

# The Economic Effects of the Abolition of Serfdom: Evidence from the Russian Empire

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## Abstract

We document a very large increase in agricultural productivity, peasants' living standards, and industrial development in late 19<sup>th</sup> century Imperial Russia as a result of the abolition of serfdom in 1861. A counterfactual exercise suggests that if serfs were freed in 1820, by 1913 Russia would have been about 40% richer, compared to what it actually was. We construct a novel province-level panel dataset of development outcomes and conduct a difference-in-differences analysis of the effects of the abolition of serfdom, relying on cross-sectional variation in the shares of serfs and the timing of the different stages of reform, controlling for unobserved variation across provinces and over time, as well as province-specific trends. We disentangle the two stages of the abolition of serfdom: the emancipation of serfs and land reform, and find that, in contrast to a large positive effect of emancipation, land reform negatively affected agricultural productivity. We provide evidence that better incentives resulting from the cease of a ratchet effect in landlord-peasant relationship is a likely mechanism behind the positive effect of emancipation and the increase in the power of re-partition peasant commune is a mechanism behind the negative effect of the land reform.

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## 1. Introduction

The effect of slavery and serfdom on economic efficiency and growth has been a subject of a long-lasting debate.<sup>1</sup> Despite many scholars view both slavery and serfdom as inefficient production systems with distorted incentives and suboptimal resource allocation (see, e.g., Cairnes 1862, Williams 1944, North and Thomas 1973, Anderson and Gallman 1977, Acemoglu and Robinson 2012, Ogilvie 2013), there is no clear theoretical argument why slave and landowners failed to provide efficient incentives to their workers. Furthermore, the literature provides many case studies of highly efficient slave systems. For example, the abolition of slavery in the US south saw a sharp decline in output per person and the stagnation of southern economy for generations (e.g., Fogel and Engerman 1974; Atack and Passell 1994).<sup>2</sup> Slave labor in the US around mid-19th century was more efficient at producing cotton than India, China, and Egypt (e.g., Fogel 1989).<sup>3</sup> Haiti of the 18th century, with production based predominantly on slave labor, was the most prosperous colony in the Americas; however, after the war of independence, it did not retain its prosperity (e.g., Gigard 2005). Similarly, some recent studies (i.e., Cerman 2012 and Stanziani 2014a) present serfdom in Eastern Europe as a dynamic institution sustaining a considerable rate of economic growth. More prominently, the Russian Empire has been used as an example confirming the idea that serfdom must not be a crucial determinant of backwardness, as Russia remained a backward agrarian society right up to the Russian Revolution despite the abolition of serfdom in the 1860s (Gerschenkron 1965). The arguments on both sides of this debate were mostly backed by case study evidence only. In this paper, we provide new systematic empirical evidence about the effect of the abolition of serfdom on development that sheds light on this debate. We document a very large positive effect of the abolition of serfdom on agricultural productivity, peasant nutrition, and industrial development

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<sup>1</sup> Serfdom is an institution of forced agricultural labor; it was widespread in Europe in the Middle Ages. By the early modern period, it disappeared from most parts of Western Europe, while persisting in most parts of Eastern Europe and, in particular, in the Russian Empire, until the mid-19th century.

<sup>2</sup> In part, this effect was due to lower hours of work per person.

<sup>3</sup> The causal interpretation of this fact has recently been contested by Omstead and Rhode (2008 and 2010), who argue that the biological innovations rather than organization of production were at the core of the explanation for the relatively high productivity at Southern slave farms.

in one of the European superpowers of the 19th century, the Russian empire. The magnitude of the effect can be illustrated with a counterfactual exercise, which, under a set of important assumptions discussed below, yields that Russia would have been about 40% richer by 1913 had it conducted its major emancipation reform in 1820 instead of 1861, as was considered by Alexander I at the time.

During serfdom, Russia's serfs were the property of the gentry, who had formal usage and transfer rights over them. The abolition of serfdom, triggered by the exogenous shock of Russia's defeat in the Crimean war (1853-1856), involved two distinct stages: 1) the emancipation of serfs, which instantaneously granted personal freedom to serfs; and 2) the land reform, which defined the communal land property rights of the emancipated peasants. The emancipation occurred in 1861 throughout the European part of the empire.<sup>4</sup> At the time of emancipation, obligations of former serfs to landlords were fixed as the institutionalized rent payment for land use. The subsequent land reform completely abolished any obligations of former serfs to landlords by transferring land rights to peasant communes in return for redemption payments. Land reform implementation took over 20 years following the emancipation.

Our goal is to measure the effect of the abolition of serfdom on agricultural productivity, peasant living standards, and industrial development. To conduct this analysis, we assembled a unique province-level panel data on development outcomes for the European Russia between the end of the 18th and throughout the 19th centuries. Our empirical strategy is difference-in-differences, with controls for province and time fixed effects and province-specific trends. We estimate the change in the provincial development trends at the time of emancipation of serfs depending on pre-emancipation prevalence of serfdom—the share of serfs as compared to formally free rural residents—across Russian provinces. We also use cross-province and over-time variation in the rate with which the land reform was implemented. To address potential

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<sup>4</sup> Baltic provinces are the exception: serfs in the Baltics were emancipated between 1816 and 1819.

endogeneity and mismeasurement concerns, we rely on exogenous variation in the distribution of serfs across provinces driven by the nationalization of church lands and serfs on these lands by Catherine the Great and on exogenous cross-province and overtime variation in land reform driven by the differential incentives of landlords to push for land reform in collateralized and non-collateralized estates. Due to Russia's vast size, different provinces had different climatic and soil conditions, and therefore, different development trajectories; thus, controlling for differential trends is essential for identification.

Serfs constituted only 43% of all rural residents in European Russia in 1858. The formally free rural population consisted of state peasants and free agricultural laborers. The composition of the rural population varied greatly across provinces: in 1858, the share of serfs ranged from 0.1% in Arkhangelsk to 83% in Mogilev; the share of serfs in the median province was 50% and in the mean province – 45% of rural population.<sup>5</sup>

Our results are as follows: First, the abolition of serfdom caused a large and statistically significant increase in agricultural productivity measured as the ratio of grain yield to seed (henceforth referred to as *grain yield*). In an average province, the abolition reform led to a 15.5% increase in grain yield, above the overall province-specific development trend. The magnitude of this effect is comparable to 37 years of aggregate development. Grain yield on average increased by 4% per decade in 19th century Russia. The quality of data on agricultural productivity also allows us to disentangle the effects of the two components of the abolition of serfdom: the emancipation of serfs per se and the subsequent land reform. We find that the positive effect of the abolition on agricultural productivity is entirely due to emancipation. Obtaining personal freedom by serfs boosted growth in productivity, whereas the land reform significantly slowed it down, cancelling out nearly one half of the overall effect.

Second, we examine the mechanism behind these effects. Consistent with Gerschenkron's (1965) arguments, we show that the roots of the inefficiency of land reform lied

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<sup>5</sup> The data on the composition of the rural population are from Bushen (1863). The sample is the European provinces of the Russian Empire, where emancipation took place in 1861, i.e., outside the Baltics.

in the re-partition peasant commune, which severely undermined peasant incentives to invest in land. We also provide evidence consistent with the change in peasants' incentives stemming from the cease of a ratchet effect in the relationship between peasants and landlords being an important mechanism behind the immediate effect of the emancipation. In particular, the positive effect of the emancipation is only present in provinces (which constitute the majority) where landlords were unable to commit to long-term implicit contracts regulating the level of serfs' obligations, and thus, where ratchet effect was present. In addition, we find that the production choices (i.e., which crops to seed, which to sell, and which to consume) were better adapted to climatic and market conditions after compared to before the emancipation in provinces with a larger share of serfs. This evidence indirectly indicates an increase in peasant effort post-emancipation and suggests that 1) peasants' incentives played an important role in production and 2) the monitoring costs were too large for serf owners to ensure efficiency.

Third, we find that the abolition of serfdom substantially increased the living standards of former serfs. In particular, the emancipation had a large effect on early child nutrition, proxied by height of draftees. Our estimates imply that the height of draftees from private estates 1.35 centimeters higher for cohorts born after the emancipation compared to cohorts born before the emancipation and most of this effect was already realized in the first two cohorts born after the emancipation. The magnitude of this effect is roughly comparable to the increase in height of males per decade in the 19th century Western Europe (Hatton and Bray 2010).

Finally, we find a significant positive effect of the abolition of serfdom on the industrial development. In an average province industrial output increased by 48%; and in provinces where land was particularly scarce or of worse quality by a factor of 2.8. This is a very large effect, especially in the face of the inefficient communal system of land titles, which reduced mobility of peasants to urban areas (Gerschenkron 1965).

The results proved to be robust to a battery of sensitivity tests. We test for and find no evidence of pre-trends, which could potentially bias the difference-in-differences estimates. We

also verify that our results cannot be driven by an underestimation of standard errors due to the presence of spatial and overtime correlation (Conley 1999, 2008). The results are also robust to controlling for a large number of potential confounds as well as an alternative data source for the prevalence of serfdom and using more granular district-level panel data for draftees height.

Our paper relates to several strands of economic and historical literatures. First, we contribute to the literature on institutions and economic development (e.g., Acemoglu and Johnson 2005, Banerjee and Iyer 2005, Nunn 2009, Acemoglu et al. 2010, Tabellini 2010, Bruhn and Gallego 2012, Michalopoulos and Papaioannou, Ogilvie 2013, 2014). Our results are consistent with the view that the early disappearance of serfdom contributed to the rise of Western Europe and the Great Divergence between the West and East (e.g., North and Thomas 1973). Second, our work speaks to the literature on the efficiency of forced labor and its effects on economic development (e.g., Acemoglu et al. 2012, Nunn 2008, Miller 2009, Dell 2010, Nunn and Wantchekon 2011 and Bertocchi and Dimicio 2014). More specifically, we contribute to the debate on the efficiency of serfdom in the Russian Empire, in which Gerschenkron (1962, 1965), Koval'chenko (1967) argued that serfdom was inefficient; in contrast to Moon (1996), Mironov (2010), Dennison (2006, 2011) and Stanziani (2014a and 2014b) who portray serfdom as a dynamic institution that sustained a considerable rate of economic development pointing out that landlords guaranteed and enforced social order, accumulated resources to launch new projects when access to credit was limited, provided minimum food consumption to peasants during famines, and adopted new technologies. The literature, prior to our paper, was based primarily based on sporadic anecdotal evidence with the important exception of Nafziger (2013) and Bugge and Nafziger (2015), who study the long-term effects of serfdom and document a negative cross-sectional relationship between the prevalence of serfdom and the long-term land inequality and wellbeing. The results of our paper combined with the findings of Bugge and

Nafziger (2015) suggest that serfdom had negative effect on development overall and that the emancipation reversed a substantial part of this influence.<sup>6</sup>

The paper proceeds as follows: In Section 2, we present our hypotheses. Historical background is provided in Section 3. In Section 4, we describe the data. Section 5 presents the empirical strategy. Section 6 reports the results. In Section 7, we present evidence to differentiate between the potential mechanisms. In Section 8, we describe a number of robustness checks. Section 9 concludes.

## **2. Hypotheses**

Our aim is to estimate the effect of the abolition of serfdom on agricultural productivity, peasants' wellbeing, and industrial development. *A priori*, these effects are ambiguous. On the one hand, it is reasonable to expect emancipation to alleviate incentive problems in agricultural production. The serfs' effort and its proceeds were largely unobservable to the landlord due to monitoring costs. Due to asymmetries of information, one could expect severe distortions in the effort of serfs as well as in production and investment decisions. The lack of credible commitment on the part of the landlord not to revise the size of peasants' obligations in the future must have reduced peasant effort due to a ratchet effect. Anecdotal evidence suggests that some landlords were able to credibly commit to follow rules that fixed amount of obligations by peasants, maximizing the stream of payments over a longer-term horizon; however, this was not a common practice (Dennison 2011). Serfdom was also associated with adverse incentives for peasants to invest in own human capital and land, both of which also belonged to the landlord, in addition to serfs' labor. However, in theory, due to differences in the reservation utility of agents, the use of coercion on forced labor could also increase effort compared to free labor relations (Acemoglu and Wolitzki 2010). Thus, the extent to which the gentry could solve incentive

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<sup>6</sup> Buggle and Nafziger (2015) were the first to use an exogenous variation prevalence of serfdom coming from the nationalization of the monasterial lands a century before the emancipation of serfs. We also rely on the historical distribution of monasterial serfs for our instrumental variable strategy and use a similar instrument, but our identification assumptions are substantially weaker due to a panel nature of the data we use, which allow controlling for province fixed effects and province-specific trends in contrast to the cross-sectional data used in Buggle and Nafziger (2015). Other relevant contributions to the empirical literature on the history of the Russian Empire are: Mironov and A'Hearn (2008); Nafziger (2012), Finkel et al. (2015) Castañeda Dower et al. (2015), Chernina et. al. (2014), Castañeda Dower and Markevich (2016).

problems by intense monitoring, commitment to long-term contracts, or coercion should determine how inefficient serfdom was. Many of these incentive problems are expected to have been alleviated with the emancipation, as it changed the status of serfs from being an agent to being a principal, owning their own human capital and labor. However, we do not expect most of these changes to take place instantaneously. By contrast, the emancipation did instantaneously solve the ratchet effect problem by fixing the level of quitrent for all (former) serfs.

Incentive problems, however, are just a part of the story. Serfdom could also have had efficiency advantages compared to post-emancipation production because of economies of scale and access to finance, which most probably were better realized in the relatively large estates of the gentry compared to the small-scale entrepreneurial agricultural production by emancipated peasants, who had no access to finance and had to solve coordination problem in order to enjoy the benefits of the economies of scale.

The expected effect of the land reform is also ambiguous. On the one hand, the land reform could have improved productivity by increasing peasants' incentives to invest in land that they acquired. On the other hand, the land reform both *de jure* and *de facto* strengthened the institution of the commune, whose power was previously counterbalanced by the landlord's authority. Communes were also associated with incentive problems, as they substantially restricted the transfer rights over land of peasant households and regulated major production decisions (Gerschenkron 1965, pp. 744-5).<sup>7</sup> In addition, the gentry could have been more flexible in adopting new technologies than the traditional peasant commune. Peasant communes were of two types: re-partition and hereditary. The re-partition communes, which were the dominant form of land use in most parts of the empire, periodically redistributed land among households, which further reduced peasants' incentives to invest in land, in contrast to hereditary communes, where peasant households had perpetual usage rights of specific land plots.

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<sup>7</sup> The major decisions were made through direct democracy at the general commune assembly (*schod*), where each peasant household had one vote. The assembly also elected a local village executive, who made day-to-day minor decisions (Bartlett 1990).



It is also *a priori* not clear whether one should expect peasant nutrition to be affected by the emancipation. The reason for this is that serfs were a valuable input into production for gentry and, therefore, rational landlords should have made sure that their serfs were well fed if nutrition affected peasant productivity. However, the asymmetry of information may have led to malnutrition of serfs in equilibrium, as gentry were concerned that peasants were hiding the proceeds of their production, which could have led to an excessively high level of peasant obligations. In addition, peasants may have had lower incentives to feed children under serfdom, as peasants' children belonged to the gentry.

Under serfdom, the ratchet effect problem also applied to artisan (industrial) activities of serfs as these activities were also subject to arbitrary levels of quitrent from their lords. The emancipation eliminated this problem for industrial production of serfs as much as their agricultural production. Personal freedom given to serfs by the emancipation reform also may have increased mobility from rural to urban areas, where productivity, and therefore wages, were higher. Thus, one could expect a positive effect of the abolition of serfdom on the development of industry. However, migration to cities was limited by the communal land titles and mutual responsibility for taxes within the commune (Gerschenkron 1965).

### **3. The history and geography of Russian serfdom: a short overview**

Serfdom was one of the key institutions in Russian history. It existed in its most severe form between 1649 and 1861 (i.e., 212 years). Originally, Russian peasants were free and could migrate across estates. The government began to limit the right of migration in the late 15th century. The 1649 Code of Law (*Sobornoye Ulozhenie*) proclaimed that peasants were the property of their estates and made migration a criminal offence. Peasants became attached to the land and had to obey the orders of their landlords. Serfs had to fulfill obligations in the form of in kind payment (quitrent) or labor (corvee) for their landlords. The landlords had (almost) full

discretion over the amount and the form of these obligations. The landlords also had the right to sell, to buy, or to lease their serfs.<sup>8</sup>

Our sample covers the European part of the Russian Empire (excluding the Kingdom of Poland and Finland), which was the home of about 80% of the total population of the empire. The map is presented on Figure 1. In the middle of the 19th century, more than ninety percent of the population lived in rural areas (Bushen 1863). 43.03% of all peasants were privately owned serfs in 1858. The rest of Russian peasantry could be classified into three large groups according to their legal status: the state peasants (40.4% of rural population); free agricultural workers (12.6%); and royal peasants (4%), all of which *de facto* can be considered (relative to serfs) as formally free peasants subjected to fixed taxation and land-lease rules.<sup>9</sup>

The composition of the rural population and, in particular, the shares of serfs vs. formally free peasants, substantially varied across provinces; there were no substantial transfers of peasants between legal groups after the reign of Pavel I (1796-1801), i.e. over the last 60 years of serfdom.<sup>10</sup> Serfs were more prevalent in the “old” regions of the empire closer to Moscow, whereas state peasants and free agricultural workers were more numerous in the outskirts of the empire. The reasons for this spatial pattern were closely connected to the construction of the army and to the specificities of Russian conquest (see the online appendix for details). Figure 2 presents the spatial distribution of serfs across the European provinces of the Russian Empire in 1858.<sup>11</sup> An important determinant of the relative shares of serfs versus state peasants was the location of monasteries. In 1764, the lands and the serfs of the Orthodox Church, which was a major landowner prior to that moment, were confiscated by the state and transferred to state

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<sup>8</sup> The state sometimes intervened in cases of starvation and torture of serfs. The law also limited sales of serfs without land.

<sup>9</sup> We describe the legal status of each of these groups of peasants in more detail in the online appendix. In short, in terms of regulation and individual constraints members of these groups faced, they could be ranked as free agricultural workers (the freest), state peasants, royal peasants and serfs (the most unfree). Royal peasants formally belonged to the royal family; nevertheless, we consider them as free relative to serfs because they were managed by a special ministry, which made them *de facto* similar to state peasants under fixed taxation.

<sup>10</sup> With the exception of the Baltics, where serfs were emancipated and became free landless agricultural workers between 1816-1819.

<sup>11</sup> Figure A1 in the online appendix confirms a strong negative correlation between the share of serfs and the proximity to Moscow (we account for this correlation in our empirical strategy). Figures A2 and A3 in the online appendix present the spatial distributions of state peasants and free agricultural workers, respectively.

ownership.<sup>12</sup> Similarly, confiscations of the Catholic Church lands occurred in the late 18<sup>th</sup> – first half of the 19<sup>th</sup> century (see the historical section of on-line appendix for details).

### *3.1. The abolition of serfdom: the emancipation and the land reform*

Discussions of a potential emancipation reform within the Russian empire began in the 18<sup>th</sup> century. However, real steps toward enacting this reform were undertaken only following Russia's defeat in the Crimean War (1853-1856). The defeat against a coalition, which included Great Britain and France, demonstrated to the government that Russia had fallen behind other European countries and that liberalization was overdue (see the online appendix for details).

The 1861 manifesto granted personal freedom to former serfs, and outlined the rules of the subsequent land reform. Serfs were granted freedom instantaneously and free of charge. Landlords lost the right to change the level of peasant obligations, to sell, buy, lease, punish, or imprison peasants.<sup>13</sup> Emancipated serfs were obligated by law to buy out the land from the landlords. Peasants (as a commune) and their landlords had to negotiate the precise terms of this buyout, namely, the plots, the price, and the exact timing of the transaction. The land reform was gradual and proceeded in two stages. The first stage regulated the peasant-landlord relationship in the form of a *regulatory charter* during the transition period, i.e., before the *buyout contract* was signed. The second stage marked the actual transfer of ownership over the land in exchange for an immediate payment, the terms of which were regulated by the buyout contract between the landlord, the peasant commune, and the state. The regulatory charters had to be signed by 1863, they fixed the amount of the lease payment (in the form of quitrent) for the use of land by peasants until the transfer of property rights and abolished all other peasants' obligations to landlords. About 50% of the regulatory charters were signed as a result of a mutual agreement between peasants and the landlords. In the absence of an agreement, local officials imposed the terms of a fallback regulatory charter. In estates—where landlords did not change the level of

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<sup>12</sup> The 1764 Catherine the Great nationalization reform was limited to the main provinces of the European Russia. In 1786 and 1788, the government expanded the nationalization of monastic lands on Ukrainian and South provinces.

<sup>13</sup> Former serfs were also granted a set of civil rights, including the right to marry without anybody's permission, to buy, sell, and lease property, to sign contracts, trade, launch businesses, and to represent themselves in court (Complete ... 1861).

peasant obligations during serfdom, i.e., they were able to commit to an implicit long-term contract with peasants—agreements were usually easier to reach as they just formalized the previously existing implicit contract (Zajchkovskij 1968).

80% of the land value specified in the buyout contract was financed by the state in a form of a 49-year state loan to peasants, who had to pay back a fixed redemption amount annually. The timing of the signature of the buyout contract ranged from 1862 to 1882. In western provinces, the land buyouts were forced to be completed by 1863 as a political measure following the Polish rebellion against the empire. In eastern provinces, initially, the timing of the signature of the buyout contracts was not regulated; as a result, for 15% of former serfs, the contract negotiations lasted until 1881, when a new law prescribed an obligatory start of land buyouts. An important determinant of the length of the transition period was landlord's indebtedness to the state. If the land was used as collateral, the buyout meant that the state wrote the debt off, leaving the landlord without money and land lease payments. Importantly, as a rule, lease payments were higher than the interest on the state loans. In contrast, landlords without debt got the full value of the land sold to former serfs at the signature of the buyout contract. We describe the details of the land reform in the online appendix.

#### **4. Data**

We combine various published and archival sources to construct a unique province-level panel dataset on development of fifty European provinces of the Russian Empire in the 19<sup>th</sup> century.<sup>14</sup> Table 1 reports descriptive statistics for all variables used in the analysis.

*Outcome variables.* Grain was the main output of the empire. We measure grain productivity as the grain yield to grain seed ratio because there are no panel data on labor and non-labor inputs that would cover both pre- and post-emancipation periods.<sup>15</sup> The grain yield is

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<sup>14</sup> Table A1 in the online appendix provides the exact sources and lists the years for which we have data for each variable used in the analysis.

<sup>15</sup> There are no data on labor inputs in agriculture in the 19th century. Employment in agriculture is known only for the 1897 population census year. In addition, figures on population with rural legal status are known only for tax census years (1795, 1811, 1816, 1851, and 1858). Arable land data are available for 1800, 1858, 1871, and 1877. There are no data on investments into land.

widely used as a proxy for productivity in agriculture in Russia before the late-19<sup>th</sup> century as well as in medieval Europe. Data on grain yield come from the annual governor reports for the years before 1883 and the official imperial statistics of the central statistical committee for the later period.<sup>16</sup> The methodologies of the data collection were different before and after 1883, but it was the same within each of these periods irrespective of prevalence of serfdom in a province.<sup>17</sup> Historians agree that the quality of the late imperial statistics and governor reports is rather high (Koval'chenko 1979; Nifontov 1974 pp. 35-46).<sup>18</sup> The nutrition of peasants is proxied by an average height of draftees by birth cohort in each province, drafted at the age of 21 years old.<sup>19</sup> Industrial development is measured by log industrial output in constant rubles of 1895.<sup>20</sup> The data on draftees height and industrial output come from the governor reports and official statistical volumes published by the Central Statistical committee. All outcomes are available at the province level. In addition, the mean height of draftees by cohort is available at the sub-province (district) level. Different numbers of snapshots over time are available for different outcomes. The largest number of over-time observations is 41 for grain yield. The number of snapshots overtime for the industrial output is 8. The number of cohorts with data on height is 15 at the province level and 10 at the district level. Occasionally, data for some provinces for grain yield and industrial output are missing in the historical sources; thus, the resulting panel data for these outcomes are unbalanced.

*The main explanatory variables.* We use the cross-sectional data on the prevalence of serfdom across provinces and across districts before the emancipation. The data on the

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<sup>16</sup> As described in the inline appendix, for governor reports, we rely on the secondary published sources based on original archival documents.

<sup>17</sup> Governor reports provide only aggregated figures on all cereals. We aggregate data on rye, oat, wheat, barley, and buckwheat for the post-1883 period to construct comparable measures. In Section 8 below, we verify that the change in the methodology of collection of grain data that occurred in 1883 does not drive our results for grain productivity. In particular, we find that the results are robust to restricting the sample to data from governor reports only, i.e., to before 1883.

<sup>18</sup> According to Nifontov (1974), the official procedure for data collection was very deliberate. It required a lot of cross checking by various local authorities. In addition, the central government carefully monitored implementation of the data collection, as the data were used for potential tax redemption and state transfers. Nifontov (1974) verified that the time-series of grain yields from the alternative sources, such as reports of the Ministry of State Property, are highly correlated with those based on the governors' reports.

<sup>19</sup> All height data are on soldiers drafted after the 1874 military reform, i.e., collected under the same procedure. Those who were drafted before 1881 were born before the emancipation.

<sup>20</sup> We use Mironov (2010) index to deflate industrial output reported in current rubles in original sources.

composition of rural provincial population by status in 1858, i.e., the shares of serfs, state peasants, free agricultural workers, and royal peasants, come from Bushen 1863.<sup>21</sup> The data on the number of serfs by district in 1858 come from (Trojnitiskii 1861); to get the share of serfs by district, we divide their number by district population in 1863 due to data limitations (Bushen 1863). We also construct a measure of the land reform implementation which varies both across provinces and over time: in particular, we use a proxy for the share of serfs who signed buyout contract in the total rural population in each province and year. To construct this variable, we use two data sources: 1) the redemption payments statistics, which report the sums that peasants had to pay to the state for the loan annually by province. These data are available for all provinces and years up to (and including) 1877; and 2) the 1877 cross-section of the number of peasants who had signed buyout contract by that time (Vilson 1878). Assuming constant redemption payments per peasant across estates and over time within each province, we construct the share of serfs who signed buyout contract each year in each province up to 1877 from these two variables. Then, we extrapolate these numbers to the remaining 4 years of the land reform implementation, i.e., 1878-1881, using a linear projection from 1871-1877. As land reform was completed in 1882 by law, we set the share of serfs who signed buyout contract in the total rural population to be equal to the total share of former serfs from 1882 onwards. Similarly, in the five most western provinces—Kiev, Mogilev, Podolsk, Vitebsk, and Volhyn—we set the proxy for the land reform implementation to be equal to the share of former serfs from 1863 onwards due to the obligatory buyouts in these provinces in 1863 (in response to the Polish rebellion).

We use the average share of formerly monasterial and clergy serfs in 1796 and 1814 by province as an instrument for the prevalence of serfdom across provinces in 1858 and, analogously, the average share of formerly monasterial and clergy serfs in 1796 and 1814 by

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<sup>21</sup> We define the number of serfs in a province as the sum of two categories of peasants from Bushen (1863): *temporary obliged peasants* and *former serf-sevants*. The number of state peasants in a province as the sum of *state peasants* and *military dwellers*. We consider the following groups as making up the rural population: *royal peasants*; *state peasants*; *military dwellers*; *soldiers in reserve*; *former soldiers*; *cantonists*; *citizens from irregular military regiments*, i.e., *cossacks*, *colonists*, *peasants under supervision of various ministries*; *foreigners in rural areas*; *non-Russians in rural areas*. Taken together, the latter eight groups comprise the free rural population in our classification. We verified that our results are robust to using 1857 tax census data (Kabuzan 1971) as a source of data for the composition of the peasantry by type instead of Bushen (1863). See robustness section for details.

district as an instrument for serfdom at the district level (we refer to them as monasterial serfs hereafter).<sup>22</sup> These data come from Beskrovnii et al. (1972).

*Additional data.* We rely on FAO GAEZ data to construct median land suitability by province and the weather station data from the Global Land Surface Databank (Rennie et. al., 2014) to construct the series of annual mean temperature by province and year. For these calculations as well as the distance to Moscow from the centroid of each province and each district, we use digitized map of the Russian empire. To examine the mechanisms behind our main results, we use the following variables. A dummy for whether re-partition communes were a prevalent form of communes in a province in 1905 comes from Dubrovsky (1963). These data are not available for earlier years, but we can use 1905 data in regression analysis because very few (if any) communes changed their status. The share of serfs who agreed to sign regulatory charters in a province comes from Vilson (1878). The data on the composition of summer and winter grains are from the same sources as grain yields. To construct a time series on relative price of winter to summer crops we use the time series of the prices of rye (the main winter crop) and wheat (the main summer crop) in the Netherlands (i.e., in the country of one of the most important export markets for Russian grain in the 19<sup>th</sup> century) from van Reil.

## 5. Empirical methodology

We use cross-province variation in the share serfs and over-time variation in the emancipation to estimate the effect of the abolition of serfdom on agricultural productivity, peasants' nutrition, and industrial development. Our main specification is as follows:

$$Y_{it} = \alpha \text{ShareSerfs}_i \times \text{PostEmancipation}_t + \mathbf{X}_{it}'\gamma + \psi_i + \Theta_t + \tau\delta_i + \varepsilon_{it}, \quad (1)$$

Subscripts  $i$  and  $t$  index provinces and time periods. Time periods are either years or decades, depending on data availability for a particular outcome. The baseline sample consists of 46 European provinces of the Russian empire.<sup>23</sup> We consider the following outcomes, denoted by  $Y$ :

<sup>22</sup> In the cases, where the data on the monasterial serfs were not available either for 1796 or 1814, we employ the shares of the available year, either 1814 or 1796 correspondingly. See online appendix for details.

<sup>23</sup> The baseline sample excludes Baltic provinces because these provinces differ from the rest in many respects. We discuss the robustness of the results to including the Baltics in the robustness section.

grain yield (harvest/seed ratio) and log(industrial output) in province  $i$  at time  $t$  and the mean height of draftees in centimeters in province  $i$  in a cohort born at  $t$ . *ShareSerfs* denotes the share of privately owned serfs in a province in 1858. *PostEmancipation* denotes a dummy indicating the time after the emancipation of serfs, i.e., post-1861 dummy for the baseline sample. The interaction between the share of serfs and the post-emancipation dummy is our main variable of interest. The coefficient on this interaction ( $\alpha$ ) is the difference-in-differences estimator of the effect of the abolition of serfdom on the considered outcome. In order to estimate this parameter consistently, we need to control macroeconomic shocks, unobservable characteristics of provinces, as well as provincial trends.  $\psi_i$  and  $\Theta_t$  are the province and year fixed effects. As different provinces are expected to have different development trajectories, we control for 46 province-specific linear trends ( $t\delta_i$ ). To account for the correlations between the share of serfs with the distance to Moscow and soil quality, we control for the interactions between post-emancipation dummy and log distance to Moscow and land suitability, minus their respective sample means; these variables are denoted by  $\mathbf{X}_{it}$ .<sup>24</sup>

To ensure that our results are not driven by the two main potentially confounding reforms, we also adjust specification (1) and report OLS panel with controls for the land reform for state peasants in 1866, and the 1859 reform of royal peasants: we include interactions of shares of these groups in provincial rural populations with post-1866 and post-1859 dummies, respectively.

The main identifying assumption in equation 1 is that there are no systematic differences in the trends of the outcomes of interest among provinces with different prevalence of serfdom before the emancipation (conditional on all other covariates, including province-specific trends). This is testable for the outcomes with sufficient number of over-time observations before the reform, namely, grain yield and draftees' height. Thus, we augment specification 1 by replacing the interaction between the share of serfs (*ShareSerfs<sub>i</sub>*) with post-emancipation dummy by a

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<sup>24</sup> The means are subtracted in order for  $\alpha$  to estimate the effect of the abolition of serfdom at the mean levels for the distance to Moscow and land suitability.



series of interactions of  $ShareSerfs_i$  with a number of dummies indicating pre-reform and post-reform time periods. We also control for the reforms for state peasants of 1866 and royal peasants of 1859 in this specification.

In the baseline specification 1, we follow Bertrand, Duflo, and Mullainathan (2004) and cluster error terms within each province separately before and after the emancipation of 1861. This system of clusters accounts for autocorrelation in residuals within each province. However, it does not account for spatial correlation. This is potentially problematic because the share of serfs is spatially correlated as can be seen in Figure 2. To verify that we do not underestimate standard errors due to the presence of both the spatial and over-time correlation in residuals, we collapse the panel data to a single cross-section, in which we explicitly account for spatial correlation. In particular, we de-trend each outcome of interest by taking residuals from regressing it on time dummies and province-specific linear trends and take the difference between the mean of de-trended outcome before and after the emancipation separately in each province. As a result, we get the province-level cross-sections of average growth in each outcome between post- and pre-emancipation periods. We regress these variables on the share of serfs controlling for log distance to Moscow and land suitability, correcting for spatial correlation of errors (Conley 1999, 2008) within a radius of 900 kilometers that is equaled to about one third of West-East and North-South dimensions of the territory for which we have data (the distance sufficiently large to account for any existing spatial correlation).<sup>25</sup>

As the differences in the prevalence of serfdom are not random (and may be driven by some unobserved factors), we also use an instrumental variable strategy to estimate equation 1. It is important to note that only those unobserved factors that change the development trends in 1861 could potentially be driving the results of OLS estimation of equation 1. Although we deem the existence of such factors as unlikely, they are not impossible given the change in the geo-

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<sup>25</sup> We verify that the results are robust to setting different thresholds for spatial correlation. We also verify that our results are not driven by influential observations in this cross-sectional regression by calculating DFBeta coefficients for the main variable of interest, i.e., the share of serfs, for each observation and reporting results on the subsample excluding observations with the largest DFBetas.

political equilibrium following Russia's defeat in the Crimean War. To address potential endogeneity, we take the historical distribution of the share of serfs in rural population that belonged to the church across provinces before their nationalization as a source of exogenous variation in the share of serfs in 1858. In order to avoid a conflict between the crown and the church, monasterial lands nationalized by the state were less likely to be subsequently redistributed to gentry than other state lands (Semevsky 1906) and, therefore, peasants who lived on these lands were less likely to become private serfs after the nationalization of church property. Figure 3 illustrates that the prevalence of the monasterial serfs before their nationalization is a good predictor of the share of private serfs prior to the emancipation; it presents the conditional scatter plot between the average share of former monasterial serfs in 1796 and 1814 (which is denoted by *MonastShare<sub>i</sub>*) and the share of serfs in 1858 conditional on log distance to Moscow and land suitability across provinces. In the panel setting of equation 1, we instrument  $ShareSerfs_i \times PostEmancipation_i$  with  $MonastShare_i \times PostEmancipation_i$ . This instrument is excludable because the distribution of church lands a century before the emancipation was orthogonal to the changes in economic fundamentals around emancipation conditional on the distance to Moscow. Monasterial serfs before nationalization did not differ systematically from private serfs, facing the same constraints and used the same agricultural technologies and practices (Zakharova 1982). As data on the height of draftees by cohort exists also at the district level, for this outcome, we also estimate an analogue of equation 1 with year and district fixed effects and province-specific trends.<sup>26</sup> In the district-level regressions, we instrument the share of serfs by district in 1858 by the average share of nationalized monasterial serfs by district in 1796 and 1814.<sup>27</sup>

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<sup>26</sup> At the district level, we cannot adjust specification 1 for the reforms affecting state and royal peasants as data on state and royal peasants by district level are not available.

<sup>27</sup> Figure A4 in the online appendix illustrates the negative relationship between the share of serfs in 1858 and the average share of nationalized monasterial serfs in 1796 and 1814 across districts. Panel A presents the scatter plot on the full sample of districts and Panel B shows that this relationship is not driven by outliers by restricting the sample to districts with the share of monasterial serfs below 30%. In the district level-panel, we omit the interaction between land suitability and the dummy for cohorts born post-emancipation as the district-level data cover only two cohorts born post-emancipation (1861 and 1862) and there is a multicollinearity in the IV district-level panel regressions if we include both distance to Moscow and suitability interacted with post-emancipation cohorts in

In order to disentangle the effect of the two components of the abolition of serfdom, namely, the emancipation, which gave personal freedom to serfs, and the land reform, which gave them communal land titles, we include in the list of covariates, our proxy for the implementation of the land reform, i.e., a measure of the number of former serfs who signed buyout contracts as a share of rural population in a particular year. This exercise can only be done for grain yield because of the relatively high frequency of the data for this outcome. The land reform variable is likely endogenous to changes in agricultural productivity. To estimate the causal effect of land reform we instrument the share of peasants who signed buyout contracts in a particular year in a particular province with a synthetic variable which predicts the progress of land reform based on the pre-reform indebtedness of estates in a province. In particular, to construct the predicted land reform variable we assume that landlords without debts initiated the land reform in 1862, immediately after the emancipation; whereas, the number of landlords with debts, who launched the land reform, grew linearly between 1862 and 1882. This instrument reflects the fact that the indebted landlords had incentives to postpone buyout operations (see on-line appendix for details). Thus, we construct the IV for the land reform as an interpolation between (1-debtedness) and 1 in the interval 1862-1882, 0 before 1862, 1 after 1882. For western provinces the IV switches from zero to 1 in 1863 because of changes in the land reform rules for these provinces as a result of the Polish revolt. To illustrate how well this instrument predicts the progress of the reforms, we take a snapshot in 1872, i.e., halfway through the land reform implementation and plot on Figure 4 the cross-sectional association between the share of peasants (former serfs) who signed buyout contracts and the predicted land reform progress in 1872. (We present the results of the actual first stage estimations in the next section together with the results of the second stage.) This instrument is likely to be excludable because historical sources suggest that the primary reason to obtain loans for gentry was the status consumption rather than productive investments (Korf 1906) and because loans were issued by non-market

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addition to our main regressor: the interaction between the share of serfs with the dummy for post-emancipation cohorts (instrumented by the interaction of the share of monasterial serfs with post-emancipation cohort dummy).

state financial institutions which granted loans for political rather than economic reasons (Gur'ev 1904). (Details are relegated to the online appendix.)

## **6. Main results: The effects of the abolition of serfdom**

### *6.1. Productivity of Russian agriculture*

Table 2 presents the estimated effect of the abolition of serfdom on the productivity of Russian agriculture. The results yield strong and robust evidence of a large positive effect of the abolition of serfdom on the grain yield. Panel A presents the results of the panel data estimation; Panel B presents the corresponding first stages, and Panel C presents the results of cross-sectional estimation. The first column of Panel A presents the results of the most basic OLS specification with no additional covariates beyond province and year fixed effects. In column 2, we add controls for the (demeaned) distance to Moscow and crop suitability interacted with post-1861 dummy and province-specific linear trends. In column 3, we instrument our main explanatory variable with the share of nationalized monasterial serfs interacted with post-emancipation dummy. In all specifications we find a positive and statistically significant average effect of the abolition of serfdom, estimated by the coefficient on the interaction term between the share of serfs and post-emancipation dummy. The first stage of the 2SLS specification is presented in Panel B of the Table just below the second stage results. The instrument is a strong predictor of the interaction between the share of serfs and post-emancipation with F-statistic above 17. In column 4, to the OLS specification we add controls for the reforms for state and royal peasants: the share of state peasants interacted with the onset of their land reform, i.e., post-1866 dummy, and the share of royal peasants interacted with the onset of their emancipation, i.e., post-1859 dummy. The coefficient of interest remains significant and roughly stable in magnitude.<sup>28</sup> In Panel C of Table 2, we report cross-sectional results with standard errors corrected for spatial

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<sup>28</sup> As the instrument predicts the variation in the prevalence of serfs versus state peasants across provinces, we cannot use IV once we control for the share of state peasants interacted with post-1866 dummy because this control is highly correlated with the interaction of the share of state peasants with post-1861 emancipation, predicted by the instrument.

correlation. Column 1 presents results for the full sample of 46 provinces and column 2 for a sub-sample excluding most influential observations. Again, we find a strong and significant correlation between the change in de-trended grain yield between pre- and post-emancipation periods and the share of serfs by province, suggesting that the presence of spatial correlation in residuals is not driving our results.<sup>29</sup>

The estimated effect is substantial. A one standard deviation increase in the share of serfs in a province before the emancipation (i.e., an increase of the share of serfs in rural population of 24 percentage points) led to an increase in grain yield of 0.29 after the emancipation or 8.3% from the mean 1858 level of 3.5 (according to the estimate in column 3 of Panel A). These are large effects, as compared to the aggregate trend in grain yield, which, on average, increased by 4 percent in a decade in the 19<sup>th</sup> century. For an average province, where serfs constituted 45% of rural population, the abolition of serfdom led to a 15.5% increase in grain productivity from the 1858 level, on top of the overall development trend. We find that the coefficient on the distance to Moscow interacted with post-emancipation dummy is negative and significant, thus, these magnitudes refer to provinces with the mean log distance to Moscow.<sup>30</sup>

We proceed to testing the main identifying assumption of the difference-in-differences approach, i.e., whether there are diverging pre-trends in agricultural productivity among provinces with high and low prevalence of serfdom. We estimate the coefficients of eleven interaction terms of the share of serfs in 1858 with dummies indicating five-year intervals, including three before the emancipation (leaving 1795-1829 period as a comparison group). In

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<sup>29</sup> Influential observations are defined as having the absolute value of DFBeta greater or equal to 0.3. Figure A4 in the online appendix illustrates cross-sectional relationship by presenting conditional scatterplot on the full sample with an indication of DFBeta for each observation.

<sup>30</sup> The closer the province was to Moscow, the larger the effect of the abolition of serfdom. This is not surprising, as the proximity to Moscow also meant the proximity to the largest markets and to market infrastructure. In Moscow, its effect was about twice as large as in a province with the mean log distance to Moscow. In the most remote provinces of our sample, the effect of the abolition of serfdom was positive, but much smaller than the average. We provide further evidence in support of this interpretation in Table A3 in the online appendix reporting results of regression analysis when we replace the distance to Moscow interacted with post-emancipation dummy by the triple interaction between the share of serfs, the distance to Moscow and post-emancipation dummy (we do not include the pair and triple interactions together into the same regression because of high collinearity between them; the coefficient of correlation is 0.87). The coefficient on the triple interaction is always negative although not precisely estimated.

this specification, we include the same controls as in column 4 of Table 2 with one important difference: Instead of 46 province-specific trends, we control for 14 region-specific trends, each of which groups together several provinces that are commonly considered as having similar development trajectories.<sup>31</sup> This change is necessary as the addition of eleven interaction terms into this specification makes the use of 46 province-specific trends too demanding. Figure 5 visually represents the results by plotting the coefficients on these interactions along with their 90% confidence intervals by time periods.<sup>32</sup> The results indicate the absence of pre-trends, as there are no significant effects before the emancipation reform. Importantly, a sharp increase in grain productivity occurred immediately after the emancipation. The coefficients are positive, statistically significant, and rather large already for the first five-year interval after the emancipation. The grain productivity continued to rise for the next fifteen years after the initial jump in the first five years after the reform. The cumulative effect of the reform in the first twenty years is more than twice as large as in the first five years. Thus, these results provide only a partial support for the claims of historians that the realization of the positive effects of the emancipation was slow because of the slow institutional adjustments and associated transaction costs (Gerschenkron 1965, Nifontov 1974) as the largest single jump in grain productivity occurred right after the emancipation. We also find a decrease in grain productivity in the late 19<sup>th</sup> century compared to the peak attained by 1876-1880. The coefficients on the interactions of the share of serfs with five-year-period dummies after 1881 are substantially smaller (but remain positive and statistically significant). In the reminder of this sub-section, we investigate the reason for this partial setback.

In columns 5 and 6 of Table 2, we disentangle the effects of the two components of the abolition of serfdom on agricultural productivity: the emancipation per se and the subsequent land reform. In particular, we add the share of peasants (former serfs) who had signed buyout contracts in this province up to this year among the provincial rural population to the list of

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<sup>31</sup> We provide the precise list of the regions and the provinces they are comprised of in the appendix.

<sup>32</sup> Column 1 of Table A2 in the online appendix presents the entire regression output.

covariates. In this specification, the coefficient on the interaction between the share of serfs and the post-emancipation dummy estimates the effect of the emancipation (per se) and the coefficient on the share of peasants who signed buyouts contracts estimates the effect of the land reform. We find that the land reform caused a significant setback to the progress in agricultural productivity, which was due to the emancipation. Column 5 presents OLS estimates and column 6 – IV estimates. In the 2SLS estimation, we instrument both the emancipation (as above, with the share of nationalized monasterial serfs) and the land reform. The instrument for the land reform, as described in the methodology section, is the interpolation between (1-indebtedness) at the beginning of the land reform (in 1862) and one at the end of the land reform (in 1882). In Panel B of the table, right below the second stage results, we present the results of the first stage regressions, which yield that both instruments are strong predictors of their respective endogenous variables (F-statistics for the excluded instruments are reported at the bottom of the table). Both in OLS and IV specifications, we find that the effect of the land reform on productivity in agriculture is negative and statistically significant, whereas the effect of the emancipation is positive and significant. The IV point estimates are much larger in magnitude compared to the OLS estimates, which points to the *a priori* plausible endogeneity of the implementation of the land reform. According to IV estimates, the effect of the emancipation per se is 2.3 as large as the total overall effect of the abolition (column 5 vs. column 3). A full implementation of the land reform from affecting zero to affecting all former serfs in an average province led to a decrease in grain productivity by 0.57, (or 16.2% from the mean 1858 level), whereas the emancipation led to an increase in grain productivity by 1.25 or 35.7% (column 5). The land reform, therefore, substantially slowed down the growth in agricultural productivity, which was initially boosted by the emancipation. The net effect of the abolishment of serfdom would have been 84% larger if not for the setback caused by the inefficiency of the land reform.<sup>33</sup>

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<sup>33</sup> The 84% figure comes from the following calculation:  $1.25 / (1.25 - 0.57) = 1.838$ .

### 6.1.1. *The mechanisms*

Gerschenkron's (1965) argued that the land reform negatively affected Russian agricultural development through its effect on the empowerment of the peasant re-partition commune. In column 1 of Table 3, we test this conjecture and find empirical support for it. We include the interaction between the land reform proxy and the dummy for re-partition commune to the specification, presented in column 5 of panel A of Table 2. We find that the average negative effect of the land reform is entirely due to the negative effect of land reform under the re-partition commune. We run OLS specification only, because we do have a credible instrument for the re-partition commune dummy. Judging by the analysis presented above, the OLS estimates underestimate the negative effect of the land reform. An additional source of bias could arise from the endogeneity of the re-partition communes if it had a direct non-linear effect on dynamics of agricultural productivity at the time of the reform, which is unlikely, but not impossible. Thus, these results should be interpreted with caution. We find that the full implementation of the land reform in an average province with the re-partition commune was associated with a decrease in grain productivity of -0.27 (or 8%). The effect of the land reform in the hereditary commune is positive albeit not statistically significant. (The difference between the two effects is significant as reflected in the negative coefficient at the interaction between the share of peasants with signed buyout contracts and the re-partition commune dummy, with p-value of 0.02).<sup>34</sup> These results suggest that the inefficient re-partition commune was the reason for the setback in the reform progress after 1882— the year, when the land reform was completed (as illustrated in Figure 5).

What was the mechanism behind the positive effect of the emancipation reform? A large and immediate effect may seem puzzling because most changes induced by the reform must have taken time and, furthermore, many were expected to have a sluggish effect on agricultural productivity. For example, one could expect an increase in human capital investment (as a result

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<sup>34</sup> These results are also consistent with recent findings on the positive effect of the Stolypin reform (1906), which allowed peasants to exit the commune (Castañeda Dower and Markevich 2016).



of granting personal freedom to serfs) and an increase in investment in land in hereditary communes (as a result of the change in property rights); however, these investments could have had an effect on productivity only with a considerable lag. It is also possible, although historians argue against it, that productivity increased because of an increase in capital inputs after the reform (as a result of acquisition of agricultural machinery) and because of new technologies (i.e., a shift to more productive seed varieties).<sup>35</sup> These changes also could not have happened over night.

One important change that did occur right after the emancipation was that the law fixed the level of peasants' obligations for all (former) serfs. This change could have had an immediate positive effect on peasants' incentives, as they became residual claimants of the proceeds of their labor, provided that serf owners were not able to commit to a fixed level of serfs' obligations under serfdom. Importantly, many contemporaries believed that an increase in peasants' effort was expected to boost agricultural productivity.<sup>36</sup> Therefore, it is reasonable to expect an immediate positive effect of the emancipation on peasants' effort and, consequently, productivity, if serfdom was subject to a ratchet effect. This hypothesis is not testable directly because there are no data on peasant effort. We aim at testing it indirectly.

First, if peasant incentives were the main driver of the productivity improvements following emancipation, in estates where serfs faced high-powered incentive schemes designed by landlords under serfdom, we expect to see no gains in productivity after the emancipation. As

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<sup>35</sup> There is a consensus in the historical literature that no improvements in agricultural capital, i.e., tools and machines, occurred until the end of the 19th century (e.g., Nifontov 1974). One could also consider a possibility that land input increased because of virgin lands exploration after the emancipation, which could have an effect on productivity if the new lands were more productive. We test and reject this mechanism. We have collected data on arable land for four cross-sections – two before and two after the emancipation. We use the logarithm of arable land as an outcome variable estimating equation 1 replacing province-specific with region-specific trends because of a small number of observations. Results of the OLS and IV estimations are presented Table A4 in the online appendix. We find that the abolition of serfdom did not affect cultivated area. The coefficients on the interaction of the share of serfs with post-emancipation dummy are not significantly different from zero, irrespective of specification.

<sup>36</sup> Agricultural handbooks from the first half of 19th century (e.g., Mordvin 1839, Usov 1840, Dmitriev 1844, Ungern-Shterenberg 1848) discuss the way to increase productivity readily available at that time. Some of these improvements were as sophisticated as new seed varieties and the introduction of multiple-field crop rotation, others as simple as a change in the timing and the order of existing agricultural operations. These handbooks explicitly name the lack of incentives on the part of serfs and landlords' monitoring problems, as the main explanations for low agricultural productivity. Mordvin (1839) singled out fifteen reasons for poor harvests, with six of them related to low serfs' effort. We provide details in the online appendix.

described above, it was easier to reach an agreement about the level of former serfs' obligations during transition period in estates where the obligations were fixed de facto before emancipation by an implicit long-term contract. We use the share of serfs who agreed to sign regulatory charters as a proxy for the presence of such implicit contracts. Column 2 of Table 3 presents the results of the estimation of the differential effect of emancipation on productivity, depending on the share of serfs with long-term implicit contracts by province. We operationalize this test by adding an interaction of the share of serfs with signed regulatory charters (i.e., agreed to the proposed terms of the fixed land lease payments in the interim period before the signature of buyout contract) with the share of serfs post-emancipation to our main specification. As above, we run only OLS regressions because we do not have a credible instrument for the use of implicit contracts under serfdom, which potentially could be a problem if there is a reason unrelated to serfdom for a change productivity trends in 1861 in provinces where landlords committed to a long term implicit contract *vis à vis* their serfs. As expected, we find that implicit contracts under serfdom left little for productivity improvements as a result of the emancipation. The share of serfs under implicit long-term contracts varies across provinces from 1% to 80%, with the median province at 41%. The productivity increase due to the abolition of serfdom (taking into account the countervailing effects of the emancipation and the land reform) was positive and significant in one half of the provinces where the share of serfs subject to implicit long-term contracts with landlords was below 42%. The productivity increase was not statistically different from zero in provinces where serf owners were committed not to change serf obligations.

Second, we can observe whether peasants make adjustments to the choice of crops to seed as opposed to sell or to consume depending on the climatic and market conditions. As effort and care are needed to make such adjustments, we expect peasants to chose more appropriate crops for cultivation with regard to climatic and market conditions after the emancipation. According to the prevailing at the time technology, each plot was divided roughly into three

parts: for winter grains, summer grains, and fallow. The peasants could change the relative sizes of the three parts depending on what made more sense in terms of climatic and price shocks. In particular, the colder temperatures were associated with higher failure of winter crops relative to summer crops, and therefore, colder years, on average, were associated with higher shares of summer grains in total amount of crops seeded. To harvest in the summer of year  $t$ , the winter crops were seeded in the fall of year  $t-1$  and the summer crops in the spring of year  $t$ . The decision on how much to allocate to winter vs. summer grains was taken in the fall of the year  $t-1$  (when the winter crops were seeded). Market conditions also mattered for the choice of what shares of each type of crops to seed. Since the price fluctuations allowed at most an imperfect forecast of the relative price of winter to summer crops for next season, it was rational to sell a larger share of more expensive crops after the harvest (in the summer and fall) and allocate to seeds and to private consumption a larger share of the less expensive crops. These choices started to have an effect on peasants' wellbeing only after the emancipation, when they became residual claimants on their harvest. Thus, we should expect higher sensitivity of the ratio of summer-to-winter crops after the emancipation to both climatic and market conditions if peasants' increased effort is the mechanism behind the effect of emancipation. In column 3 of Table 3, we regress the ratio of summer-to-winter crops on the last year's temperature and its interaction with the share of serfs post-emancipation. We find that, on average, the ratio of summer-to-winter crops was lower during cold shocks and that this relationship became significantly stronger for the emancipated serfs after 1861. In column 4, we explore the choice between the summer and winter crops depending on their relative price. Again, as expected, we find that the emancipated serfs sold a larger share of the more expensive crops (leaving cheaper crops for seeds and own consumption). In column 5, we combine the interactions with temperature and with the relative price in one regression and get the same result.<sup>37</sup>

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<sup>37</sup> Note that we do not combine these specifications with our measure of implicit contracts because these contracts could also regulate directly the shares of winter and summer crops. In addition, it is worth noting that the interaction between the temperature and post-1861 dummy has zero effect on productivity and just adds noise to the estimation.

To sum up, we find suggestive evidence that an increase in peasants' incentives was an important mechanism through which the emancipation boosted agricultural productivity.

### *6.2. Peasants' nutrition*

We proceed by estimating the effect of the abolition of serfdom on development outcomes beyond agricultural productivity. We start with draftees' height as a measure of nutrition.<sup>38</sup> As nutrition affects subsequent adults' height primarily in the first three years of life starting with time in utero (Costa 2015), the effect of reform is expected to be almost immediate and, thus, we compare the average height of cohorts born before and after the reform and relate this difference to the variation in the prevalence of serfdom. Table 4 presents the results: we find a large and immediate positive effect of the emancipation on the height of draftees. The structure of the table is similar to that of Table 2. In particular, in Panel A, we present the results of the panel estimations; Panel B presents the first stages for the corresponding 2SLS regressions presented in the Panel A; and Panel C presents the cross-sectional results for first differences with standard errors adjusted for spatial correlation in error terms with a cut off at 900 km. As described above, we have used two sources of data: with average height of draftees by province and by district. We have almost ten times more observations in a cross-section at the district than at the province level but fewer cross-sections (ten vs. fifteen) at the district-level than at the province-level. Let us first discuss panel results. Columns 1 to 3 presents province-level results: baseline OLS and IV, as well as OLS with controls for reforms affecting state and royal peasants, respectively. Columns 4 and 5 present OLS and IV results at the district-level.<sup>39</sup> The coefficient on the main variable of interest is a large and statistically significant irrespective of specification and the first stages are sufficiently strong not to worry about weak instrument problem. Since both serfs and free peasants had the same chance to be drafted and serfs constituted 45% of the total population in an average province and 40% of the total in an average

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<sup>38</sup> Rural citizens were the main source of draftees for the army (Beskrovnii 1973).

<sup>39</sup> In district level-panel, we omit one covariate, namely, the interaction between land suitability and the dummy for cohorts born post-emancipation as we have only two cohorts born post-emancipation in the district-level data set and there is a multicollinearity in the IV district-level panel regressions if we include both distance to Moscow and suitability interacted with post-emancipation cohorts in addition to our main regressor.

district, the abolition of serfdom in an average province led to an increase in the height of draftees by 0.61 centimeters ( $0.61=1.35*0.45$ ) and in an average district by 0.38 ( $0.38=0.96*0.4$ ) centimeters (according to the IV specifications). An important reason why the point estimates are smaller in the district-level analysis compared to the province-level analysis is that there are only two cohorts born after the emancipation in the district-level data as compared to seven post-emancipation cohorts in the province-level data. As the draftee's height is an individual characteristic (rather than a characteristic of the economy), we can interpret the results one to one: IV estimates imply that the abolition of serfdom led to an increase in the height of a (former) serf by 1.35 centimeters on average according to province-level results and by 0.96 according to district-level results. These large effects is most likely driven by a combination of two factors: 1) the boost of productivity as a result of the abolition of serfdom (that we find in Table 2) and 2) the redistribution from landlords to peasants as a result of emancipation, which fixed the peasants' obligations to landlords (as discussed above and in the online appendix).

As with grain yield, to test for pre-trends and to study the dynamics of the effect, we estimate an event-study regression at the province level interacting the share of serfs with the dummies for the following birth cohorts: 1855-56, 1857-58, 1859-60, 1861-62, 1863-64, 1865-66, and 1875 (leaving two cross-sections for draftees' born in 1853 and 1854 as the comparison group). Figure 6 reports the results in a graphic form and column 2 of Table A2 in the appendix reports the regression output. The coefficients on interactions with pre-1861 period dummies are close to zero in magnitude and not statistically significant. Thus, we conclude that there is no pre-trend. In contrast, the coefficients on the interactions with post-1861 period dummies are positive and statistically significant (with the exception of the last 1875 snapshot, where the effect is imprecisely estimated). The bulk of the positive effect of the emancipation on height was realized immediately after the reform, consistent with the finding of the health literature of effect of nutrition on height in early childhood (Costa 2015).<sup>40</sup>

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<sup>40</sup> We also test for and find no evidence of the pre-trends at the district level by estimating an equation interacting dummies for each pair of consecutive birth cohorts with the share of serfs by district controlling for district fixed

In Panel C of Table 4, we present cross-sectional regressions with standard errors corrected for spatial correlation for both province and district-level data. As above, we de-trend the outcome by regressing it on time dummies and province-specific trends, take averages of the de-trended outcome over time for each province and district, respectively, separately before and after the reform, take a difference and regress it on the pre-emancipation share of serfs. We also repeat this exercise excluding most influential observations at the province and at the district level.<sup>41</sup> The results prove to be robust to accounting for spatial correlation of errors and to excluding outliers, as we find positive and significant coefficient on the main variable of interest in these regressions.

### *6.3. Industrial development*

In Table 5, we estimate the effect of the abolition of serfdom on log industrial output. The three panels of the table have the same structure as Tables 2 and 4. The main difference between this analysis and the province-level analysis presented above is that the time dimension of the data for industrial output is substantially shorter (eight snapshots) and, as a consequence, we do not have enough statistical power to control for trends specific to each province, thus, instead we control for 15 region-specific trends. We find a positive and statistically significant effect of the abolition of serfdom on industrial employment in all specifications (i.e., OLS with and without controls for state and royal peasants, as presented in columns 1 and 3 of Panel A of Table 5, respectively, and IV, as presented in column 2 of the same panel). Panel B presents the first stage, which is sufficiently strong. Panel C presents the cross-sectional relationship between the change in de-trended log industrial output between before and after the emancipation and the

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effects and province-specific trends holding the first two cohorts born in 1853 and 1854 as the comparison group. The only significant coefficient is for the two cohorts born after the emancipation. We illustrate the results on Figure A6 and present regression output in column 3 of Table A2 in the online appendix.

<sup>41</sup> At the province level, as above, we set the cut off for influential observations at  $|DFBeta|=0.3$ ; at the district level, the cut off is set for 0.15, as the highest value for  $|DFBeta|$  is 0.22. Due to a larger number of observations at district level, each individual observation has a smaller effect on the estimated coefficient. The cross-sectional relationships are illustrated with conditional scatterplots in two panels of Figure A7 in the online appendix with an indication of  $DFBeta$  for each observation. In order to illustrate that the panel results at the district level are not driven by exclusion of the control for suitability interacted with post-emancipation cohorts, in cross-section at district level, we report results conditional on both log distance to Moscow and land suitability.

prevalence of serfdom across provinces with an adjustment for spatial correlation on the full sample and excluding most influential observations. Again, we find that the results are robust.<sup>42</sup>

As far as the magnitude of the estimated effect is concerned, in contrast to the results for grain yield and height of draftees, there is a substantial difference in the size of point estimates of the effect of the abolition of serfdom on industrial output between OLS and IV specifications: 0.9 vs. 2.3. This implies the following magnitudes: a one standard deviation increase in the share of serfs before the emancipation increased industrial output by 23% according to the OLS specification and 72% according to the IV specification. In an average province, industrial output increased by 48% according to the OLS specification and by a factor of 2.77 according to the IV specification. The most likely reason for such a large difference between OLS and IV is the heterogeneous effect of the abolition of serfdom on industrial development. It is quite possible that the abolition of serfdom had different effects on industrial output in those provinces, where in the absence of monasteries, the lands would have been transferred into private ownership, i.e., because of a high demand for land (so-called “compliers”), and those provinces, where in the absence of monasteries, the lands would have stayed in state ownership anyway because gentry was not interested in owning land in these provinces (so-called “always takers”). In that case, the OLS estimates the average treatment effect across all provinces, whereas IV estimates the local average treatment effect (LATE) across provinces where the instrument made a difference, i.e., compliers (Imbens and Angrist 1994). The large magnitude of the estimated effect on industrial development that we find is in line with recent findings on the substantial level of labor migration within provinces from villages into the provincial industrial sector after the emancipation in spite of the constraints erected by the peasant commune (Borodkin et al. 2008, Burds 1998, Crisp 1976, and Nafziger 2010). Similarly to Figures 5 and 6, Figure 8 presents the estimates of dynamics of the effect of the abolition of serfdom on industrial output confirming the absence of pre-trends.

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<sup>42</sup> Figure A8 in the online appendix illustrates the cross-sectional relationship, presented in Panel C of Table 5, with an indication of DFBeta for each observation.

Overall, we find a large effect of the abolition of serfdom on agricultural productivity, nutrition of emancipated peasants and the economic development.

## 7. Additional sensitivity tests

We conducted a multitude of sensitivity tests to verify robustness of our findings controlling for potentially confounding factors, using different data sources, and excluding potentially influential observations from the sample. First, we estimate equation 1 for grain yield height and industrial output, including the following potentially confounding factors in the list of covariates: the length of railway network in a province  $X$  year (in log kilometers), historical yearly temperature, the court reform, which started in 1864 and was implemented in different provinces at different rates, and the so-called *zemstvo* reform, which introduced elected local self-government bodies in thirty-four out of forty-six provinces in 1864. To account for these two reforms, we construct a dummy variable, which switches on when the court reform was launched in a particular province, and a variable equal to the size of *zemstvo* expenditures per capita in a particular year and a particular province, which is equal to zero before *zemstvo* was established in 1864. Tables A5, A6 and A7 in the online appendix report results including each of these factors separately and together. Our main coefficients of interest, estimating the effect of the abolition of serfdom, remain positive, statistically significant, and are roughly stable in magnitude in all specifications. Railways are positively associated with grain productivity, and heat waves are negatively associated with it; while railways and *zemstvo* expenditures are negatively associated with height and industrial output.<sup>43</sup>

As a next step, we verify that the negative effect for the land reform we found is robust to the sample restriction with data for the Great Russia provinces only, i.e. for thirty-five out of forty-six provinces where the main charter regulated details of the land reform (another three

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<sup>43</sup> The length of railways in a province is certainly endogenous, and *zemstvo* expenditures are likely endogenous as well. Therefore, regressions including these variables only serve one purpose: to show that our results are robust controlling for public expenditures and infrastructure created by industrialization. We do not have a reasonable instrument to explore causal effect of the railway construction or *zemstvo* activities on development.



local charters defined rules of the land reform in the rest eleven provinces). In columns 1 to 4 of tables A8 in the online appendix, we report results of regressions estimated on the restricted sample similar to those reported in columns 5 and 6 of sections A and B of table 2 estimated on the whole sample. Our main coefficients of interest, remain positive, statistically significant, and are roughly stable in magnitude to the sample restriction in both OLS and IV specifications. Then, we explore that the redistribution between peasants and landlords that occurred as a result of the land reform did not drive the main effects of the abolition of serfdom on agricultural productivity. Legally, all land belonged to the landlord under serfdom; the landlords allocated some part of their lands to peasants to run individual peasant farms on it. Peasants got less land as a result of the land reform than they cultivated under serfdom; the size of such land cuts was the largest in the Great Russian provinces. Following historical literature (Zajonchkovskij 1968), we measure land cuts as the ratio of land that peasants “lost” because of the reform to the land they cultivated under serfdom. We interact land cuts with the post-emancipation dummy and add this variable as an additional control into the specification reported in columns 1 of Table A8. We present the results in the last column of Table A8 of the online appendix. The estimated effect of the emancipation is unaffected by the inclusion of this additional covariate. The effect of the land reform is the same in sign and magnitude but not statistically significant any more; the coefficient on the land cuts interacted with post-emancipation dummy is also negative and not statistically significant. The two coefficients on variables related to the land reform are jointly statistically insignificant.

Further, we examine the robustness of our results to measurement issues in two ways. First, we reproduce our main estimations using 1857 tax census data (Kabuzan 1971), instead of 1858 data from Bushen (1863) on the spatial variation of serfs (the results are presented in Tables A9-A12 of the online appendix). Our results are broadly robust to using this alternative measure: The signs of coefficients on the variables of interest data are consistent with the results of the baseline exercise based on 1858 data. The magnitudes of these coefficients are usually

somewhat smaller, and in one case the coefficient of interest loses statistical significance. This is to be expected, as the 1857 data are noisier and represent a much smaller sample size. Nevertheless, the vast majority of results remain statistically significant with 1857 tax census data. Second, in regressions for grain yield, we restrict the sample to years before 1883, when the grain productivity data all come from governor reports. In Table A13 we report the same specifications as in columns 1 to 4 of sections A and B of Tables 2, but for the restricted sample. All our results hold, and the magnitude of coefficients on the main variable of interest remains roughly the same, despite the reduction of the sample size.

Nest, we study the robustness of our results to inclusion of Baltic provinces. We use the interaction  $ShareSerfs_i \times PostEmancipation_{it}$  as our main variable of interest, where  $PostEmancipation_{it}$  varies both over time and across provinces.  $PostEmancipation_{it}$  switches on in 1819 in three Baltic provinces and in 1861 in all other provinces.  $ShareSerfs_i$  for Baltic provinces is equal to the share of former serfs in 1858 according to Bushen (1863). Alternatively, we replace the main interaction term of interest with two interaction terms:  $Share\ of\ non-Baltic\ serfs_i \times Post\_1861_t$  and  $Share\ of\ Baltic\ serfs_i \times Post\_1820_t$  to estimate the effect of the emancipation of serfs separately for Baltic and non-Baltic provinces, where  $Post\_1861_t$  and  $Post\_1820_t$  are dummies which switch on in 1861 and 1820, respectively. In either of these augmented specifications, we allow the two main controls – the interactions of post-1861 dummy with log distance to Moscow and land suitability – to have different effects in Baltic and non-Baltic provinces to account for the fact that Baltic provinces are special. In table A14 of the online appendix we present results for the sample including Baltic provinces, using described specifications. Our main results hold. The estimated coefficients on the main variable of interest are positive and significant, even though they are slightly smaller in terms of magnitude than in the baseline sample (see Table 2). In columns 3 and 4 of table A14, we allow for the effect of the emancipation of serfs to be different in Baltic provinces than in the rest of the sample. The effect of the emancipation of Baltic serfs is positive but imprecisely estimated and smaller in

magnitude than for European Russia. This may be explained by better conditions of serfs and a more efficient production under serfdom in Baltic provinces and also by a possibly worse condition of their freedom. The historical literature (Fedorov 2000) argues that former serfs in the Baltics remained heavily dependent on the landlord even after their emancipation, in particular, because emancipated peasants remained landless in the Baltics.

Finally, we study whether our results are driven by any influential observations. In particular, we estimate our main specifications for grain productivity as reported in columns 2 and 3 of sections A and B of Table 2 but excluding the capital provinces of Moscow and Saint Petersburg, and sequentially excluding four provinces with the lowest (smaller than five percent) and four provinces the highest sharers of serfs (larger than 75 percent). Table A14 of the online appendix presents the results. They remain robust to these restrictions of the sample.

## **8. Conclusions**

We find a very large positive effect of the abolition of serfdom on agricultural productivity, peasants' living standards, and industrial development in 19<sup>th</sup> century Russia. The main lesson from this exercise is that serfdom substantially slowed down Russia's economic development both in agriculture and in industry. A simple counterfactual exercise shows that if serfdom were to have been abolished in 1820, rather than 1861, by 1913 Russia would have been about one-and-a-half times richer compared to what it actually was. In 1913, according to Maddison (2007), Russia's GDP per capita was \$1,488 (measured in 1990 US dollars). Our estimates suggest that an abolition of serfdom in 1820 would have resulted in per capita GDP between \$1,751 and \$2,341 (in the online appendix we present the derivation of these figures from our estimates), or about 40 % richer. Thus, by 1913 Russia would have had a level of GDP per capita comparable to Norway (\$2,447) or Finland (\$2,111).<sup>44</sup>

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<sup>44</sup> Finland was actually a part of the Russian Empire, but had a considerable degree of political and economic autonomy, including an independent monetary policy. We present details of these counterfactual estimations in the online appendix (see Table A19 for the summary).

The evidence suggests that such a large effect of the abolition of serfdom on Russia's development occurred because of a sharp change of incentive structure of the 43% of Russia's rural population, which was transformed by the 1861 emancipation from serfs with no rights over their own labor or human capital into small-scale agricultural entrepreneurs. This change led to greater effort, better use of local conditions, and better use of available agricultural knowledge and technologies.

The abolition of serfdom would have contributed to even faster development if the land reform transferred ownership rights over land to peasant households rather than the commune, or at least to hereditary rather than re-partition communes. The increase in the power of the re-partition peasant commune (designed by the emancipation reform) was the main mechanism behind the negative effect of the land reform.

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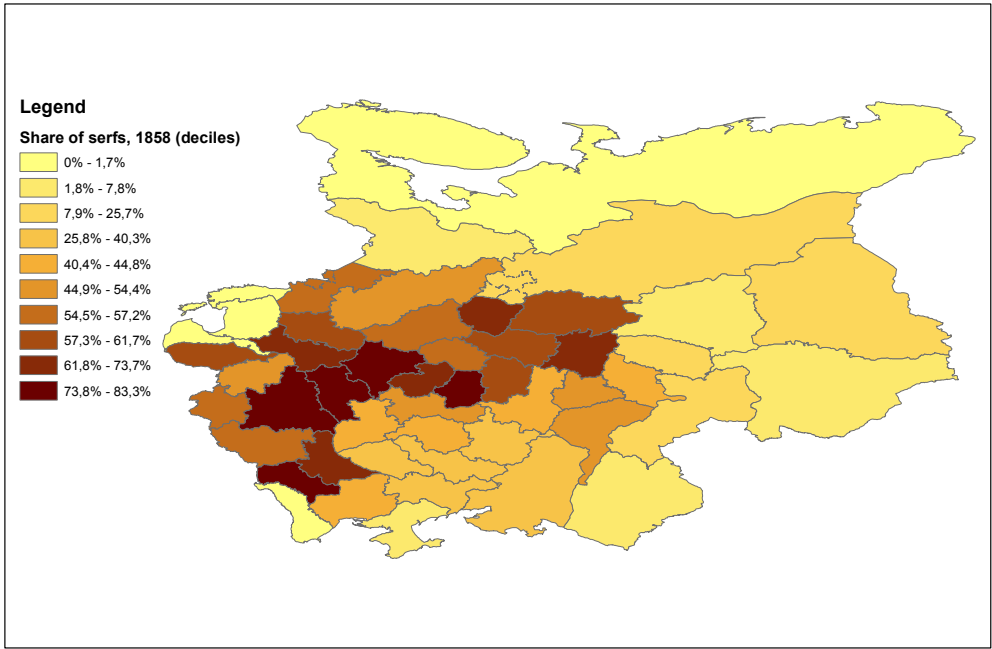


**Figure 1. European provinces of the Russian Empire**



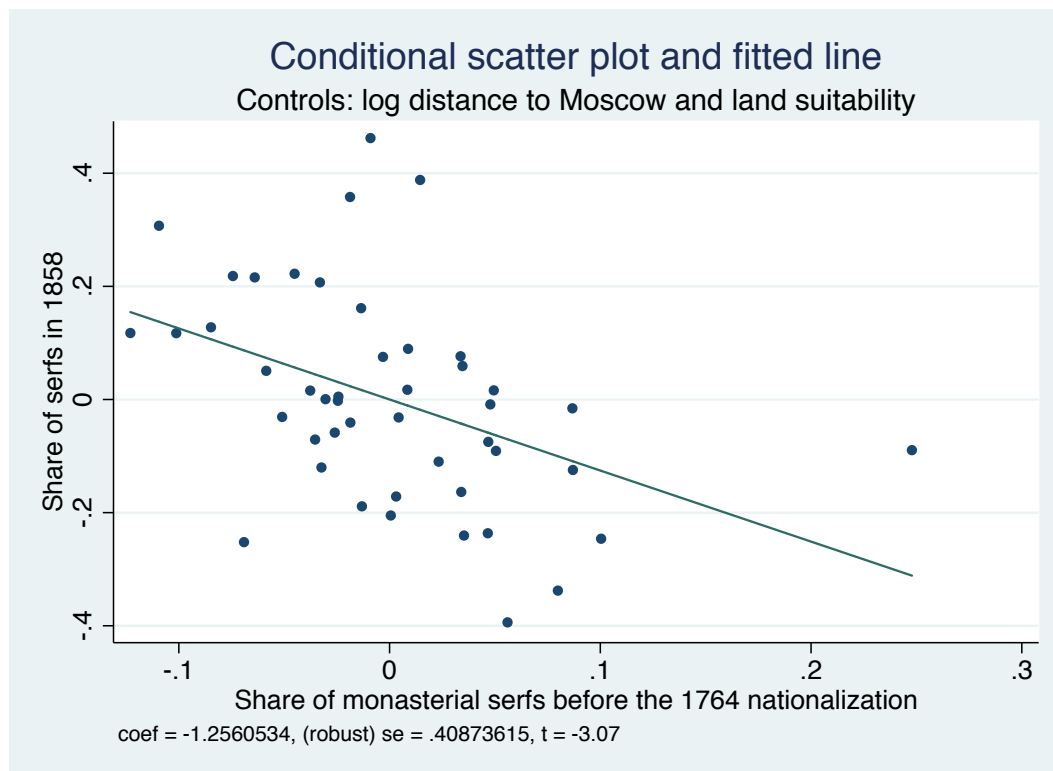
Note: Equirectangular projection used. Serfs in the Baltic provinces, Estlyndiya, Liflyandya, and Kurlyandia, were liberated 40 years before the emancipation of serfs in the rest of the empire. We run regressions both with and without Baltic provinces in the sample. The baseline sample excludes them.

**Figure 2. Geography of serfdom: serfs in 1858 as a share of rural population**

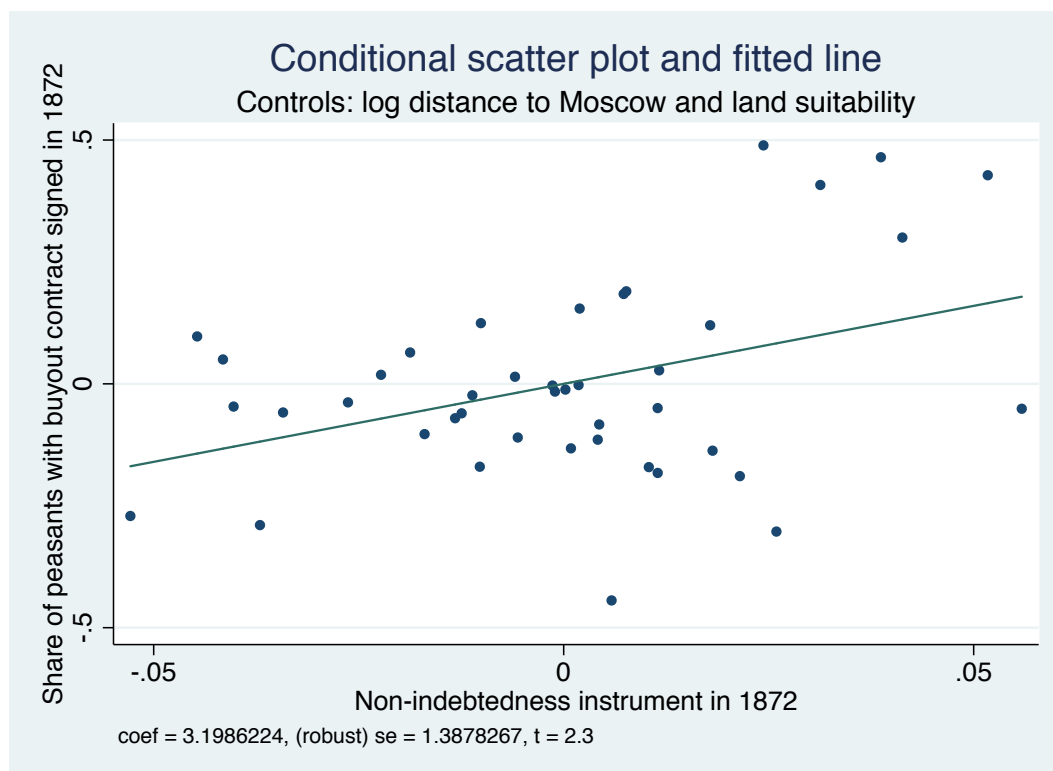


Note: Equirectangular projection used.

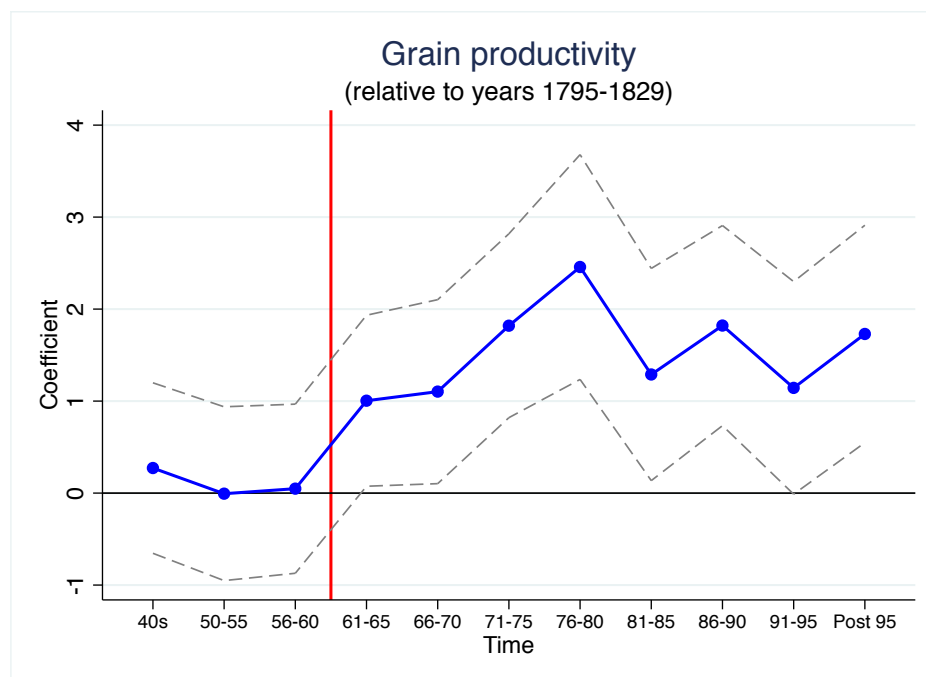
**Figure 3. Monasterial serfs before nationalization and private serfs in 1858 across provinces**



**Figure 4. The progress of land reform and the land reform instrument in 1872, i.e., halfway through land reform implementation, across provinces**

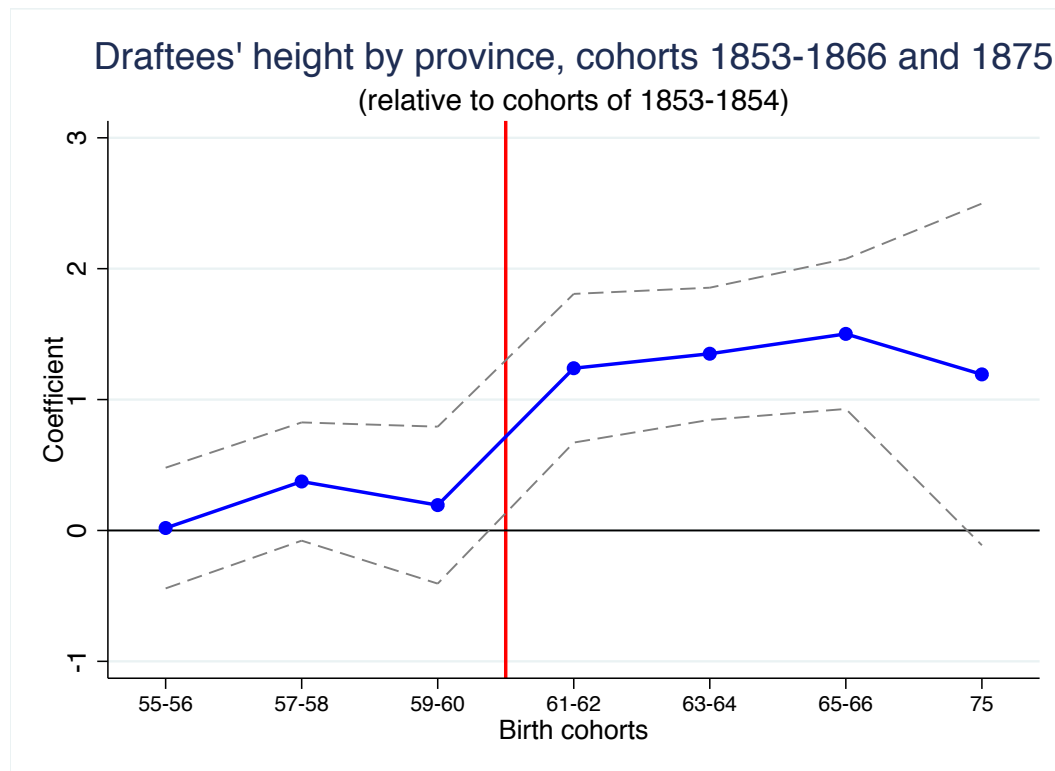


**Figure 5. The time-varying effect of emancipation: grain productivity**



Note: The number of cross-sections within five-year intervals varies because of missing data for 1867-1869 and 1877-1882. The figure presents coefficients (along with their 90% confidence interval) in the regression of grain yield on 5-year interval dummies, province and year fixed effects, region-specific linear trends, and controls for demeaned suitability interacted with post-emancipation dummy, and demeaned distance to Moscow interacted with post-emancipation dummy, the share of state peasants interacted with post-1866 dummy, and the share of royal peasants interacted with post-1859 dummy. Four cross-sections between 1795 and 1829 are held as the comparison group. The vertical red line marks the timing of the emancipation. The table-form representation of the results of this estimation is presented in column 1 of Table A2 in the online appendix.

**Figure 6. The time-varying effect of emancipation: draftees' height by province**



Note: The figure presents coefficients (along with their 90% confidence interval) in the regression of height of draftees on 2-year interval dummies for birth cohorts, province and birth-cohort fixed effects, region-specific linear trends, and controls for demeaned suitability interacted with post-emancipation dummy, and demeaned distance to Moscow interacted with post-emancipation dummy, the share of state peasants interacted with post-1866 dummy, and the share of royal peasants interacted with post-1859 dummy. Two cohorts of 1853 and 1854 are held as the comparison group. The vertical red line marks the timing of the emancipation. The table-form representation of the results of this estimation is presented in column 2 of Table A2 in the online appendix.

**Figure 7. The time-varying effect of emancipation: industrial output**



Note: The figure presents coefficients (along with their 90% confidence interval) in the regression of log industrial output on 4 dummies for: 1849, 1856 and 1858, 1882 and 1883, and for 1885 and 1897, province and year fixed effects, region-specific linear trends, and controls for demeaned suitability interacted with post-emancipation dummy, demeaned distance to Moscow interacted with post-emancipation dummy, the share of state peasants interacted with post-1866 dummy, and the share of royal peasants interacted with post-1859 dummy. The year of 1795 is held as the comparison group. The vertical red line marks the timing of the emancipation. The table-form representation of the results of this estimation is presented in column 4 of Table A2 in the online appendix.

Table 1. Summary statistics (without Baltic provinces)

Panel A. Distribution of rural population by status in 1858 (Source: 1858 police data)

	Obs	Mean	Std. Dev.	Min	Max
Share of serfs	46	0.45	0.24	0.001	0.83
Share of state peasants	46	0.39	0.21	0	0.88
Share of royal peasants	46	0.04	0.09	0	0.47
Share of free rural population	46	0.12	0.17	0.04	0.85

Panel B. Distribution of serfs by the measures of land reform

	Obs	Mean	Std. Dev.	Min	Max
Share of rural population with land-buyout started in 1862-1882 (Land reform)	877	0.32	0.24	0	0.83
Share of serfs with signed regulatory charters by 1863	45	0.43	0.2	0.02	0.85
Repartition commune dummy	46	0.87	0.34	0	1

Panel C. Development outcomes

	Obs	Mean	Std. Dev.	Min	Max
Grain productivity (yield to seed ratio)	1777	3.79	1.27	.59	12.3
Industrial output (mln 1895 rubles)	341	17.2	36	0.017	334
Population (thousands)	884	1245	843	37.5	4610
Height of draftees (centimeters)	690	164.32	1.02	161.86	168.15
Winter seed to summer seed ratio	629	0.77	0.335	0.1	1.77

Panel D. Monasteries and Gentry Indebtedness

	Obs	Mean	Std. Dev.	Min	Max
Average share of monastic serfs in 1796 and 1814	46	0.09	0.08	0	0.39
Gentry Indebtedness in 1858	43	0.12	0.07	0.003	0.29

Panel E. Geographical variables

	Obs	Mean	Std. Dev.	Min	Max
Distance to Moscow (km)	46	666	323	24	1307
Crop suitability (one to five index)	46	2.17	1.33	1	5

Table 2. The effect of the abolition of serfdom on productivity in agriculture

Panel A: Panel data estimation							
	(1)	(2)	(3)	(4)	(5)	(6)	
Dependent var:	Grain yield	Grain yield	Grain yield	Grain yield	Grain yield	Grain yield	
Model:	OLS	OLS	IV, 2nd stage	OLS	OLS	IV, 2nd stage	
Share of serfs X Post-emancipation	0.8626*** [0.233]	0.7966*** [0.289]	1.2126** [0.551]	1.0610*** [0.302]	1.0376** [0.407]	2.7894*** [0.706]	
Share of peasants with signed buyout contracts					-0.4375* [0.255]	-1.2684*** [0.334]	
Demeaned log distance to Moscow X Post-emancipation		-1.0389** [0.443]	-0.7367 [0.535]	-0.9525** [0.439]	-0.6945 [0.500]	0.5679 [0.562]	
Demeaned crop suitability X Post-emancipation		0.0437 [0.046]	0.0379 [0.050]	0.0345 [0.044]	0.0415 [0.046]	0.0357 [0.055]	
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	
Province-specific trends	No	Yes	Yes	Yes	Yes	Yes	
State and royal peasant reforms	No	No	No	Yes	No	No	
Observations	1,777	1,756	1,756	1,756	1,701	1,701	
R-squared	0.361	0.398	0.525	0.399	0.396	0.531	
Panel B: First stages of the corresponding 2SLS panel regressions							
	(3)		(6.1)		(6.2)		
Dependent var:	Share of serfs X Post- emancipation		Share of serfs X Post- emancipation		Share of peasants with signed buyout		
Model:	IV, 1st stage		IV, 1st stage		IV, 1st stage		
Share of nationalized monasterial serfs X Post-emancipation	-1.2508*** [0.299]		-1.2893*** [0.305]		-1.3328*** [0.296]		
Interpolation b/w (1-indebtedness) and 1 in the interval 1862-1882			0.0974 [0.150]		2.7038*** [0.231]		
Controls as in respective column of Panel A	Yes		Yes		Yes		
Observations	1,756		1,701		1,701		
F, monasterial serfs instrument	17.45		17.85		20.28		
F, indebtedness instrument			0.421		136.8		
Panel C: Cross-sectional estimation robust to spatial correlation							
	(1)	(2)					
Dependent var:	The change in detrended grain yield b/w pre- and post-emancipation						
Model:	OLS spatial HAC	OLS spatial HAC					
Sample:	full	DFBeta <0.3					
Share of serfs	0.8968*** [0.259]	0.7451*** [0.197]					
Log distance to Moscow, crop suitability	Yes	Yes					
Observations	46	43					
Adj R-squared	0.255	0.344					

Notes: In Panels A and B, standard errors are clustered by province separately before and after the 1861 emancipation reform. In Panel C, standard errors are adjusted to spatial correlation within 900 km. Post-emancipation is a dummy, which is switched on in 1861. Share of peasants with signed buyout contracts equals 0 in all provinces for the years before 1862 and then gradually reaches the share of serfs in the corresponding province. In the non-western provinces this happened by 1882, and in western provinces in 1863. Indebtedness is the number of serfs in the province used as collateral in landlords' debt contracts in 1858 as a share of total number of serfs in the province.

\*\*\* indicates p-value <0.01, \*\* p-value <0.05, \* p-value<0.1.

Table 3. The mechanisms behind the effects of the land reform and the emancipation

	(1)	(2)	(3)	(4)	(5)
Dependent var:	Grain yield	Grain yield	Share of summer crops seeded at t in total winter and summer crops seeded at [t-1;t] production cycle		
	OLS	OLS	OLS	OLS	OLS
Share of serfs X Post-emancipation	0.7925* [0.416]	1.9087*** [0.489]	-0.1323*** [0.037]	-0.0437** [0.019]	-0.1500*** [0.048]
Share of peasants with signed buyout contract	0.1808 [0.298]	-0.6160** [0.258]			
Share of peasants with signed buyout contract X repartition commune	-0.8214** [0.351]				
Share of serfs X Post-emancipation X Implicit contracts		-1.8926*** [0.598]			
Temperature (t-1)			0.0077** [0.004]		0.0046 [0.004]
Share of serfs X Post-emancipation X Temperature (t-1)			0.0132*** [0.005]		0.0142** [0.005]
Share of serfs X Post-emancipation X Summer-to-winter-rye-world-price ratio (t-1)				-0.3471*** [0.121]	-0.3044** [0.117]
Demeaned log distance to Moscow X Post-emancipation	-1.0525* [0.544]	-0.8284* [0.488]	-0.0624*** [0.023]	-0.0088 [0.020]	-0.0775*** [0.026]
Demeaned crop suitability X Post-emancipation	0.0209 [0.044]	0.0250 [0.042]	0.0026 [0.002]	-0.0007 [0.003]	0.0017 [0.002]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes	Yes	Yes
Observations	1,701	1,648	629	592	589
R-squared	0.397	0.415	0.789	0.770	0.780

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861.

\*\*\* indicates p-value <0.01, \*\* p-value <0.05, \* p-value <0.1.



Table 4. The abolition of serfdom and peasant living standards: draftees' height

Panel A: Panel data estimation

	(1)	(2)	(3)	(4)	(5)
Dependent var:	Draftees' height (cohorts 1853-1866, 1875)			Draftees' height (cohorts 1853-1862)	
Data set:	Province-level data			District-level data	
Model:	OLS	IV, 2nd stage	OLS	OLS	IV, 2nd stage
Share of serfs X Post-emancipation cohorts	0.9877*** [0.354]	1.3513** [0.631]	0.9757*** [0.350]	0.3525** [0.175]	0.9569*** [0.348]
Demeaned log distance to Moscow X Post-emancipation	0.4706 [0.339]	0.7399 [0.614]	0.7399 [0.614]	0.0328 [0.080]	0.2236*** [0.079]
Demeaned crop suitability X Post-emancipation	0.1565*** [0.051]	0.1511*** [0.055]	0.1511*** [0.055]		
Birth cohort and province or district fixed effects	Yes	Yes	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes	Yes	Yes
Reforms for state and royal peasants	No	No	Yes	No	No
Observations	690	690	690	4,670	4,580
R-squared	0.761	0.761	0.761	0.606	0.589

Panel B: First stages of the corresponding 2SLS panel regressions

	(2)	(4)
Dependent var:	Share of serfs X Post-emancipation cohorts	Share of serfs X Post-emancipation cohorts
Model:	IV, 1st stage	IV, 1st stage
Share of nationalized monasterial serfs X Post-emancipation cohorts	-1.2561*** [0.319]	-0.5130*** [0.052]
Controls as in respective column of Panel A	Yes	Yes
Observations	690	4,580
F, excluded instrument	15.47	95.85

Panel C: Cross-sectional estimation robust to spatial correlation

	(1)	(2)	(3)	(4)
Dependent var:	The change in detrended height by province b/w pre- and post-emancipation cohorts		The change in detrended height by district b/w pre- and post-emancipation cohorts	
Model:	OLS spatial HAC		OLS spatial HAC	
Sample:	full	DFBeta <0.3	full	DFBeta <0.15
Share of serfs	0.9241*** [0.202]	0.6596*** [0.147]	0.6170*** [0.204]	0.4468*** [0.136]
Log distance to Moscow, crop suitability	Yes	Yes	Yes	Yes
Observations	46	42	466	457
Adj R-squared	0.354	0.391	0.043	0.041

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861. \*\*\* indicates p-value <0.01, \*\* p-value <0.05, \* p-value <0.1

Table 5. The abolition of serfdom and industrial development

## Panel A: Panel data estimation

	(1)	(2)	(3)
Dependent var:		Ln (industrial output)	
	OLS	IV, 2nd stage	OLS
Share of serfs X Post-emancipation	0.8774** [0.365]	2.2725* [1.243]	1.8387*** [0.334]
Demeaned log distance to Moscow X Post-emancipation	0.2900 [0.456]	1.2123 [0.966]	0.4622 [0.460]
Demeaned crop suitability X Post-emancipation	0.1190* [0.066]	0.1091 [0.079]	0.1096 [0.067]
Year and province fixed effects	Yes	Yes	Yes
Regione-specific trends	Yes	Yes	Yes
State and royal peasant reforms	No	No	Yes
Observations	341	341	341
R-squared	0.896	0.936	0.899

## Panel B: First stages of the corresponding 2SLS panel regressions

Dependent var:	(2) Share of serfs X Post-emancipation
Model:	IV, 1st stage
Share of nationalized monasterial serfs X Post-emancipation	-1.1462*** [0.253]
Controls as in respective column of Panel A	Yes
Observations	341
F, monasterial serfs instrument	20.45

## Panel C: Cross-sectional estimation robust to spatial correlation

	(1)	(2)
Dependent var:	The change in detrended log industrial output b/w pre- and post-emancipation	
Model:	OLS spatial HAC	
Sample:	full	DFBeta <0.3
Share of serfs	1.9212*** [0.371]	1.7085*** [0.379]
Log distance to Moscow, crop suitability	Yes	Yes
Observations	45	41
Adj R-squared	0.290	0.284

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861. \*\*\* indicates p-value <0.01, \*\* p-value <0.05, \* p-value <0.1

# Online Appendix

## A. Historical background

### A1. Legal status of Russian peasants, who were not serfs

**State peasants:** Formerly, state peasants (40.4% of rural population) were free individuals living and working on the land belonging to the state. By law, they had personal and property rights and could change their occupation and place of living. The required administrative procedure for moving was so complicated, however, that few actually did this.<sup>45</sup> State peasants had to pay a tax (in a form of quitrent) to the state in the amount fixed by the law in return for the ability to cultivate the land. A special ministry regulated the magnitude of the quitrent as well as the types of actual agricultural production. The ministry changed the quitrent only rarely (three times in the 18th and four times in the 19th century). Historians agree that, on average, the living standards of state peasants were higher, individual land plots were larger in all but two provinces, and the system of quitrent was more transparent than that of serfs (Druzhinin 1958). In the late 1830s - 1840s the government conducted the so-called Kiselev reforms, which guaranteed a minimal-size land plot to each state-peasant household and improved the administration of the state-peasant villages. If the population in these villages grew above the minimum required land-household ratio, the state initiated migration programs to virgin lands in the south and east of the empire (Druzhinin 1958; Crisp 1976).

We count former military dwellers, i.e., soldiers in special regiments who were supposed to participate full-scale in agriculture along with their military service, as state peasants. The state established the group of military dwellers in 1810 to economize on military expenditures. For that purpose, the government selected several regular regiments and settled them down on state lands in military settlements. Military settlements were abandoned in 1857 and former military dwellers legally became state peasants.

**Free agricultural laborers:** Free peasants with or without land titles constituted 12.6% of the rural population in 1858. This group consisted of Cossacks with communal land title, former soldiers (including soldiers in reserve and soldiers' children, so called cantonists) who became free after retirement, colonists who cultivated land under various land arrangements, and non-Russians in the Astrakhan and Bessarabiya provinces without land, foreigners in rural areas and peasants under the supervision of various ministries. In addition, after the 1819 reform, the largely landless peasants in the three Baltic provinces became free laborers.

**Appanage peasants:** Royal ("appanage," *udel'nye*) peasants constituted another, much less numerous, group of the peasantry. They were serfs belonging to the royal family on quitrent. They were managed by a special ministry (Department of Appanages), were emancipated in 1859, and got a subsequent land reform in 1863.

### A2. The timing of the abolition of serfdom

The Russian government had discussed the emancipation reform for a long period before the abolition of serfdom actually happened in 1861. Already, Alexander I (1801-1825), influenced by the spread of ideas of Enlightenment and emancipation reforms in the Habsburg and Prussian empires (1781 and 1809, respectively), considered various projects regarding restrictions of

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<sup>45</sup> Note that the state peasants were free only relative to serfs, particularly, in the 18<sup>th</sup> century, as we describe below, until 1801, the tsars often granted state lands with state peasants on these lands to nobility as private estates in exchange for military service; in that case, state peasants acquired the status of serfs. In addition, state peasants were subject to several other administrative restrictions, which were largely removed by the first quarter of 19th century (Crisp 1976). The state peasants described themselves in the following way in the 18<sup>th</sup> century: "*we are not free, we belong to the state*" (Crisp 1976 p. 76).

landlords' authority over serfs, including the abolition of serfdom altogether. But the vast majority of the suggested plans remained unrealized. Alexander I ventured to liberate serfs only in the outskirts of the empire, in particular in the three Baltic provinces (1816-1819), and to implement reforms that only marginally affected serfdom (such as the 1801 and 1803 decrees allowing landlords to liberate peasants on their private will, or the 1809 prohibition on landlords penalizing serfs by sending them to penal works in Siberia).

Similarly, Alexander's successor, Nicolas I (1825-1855) considered an emancipation reform. During his reign he organized a number of secret committees to discuss how to deal with serfdom, which also failed to find a solution (Mironenko 1990; Zajonckovskij 1968).

The gentry's opposition to emancipation was the main concern forcing the government to postpone the reform. Serfdom remained profitable for the gentry until its very end. Dormar and Machina (1984) disentangled prices on serfs and land from historically known prices of estates (the law prohibited selling serfs without land in the first half of the 19th century) and showed that serfs had positive value. The prices of licenses in the 1840s and 1850s that allowed the serfs to avoid the draft into the army were high: 485 silver rubles or about ten times the annual GDP per capita (Obruchev 1871). Historical literature views these licenses as a proxy for the price of serfs because of life-span military service before the 1874 military reform.

The defeat in the Crimean War (1853-1856) demonstrated that Russia lacked modern industries and technologies to compete with most developed countries. This convinced the skeptics of the necessity for deep reforms, including the abolition of serfdom. While the new government of Alexander II (1855-1881) used the defeat as a motivating factor to overcome the gentry's opposition to the liberation of serfs, it took the government more than five years to enact the reform (Zakharova 1984).

### **A3. The details of the land reform**

Emancipated serfs were obligated to buy out the land from the landlord in the future. The law explicitly prohibited peasants from quitting the countryside without the buyout of land within nine years of emancipation. After 1870, in order to quit their village without buying the land, peasants had to satisfy a number of restrictive conditions. In practice, less than one percent of peasants chose quitting without the buyout of land (Litvak 1972). The landlord and the peasant commune had to negotiate the precise terms of the buyout, namely the amount of land, the price, and the timing. If the landlord and the peasants could not reach an agreement, the law prescribed the terms of the fallback deal. The rules varied across regions. For example, in the western provinces (for instance, the right-bank Ukraine, Byelorussia and Lithonia), the terms of the fallback option were less favorable for gentry, and the parties were given less time to implement the land reform.<sup>46</sup> The land reform was completed when the peasants got communal property rights title on their land. This happened with varying speed in different provinces, but by 1882 the land reform was fully completed in all provinces. In western provinces, where the land reform was the fastest, the legislation mandated that peasants and landlords start the buyout operation in 1863, following the Polish rebellion.

The negotiations between the peasants and the landlord proceeded in two stages. During the first two years after the emancipation (until 1863), the landlord and the peasants had to agree on the terms of the regulatory charter (*ustavnaya gramota*) that fixed the land plots in peasants' use, and the obligations they had to perform in exchange for the use of the land during the transition period, before the actual start of the buyout operation.<sup>47</sup>

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<sup>46</sup> Initially, the rules were similar throughout the empire. The change in the rules was caused by the 1863 Polish rebellion. The government introduced pro-peasant changes for political reasons. The vast majority of former serfs were Ukrainians or Byelorussians in these regions, whereas the landlords were Polish. The new legislation for the western provinces required no land cuts and reduced redemption payments for peasants.

<sup>47</sup> Before the regulatory charter was produced, peasants had to continue to carry out their obligations, as they existed before the emancipation; but the law limited their amount (Litvak 1972, p321; Zajonckovskij 1968, p244).

Once the charter was produced, the buyout operation could be initiated, i.e., the buyout contract signed, either by mutual agreement between the landlord and the peasants, or at the request of either the landlord or the peasants under the terms specified by the law. The charter's terms were used as a focal point for determining the value and the exact plots of the land for the buyout contract, such that the land price was often determined as capitalized quitrent (or corvee equivalent) fixed in the charter (Complete ... 1861). The start of the buyout operation marked the second and final stage of the land reform, i.e., the transfer of the communal land ownership title to the peasants in exchange for the obligatory redemption of the value of the land and the cessation of any temporary obligations of the peasants to the landlord.

At the first stage, the landlord was supposed to produce a draft of the charter, which the peasants could accept or reject. Some (but far from all) landlords did not revise their peasants' obligations under serfdom; in this case, the landlord and the peasants considered the level of obligations as an implicit long-term contract. If such an implicit contract existed and the charter closely followed its terms, it was easier for the peasants and the landlord to reach agreement. The charter had to be authorized by a local official (*mirovoj posrednik*), and if there was of no agreement, the local official had to produce the fallback document on his own, following the law (Easley 2008). About one-half of all former serfs signed the regulatory charters following an agreement with the landlord (Zajonckovskij 1968). The law defined the maximum and minimum amount of land that peasants could get as a result of the land reform, and outlined the peasants' obligations per each unit of land.<sup>48</sup> After the emancipation, the land became the main asset of the landlords, and they tried to keep as much land in their possession as possible. According to calculations by Soviet historians, peasants lost up to one-third of all peasant pre-reform land as a result of the first stage of the land reform (Litvak 1974; Zajonckovskij 1968).

At the second stage, the buyout contract determined the amount that peasants needed to pay to buy out the land into the communal ownership.<sup>49</sup> Peasants paid twenty percent of the land price and the state provided a loan for the other eighty percent of the value of the land. Peasants had to repay this loan to the state in annual installments during the next 49 years. On average, the annual redemption burden was not higher than previous quitrent or corvee (Gerschenkron 1965 p. 741).

An initiation of the buyout operation by the peasants or the landlord without a mutual agreement implied some losses for the initiator. If peasants launched the buyout operation, they could buy out only small plots around their houses in the village, but not the arable land. In addition, in that case, they did not get a loan from the government. If the landlord launched the operation, peasants did not pay their initial twenty percent of the land price. Potential losses forced both peasants and landlords to search for mutual agreement, postponing the start of the buyout operation and providing substantial sources of variation in the timing of the completion of the land reform. Fifteen percent of former serfs postponed the buyout operation until 1881, when a new law prescribed an obligatory start of the buyout operation by the beginning of 1883 for all peasants who had not yet done so. State peasants, who were formerly free, went through land reform in 1866. The local authorities issued special commune land title documents

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<sup>48</sup> The maximum and the minimum varied across provinces. They were equal to about 3 and 7 *desyatinas* per male, respectively, in Russia's non-"black earth" regions, and about 2 and 6 *desyatinas*, respectively, in the black earth regions. (*Desyatina* is a measure of area: 1 *desyatina* = 0.37 acre.) "Step" provinces represented an exception, where the law determined the precise size of the peasant plot. If peasants cultivated more land before the emancipation than the legal maximum stipulated, the landlord had to cut both their plots and obligations. If peasants had less land than the legal minimum, the law prescribed the landlord to increase their plots. In practice land cuts were more widespread than land extensions. The law also guaranteed the landlord a minimum of land that he or she could keep in his or her possession, even if peasants got less land than the legal minimum prescribed. The landlords' minimum also varied across provinces; it ranged from one-third to one-half of the total size of the estate. Landlords of estates with less than twenty-one male serfs had some additional privileges (Complete ... 1861).

<sup>49</sup> In the case of a mutual agreement, peasants could take one-quarter of the maximum land plot stipulated by law without any payment to the landlord, a so-called gifted pauper plot (*darstvennij nadel*). Peasants could also request a gifted pauper plot if the landlord initiated the buyout operation. About a million peasants, or about 4 percent of former serfs, got gifted pauper plots as a result of the land reform (Zajonckovskij 1968).

(*vladennie zapisi*). These documents guaranteed former state peasants land usage rights in return for a fixed quitrent over the next twenty years, after which the quitrent was replaced by obligatory redemption payments. In western provinces, redemption payments for former state peasants were introduced in 1867. Similar to the case of serfs, the land value for state peasants was estimated as capitalized quitrent for forty-six years. The land plots that state peasants got as a result of their land reform were on average twice as large as the plots of serfs (Zajonckovskij 1968; Druzhinin 1978).

Royal peasants experienced land reform in 1863. Their terms of land reform were similar to the terms of serfs (Zajonckovskij 1968). In the Baltic provinces, former serfs did not have land reform, as they did not have to buy out land.

#### **A4. Nationalization of monasterial and church lands in 1764**

The royal family and individual landowners granted lands to the Orthodox Church since the Christianization of Russia. Peasants who lived on church land became serfs belonging to the Orthodox Church with the establishment of serfdom in the late 16<sup>th</sup> – mid-17<sup>th</sup> century. The bulk of church property belonged to monasteries. Monasteries accumulated 2 million serfs by the 18<sup>th</sup> century. Monasterial serfs faced the same constraints as other privately owned serfs and used the same agricultural technologies and practices (Zakharova 1982). We did not find any evidence in historical literature of a systematic difference in the quality of land that was donated to monasteries or in the literacy rate of monasterial serfs. This is not surprising, as religiosity was the overriding motive behind the flow of testaments and private donations of land to the Orthodox Church.

The modern state built in Russia in the 18<sup>th</sup> century accumulated enough power to progressively confiscate Church property. As the first step, Peter the Great took all Orthodox Church property under state control in 1701. The government created a special department that managed church estates and collected all revenues from them, transferring a part of the revenues to church institutions to finance their activities. In 1744, however, the Church managed to regain control over revenues from its property. Finally, Catherine the Great nationalized Church property. This nationalization took place in 1764 in the core part of the Russian Empire, in 1786-1788 in Ukrainian provinces, and in 1793-1795 in provinces integrated into the empire as a result of the partitions of Poland. Former monasterial serfs got legal status of state peasants as a result of this reform (Shchapov 1989). The government did not grant estates with former monasterial serfs into private possession of gentry, in order to avoid antagonizing the church further.

Zverinskij (1890, 1897) collected and systemized data on all monasteries that ever existed in the Russian Empire. Zverinskij (1890) provides information on all monasteries closed by 1764, and Zverinskij (1897) provides information on all monasteries that continued to operate during the reign of Catherine the Great. Using this information we construct a number of monasteries (both open and closed) by province, and normalize it by provincial population in 1897.<sup>50</sup>

#### **A5. Gentry indebtedness in 1858**

The government had provided credit to Russian gentry since the late 18<sup>th</sup> century. The landlords had the privilege of taking long-term loans, with serfs as collateral, from the state financial institutions (so called *Ssudnaya kazna* and *prikazi obshchestvennogo prizreniya*), which was their main source of credit due to the poorly developed financial market. The government viewed the credit privilege of the landlords as another way to secure the political loyalty and economic welfare of the gentry. The terms of credit improved over time. Four years before the emancipation of serfs, the state decreased the interest rate for gentry from five to four percent. The new interest rate was above the profitability rate of an average estate, which was about five

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<sup>50</sup> We use 1897 census figures for provincial population because of data quality.

percent. In anticipation of emancipation, the state stopped issuing new loans in 1858 (Gur'ev 1904).

Russian gentry widely used state loans for status consumption (such as real estate in the capital cities, imported luxury goods, etc.) rather than investment in production within their estates (Korf 1906). Due to the status consumption, the level of indebtedness was orthogonal to the productivity of the estates. About forty-four thousand estates had debts and about 7.1 million male serfs, about sixty-three percent of all serfs, were used as collateral by 1858 (Skrebetskii, 1862-1866 vol. 4). In an average province in our sample this number is fifty-nine percent.

As noted above, during the land reform, which was an integral part of the abolition of serfdom, the state provided loans to former serfs to finance buyouts of land from landlords. The land prices were set to fully compensate landlords for their loss in income due to emancipation (the reform postulated the land price to be equal to capitalized quitrent), and the buyout was obligatory. The state paid landlords directly with special bonds that had a five percent interest rate. The landlords got these bonds only if they did not have debts to the state themselves. Indebted landlords had to pay their debts back to the state first once the buyout operation was launched. Thus, for the landlords with debts, the buyout operation meant a drop in revenues. They got five percent from the market value of their estate in the form of quitrent before the land reform (including the period after the emancipation), and paid four percent back to the state; this left them one percentage point of revenue. The indebted landlords lost this one percent once the buyout operation was launched. The state provided loans to landlords with fixed maturity, and which could not be refinanced after 1858. As a result, the pool of landlords who could enjoy the one percentage point privilege shrunk over time.

#### **A6. The shift from traditional to modern crop varieties**

The three-fields system (an annual rotation of summer crops, winter crops, and fallow on the same plot) dominated in Russian agriculture before the emancipation. The winter rye was the main winter cereal in European Russia for centuries because of its better resistance to harsh climate (short summers, cold winters, and frequent droughts), and correspondingly higher productivity under the use of traditional agricultural technologies, provided that local soil conditions were not taken into consideration. Oat was a traditional summer crop that was mostly used to feed horses and cattle. Summer wheat, barley, or buckwheat were not widespread because they were believed to require milder climates and/or more inputs. In places where wheat and barley were cultivated, these crops were mostly sold, whereas peasants grew winter rye for their own consumption. Gradual accumulation of agricultural knowledge and slow improvements in agricultural technology (e.g., the development and adoption of new seed varieties, a shift to a more sophisticated multi-field crop rotation systems, and better use of knowledge about crop productivity on different types of local soil) allowed for extending the area of cultivation of the advanced summer crops, and secure their higher productivity in localities which previously were considered to be ill-suited for summer crop cultivation. Technological advances, together with growing market demand for wheat in Western Europe, led to a gradual shift away from winter rye to summer crops in European Russia. This shift was well recognized by the 19<sup>th</sup> century (Nifontov 1974).

We do not have systematic data on cereal cultivation by crops before the emancipation. Governor reports provide only aggregated figures on all cereals, without distinction of particular crops. We aggregate data on corresponding winter and summer crops to construct comparable measures for the late 19th century.

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## **B. The definition of the 15 regions**

We use the standard classification reported in imperial statistical volumes with two modifications discussed in the literature (Rossiya [Russia] in *Entsiklopedicheskii ... 1890—1907*). First, we construct a special region for capital provinces, namely for Moscow and Saint Petersburg. Second, we separate Astrakhan' from Low Volga, treating it as a separate region. Moscow and Saint Petersburg were the only two large cities in an agrarian country. Astrakhan' was very different from other Low Volga provinces in terms of geography (desert vs. step) as well as in terms of serfdom (local non-Russians who formed the majority in the Astrakhan' province were free).



1. North: Arkhangelsk, Vologoda and Olonets provinces;
  2. North-West: Novgorod and Pskov provinces;
  3. West: Smolensk, Vitebsk and Mogilev provinces;
  4. Belorussia and Lithonia: Minsk, Grodno, Vil'no and Kovno provinces;
  5. Central Industrial Region: Vladimir, Nizhnij Novgorod, Kostroma, Yaroslavl' and Tver' provinces;
  6. Central Black Earth Region: Kaluga, Tula, Ryasan', Orel, Tambov, Kursk, Voronezh provinces;
  7. Middle Volga: Kazan', Penza and Simbirsk provinces;
  8. Left Bank Ukraine: Chernigov, Poltava and Khar'kov provinces;
  9. Right Bank Ukraine: Kiev, Podoliya, Volyn' and Bessarabiya provinces;
  10. South: Kherson, Tavrida, Ekaterinoslav, Don and Stavropol' provinces;
  11. Low Volga: Saratov and Samara provinces;
  12. Astrakhan': Astakhan' province;
  13. Urals: Orenburg, Vyatka and Per'm provinces;
  14. Capitals: Moskovskaya and Saint-Peterburgskaya.
- In addition, Estlyandiya, Liflyandiya and Kurlyandiya provinces composed the Baltic region.

### **C. Counterfactual scenarios of Russian economic growth in the case of earlier abolition of serfdom**

To illustrate the magnitude of the overall effect of the institution of serfdom on economic development, we estimate the level of per capita income in Russia in 1913 under three alternative counterfactual scenarios. In each of which we set the counterfactual date for the abolition of serfdom to 1820 instead of 1861. We consider 1820 as the year of the early abolition of serfdom in the counterfactual scenarios because of the serious political discussions in Russian society about emancipation reform under the rule of Alexander I (1801-1825). The emancipation of peasants in Prussia occurred just 13 years before (in 1807) our considered counterfactual year. Table A19 below in this online appendix summarizes our counterfactual estimates. The text below describes the derivation of these figures.

Our starting point is Maddison's (2007) estimate of Russian GDP per capita in 1820, which is \$688 in 1990 USD. We assume that the industrial structure of the Russian economy was approximately stable before Russia's industrialization in the late 19<sup>th</sup> century, and estimate the value added in industry, agriculture, and services in 1820.

We apply data on industrial structure as of 1860, which is the earliest available date for these figures. The shares of each sector in value added are obtained from Goldsmith (1961), who gives figures for the shares of each of the three sectors in 1913, and their growth rates, between 1860-1913. In particular, according to Goldsmith (1961), agriculture, industry, and service sectors accounted for 50%, 20%, and 30% of national income in 1913, respectively. These sectors grew on average by 2%, 5%, and 2% per year, respectively. Rolling back these growth rates, we estimate the shares of agriculture, industry, and service sector in 1860 as 59.3%, 5.1%, and 35.6%, respectively.

We obtain the counterfactual estimates of sectorial output in 1820 by momentarily increasing the level of output in each sector according to the following multipliers:

For the agricultural sector, we apply the effect for grain productivity (15.5% increase, or 1.155 multiplier) because grain was the main product produced by Russia's agricultural sector in the 19<sup>th</sup> century. Grain production accounted for about half of total agricultural output in 1913 (Markevich and Harrison 2013). This share is unknown for the earlier years but was most probably higher.

For the industrial sector, we apply the effect of the abolition of serfdom on industrial output (1.48 multiplier), based on OLS rather than IV estimation in order to be on the conservative side.

For the service sector, we take the average multiplier in industry and agriculture weighted by the size of these sectors.

We sum the sectorial estimates to get a counterfactual value added in the total economy in 1820, and get \$44,888.2 million in 1990 USD. Then, we divide this figure by Maddison's estimate of the total population in 1820 (54.765 million people) to get the counterfactual level of GDP per capita in 1820: \$812 in 1990 USD.

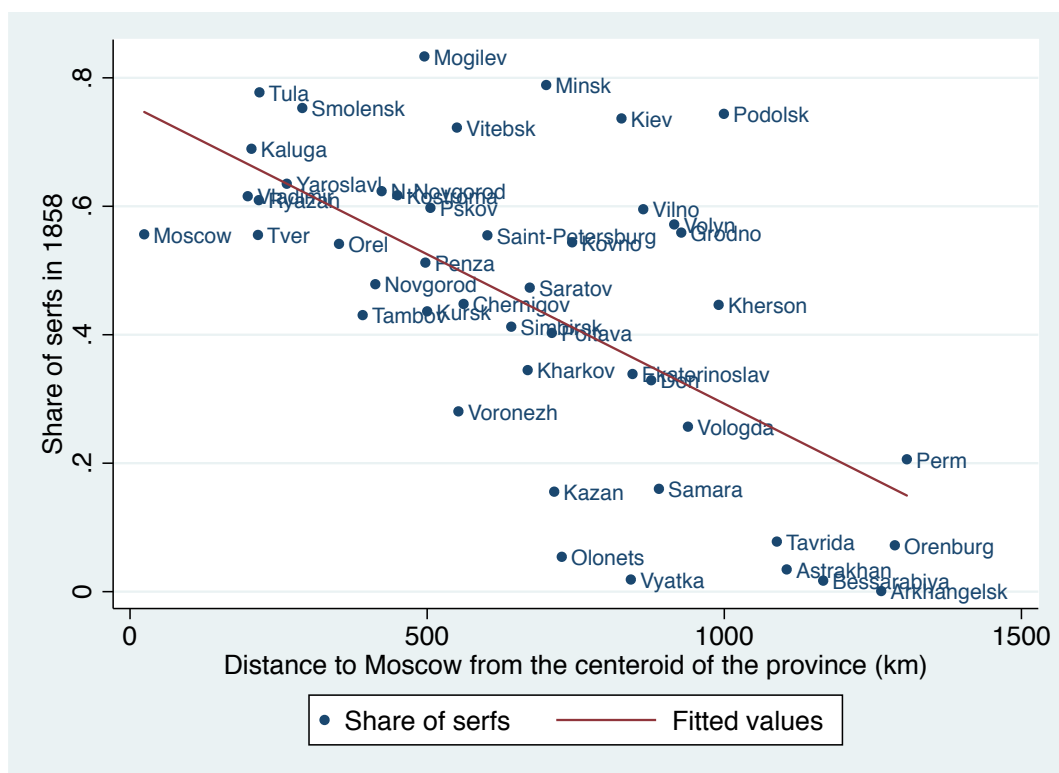
Finally, we allow GDP per capita to grow at three different rates: 1) The rate it actually grew after the emancipation during the industrial spurt, (1.06% per year between 1870 and 1913). We call this "the optimistic scenario." 2) Its actual historical rates (0.83% per year between 1820 and 1913). We call this "the pessimistic scenario." 3) The average rate of growth between 1820 and 1913 of the Eastern and Central European countries, which abolished serfdom in the late 18<sup>th</sup> – early 19<sup>th</sup> century (1.15% per year). We call this "the East-European scenario." We obtain \$1,751 \$2,164 and \$2,342 (in 1990 USD) as our counterfactual estimates of the GDP per capita in 1913 in these three scenarios, respectively.

For the optimistic scenario we use 1870 because this is the closest year to 1861 for which Maddison provides an estimate of GDP. For the East-European scenario, we use GDP growth rates for countries available from Maddison (reported in Table A20 below in this online appendix). Note that these territories only partially correspond to territories with emancipation reforms in the late 18<sup>th</sup> – early 19<sup>th</sup> centuries (namely, Austria, Bohemia, Denmark and Prussia). We do not allow a scenario with a decreasing growth rate after the emancipation reform because all Eastern European countries that abolished serfdom in the late 18<sup>th</sup> – early 19<sup>th</sup> century had increasing growth rates throughout the 19<sup>th</sup> century.

#### **References for online appendix section C:**

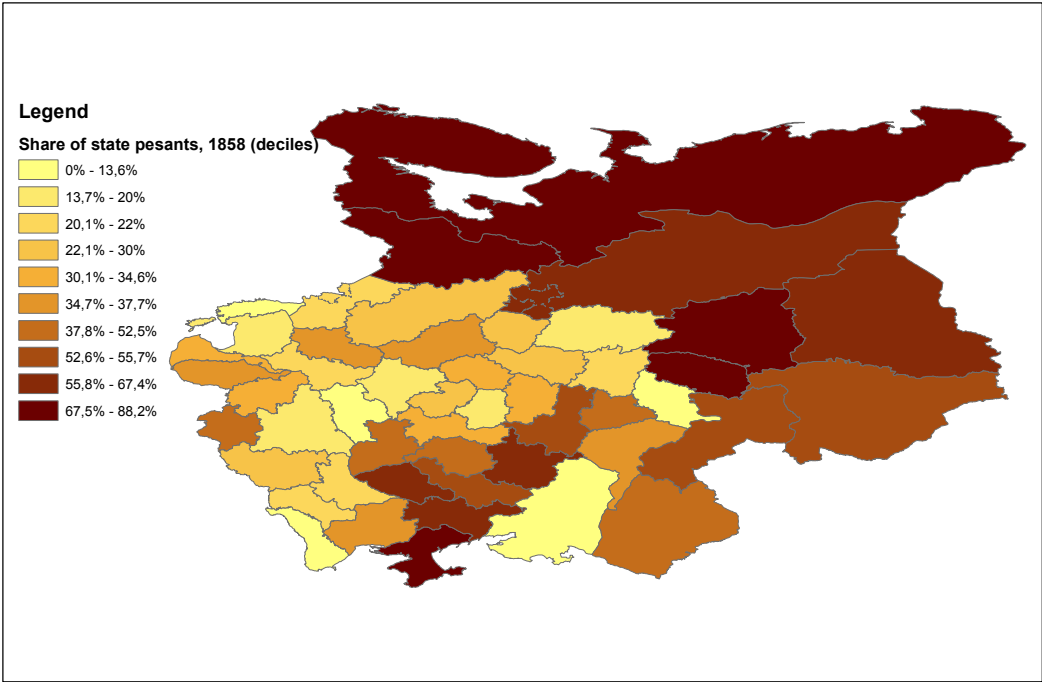
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Figure A1. Geography of serfdom: share of serfs in 1858 and the distance to Moscow



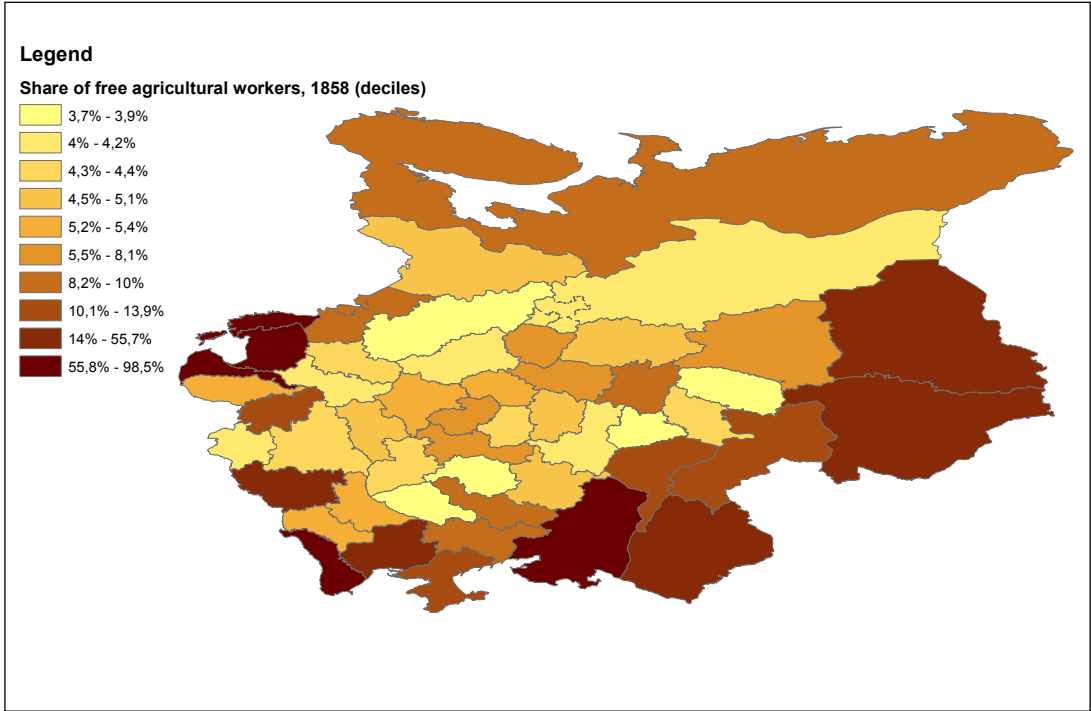
Coef: -0.0005; SE=0.00009;  $R^2=0.36$ .

Figure A2. Geography of serfdom: state peasants in 1858 as a share of rural population



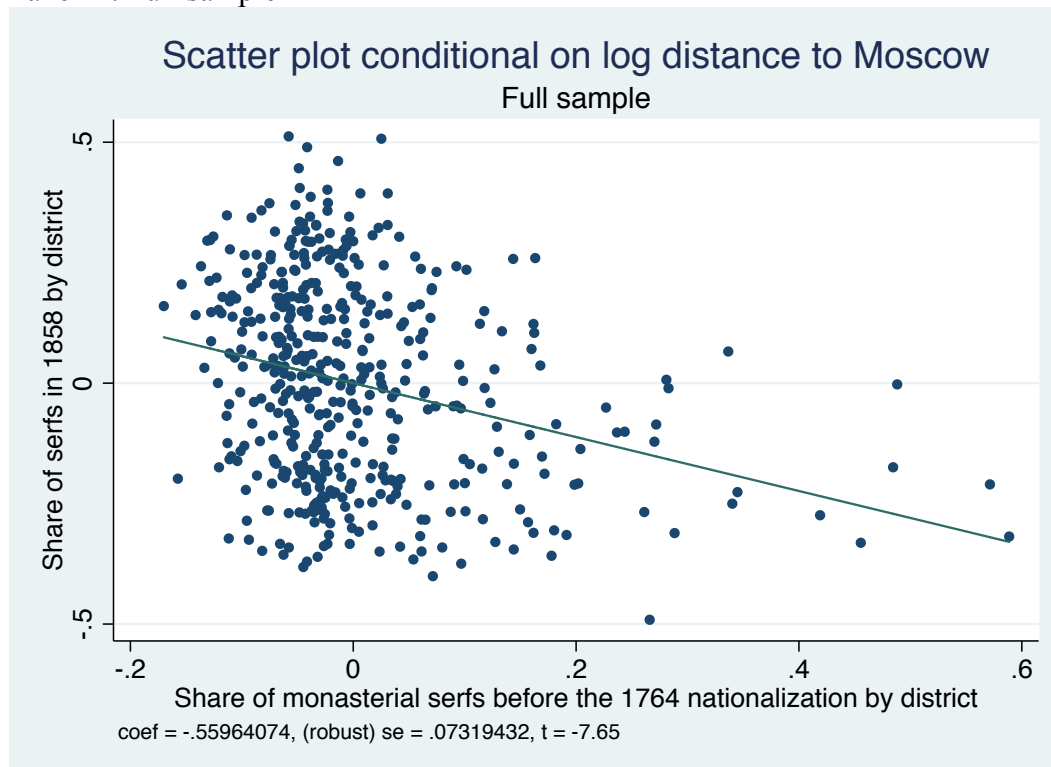
Note: Equirectangular projection used.

Figure A3. Geography of serfdom: free agricultural workers in 1858 as a share of rural population



Note: Equirectangular projection used.

Figure A4. Illustration of the first-stage relationship at district level  
Panel A. Full sample



Panel B. Sample restricted to districts with the share of nationalized monasterial serfs below 0.3.

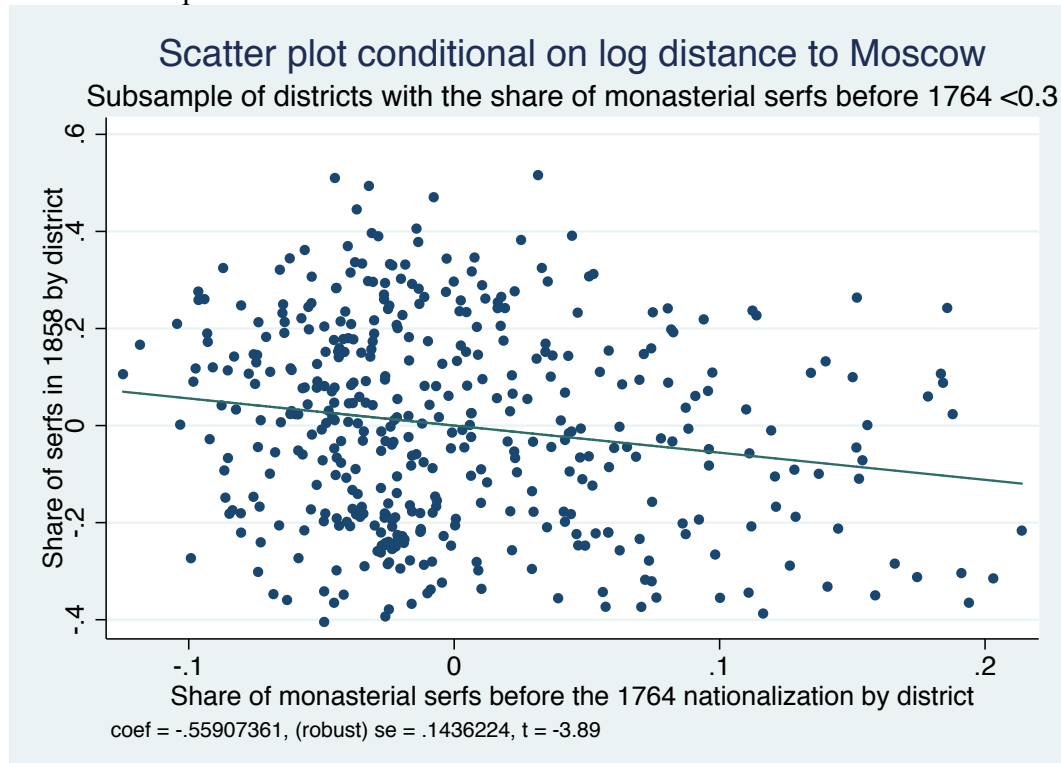


Figure A5. Cross-sectional relationship between prevalence of serfdom and the growth in grain yield between before and after the emancipation

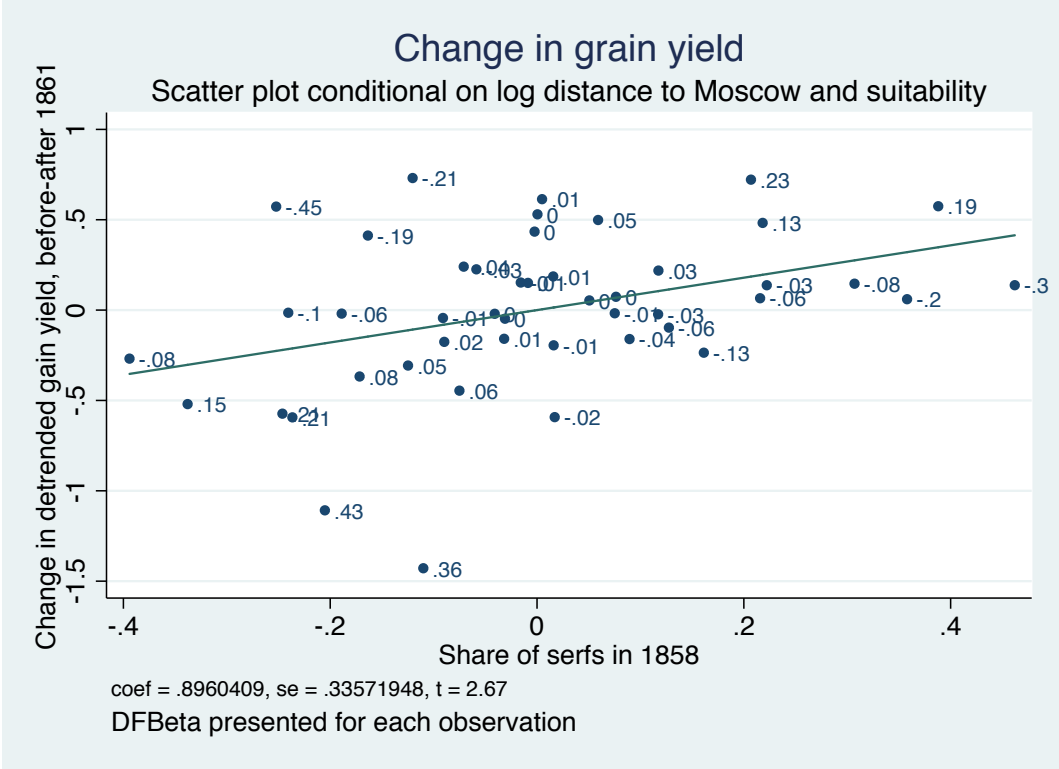
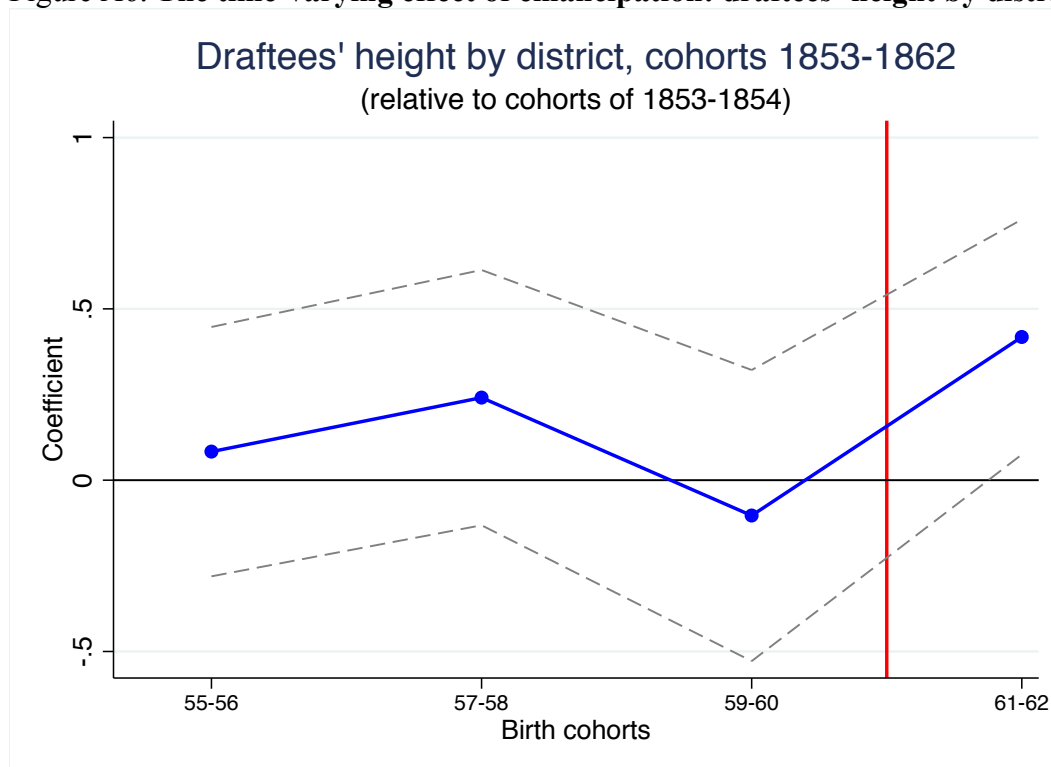


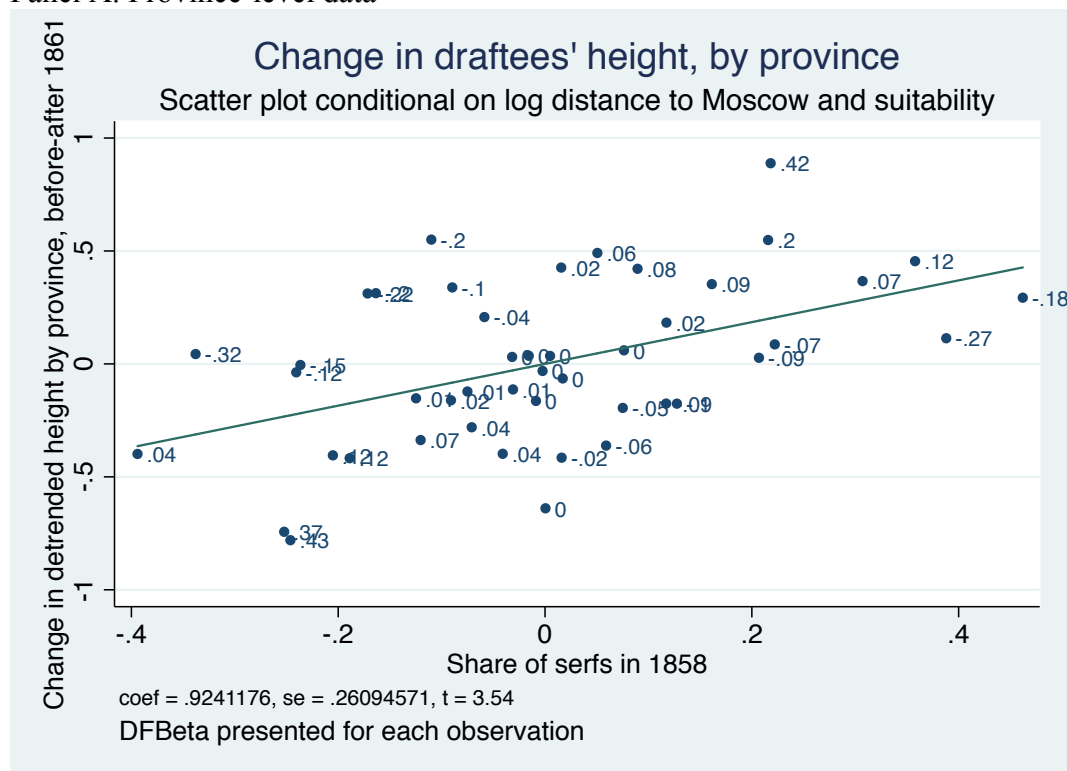
Figure A6. **The time-varying effect of emancipation: draftees' height by district**



Note: The figure presents coefficients (along with their 90% confidence interval) in the regression of height on 2-year interval dummies for birth cohorts, district and birth-cohort fixed effects, and province-specific linear trends. Two cohorts of 1853 and 1854 are held as the comparison group. The vertical red line marks the timing of the emancipation. The table-form representation of the results of this estimation is presented in column 3 of Table A2 in the online appendix.

Figure A7. Cross-sectional relationship between prevalence of serfdom and the growth in height of draftees between before and after the emancipation

Panel A. Province-level data



Panel B. District-level data

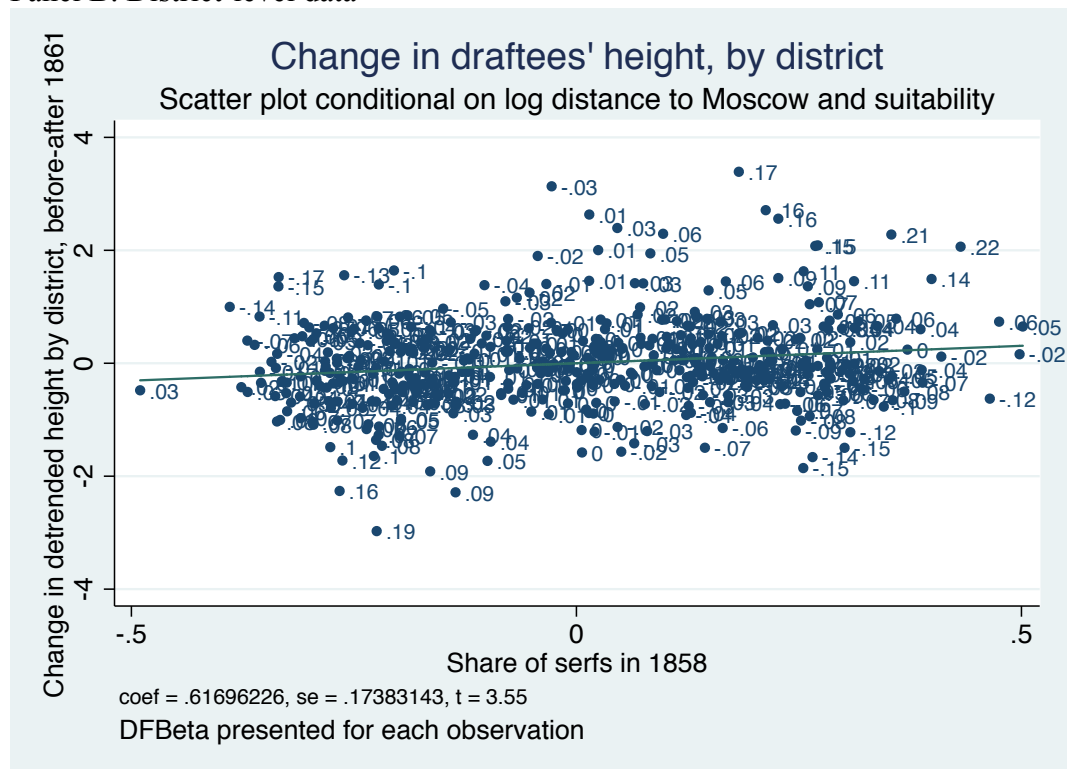




Figure A8. Cross-sectional relationship between prevalence of serfdom and the growth in industrial output between before and after the emancipation

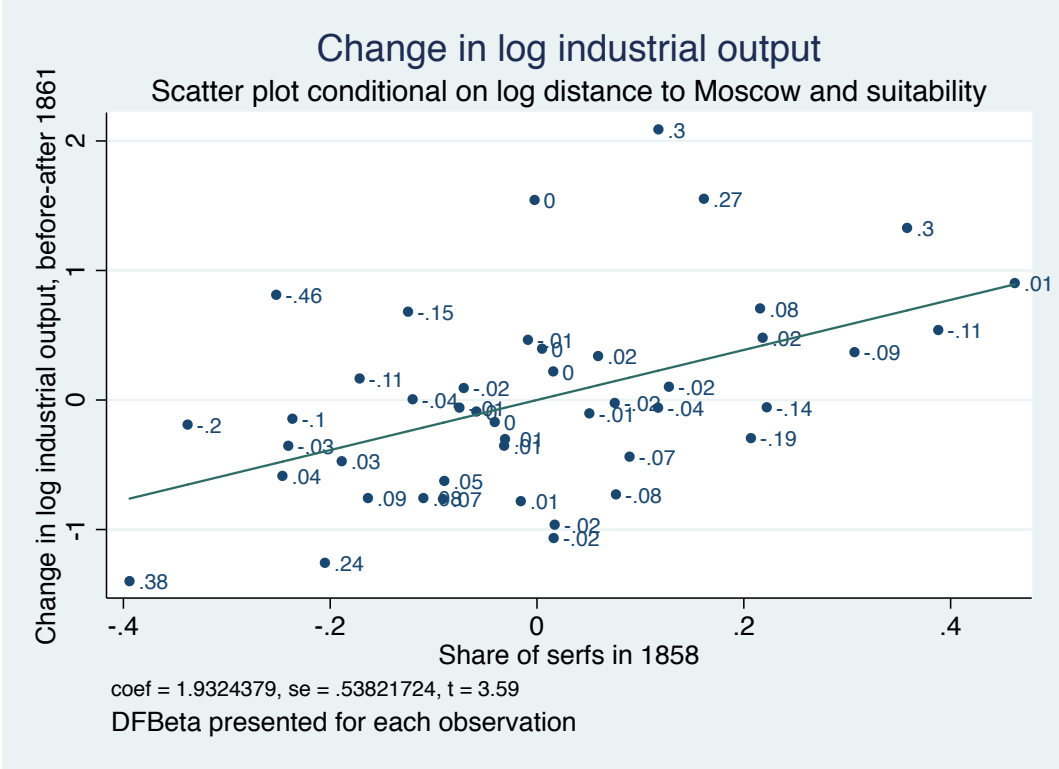


Table A1. Data sources.

Outcome variables		
Variable:	Years:	Source:
Grain yield	1795 and 1858	Kessler and Markevich (2015)
	1800s-1820s, 1840s and 1850s by decade	Koval'chenko (1959)
	1857, 1859-1863 by year	Vilson (1869)
	1864-1866 by year	Obruchev (1871)
	1870-1876 by year	Materialy ... (1880)
	1883-1887 by year	TsSK MVD (1888)
	1888-1900 by year	Urozhaj v ... (1889-1901)
Winter and summer grain seeds planted	1858	Kessler and Markevich (2015)
	1893-1900 by year	Urozhaj v ... (1889-1901)
Height of draftees	1853-1862 by year	Vseobshchaya ... (1886)
	1863-1864	Sbornik ... (1887)
	1865-1866 by year	Sbornik ... (1890)
	1875	Sbornik ... (1897)
Number of births	1856	Statisticheskii ... (1858)
	1858	Kessler and Markevich (2015)
	1867	Statisticheskii ... (1872)
	1868-1870 by year	Statisticheskii ... (1877, 1879)
	1875	Statisticheskii ... (1883a)
	1880	Statisticheskii ... (1883b)
	1885	Statisticheskii ... (1890)
	1890	Statisticheskii ... (1895)
Number of deaths	1896	Statisticheskii ... (1898)
	1856	Statisticheskii ... (1858)
	1858	Kessler and Markevich (2015)
	1867	Statisticheskii ... (1872)
	1868-1870 by year	Statisticheskii ... (1877, 1879)
	1875	Statisticheskii ... (1883a)
	1880	Statisticheskii ... (1883b)
	1885	Statisticheskii ... (1890)
Industrial output	1890	Statisticheskii ... (1895)
	1896	Statisticheskii ... (1898)
	1796	Kessler and Markevich (2015)
	1849	Statisticheskii ... (1852)
	1856	Statisticheskii ... (1858)
	1858	Kessler and Markevich (2015)
	1882	Sbornik ... (1884)
	1884	Statisticheskii ... (1887)
Industrial employment	1897	Kessler and Markevich (2015)
	1847	Statisticheskii ... (1849)
	1882	Sbornik ... (1884)
Population	1897	Kessler and Markevich (2015)
	1800s-1850s by decade	Kabuzan (1971)
	1849	Statisticheskii ... (1852)
	1856	Statisticheskii ... (1858)

	1858	Kessler and Markevich (2015)
	1863	Bushen (1863)
	1870	Statisticheskii ... (1875)

Table A1 continued

Population	1883	Statisticheskii ... (1886)
Arable land	1800, 1858	Kessler and Markevich (2015)
	1871, 1877	Statistika ... (1880-1886)
<b>Explanatory variables</b>		
Variable:	Years:	Source:
Distribution of rural population by status	1858	Bushen (1863), Troinitskii (1861)
	1857	Kabuzan (1971)
Redemption payments	1862-1876 by year	Vilson (1878)
Monasterial and clergy serfs	1796 and 1814	Beskrovnii et al. (1972)
Gentry debts and mortgages	1858	Skrebetskii (1862-1866)
Signed and unsigned regulatory charters	1863	Vilson (1878)
Serfs per estate	1857	Troinitskii (1858)
Land cuts (in percentage to peasants land before the emancipation)	1863	Zaionchkovskii (1960)
Crops suitability	Modern day; under the assumption of rain-fed low-input agriculture for the main crops grown in the area	GAEZ Portal: <a href="http://www.gaez.iiasa.ac.at/">http://www.gaez.iiasa.ac.at/</a>
Temperature	1795-1900	The Global Land Surface Databank (Rennie et al, 2014) <sup>51</sup>
Re-partition commune dummy	1905	Durbrovskii (1963)
Zemstvo expenditures	1864	Statisticheskii ... (1866)
Court reform	1864-1896	Ministry of Justice (1902)
Railways density	1795-1900	Sollogub (1874), Sbornik ... (1884), Kessler and Markevich (2015) <sup>52</sup>

<sup>51</sup> To construct our historical yearly temperature series, we use weather station data provided by the Global Land Surface Databank (Rennie et al, 2014). We use the "IDW (inverse distance weighted)" tool of ArcGIS software to perform interpolation. IDW is an interpolation technique that determines cell values using a linearly weighted combination of a set of sample points. The weight is a function of inverse distance of the cell and sample points. Before performing the interpolation, we compute the temperature at sea level for each weather station. We assume that for every one thousand meters the temperature falls by 6.4 C degrees. After the IDW interpolation, we calculate the temperature at the exact altitude for the whole raster data. Lastly, we import the interpolated data into Stata and calculate the mean temperature at the province level.

<sup>52</sup> Sollogub (1874) provides a cross-section on the lengths of railways in provinces in 1874 by railway lines and dates of construction of these lines. We combine the two pieces of data to construct pre-1874 railway dynamics. We use data from Sbornik (1884) to repeat a similar procedure for the 1874-1884 decade. Kessler and Markevich (2015) report data for the 1897. We use various sources to reconstruct the 1884-1896 and 1898-1900 dynamics of railway construction.

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Table A2. Dynamics of the results of the abolition of serfdom

Dependent var: Sample:	(1) Grain yield provinces	(2) Draftees' height provinces	(3) log industrial output districts	(4) log industrial output provinces
Share of serfs X (years 1840s)	0.2721 [0.565]			
Share of serfs X (years 1850-	-0.0068 [0.576]			
Share of serfs X (years 1856-	0.0478 [0.560]			
Share of serfs X (years 1861-	1.0039* [0.566]			
Share of serfs X (years 1866-	1.1026* [0.609]			
Share of serfs X (years 1871-	1.8194*** [0.609]			
Share of serfs X (years 1876-	2.4574*** [0.745]			
Share of serfs X (years 1881-	1.2889* [0.703]			
Share of serfs X (years 1886-	1.8210*** [0.663]			
Share of serfs X (years 1891-	1.1433 [0.704]			
Share of serfs X (years post 1895)	1.7296** [0.720]			
Share of serfs X (cohorts 1855-		0.0183 [0.281]	0.0832 (0.222)	
Share of serfs X (cohorts 1857-		0.3737 [0.275]	0.241 (0.227)	
Share of serfs X (cohorts 1859-		0.1933 [0.366]	-0.103 (0.259)	
Share of serfs X (cohorts 1861-		1.2394*** [0.346]	0.418** (0.209)	
Share of serfs X (cohorts 1863-		1.3502*** [0.308]		
Share of serfs X (cohorts 1865-		1.5016*** [0.350]		
Share of serfs X (cohort 1875)		1.1921 [0.796]		
Share of serfs X (year 1849)				0.3295 [0.723]
Share of serfs X (years 1856,				0.4524 [0.796]
Share of serfs X (years 1882,				2.2447*** [0.728]
Share of serfs X (year 1885)				2.4346*** [0.728]
Share of serfs X (year 1897)				1.9087** [0.861]
Dmnd log distance to Moscow X Post-emancipation	-0.7426* [0.403]	0.8143*** [0.300]	-	0.4517 [0.480]
Dmnd crop suitability X Post-emancipation	0.0294 [0.048]	0.1041** [0.042]	-	0.1098 [0.067]
Share of state peasants X Post-	Yes	Yes	No	Yes
Share of royal peasants X Post-	Yes	Yes	No	Yes
Province/district and year FEs	Yes	Yes	Yes	Yes
Region-specific trends	Yes	Yes	Yes	Yes
Observations	1,756	690	4,684	341
R-squared	0.514	0.881	0.593	0.900

Notes: Standard errors are clustered by province or by district separately before and after 1861 emancipation reform.

\*\*\* indicates p-value <0.01, \*\* p-value <0.05, \* p-value <0.1.

Table A3. The effect of the abolition of serfdom conditional to the distance to Moscow on productivity in agriculture

	(1)	(2)
Dependent var:	Grain yield	Grain yield
Model:	OLS	OLS
Share of serfs X Post-emancipation	1.1511*** [0.251]	1.3940*** [0.258]
Share of serfs X Demeaned log distance to Moscow X Post-emancipation	-1.1033 [0.774]	-1.0348 [0.761]
Demeaned crop suitability X Post-emancipation	0.0331 [0.046]	0.0244 [0.044]
Year and province fixed effects	Yes	Yes
Province-specific trends	Yes	Yes
State and royal peasant reforms	No	Yes
Observations	1,756	1,756
R-squared	0.398	0.399

Notes: Standard errors are clustered by province separately before and after 1861 emancipation reform.

\*\*\* indicates p-value <0.01, \*\* p-value <0.05, \* p-value<0.1.



Table A4. The effect of the abolition of serfdom on arable lands

	(1)	(2)	(3)	(4)
Dependent var: Ln (arable land)		Share of serfs	Ln (arable land)	Ln (arable land)
		X Post-emancipation		
	OLS	IV, 1st stage	IV, 2nd stage	OLS
Share of serfs X Post-emancipation	-0.1764 [0.203]		0.2212 [0.434]	0.4028 [0.985]
Share of nationalized monasterial serfs X Post-emancipation		-1.0531*** [0.310]		
Demeaned log distance to Moscow X Post-emancipation	0.3734* [0.198]	-0.9396*** [0.102]	0.6629** [0.324]	0.4624** [0.191]
Demeaned crop suitability X Post-emancipation	0.0219 [0.032]	0.0325* [0.019]	0.0228 [0.036]	0.0254 [0.034]
Share of state peasants X Post-1866	No	No	No	Yes
Share of royal peasants X Post-1859	No	No	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes
Region-specific trends	Yes	Yes	Yes	Yes
Observations	186	186	186	186
F, monasterial serfs instrument		11.57		
R-squared	0.345	0.964	0.939	0.348

Notes: Standard errors are clustered by province separately before and after 1861 emancipation reform.

\*\*\* indicates p-value <0.01, \*\* p-value <0.05, \* p-value<0.1.

Table A5. The effect of the abolition of serfdom on productivity and potential confounding factors

	(1)	(2)	(3)	(4)	(6)
Dependent var: Grain yield					
	OLS	OLS	OLS	OLS	OLS
Share of serfs X Post-emancipation	0.8818*** [0.291]	0.9174*** [0.296]	1.0786*** [0.310]	0.9795*** [0.321]	0.6744** [0.310]
Share of peasants with signed buyout contracts					
Ln(railways)	0.0371*** [0.014]				0.0473*** [0.015]
Temperature		-0.1764*** [0.066]			-0.1786** [0.069]
Court reform			0.0565 [0.159]		0.0357 [0.168]
Zemstvo expenditures per capita in 1869 X Post-1864				-0.0010 [0.001]	-0.0008 [0.001]
Demeaned _og distance to Moscow X Post-emancipation	-0.8484** [0.426]	-0.9204** [0.443]	-0.9095** [0.456]	-1.1339** [0.485]	-0.8569* [0.497]
Demeaned _rop suitability X Post-emancipation	0.0205 [0.043]	-0.0184 [0.043]	0.0388 [0.045]	0.0293 [0.042]	-0.0395 [0.042]
Share of state peasants X Post-1866	Yes	Yes	Yes	Yes	Yes
Share of royal serfs X Post-1859	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes	Yes	Yes
Observations	1,729	1,701	1,756	1,756	1,674
R-squared	0.403	0.406	0.399	0.400	0.411

Notes: Standard errors are clustered by province separately before and after 1861 emancipation reform.

\*\*\* indicates p-value <0.01, \*\* p-value <0.05, \* p-value<0.1.

Table A6. The effect of the abolition of serfdom on height and potential confounding factors

Dependent var:	(1) Height OLS	(2) Height OLS	(3) Height OLS	(4) Height OLS	(5) Height OLS
Share of serfs X Post-emancipation	0.9677*** [0.352]	0.9404*** [0.355]	0.9599*** [0.347]	0.9515*** [0.349]	0.8646** [0.353]
Ln(railways)	-0.0421* [0.024]				-0.0463* [0.023]
Temperature		-0.0156 [0.043]			-0.0103 [0.042]
Court reform			0.1078 [0.142]		0.1957 [0.149]
Zemstvo expenditures per capita in 1869 X Post-1864				-0.0011* [0.001]	-0.0013* [0.001]
Demeaned log distance to Moscow X Post-emancipation	0.3741 [0.350]	0.4637 [0.335]	0.4417 [0.331]	0.4224 [0.335]	0.2935 [0.349]
Demeaned crop suitability X Post-emancipation	0.1832*** [0.052]	0.1531*** [0.050]	0.1509*** [0.049]	0.1574*** [0.049]	0.1648*** [0.051]
Share of state peasants X Post-1866	Yes	Yes	Yes	Yes	Yes
Share of royal serfs X Post-1859	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes	Yes	Yes
Observations	687	684	690	690	681
R-squared	0.757	0.758	0.762	0.762	0.756

Notes: Standard errors are clustered by province separately before and after 1861 emancipation reform.

\*\*\* indicates p-value <0.01, \*\* p-value <0.05, \* p-value<0.1.

Table A7. The effect of the abolition of serfdom on industrial output and potential confounding factors

Dependent var:	(1)	(2)	(3)	(4)	(6)
	OLS	OLS	Ln (industrial output) OLS	OLS	OLS
Share of serfs X Post-emancipation	2.0166*** [0.312]	1.5218*** [0.330]	1.8263*** [0.342]	1.6718*** [0.357]	1.6370*** [0.330]
Ln(railways)	-0.0080 [0.028]				-0.0495** [0.022]
Temperature		0.0183 [0.052]			0.0238 [0.048]
Court reform			0.0560 [0.107]		-0.0230 [0.125]
Zemstvo expenditures per capita in 1869 X Post-1864				-0.0027** [0.001]	-0.0030** [0.001]
Demeaned _og distance to Moscow X Post-emancipation	0.6047 [0.472]	0.6412 [0.418]	0.4739 [0.461]	-0.1790 [0.515]	0.2627 [0.480]
Demeaned _rop suitability X Post-emancipation	0.0762 [0.075]	0.0623 [0.063]	0.1146 [0.069]	0.0873 [0.064]	-0.0200 [0.062]
Share of state peasants X Post-1866	Yes	Yes	Yes	Yes	Yes
Share of royal serfs X Post-1859	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes
Region-specific trends	Yes	Yes	Yes	Yes	Yes
Observations	337	315	342	342	310
R-squared	0.900	0.884	0.899	0.900	0.889

Notes: Standard errors are clustered by province separately before and after 1861 emancipation reform.

\*\*\* indicates p-value <0.01, \*\* p-value <0.05, \* p-value<0.1.

Table A8. Robustness of the effect of the land reform to the sample restriction with data for the Great Russia provinces only

Dependent var:	(1) Grain yield OLS	(2) Share of serfs X Post-emancipation IV, 1 stage	(3) Share of serfs with land-buyout started IV, 1 stage	(4) Grain yield IV, 2nd stage	(5) Grain yield OLS
Share of serfs X Post-emancipation	1.3746** [0.523]			2.7221*** [0.799]	1.3977*** [0.520]
Share of serfs with land-buyout started	-0.6273* [0.372]			-1.4709*** [0.496]	-0.6409 [0.391]
Land cuts X Post-emancipation					-0.0070 [0.007]
Share of nationalized monasterial serfs X Post-emancipation		-1.0009*** [0.326]	-1.1302*** [0.341]		
Interpolation b/w (1-indebtedness) and 1 in the interval 1862-1882		-0.2806* [0.143]	2.2238*** [0.268]		
Demeaned log distance to Moscow X Post-emancipation	-0.3403 [0.705]	-1.0139*** [0.107]	-0.7561*** [0.114]	0.6699 [0.778]	-0.4811 [0.707]
Demeaned crop suitability X Post-emancipation	-0.0153 [0.054]	0.0358* [0.019]	0.0286 [0.019]	-0.0151 [0.061]	0.0421 [0.066]
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes	Yes	Yes
Observations	1,310	1,336	1,310	1,310	1,256
F, monasterial serfs instrument		9.398	11		
F, indebtedness instrument		3.847	68.94		
R-squared	0.402	0.983	0.961	0.521	0.412

Notes: Standard errors are clustered by province separately before and after 1861 emancipation reform.

\*\*\* indicates p-value <0.01, \*\* p-value <0.05, \* p-value<0.

Table A9. Robustness to using 1857 tax census data: the effect of the abolition of serfdom on productivity in agriculture

Panel A: Panel data estimation						
Dependent var:	(1) Grain yield OLS	(2) Grain yield OLS	(3) Grain yield IV, 2nd stage	(4) Grain yield OLS	(5) Grain yield OLS	(6) Grain yield IV, 2nd stage
Model:						
Share of serfs X Post-emancipation	1.0464*** [0.224]	0.8129** [0.386]	1.6074** [0.635]	1.1977*** [0.403]	1.2849** [0.504]	3.0571*** [0.863]
Share of peasants with signed buyout contracts					-0.7444** [0.288]	-1.3573*** [0.389]
Demeaned log distance to Moscow X Post-emancipation		-1.1027** [0.529]	-0.5527 [0.625]	-1.0266* [0.523]	-0.6268 [0.549]	0.5487 [0.652]
Demeaned crop suitability X Post-emancipation		0.0642 [0.061]	0.0795 [0.061]	0.0320 [0.061]	0.0487 [0.063]	0.0791 [0.069]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	No	Yes	Yes	Yes	Yes	Yes
State and royal peasant reforms	No	No	No	Yes	No	No
Observations	1,376	1,355	1,355	1,329	1,328	1,328
R-squared	0.377	0.419	0.574	0.424	0.419	0.577
Panel B: First stages of the corresponding 2SLS panel regressions						
Dependent var:	(3) Share of serfs X Post- emancipation		(6.1) Share of serfs X Post- emancipation		(6.2) Share of peasants with signed buyout contracts	
Model:	IV, 1st stage		IV, 1st stage		IV, 1st stage	
Share of nationalized monasterial serfs X Post-emancipation	-1.1643*** [0.362]		-1.1363*** [0.362]		-1.1926*** [0.358]	
Interpolation b/w (1-indebtedness) and 1 in the interval 1862-1882			0.0299 [0.157]		2.6002*** [0.252]	
Controls as in respective column of Panel A	Yes		Yes		Yes	
Observations	1,355		1,328		1,328	
F, monasterial serfs instrument	10.35		9.863		11.08	
F, indebtedness instrument			0.0364		106.5	

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861. Share of peasants with signed buyout contracts equals 0 in all provinces for the years before 1862 and then gradually reaches the share of serfs in the corresponding province. In the non-western provinces this happened by 1882, and in western provinces in 1863. Indebtedness is the number of serfs in the province used as collateral in landlords' debt contracts in 1858 as a share of total number of serfs in the province.

\*\*\* indicates p-value <0.01, \*\* p-value <0.05, \* p-value<0.1.

Table A10. Robustness to using 1857 tax census data: the effect of the abolition of serfdom on draftees' height

Panel A: Panel data estimation

	(1)	(2)	(3)
Dependent var:	Draftees' height (cohorts 1853-1866, 1875)		
Data set:	Province-level data		
Model:	OLS	IV, 2nd stage	OLS
Share of serfs X Post-emancipation cohorts	0.7604* [0.438]	1.6087** [0.677]	0.5969 [0.420]
Demeaned log distance to Moscow X Post-emancipation	0.2485 [0.374]	0.8419 [0.640]	0.2057 [0.368]
Demeaned crop suitability X Post-emancipation	0.1195** [0.058]	0.1359** [0.065]	0.1341** [0.057]
Birth cohort and province or district fixed effects	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes
Reforms for state and royal peasants	No	No	Yes
Observations	599	599	573
R-squared	0.737	0.901	0.757

Panel B: First stages of the corresponding 2SLS panel regressions

	(2)
Dependent var:	Share of serfs X Post-emancipation cohorts
Model:	IV, 1st stage
Share of nationalized monasterial serfs X Post-emancipation cohorts	-1.1759*** [0.390]
Controls as in respective column of Panel A	Yes
Observations	599
F, excluded instrument	9.095

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861.

\*\*\* indicates p-value <0.01, \*\* p-value <0.05, \* p-value<0.1.

Table A11. Robustness to using 1857 tax census data: the effect of the abolition of serfdom on industrial development

Panel A: Panel data estimation

Dependent var:	(1) OLS	(2) Ln (industrial output) IV, 2nd stage	(3) OLS
Share of serfs X Post-emancipation	1.7269*** [0.277]	2.3360*** [0.769]	2.4088*** [0.228]
Demeaned log distance to Moscow X Post-emancipation	2.1454*** [0.448]	2.5670*** [0.787]	0.6890 [0.431]
Demeaned crop suitability X Post-emancipation	-0.1408*** [0.053]	-0.1279** [0.055]	0.0636 [0.068]
Year and province fixed effects	Yes	Yes	Yes
Regione-specific trends	Yes	Yes	Yes
State and royal peasant reforms	No	No	Yes
Observations	292	292	292
R-squared	0.863	0.926	0.925

Panel B: First stages of the corresponding 2SLS panel regressions

Dependent var:	(2) Share of serfs X Post- emancipation
Model:	IV, 1st stage
Share of nationalized monasterial serfs X Post-emancipation	-1.1706*** [0.373]
Controls as in respective column of Panel A	Yes
Observations	292
F, monasterial serfs instrument	9.825

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861.

\*\*\* indicates p-value <0.01, \*\* p-value <0.05, \* p-value<0.1



Table A12. Robustness to the restricted sample with the data from governor reports only: the effect of the abolition of serfdom on grain productivity

Panel A: Panel data estimation				
Dependent var: Model:	(1) Grain yield OLS	(2) Grain yield OLS	(3) Grain yield IV, 2nd stage	(4) Grain yield OLS
Share of serfs X Post-emancipation	1.1165*** [0.176]	0.6960** [0.303]	1.8693*** [0.505]	0.9423*** [0.318]
Demeaned log distance to Moscow X Post-emancipation		-0.6620 [0.446]	0.1532 [0.472]	-0.6175 [0.437]
Demeaned crop suitability X Post-emancipation		0.0151 [0.041]	0.0090 [0.053]	0.0103 [0.041]
Year and province fixed effects	Yes	Yes	Yes	Yes
Province-specific trends	No	Yes	Yes	Yes
State and royal peasant reforms	No	No	No	Yes
Observations	952	931	931	931
R-squared	0.231	0.289	0.486	0.295
Panel B: First stages of the corresponding 2SLS panel regressions				
Dependent var: Model:	(3) Share of serfs X Post- emancipation IV, 1st stage			
Share of nationalized monasterial serfs X Post-emancipation	-1.2942*** [0.354]			
Interpolation b/w (1-indebtedness) and 1 in the interval 1862-1882				
Controls as in respective column of Panel A	Yes			
Observations	931			
F, monasterial serfs instrument	13.33			

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861.

\*\*\* indicates p-value <0.01, \*\* p-value <0.05, \* p-value<0.1

Table A13. The effect of the abolition of serfdom on productivity in agriculture on the samples including Baltic provinces

Dependent var:	(1) Grain yield OLS	(2) Grain yield OLS	(3) Grain yield OLS	(4) Grain yield OLS
Share of serfs X Post-emancipation	0.7499*** [0.282]	0.8849*** [0.308]		
Share of non-Baltic serfs X Post-1861			0.7927*** [0.289]	1.0359*** [0.302]
Share of Baltic serfs X Post 1820			0.6220 [0.707]	0.4754 [0.728]
Demeaned log distance to Moscow in non-Baltic provinces X Post-1861	-1.0673** [0.428]	-1.0581** [0.430]	-1.0371** [0.443]	-0.9594** [0.439]
Demeaned log distance to Moscow in Baltic provinces X Post-1861	0.5972 [1.431]	-0.0956 [1.490]	0.7229 [1.710]	0.2508 [1.772]
Demeaned crop suitability in non-Baltic provinces X Post-1861	0.0434 [0.046]	0.0369 [0.044]	0.0429 [0.046]	0.0347 [0.044]
Demeaned crop suitability in Baltic provinces X Post-1861	0.3242*** [0.090]	0.3993*** [0.104]	0.3235*** [0.091]	0.4035*** [0.100]
Share of state peasants X Post-1866	No	Yes	No	Yes
Share of royal peasants X Post-1859	No	Yes	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes	Yes
Observations	1,891	1,891	1,891	1,891
R-squared	0.392	0.393	0.392	0.393

Notes:

Standard errors are clustered by province separately before and after 1861 emancipation reform.

\*\*\* indicates p-value <0.01, \*\* p-value <0.05, \* p-value <

Table A14. Robustness to using restricted samples: the effect of the abolition of serfdom and land reform on agricultural productivity

Panel A: Panel data estimation																		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Dependent var:	Grain yield	Grain yield	Grain yield	Grain yield	Grain yield	Grain yield	Grain yield	Grain yield	Grain yield	Grain yield	Grain yield	Grain yield	Grain yield	Grain yield	Grain yield	Grain yield	Grain yield	Grain yield
Sample	No Moscow	S-Petersburg	No Arkhangelsk	No Arkhangelsk	No Bessarabiya	No Bessarabiya	No Vyatka	No Vyatka	No Astrakhan	No Astrakhan	No Mogilev	No Mogilev	No Minsk	No Minsk	No Tula	No Tula	No Smolensk	No Smolensk
Model:	OLS	IV, 2nd stage	OLS	IV, 2nd stage	OLS	IV, 2nd stage	OLS	IV, 2nd stage	OLS	IV, 2nd stage	OLS	IV, 2nd stage	OLS	IV, 2nd stage	OLS	IV, 2nd stage	OLS	IV, 2nd stage
Share of serfs X Post-emancipation	0.6563** [0.280]	1.1126* [0.590]	0.8927*** [0.290]	1.5395** [0.596]	0.7065** [0.290]	1.2037** [0.543]	0.6967** [0.301]	1.1092* [0.613]	0.7317** [0.296]	1.2863** [0.499]	0.7422** [0.297]	1.1443* [0.632]	0.8457*** [0.313]	1.2403** [0.564]	0.8342*** [0.289]	1.4077** [0.542]	0.8265*** [0.289]	1.4153** [0.566]
Demeaned log distance to Moscow X Post-emancipation	-1.4226*** [0.448]	-1.0580* [0.594]	-1.0755** [0.449]	-0.6345 [0.535]	-0.9898** [0.447]	-0.6473 [0.527]	-1.0760** [0.447]	-0.7877 [0.561]	-1.0290** [0.443]	-0.6468 [0.503]	-1.0678** [0.442]	-0.7828 [0.570]	-0.9992** [0.458]	-0.7097 [0.547]	-1.0724** [0.455]	-0.6692 [0.534]	-1.0735** [0.454]	-0.6567 [0.529]
Demeaned crop suitability X Post-emancipation	0.0570 [0.049]	0.0515 [0.052]	0.0214 [0.046]	0.0069 [0.053]	0.0339 [0.047]	0.0289 [0.051]	0.0435 [0.046]	0.0383 [0.049]	0.0532 [0.046]	0.0423 [0.051]	0.0418 [0.046]	0.0377 [0.049]	0.0452 [0.046]	0.0413 [0.049]	0.0369 [0.046]	0.0279 [0.052]	0.0482 [0.046]	0.0411 [0.051]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,678	1,678	1,717	1,717	1,720	1,720	1,717	1,717	1,720	1,720	1,716	1,716	1,719	1,719	1,717	1,717	1,715	1,715
R-squared	0.402	0.522	0.403	0.530	0.407	0.530	0.396	0.523	0.399	0.533	0.397	0.523	0.397	0.525	0.396	0.525	0.397	0.520
Panel B: First stages of the corresponding 2SLS panel regressions																		
	(2)	(4)	(6)	(8)	(10)	(12)	(14)	(16)	(18)									
Dependent var:	Share of serfs X Post-emancipation	Share of serfs X Post-emancipation	Share of serfs X Post-emancipation	Share of serfs X Post-emancipation	Share of serfs X Post-emancipation	Share of serfs X Post-emancipation	Share of serfs X Post-emancipation	Share of serfs X Post-emancipation	Share of serfs X Post-emancipation									
Model:	IV, 1st stage	IV, 1st stage	IV, 1st stage	IV, 1st stage	IV, 1st stage	IV, 1st stage	IV, 1st stage	IV, 1st stage	IV, 1st stage									
Share of nationalized monasterial serfs X Post-emancipation	-1.2080*** [0.288]	-1.1796*** [0.301]	-1.2500*** [0.303]	-1.1383*** [0.278]	-1.3851*** [0.312]	-1.1373*** [0.290]	-1.2178*** [0.299]	-1.2384*** [0.309]	-1.2552*** [0.315]									
Controls as in respective column of Panel A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes									
Observations	1,678	1,717	1,720	1,717	1,720	1,716	1,719	1,717	1,715									
F, monasterial serfs instrument	17.54	15.38	16.97	16.8	19.71	15.41	16.61	16.08	15.89									

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861. \*\*\* indicates p-value <0.01, \*\* p-value <0.05, \* p-value<0.1

Table A15. Placebo with ‘other’ years than the actual year of emancipation: the effect of the abolition of serfdom on agricultural productivity

Dependent var: Model:	(1) Grain yield OLS	(2) Grain yield OLS	(3) Grain yield OLS	(4) Grain yield OLS	(5) Grain yield OLS	(6) Grain yield OLS	(7) Grain yield OLS	(8) Grain yield OLS	(9) Grain yield OLS	(10) Grain yield OLS	(11) Grain yield OLS	(12) Grain yield OLS	(13) Grain yield OLS	(14) Grain yield OLS
Share of serfs X Post-1853	0.3677 [0.316]													
Share of serfs X Post-1858		0.6434* [0.344]												
Share of serfs X Post-1859			1.0323*** [0.311]											
Share of serfs X Post-1860				0.9562*** [0.287]										
Share of serfs X Post-emancipation (1861)					1.1623*** [0.343]									
Share of serfs X Post-1862						1.4342*** [0.325]								
Share of serfs X Post-1863							1.0171*** [0.337]							
Share of serfs X Post-1864								0.9098** [0.343]						
Share of serfs X Post-1865									0.5251 [0.359]					
Share of serfs X Post-1866										0.5702* [0.332]				
Share of serfs X Post-1867											0.4952* [0.264]			
Share of serfs X Post-1871												0.6549** [0.304]		
Share of serfs X Post-1872													0.6197* [0.310]	
Share of serfs X Post-1873														0.1809 [0.255]
Distance to Moscow and Crop suitability interactions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,777	1,777	1,777	1,777	1,777	1,777	1,777	1,777	1,777	1,777	1,777	1,777	1,777	1,777
R-squared	0.394	0.396	0.399	0.396	0.399	0.403	0.397	0.396	0.394	0.394	0.393	0.394	0.394	0.393

Table A16. Robustness to using WLS by province population: the effect of the abolition of serfdom on agricultural productivity, draftee's height and industrial output

	(1)	(2)	(3)
Dependent var:	Grain yield	Draftees' height (cohorts 1853-1866, 1875)	Ln (industrial output)
Model:	OLS	OLS	OLS
Share of serfs X Post-emancipation	0.9542*** [0.332]	0.8665*** [0.316]	1.7050*** [0.335]
Demeaned log distance to Moscow X Post-emancipation	-1.2497*** [0.461]	0.4225 [0.317]	0.0655 [0.427]
Demeaned crop suitability X Post-emancipation	-0.0023 [0.047]	0.1769*** [0.043]	0.0538 [0.072]
Year and province fixed effects	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes
State and royal peasant reforms	Yes	Yes	Yes
Observations	1,735	651	336
R-squared	0.549	0.920	0.951

Notes: Standard errors are clustered by province separately before and after 1861 emancipation reform.

\*\*\* indicates p-value <0.01, \*\* p-value <0.05, \* p-value <

Table A17. Robustness to using WLS by province population: the mechanisms behind the effects of the land reform and the emancipation

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent var:		Grain yield	Grain yield	Share of summer crops seeded at t in total winter and summer crops seeded at [t-1;t] production cycle		
	OLS	OLS	OLS	OLS	OLS	OLS
Share of serfs X Post-emancipation	1.1262** [0.430]	0.8951** [0.427]	2.1884*** [0.494]	-0.1546*** [0.046]	-0.0402 [0.024]	-0.2035*** [0.059]
Share of peasants with signed buyout contract	-0.5924** [0.256]	0.0240 [0.290]	-0.6747*** [0.243]			
Share of peasants with signed buyout contract X repartition commune		-0.8276** [0.328]				
Share of serfs X Post-emancipation X Implicit contracts			-2.2452*** [0.544]			
Temperature (t-1)				0.0080* [0.005]		0.0025 [0.005]
Share of serfs X Post-emancipation X Temperature (t-1)				0.0160*** [0.005]		0.0199*** [0.006]
Share of serfs X Post-emancipation X Summer-to-winter-rye-world-price ratio (t-1)					-0.4047*** [0.110]	-0.3580*** [0.111]
Demeaned log distance to Moscow X Post-emancipation	-0.9268* [0.517]	-1.2486** [0.543]	-0.9797** [0.470]	-0.0676** [0.027]	-0.0054 [0.023]	-0.0921*** [0.032]
Demeaned crop suitability X Post-emancipation	0.0030 [0.049]	-0.0212 [0.050]	-0.0073 [0.044]	0.0020 [0.003]	-0.0012 [0.003]	0.0029 [0.003]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,680	1,680	1,627	627	592	589
R-squared	0.553	0.554	0.563	0.928	0.927	0.932

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861.

\*\*\* indicates p-value <0.01, \*\* p-value <0.05, \* p-value<0.1

Table A18. Additional results: the effect of the abolition of serfdom on fertility and mortality

Panel A: Panel data estimation

Dependent var:	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	Fertility (births per capita) IV, 2nd stage	OLS	Mortality (deaths per capita) OLS	IV, 2nd stage	OLS
Share of serfs X Post-emancipation	0.0143*** [0.003]	0.0318*** [0.010]	0.0155** [0.006]	-0.0043 [0.003]	0.0038 [0.008]	-0.0049* [0.003]
Demeaned log distance to Moscow X Post-emancipation	0.0139*** [0.004]	0.0264*** [0.008]	0.0137*** [0.004]	-0.0063** [0.003]	-0.0006 [0.006]	-0.0062** [0.003]
Demeaned crop suitability X Post-emancipation	0.0004 [0.001]	0.0002 [0.001]	0.0005 [0.000]	0.0003 [0.001]	0.0002 [0.001]	0.0002 [0.001]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Region-specific trends	Yes	Yes	Yes	Yes	Yes	Yes
State and royal peasant reforms	No	No	Yes	No	No	Yes
Observations	540	540	540	540	540	540
R-squared	0.515	0.801	0.522	0.430	0.754	0.432

Panel B: First stages of the corresponding 2SLS panel regressions

Dependent var:	(2)	(4)
	Share of serfs X Post- emancipation IV, 1st stage	Share of serfs X Post- emancipation IV, 1st stage
Model:		
Share of nationalized monasterial serfs X Post-emancipation	-1.2429*** [0.321]	-1.2429*** [0.321]
Controls as in respective column of Panel A	Yes	Yes
Observations	540	540
F, monasterial serfs instrument	15.01	15.01

Notes: Standard errors are clustered by province separately before and after the 1861 emancipation reform. Post-emancipation is a dummy, which is switched on in 1861.

\*\*\* indicates p-value <0.01, \*\* p-value <0.05, \* p-value <0.1

Table A19. Counterfactual estimates of Russian economic development in the case of earlier abolition of serfdom, 1820-1913 (in 1990 USD)

	Agriculture	Industry	Service	All sectors
GDP per capita in 1820				688 <sup>(1)</sup>
1860 sectorial shares	59.3 <sup>(2)</sup>	5.1 <sup>(2)</sup>	35.6 <sup>(2)</sup>	
Value added in 1820	22,347 <sup>(3)</sup>	1,923 <sup>(3)</sup>	13,408 <sup>(3)</sup>	37,678 <sup>(4)</sup>
The multiplier effect due to the abolition of serfdom	1.16 <sup>(5)</sup>	1.48 <sup>(5)</sup>	1.18 <sup>(5)</sup>	
Counter-factual estimates of value added in 1820 (mln USD 1990)	25,810.4 <sup>(6)</sup>	2,846.5 <sup>(6)</sup>	15,831.3 <sup>(6)</sup>	44,488.3 <sup>(6)</sup>
Counter-factual estimates of GDP per capita in 1820				812 <sup>(7)</sup>
Counter-factual estimate of GDP per capita in 1913 (pessimistic scenario)				1,751 <sup>(8)</sup>
Counter-factual estimate of GDP per capita in 1913 (East-European scenario)				2,341 <sup>(9)</sup>
Counter-factual estimate of GDP per capita in 1913 (optimistic scenario)				2,164 <sup>(10)</sup>

Sources: (1) and (4) – Maddison (2007); (2) – estimated from Goldsmith (1961), see text on the previous page for details; (3) – estimated as (4) multiply by (2) and divide by a 100; (5) – authors’ estimates from this paper; (6) – estimated as (3) multiply by (5); (7) – estimated as (6) divided by Maddison (2007) estimate of Russian population in 1820; (8) – estimated as (7) multiplied by actual GDP per capita growth in 1820 – 1913 from Maddison (2007); (9) – estimated as (7) multiplied by average GDP per capita growth in 1820 – 1913 in the Eastern European countries abolished serfdom in the late 18<sup>th</sup> – early 19<sup>th</sup> centuries (Maddison 2007); (10) – estimated as (7) multiplied by actual GDP per capita growth in 1870 – 1913 from Maddison (2007).



Table A20. Growth rates of GDP per capita in the Eastern European countries that abolished serfdom in the late 18<sup>th</sup> – early 19<sup>th</sup> century

	1700-1820	1820-1870	1870-1913
Germany	0.001	0.011	0.016
Austria	0.002	0.008	0.014
Czechoslovakia	n.d.	0.006	0.014
Denmark	0.002	0.009	0.016

Source: Maddison (2007).