluding counties adjacent to the Indiana gas field. In addition, I omit any region with substantial coal discoveries, drop counties adjacent to coal regions, and exclude Ohio counties bordering Appalachia. Finally, I estimate specifications that remove Chicago-adjacent counties from the comparison group.[11] Figure 9 shows the treatment and comparison groups under the least restrictive as well as under the most restrictive specification. Descriptive statistics for the restrictive specification appear in Table 1.

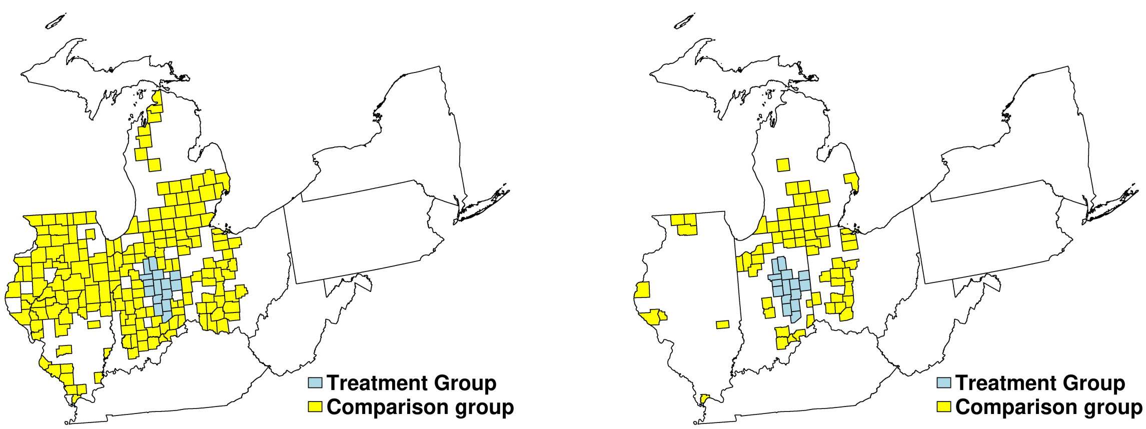

FIGURE 9: TREATMENT AND COMPARISON GROUPS FOR THE INDIANA GAS REGION

These maps show the treatment and comparison groups for the Indiana gas region under two specifications. The left-hand map depicts the base specification, in which the sample is restricted to rural counties with rail connectivity in 1880. The right-hand map depicts the most restrictive specification, in which counties below the 80th percentile in Market Access are omitted, as are "Doughnut" counties, coal counties, coal-adjacent counties, Appalachian Basin-adjacent counties, and Chicago-adjacent counties.

[10]Kentucky is not included because, as a former slave-state, is likely to be different along unobserved dimensions.

[11]It can be shown that World War II factory subsidies heavily favored Chicago and its surrounding counties, making it an outlier relative to the largely rural pattern of wartime industrial expansion. Therefore, including Chicago in the comparison group could bias downward my estimates of manufacturing persistence in the Indiana gas region after the 1940s. (Garin and Rothbaum, 2025)

TABLE 1: COUNTY DESCRIPTIVE STATISTICS IN 1880 INDIANA GAS REGION

	Treatment group	Comparison group	Difference (t-statistic)
Total Population	22,221.13	24,398.67	-1.42
	(3,756.37)	(9,538.46)	
% Living on Farm	58.44	56.88	0.94
	(5.14)	(1.02)	
% Employed in Manufacturing	3.33	3.53	-0.68
	(0.90)	(1.63)	
% Urban	11.06	12.47	-0.48
	(9.78)	(13.0)	
Farm Value per Acre	38.59	38.53	-0.03
	(13.17)	(5.1)	
Market Access Percentile	98.00	92.33	5.80
	(2.48)	(5.98)	
Number of Counties	15	64	

Group means shown; standard deviations in parentheses on the following line. The "Difference (t-statistic)" column reports the t-statistic from regressing the variable described on a dummy variable indicating the treatment group, using robust standard errors. Note that parallel trends, not similar levels, is the identification assumption. This table is only meant to describe the underlying sample.

Using a difference-in-differences framework, I estimate the following empirical specification:[12]

$$Y_{ct} = \alpha + I_c + I_t + \sum_{k \neq 1880} \beta_k \, I(t = k) \, I(\text{TreatmentGroup}_c) + \varepsilon_{ct} \tag{2}$$

Y_{ct} represents the outcome of interest for county c in year t. The term α is a constant, I_c denotes county fixed effects, and I_t denotes time fixed effects. The variable $I(\text{TreatmentGroup}_c)$ is an indicator for whether county c is in the Indiana gas field, and it is interacted with indicator variables for pre-treatment decadal years (1860 and 1870) and the post-treatment decadal years (1890–2010).[13] ε_{ct} is an error term.[14]

[12] Whenever feasible, I use the logs of outcome variables, but because zero or near-zero values present challenges for logs (and also complicate the interpretation of logs), I use the de-logged form for variables that are typically zero in the pre-treatment period.

[13] The final pre-treatment decadal year, 1880, is omitted.

[14] Conley standard errors (with a 200km cut-off and temporal correlation) are used. As a robustness check, I also run these regressions while clustering standard errors by county. The standard errors do not meaningfully change.

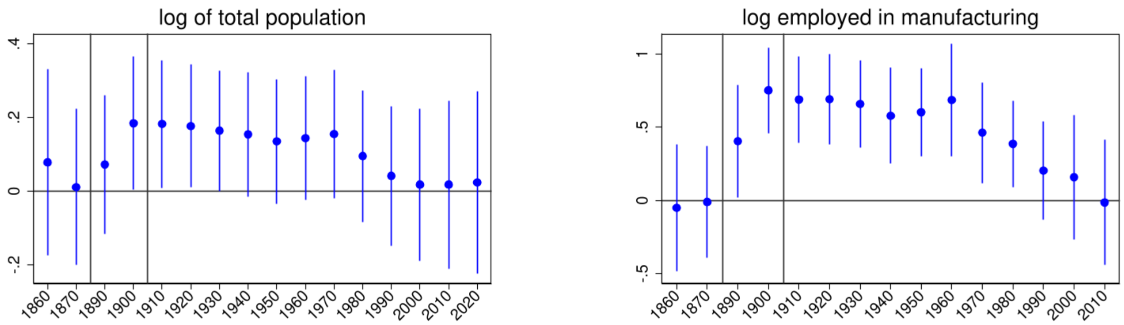

FIGURE 10: POPULATION AND MANUFACTURING GROWTH IN INDIANA

In the left panel, I show coefficients $\hat{\beta}_t$ for the log of total population. In the right panel, I show coefficients $\hat{\beta}_t$ for the log of aggregate manufacturing employment by county. Manufacturing is defined using the variable IND1950 from IPUMS USA. Manufacturing is all cases where IND1950 includes 3-digit values ranging from 306 to 499. Because the 1890 census of population was lost in a fire, I use in 1890 log of the aggregate reported employment in manufacturing taken from Haines (2010). Confidence intervals are constructed using Conley standard errors (200km cut-off).

Figure 10 shows that the Indiana Gas Boom led to increased population density (left) largely through manufacturing growth (right): treated counties experienced excess manufacturing growth of over 0.7 log points (roughly a doubling). The effect persisted after depletion and only began to fade in the late twentieth century, while manufacturing wages became permanently higher (Table 2). Manufacturing initially concentrated in glass and iron (Table 3), then later diversified into machinery and automobiles (Table 4). Together, these patterns point to agglomeration economies that sustained manufacturing even after the gas was depleted.

TABLE 2 - INDIANA GAS REGION REGRESSIONS

Panel A: Manufacturing employment

VARIABLES	(1) $\ln\left(\frac{mnfct}{non-mnfct}\right)$	(2) $\ln\left(\frac{mnfct}{non-mnfct}\right)$	(3) $\ln\left(\frac{mnfct}{non-mnfct}\right)$	(4) $\ln\left(\frac{mnfct}{non-mnfct}\right)$	(5) $\ln\left(\frac{mnfct}{non-mnfct}\right)$	(6) $\ln\left(\frac{mnfct}{non-mnfct}\right)$
β_{1900}	0.410***	0.423***	0.390***	0.380**	0.387***	0.343**
	(0.144)	(0.148)	(0.142)	(0.149)	(0.150)	(0.168)
β_{1950}	0.502***	0.510***	0.441***	0.431***	0.472***	0.458***
	(0.105)	(0.109)	(0.104)	(0.109)	(0.108)	(0.117)
Constant	0.000	0.000	-0.000	0.000	-0.000	0.000
	(0.019)	(0.019)	(0.019)	(0.020)	(0.021)	(0.025)
Observations	3,112	2,856	2,478	2,143	2,000	1,264
R-squared	0.009	0.010	0.010	0.010	0.012	0.015
Drop doughnut	No	Yes	Yes	Yes	Yes	Yes
Limit by MA	No	No	Yes	Yes	Yes	Yes
Drop coal regions	No	No	No	Yes	Yes	Yes
drop Chicago doughnut	No	No	No	No	Yes	Yes
Drop coal doughnut	No	No	No	No	No	Yes
Drop Appalachian doughnut	No	No	No	No	No	Yes

Conley standard errors (200km cut-off) in parentheses.
*** p<0.01, ** p<0.05, * p<0.10

Panel B: Manufacturing wages

VARIABLES	(1) lg(wages)	(2) lg(wages)	(3) lg(wages)	(4) lg(wages)	(5) lg(wages)	(6) lg(wages)
β_{1900}	0.252***	0.254***	0.260***	0.256***	0.259***	0.263***
	(0.035)	(0.038)	(0.035)	(0.034)	(0.036)	(0.035)
β_{1950}	0.191***	0.199***	0.187***	0.168***	0.166***	0.157***
	(0.038)	(0.040)	(0.037)	(0.036)	(0.037)	(0.035)
Constant	0.000	0.000	0.000	-0.000	-0.000	-0.000
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Observations	1,713	1,570	1,365	1,180	1,099	700
R-squared	0.019	0.021	0.025	0.025	0.028	0.043
Drop doughnut	No	Yes	Yes	Yes	Yes	Yes
Limit by MA	No	No	Yes	Yes	Yes	Yes
Drop coal regions	No	No	No	Yes	Yes	Yes
drop Chicago doughnut	No	No	No	No	Yes	Yes
Drop coal doughnut	No	No	No	No	No	Yes
Drop Appalachian doughnut	No	No	No	No	No	Yes

Conley standard errors (200km cut-off) in parentheses.
*** p<0.01, ** p<0.05, * p<0.10

Drop doughnut option refers to the doughnut around the Indiana gas region treatment group. Limit by MA means limiting the sample to include only counties with market access above the 80th percentile. Coal regions are defined as any county in which, in any decade during 1860–2000, there were at least 400 people employed in coal mining. The coal doughnut is the set of counties that form doughnuts around coal regions. The Appalachian doughnut refers to the set of counties in Ohio that border the Appalachian region. The "Drop Chicago" option refers to dropping any county whose centroid is within 100km from Chicago.

TABLE 3 - INDIANA GAS REGION REGRESSIONS

Panel A: Glass manufacturing

VARIABLES	(1) %glass	(2) %glass	(3) %glass	(4) %glass	(5) %glass	(6) %glass
β_{1900}	2.938***	2.938***	2.933***	2.927***	2.925***	2.919***
	(0.513)	(0.513)	(0.513)	(0.515)	(0.515)	(0.512)
β_{1950}	1.775***	1.768***	1.728***	1.780***	1.762***	1.928***
	(0.613)	(0.614)	(0.615)	(0.619)	(0.621)	(0.614)
Constant	-0.000	0.000	0.000	0.000	-0.000	-0.000
	(0.014)	(0.015)	(0.017)	(0.019)	(0.020)	(0.023)
Observations	1,755	1,611	1,395	1,206	1,125	711
R-squared	0.146	0.147	0.148	0.162	0.160	0.229
Drop doughnut	No	Yes	Yes	Yes	Yes	Yes
Limit by MA	No	No	Yes	Yes	Yes	Yes
Drop coal regions	No	No	No	Yes	Yes	Yes
drop Chicago doughnut	No	No	No	No	Yes	Yes
Drop coal doughnut	No	No	No	No	No	Yes
Drop Appalachian doughnut	No	No	No	No	No	Yes

Conley standard errors (200km cut-off) in parentheses.
*** p<0.01, ** p<0.05, * p<0.10

Panel B: Iron manufacturing

VARIABLES	(1) %iron	(2) %iron	(3) %iron	(4) %iron	(5) %iron	(6) %iron
β_{1900}	1.319**	1.320**	1.281**	1.260**	1.315**	1.272**
	(0.513)	(0.518)	(0.526)	(0.531)	(0.529)	(0.524)
β_{1950}	1.477**	1.451**	1.254**	1.135*	1.614**	1.680***
	(0.603)	(0.621)	(0.632)	(0.644)	(0.645)	(0.616)
Constant	0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.055)	(0.059)	(0.064)	(0.071)	(0.045)	(0.042)
Observations	1,755	1,611	1,395	1,206	1,125	711
R-squared	0.014	0.014	0.012	0.011	0.042	0.065
Drop doughnut	No	Yes	Yes	Yes	Yes	Yes
Limit by MA	No	No	Yes	Yes	Yes	Yes
Drop coal regions	No	No	No	Yes	Yes	Yes
drop Chicago doughnut	No	No	No	No	Yes	Yes
Drop coal doughnut	No	No	No	No	No	Yes
Drop Appalachian doughnut	No	No	No	No	No	Yes

Conley standard errors (200km cut-off) in parentheses.
*** p<0.01, ** p<0.05, * p<0.10

Drop doughnut option refers to the doughnut around the Indiana gas region treatment group. Limit by MA means limiting the sample to include only counties with market access above the 80th percentile. Coal regions are defined as any county in which, in any decade during 1860–2000, there were at least 400 people employed in coal mining. The coal doughnut is the set of counties that form doughnuts around coal regions. The Appalachian doughnut refers to the set of counties in Ohio that border the Appalachian region. The "Drop Chicago" option refers to dropping any county whose centroid is within 100km from Chicago.

TABLE 4 - INDIANA GAS REGION REGRESSIONS

Panel A: Machinery manufacturing

VARIABLES	(1) %mchnry	(2) %mchnry	(3) %mchnry	(4) %mchnry	(5) %mchnry	(6) %mchnry
β_{1900}	0.075	0.102	0.067	0.029	0.026	-0.061
	(0.836)	(0.885)	(0.935)	(0.996)	(1.035)	(0.824)
β_{1950}	5.080***	5.465***	4.941***	4.557***	4.578***	3.621***
	(1.200)	(1.275)	(1.324)	(1.378)	(1.440)	(1.147)
Constant	-0.000	0.000	0.000	0.000	0.000	-0.000
	(0.135)	(0.141)	(0.155)	(0.169)	(0.179)	(0.121)
Observations	1,755	1,611	1,395	1,206	1,125	711
R-squared	0.023	0.028	0.024	0.022	0.023	0.032
Drop doughnut	No	Yes	Yes	Yes	Yes	Yes
Limit by MA	No	No	Yes	Yes	Yes	Yes
Drop coal regions	No	No	No	Yes	Yes	Yes
drop Chicago doughnut	No	No	No	No	Yes	Yes
Drop coal doughnut	No	No	No	No	No	Yes
Drop Appalachian doughnut	No	No	No	No	No	Yes

Conley standard errors (200km cut-off) in parentheses.
*** p<0.01, ** p<0.05, * p<0.10

Panel B: Automobile manufacturing

VARIABLES	(1) %auto	(2) %auto	(3) %auto	(4) %auto	(5) %auto	(6) %auto
β_{1900}	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.711)	(0.756)	(0.808)	(0.867)	(0.903)	(0.714)
β_{1950}	3.166***	3.222***	3.050***	2.652**	2.451*	2.352**
	(1.077)	(1.113)	(1.159)	(1.212)	(1.255)	(1.095)
Constant	-0.000	-0.000	0.000	-0.000	-0.000	-0.000
	(0.109)	(0.118)	(0.130)	(0.143)	(0.150)	(0.089)
Observations	1,755	1,611	1,395	1,206	1,125	711
R-squared	0.018	0.019	0.017	0.014	0.012	0.035
Drop doughnut	No	Yes	Yes	Yes	Yes	Yes
Limit by MA	No	No	Yes	Yes	Yes	Yes
Drop coal regions	No	No	No	Yes	Yes	Yes
drop Chicago doughnut	No	No	No	No	Yes	Yes
Drop coal doughnut	No	No	No	No	No	Yes
Drop Appalachian doughnut	No	No	No	No	No	Yes

Conley standard errors (200km cut-off) in parentheses.
*** p<0.01, ** p<0.05, * p<0.10

Drop doughnut option refers to the doughnut around the Indiana gas region treatment group. Limit by MA means limiting the sample to include only counties with market access above the 80th percentile. Coal regions are defined as any county in which, in any decade during 1860–2000, there were at least 400 people employed in coal mining. The coal doughnut is the set of counties that form doughnuts around coal regions. The Appalachian doughnut refers to the set of counties in Ohio that border the Appalachian region. The "Drop Chicago" option refers to dropping any county whose centroid is within 100km from Chicago.

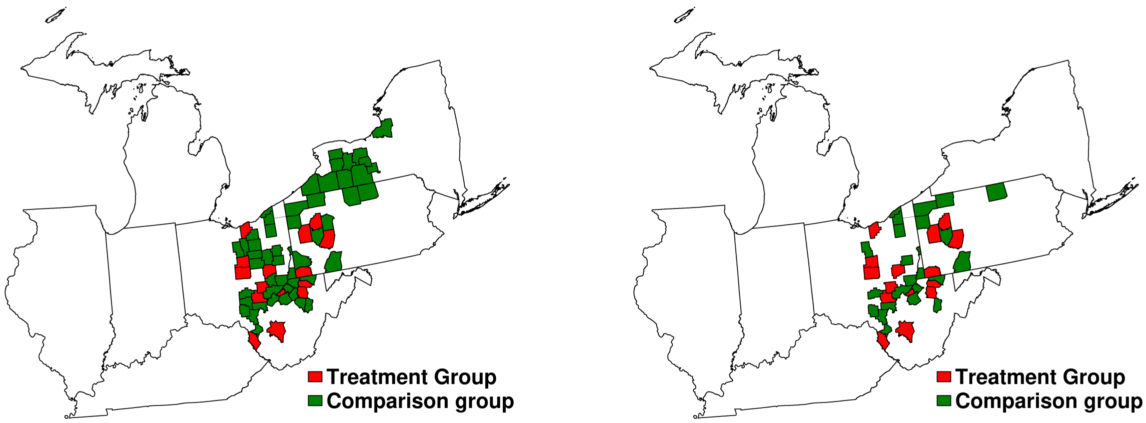

FIGURE 11: TREATMENT AND COMPARISON GROUPS FOR THE APPALACHIAN BASIN GAS REGION

These maps show the treatment and comparison groups for the Appalachian Basin gas region under two specifications. The left map depicts the base specification, where the sample is limited to rural counties with rail connectivity in 1890. The right map depicts a more restrictive specification, which omits counties in the middle quintile in terms of number of gas wells in 1900–1950. It also drops New York state.

I next examine the Appalachian gas region, where natural gas was sold as a tradable commodity rather than primarily used locally.[15] Because county-level gas production data are not systematically available for my study period, I use a U.S. Geological Survey dataset of all natural gas wells ever recorded (Skinner et al., 2022). I aggregate the data to the county level and, for each decade, compute wells drilled per county. I define "high-gas" treatment counties as those in the top quintile of total wells drilled over 1900–1950.

I restrict the sample to agricultural counties with railroad connectivity (as of 1890).[16] I construct four comparison groups: with and without middle-quintile counties in terms of gas extraction; and with and without including New York state (which is at the periphery of Appalachia). Figure 11 maps the most and the least restrictive specifications, and Table 5 reports descriptive statistics for the latter specification.

Unlike Indiana, Appalachia has substantial overlap among coal, oil, and gas fields,

[15] Another key difference is that, while the Indiana Gas Boom lasted for less than twenty years, the Appalachian Basin region experienced decades of abundant natural gas.

[16] I use railway connectivity in 1890 rather than 1880 because the sample is already quite thin. Moreover, because of the thins sample, I choose not to omit Doughnut counties—this is less important than in Indiana, because the gas-rich counties of the Appalachian Basin were more geographically dispersed than in Indiana, and did not form a single contiguous geographic unit.

TABLE 5: COUNTY DESCRIPTIVE STATISTICS IN 1880 APPALACHIAN BASIN GAS REGION

	Treatment group	Comparison group	Difference (t-statistic)
Total Population	28,772.87	30,623.42	-0.47
	(12,023.96)	(17,672.9)	
% Living on Farm	54.89	53.9	0.36
	(9.22)	(10.46)	
% Employed in Manufacturing	3.13	4.04	-2.89
	(0.8)	(1.69)	
% Urban	7.43	10.305	-1.03
	(9.41)	(10.57)	
Farm Value per Acre	31.53	36.35	-1.20
	(12.8)	(16.95)	
Market Access Percentile	83.73	82.65	0.31
	(10.93)	(14.92)	
% Employed in Coal Mining	1.24	0.68	1.15
	(1.85)	(1.09)	
% Employed in Oil Mining	0.467	0.093	1.22
	(1.2)	(0.23)	
Avg Max Gas Pressure 1906-1908	434.29	332.74	1.13
	(295.29)	(298.72)	
Avg Max Gas Pressure 1912-1916	513.59	369.77	2.20
	(189.62)	(263.32)	
# of Gas Wells 1900	162.4	24.52	2.04
	(263.09)	65.09	
# of Gas Wells 1910	162.87	16.32	2.86
	(201.7)	(25.02)	
# of Gas Wells 1920	257.73	211.41	3.77
	(50.66)	(78.96)	
# of Gas Wells 1930	338.53	52.45	4.98
	(223.33)	(62.67)	
# of Gas Wells 1940	219.466	46.66	6.17
	(106.78)	(46.24)	
# of Gas Wells 1950	296.2	57.05	5.15
	(176.86)	(79.17)	
Number of Counties	15	52	

Group means shown; standard deviations in parentheses on the following line. The “Difference (t-statistic)” column reports the t-statistic from regressing the variable described on a dummy variable indicating the treatment group, using robust standard errors. Note that parallel trends, not similar levels, is the identification assumption. This table is only meant to describe the underlying sample so it is hard to pre-select a sample that excludes coal or oil areas. Instead, I control for coal-mining and oil-drilling intensity (signified by X_{ct}).[17][18] I use the following regression framework:[19]

$$Y_{ct} = \alpha + I_c + I_t + \sum_{k \neq 1880} \delta_k \, I(t = k) \, I(\text{TreatmentGroup}_c) + X_{ct} + \varepsilon_{ct} \tag{3}$$

Appalachian gas fields also experienced some growth in population density, but this did not translate into substantially increased manufacturing intensity (Figure 12).[20] Instead, the increase was driven mainly by expansion in the services sector (Table 6), likely reflecting wealth effects from gas-related windfalls.

[17] Gas and oil regions were often discovered in proximity to one another, making it hard to disentangle the effect of gas discoveries from that of oil discoveries. Fortunately, the overlap was not complete. Some regions, such as western Pennsylvania, were rich in both gas and oil, while others—notably the gas fields of West Virginia—were disproportionately gas-intensive relative to oil. Thus, although every gas region also had oil and every oil region also had gas, there was variation in the relative intensity of gas and oil production, allowing me to disentangle the effects of oil and gas.

[18] Controlling for oil drilling is not a bad control because gas drillers could not know ex ante whether a well would produce oil, gas, or both; the oil–gas mix can therefore be treated as quasi-random. Controlling for coal mining is likewise not a bad control under the assumption that where coal exists in the Appalachian Basin and is reachable by rail, it will be mined. Because I already restrict the sample to counties with sufficient rail connectivity, coal mining can be treated as a natural consequence of coal presence rather than economic activity induced by gas discoveries. I proxy county-level oil production intensity with oil-well prevalence, since annual county production data are not systematically recorded (as with gas). I control for coal mining employment directly.

[19] The inverted hyperbolic sine is useful because it behaves similarly to logs in large values, but takes the value zero when the core variable is also zero. This solves many of the problems of working with logs.

[20] This is despite persistently strong local gas production.

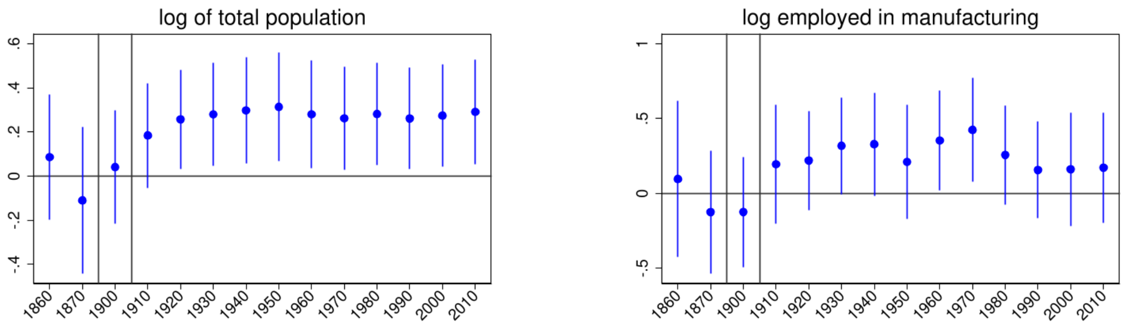

FIGURE 12: APPALACHIAN POPULATION AND MANUFACTURING GROWTH

In the left panel, I show coefficients $\hat{\delta}_t$ for the log of total population. In the right panel, I show coefficients $\hat{\delta}_t$ for the log of aggregate manufacturing employment by county. Manufacturing is defined using the variable IND1950 from IPUMS USA. Manufacturing is all cases where IND1950 includes 3-digit values ranging from 306 to 499. Because the 1890 census of population was lost in a fire, I use in 1890 log of the aggregate reported employment in manufacturing taken from Haines (2010). Confidence intervals are constructed using Conley standard errors (200km cut-off).

Finally, I assess whether the treatment effects differ in magnitude between the Indiana gas region and the Appalachian Basin by using a triple difference-in-differences design—comparing the Appalachian DiD estimates to the Indiana DiD estimates. I pool the two samples to implement the triple difference-in-differences analysis. Figure 13 maps the pooled sample (under the most restrictive specification).

TABLE 6 - APPALACHIAN GAS REGION REGRESSIONS

Panel A: Manufacturing employment

VARIABLES	(1) $\ln\left(\frac{mnfct}{non-mnfct}\right)$	(2) $\ln\left(\frac{mnfct}{non-mnfct}\right)$	(3) $\ln\left(\frac{mnfct}{non-mnfct}\right)$	(4) $\ln\left(\frac{mnfct}{non-mnfct}\right)$
δ_{1900}	-0.015	0.069	-0.026	0.042
	(0.101)	(0.107)	(0.109)	(0.118)
δ_{1950}	0.086	0.292**	0.050	0.307*
	(0.131)	(0.146)	(0.135)	(0.172)
Constant	-0.000	0.000	0.000	-0.000
	(0.014)	(0.015)	(0.016)	(0.018)
Observations	530	386	431	287
R-squared	0.037	0.096	0.036	0.101
Drop middle quintile	No	Yes	No	Yes
Drop New York state	No	No	Yes	Yes

Conley standard errors (200km cut-off) in parentheses.
*** p<0.01, ** p<0.05, * p<0.10

Panel B: Services employment

VARIABLES	(1) $\ln\left(\frac{srvc}{non-srvc}\right)$	(2) $\ln\left(\frac{srvc}{non-srvc}\right)$	(3) $\ln\left(\frac{srvc}{non-srvc}\right)$	(4) $\ln\left(\frac{srvc}{non-srvc}\right)$
δ_{1900}	0.139	0.198*	0.121	0.192*
	(0.101)	(0.117)	(0.094)	(0.112)
δ_{1950}	0.357***	0.432***	0.329***	0.429***
	(0.111)	(0.136)	(0.102)	(0.132)
Constant	-0.000	0.000	0.000	0.000
	(0.016)	(0.015)	(0.019)	(0.019)
Observations	530	386	431	287
R-squared	0.146	0.228	0.139	0.214
Drop middle quintile	No	Yes	No	Yes
Drop New York state	No	No	Yes	Yes

Conley standard errors (200km cut-off) in parentheses.
*** p<0.01, ** p<0.05, * p<0.10

Drop middle quintile refers to counties that rank in the middle quintile in terms of number of gas wells drilled in 1900-1950.

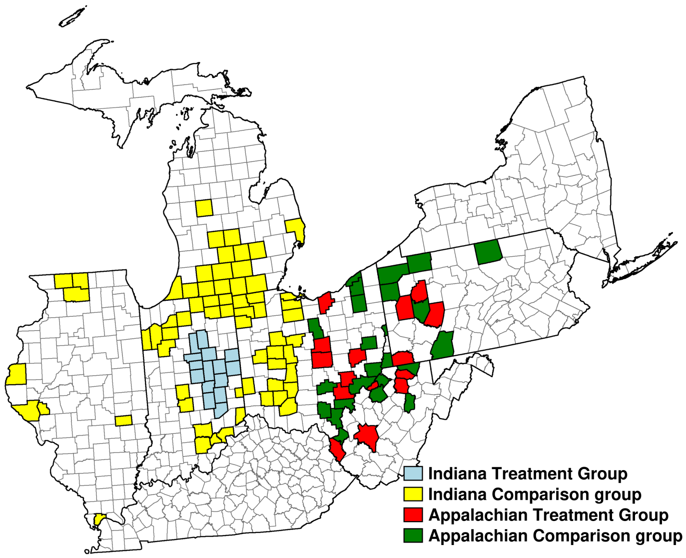

FIGURE 13: POOLED SAMPLES FOR THE INDIANA AND APPALACHIAN BASIN GAS REGIONS

These maps display the pooled treatment and comparison groups for the Indiana gas region and the Appalachian Basin gas region, under my preferred specifications. In the Indiana gas region subsample, the treatment and comparison groups comprise rural counties with rail connectivity in 1880; counties below the 80th percentile in Market Access are omitted, as are "Doughnut" counties, coal counties, coal-adjacent counties, other gas and oil counties, Appalachian Basin-adjacent, and Chicago-adjacent counties. In the Appalachian Basin subsample, the treatment and comparison groups comprise all rural counties with rail connectivity in 1890. New York state is omitted, and so are all middle-quintile counties in terms of gas production.

$$\begin{aligned} Y_{ct} = \alpha + I_c + I_t + \sum_{k \neq 1880} \lambda_k \, I(t = k) \, I(\text{TreatmentGroup}_c) \\ + \sum_{k \neq 1880} \mu_k \, I(t = k) \, I(\text{IndianaRegion}_c) \\ + \sum_{k \neq 1880} \theta_k \, I(t = k) \, I(\text{TreatmentGroup}_c) \times I(\text{IndianaRegion}_c) \\ + X_{ct} + \varepsilon_{ct} \end{aligned} \quad (4)$$

In equation (4), $I(\text{TreatmentGroup}_c)$ equals 1 for counties in either treatment group

(Indiana or Appalachian Basin). $I(\text{IndianaRegion}_c)$ equals 1 for all counties in the Indiana subsample (treatment and comparison). Their interaction, $I(\text{TreatmentGroup}_c) \times I(\text{IndianaRegion}_c)$, equals 1 only for treated Indiana counties and 0 otherwise.

In this setup, λ_k corresponds to the Appalachian Basin treatment effects (the same role as δ_k in the Appalachian Basin-only regressions). The Indiana treatment effects are $\lambda_k + \theta_k$. Thus, θ_k captures how Indiana's treatment effects differ from the Appalachian Basin's.[21] Because the results are directly comparable to those from the separate Indiana Gas Boom and Appalachian Basin regressions, I only report the coefficients $\hat{\theta}_k$, which capture the non-transportability advantage in the Indiana gas region. Table 7 shows that that, while both regions grew after their resource discoveries, Indiana shifted toward manufacturing while Appalachia shifted toward services-driven growth.

This comparison must address a timing mismatch: Indiana's gas boom ended in 1901, when the Appalachian gas region was still expanding. My approach effectively compares Appalachian gas production when it was still taking place, to Indiana after its boom had already ended. The estimated non-transportability advantage should thus be interpreted as a lower bound. If Indiana's gas supply had been as large and long-lived as Appalachia's, the manufacturing gap between the regions could have been substantially larger.[22][23]

[21] I include the same controls as in the Appalachian Basin sample: the inverse hyperbolic sine of coal mining and of oil drilling. In the Indiana Gas Boom subsample, both variables are zero because neither the treatment nor the comparison group experienced any oil or coal discoveries. As a result, the pooled-sample triple difference-in-differences coefficients are directly comparable to the coefficients from running difference-in-differences separately on the two samples.

[22] Moreover, because the Indiana region and the Appalachian Basin region reached their gas production peaks at different times, it is essentially impossible to separate the effects of transportability from the effect of the timing of the treatments. For example, the core period of the Indiana Gas Boom—the 1890s—may itself have been particularly favorable for the formation of new manufacturing establishments. Indeed, the Gas Boom may have helped Indiana escape the economic depression of the 1890s, thereby bestowing its manufacturing sector with a certain resilience that the Appalachian Region did not enjoy. I cannot fully rule that out. That said, the entire period 1880–1940 was a period of massive manufacturing growth, when many small, rural towns transformed into factory towns (Eckert, Juneau, and Peters, 2023). Any rural town would have greatly benefited from cheap energy and transformed into a factory town during this time. Therefore, my basic framework assumes that throughout this entire period, all else equal, local energy prices help determine the potential for local manufacturing growth. The discovery of natural gas should thus have a similar effect in both regions, the only difference being whether the gas is used locally—leading to lower local energy prices—or sold to distant markets.

[23] One might ask about differences in treatment intensity across the two regions. As noted, high-quality data on the actual amount of natural gas produced at the county level are lacking, making it difficult to

TABLE 7 - TRIPLE DID REGRESSIONS

Panel A: Manufacturing employment

VARIABLES	(1) $\ln\left(\frac{mnfct}{non-mnfct}\right)$	(2) $\ln\left(\frac{mnfct}{non-mnfct}\right)$	(3) $\ln\left(\frac{mnfct}{non-mnfct}\right)$	(4) $\ln\left(\frac{mnfct}{non-mnfct}\right)$	(5) $\ln\left(\frac{mnfct}{non-mnfct}\right)$	(6) $\ln\left(\frac{mnfct}{non-mnfct}\right)$	(7) $\ln\left(\frac{mnfct}{non-mnfct}\right)$
θ_{1900}	0.744***	0.742***	0.734***	0.732***	0.751***	0.755***	0.671***
	(0.141)	(0.142)	(0.143)	(0.148)	(0.148)	(0.145)	(0.148)
θ_{1950}	0.486***	0.507***	0.427***	0.410**	0.446***	0.415**	0.208
	(0.163)	(0.164)	(0.165)	(0.169)	(0.169)	(0.166)	(0.178)
Constant	-0.000	-0.000	-0.000	-0.000	-0.000	0.000	0.000
	(0.011)	(0.012)	(0.011)	(0.012)	(0.012)	(0.010)	(0.011)
Observations	2,284	2,140	1,925	1,736	1,655	1,241	1,097
R-squared	0.061	0.062	0.061	0.066	0.085	0.103	0.129
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Drop doughnut	No	Yes	Yes	Yes	Yes	Yes	Yes
Limit by MA	No	No	Yes	Yes	Yes	Yes	Yes
Drop coal regions	No	No	No	Yes	Yes	Yes	Yes
drop Chicago doughnut	No	No	No	No	Yes	Yes	Yes
Drop coal doughnut	No	No	No	No	No	Yes	Yes
Drop Appalachian doughnut	No	No	No	No	No	Yes	Yes
Limit Appalachian sample	No	No	No	No	No	No	Yes

Conley standard errors (200km cut-off) in parentheses.
*** p<0.01, ** p<0.05, * p<0.10

Panel B: Services employment

VARIABLES	(1) $\ln\left(\frac{srvc}{non-srvc}\right)$	(2) $\ln\left(\frac{srvc}{non-srvc}\right)$	(3) $\ln\left(\frac{srvc}{non-srvc}\right)$	(4) $\ln\left(\frac{srvc}{non-srvc}\right)$	(5) $\ln\left(\frac{srvc}{non-srvc}\right)$	(6) $\ln\left(\frac{srvc}{non-srvc}\right)$	(7) $\ln\left(\frac{srvc}{non-srvc}\right)$
θ_{1900}	0.004	0.005	0.003	0.027	0.044	0.076	0.017
	(0.113)	(0.115)	(0.115)	(0.113)	(0.113)	(0.107)	(0.122)
θ_{1950}	-0.502***	-0.511***	-0.470***	-0.420***	-0.423***	-0.350***	-0.426***
	(0.127)	(0.129)	(0.129)	(0.127)	(0.129)	(0.120)	(0.143)
Constant	0.000	0.000	-0.000	0.000	-0.000	-0.000	0.000
	(0.008)	(0.009)	(0.009)	(0.008)	(0.008)	(0.008)	(0.007)
Observations	2,285	2,141	1,925	1,736	1,655	1,241	1,097
R-squared	0.051	0.054	0.064	0.082	0.089	0.134	0.159
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Drop doughnut	No	Yes	Yes	Yes	Yes	Yes	Yes
Limit by MA	No	No	Yes	Yes	Yes	Yes	Yes
Drop coal regions	No	No	No	Yes	Yes	Yes	Yes
drop Chicago doughnut	No	No	No	No	Yes	Yes	Yes
Drop coal doughnut	No	No	No	No	No	Yes	Yes
Drop Appalachian doughnut	No	No	No	No	No	Yes	Yes
Limit Appalachian sample	No	No	No	No	No	No	Yes

Conley standard errors (200km cut-off) in parentheses.
*** p<0.01, ** p<0.05, * p<0.10

Drop doughnut option refers to the doughnut around the Indiana gas region treatment group. Limit by MA means limiting the sample to include only counties with market access above the 80th percentile. Coal regions are defined as any county in which, in any decade during 1860–2000, there were at least 400 people employed in coal mining. The coal doughnut is the set of counties that form doughnuts around coal regions. The Appalachian doughnut refers to the set of counties in Ohio that border the Appalachian region. The “Drop Chicago” option refers to dropping any county whose centroid is within 100km from Chicago.

5 Conclusion

I show that how easily a natural resource can be transported shapes the nature of local economic development. Using two parallel U.S. natural gas regions—Indiana's contiguous Trenton Gas Field and the dispersed Appalachian fields—I find that the Indiana field's contiguity led to underinvestment in pipelines and kept gas largely local, while Appalachia developed a dense long-distance pipeline network that piped gas to distant markets. These differences led to decades of economic divergence: the non-transportable gas region experienced sustained manufacturing growth, whereas the transportable-gas region saw only modest manufacturing growth.

Reconstructed prices show that during the Gas Boom, Indiana's local gas was over 30% cheaper than coal, while Pennsylvania's gas price converged with coal's. In effect, Indiana enjoyed a temporary, place-based energy subsidy because its gas was not transportable.

In Indiana, gas-rich counties more than doubled their manufacturing growth relative to comparable nearby counties during the Gas Boom. This excess growth persisted for decades. In contrast, gas-rich Appalachian counties saw only modest manufacturing gains. A triple difference-in-differences design shows that, compared with Indiana, gas discoveries had smaller effects on manufacturing in the Appalachian Basin.

Much has been written about the resource curse—about how resource discoveries have affected local economies in all kinds of ways, not all fully positive. Meanwhile, there is consensus that resource discoveries during early industrialization were pivotal for the growth of manufacturing economies. I bridge these two discussions by suggesting that a key difference between them is the degree of resource transportability. It had a major effect on how resource discoveries affect local economic development.

compare the size of local gas discoveries in the two treatment regions. Nevertheless, based on my main proxy for county-level natural gas production—the number of gas wells drilled by decade—the magnitude of drilling in the treatment group relative to the comparison group in the Appalachian Basin appears similar to, or even greater than, that in the Indiana Gas Boom. By this metric, we can plausibly argue that the treatment intensity was similar in the two regions.

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