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# Land prices and railroad building in European Russia, 1860s to the early 1900s

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**Abstract**

This paper shows that railroad building in Russia, as in Europe and the US in the nineteenth century, improved the value of land, a classic benefit of transportation investment in largely agrarian countries. From a database constructed for this paper, we use cross-sectional data for the fifty European Russian regions to show the association of the length of the railroad (measured in 1894), land prices (measured in 1900) and annual growth of land prices (in rubles) for 1885–1910.

*Keywords:* economic history, transportation history, history of financial markets, urban history, regional history.
*JEL classification:* D62, N13, N53, N73, N93, O13, O18, O33, R14.

## 1. Introduction

Railroad building improved the value of land and thus contributed substantially to domestic investment during industrialization in nineteenth century Europe and the US (Atack and Margo, 2011; Berger and Enflo, 2017; Peterson, 2009; Coffman and Gregson, 1998; Craig et al., 1998). This paper assesses the impact of extensive new railroad lines on land prices in European Russia by the end of the nineteenth century, when some regions were drawn closely into the new networks and others left behind. The classic benefits of transportation investment, reduction in the costs of trading and rise in real income, in a largely agrarian country, also help spread land-based financing for agriculture and urban development (Donaldson, 2018; Peterson, 2009). We use cross-sectional data for the fifty European Russian

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regions to show the association of the length of the railroad, land prices and annual growth of land prices for 1885–1910. Figs. 1 and 2 show the positive association between the length of the railroad by region with both land prices and the land price growth rate, supporting our hypothesis that access to the railroad should have inflated the price for tangible capital such as arable land.

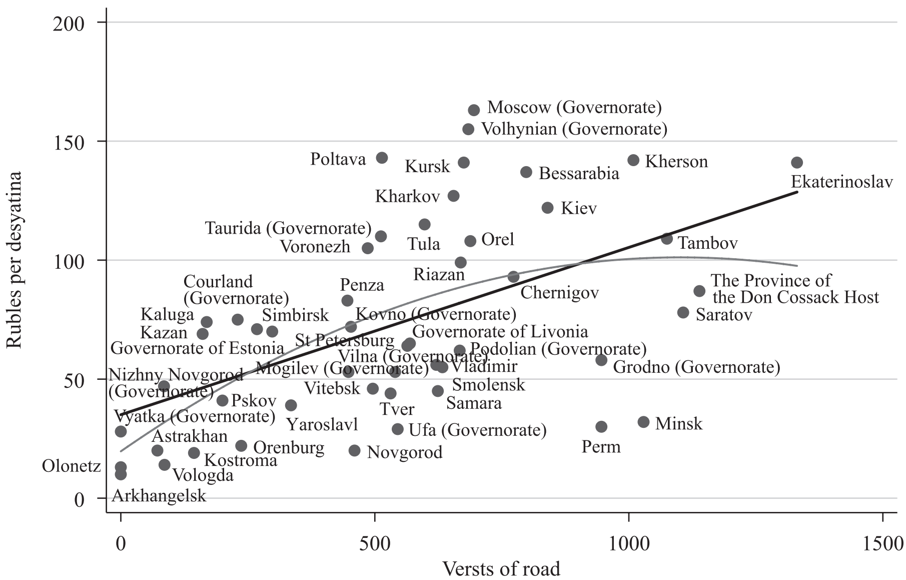


**Fig. 1.** Graphical relationship between "Sales price of land in 1900" and "*Versts* of railroad in 1894".

*Source:* Authors' calculations using Anfimov and Makarov (1989, table 35, pp. 78–81), Sviatlovskii (1911) and Radtsig (1896).

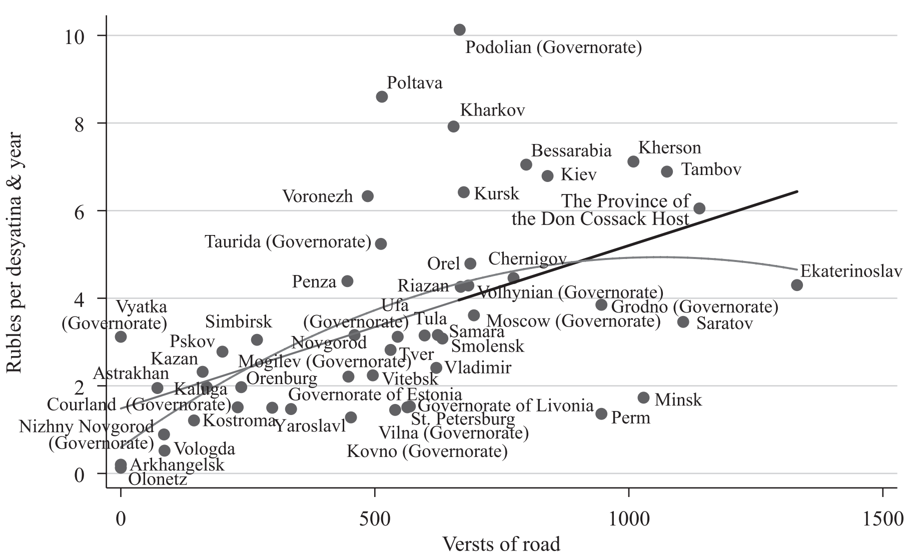


**Fig. 2.** Graphical relationship between "Growth rate of land prices, 1885–1910" and "*Versts* of railroad in 1894".

*Source:* Authors' calculations using Anfimov and Makarov (1989, table 35, pp. 78–81), Sviatlovskii (1911) and Radtsig (1896).

This simple comparison obscures the econometric issue facing any study assessing these relationships. The problem is the simultaneity of the railroad network's length in the *guberniia* (province) with any changes in land prices. For example, the path of the lines could have been chosen based on the land prices at the time of lines projection. The more productive agricultural lands, thus the most valuable plots, may have been chosen to be part of the future railroad network. At the same time, land prices could have directly been affected by the introduction of the network due to the migration of workers and peasants, diffusion of technology or faster accumulation of capital.

We address the simultaneity problem by two approaches. First, we rely on a rich set of control variables available in survey data (see below, Data sources), that the principal coefficient corresponding to the length of the railroad decreases in magnitude with each additional control variable. However, the simultaneity issue cannot be resolved only by controlling for perceived differences across regions. Our small sample size constrains the number of variables we can include in the model. We therefore turn, second, to the Instrumental Variable approach, where we instrument the main independent variable, the length of the railroad, by an exogenous factor that is indirectly related to land prices. Our instrument is the latitude of the *guberniia* capital city.

We develop this instrument because the main strategy of railroad development was to connect the major cities with the cities of the southern borders and ports. Among other reasons, this was to assist in the defense of those regions that were more prone to military invasions, rather than to connect the sparsely populated northern regions. As a result, the latitude of the *guberniia*'s main city acts as a natural instrument, which, as is expected, is negatively correlated with the length of railroad lines in the *guberniia* as shown in Fig. 3.

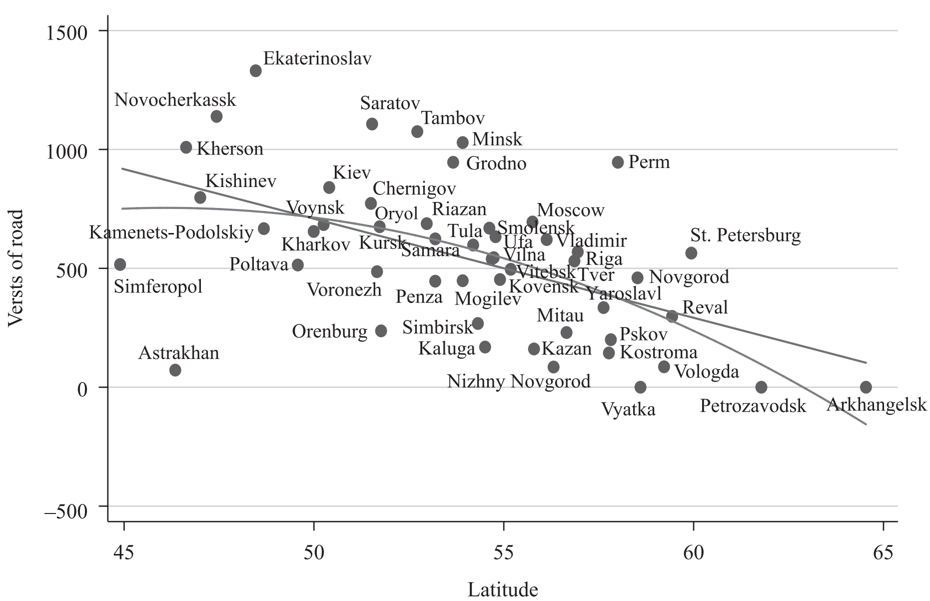


**Fig. 3.** Graphical relationship between "Latitude of *guberniia*'s center" and "*Versts* of railroad in 1894".

*Source:* Authors' calculations using Anfimov and Makarov (1989, table 35, pp. 78–81), Sviatlovskii (1911) and Radtsig (1896).

Our results show positive associations of the length of the railroad with both land prices and the price growth rate in the first analysis. The IV (Instrumental Variables) approach not only confirms these positive relationships but also provides effects greater in magnitude. Specifically, one *verst* of the railroad may have increased the land price by 11 kopeks per *desiatina*[1] of land or by about 1 kopek per *desiatina* in each year.

This paper is organized as follows. Following this introduction, Part 1.1 provides background on Russia's railroad construction, the economic geography of European Russia, and the rise in land values during the burst of industrialization in the late nineteenth and early twentieth century. Part 2 discusses the model, and Part 3 considers the data and results. Part 4 is the conclusion.

### *1.1. Background: Railroads, economic geography and land prices in late imperial Russia*

Fig. 3 shows that the spread of the railroad network by region favored the southern agricultural regions. From the 1860s, projects aimed mainly to link the South and Southeast, Russia's main agricultural regions, to export locations. By 1904, nine lines stretched from Moscow to the North, West, East and South, that is, to the major ports and trading centers, and St. Petersburg had lines to Moscow, Warsaw, Riga and Finland. In the 1880s, Kharkov linked Moscow, Rostov-on-Don, Kiev and Odessa. Railroad building lagged after the financial loss in the Russo-Turkish War (1877–1878), but in the 1880s, it picked up again, spreading through central Russia, giving access to iron and coal production in Krivoi Rog and the Yuzovka (Donetsk), and in the 1890s, it rapidly accelerated. Eight joint stock companies in partnership with government dominated investment, bringing oil to Moscow and abroad from the Black and Caspian Sea; in the 1890s in Russia, Novorossiisk was the largest grain elevator in Europe.

The railroad era encouraged foreign and domestic investment and had a significant population impact during industrialization, especially in some sectors and communities (Craig et al., 1998). In Europe, the US and Russia, new rail networks enhanced commodity trade and stimulated migration to factory locations, underscoring the importance of cheaper transportation to growth and capital formation. As Eli Heckscher (1954) and others have emphasized and empirically demonstrated, revolution in transport opens up domestic and foreign markets to trade (Berger and Enflo, 2017).

In this paper, we show that movements in the price of land varied in response to the extent of new railroad lines in affected regions. The variation in the price can be separated into quality improvements, or the conversion of land from unimproved to improved, and price-based change. The latter is the result of human investment of money and effort, a shift in transportation costs and/or property entitlements, and new linkages to farm-product markets, asset markets and other input markets (Lindert, 1974). The importance for growth of the rise in land prices is shown for US nineteenth-century economic history (Engerman et al., 2000), and, we suggest, with further development, the impact on the price of land can be assessed from our evidence for Russia.

[1] 1 *verst* = 1.067 m, 1 *desiatina* = 1.09 hectares.

Land quality was sufficiently differentiated to divide Imperial Russia's regions in the railroad era into agricultural and primarily non-agricultural: northern and centrally located populations lived mainly by crafts, manufacturing and trade along riverways that linked southern ports to northern; they obtained much of their grain from agricultural settlements on the southern steppe, an "immense expanse of rich arable land."[2] The southern region was identified by its soils as Blackearth, and the central and northern as non-Blackearth Russia. In these two areas, initially, from 1873 to 1882, land prices rose far more rapidly, 28% faster, in the southern Blackearth region.[3] Subsequently, as industrialization accelerated to 1902, the price of land grew at approximately the same rate in both regions (Svyatlovskiy, 1911, p. 87). The further south one ventured, the faster the price grew, as in present-day Ukraine. Since the price of land was lower than average in central and northern Russia (by 45–64%) and higher than average in the southern Blackearth regions (by 41–93%), the gap as a whole remained wide, with the average being roughly in central Russia. We show elsewhere that in Russia, as in the US, railroad building had an impact on population growth in cities and urbanization during this period (Nazarov et al., 2021; Konchakov and Karpenko, 2020; Atack et al., 2010). In this paper, as in Atack and Margo (2011), we assess the impact on land values (see also Wright, 2018).

## 2. Material and methods

### *2.1. Model*

In our empirical model, we assume that *i*-th *guberniia*'s land price $P_i$ is linearly related to the length of the railroad in this *guberniia* $L_i$, to characteristics included in vector $X_i$ and the random factor $e_i$.

$$P_i = X_i b_1 + dL_i + e_i. \tag{1}$$

Our primary interest is $d$, the coefficient measuring the impact of one *verst* of the railroad on the land price. The simultaneity issue arises because of the existence of some factors that are directly correlated with the land price and the total length of the railroad system in the region's transportation network. One example is the effect of the grain market on motives behind the design of the railroad system in Russia. For example, the goal was to connect the highly productive agricultural regions with the main cities, Moscow and St. Petersburg. This dictates the choice of variables in vector $X_i$.

Specifically, based on the agricultural story, we presume that the Blackearth regions have a higher likelihood for inclusion in the network and consequently, for greater increases in land prices. Furthermore, grain yield could have also positively correlated with land prices and development of the railroad in the region. Another important factor supporting the agricultural story is the use of land in agricultural production, the percent of arable land of all available land. The more intensive use of land (percent of arable) controls for some unob-

[2] Donald Wallace, cited in Moon (2014, pp. 37–38), and see Pallot and Shaw (1990).

[3] http://elib.shpl.ru/nodes/10755#mode/inspect/page/94/zoom/5

served factors affecting land prices that are not captured by soil quality or land productivity.

Finally, another important factor explaining the development of the railroad network and land prices could be the presence of the alternative use of arable land. For example, land prices could be higher in some non-agricultural regions because of a vibrant manufacturing sector and because agricultural land markets in non-Blackearth Russia, not largely driven by market forces (Kovalchenko and Milov, 1974; Kovalchenko and Borodkin, 1988), might still be affected. To control for this possible scenario, we introduce in our model a variable which measures the size of the manufacturing workforce in the region, the number of workers per 1,000 persons.

In our analysis, we pay particular attention to the problem of model over-specification. Since our dataset is a cross-section of 50 observations, any additional variable in the model puts some constraint on the explanatory power of the model. Thus, it is nearly impossible to control for all perceived pathways whereby the length of the railroad may have affected land prices. In the second analysis, we introduce an instrument, $Z_i$, which, by our expectation, should be strongly correlated with the length of the railroad, $L_i$, to satisfy the *relevance* condition of the IV method, without directly affecting land prices, known as the *validity* condition. The statistical relationship between $Z_i$ and $L_i$ is outlined by the following equation, which is the first-stage equation and estimated with equation 1, which becomes the second-stage equation.

$$L_i = X_i b_2 + \gamma Z_i + u_i. \tag{2}$$

Based on Fig. 3, our instrument, the latitude of the *guberniia*'s main city, satisfies the first condition. This figure shows a strong correlation between the latitude and the length of railroad. A typical *guberniia* located in the northern region has fewer *versts* of railroad lines compared to its southern counterparts. In the subsequent section, we show the strong correlation between two variables even after controlling for all other control variables in the first stage along with the *F*-test statistic of the excluded instrument, which should exceed the suggested value of 10 (Stock and Yogo, 2005) when the instrument is strong.

Whether our instrument satisfies the validity condition is hard to establish. Conventional wisdom suggests that the northern *guberniias* may have lower land prices because of other factors besides the length of the railroad, e.g., land productivity. However, we control for grain yield or percent of arable land in our IV model, so we eliminate this pathway. Our assumption is that the latitude in the first stage captures the natural geographical location of the *guberniia* but not the shadow price of arable land.

### *2.2. Data and descriptive statistics*

We report descriptive statistics for the key variables used in Table 1. The sales price of one *desiatina* of land in the Western part of Russia in 1900 was about 81 rubles. In the period between 1885 and 1910, land prices on average increased by 4 rubles per *desiatina* per year. The average *guberniia* has 615 *versts* of railroad. Only three *guberniias* were not part of the railroad net-

**Table 1**
Descriptive statistics.

| Variables | Mean | St. dev. | Min | Max |
|---|---|---|---|---|
| Sales price of land in 1900 | 80.98 | 43.60 | 10.00 | 163.00 |
| Growth rate of land prices, 1885–1910 | 4.09 | 2.43 | 0.13 | 10.13 |
| *Versts* of railroad in 1894 | 615.13 | 317.93 | 0.00 | 1331.00 |
| Blackearth region | 0.62 | 0.49 | 0.00 | 1.00 |
| Grain yield (poods per *desiatina*) | 43.23 | 7.51 | 25.30 | 62.60 |
| Meadows in 1871 | 68.41 | 81.93 | 8.80 | 424.20 |
| % arable of all land | 37.03 | 17.69 | 0.10 | 70.00 |
| Number of workers for 1,000 citizens | 20.91 | 29.25 | 3.00 | 156.00 |

*Note:* Weighted using "Population size in 1897".
*Source:* Authors' calculations using data from Obruchev (1871) and Anderson (1980, p. 51).

work, all these in the North of Russia: Vyatskaia, Olonetskaia, Arkhangelskaia *guberniias*. Sixty-two percent of all *guberniias* were in the Blackearth region. The average grain yield was about 43 poods (16 kg) of grain per *desiatina* with the lowest yield, 25.30 poods, in Astrakhanskaia *guberniia* (Southern region) and the highest yield in Lifliandskaia (Northern region, 62.6 poods). In the average *guberniia*, only 37% of total land was arable. The maximum was in Tulskaia *guberniia*, with 70% arable, and the minimum was in Arkhangelskaia *guberniia* with 0.1%. Finally, on average, of 1,000 persons 21 were workers with the maximum 156 workers in Moscow *guberniia* and the minimum three workers in Mogilev *guberniia*.

## 3. Results and Discussion

### *3.1. Ordinary Regressions Results*

Tables 2 and 3 report results from ordinary regressions where the model was incrementally enriched by an additional control variable. It was expected that the parameter associated with the main independent variable, *versts* of railroad in 1894, should decrease in magnitude with each additional control.

Results of the baseline model are reported in the first column. Without any controls, one *verst* of the railroad is associated with an increase in the land price by 6.3 kopeks per *desiatina* or 0.3 kopeks per year per *desiatina*. As expected, this association decreases with additional controls for both outcomes. In model 5, with the complete set of variables, the associations dropped to 3.5 kopeks or a 0.2 kopek growth rate per year per *desiatina*. Thus, this analysis confirms that increasing *versts* of the railroad has a positive implication for land prices in western Russia.

Both tables show that "Blackearth" is an important variable to include in the analysis. On average, the Blackearth region had a 38 rubles higher land price than its counterpart region, and prices grew faster in the region by 2.8 rubles per year. In Model 6, the interaction term between the indicator, Blackearth region, and the length of the railroad is positive in both regressions, showing specifically, one *verst* of the railroad is associated with an increase in land price by 2.5 kopeks or 0.3 kopeks per year per *desiatina* in the Blackearth region, by comparison with its counterpart region.

**Table 2**
Regression analysis of "Sales price of land in 1900" and "*Versts* of railroad in 1894".

| Variables | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 |
|---|---|---|---|---|---|---|
| *Versts* of railroad in 1894 | 0.063*** | 0.046*** | 0.043*** | 0.039*** | 0.035*** | 0.019* |
| | (0.016) | (0.016) | (0.015) | (0.013) | (0.011) | (0.010) |
| Blackearth region | | 38.065*** | 42.753*** | 31.105** | 37.861*** | 22.294 |
| | | (13.090) | (12.755) | (12.122) | (9.518) | (14.443) |
| *Versts* of railroad in 1894 × Blackearth region | | | | | | 0.027 |
| | | | | | | (0.019) |
| Grain yield (poods per *desiatina*) | | | 1.663*** | 1.336** | 1.532** | 1.482** |
| | | | (0.556) | (0.610) | (0.645) | (0.667) |
| % arable of all land | | | | 0.953*** | 0.982*** | 0.978*** |
| | | | | (0.226) | (0.235) | (0.231) |
| Number of workers in production per 1,000 citizens | | | | | 0.409* | 0.420* |
| | | | | | (0.240) | (0.250) |
| Constant | 42.486*** | 29.294*** | –43.897* | –55.307** | –75.190** | –64.832** |
| | (8.868) | (7.910) | (25.382) | (26.575) | (29.007) | (31.389) |
| Observations | 50 | 50 | 50 | 50 | 50 | 50 |
| *R*-squared | 0.208 | 0.378 | 0.457 | 0.586 | 0.655 | 0.663 |

*Note:* Weighted using "Population size in 1897"; robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
*Source:* Authors' calculations using data from Obruchev (1871) and Anderson (1980, p. 51).

**Table 3**
Regression analysis of "Growth rate of land prices in 1885–1910" and "*Versts* of railroad in 1894".

| Variables | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 |
|---|---|---|---|---|---|---|
| *Versts* of railroad in 1894 | 0.003*** | 0.002* | 0.002* | 0.002* | 0.002* | 0.0003 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Blackearth region | | 2.812*** | 2.925*** | 2.397*** | 2.372*** | 1.137 |
| | | (0.574) | (0.589) | (0.494) | (0.497) | (1.098) |
| *Versts* of railroad in 1894 × Blackearth region | | | | | | 0.002 |
| | | | | | | (0.001) |
| Grain yield (poods per *desiatina*) | | | 0.040 | 0.025 | 0.025 | 0.021 |
| | | | (0.030) | (0.022) | (0.023) | (0.023) |
| % arable of all land | | | | 0.043*** | 0.043*** | 0.043*** |
| | | | | (0.012) | (0.012) | (0.012) |
| Number of workers in production per 1,000 citizens | | | | | –0.001 | –0.001 |
| | | | | | (0.006) | (0.006) |
| Constant | 2.199*** | 1.225** | –0.544 | –1.061 | –0.989 | –0.166 |
| | (0.533) | (0.547) | (1.397) | (1.088) | (1.131) | (1.286) |
| Observations | 50 | 50 | 50 | 50 | 50 | 50 |
| *R*-squared | 0.162 | 0.460 | 0.475 | 0.560 | 0.561 | 0.578 |

*Note:* Weighted using "Population size in 1897"; robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
*Source:* Authors' calculations using data from Obruchev (1871) and Anderson (1980, p. 51).

Among other important variables, at least in determining the land price and, to a lesser extent, its growth rate, is grain yield. One pud increase in grain productivity increases land prices by 1.66 rubles per *desiatina*. The intensity of land used in agriculture also increased prices and growth in land prices. One percentage point increase in land used for agricultural production increased prices by 95 kopeks and the growth rate of prices by 4 kopeks per year. Finally, the alternative use of land in manufacturing also positively affected land prices. A unit increase in the number of workers in production per 1,000 citizens increased prices by 41 kopeks.

### 3.2. Instrumental variable results

Table 4 reports results of IV analysis. The first column shows that latitude has a negative implication for the *guberniia*'s length of railroad lines. If the *guberniia*'s center is located one degree further north, the length of the railroad in the *guberniia* falls by 57 *versts*. The statistical significance of the instrument in the first stage is substantial, suggesting significant validity of that instrument. The $F$-test statistic of the excluded instrument is 11.67, above the suggested threshold value for a weak instrument of 10.

Another significant relationship in the first stage regression is the number of workers involved in production per 1000 in the population. However, a unit increase in the number of workers in manufacturing increases the length of the railroad by 1.3 *versts*. This finding reinforces our hypothesis that the manufacturing economy, not agricultural production and exports alone, had influence in determining the direction and length of railroad lines.

**Table 4**
The effect of railroad length on the sales price of land using IV method.

| Variables | Stage 1: *Versts* of railroad in 1894 | Stage 2: Sales price of land in 1900 | Growth rate of land prices, 1885–1910 |
|---|---|---|---|
| *Versts* of railroad in 1894 | | 0.114*** | 0.007*** |
| | | (0.035) | (0.002) |
| Latitude | –57.347*** | | |
| | (16.786) | | |
| Blackearth region | –107.832 | 23.158* | 1.414** |
| | (110.298) | (12.466) | (0.649) |
| Grain yield (poods per *desiatina*) | 7.602 | 1.325* | 0.011 |
| | (5.046) | (0.802) | (0.033) |
| % arable of all land | 0.428 | 0.859*** | 0.035** |
| | (2.763) | (0.325) | (0.017) |
| Number of workers in production per 1,000 citizens | 1.348* | 0.322 | –0.007 |
| | (0.684) | (0.220) | (0.007) |
| Constant | 3360.971*** | –99.305** | –2.559 |
| | (1030.952) | (40.387) | (1.947) |
| Observations | 50 | 50 | 50 |
| $F$-test of the excluded instrument | 11.67 | | |

*Note:* Weighted using "Population size in 1897"; robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
*Source:* Authors' calculations using data from Obruchev (1871) and Anderson (1980, p. 51).

Establishing a strong correlation between the instrument and the main independent variable, we can now discuss results from a second stage equation, reported in columns two and three of Table 4. With the IV approach, we end up with stronger gradients between the length of the railroad and land prices and their growth rates. For example, one *verst* of the railroad increased the price by 11 kopeks per *desiatina* with a growth rate of 0.7 kopeks per year. In sum, the results from the IV approach is about three times greater than in the ordinary regressions, even after applying an extensive set of controls.

How do we explain these differences? First, the greater impact of the railroad on the outcome using the IV approach is compatible with the findings reported in Attack and Margo (2011). A significant increase in the estimate can be anticipated if the variable not included in the first analysis is negatively correlated with the instrumented variable, such as the length of the railroad. In this case, omitting an important variable from the regression biases the estimate downward. The IV approach, with the relevant and valid instrument, fixes this problem and brings the estimate closer to the true value.

Then, we ask, what unobserved factor may have a negative implication on the length of the railroad? We believe that the unobserved managerial characteristics of the governor generals is one candidate for explaining differences. Governors assigned to the northern provinces may have overlooked the importance of railroad development in the region although their decision-making in other spheres may have had positive implications for land prices. We will address this hypothesis in future research.

## 4. Conclusion

A simple supply-demand framework predicts that, in an economic system where market forces predominate over political and social forces, a technological shock will have a favorable implication on demand and lead to higher prices. We use the changes in Russia's land market in the late nineteenth century to test this theoretical prediction. The introduction of the railroad can be viewed as a technological shock to the land market. As in any economic system, where market forces prevail, Russia in the late imperial era followed this trend, and a technological shock led to increased land prices.

Like any empirical work, this study encounters the problem of simultaneity between the main independent variable, length of the railroad, and the dependent variable, land prices. We resolve this problem using exogenous variation in the way the railroad system was expanded in Russia, based on its geopolitical and economic needs as perceived at that time. The main directions of the railroad lines were selected to connect the agrarian central and southern *guberniias* with the western borders and a handful of northern ports. The rationale behind this was to decrease the transportation cost of wheat exports to the Northern European countries and, later on, to strengthen the connection between manufacturing and export locations with coal and iron production. As a result, the railroad system of northern *guberniias* remained less extensive than in central or southern *guberniias*, at least in this period of railroad development. Using these differences in regional development of the railroad system, we were able to come up with a significant positive effect of the railroad on the land prices.

This study has its limitations. First, it uses a single snapshot of the data, ignoring the time-variable components that affected both railroad development and the land market. Future studies can address this shortcoming by constructing panels to capture simultaneous changes in the transportation network and land market. Second, the unit of observation of the study is a region. The more granular unit of observation, e.g., city-level data, would bring a deeper level of detail in exploring this research question. Third, not all effects of railroad network expansion may have been positive. One underlying complexity of defining the hike in prices for tangible capital as 'inflationary,' is that it recalls what in contemporary discourse is referred to as an "asset bubble." This issue we reserve for future research. Another, finally, is that the study ignores other competing events that affected land markets in late Imperial Russia, including the emancipation of serfs on privately owned land and state peasants. The interplay of various historical events that affected Russia's land market and transportation network is also left for future research.

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