The Relationship between Modern Railway Construction and Financial Market Integration: A Quantitative Study Based on Henan Province

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Abstract: Finance is the bloodline of national economy and the core of modern economy, and the development of financial market plays a vital role in regional development. The relationship between railroad construction and financial market integration is less discussed in the literature. This paper takes Henan, which is more exogenous, as a sample, and constructs financial indicators through recent complete grain price data using the STSM model; empirically analyzes the difference in the impact of the presence or absence of railroads on financial markets as well as divides the groups by railroad opening periods to discuss the complex impact of railroads on financial market integration in different opening periods. It is found that interest rates are lower in all areas along the railroad, but there are significant group differences. Among the groups by railroad opening period, the railroads that opened around 1910 and mainly connected to the central cities did not improve their integration with the provincial financial markets; the railroads that opened in the 1930s and mainly connected to the hinterland improved the regional financial market integration. This suggests that the impact of railroads on financial market development is subject to the economic relationships along the route, the economic attributes of each sector, etc., and that it is not appropriate to generalize. This helps to understand the divergence in empirical studies, but also highlights the impact of railroads on economic patterns and urbanization.

1 INTRODUCTION

In the late 19th and early 20th centuries, with the modern transformation of modern China's economy and society, a series of new modes of transportation emerged. The railroad, as one of them, has been closely associated with the socio-economic changes since its emergence. Zhang Peigang (1984) mentions that different means of transportation have different effects on the market, with railroads tending to concentrate the market more (Zhang, 1984) In theory, because railroads reduce transportation costs, they help optimize factor allocation and promote market integration. In turn, market consolidation caused by the reduction of transportation costs is considered to be an important cause of economic growth in recent modern times. Therefore, discussing the impact of railroads on economic development, especially on market integration, has been a concern of scholars. Finance is the bloodline of the national economy and the core of the modern economy, and the development of financial markets has a crucial role in regional development. Welfens and Ryan (2011) also mention the development of financial markets as a key factor in the economic growth of modern Europe and America (Paul, 2011).

Due to the lack of complete panel data for recent interest rate data, testing the relationship between railroads and financial market integration is a matter of both data selection and the design of selected indicators. In the literature, consistency between prices across locations is usually used to test market integration. Since only data on grain prices are relatively systematic before modern times, grain market integration has the most research. Therefore, this paper tries to construct a relevant indicator using grain prices. There have been a number of studies in this area. As mentioned by McCloskey and Nash (1984), the storage of grain is actually an investment. Wheat is stored in October and then in November it has to pay out the costs of the month, such as storage costs, depletion costs (spoilage), etc (McCloskey, 1984). If the wheat is sold immediately in November,

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it means that the grain sold and the return on the money owned (the value of the interest rate) coincide. If the two do not agree, people will not sell wheat in November. However, the difference between the two will converge over time. Therefore, the price of wheat is equal to the approximate value of interest rates plus costs such as storage. Based on the above principle, McCloskey and Nash (1984) used the spread of wheat prices in medieval England over time to estimate the interest rate at that time. Assuming that the cost of storage, etc.is close to a constant, the differences in seasonal fluctuations in prices across locations are primarily caused by the interest rate. This method is used by Mullen Peng (2005, p. 6) to estimate interest rates using monthly grain prices in the Shandong states (Peng, 2005). However, the shortcoming of the above study is that it does not take into account the exclusion of the non-seasonal component of grain prices, including the consideration of the unit root, etc.

This paper takes Henan as a sample, one is the modern The contribution of this paper is to take the exogenous Henan Province as the sample and to construct financial indicators using recent complete data on grain prices; the empirical analysis not only estimates the difference in the impact of the presence or absence of railroads on financial markets, but also divides the groups by railroad opening periods and discusses the complex impact of railroads on financial market integration in different opening periods.

2 HYPOTHESIS AND RESEARCH METHODOLOGY

2.1 Hypothesis

The railroad construction in Henan, which is located in the Central Plains, began at the end of the 19th century with the passage of national railroads, namely the Ping-Han Railway and the Longhai Railway. Subsequently, it was continuously expanded and extended. With the expansion of the railroad network, different regions became more and more closely connected to each other. In theory, because railroads lowered transportation costs, they not only promoted the flow of goods and labor, but also influenced the flow of capital. The completion of the Beijing-Han railroad in 1906 soon stimulated the development of mining and commercial agriculture along the railroad lines in the North China Plain, and the demand for capital would expand. At the same time, the increase in productivity in the areas along the railroad implied higher marginal returns to capital, which would lead to a concentration of capital in these areas. Banerjee, Duflo, and Qian (2012) argue that this process was achieved through higher interest rates around the railroad (Banerjee, 2012). However, significant economies of scale are usually considered to exist in finance, and with the increase in the size of financial markets and the decrease in transaction costs brought about by capital inflows, capital inflows to areas along railroads do not require higher interest rates; on the contrary, interest rates are likely to be lower as a result.

According to the previous discussion, when the impact of railroads on economic development is predominantly positive, d(rail) > 0 corresponds to

d(interest rate) < 0: a decrease in the interest rate.

2.2 Research Methodology

The existing empirical studies show that identifying the railroad-financial market relationship is not easy due to the presence of endogeneity. However, as mentioned earlier, if the construction of railroads covers only a part of the economy and the selection of this part is exogenous, it can be considered as a natural experiment to verify the railroad-financial market relationship using a double difference (DD) model. The basic model, with regions with railroad passage as the experimental group and regions without railroad passage as the control group, is as follows.

$$(Interest\ rate)_{it} = cont + \alpha rail_{it} + \beta year_t + \gamma county_i + \lambda X_{it} + \varepsilon_{it} \quad (1)$$

Where the subscript i represents the region and t represents the period; Interest rate: a variable measuring the change in interest rates; rail: a dummy variable with a railroad connection and taking 1 after opening and 0 otherwise; county: a region fixed effect; year: a period fixed effect; X: other factors affecting economic development, such as natural disasters, etc. Of course, among these coefficients α is the most concerned in this paper.

Further, combined with the sequence of railroad construction in time, the experimental group can be staged and the impact of the experimental group at different times can be compared, so as to examine the dynamic impact of railroad construction on the financial market in different periods. Combining the opening time of Henan Railway and the availability of information, this paper divides the sample period into three periods: before 1905 (pre1905), around 1910 (1910s), and 1930s (1930s). Other factors affecting economic development, such as war, are basically excluded from the selection of the sample period. The wars that occurred in Henan during the late Qing Dynasty and early Republic of China were mainly the Warlord Conflict in the 1920s and the Great War in the Central Plains in 1930s, so the first two sample periods were not affected by major wars. As for the sample period of 1930s, the data are mainly taken from 1933-1937, when the society has basically restored stability, and the impact of war can be largely ignored. Of course, the situation was very different across the country in different periods, and the stability of the provincial political situation was also different, and these effects are controlled for in the econometric model through time fixed effects. In the three periods, pre1905 is the control period in which the province was unaffected by the railroad, and each subsequent period has additional areas open to traffic. If these areas are divided into different experimental groups by period - for example, the 1930s opening group is the areas opened between 1910 and 1930 - then there will be different experimental and control groups for different periods, and the short- and long-term effects of each group can be compared.

At the same time, a more detailed examination of the specific situation in the experimental group is necessary in the context of the actual operation of the railroad. Among them, the presence or absence of stations and the number of stations in the same railroad passing area will affect the role of the railroad. For example, Zhengzhou is located in the node of the Ping-Han, Longhai Railway, the transportation location advantage to highlight, the railroad has become a booster of its development. Not only that, the industrial structure of different places, the degree of dependence on the railroad is also different. (Beijing-Han railroad is located in the main north-south traffic route, and there are Zhengtai, Yangluo and Daoqing railroads as branch lines, the source of goods is wider. The main cargoes transported by this railroad were "coal and grain", while coal was the bulk of the transportation in the northern section, accounting for about half of the passenger and cargo traffic, and coal produced by Lincheng coal mine, Jinglong coal mine and coal mines in Shanxi were directly or indirectly transported by this railroad. (The main suppliers of these coals were Beijing, Tianjin and the areas along the Beijing-Han railroad.) For example, coal transportation was particularly dependent on the railroad. Chen Kang mentions that the opening of the Daoqing Railway provided a cheap way to transport coal and greatly reduced transportation costs, causing the price of coal produced in Jiaozuo to drop sharply in the market. Based on these considerations, the model is further set as follows.

$$(Interest\ rate)_{it} = cont + \sum_{p=1910s}^{1980s} \alpha_{0p} railp_{pit} + \sum_{p=1910s}^{1980s} \alpha_{1p} railp_{pi(t-1)} + \phi_0\, \mathrm{rail}_{it} \mathrm{station}_{it} + \phi_1\, \mathrm{rail}_{it} \mathrm{coal}_{it} + \beta year_t + \gamma county_i + \lambda X_{it} + \varepsilon_{it} \quad (2)$$

Where, p represents the group of through traffic; railp: a dummy variable for the p-period through traffic, and also introduces its first-order lag term to examine the long-term impact of the railroad; station: station density; coal: a dummy variable with coal companies. The rest is the same as (1).

3 DATA INTRODUCTION

To examine the relationship between railroads and financial markets based on the model in the previous section, this paper compiles panel data on the socio-economy of Henan region from the late 19th century to the early 20th century. Among them, the sample period is divided into three periods before 1905 (pre1905), before and after 1910 (1910s), and 1930s (1930s) as mentioned before. The sample is observed in counties, and there are 111 counties according to the administrative division of Henan in the 1930s.

3.1 Railway Data

Railroads are the explanatory variables of most interest in this paper. The development of railroads is well documented in various transportation histories, which facilitates the compilation of this data. The approach of this paper is to set each county to 1 after the opening of the railway, so as to obtain the dummy variable for each opening group. Considering the time required for the impact of railroad opening, we put the counties opened to traffic in the first decade of the 20th century into the 1910s opening group, so pre1905 is a pure control group not affected by the railroad.

Due to the limitation of information, the quantitative indicators such as the mileage of railroads in each county and the degree of coverage are not considered. However, what can better reflect the degree of railroad development in a place is its station setting status, because the railroad only stops and carries passengers and goods at the station, and the setting of railroad stations in the early days was mainly restricted by exogenous factors such as location. The Railway Yearbook records in detail the status of stations of different railroads, including the time when each station was set up and the time when the station was converted into a post. Based on this, this paper collates the number of stations owned by each county by period and by railroad line. For example, the number of stations in Zheng County in the 1930s actually reached five, three of which were on the Beijing-Guangzhou line and two on the Longhai line, which naturally made the convenience of the railroad in the area much greater than that of the counties through which a single railroad passed. However, the number of sites in a certain place may not necessarily mean that the local passengers and goods can be more convenient to use the railroad, but may be simply because the county is too large, the railroad travels too long miles. Therefore, on the basis of the number of stations, it is used to divide the area of each county to calculate the station density of the county to better measure the convenience of the railroad.

3.2 Interest Rate Data

In the previous discussion, due to the lack of complete panel data for interest rate data, this paper tries to construct a relevant indicator using food prices.

In terms of data, this paper collates grain prices from pre1905 to 1930s. Considering the high degree of commercialization of wheat among the grains in Henan, wheat prices are selected for the study. The sources are: pre1905 and 1910s, monthly data of sub-prefectures from 1895 to 1910 compiled by grain price transcription files according to the "Grain Price Table between Daoguang and Xuantong of Qing Dynasty", with the data of the prefectures to which they belong instead of the data of each county; 1930s, monthly prices of sub-prefectures from September 1935 to July 1937 according to the "Henan Monthly Statistical Report".

In terms of methodology, based on McCloskey and Nash (1984) and Peng Mullen (2005) studies, assuming that costs such as storage are close to constant, the differences in seasonal fluctuations in prices across locations are mainly caused by interest rates. However, the shortcoming of the above studies is that they do not take into account the exclusion of the non-seasonal component of food prices, including the consideration of the unit root, etc. Developing a structural time series model (STSM)

Since grain price data usually contain dynamic features such as unit roots, it is assumed that for each period, monthly wheat price data are generated with the following expression.

$$P_{ti} = \mu_{ti} + \gamma_{ti} + \varphi_{ti} + \varepsilon_{ti} \quad i = 1 \cdots 111, \varepsilon_{ti} \sim NID(0, \sigma^2_{\varepsilon,i}) \quad (3)$$

$$\mu_{ti} = \mu_{(t-1)i} + \beta_{(t-1)i} + \eta_{(t-1)i} \quad \eta_{(t-1)i} \sim NID(0, \sigma^2_{\eta,i}) \quad (4)$$

$$\beta_{ti} = \beta_{(t-1)i} + \zeta_{(t-1)i} \quad \zeta_{(t-1)i} \sim NID(0, \sigma^2_{\zeta,i}) \quad (5)$$

$$\begin{pmatrix} \varphi_{ti} \\ \varphi^*_{ti} \end{pmatrix} = \rho \begin{pmatrix} \cos\lambda_c & \sin\lambda_c \\ -\sin\lambda_c & \cos\lambda_c \end{pmatrix} \begin{pmatrix} \varphi_{(t-1)i} \\ \varphi^*_{(t-1)i} \end{pmatrix} + \begin{pmatrix} \chi_{ti} \\ \chi^*_{ti} \end{pmatrix} \quad (6)$$

$$\gamma_{ti} = \sum_{j=1}^{[s/2]} \gamma^+_{j,ti}, where \begin{pmatrix} \gamma^+_{j,ti} \\ \gamma^*_{j,ti} \end{pmatrix} = \begin{pmatrix} \cos\lambda_j & \sin\lambda_j \\ -\sin\lambda_j & \cos\lambda_j \end{pmatrix} \begin{pmatrix} \gamma^+_{j,(t-1)i} \\ \gamma^*_{j,(t-1)i} \end{pmatrix} + \begin{pmatrix} \omega^+_{j(t-1)} \\ \omega^*_{j(t-1)} \end{pmatrix} \quad (7)$$

where P is the price of wheat. Equation (3) means that it has a trend component μ, a seasonal component γ, a periodic component φ, and a sum of random perturbations ε.

The variation of the trend component μ consists of the horizontal equation (4) and the slope equation (5).

The periodic component φ is defined by (6), which has a period of 2π/λc.

The seasonal component γ is defined by (7), where s denotes the seasonal cycle length.

In the model, the changes in each of the trend, cycle and seasonal components reflect the normal dynamic adjustment process of the market, and the STSM defined in equation (3) precisely allows us to conveniently extract the seasonal differential in wheat prices. It is easy to see that the size of the seasonal spread depends on the variance of the disturbance term in the seasonal equation of equation (7), and the standard deviation of the cyclical fluctuations is calculated from the estimated value of this variance to measure the level of interest rates.

Table 1 provides a statistical description of each of these variables by period. As can be seen, there appears to be no sustained and steady increase in population density and welfare levels, while market consolidation has improved over the sample period. So, what exactly is the role of railroads in this? The following section will test this through DD analysis.

Table 1: Descriptive Statistics of Variables.

Time	Variable	Interest rate data	Welfare level	Drough	Flood
Pre1905	AVG	0.029	1.559	0.107	0.039
	MAX	0.069	1.874	0.38	0.26
	MIN	0.001	1.304	0	0
	Std	0.022	0.154	0.118	0.073

	n	106	109	111	111
1910s	AVG	0.032	1.575	0.001	0.391
	MAX	0.069	1.909	0.03	1.03
	MIN	0.004	1.353	0	0
	Std	0.02	0.162	0.004	0.23
	n	111	110	111	111
1930s	AVG	0.026	1.439	0.304	0.042
	MAX	0.129	3.281	1.01	0.38
	MIN	0	0.919	0	0
	Std	0.031	0.326	0.297	0.083
	n	111	104	111	111
		328	410	333	333

4 EMPIRICAL ANALYSIS

Table2 gives the estimation results of the causal relationship between railroads and interest rates identified using the double difference model.

In model 1, only the standard deviation of cyclical fluctuations is regressed on the railroad dummy variable, and the results show a negative coefficient of the double difference estimator with a significant level of 10%. That is, interest rates in areas along railroads are 1.2% lower than those in areas without railroads. If we look at the access group, the estimation results of model 2 show that the 1930s access group has a significantly lower interest rate of 2.2% than its control group, but the 1910s access group does not have a significant effect on the interest rate. After adding control variables such as disasters, in models 3 and 4, the 1910s pass-through group has a 5.8% lower interest rate than its control group and is significant at the 10% level, and the 1930s pass-through group has a 4.8% lower interest rate than its control group at the 1% level of significance. Compared to the results in model 2, the coefficients have increased in absolute value and significant level. Since there are strong economies of scale in the financial sector, interest rates decrease in both the 1910s pass-through group, and the 1930s pass-through group, which rejects the hypothesis of Banerjee, Duflo, and Qian (2012). Meanwhile, the 1910s station density is negatively but insignificantly related to the interest rate, then it may be because the railroad attracts population in this group of areas mainly through administrative status improvement and material security improvement, so that the increase in stations and the convenience of trade do not play a further impact. As for, the 1930s coal and interest rates were significantly positive, probably because the development of the coal industry increased capital demand, coupled with the remote location of the mines, which made it difficult for the development of financial services to follow.

If economies of scale existed, the agglomeration effect would have been strengthened, so would interest rates along the railroad have been relatively and consistently lower? In order to test this dynamic effect, in model 5, this paper tries again to include the lag term of 1910s through group. Unfortunately, the effect of the 1910s opening on the 1930s interest rate is significantly positive. As explained by Banerjee, Duflo, and Qian (2012), it is possible that this is due to the increase in productivity in this group of regions, which leads to an increase in the return to capital. However, taking the previous evidence together, it is more likely that the 1910s opening group (i.e., the area along the Beijing-Han railroad) did not gain significant market development and the agglomeration of the financial sector could hardly have occurred consistently.

Table 2: Estimated results of railway impact on modern Henan interest rate.

Explained variable: Interest rate data	**model 1**	**model 2**	**model 3**	**model 4**	**model 5**
Rail	-0.012^{*} (0.006)				
1910s through group		-0.007 (0.007)	-0.058^{*} (0.033)	-0.015^{*} (0.008)	-0.019^{**} (0.008)
1930s through group		-0.022^{*} (0.012)	-0.048^{***} (0.007)	-0.046^{***} (0.007)	-0.040^{***} (0.007)

1910s through group* (year=1930s)					0.015* (0.009)
Site density * (year=1910s)			-0.007 (0.005)		
Coal* (year=1930s)				0.025** (0.012)	
control variable:					
Drough			-0.024** (0.011)	-0.023** (0.011)	-0.018 (0.011)
Flood			0.003 (0.018)	0.005 (0.019)	0.004 (0.019)
Welfare level			-0.023* (0.012)	-0.025* (0.013)	-0.028** (0.013)
Constant term	0.032*** (0.003)	0.031*** (0.002)	0.071*** (0.019)	0.073*** (0.020)	0.076*** (0.020)
n	328	328	258	258	258
R^2	0.266	0.272	0.377	0.374	0.381
DW	2.654	2.667	2.776	2.701	2.686

5 CONCLUSION

The relationship between railroads and economic development has been of considerable interest. Considering that railroad development is often endogenous to economic development, this paper selects a sample with a strong exogenous nature, modern Henan, to examine the impact of railroads on financial market integration. Unlike previous literature, this paper examines the diversification of the impact of railroads, and the results show that: In the group divided by the period of railroad opening, interest rates along the railroad all decrease, the 1930s opening group improves regional financial market integration, while the 1910s opening group does not gain significant market development and financial agglomeration does not occur consistently.

Interestingly, this paper finds two patterns in the relationship between railroads and Henan's economic development: the Beijing-Han line (corresponding to the 1910s through group), which connects the central cities of the country, has a limited role in the development of regional financial markets; in contrast, the Longhai line (corresponding to the 1930s through group), which mainly connects the hinterland, had a more robust role in financial development. Clearly, if urbanization goes hand in hand with administrative capacity and economic efficiency, the railroad did not help modern Henan achieve economic development through this route. This finding helps us not only to explain the relationship between railroads and economic development, but also to reflect on the general path of economic development. At the same time, the two modes must be weighed when planning railroad construction in order to make a reasonable assessment of their effects.

REFERENCES

Banerjee Abhijit., Esther Duflo and Nancy Qian (2012) On the Road: Access to Transportation Infrastructure and Economic Growth in China. Working Paper17897.cords.

McCloskey and John Nash (1984) Corn at interest: The Extent and cost of Grain Storage in in Medieval England American Economic Review,74:1.

Paul J.J. Welfens and Cillian Ryan (2011) Financial Market Integration and Grown. Springer-Verlag Berlin Heidelberg.

Peng Mulan (2005) The Construction of the Hinterland: The State, Society, and Economy of The North China Mainland (1853-1937). Social Science Literature Publishing, Beijing.

Zhang, Peigang. (1984) agriculture and industrialization. Central China Institute of Technology Press. Wuhan.