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Impact of Railroads on Local Economies: Evidence from U.S. History

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Abstract

Purpose – The introduction and expansion of the railway network since the 19th century brought revolutionary changes in economic activities, performance, and structure. The purpose of this study is estimating the impact of railroads on the local agricultural and manufacturing structures in the 19th century USA.

Research design, data, and methodology – To identify the impact of railroads on local economic structure, county-level panel data from the U.S. census were analyzed using a panel fixed-effect differences-in-differences regression. The empirical investigation focuses on whether railroads changed the overall volume and sectoral composition of the local agricultural sector, and whether they contributed to the growth of the local manufacturing industry and its productivity.

Results – The railroad introduction led to the relative decline of the agricultural sector, while encouraging the growth of market-oriented gardening. As such, manufacturing productivity increased by the introduction of railroads, although manufacturing inputs and home manufactures were unaffected.

Conclusions – The findings imply that railroads contributed to the growth of market-oriented farming in rural areas, and the rise of productivity in the local manufacturing sector. Meanwhile, evidence of railroad-driven growth for the entire agricultural sector or a massive reallocation of resources from agriculture to manufacturing were not found.

Keywords: Local Economic Structure, Railroad, Agriculture, Manufacture, Productivity.

JEL Classifications: N71, O47, R11, R49.

1. Introduction

One of the most representative, significant, and conspicuous transportation innovations in distribution over the course of history was the fast spread of railroads since the 19th century. For example, the USA experienced a transportation revolution during the 19th century, the leader of which was the expansion of the railroad system across the country promoted by both the public and private sectors (Dove, 2016). European countries also experienced the expansion of railways and the transportation revolution in the 19th century, and many developing countries had similar experiences in the 20th century. The introduction of railroads has been accompanied by various shocks to the economy. It reduced transportation cost of production factors and commodities, which led to positive productivity shocks for the wholesale and retail distribution channels and, consequently, promoted the mobility of production factors and commodities (Atack, 2013). The transportation innovation in distribution, triggered by the expansion of railroads, also contributed to market integration, price convergence, and improved of market access for remote rural areas.

Indeed, scholars have studied various impacts of transportation innovation by the introduction of railroads on social and economic activities. Besides the empirical evidence on price convergence and market integration, existing literature on the 19th-century expansion of the railway system in the USA found that railroads were linked to urbanization, the development of the financial market, and increase in the improved land and agricultural productivity (Atack, Bateman, Haines, & Margo, 2010; Atack, Jaremski, & Rousseau, 2014; Atack & Margo, 2011). Railroads also effectively enhanced local market access (Donaldson & Hornbeck, 2016). A significant impact of railroads on

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economic development has also been identified in countries such as Sweden, India, Portugal, and China more recently (Berger & Enflo, 2017; Donardson, 2017; Pereira & Andraz, 2012; Wang & Wu, 2015; Xu, 2016).

This paper extends the scope of extant literature to the changes in local economic structure, as the introduction of railroads to localities can affect both the agricultural and manufacturing sectors. Using detailed county-level panel data compiled from historical U.S. federal census records, we estimate the direction and magnitude of the impact of railroad access on local agricultural and manufacturing structure in the 19th century USA. To deal with the endogeneity issue, a differences-in-differences method, which is commonly used in literature, is applied to the panel fixed-effect estimation.

2. Literature Review

Existing literature has studied various aspects of railroad impact on the economy, using data in various cases in the world from the 19th century USA and Europe to developing countries today. Many previous studies used the differences-in-differences estimation method to identify the causal impact of railroads on various outcomes, such as population growth, urbanization, economic growth, and export.

Several studies on the USA focused on the mid-19th century expansion of the rail system across the country. The expansion of railroad was not only related to industrialization, but also connected to the growth of market-oriented agricultural businesses. The 19th century industrialization in the USA was characterized by the increase of large establishments using steam power, which led to a rise in labor productivity (Atack, Bateman, & Margo, 2008). This is consistent with the argument of Kim (2005), in that the use of steam-powered engines was not necessarily correlated with urbanization. The use of steam engines became popular as the price of coal fell, which was at least partly caused by the expansion of the railroad system and the associated decrease in transportation costs.

Extant literature also identifies the positive role of railroads in the development of the agricultural sector. Atack and Margo (2011) showed that, using the differences-in-differences and instrumental variable methods, the introduction of railroads into Midwestern counties raised the share of cultivable farmland and the farm value per hectare. Meanwhile, Atack et al. (2010) studied the impact of railroad access on population density and urbanization between 1850 and 1860, using the differences-in-differences approach. According to their results, the impact of railroads on population density was moderately positive, but rail access was found to considerably promote urbanization.

A conspicuous consequence of the transportation innovation brought by railroads was expanded market access. As such, Donaldson and Hornbeck (2016) explained the role of railroads in the economic growth of the USA from the perspective of market access. The introduction of railroads into a county expanded its access to the market by reducing transaction cost, thus promoting economic growth. On the other hand, the role of railroads in economic development was not confined to the transportation of production factors and commodities. The expansion of the rail system was also closely correlated with the growth of the financial market. According to the empirical findings of Atack et al. (2014), the existence of a banking system promoted the construction of railroads, and the extension of the rail system into a new county promoted the rapid expansion of the banking industry in rural areas.

The significant impact of railroads on economic development has also been reported in other countries. In Sweden, for example, the introduction of railroads into a town led to a substantial population growth, and reallocated economic activities (Berger & Enflo, 2017). Pereira and Andraz (2012) reported that the infrastructure investment in the railroad system in Portugal contributed to output growth, employment, and even private investment at the aggregate level. Donaldson (2017) explained the beneficial impact of railroads on the economy using a general equilibrium trade model and data analysis from colonial India. According to this research, railroads integrated regional markets by reducing trade costs and price gaps across regions, and promoted both interregional and international trade, which, in turn, led to an income increase. Schwartz (2010) comparatively studied structural changes in agriculture, related to the expansion of the rail system in late-19th century France and Great Britain. Finally, Gregory and Henneberg (2010) argued that the spread of the rail network in Britain in the 19th century was also linked to a relatively faster population growth.

The economic impact of railroads has also been studied from recent experiences of developing countries, including China. For example, Wang and Wu (2015) investigated the impact of railway construction on the local economy. They applied the differences-in-differences method to analyze the case of the Qingzang railway, and found that its introduction brought an approximate 33% increase in annual GDP per capita to the counties the railway crosses. Xu (2016) took a different approach by looking at the impact of a railways improvement project on exports. This paper found that the improvement of the Longhai and Lanxin lines in China, which enhanced railroad speed and capacity, contributed to the significant increase in the volume of trade by the railroad, and also helped Xinjiang exporters expand their market over Central Asia by providing better access to the East coast.

3. Research Design, Methodology, and Data

3.1. Research Design

We empirically estimate the direction and magnitude of the impact of a transportation innovation on local economic structure in the 19th century USA. As described in the previous section, the existing literature has studied the impact of railroad access on population growth, urbanization, gross income, and export at the local level. We extend the scope of the research to changes in local economic structure using county-level panel data compiled from historical U.S. federal census records and the differences-in-differences methodology, which has been commonly used in the literature. The key objective is identifying the impact the introduction of railroads has on a county's agricultural and manufacturing structures. Specifically, we empirically investigate if railroads changed the overall volume and sectoral composition of the local agricultural sector, and if they contributed to the growth of the local manufacturing industry and its productivity.

3.2. Methodology

A differences-in-differences method is used to estimate the impact of the introduction of railroads on local economic structures. This is a popular estimation method in empirical economics for evaluating the causal effects of a policy, examples of research including Eissa and Liebman (1996), Qian (2008), and Hoynes, Miller, and Simon (2015). To identify the effect of the treatment on an outcome, the differences-in-differences method compares two groups, treatment and control, before and after the treatment. Here, the treatment is the introduction of railroads into a county between the two census years, 1850 and 1860. The treatment group is formed of U.S. counties having railroads, and the control group is represented by counties without railroads. The outcomes of interest are the variables that indicate local agricultural and manufacturing structures.

The method first calculates the two differences—a difference in an outcome variable between the treatment and control groups before the treatment and a difference in an outcome variable between the two groups after the treatment. The difference in the outcome variable between the counties having railroad and those without railroads before the treatment represents a pre-existing systemic difference between the two groups in 1850, thus irrelevant to the treatment from 1850 to 1860. On the other hand, the difference in the outcome variable between the two groups after treatment reflects both the pre-existing systemic differences and the impact of the treatment on the treated counties. By subtracting the first difference from the second difference, the impact of railroads on the outcome variables, showing the local economic structure, can be estimated.

One concern that arises from the application of this method is a possible bias caused by the heterogeneous characteristics of counties. All counties have their own historical background, locational singularity, and natural environment, which may lead to a systemic difference between the treated and the controlled ones, thus causing a bias in the differences-in-differences estimation. To deal with this problem, we control for county fixed effects in our regressions, which cancel the differences in outcome variables caused by all unobserved time-invariant characteristics at the county level.

Another concern is the existence of a possible heterogeneous trend in outcome variables between the treated and controlled. If the over-time variation in outcome variables in the railroad counties was different from that in non-railroad counties, not being solely linked to the construction of railroads in the 1850s, the differences-in-differences estimation may lead to a biased result. To mitigate this problem, a time-varying control variable of the urbanization ratio was included in the regressions. The urbanization ratio, ranging between zero and one, shows the ratio of the county population who resided in the urban areas with a population above 2,500. Urbanization in the 19th century was closely related to the variations of local economic structure, representing various changes in the local social, economic, and cultural backgrounds. Hence, controlling for the local degree of urbanization can help us reduce possible biases from the differences-in-differences estimation.

We also control for the availability of water transportation to further eliminate possible biases in estimating the impact of railroads on local economic structure. Before the era of railroads, water transportation was common and important for the distribution of production factors and commodities. The water transportation was not confined to using natural channels, but also included canals. Canal constructions, as internal improvement projects, were popular in the mid-19th century USA (Wallis, 2003). Natural waterways and canals have been frequently complimentary to railroads, affecting the location and efficiency of the railroad system. Therefore, part of the railroad effect on local economic structures can be attributed to water transportation if the availability of the latter is not properly controlled in the regression model.

$$y_{ti} = \alpha + \beta_r R_{ti} + \beta_\tau \tau_{ti} + \beta_{rD} R_{ti}\tau_{ti} + \beta_w W_{ti} + \beta_{wD} W_{ti}\tau_{ti} + \gamma U_{ti} + \mu_{ti} + \epsilon_{ti} \quad (1)$$

Equation (1) is the differences-in-differences equation used in this paper. y is the outcome variable of county i in year t. R is an indicator variable having the value 1 if county i had railroads in year t, and 0 otherwise. τ is an indicator variable having the value 1 if the observation was in 1850, and 0 in 1860. $R\tau$ is an interaction term of the railroad and

year dummy variables, and its coefficient β_{rD} captures the impact of railroads on local economic structure by the differences-in-differences method. W is an indicator variable having the value 1 if water transportation was available in county i in year t, and 0 otherwise. $W\tau$ is an interaction term of the water transportation and year dummies, and β_{wD} leads to the differences-in-differences estimate of the impact of water transportation on the outcome variables in the same way as β_{rD} does. U is the time-varying control variable of the county-level urbanization ratio, and μ represents the county fixed effects. α is a constant, and ϵ is the error term. To consider heteroscedasticity, robust standard errors are calculated and reported, following White (1980).

3.3. Data

County level data, digitized from the 1850 and 1860 U.S. federal census compendiums, were used for the differences-in-differences analysis. The data are compiled by Haines and Inter-university Consortium for Political and Social Research (2010), including rail and water transportation variables, not originally available at the census compendiums, but were added later by the authors. To estimate the fixed-effect models using the panel dataset, only the states and counties available both in 1850 and 1860 were included. The total number of counties in the dataset is 1,617, but a slightly lower number of observations was used for analysis because not all variables were available for all the counties in the dataset.

Among the total 1,617 counties in the dataset, only 21.41% had railroads in 1850, as reported in <Table 1>. However, the railway system expanded rapidly during the 1850s, the percentage of counties having railroads increasing to 44.4% in 1860. The percentage of counties where water transportation was available was 45.67% in 1850, which means that water transportation was more widely utilized than railroads before 1850. It moderately increased to 46.44% in 1860. Although the railroad expansion occurred after that of water transportation, the railroad system was not subordinate to the water transportation system. The percentage of counties where both railways and waterways were available was 12.87% in 1850 and 22.88% in 1860, which indicates that only 60.11% of the counties with railroads in 1850, and 51.53% in 1860, had waterways as well.

<Table 1> The percentage of counties having railroads and water transportation in 1850 and 1860

N = 1,617 counties	1850	1860
% of counties with railroads	21.41%	44.40%
% of counties with water transportation	45.67%	46.44%
% of counties with both railroads and water transportation	12.87%	22.88%

The descriptive statistics of the variables are reported by year in <Table 2>. Urban is the urbanization ratio, whose average was 0.0357 in 1850 and slightly increased to 0.0558 by 1860. The next 10 variables are dependent variables in the differences-in-differences analysis, which characterize the county's agricultural and manufacturing structure in 1850 and 1860. Farmvalpc is the cash value of farms per capita, capturing the overall size of the agricultural sector in a county. Equipvalpc is the value of farm implements and machinery per capita, which shows capital investment in agriculture. Livstockpc is the value of farm livestock per capita, Slaugvalpc is the value of animals slaughtered per capita, Orchardpc is the value of orchard products per capita, and Gardenpc is the value of market garden products per capita. These variables show the sizes of agricultural subsectors in agriculture, such as livestock, meat, orchard, and commercial gardening industries. The last four variables depict the manufacturing sector of a county. As such, Homemfgpc is the value of home manufactures per capita, which represents the degree of early industrialization led by small-sized manufacturing of marketable commodities at home. Mfgcappc, Mfglaborpc, and Mfgoutpc are the amount of capital invested, number of individuals employed, and value of the annual product in manufacturing establishments, respectively, all divided by total population. All the values are in 1860 US dollars. The 1850 values were converted into 1860 dollars using the wholesale price index for all commodities reported in Carter, Gartner, Haines, Olmstaed, Sutch, and Wright (2006).

<Table 2> Descriptive statistics

	1850			1860		
	N	Mean	Std. dev.	N	Mean	Std. dev.
Urban	1612	0.0357	0.1261	1617	0.0558	0.1532
Farmvalpc	1606	133.8435	91.0656	1607	220.9135	124.7408
Equipvalpc	1606	7.8509	8.2027	1607	8.7946	8.4756
Livstockpc	1607	33.4622	32.9533	1607	46.1837	41.4081
Slaugvalpc	1607	6.0193	4.0657	1607	8.2496	4.0068
Orchardpc	1607	0.2856	0.8157	1607	0.6286	1.2731
Gardenpc	1607	0.2445	2.2569	1607	0.3050	1.0441
Homemfgpc	1607	1.9047	1.8931	1607	1.2737	1.9455
Mfglaborpc	1612	0.0181	0.0355	1488	0.0204	0.0327
Mfgcappc	1612	12.2398	22.4709	1488	18.1985	31.0414
Mfgoutpc	1612	22.6980	68.2628	1488	29.8872	40.9407

The averages of the variables reported in <Table 2>, except the value of home manufactures per capita, increased between 1850 and 1860. During this period, the U.S. economy grew rapidly, both in the manufacturing and agricultural sectors. Meanwhile, the home production of manufacturing goods was progressively replaced by factories and large manufacturing establishments.

4. Results and Discussion

The differences-in-differences estimation results reveal the significant impact of the transportation innovation of introducing railroads to a county on local economic structures. <Table 3> presents the panel fixed-effect regression results of the dependent variables related to the county agricultural structure. The coefficients of the interaction term of the two dummy variables, Rail and Y1860, are the differences-in-differences estimators of the impact of railroad introduction between 1850 and 1860 on the dependent variables. The results show that railroads had a negative impact on the cash value of farms per capita (Farmvalpc), the value of farm implements and machinery per capita (Equipvalpc), and the value of farm livestock per capita (Livstockpc), being statistically significant at the at least 10 percent level. This implies that, although the average size of the agricultural sector still grew in the USA, the introduction of railroads led to the relative decline of the agricultural sector at the local level, compared to non-railroad counties. When railroads were introduced, the cash value of farms per capita decreased by 19 dollars, the value of farm implements and machinery per capita declined by 0.6 dollars, and the value of farm livestock per capita was reduced by 4.8 dollars. The differences-in-differences estimator of railroads on the value of animals slaughtered per capita was also negative, although its statistical significance was not clearly established.

However, the impact of railroads on the agricultural sector was not one-sided. The overall size of the agricultural sector and traditional farming were negatively affected by innovations in transportation technology, but the growth of market-oriented farming was actually fostered by the introduction of railroads. According to the differences-in-differences analysis, the introduction of railroads raised the value of market garden products per capita by 0.37 dollars. The effect of railroads on the value of orchard products per capita was also estimated to be positive, although the statistical significance was not sufficiently high. The relative growth of commercial farming due to railroads was not the result of urbanization and population growth, as the model controlled for the urbanization ratio separately and the dependent variables were in per-capita terms. Rather, this estimation result implies that railroads contributed to improving the distribution channel of commercial farm products, thus promoting market-oriented farming in the rural areas where the railroad transportation of products became newly available.

The waterways' impact on the local agricultural structure was also estimated using the differences-in-differences method. However, their effect was unclear in general. Most coefficients were statistically insignificant, and the magnitudes were smaller relative to the effect of railroads. The only effect identified by the model was the negative impact of waterways on the value of animals slaughtered per capita. Overall, the weak and smaller effects of waterways support that the estimation of the railroad effects was not likely biased by the other transportation mediums.

<Table 3> The impact of railroads on agricultural structure

	Farmvalpc	*Equipvalpc*	*Livstockpc*	*Slaugvalpc*	*Orchardpc*	*Gardenpc*
Rail × Y1860	-19.0687**	-0.6138+	-4.8304*	-0.3550	0.0326	0.3746**
	[5.3778]	[0.3710]	[1.9359]	[0.3144]	[0.0853]	[0.1341]
Water × Y1860	-3.3198	0.4719	-1.8239	-1.1621**	0.0869	-0.0953
	[4.9822]	[0.3902]	[2.0175]	[0.2523]	[0.0821]	[0.1406]
Rail	36.3845**	0.5201+	2.9587**	0.1532	-0.0826	-0.1942**
	[5.1210]	[0.2747]	[0.8131]	[0.2908]	[0.0579]	[0.0601]
Water	15.6549	-0.4186	14.7658*	0.0054	-0.0800	1.0428+
	[29.5467]	[1.1203]	[7.0881]	[0.8385]	[0.4907]	[0.5879]
Y1860	91.3393**	1.0075**	14.9224**	2.9415**	0.3032**	-0.0391
	[3.0937]	[0.1727]	[1.1594]	[0.1414]	[0.0409]	[0.0573]
Urban	-113.9678**	-3.2159*	-21.0473+	-3.4371**	0.1029	0.2233
	[27.6326]	[1.3579]	[12.7883]	[1.1452]	[0.3082]	[0.5176]
Constant	122.7568**	8.0171**	27.0559**	6.1196**	0.3376	-0.1938
	[13.5525]	[0.4981]	[3.2314]	[0.3903]	[0.2218]	[0.2686]
N	3,212	3,212	3,213	3,213	3,213	3,213
Number of Counties	1,617	1,617	1,617	1,617	1,617	1,617

Note: All reported models control for county fixed effects. Robust standard errors are reported in brackets. **p< 0.01, *p < 0.05, +p < 0.1.

The urbanization ratio (Urban) shows an effect on the local agricultural structure similar to that of railroads. The increase in the urban population share was linked to the overall decline of agriculture in the county. On the other hand, although the statistical significance was not strong enough, commercial orchard and garden farming appeared to evolve further in the more urbanized counties. Because the railroad effect is still found under controlling for urbanization, the estimated impact of railroads must be their own effect, possibly through the distribution channels and market expansion, rather than the indirect effect of urbanization and population growth.

The remaining three dummy variables, Rail, Water, and Y1860, are included to identify the differences-in-differences impact of railroads and waterways by the interaction terms Rail × Y1860 and Water × Y1860. The coefficients of Rail and Water dummies represent the average difference of the dependent variable between the counties having railroads or waterways and the counties without them. This simple cross-sectional average difference differs from the impact of railroads on the dependent variable because of endogeneity. That is, the positive coefficients of the Rail dummy on the per-capita values of farms, farm equipment, and livestock show that railroads were initially built in the more developed counties. The negative coefficient of the Rail dummy on Gardenpc means that commercial garden farming was minor in more agriculturally developed counties relative to their remote counterparts. The coefficient of Y1860 shows the average difference of the dependent variable between 1850 and 1860, whose estimated values support the general growth of agriculture in the USA.

<Table 4> reports the panel fixed-effect estimation results of the differences-in-differences analysis for the impact of railroads on the characteristics of the county's manufacturing sector. The coefficients of the interaction term Rail × Y1860 on the value of home manufactures per capita (Homemfgpc), the number of individuals employed in manufacturing (Mfglaborpc), and the amount of capital invested per capita (Mfgcappc) were estimated to be positive, but not statistically different from 0. This is probably because the introduction of railroads did not directly cause the expansion of the relative volume of the manufacturing sector in the local economy. Rather, the impact of railroads on local manufacture was related to output growth. According to the estimation results in <Table 4>, the introduction of railroads into a county led to the growth of the manufacturing output per capita in the county by 9.07 dollars. The fact that the manufacturing output per capita increased while holding the inputs of labor and capital per capita constant implies that railroads may have raised productivity in the local manufacturing sector. The efficiency gains from railroads in the distribution channel may have thus contributed to the productivity increase.

<Table 4> The impact of railroads on the manufacturing structure

	Homemfgpc	*Mfglaborpc*	*Mfgcappc*	*Mfgoutpc*
Rail × Y1860	0.1771	0.0011	1.7727	9.0716**
	[0.1445]	[0.0017]	[1.5273]	[3.0018]
Water × Y1860	0.5757**	0.0019	3.0022*	1.8682
	[0.0910]	[0.0014]	[1.3875]	[2.9694]
Rail	-0.4092**	-0.0009	-1.6280	-4.2389*
	[0.1388]	[0.0013]	[1.1469]	[1.9910]
Water	-0.4319*	-0.0104	-14.8330	4.2437
	[0.1984]	[0.0152]	[12.6587]	[14.2982]
Y1860	-0.9014**	-0.0005	3.0419**	0.7979
	[0.0830]	[0.0015]	[0.9175]	[3.6205]
Urban	0.5219	0.0226	6.9557	20.6124+
	[0.4372]	[0.0139]	[5.9398]	[11.5023]
Constant	2.1777**	0.0229**	19.6530**	21.7907**
	[0.1001]	[0.0070]	[5.7636]	[6.6050]
N	3,213	3,099	3,099	3,099
Number of counties	1,617	1,615	1,615	1,615

Note: All reported models control for county fixed effects. Robust standard errors are reported in brackets.
** $p < 0.01$, * $p < 0.05$, + $p < 0.1$.

Different from the impact of railroads, the introduction of waterways led to an early-stage increase in local manufacturing. The differences-in-differences estimators for the effect of waterways on county manufacturing show that the introduction of waterways into a county between 1850 and 1860 raised the value of home manufactures per capita by 0.58 dollars and the amount of capital invested per capita by about 3 dollars. However, the waterway's impact on manufacturing labor was moderate, and its impact on the manufacturing output per capita was unclear.

Urbanization was not clearly associated with structural changes in local manufacture in the mid-19th century USA, as revealed by the estimation results in <Table 4>. The coefficients of the Rail and Water dummies were mostly estimated to be negative, which is reasonable because most inland counties connected to the railway and waterway systems generally consisted of agricultural towns, the manufacturing industry being relatively concentrated in New England and the Atlantic coast before 1850. Therefore, railroads did not cause a massive reallocation of manufacturing, but contributed to the productivity growth in the existing local manufacturing sector. The coefficient estimates of the Y1860 dummy indicate that, during this period, the early-stage home manufacturing was diminishing and the capital investment in the manufacturing sector was growing rapidly in the entire USA.

5. Conclusions

5.1. Findings

The impact of railroads on the local agricultural and manufacturing structure in the 19th century was estimated using county-level U.S. census data. The panel fixed-effect differences-in-differences regression results show that railroads induced a sectoral change in the 19th century America. The introduction of railways to a county increased the value of market garden products per capita by 0.37 dollars between 1850 and 1860. Railroads also raised the manufacturing output per capita by 9.07 dollars during the same period. The introduction of railroads in the mid-19th century USA significantly affected both agricultural and manufacturing sectors at the county level.

The access to railroads contributed to the improvement of distribution channels for commercial farm products, thus promoting market-oriented farming in the rural areas, where the railroad transportation of products became newly available. Participation in the railway network also led to a rise in productivity for the local manufacturing sector. However, the empirical findings in this paper do not support the view of railroad-driven growth for the entire agricultural sector or the argument of a massive shift from agriculture to manufacture. Rather, the effect of railroads on the local economy was close to restructuring. Railroads stimulated the growth of commercial farming, but contracted traditional farming. They did not expand the overall volume of the local manufacturing sector measured by labor and capital, but increased the manufacturing productivity in terms of output per capita.

5.2. Scope for Future Research

Today, technological advances cause significant changes in economic structure, especially in the distribution industry, through various channels including transportation and logistics (Ahmed, Zin, & Majid, 2016; Li, 2012; Mago, Musasa, & Matunhu, 2013). Historical studies contribute to better understanding the impact of technology on the economy in the current era. As such, railroads have brought revolutionary changes in economic activities, performance, and structure. The findings of this paper show part of a complex mechanism that links technological advances to sectoral shifts in the economy.

The findings of this paper are still preliminary and can be further developed by follow-up studies in at least two directions to more rigorously investigate the causal impact of railroads on local economic structure. First, a scrutiny of the individual and establishment level data will be beneficial for overcoming the limitations of this research of using county-level aggregate data. Second, an analysis of cases in different countries, in different periods, and comparing the results with the current findings will be useful for enhancing our understanding on the relationship among transportation innovation, agriculture, and manufacturing.

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