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**ECONOMIC EFFECTS OF THE ABOLITION  
OF SERFDOM: EVIDENCE FROM THE  
RUSSIAN EMPIRE**

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*DEVELOPMENT ECONOMICS and  
PUBLIC ECONOMICS*



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# ECONOMIC EFFECTS OF THE ABOLITION OF SERFDOM: EVIDENCE FROM THE RUSSIAN EMPIRE<sup>†</sup>

## Abstract

We document substantial increases in agricultural productivity, industrial output and peasants' nutrition in Imperial Russia as a result of the abolition of serfdom in 1861. Before the emancipation, provinces where serfs constituted the majority of agricultural laborers lagged behind provinces that primarily relied on free labor. The emancipation led to a significant but partial catch up. Better incentives of peasants resulting from the cessation of ratchet effect were a likely mechanism behind a relatively fast positive effect of reform on agricultural productivity. The land reform, which instituted communal land tenure after the emancipation, diminished growth in productivity in repartition communes.

JEL Classification: J3, N23, P4

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

By ANDREI MARKEVICH AND EKATERINA ZHURAVSKAYA\*

*We document substantial increases in agricultural productivity, industrial output and peasants' nutrition in Imperial Russia as a result of the abolition of serfdom in 1861. Before the emancipation, provinces where serfs constituted the majority of agricultural laborers lagged behind provinces that primarily relied on free labor. The emancipation led to a significant but partial catch up. Better incentives of peasants resulting from the cessation of ratchet effect were a likely mechanism behind a relatively fast positive effect of reform on agricultural productivity. The land reform, which instituted communal land tenure after the emancipation, diminished growth in productivity in repartition communes. (JEL: J3, N23, P4)*

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The effect of slavery and serfdom on economic efficiency and growth has been the subject of a long-lasting debate.<sup>1</sup> Despite many scholars who view 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 for why slave and landowners failed to provide efficient incentives to their workers.

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 the southern economy for generations (e.g., Fogel 1989; Atack and Passell 1994).<sup>2</sup> Slave labor in the US around mid-19th century was more efficient at producing cotton than free labor in the West Indies, Brazil, India, and Egypt (e.g., Fogel and Engerman 1974, Omstead and Rhode 2008).<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., Girard 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 1962, 1965, Moon 1996). The arguments on both sides of this debate were mostly backed by case study evidence.

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 substantial positive effects of the abolition of serfdom on agricultural productivity, industrial development and peasant nutrition in the 19th century Russian empire. Our estimates imply that Russia's GDP increased by about 17.7% as a result of the reform in the second half of the 19<sup>th</sup> century.

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

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<sup>1</sup> Serfdom is an institution of forced labor in agrarian economies; 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 19th century.

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

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

Russia's defeat in the Crimean War (1853-1856), involved two distinct stages: 1) the emancipation of serfs, which instantaneously granted personal freedom to all 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, the 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 twenty years following the emancipation.

After having stagnated at least since the beginning of the 19<sup>th</sup> century, agricultural productivity in Russia started to grow approximately at the time of the emancipation of serfs, as illustrated in Figure 1. Our goal is to test whether this change in the trend was causal and to measure the impact of the abolition of serfdom on agricultural productivity, industrial development and peasant living standards.<sup>5</sup> 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. For the two main outcomes—agricultural productivity and industrial output—we also control for province-specific trends, as due to Russia's vast size, different provinces had different climatic and soil conditions, and therefore, different development trajectories. We estimate the change in the provincial development trends at the time of the emancipation of serfs depending on the 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 endogeneity and mismeasurement concerns, we rely on exogenous cross-province variation in the distribution of serfs 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

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

<sup>5</sup> Contemporaries did not agree on whether the change in the trends was a result of the reform. On the one hand, the special government commission in 1872 concluded that: "*the positive consequences of the reform are more or less clear;*" on the other hand, intellectuals, such as Pyotr Struve, attributed the change in the trends to other factors, such as industrialization. Online appendix section A1 describes the sources of these contemporaries' quotes as well as the results of the survey of experts conducted in 1872 by the special government's commission evaluating the impact of the reform. The main results of this survey are summarized in Figure A1 in the online appendix.

differential incentives of landlords to push for land reform in collateralized and non-collateralized estates.

Serfs constituted 43% of all rural residents in European Russia in 1858. The formally free rural population consisted mainly 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>6</sup>

We find that provinces, where there were a lot of serfs before the emancipation, lagged behind those provinces, in which serfdom was not as prevalent, in terms of agricultural productivity, measured as the ratio of grain yield to seed (henceforth referred to as *grain productivity*). The abolition of serfdom caused a partial convergence in these two groups of provinces.

Difference-in-differences methodology allows estimating the difference in the effects between provinces with different initial level of serfdom and not the level of the effect for any of the provinces. Theoretically, it is possible that the reform had a negative effect on provinces that relied on free labor under serfdom because of an increase in competition for non-labor variable inputs after the emancipation from the provinces that initially relied on serf labor. Such a negative causal effect is, however, unlikely because inputs, other than labor and land, played a relatively minor role in agricultural production in the 19<sup>th</sup> century Russia.<sup>7</sup> Assuming that any observed fluctuations in agricultural productivity around the emancipation in provinces that relied on free labor were driven by a macro shock and were not related to the abolition of serfdom, we can interpret the difference-in-differences estimates as the effect on the level. Under this assumption, the abolition reform led to a 16% increase in grain productivity in the Russian empire, above the overall development trend. The magnitude of this effect is comparable to 38 years of aggregate development as grain productivity on average increased by 4% per decade in 19th century Russia.

The quantity of the data on agricultural productivity 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 reform on agricultural productivity is entirely due to the emancipation. Obtaining personal freedom by serfs boosted

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<sup>6</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.

<sup>7</sup> We do observe a slight fall in productivity in the first two decades after the emancipation in provinces that were in the first tercile of the distribution of the share of serfs. This fall could be due to such a negative general equilibrium effect of the reform or it could be due to an unfavorable external macro shock.

growth in productivity, whereas the land reform significantly slowed it down, cancelling out nearly one half of the overall effect.

We examine the mechanism behind these effects. Consistent with Gerschenkron's (1965) arguments, we show that the inefficiency of land reform was associated with the re-partition peasant commune, which undermined peasant incentives to invest in land. We also provide evidence consistent with the view that the change in peasants' incentives due to the loss of landlord's right to change the level of future obligations of peasants based on their previous performance, i.e., the cessation of the ratchet effect, was an important mechanism behind the relatively fast positive effect of the emancipation. The increase in agricultural productivity as a result of the emancipation occurred only in provinces (which constitute the majority) where landlords were unable to commit to long-term implicit contracts regulating the level of serfs' obligations, i.e., which suffered from the ratchet effect under serfdom. In addition, the production choices (i.e., which crops to seed, which to sell, and which to consume) became better adapted to climatic and market conditions following the emancipation in provinces with a larger share of serfs. These results are consistent with an increase in peasant effort post-emancipation and suggest that peasants' incentives played an important role in production and that the monitoring costs were too large for serf owners to ensure efficiency.

Further, we find a significant positive effect of the abolition of serfdom on industrial development. In all provinces industrial output grew throughout the 19<sup>th</sup> century. Assuming that industry was not affected by the abolition of serfdom in provinces, where labor was free to begin with, the difference-in-differences estimates yield that, in an average province, where 45% of rural population was comprised of serfs, the abolition of serfdom led to an additional increase in industrial output of 39% throughout the second half of the 19<sup>th</sup> century. This is a large effect, especially in the face of the communal system of land titles and post-emancipation mobility restrictions set by the peasant commune, which reduced migration to urban areas (Gerschenkron 1965).

Finally, we find suggestive evidence that the abolition of serfdom also increased nutrition of former serfs. In particular, the emancipation was associated with a larger increase in the height of draftees under the universal conscription from areas with larger pre-emancipation share of serfs. There are many potential unobserved confounds in any analysis that uses the height of draftees as a proxy for nutrition, such as differences in local implementation of draft rules, local exogenous shocks to food supply or local epidemics. Under the assumption that these confounds are not driving our results, the estimates imply

that the height of draftees from private estates was 0.78 centimeters higher on average for cohorts born after the emancipation compared to cohorts born before the emancipation. The magnitude of this effect is comparable to an increase in the height of young adult men per decade in the 19th century Western Europe (Hatton and Bray 2010).

The results proved to be robust to a battery of sensitivity tests. We test for and find no evidence of pre-trends in the analyses of grain productivity and industrial output. We also verify that our results are not 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 several potentially confounding factors 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 literature. 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) and Koval'chenko (1967) argued that serfdom was inefficient, in contrast to Hoch (1986), Moon (1996), Mironov (2010), Dennison (2006, 2011) and Stanziani (2014a, b) who portray serfdom as a dynamic institution that sustained a considerable rate of economic development.

The literature, prior to our paper, was based primarily on sporadic anecdotal evidence with the important exception of Nafziger (2013) and Buggle and Nafziger (2016), 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 Buggle and Nafziger (2016) suggest that serfdom had a negative effect on development overall and that the emancipation reversed a substantial part of this influence.<sup>8</sup> Our work is also related to the literature on land reforms

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<sup>8</sup> Buggle and Nafziger (2016) 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

and land property rights (e.g., Besley and Ghatak 2010, Deininger and Feder 2001, and Fenske 2011). We show that the introduction of communal land titles had a negative effect in contrast to many examples of growth-promoting land reforms (Lipton 2009).

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 describe a number of robustness checks. Section 8 concludes.

## I. Hypotheses

The effects of the abolition of serfdom on agricultural productivity, industrial development and peasants' wellbeing are *a priori* ambiguous. On the one hand, it is reasonable to expect the emancipation to alleviate incentive problems in agricultural production. The serfs' effort and their proceeds were largely unobservable to the landlord due to monitoring costs, which led to severe distortions in the serfs' effort. The lack of credible commitment on the part of landlords not to revise the size of peasants' obligations in the future must have reduced peasant effort as a consequence of the ratchet effect. Anecdotal evidence suggests that some landlords were able to credibly commit to follow rules that fixed the amount of the obligations of 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 their own human capital and land, both of which belonged to the landlord, in addition to the serfs' labor.

On the other hand, the use of coercion on forced labor under serfdom may have been a more effective enforcement mechanism to ensure effort on landlord farms compared to subsequent free labor relations (Acemoglu and Wolitzki 2010): the emancipation prohibited landlords to whip their former serfs—a common practice under serfdom—and that could have decreased productivity of landlord farms after the emancipation (e.g., Hoch 1986, Druzhinin 1966).<sup>9</sup>

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historical distribution of monasterial serfs for our instrumental variable strategy, but our identification assumptions are weaker due to the panel nature of the data we use, which allows controlling for province-specific trends. 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. (2017), Chernina et al. (2014), Castañeda Dower and Markevich (2017), Nafziger (2016).

<sup>9</sup> We describe qualitative historical evidence of the changes in the Russian countryside after the emancipation in the online appendix. It suggests that the emancipation brought about an increase in productivity on peasant farms and a decrease in productivity in landlord farms.

Thus, the extent to which the gentry could solve incentive 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. However, we expect most of these changes to be gradual. By contrast, the emancipation solved the ratchet effect problem right away by fixing the level of obligations for all (former) serfs. Yet, as the emancipation also prohibited landlords to whip their former serfs, the enforcement power of landlords on their own farms was also momentarily reduced.<sup>10</sup>

Incentive problems are just a part of the story. Serfdom could have had efficiency advantages compared to post-emancipation production because of the economies of scale, access to finance and to new technologies, the enforcement of social order, and the ability to smooth consumption during shocks; all of which most probably were better realized in the large estates of gentry compared to the small entrepreneurial farms of emancipated peasants (Moon 1996, Mironov 2010, Dennison 2006, 2011 and Stanziani 2014a and 2014b).

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 the 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 restricted the transfer rights over land and regulated major production decisions based on traditional practices, which could create distortions (Gerschenkron 1965, pp. 744-5). The so-called re-partition communes that were the dominant form of land use in most parts of the empire periodically redistributed land among households despite the perverse effect on incentives to invest in land.<sup>11</sup>

One could expect a positive effect of the abolition of serfdom on the development of industry. First, under serfdom, the ratchet effect problem also applied to the artisan (industrial) activities of serfs, as these activities were also subject to arbitrary levels of quitrent from the lords. The emancipation eliminated this problem for the industrial production of serfs as much as for their agricultural production. Second, personal freedom given to serfs by the emancipation reform also could have increased mobility from rural to urban areas, where productivity and wages were higher. However, migration to cities was limited by the communal land titles, passport system regulated by the commune, and mutual

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<sup>11</sup> Gerschenkron (1965) wrote about the re-partition communes that "*in Russian reality, the general shortcoming of the strip system were further aggravated by the temporary character of land use and the strong disincentive to improve a piece of land that sooner or later was to be transferred to another household.*" (p.747). A recent literature studies the implementation of these legal constraints and their effect on Russian agriculture (Castaneda Dower and Markevich 2017, Chernina et. al. 2014, Gregory 1980, Nafziger 2010, 2016).

tax responsibility within the commune, which should have slowed down industrial development (Gerschenkron 1965).

Similarly, it is also not clear whether one should expect peasant nutrition to be affected by the emancipation. If the emancipation led to higher productivity of former serfs, productivity improvements could translate into higher consumption. In addition, peasants may have also had lower incentives to feed children under serfdom, as peasants' children belonged to the gentry. Yet, serfs were the most valuable input into production for gentry and, therefore, rational landlords should have made sure that their serfs were well fed. However, the asymmetry of information may have led to the malnutrition of serfs in equilibrium due to an excessively high level of peasant obligations arising from the concern of gentry that peasants hid the proceeds of their production.

## II. 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 (Svod ... 1857, vol. 9, articles 208, 1027, 1029, 1037, 1047, 1048, 1068).<sup>12</sup>

Our sample covers the European part of the Russian Empire (excluding the Kingdom of Poland and the Great Duchy of Finland), which was the home of about 80% of the total population of the empire (see the map on Figure 2). 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*

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<sup>12</sup> The state sometimes intervened in cases of starvation and torture of serfs. The law also limited sales of serfs without land (Svod ... 1857, vol. 9 208, 1045, 1080-1084, 1102-1106, 1109-1113).

can be considered (relative to serfs) as formally free peasants subjected to fixed taxation and land-lease rules.<sup>13</sup>

The composition of the rural population and, in particular, the shares of serfs vs. all other groups of peasants who were formally free, substantially varied across provinces while being relatively stable over time in the last 60 years of serfdom.<sup>14</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.<sup>15</sup> Figure 3 presents the spatial distribution of serfs across provinces in 1858.<sup>16</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 ownership.<sup>17</sup>

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

Discussions of a potential emancipation reform within the Russian empire began in the late 18<sup>th</sup> century – early 19<sup>th</sup> century (Dolgikh 2006). 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.<sup>18</sup>

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<sup>13</sup> We describe the legal status of each of the non-serf groups of peasants in more detail in the online appendix (see section A2). In terms of the severity of the individual constraints on members of each of these groups, the free agricultural workers were the less constrained compared to state peasants and royal peasants, who, in turn, were much freer than serfs.

<sup>14</sup> There were no conversions of state or royal peasants or free rural population into serfs after the reign of Pavel I (1796-1801). The only major change in the respective shares of serfs and non-serf rural population took place in 1816-1819 when serfs in the Baltic provinces were emancipated and became free landless agricultural workers. The law of 1803 introduced a right of landlords to free their own serfs. Only about 100,000 male serfs (i.e., less than 0.5% of rural male population) were freed between 1803 and 1858 under this law (Veshnyakov 1858).

<sup>15</sup> See online appendix section A3 for details.

<sup>16</sup> Figure A2 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). Figure A3 in the online appendix presents the spatial distributions of state peasants (Panel A) and free agricultural workers (Panel B).

<sup>17</sup> The nationalization reform of 1764 affected only monasteries in the central provinces of the European Russia. In 1786 and 1788, monasterial lands were nationalized in Ukrainian and Southern provinces. The confiscations of the lands belonging to the Catholic Church took place in the late 18<sup>th</sup> – the first half of the 19<sup>th</sup> century. We describe the historical details of the nationalizations of the church lands in the online appendix section A4.

<sup>18</sup> See online appendix section A5 for details.

The Manifesto of February 1861 (and related laws) granted personal freedom to former serfs instantaneously and free of charge and outlined the rules of the subsequent land reform (Polnoe ... 1863, vol. 36, part 1). Landlords lost the right to change the level of peasant obligations, to sell, buy, lease, punish, or imprison peasants.<sup>19</sup> Emancipated serfs had an obligation 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 a quitrent or labor obligation of the landlord farm) for the use of land by peasants until the transfer of property rights and abolished all other peasant obligations to landlords. About 50% of the regulatory charters were signed as a result of a mutual agreement between peasants and landlords. In the absence of an agreement, local officials imposed the terms of a fallback regulatory charter. On estates where landlords did not change the level of peasant obligations during serfdom, i.e., where landlords were able to commit to an implicit long-term contract with peasants, these agreements were usually easier to reach, as they formalized the previously existing implicit contract. Peasants were less likely to agree with the terms of proposed regulatory charter if the terms were worse than those under serfdom (Litvak 1972; Zajchkovskij 1968). Other factors, such as the attitude and skills of local officials, who arbitrated signing the regulatory charters, could also have affected chances to reach an agreement. However, in practice, the central government closely controlled the procedure and established an independent institution of local arbitrators, who secured relatively homogeneous implementation of the reform (we provide further details in the online appendix).

80% of the land value specified in the buyout contract was financed by the state in the form of a 49-year state loan to peasants, who had to pay back a fixed redemption amount annually. The time period for signature of the buyout contract ranged from 1862 to 1882. In

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<sup>19</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 (Polnoe ... 1863, vol. 36, part 1).

western provinces, the land buyouts were completed by 1863 as a political measure following the Polish rebellion against the empire. In the 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 (Polnoe ... 1885, vol. 1; Zajonchkovskij 1968). 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 deducted landlord's debts from the buyout amount and collected the payments, which the landlord otherwise would have gotten from the peasants for the land, 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 signing of the buyout contract.<sup>20</sup>

### III. Data

We combine various published and archival sources to construct a unique province-level panel dataset on the development of 46 European provinces of the Russian Empire in the 19<sup>th</sup> century.<sup>21</sup> Table 1 reports descriptive statistics and Table A1 in the online appendix provides the data sources and lists the years for which the data are available 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. Grain productivity is widely used as a proxy for productivity in agriculture in Russia before the late-19<sup>th</sup> century as well as in medieval and early modern Europe. Data on grain productivity 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>22</sup> The methodologies of the data collection were different before and after 1883, but the same within each of these periods

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<sup>20</sup> We describe the details of the land reform and the determinants of gentry's indebtedness in the online appendix sections A6 and A7, respectively.

<sup>21</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 sensitivity section.

<sup>22</sup> For governor reports, we rely on the secondary published sources based on original archival documents.

irrespective of prevalence of serfdom in a province.<sup>23</sup> The quality of the late imperial statistics and governor reports is rather high (Koval'chenko 1979; Nifontov 1974 pp. 35-46).<sup>24</sup>

Industrial development is measured by log industrial output in constant rubles of 1895.<sup>25</sup> These data also come from the governor reports and official statistical volumes published by the Central Statistical Committee.

The nutrition of peasants is proxied by the average height of 21-year-old draftees by birth cohort and province or sub-province (district) of residence; we calculate it from the data on the number of draftees in each of the nine height categories, reported by the Ministry of Defense of the Russian Empire. These measurements were collected for conscripts drafted between 1874 and 1887 after the universal conscription was introduced by the 1874 military reform. Rural citizens were the main source of draftees for the army (Beskrovnnii 1973). Draftees were chosen at random through an official lottery from the pool of all eligible 21-year-old men. This pool differed from the population of all 21-year-old men because of a number of exceptions based on family status, health, and anthropometric characteristics. Eligibility rules were the same across administrative units in each given year but varied slightly over-time. The minimum height requirement of 153.35 centimeters was constant but the required minimum chest size (expressed in relative chest-to-height terms) changed in 1882, 1883 and 1885. We use available disaggregated data on height and chest size of draftees from Bobruisk district (available from Gorskij 1910) to estimate the share of men, who got the exemption from service because of their chest size, in each height category by cohort and province (district). Then, we use these estimates to correct for a possible selection bias introduced by the changes in eligibility rules in each height category in the data reported by the Ministry of Defense. Importantly, as we show below, this correction did not have any

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<sup>23</sup> Governor reports provide only aggregated figures on all cereals before 1883. We aggregate data on rye, oat, wheat, barley, and buckwheat for the post-1883 period by summing up yields and seeds of these crops and taking a ratio of the sums to construct comparable measures. In Section 7 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. We provide further details in online appendix section A9 (on the methodology of data collection in the Russia empire) and section B (on the variables used in the paper).

<sup>24</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. Fortunatov (1893) compared data on yields from governors' reports with the figures from individual estate archives and concluded that they are very similar (see online appendix section A9 for details).

<sup>25</sup> We use the Mironov (2010) index for Saint Petersburg to deflate industrial output reported in current rubles in the original sources. There are no deflation indexes for other regions; we check that our results are robust to deflation by regional rye prices taken from Mironov (1985). Table A16 of the online appendix presents the results.

impact on the estimates of the differential effect of the emancipation on provinces with high and low share of serfs, even though it did affect the average height of draftees. (Section A11 of the online appendix provides detailed description of military draft rules, the possible biases created by the eligibility rules, and the correction procedure that we employ).

All three outcomes are available at the province level.<sup>26</sup> In addition, height data are available at district level with 447 districts in the baseline sample. Different numbers of snapshots over time are available for different outcomes. The largest number of over-time observations, 43, is available for grain productivity. The number of cross-sections for the industrial output is 8. The number of cohorts with data on height is 14 at the province level; these are data covering all cohorts born between 1853 and 1866. At the district level, height data are available for 10 cohorts born between 1853 and 1862.

There are time gaps in the data for agricultural productivity and industrial output. We examined whether the years for which the data are available systematically differ from those years when the data are missing and find no systematic differences; we also found no change in this pattern between before and after the abolition of serfdom.<sup>27</sup> Occasionally, data on grain productivity and industrial output for some provinces are missing in the historical sources; thus, the resulting panels for these outcomes are unbalanced.

*The main explanatory variables.*—We use cross-sectional data on the prevalence of serfdom across provinces and across districts before the emancipation. The data on the composition of the 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>28</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 total population in 1858 from Bushen (1863).

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<sup>26</sup> For height, our sample consists of 42 provinces because we exclude Don, Orenburg, Astrakhan, and Arkhangelsk for the following reasons. Data on height of draftees exclude Cossacks, who were a sizable share of the population in Don and Orenburg provinces. Local minorities present in Astrakhan and Arkhangelsk provinces in fairly large numbers were excluded from the military conscription. See section A11 of the online appendix for further details on the rules of draft and height data.

<sup>27</sup> Table A2 in the online appendix presents the results: in a time series setting, we regress dummies for whether our outcome variables are available for the de-trended average of Russia's grain productivity by year and its interaction with the post-emancipation dummy for the entire 19<sup>th</sup> century.

<sup>28</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-servants*. The number of state peasants in a province is the sum of *state peasants* and *military dwellers*. We consider the following groups as making up the rural population: *serfs*, *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*, *rural raznochintzi*, *foreigners in rural areas*, *non-Russians in rural areas*. Taken together, the latter nine 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 section 7 below for details).

We measure land reform implementation across provinces and over time with a proxy for the share of serfs who signed buyout contracts among the total rural population in each province and year. To construct this variable, we use two data sources: 1) the redemption payment statistics, which report the sums that peasants paid to the state for the loan annually by province. These data are available for all provinces and years up to (and including) 1876 and 2) the 1877 cross-section of the number of peasants who had signed buyout contracts by that time (Vilson 1878). First, we extrapolate the redemption payment statistics for each province for 1877, using a linear projection from 1870-1876 province specific figures (after verifying that the redemption payments grew linearly in each province between 1870 and 1876). Then, we calculate the redemption payments per peasant in 1877 by dividing our estimate of redemption payments in 1877 by the number of peasants who signed buyout contracts in 1877. As a next step, we construct the share of serfs who signed buyout contracts each year in each province between 1862-1877 using redemption payment statistics and assuming constant redemption payments per peasant across estates and over time within each province. Finally, 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 (Polnoe ... 1885, vol. 1), we set the share of serfs who signed buyout contracts among the total rural population to be equal to the total share of former serfs from 1882 onwards.<sup>29</sup> In the nine westernmost provinces—Kovno, Vilno, Grodno, Minsk, 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 share of serfs that belonged to monasteries and clergy before their nationalization (most of which took place in 1764) as an instrument for the prevalence of serfdom across provinces and districts in 1858. Henceforth, we refer to serfs that belonged to monasteries and clergy before the nationalization of church lands as monasterial serfs. These data come from Beskrovnii et al. (1972).<sup>30</sup> We also use data on the gentry's debts to a state bank and other state financial institutions, which accepted deposits and provided credit, before the emancipation from Skrebitskii (1862-1866) to construct an instrument for the

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<sup>29</sup> We provide the exact formula for the land reform implementation variable in the online appendix section B. The actual figures for the implementation of the land reform are available for a number of provinces in 1870 (Obruchev 1871). The coefficient of correlation between our proxy for the land reform implementation and these numbers is 0.94.

<sup>30</sup> Beskrovnii et al. (1972) gives information about the number of (former) monasterial serfs per district at two points in time, 1796 and 1814. We take an average of the shares of monasterial serfs for the two periods. Details on the construction of this variable are presented in the online appendix section B.

implementation of the land reform between 1862 and 1882 (we describe this instrument in the methodology section below). Henceforth, we refer to all the state financial institutions as state banks (historical details about gentry's debts are provided in the online appendix section A7).

*Additional data.*—We rely on FAO GAEZ data and the digital map the Russian Empire to construct land suitability for grain cultivation by province and district using the median value for the respective polygon and the weather station data from the Global Land Surface Databank (Rennie et. al., 2014) to construct the series of annual mean temperatures 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 the digitized map of the Russian empire (Kessler and Markevich 2015). 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.<sup>31</sup> The share of serfs who agreed to sign regulatory charters in a province (our proxy for the prevalence of implicit contracts under serfdom) comes from Vilson (1878). The data on the composition of winter and spring grains are from the same sources as grain productivity, but they are available only for eighteen points in time. To measure the relative price of winter to spring crops we use: 1) the time series of the relative price of rye (the main winter crop) to wheat in the Netherlands goods exchange available from van Reil (2016) and 2) the panel data on the regional relative price of rye to oats in Russia from Mironov (1985).

#### IV. Empirical methodology

We use cross-province variation in the share serfs to estimate the effect of the abolition of serfdom on the considered outcomes. For agricultural productivity and industrial development, our main specification is as follows:

$$Y_{it} = \alpha \text{ShareSerfs}_i \times \text{PostEmancipation}_t + \mathbf{X}_{it}'\gamma + \psi_i + \Theta_t + t\delta_i + \varepsilon_{it}, \quad (1)$$

Subscripts  $i$  and  $t$  index provinces and time periods. Time periods are either years or a series of consecutive years, e.g., decades, depending on data availability for a particular outcome.  $Y$  denotes grain productivity (yield/seed ratio) or log(industrial output) in province  $i$  at time  $t$ .

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<sup>31</sup> Note that not all re-partition communes, which had the legal right to redistribute the land across households, actually did this; and there are some anecdotes of redistribution of land across households in the hereditary communes (e.g., Dubrovsky 1963). As there are no systematic data on actual redistributions of land, we rely on the legal distinction between the re-partition and hereditary communes, as the first approximation to the actual practices.

*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., this dummy switches on in 1861 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 for 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 ( $t\delta_i$ ) in the case of grain productivity and 14 region-specific trends in the case of industrial output. (The time dimension of the data for industrial output is insufficient to control for linear trends for each province.) To account for the correlations between the share of serfs with the distance from Moscow and soil quality, we control for the interactions between the post-emancipation dummy and log distance from Moscow and land suitability, minus their respective sample means; these variables are denoted by  $\mathbf{X}_{it}$ .<sup>32</sup>

To ensure that our results are not driven by the two main potentially confounding reforms, we adjust specification by including controls for the state peasants' and royal peasants' reforms into the OLS panel regressions: we add the interactions of the shares of these groups in provincial rural populations with post-1866 and post-1859 dummies, respectively.<sup>33</sup>

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). We test this for each outcome by replacing the interaction between the share of serfs (*ShareSerfs<sub>i</sub>*) with the post-emancipation dummy by a series of interactions of *ShareSerfs<sub>i</sub>* with a number of dummies indicating different pre-reform and post-reform time periods.

To study the effect of the emancipation on nutrition, we also use a difference-in-differences methodology, but with one important difference compared to the analysis which uses grain productivity or industrial output as outcomes: we do not observe height of draftees

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<sup>32</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 from Moscow and land suitability.

<sup>33</sup> To be precise, the post-1866 dummy switches on in 1866 and post-1859 switches on in 1859.

before the reform. All cohorts for which height data are available had been affected by the emancipation, but to a different extent. The draftees from the oldest cohort in our data were eight years old at the time of emancipation and draftees from the youngest cohorts were born five years after the emancipation. If emancipation affected nutrition and nutrition throughout childhood affected height of young adults, one should observe the differential trends in the average height of draftees in provinces with different shares of serfs, as younger cohorts spend a larger share of their childhood after the emancipation. Importantly, nutrition of the pregnant mother and of an infant in the first few years of life are particularly important for the height of an adult (Costa 2015), therefore, one should also expect the largest differences in height between cohorts born right before and right after the emancipation in provinces where serfdom was prevalent.

To account for the fact that the differential trends are an important part of the main effect in the case of height, we estimate the following equation:

$$H_{ic} = \sum \alpha_c \times ShareSerfs_i \times D_c + \mathbf{X}_{ic}'\gamma + \psi_i + \sigma_c + \varepsilon_{ic}, \quad (2)$$

where  $H$  stands for the average height of draftees,  $c$  indexes cohorts and  $i$  indices either provinces or districts.  $D_c$  denotes dummies for the pairs of consecutive cohorts. A series of coefficients  $\alpha_c$  estimates the dynamics of the effect of the emancipation on height. We expect a gradual increase in  $\alpha_c$  coefficients both before and after the emancipation. We also estimate an additional specification, in which we replace the series of interactions between the share of serfs ( $ShareSerfs_i$ ) and cohort dummies  $D_c$  with a single interaction between the share of serfs and a dummy for cohorts born after the emancipation. On average, we expect an increase in height to be bigger between cohorts born after the emancipation compared to cohorts born before the emancipation in provinces with a large pre-emancipation share of serfs than in provinces with a small share of serfs because in provinces with a larger share of serfs larger shares of draftees from cohorts born before the emancipation had a part of their childhood under serfdom.<sup>34</sup>

We follow Bertrand, Duflo, and Mullainathan (2004) and cluster error terms within each province separately before and after the emancipation of 1861 in panel specifications for all three outcomes. 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 3. To

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<sup>34</sup> We cannot control for the reforms affecting state and royal peasants in the case of height, because we do not have enough cross-sections for the period after the state peasants land reform (one in the province-level dataset and zero in district-level dataset). In addition, data on state and royal peasants are not available at district level.

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 for all outcomes, and in the case of grain productivity on province-specific linear trends and in the case of industrial output on region-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 the average growth in each outcome between post- and pre-emancipation periods and regress these variables on the share of serfs controlling for log distance from Moscow and land suitability, correcting for spatial correlation of errors (Conley 1999, 2008). We allow for correlation across space within a radius of 900 kilometers, the distance, equal to about one third of the West-East and North-South dimensions of the territory for which we have data (it is sufficiently large to account for any existing spatial correlation).<sup>35</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 the OLS estimation of equation 1. Although we deem the existence of such factors to be unlikely, they are not impossible given the change in the geo-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 the rural population that belonged to the church across provinces and districts 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 (Semevskij 1906) and, therefore, peasants who lived on these lands were less likely to become private serfs after the nationalization of church property. Figure 4 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 at the province level; it presents the conditional scatter plot between the share of former monasterial serfs (which is denoted by *MonastShare<sub>i</sub>*) and the share of

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<sup>35</sup> We verify that the results are robust to setting different thresholds for spatial correlation (unreported for conciseness). 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.

serfs in 1858 conditional on log distance from Moscow and land suitability across provinces.<sup>36</sup>

We instrument  $ShareSerfs_i \times PostEmancipation_t$  with  $MonastShare_i \times PostEmancipation_t$ . 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 from Moscow. Monasteries accumulated the vast majority their land before the institution of serfdom (Vodarskii 1988). With serfdom, peasants living on monasterial lands became monasterial serfs. As described in the online appendix section A4, before their nationalization, monasterial serfs did not differ systematically from other private serfs (e.g., Zakharova 1982).

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 share of former serfs who signed buyout contracts in the rural population in a particular year. This exercise can only be done for grain productivity because of the high frequency of the data for this outcome. As the land reform implementation was endogenous, to estimate the causal effect of land reform we instrument the share of peasants (former serfs) who signed buyout contracts in this province up to this year among the provincial rural population 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 signature of buyout contract immediately after the emancipation in 1862; 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 because lease payments were higher than the interest on loans.<sup>37</sup> Thus, we construct the IV for the land reform as an interpolation between (1-indebtedness) and 1 in the interval 1862-1882, 0 before 1862, 1 after 1882. We measure indebtedness as the ratio of serfs in the province used as collateral in landlords' debt contracts in 1858 to the total rural population in the province. 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.

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<sup>36</sup> Similarly, Figure A4 in the online appendix illustrates the negative relationship between the share of serfs in 1858 and the share of nationalized monasterial serfs 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 as it restricts the sample to districts with the share of monasterial serfs below 30%.

<sup>37</sup> See online appendix section A7 for details.

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 5 the cross-sectional association between the share of peasants who signed buyout contracts and the predicted land reform progress in 1872. The results of the first stage estimations are presented in the next section alongside the results of the second stage. Historical sources suggest that this instrument is excludable because the primary reason to obtain loans for the gentry was status consumption rather than productive investments, and the primary reason for the state banks to grant loans was political (Gur'ev 1904; Korf 1906; Borovoj 1958). We describe in detail the historical evidence in favor of the excludability of this instrument in online appendix section A7. A quote from the government's committee on gentry's loans concluded in 1856 that "*the amount of loans in a province did not depend on its economic prospects*" (cited in Borovoj 1958 p. 204). The number of landlords who used loans to invest in their farms was negligible (Borovoj 1958). For example, only 1 percent of 8.5 thousand landlords in Ryazan and Tambov provinces invested in "modernization" of their estates and only a small subset of them used loans (Kovalchenko 1959). These two provinces were from the region specializing on grain production, where landlords predominantly chose to run their own farms on corvee. To corroborate this anecdotal evidence, Figure A5 in the online appendix shows that the gentry's indebtedness in 1858 was uncorrelated with either the level of grain productivity in 1858, or the change in grain productivity between 1858 and 1853, or the size of landlords' farms (measured by the number of peasants on corvee) in a province.

## V. Main results: The effects of the abolition of serfdom

### B. 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 substantial positive effect of the abolition of serfdom on grain productivity. 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 from Moscow and crop suitability interacted with post-emancipation 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. 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 dummy with F-statistic above 18. In column 4, to the OLS specification we add controls for the reforms for state and royal peasants: the shares of state and royal peasants interacted with the onset of their respective reforms.<sup>38</sup> In column 5, we estimate the effect separately for the first decade after the 1861 reform and for the remainder of the 19<sup>th</sup> century.

In all specifications we find positive and statistically significant estimates of the effect of the abolition of serfdom, estimated by the coefficient on the interaction term between the share of serfs and post-emancipation dummies. The magnitude of the coefficient of interest is somewhat larger in the IV specification compared to the OLS specifications, although the point estimates of the OLS specifications are well within the confidence interval for the IV point estimate. This difference in magnitude is probably due to an inherent measurement error bias in OLS estimates, as we measure the prevalence of serfdom at one point in time, in 1858, whereas the share of (former) serfs year-to-year differs, for example, as a result of idiosyncratic shocks to mortality due to infectious diseases. The difference in the magnitudes of the coefficients presented in column 5 suggests that three quarters of the overall effect on grain productivity for the 19<sup>th</sup> century was realized in the first decade after the emancipation. These results provide only a partial support for the claims of historians that the realization of the positive effects of the emancipation was very slow because of the slow institutional adjustments and associated transaction costs (Gerschenkron 1965, Nifontov 1974). In Panel C of Table 2, we report cross-sectional results with standard errors corrected for spatial correlation. Column 1 presents results for the full sample of 46 provinces and column 2 for a sub-sample excluding the most influential observations. Again, we find a strong and significant correlation between the change in de-trended grain productivity between the 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>39</sup>

The difference-in-differences estimates show the average change in the difference in trends between provinces with large and small pre-emancipation share of serfs as a result of the emancipation and are not informative of the absolute level of the change in the trend in

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<sup>38</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 the post-1866 dummy because this control is highly correlated with the interaction of the share of state peasants with the post-1861 dummy, predicted by the instrument.

<sup>39</sup> Influential observations are defined as having an absolute value of DFBeta greater or equal to 0.3. Figure A6 in the online appendix illustrates the cross-sectional relationship by presenting a conditional scatterplot on the full sample with an indication of DFBeta for each observation.

either group of provinces. In Figure 6, we present the summary of raw data around emancipation to shed light on the changes in absolute levels of grain productivity that gave rise to our estimates. The figure portrays the level of grain productivity around the emancipation (smoothed by taking averages by decade) separately in three subsamples defined by terciles of the pre-emancipation shares of serfs. In the first tercile, the share of serfs ranges from 0.08% to 40.3% with the mean of 17%, in the second tercile, it is between 41.2% and 57.2% with the mean of 50%; and in the third tercile, the range of the share of serfs is from 59.5% to 83.3% with the mean of 69%.

Several facts, important for the interpretation of the results, become apparent from this figure. First, before the emancipation, provinces with a larger share of serfs lagged behind provinces with a smaller share of serfs in terms of grain productivity. This gap partially closed with the emancipation. Second, productivity rose in provinces in the second and third terciles after the emancipation. In contrast, the productivity in provinces of the first tercile fell during the first two decades after the emancipation and recovered in the third decade. This fall could be a result of confounding negative macro shocks (for instance, climate shocks), which, in provinces that had a lot of serfs, were offset by the positive dynamics as a result of the reform. It also could be due to a general-equilibrium negative causal effect of the emancipation on provinces that relied on free labor in agriculture before the emancipation. It is possible that an increase in productivity in the high-serfdom provinces as a result of the emancipation led to an increase in the demand for variable non-labor production inputs, such as fertilizers or agricultural machines, which could have led to an increase in the price of these inputs. Such an increase in input prices, in turn, could have had a negative effect on the productivity in the provinces, which were more productive to start with. One should note, however, that non-labor non-land inputs played a minor role in agricultural production at that time, so it is unlikely that the changes in prices of these inputs had a big effect on productivity.

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 the comparison group).<sup>40</sup> In 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-

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<sup>40</sup> We use a decade dummy for the 1840s rather than two five-years dummies because of data availability.

specific trends, each of which groups together several provinces that are commonly considered to have similar development trajectories.<sup>41</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 7 visually represents the results by plotting the coefficients on these interactions along with their 90% confidence intervals by time period.<sup>42</sup> The results indicate the absence of pre-trends, as there are no significant effects before the emancipation reform.<sup>43</sup> The figure also illustrates how the magnitude of the effect evolved over time. The effect during the immediate aftermath of the emancipation is positive, but not statistically significant. Grain productivity in the provinces with emancipated serfs rose continuously (relative to the dynamics of grain productivity in provinces with free labor) throughout the 1870s. After 1881, the difference between provinces with high and low share of serfs became substantially smaller (but coefficients remain positive and jointly statistically significant). Below, after the discussion of the magnitude of the effect, we investigate the reason for this partial setback.

To present the magnitude, we rely on the estimate from column 3 of Panel A, which – unlike the raw data presented in Figure 6 – factors out province-specific trends and differences in productivity due to distance from Moscow and land suitability and uses IV. An increase in the share of serfs from 17% to 69% (i.e., the mean values in the bottom and top terciles, equivalent to an increase of 2 standard deviations of the share of serfs) led to an additional increase in grain productivity after the emancipation of 0.67 above the trend or an increase of 19.2% from the mean 1858 level.<sup>44</sup>

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<sup>41</sup> We provide the precise lists of the regions and of the provinces they are comprised of in the online appendix section B.

<sup>42</sup> Column 1 of Table A3 in the online appendix presents the entire regression output.

<sup>43</sup> Grain productivity insignificantly decreased in provinces with a large share of serfs right before the emancipation compared to 1840s or the comparison years, 1795-1829. This could possibly be due to disorganization in an anticipation of the reform.

<sup>44</sup> The coefficient on the distance from Moscow interacted with post-emancipation dummy is negative and in some specifications significant, thus the described magnitudes refer to provinces with the mean log distance from Moscow. Table A4 in the online appendix reports the results of a regression in which we replace the distance from Moscow interacted with the post-emancipation dummy by the triple interaction between the share of serfs, the distance from Moscow, and the post-emancipation dummy. (The interaction of the distance from Moscow with the post-emancipation dummy is excluded from this specification because of multicollinearity with this triple interaction term due to high correlation between the share of serfs and distance from Moscow.) The point estimate of the coefficient on the triple interaction term is negative and statistically significant at the 10% level, suggesting that the closer the province to Moscow, the larger the effect of the abolition of serfdom. This is not surprising, as the proximity to Moscow also meant proximity to the largest markets and to market infrastructure. The magnitude of the estimated coefficients implies that in the most remote provinces of our sample, the effect of the abolition of serfdom was positive, but much smaller than the average. We also check that our results are not driven by productivity in regions where agriculture played a relatively limited role by

These are large effects, as compared to the aggregate trend in grain productivity, which, on average, increased by 4% per decade in the 19th century. However, these effects are relatively small compared to the level of volatility in the economy.<sup>45</sup>

In columns 6 and 7 of Table 2, we attempt to disentangle the effects of the two components of the abolition of serfdom on agricultural productivity: the emancipation itself and the subsequent land reform. In particular, we add our proxy for 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 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, and the coefficient on the share of peasants who signed buyouts contracts estimates the effect of the land reform. Column 6 presents OLS estimates and column 7 – 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 linear interpolation between (1-indebtedness) at the beginning of the land reform (in 1862) and one at the end of the land reform (in 1882). Panel B presents the results of the first stage regressions below the second stage: both instruments are strong predictors of the respective endogenous regressors (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 emancipation on productivity in agriculture is positive and statistically significant. The effect of the land reform is negative in OLS and IV specifications, but it is statistically significant only in IV. The IV point estimates are much larger in magnitude, 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 2.1 as large as the total overall effect of the abolition of serfdom (column 7 vs. column 3).

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reproducing panel regressions on grain productivity with weights by the logarithm of grain output. Table A5 in the online appendix presents the results. The point estimates are very similar to unweighted regressions. A smaller number of observations in Table A5 is due to the fact that for several years we have data only on the yield-to-seed ratio, and not on the yield output.

<sup>45</sup> As shown in Figure 1, productivity jumped up and down by about 1 point from one year to the next. This volatility may explain why there is no vivid jump in productivity in the first decade following the emancipation in Figure 1, which is evident from Figure 7. As we argue above, difference-in-differences methodology allows drawing inference only about the difference in the effects of the reform in provinces with high and low prevalence of serfdom and not about the level of the effect in either of these groups of provinces, which theoretically could be negative in provinces that always relied on free labor. Such possible negative effect may also be a reason why one does not see a jump on Figure 1 during the first decade after the emancipation.

IV estimates imply that the emancipation without the inefficiencies of the land reform would have led to an additional increase in grain productivity in the second half of 19<sup>th</sup> century of 1.44 points (41% of mean 1858 level) in the provinces in the bottom compared to the top tercile of the share of serfs. However, the land reform reduced this difference by 0.62 points (column 7). Thus, IV estimates imply that the land reform substantially slowed down post-emancipation-growth in agricultural productivity among provinces that relied on serfs labor pre-emancipation: only 56.5% of the emancipation reform's potential was realized due to inefficiencies of the land reform.<sup>46</sup> Importantly, these IV estimates are valid only if the assumption of the excludability of the synthetic indebtedness instrument for the land reform is valid. We provide anecdotal evidence in the online appendix in support of this assumption, but it cannot be verified directly.

*The mechanisms.*—Gerschenkron (1965) has argued that the land reform negatively affected Russian agricultural development by empowering the peasant re-partition commune, where land was redistributed among households, in contrast to the hereditary commune in which households had perpetual usage rights of specific land plots. 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 the re-partition commune to the specification, presented in column 6 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. The effect of the land reform in the hereditary commune is positive albeit not statistically significant and the effect of the land reform in the re-partition commune is negative and significant. The difference between the effects of the land reform in provinces with the two types of communes is estimated by the coefficient on the interaction between the share of peasants with signed buyout contracts and the re-partition commune dummy). We run an OLS specification only because we do not 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. If taken at face value, these results suggest

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<sup>46</sup> The 56.5% figure comes from the following calculation using point estimates presented in column 7 of Table 2:  $(2.76 - 1.20) / 2.76$ .

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.

What was the mechanism behind the positive effect of the emancipation reform? As we have shown above, three quarters of the overall effect of the abolition of serfdom on grain productivity were realized during the first decade after the emancipation. This may seem puzzling because the reform implementation took time and many aspects of the reform, once implemented, arguably are expected to have a sluggish effect on agricultural productivity. For example, an increase in human capital investment (as a result 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) 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 the acquisition of agricultural machinery) and because of new technologies (i.e., a shift to more productive seed varieties).<sup>47</sup> These changes also could not have happened fast.

One important change that did occur right after the emancipation was the cessation of the ratchet effect, as the law fixed the level of peasants' obligations for all (former) serfs (Polnoe ... 1863, vol. 36, part 1). This change could have had a positive effect on peasants' incentives right at the time when 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 peasant effort and care was what was needed to boost agricultural productivity.<sup>48</sup> Therefore, one could

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<sup>47</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). Mironov (2011 p. 557) shows that the number of working days in an average peasant household decreased after the abolition of serfdom because of the improved efficiency. Strumilin (1966) shows that the time (in working days) need to cultivate a unit of land was approximately constant between 1850s and 1890s (see online appendix section A10 for details). It is also theoretically possible that land input increased because of virgin lands exploration after the emancipation, which could have had an effect on productivity if the new lands were more productive. We test and reject this mechanism. We have collected data on cultivated land for four cross-sections – two before and two after the emancipation – and used the logarithm of cultivated land as an outcome variable estimating equation 1 with region-specific trends. We find that the abolition of serfdom did not affect cultivated areas. The results of the OLS and IV regressions are presented in Table A6 in the online appendix. The coefficients on the interaction of the share of serfs with the post-emancipation dummy are not significantly different from zero irrespective of specification.

<sup>48</sup> Agricultural handbooks from the first half of 19th century (e.g., Mordvin 1839, Usov 1840, Dmitriev 1844, Ungern-Shterenberg 1848) discuss ways of increasing agricultural 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 to exert effort 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; six of them were directly related to serfs' low effort. Ignatovich (1925) studied the contemporaries' assessment of productivity under serfdom and concluded that serfs did not exert effort without

expect a relatively fast 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 test it indirectly.

First, if peasant incentives were the main driver of the productivity improvements following the 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 described above, it was easier to reach an agreement about the level of former serfs' obligations during the transition period on 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 in 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 significantly decreased productivity improvements as a result of the emancipation, as can be seen from the negative significant coefficient on the triple interaction between the share of serfs with implicit contracts, the share of serfs, and the post-emancipation dummy. The share of serfs under implicit long-term contracts varies across provinces from 2% to 85%, with the median province at 43%. A one standard deviation increase in the share of serfs with implicit contracts (equal to 21 percentage points) increased the effect of the reform on grain productivity by 26.5%. The total effect of the abolition of serfdom (taking into account the countervailing effects of the emancipation and the land reform) was positive and statistically significant in provinces where the share of serfs subject to implicit long-term contracts with landlords was below 50.5%, in other provinces, it was positive and insignificant with one exception: in one province – where the share of serfs with implicit contracts attained its maximum –the overall effect of the reform was negative and insignificant.

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constant monitoring, and with monitoring they spent 25 to 30% more time to carry out any particular task compared to free labor (p. 160).

Second, we can observe whether peasants made adjustments to the choice of which crops to seed, which to sell, and which to consume depending on the climatic and market conditions. As effort and care are needed to make such adjustments, we expect peasants to choose more appropriate crops for cultivation with regard to climatic and market conditions after the emancipation. Due to the technology that prevailed at the time, each plot was divided roughly into three parts: for winter grains, spring 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, colder temperatures were associated with higher failure of winter crops relative to spring crops, and therefore, warmer years, on average, were associated with higher shares of winter 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 spring crops in the spring of year  $t$ . The decision of how much to allocate to winter vs. spring 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 crop to seed. Since price fluctuations allowed at most an imperfect forecast of the relative price of winter to spring crops for the 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 the share of winter crops in the total of crops seeded to be more sensitive to climatic and market conditions after the emancipation if increased effort is the mechanism behind the effect of emancipation.

In column 3 of Table 3, we regress the share of winter crops seeded in total seed on the last year's temperature and its interaction with the share of serfs post-emancipation. We find that, on average, the share of winter crops was lower during cold shocks and that this relationship became significantly stronger for the emancipated serfs after 1861. In columns 4 and 6, we explore the choice between the winter and spring crops to be seeded depending on their relative price. In column 4, we use time series of the price of rye relative to wheat in Dutch commodity exchange in Amsterdam, which we interact with the share of serfs and post-emancipation dummy. In column 6, we use the price of rye relative to oats in Russian regions, again interacted with the share of serfs and the post-emancipation dummy. Price of rye relative to oats varies both across space and over time, and therefore, in addition to the triple interaction term, we include the relative price itself and its double interaction with the share of serfs in the list of covariates in column 6. 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): an increase in the price of rye—the main winter crop—relative to spring crops made peasants seed a relatively lower share of winter rye, because they sold a larger share of it on the market.<sup>49</sup> In columns 5 and 7, we combine the climate and market conditions and get the same result.<sup>50</sup>

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

### *C. Industrial development*

In Table 4, we estimate the effect of the abolition of serfdom on log industrial output. The table presents the results of estimating the same specifications as the first four columns of Table 2 but with log industrial output as dependent variable. The only difference between this analysis and the analysis of grain productivity 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 the 14 region-specific trends. We find a positive and statistically significant effect of the abolition of serfdom on industrial output in all specifications (i.e., in OLS with and without controls for region-specific trends and with and without controls for state and royal peasants, as presented in columns 1, 2 and 4 of Panel A of Table 4 and in IV, as presented in column 3 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 the pre- and post-emancipation periods and the prevalence of serfdom across provinces with an adjustment for spatial correlation on the full sample and excluding the most influential observations. Again, we find that the results are robust.<sup>51</sup> As we illustrate in Figure A7 in the online appendix, which plots raw data, industrial output was uncorrelated with the share of serfs before the emancipation; and at the end of the 19<sup>th</sup> century it became positively correlated with the share of serfs across provinces. Output

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<sup>49</sup> In the second half of the 18<sup>th</sup> century, Russia became an important supplier of grain to European markets. Russia's export of grain was negligible in 1700. However, already by 1800, about a quarter of all Russia's "marketed" grain (i.e., excluding grain consumed by producers) was sold abroad (Mironov 1985).

<sup>50</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 spring crops. In addition, it is worth noting that the interaction between the temperature and the post-1861 dummy has zero effect on productivity and just adds noise to the estimation.

<sup>51</sup> Figure A8 in the online appendix illustrates the cross-sectional relationship presented in Panel C of Table 4 with an indication of DFBeta for each observation.

grew in all provinces throughout the 19<sup>th</sup> century, but after the emancipation it started growing faster in provinces where serfdom was more prevalent before.

As far as the magnitude of the estimated effect is concerned, in contrast to the results for grain productivity, 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: 0.73 vs. 2.6 (columns 2 and 3). This implies the following magnitudes: a one standard deviation increase in the share of serfs before the emancipation led to an additional increase in industrial output of 19% over the course of the second half of the 19<sup>th</sup> century according to the OLS specification and of 86% according to the IV specification. In an average province, with 45% of serfs in rural population prior to the emancipation, industrial output increased by 39% above the trend according to the OLS specification and by a factor of 3.2 according to the IV specification. It is implausible that measurement error is the only explanation. 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 (“compliers”), and those provinces, where in the absence of monasteries, the lands would have stayed in state ownership anyway because the gentry was not interested in owning land in these provinces (“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). A possible reason for why the abolition of serfdom had differential effects across provinces on industrial output is that the reform affected industry mostly through labor market spillovers, which could only occur in places where peasants were tied to large landlords’ farms.

The large magnitude of the effect on industrial development that we find is in line with findings on the substantial level of labor migration within provinces from villages into the provincial industrial sector in the late 19<sup>th</sup> century in spite of the constraints erected by the peasant commune (Borodkin et al. 2008, Burds 1998, Crisp 1976, and Nafziger 2010). Figure 8 presents the estimates of the dynamics of the effect of the abolition of serfdom on industrial output (similarly to Figure 7 presented above); it confirms the absence of pre-trends, as the estimates for the years before the emancipation are small and statistically insignificant. Data limitations do not allow us to make any conclusions about the dynamics of the effect of the reform on industrial output during the first two decades after the emancipation.

*A back-of-the-envelope calculation of the effect of the reform on the value added.*—If we assume that there was no negative general-equilibrium effect of the abolition of serfdom on provinces that relied on free labor before 1861 (which means that the decline of grain productivity observed in the 1860 and 1870s in provinces in the first tercile of share of serfs was due to an unfavorable external macro shock, such as a weather shock), we can use our estimates to calculate the effect of the reform on the total value added. Under this assumption, our estimates imply that the value added in agriculture increased by 16% and in industry by 37%.<sup>52</sup> The composition of the value added across sectors in the Russian empire in 1860 was as follows: agriculture constituted 59.3%, industry – 5.1%, and the rest of the economy was comprised of services broadly defined (Goldsmith 1961). We have no data to calculate the effect of the abolition of serfdom on the service sector. We consider a market-based scenario, in which the service sector grew at the same rate as the rest of the economy on average, which is reasonable because the main driving force for the service sector growth was the increase in demand as the main contributors to this sector were trade and transport. Applying this sectoral composition, we get that an increase in Russia’s GDP a result of the abolition of serfdom in the second half of the 19<sup>th</sup> century amounted to 17.7%.<sup>53</sup>

#### *D. Peasants’ nutrition*

We proceed by estimating the effect of the abolition of serfdom on draftees’ height as a measure of nutrition. As all cohorts of the 21-year-old draftees that we have the data for have lived at least a part of their childhood after the emancipation, we start with estimating an event-study regression equation 2 at the province level interacting the share of serfs separately with the dummies for each pair of two consecutive cohorts between 1855-1866 leaving cohorts born in 1853 and 1854 as the comparison group. As we discussed in the methodology section, one should expect to find an increasing trend in the estimated coefficients before the emancipation because older cohorts born before the emancipation spent more time during their childhood under serfdom. In addition, the positive trend could continue after the emancipation because the effects of the reform on nutrition are not immediate. This is exactly what we find. Figure 9 reports the results in a graphic form and column 3 of Table A3 in the

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<sup>52</sup> These numbers are calculated using the estimates from column 3 of Table 2 and column 2 of Table 4 and applying these effects to the average share of serfs in the European Russia, which amounted to 43% of rural population.  $16 \approx 0.43 * 1.29 / 3.5$ , where 3.5 is the mean productivity in 1858.  $37 \approx \exp(0.73 * 0.43)$ .

<sup>53</sup> We can calculate the lower bound for the effect of the reform on the value added by making the extremely conservative and most probably unreasonable assumption that the service sector was not affected by the abolition of serfdom. In that case, the increase in the total value added as a result of the reform would amount to 11.4%.

online appendix reports the full regression output. The coefficients on interactions with cohort dummies are all positive and increasing in magnitude. The largest increase in the coefficients is between the period immediately before and immediate after the emancipation. This is consistent with the findings of the health literature that nutrition in the early infancy has the most important effect on height during adulthood (Costa 2015). The continuing rising trend in coefficients for cohorts born after the emancipation is consistent with our findings on the gradual effect of the abolition of serfdom on grain productivity during the first twenty years after the reform.<sup>54</sup>

Table 5 estimates the average difference in increases in height between cohorts that were born before and after the emancipation for provinces with high and low prevalence of serfdom. We find that this average difference is statistically significant. The structure of the table is similar to that of Tables 2 and 4. In particular, in Panel A, we present the results of the panel estimations; Panel B presents the first stages for the corresponding 2SLS regressions; 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. In the table, we present results using both province- and district-level data.

Columns 1 to 3 of Panel A present the province-level panel results and columns 4 to 6 – district-level results. In each sample, we present three specifications: the most basic one with district and birth-cohort fixed effects and without any additional controls and the baseline OLS and IV specifications with controls for the (demeaned) distance from Moscow and land suitability interacted with post-emancipation dummy.<sup>55</sup> The coefficient on the main variable of interest is positive and statistically significant irrespective of specification; and the first stages are sufficiently strong not to worry about a weak instrument problem. IV and OLS point estimates are within the confidence interval range of the other estimate and IV estimates in the province-level and district-level samples are close in magnitude. The precision of district-level estimates is somewhat smaller most likely because there are only two post-emancipation cross-sections.

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<sup>54</sup> We also study the dynamics of the effect of the emancipation on height using district level data by estimating the same equation at district level. The results are similar as they also reveal an increasing pre-trend but are slightly less strong. We illustrate these results in Figure A9 and present the full regression output in column 4 of Table A3 in the online appendix.

<sup>55</sup> In the district-level regressions, we exclude districts with less than thirty draftees to be able estimate precisely the average height of draftees. The results are robust to using all districts. The baseline district sample also excludes the Moscow district because this observation is an outlier in the cross-sectional regression. We also verify that the results are robust to excluding the Saint-Petersburg district as well (we report these results in Table A7 in the online appendix).

These regressions can be interpreted as estimates of the effect of the abolition of serfdom on height of draftees under the following strong assumptions. We need to assume that: first, there were no confounding epidemics; second, the draft rules, i.e., the universality of conscription and the random nature of the lottery, were enforced; and third, the chest-to-height restrictions that were introduced in 1882 and almost completely undone in 1883 and 1884 were implemented as designed (below in section 6.3.1, we address the question of how these reforms could have affected our estimates if they were properly implemented). It is important to note that we cannot fully verify these assumptions and that the enforcement of rules was not perfect. Thus, one should interpret the estimates with caution. In addition, to interpret the estimates directly even though they represent the differences between the change in height of draftees in provinces with high and low level of serfdom, we need to assume that the emancipation had no effect on nutrition in provinces that relied on free labor.

Under these assumptions, the IV estimates imply that the abolition of serfdom in an average province led to an increase in the height of draftees by 0.35 centimeters ( $0.35=0.78*0.45$ ) as both serfs and free peasants had the same chance to be drafted and serfs constituted 45% of the total population in an average province. As the draftee's height is an individual characteristic rather than a characteristic of the economy, one could also interpret the results at the individual level: those born after the emancipation in (former) serf families were 0.78 centimeters taller on average than they would have been without the abolition of serfdom. Using the relationship between height and per capita incomes of European males in the second half of the 19th century presented by Floud (1990), we can calibrate the increase in incomes that these gains in height were typically associated with. In particular, the average height of draftees born in 1858 (164.82 cm) implied an income per capita of 664.52\$ (in 1970 U.S. \$) and the average height of emancipated peasants, according to our estimates ( $165.6\text{ cm}=164.82+0.78$ ) implied an income per capita of 790.32\$; i.e., the emancipation was associated with an increase in wellbeing comparable to a 18.9% increase in per capita income at that level of development.<sup>56</sup> These improvements in wellbeing could be driven by a combination of two factors: the boost of productivity as a result of the abolition of serfdom which we find in Table 2 and the redistribution from landlords to peasants which may have

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<sup>56</sup> The first two rows of Table 5 in Steckel (1995) and of column 3 in Table 3 in Floud (1990) suggest that for heights between 163.8 and 166.9 for the European adult males in the second half of the 19th century, the relationship between per capita income (Y) and height (H) can be approximated by the following equation:  $Y = (H-160.7)*5000/31$ . It is important to note that the relationships between height and per capita income could be different for European and Russian males, in which case one cannot apply this formula. There are no similar studies for the Russian empire.

occurred as a result of the emancipation, when the peasants' obligations to landlords were fixed.<sup>57</sup>

In Panel C of Table 4, as is the case for the other two outcomes, we present cross-sectional regressions with standard errors corrected for spatial correlation for both province and district-level data. We de-trend the average height by regressing it on birth-cohort dummies, take averages of the de-trended height for each province and district, respectively, separately for those born before and after 1861, take a difference and regress it on the pre-emancipation share of serfs. We also repeat this exercise, excluding the most influential observations.<sup>58</sup> The results are robust to accounting for a spatial correlation of errors and to excluding outliers.

*The confounding reforms of draft rules.*—An important potential concern with our analysis of height is the confounding reforms of draft rules that occurred in 1882, 1883, and 1885, affecting cohorts born in 1861 (the year of the emancipation), 1862-1863, and 1864 and after, respectively. The law expressed minimum requirement for chest in terms of height. The minimum required chest size was increased in 1882 and decreased in 1883 and then again in 1885 (almost to the level before the 1882 draft reform). For example, for the height of 164.82cm (equal to the average height of 1858 cohort drafted in 1879), draft rules required the minimum chest size of 80.1875cm before 1882; the required chest size was increased by 5.5% in 1882 and decreased by 1.3% in 1883 and then decreased further by 3.3% in 1885; overall, the minimum chest size requirement after 1885 was only 0.7% higher than before 1881. In percentage terms, the magnitude of the changes in minimum chest size requirements was almost the same for height of the range between plus and minus three standard deviations around the average height of 1858 cohort. Potentially, the 1882 reform of draft rules could lead to a bias in favor of finding a positive effect of the emancipation on height because of a negative relationship between height and the ratio of chest to height. One should note, however, that our results on the increasing trend in the difference in height between provinces with high and low prevalence of serfdom for cohorts born before the emancipation presented at figure 9 cannot be driven by these reforms of draft rules.

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<sup>57</sup> A potential alternative mechanism is that the differential access to healthcare for serfs and free peasants was affected by the emancipation. However, there is no historical evidence that serfs and other rural citizens suffered differentially from the pandemic diseases that had an effect on the biometrics in adulthood, such as cholera or typhus (e.g., Cholera in *Entsiklopedicheskii ... 1890-1907*, vol. 37, 1903; Arkhangel'skii 1874).

<sup>58</sup> At the province level, as above, we set the cut off for influential observations at  $|DF\beta| = 0.3$ ; at the district level, the cut off is set for 0.15, as the highest value for  $|DF\beta|$  is 0.22. Due to a larger number of observations at the district level, each individual observation has a smaller effect on the estimated coefficient. The cross-sectional relationships are illustrated by conditional scatterplots in the two panels of Figure A10 in the online appendix, in which we indicate  $DF\beta$  for each observation.

We have used disaggregated data on height and chest of Russian Orthodox draftees in Bobruisk district from Gorskij (1910) to correct for the potential selection bias due to changes in draft rules.<sup>59</sup> If, however, the draftees from Bobruisk were not representative of draftees in the rest of Russia in terms of their anthropometric characteristics, this correction is not enough to eliminate the potential bias in our estimates. To address this concern, we use 1883 and 1885 changes in minimum chest-to-height requirement as a placebo and estimate the difference-in-differences effect of placebo emancipations that took place in these years. The prediction is that if our estimate of the effect of the emancipation on height is driven by the confounding change in draft rules in 1882, the estimated placebo effects for years 1883 and 1885 should be of the opposite sign and their sum should be of approximately the same in magnitude as the effect of the reform, as the changes made in 1883 and 1885 practically reversed the change introduced in 1882.

Table A9 in the online appendix presents the results of the placebo tests for height adjusted for possible selection using disaggregated data from Bobruisk and unadjusted raw height data. We run specifications analogous to the one presented in column 1 of Table 5 on the sample of cohorts born after the emancipation (i.e., starting with the draft year of 1882) to estimate the differential effect of the 1883 and 1885 changes in the draft rules for provinces with high and low shares of serfs. We estimate the effect of the 1883 reform in columns 1 and 4 by focusing on cohorts born after the emancipation but drafted before the 1885 reform, the effect of the 1885 reform in columns 2 and 5 by focusing on cohorts drafted after the 1883 reform, and on the cumulative effect of the two reforms in columns 3 and 6 by comparing cohort drafted in 1882 with cohorts drafted after 1885. In all specifications, we find positive insignificant coefficients on the interactions between the pre-emancipation share of serfs and post-1862- or post-1864-birth-cohort dummies. The positive sign of the coefficients is inconsistent with the hypothesis that the change in minimum chest-size requirement that occurred in 1882 had a positive differential effect on provinces with different pre-emancipation shares of serfdom (as that reform went into the opposite direction to the reforms of 1883 and 1885). Thus, we can attribute the differential increase in height between cohorts born before and after 1861, presented in Figure 9 and Table 5 to the emancipation. Consistent with Figure 9, these positive placebo coefficients provide additional evidence that the emancipation reform had a gradual impact, as the effect continued to increase with time after the emancipation.

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<sup>59</sup> Table A8 in the online reports the minimum and maximum chest sizes of Orthodox men in Bobruisk by height categories from Gorskij (1910).

Finally, whether we correct the average height figured for the selection due to changes in chest-to-height requirements does not affect any of our estimates of the differential effect (even though they do change the average height figures). This can be seen from virtually identical estimates in Table 5 in the main text, which presents results for the adjusted height, and Table A10 in the online appendix, which presents results for unadjusted height figures, as well as in columns 1-3 as compared to columns 4-6 in Table A9. Overall, we find no effect of the confounding reforms of draft rules.

## VI. Additional sensitivity tests

This section briefly describes a multitude of sensitivity tests that we conducted to verify the robustness of our findings to controlling for potentially confounding factors and using alternative data sources, various sample restrictions, and different specifications.

First, we verify that our results are not driven by the following potentially confounding factors: the length of the railway network in a province and year (in log kilometers), historical yearly temperature, and measures of court reform, which started in 1864 and was implemented in different provinces at different rates, and of the so-called *zemstvo* reform, which introduced elected local self-government bodies in thirty-four out of forty-six provinces in our baseline sample in 1864.<sup>60</sup>

Second, we verify that the results concerning the land reform are robust to excluding observations for the provinces of the former Polish-Lithuanian Commonwealth in the years before 1843 (see Table A14 in the online appendix). We do this to rule out a concern of possible endogeneity of the share of monasterial serfs in these provinces before 1843, as there, in contrast to the rest of the empire, the nationalization of monasterial lands continued until 1842. We also verify that the results are robust to restricting the sample to only the core provinces of the empire, i.e., Great Russia, New Russia and the Eastern part of Belorussia, consisting of the thirty-five out of forty-six provinces, where the land reform was regulated by

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<sup>60</sup> To account for the court reform, we construct a dummy variable, which switches on when the court reform was launched in a particular province. To account for the *zemstvo* reform, we interact the annual *zemstvo* expenditure in each province (averaged across years for which the data are available: 1868, 1871, 1876, 1880, 1885, 1890, 1895 and 1903) normalized by rural provincial population in 1858 with the post-1864 period dummy. Tables A11, A12, and A13 in the online appendix report the results for each of our outcomes controlling for each of these potentially confounding factors separately and together. Our main coefficients of interest, estimating the effect of the abolition of serfdom, remain positive and statistically significant in 13 out of 15 regressions. In 2 regressions with industrial output as the outcome variable and *zemstvo* expenditures as an additional control statistical significance is lost. This is not surprising as these expenditures were channeled to the least industrially developed provinces as reflected in the negative and significant coefficient on this control, which makes them highly endogenous.

a single statute.<sup>61</sup> We further verify that the redistribution of land between peasants and landlords, which was decided at the signature of the 1863 regulatory charters, did not drive the main effects of the abolition of serfdom on agricultural productivity: we add a measure of how much land peasants “lost” as a result of the reform to the list of covariates and find similar results.<sup>62</sup> We also show that the effect on productivity does not depend on the size of the estate or the prevalence of small peasant farms as opposed to large private landlord farms, measured as a share of serfs on quitrent in a province. Both of these measures can be viewed as proxies for the access to capital and technologies.<sup>63</sup>

Tables A17-A20 show that the results are robust to using 1857 tax census data on the share of serfs across provinces (Kabuzan 1971) instead of the 1858 data from Bushen (1863).<sup>64</sup> Further, in regressions for grain productivity, we restrict the sample to years before 1883, as for this sub-sample the data came from a single source, governor reports.<sup>65</sup>

We study the robustness of our results to the inclusion of Baltic provinces into the sample; the results are presented in Table A22 in the online appendix.<sup>66</sup> We also verify the robustness of the results to weighting observations by log provincial population as reported in Tables A23 to A26 of the online appendix.

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<sup>61</sup> In the empire, there were four different laws (charters) that regulated the rules of the land reform throughout the empire. They differed in terms of the size of the minimum and the maximum plots that former serfs’ households could get as a result of the land reform (Polnoe ... 1863, vol. 36, part 1). See columns 1 to 4 of Table A15 in the online appendix, which replicate columns 6 and 7 of Table 2 on the restricted sample.

<sup>62</sup> On average, peasants got less land in ownership than they cultivated under serfdom (Zajonchkovskij 1968). These results are presented in the columns 5 and 6 of Table A15. Column 5 presents the results for the subsample of the Great Russia provinces, which experienced the biggest land “cuts,” and column 6 for the baseline sample.

<sup>63</sup> See columns 7 and 8 of table A15 in the online appendix. We do not have instruments for either the size of the estates or the prevalence of private landlord farms, both of which could be endogenous. Therefore, one should be cautious about the interpretation of these results.

<sup>64</sup> The point estimates have similar magnitude to the baseline. The precision of estimates, however, goes down. In two out of 21 regressions, the coefficient of interest loses statistical significance at the conventional level. The decrease in the precision of estimates is to be expected because the 1857 data are much noisier.

<sup>65</sup> Table A21 reports specifications presented in the two top panels of Tables 2 for this sub-sample. The main result on the overall effect of the abolition of serfdom holds (columns 1-5). In columns 6 and 7, we present the regressions that aim at disentangling the effects of the emancipation per se and of the land reform for this reduced sample. The results hold only in the IV specification (column 7). In OLS, the coefficients of interest are insignificant, and the coefficient on the land reform has a wrong sign. This might be because in this subsample, there are no observations for the years after the end of the land reform. Importantly, as the land reform is endogenous, only IV regressions are valid (provided that the IV is excludable).

<sup>66</sup> In the sample including Baltic provinces, the post-emancipation dummy varies both over time and across provinces: it switches on in 1819 in the three Baltic provinces and in 1861 in all other provinces. The *ShareSerfs<sub>i</sub>* for the Baltic provinces is equal to the share of former serfs in 1858 according to Bushen (1863). As the Baltic provinces are special in many ways, we also include the interaction of control variables with the Baltic provinces dummy. The first two columns of Table A22 present the results. We find a positive and significant effect of the emancipation on grain productivity. In columns 3 and 4 of Table A22, we allow the effect of the emancipation to differ between Baltic provinces and the rest of the sample. The effect in the Baltics is positive but imprecisely estimated, so we cannot reject the hypothesis that the effects are the same in the two groups of provinces. Point estimates for Baltic provinces and for the provinces from our baseline sample are similar in magnitude.

Finally, we run a series of placebo tests on the sample before 1861, in which we replace our main explanatory variable of interest, i.e., the interaction between the share of serfs and the post-1861 dummy with the interaction between the share of serfs and dummies, which switch on in different consecutive years. We present the estimated coefficients along with their confidence intervals graphically on Figure A11 in the online appendix. All of them are fairly precisely estimated zeros.

## VII. Conclusions

The abolition of serfdom had a substantial positive effect on agricultural productivity, industrial development and peasants' nutrition in 19th century Russia. The improvements amounted to about 17.7% increase in Russia's GDP in the second half of the 19<sup>th</sup> century. The evidence suggests that a primary reason for the large effect of the abolition of serfdom on agricultural productivity was a sharp change in the incentive structure of 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 free small-scale farmers. This change led to a 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 had transferred ownership rights over land to peasant households rather than the commune, or at the very least to hereditary rather than the re-partition communes. The increase in the power of the re-partition peasant commune (designed by the land reform) was the most likely mechanism behind the negative effect of the land reform.

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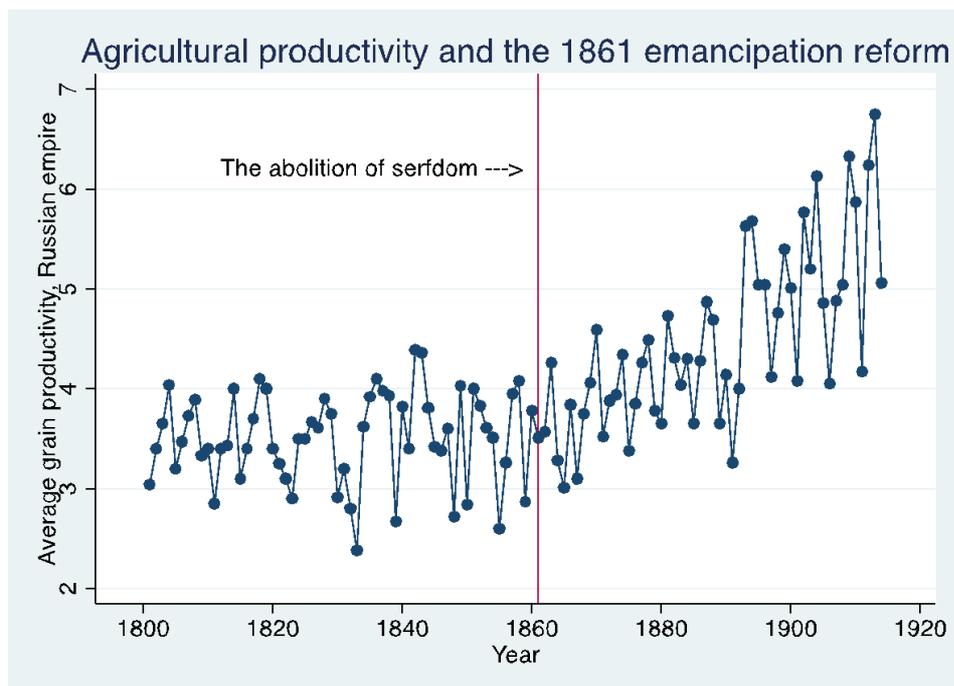


FIGURE I. DYNAMICS OF AGRICULTURAL PRODUCTIVITY IN THE RUSSIAN EMPIRE

Notes: The vertical line indicates the 1861 Emancipation reform. Source: Mikhajlovskij V.G. (1921). *Urozhai v Rossii, 1801-1914 gg.* [Grain productivity in Russia, 1801-1914], *Bulleten Tsentralnogo Statisticheskogo Upravleniya* [Bulletins of the Central Statistical Administration], 50.

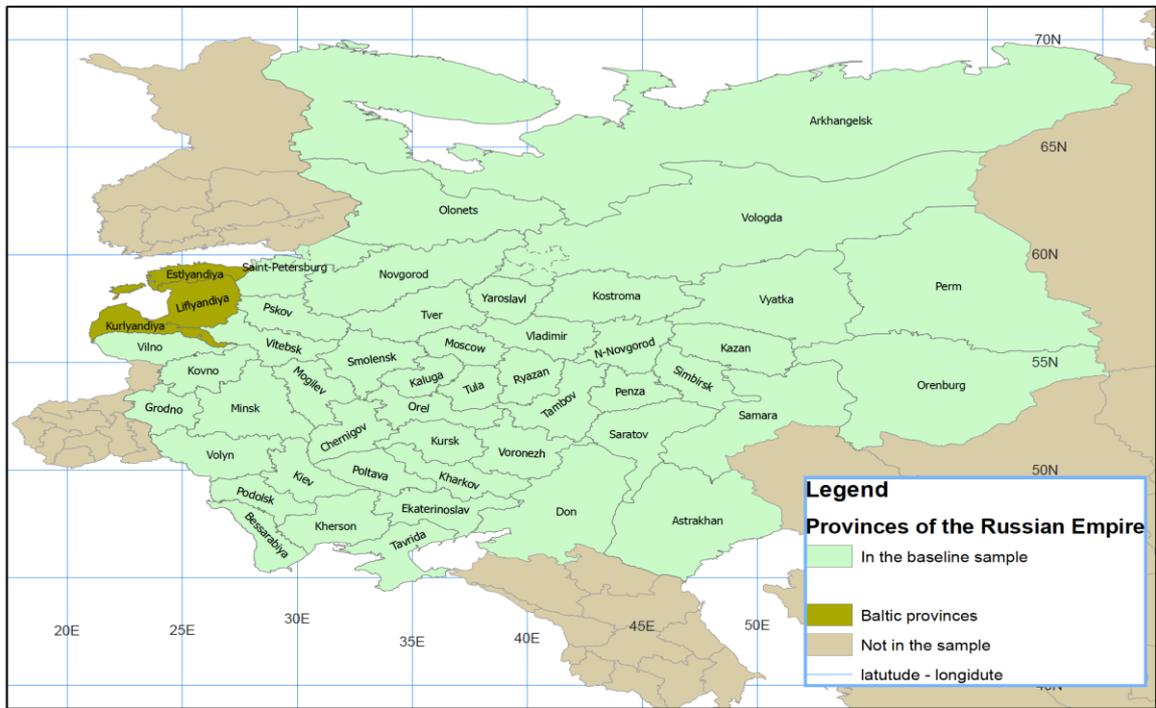


FIGURE 2. EUROPEAN PROVINCES OF THE RUSSIAN EMPIRE

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

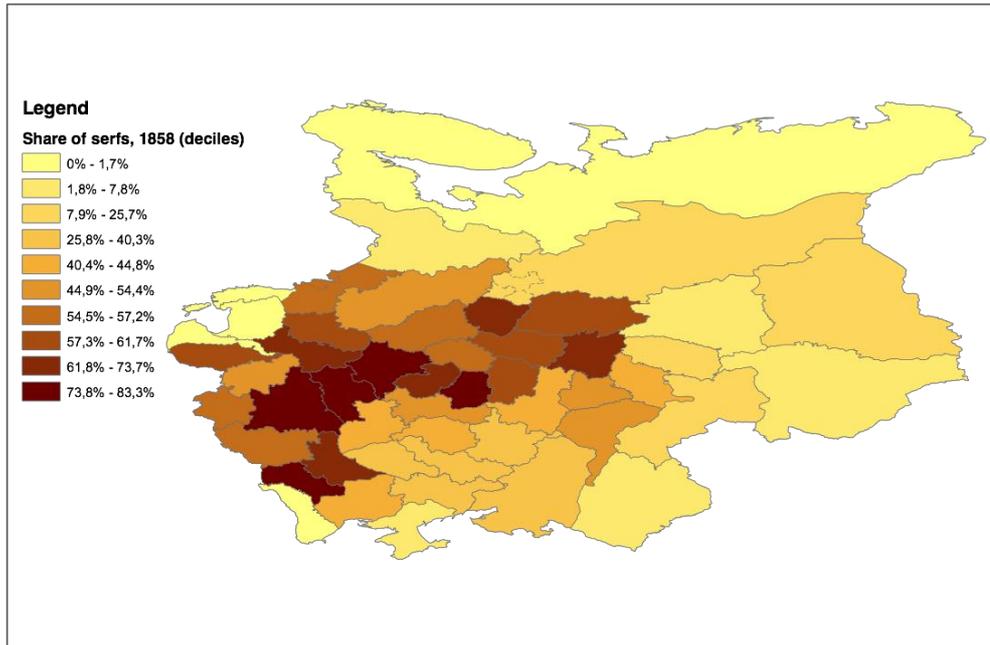


FIGURE 3. GEOGRAPHY OF SERFDOM: SERFS IN 1858 AS A SHARE OF RURAL POPULATION

*Notes:* Equirectangular projection used.

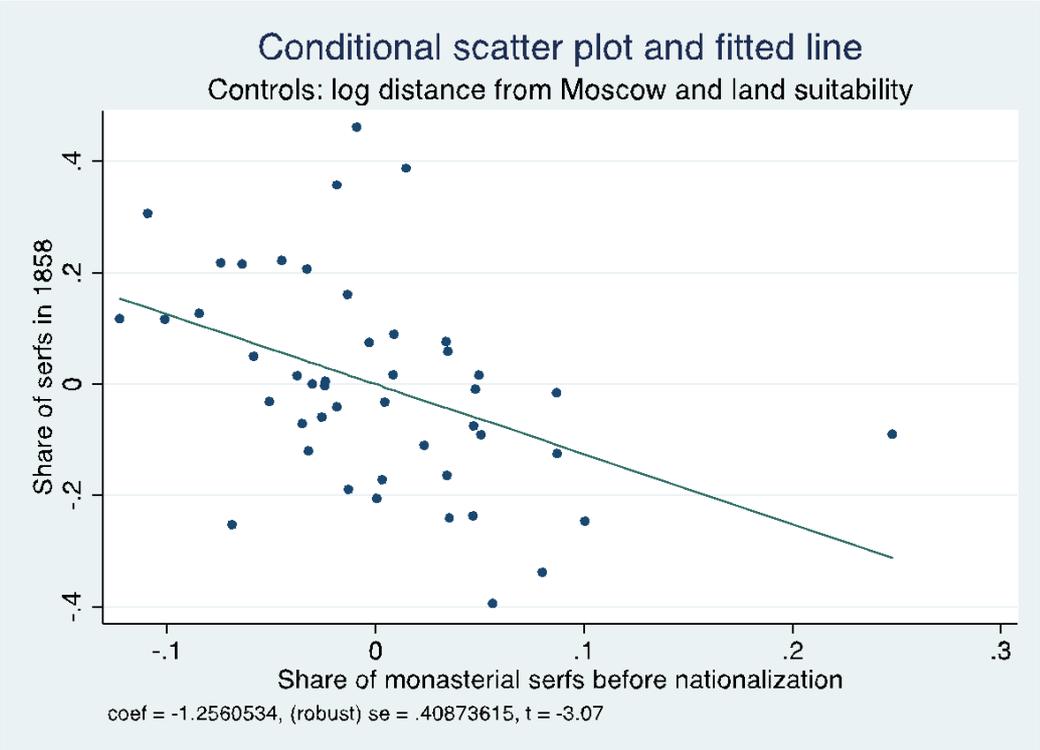


FIGURE 4. MONASTERIAL SERFS BEFORE NATIONALIZATION AND PRIVATE SERFS IN 1858 ACROSS PROVINCES

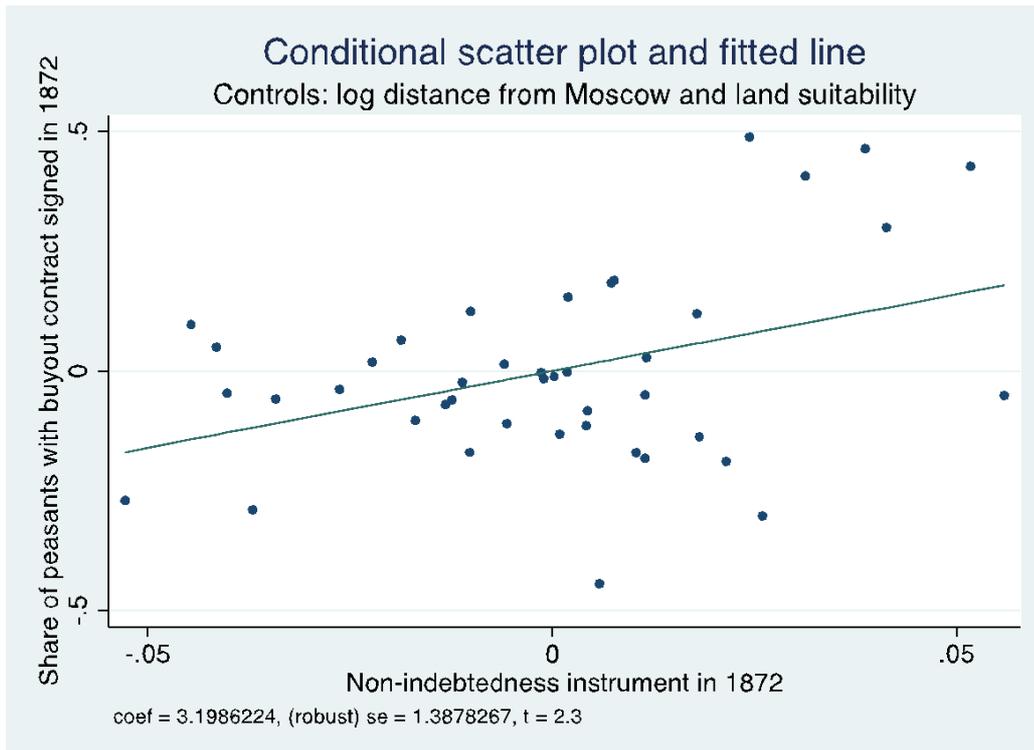


FIGURE 5. THE PROGRESS OF LAND REFORM AND THE LAND REFORM INSTRUMENT IN 1872, I.E., HALFWAY THROUGH LAND REFORM IMPLEMENTATION, ACROSS PROVINCES

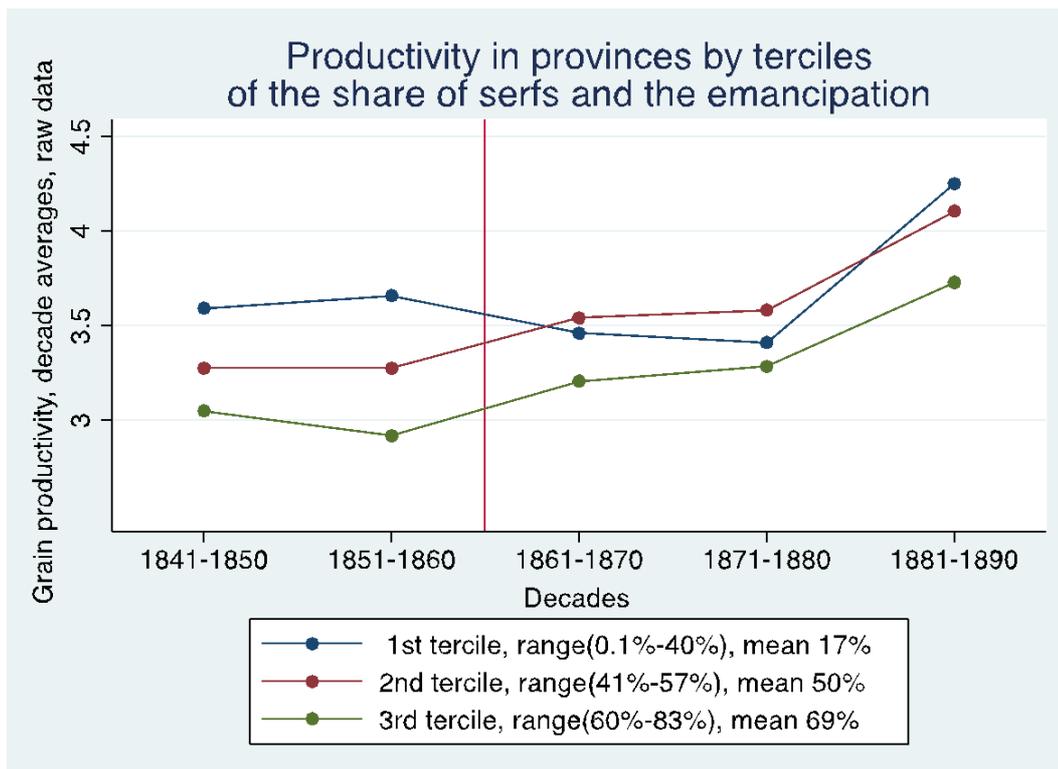


FIGURE 6. GRAIN PRODUCTIVITY IN THE THREE TERCILES OF THE SHARE OF SERFS IN 1800-1900

Notes: The series represent decade averages separately for 16 provinces in the first tercile of the pre-emancipation share of serfs, 15 provinces in the second tercile, and 15 provinces in the third tercile of the share of serfs. The vertical line indicates the 1861 Emancipation reform.

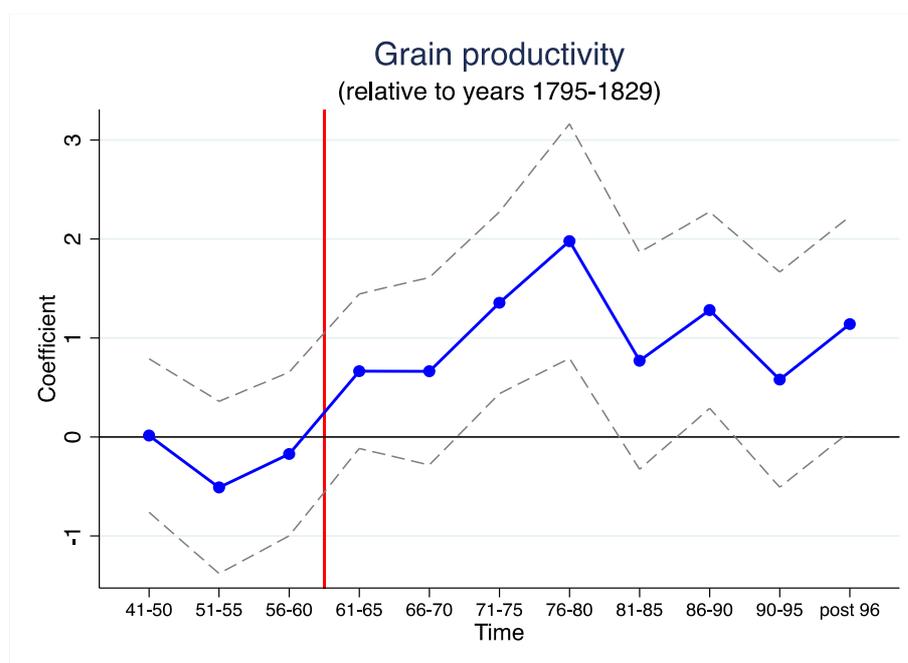


FIGURE 7. THE TIME-VARYING EFFECT OF EMANCIPATION: GRAIN PRODUCTIVITY

*Notes:* 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 productivity on 5-year interval dummies interacted with the share of serfs in a province, province and year fixed effects, region-specific linear trends, and controls for demeaned suitability interacted with the post-emancipation dummy, and demeaned distance from Moscow interacted with the post-emancipation dummy, the share of state peasants interacted with the post-1866 dummy, and the share of royal peasants interacted with the 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.

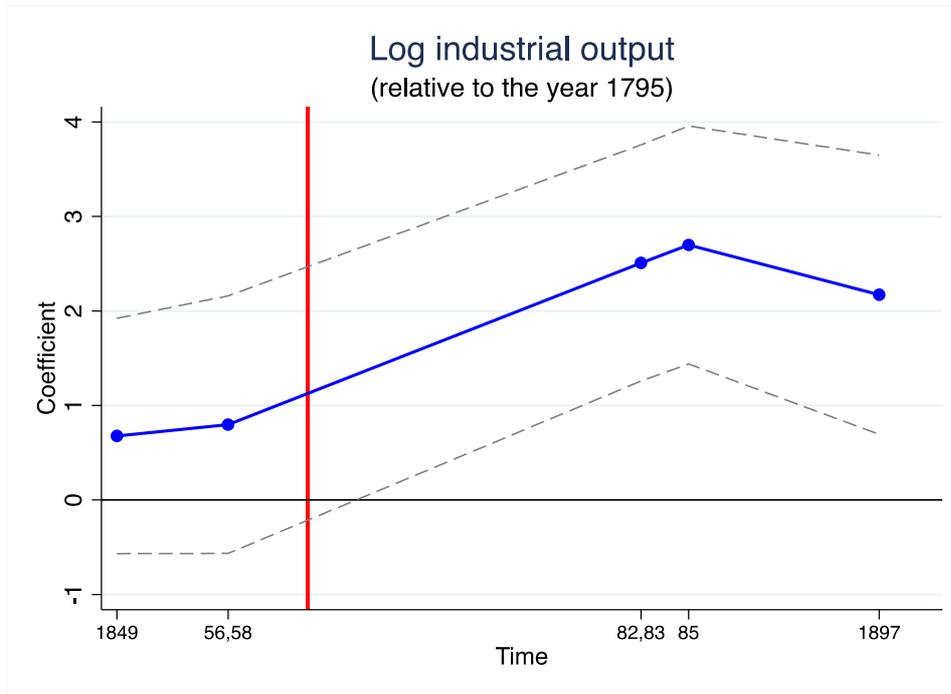


FIGURE 8. THE TIME-VARYING EFFECT OF EMANCIPATION: INDUSTRIAL OUTPUT

*Notes:* The figure presents coefficients (along with their 90% confidence interval) in the regression of log industrial output on interactions of the share of serfs in a province with 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 the post-emancipation dummy, demeaned distance from Moscow interacted with the post-emancipation dummy, the share of state peasants interacted with the post-1866 dummy, and the share of royal peasants interacted with the post-1859 dummy. The year 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 2 of Table A2 in the online appendix.

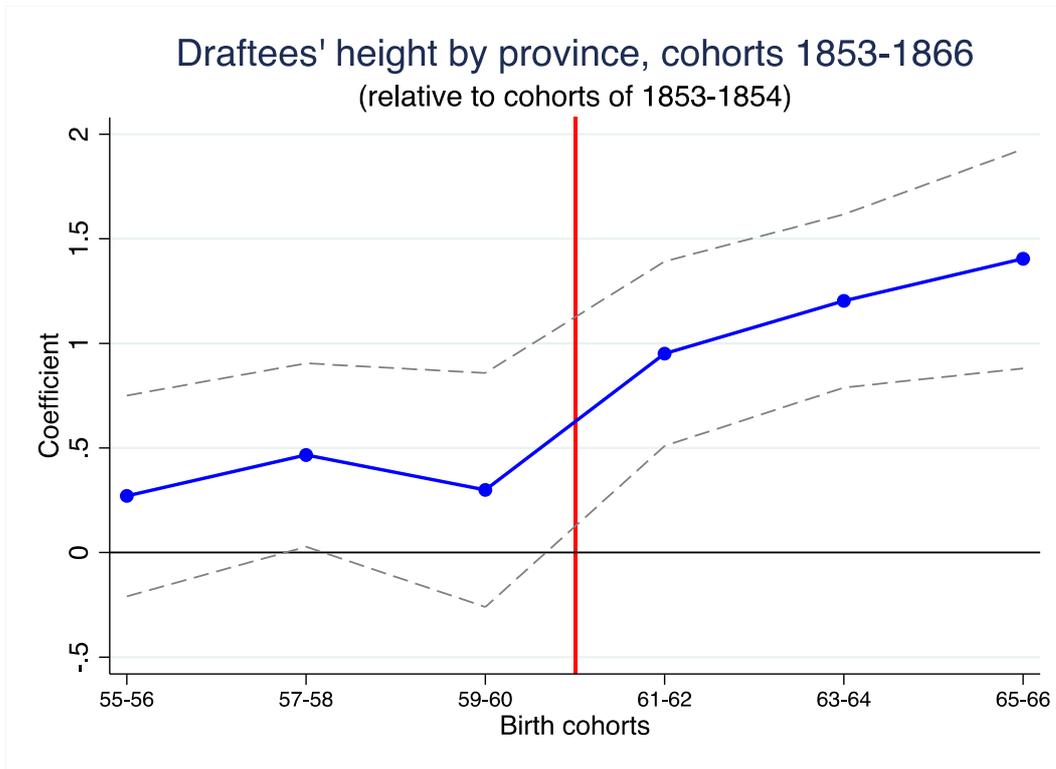


FIGURE 9. THE TIME-VARYING EFFECT OF EMANCIPATION: DRAFTEES' HEIGHT.

*Notes:* The figure presents coefficients (along with their 90% confidence interval) in the regression of the height of draftees on 2-year interval dummies for birth cohorts born around the emancipation interacted with the share of serfs in a province, province and birth-cohort fixed effects, and controls for demeaned suitability interacted with the post-emancipation dummy, and demeaned distance from Moscow interacted with the post-emancipation 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 3 of Table A3 in the online appendix.

TABLE 1— SUMMARY STATISTICS

Panel A. Serfdom in 1858					
	Obs	Mean	Std. Dev.	Min	Max
Share of serfs (by province)	46	0.45	0.24	0.001	0.83
Share of serfs (by district)	447	0.42	0.23	0	0.85
Share of state peasants (by province)	46	0.39	0.21	0	0.88
Share of formally free rural population (by province)	46	0.12	0.17	0.04	0.85
Panel B. Land reform during the years of its implementation (1862-1882)					
	Obs	Mean	Std. Dev.	Min	Max
Land reform: Share of peasants with signed buyout contracts in 1862-1882 (by province & year)	877	0.32	0.24	0	0.83
Panel C. Development outcomes					
	Obs	Mean	Std. Dev.	Min	Max
Grain productivity, yield-to-seed ratio (by province & year)	1835	3.79	1.26	0.59	12.30
Log industrial output, mln 1895 rubles (by province & year)	347	15.46	1.67	9.75	19.63
Height of draftees, centimeters (by province & birth cohort)	584	164.75	0.83	162.55	167.02
Height of draftees, centimeters (by district & birth cohort)	4437	162.60	1.64	157.72	169.99
Panel D. Instruments					
	Obs	Mean	Std. Dev.	Min	Max
Average share of monasterial serfs b/w 1796 and 1814 (by province)	46	0.09	0.08	0	0.39
Average share of monasterial serfs b/w 1796 and 1814 (by district)	439	0.09	0.11	0	0.64
Gentry indebtedness in 1858 (by province)	44	0.13	0.07	0.003	0.29
Interpolation b/w [1-indebtedness] and 1 in the interval 1862-1882 (by province & year)	877	0.95	0.06	0.71	1
Panel E. Other important variables					
	Obs	Mean	Std. Dev.	Min	Max
Implicit contracts: Share of serfs with signed regulatory charters by 1863 (by province)	44	0.43	0.21	0.019	0.85
Repatriation commune dummy (by province)	46	0.87	0.34	0	1
Share of winter crops seeded in total crops seeded (by province)	800	0.41	0.10	0.09	0.64
Distance to Moscow, km (by province)	46	666	323	24	1307
Distance to Moscow, km (by district)	447	600	303	43	1596
Crop suitability index (by province)	46	2.17	1.33	1	5
Crop suitability index (by district)	447	2.25	1.35	1	6
Rye-to-wheat world price ratio (by year, for the years with data on the composition of crops)	18	0.73	0.069	0.64	0.88
Rye-to-oat local price ratio (by mega-region & year, for the years with data on the composition of crops)	759	1.08	0.21	0.55	1.94

Notes: The summary statistics are reported for the baseline sample without the Baltic provinces and for district level without Moscow.

TABLE 2.— THE EFFECT OF THE ABOLITION OF SERFDOM ON PRODUCTIVITY IN AGRICULTURE

Panel A: Panel data estimation							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent var:	Grain productivity						
Model:	OLS	OLS	IV, 2nd stage	OLS	OLS	OLS	IV, 2nd stage
Share of serfs X Post-emancipation	0.81 [0.23]	0.80 [0.25]	1.29 [0.46]	1.04 [0.25]		1.03 [0.34]	2.76 [0.60]
Share of serfs X 1861-1870					0.75 [0.24]		
Share of serfs X post-1871					0.98 [0.38]		
Share of peasants with signed buyout contracts						-0.40 [0.25]	-1.20 [0.32]
Demeaned log distance to Moscow X Post-emancipation		-0.93 [0.36]	-0.58 [0.42]	-0.86 [0.36]	-0.93 [0.36]	-0.63 [0.42]	0.61 [0.47]
Demeaned crop suitability X Post-emancipation		0.07 [0.04]	0.06 [0.04]	0.06 [0.04]	0.07 [0.04]	0.06 [0.04]	0.06 [0.05]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	No	Yes	Yes	Yes	Yes	Yes	Yes
State and royal peasant reforms	No	No	No	Yes	No	No	No
Observations	1,835	1,835	1,835	1,835	1,835	1,780	1,780
R-squared	0.368	0.403	0.533	0.404	0.403	0.402	0.539
Panel B: First stages of the corresponding 2SLS panel regressions							
		(3)		(7.1)	(7.2)		
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		-1.25 [0.30]		-1.29 [0.30]	-1.34 [0.28]		
Interpolation b/w (1-indebtedness) and 1 in the interval 1862-1882				0.12 [0.17]	2.70 [0.26]		
Controls as in respective column of Panel A		Yes		Yes	Yes		
Observations		1,835		1,780	1,780		
F, monasterial serfs instrument		18.15		18.87	23.90		
F, indebtedness instrument				0.512	111.6		
Panel C: Cross-sectional estimation robust to spatial correlation							
	(1)	(2)					
Dependent var:	The change in detrended grain productivity b/w pre- and post-emancipation						
Model:	OLS spatial HAC			OLS spatial HAC			
Sample:	full			DFBeta <0.3			
Share of serfs	0.90 [0.26]			0.76 [0.23]			
Log distance to Moscow, crop suitability	Yes			Yes			
Observations	46			43			
Adj R-squared	0.257			0.332			

*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. (1861-1870) and post-1871 are dummies equal to 1 in the corresponding years and 0 otherwise. 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 there is a discrete jump in this variable to the share of serfs in 1863. Indebtedness is the ratio of serfs in the province used as collateral in landlords' debt contracts in 1858 to the total rural population in the province

TABLE 3— THE MECHANISMS BEHIND THE EFFECTS OF THE LAND REFORM AND THE EMANCIPATION

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent var:	Grain productivity		Share of winter crops seeded at t-1 in total winter and spring crops seeded at [t-1;t] production cycle				
	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Share of serfs X Post-emancipation	0.833 [0.331]	1.734 [0.429]	-0.064 [0.016]	-0.050 [0.016]	-0.072 [0.017]	-0.042 [0.021]	-0.076 [0.019]
Share of peasants with signed buyout contracts	0.109 [0.267]	-0.499 [0.254]					
Share of peasants with signed buyout contract X repartition commune	-0.697 [0.337]						
Share of serfs X Post-emancipation X Implicit contracts		-1.561 [0.532]					
Demeaned temperature (t-1)			0.005 [0.003]		0.003 [0.003]		0.005 [0.003]
Share of serfs X Post-emancipation X Demeaned temperature (t-1)			0.010 [0.004]		0.008 [0.004]		0.013 [0.005]
Share of serfs X Post-emancipation X Demeaned rye-to-wheat world price ratio (t-1)				-0.495 [0.120]	-0.441 [0.119]		
Share of serfs X Post-emancipation X Demeaned rye-to-oat local price ratio (t-1)						-0.100 [0.042]	-0.114 [0.042]
Share of serfs X Demeaned rye-to-oat local price ratio (t-1)						-0.012 [0.047]	0.009 [0.043]
Demeaned rye-to-oat local price ratio (t-1)						0.030 [0.022]	0.021 [0.019]
Demeaned log distance to Moscow X Post-emancipation	-0.920 [0.438]	-0.788 [0.420]	-0.030 [0.020]	0.024 [0.017]	-0.020 [0.020]	0.020 [0.020]	-0.044 [0.023]
Demeaned crop suitability X Post-emancipation	0.045 [0.039]	0.037 [0.035]	0.001 [0.002]	-0.001 [0.002]	0.000 [0.002]	-0.001 [0.003]	0.002 [0.002]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,780	1,726	792	796	792	755	751
R-squared	0.403	0.420	0.792	0.794	0.802	0.783	0.795

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.

TABLE 4—THE ABOLITION OF SERFDOM AND INDUSTRIAL DEVELOPMENT

Panel A: Panel data estimation				
	(1)	(2)	(3)	(4)
Dependent var:		Ln (industrial output)		
Model:	OLS	OLS	IV, 2nd stage	OLS
Share of serfs X Post-emancipation	0.78 [0.31]	0.73 [0.38]	2.60 [1.23]	1.38 [0.57]
Demeaned log distance from Moscow X Post-emancipation		0.36 [0.44]	1.70 [1.01]	0.52 [0.44]
Demeaned crop suitability X Post-emancipation		0.13 [0.06]	0.13 [0.07]	0.12 [0.06]
Year and province fixed effects	Yes	Yes	Yes	Yes
Region-specific trends	No	Yes	Yes	Yes
State and royal peasant reforms	No	No	No	Yes
Observations	347	347	347	347
R-squared	0.800	0.885	0.934	0.887
Panel B: First stages of the corresponding 2SLS panel regressions				
Dependent var:		(3) Share of serfs X Post- emancipation		
Model:		IV, 1st stage		
Share of nationalized monasterial serfs X Post-emancipation		-1.02 [0.26]		
Controls as in respective column of Panel A		Yes		
Observations		347		
F, excluded instrument		15.42		
Panel C: Cross-sectional estimation robust to spatial correlation				
Dependent var:		(1)	(2)	
Model:		The change in detrended log industrial output b/w pre- and post-emancipation		
Sample:		full	OLS spatial HAC  DFBeta <0.3	
Share of serfs		1.90 [0.38]	2.02 [0.40]	
Log distance from Moscow, crop suitability		Yes	Yes	
Observations		45	41	
Adj R-squared		0.273	0.349	

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.

TABLE 5 — THE ABOLITION OF SERFDOM AND PEASANT LIVING STANDARDS: DRAFTEES' HEIGHT

Panel A: Panel data estimation						
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent var:	Draftees' height (cohorts 1853-1866)			Draftees' height (cohorts 1853-1862)		
Data set:	Province-level data			District-level data		
Model:	OLS	IV, 2nd stage		OLS	IV, 2nd stage	
Share of serfs X Post-emancipation cohorts	0.75 [0.16]	0.92 [0.13]	0.78 [0.32]	0.41 [0.14]	0.65 [0.16]	0.82 [0.49]
Demeaned log distance from Moscow X Post-emancipation		0.73 [0.18]	0.65 [0.24]		0.18 [0.05]	0.21 [0.096]
Demeaned crop suitability X Post-emancipation		0.15 [0.02]	0.16 [0.02]		0.08 [0.02]	0.08 [0.03]
Birth cohort and province or district fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	No	No	No	No	No	No
Observations	584	584	584	4,437	4,437	4,357
R-squared	0.114	0.217	0.853	0.559	0.561	0.730
Panel B: First stages of the corresponding 2SLS panel regressions						
		(3)		(6)		
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		-1.29 [0.31]		-0.63 [0.08]		
Controls as in respective column of Panel A		Yes		Yes		
Observations		584		4,357		
F, excluded instrument		17.32		72.12		
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	0.90 [0.153]	0.73 [0.164]	0.65 [0.198]	0.46 [0.141]		
Log distance from Moscow, crop suitability	Yes	Yes	Yes	Yes		
Observations	42	38	447	438		
Adj R-squared	0.554	0.541	0.043	0.040		

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.

Online Appendix to:  
The Economic Effects of the Abolition of Serfdom:  
Evidence from the Russian Empire

*By* ANDREI MARKEVICH AND EKATERINA ZHURAVSKAYA

**Contents:**

- **Appendix figures**
- **Appendix tables**
- **Appendix sections**

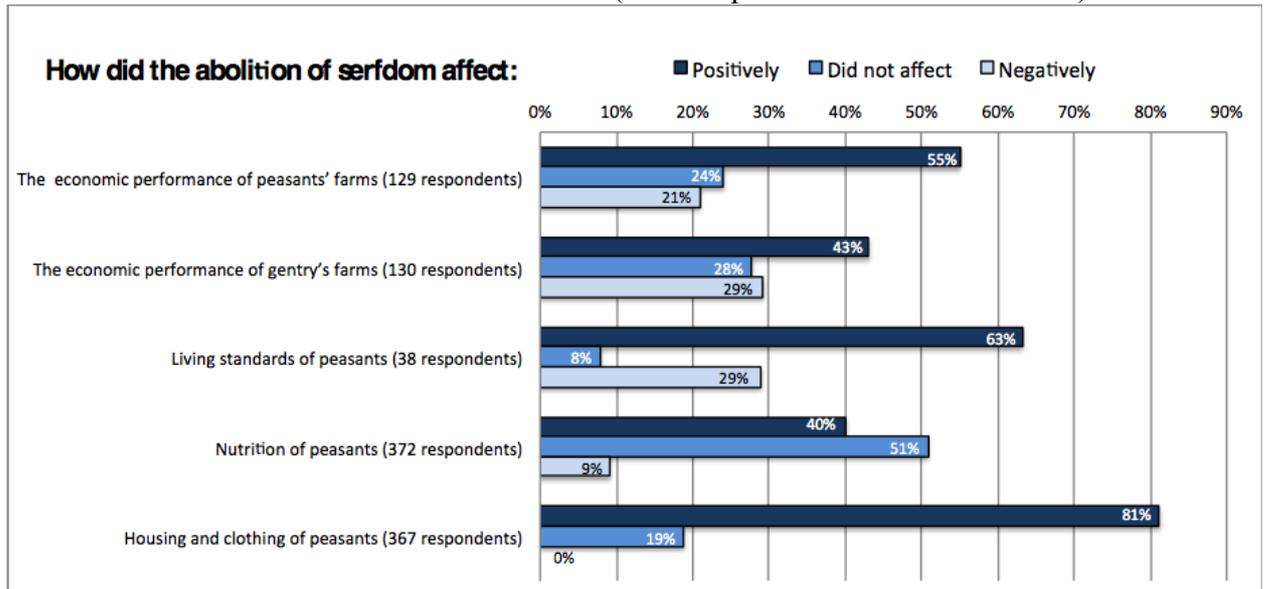
**A. Historical Background**

- A1. Contemporaries on the economic consequences of the abolition of serfdom
- A2. Legal status of Russian peasants, whom we characterize as (relatively) free population
- A3. The reasons geographical concentration of serfdom in the center of the empire
- A4. The nationalization of monasterial lands
- A5. The timing of the abolition of serfdom
- A6. The details of the land reform
- A7. Gentry's indebtedness
- A8. The qualitative accounts of changes in the Russian countryside that occurred right after 1861 reform
- A9. Procedures for statistical data collection in the Russian empire of the 19th century
- A10. Agricultural technologies in the 19th century Russia
- A11. The rules of military draft

**B. Additional information about the data and the construction of variables**

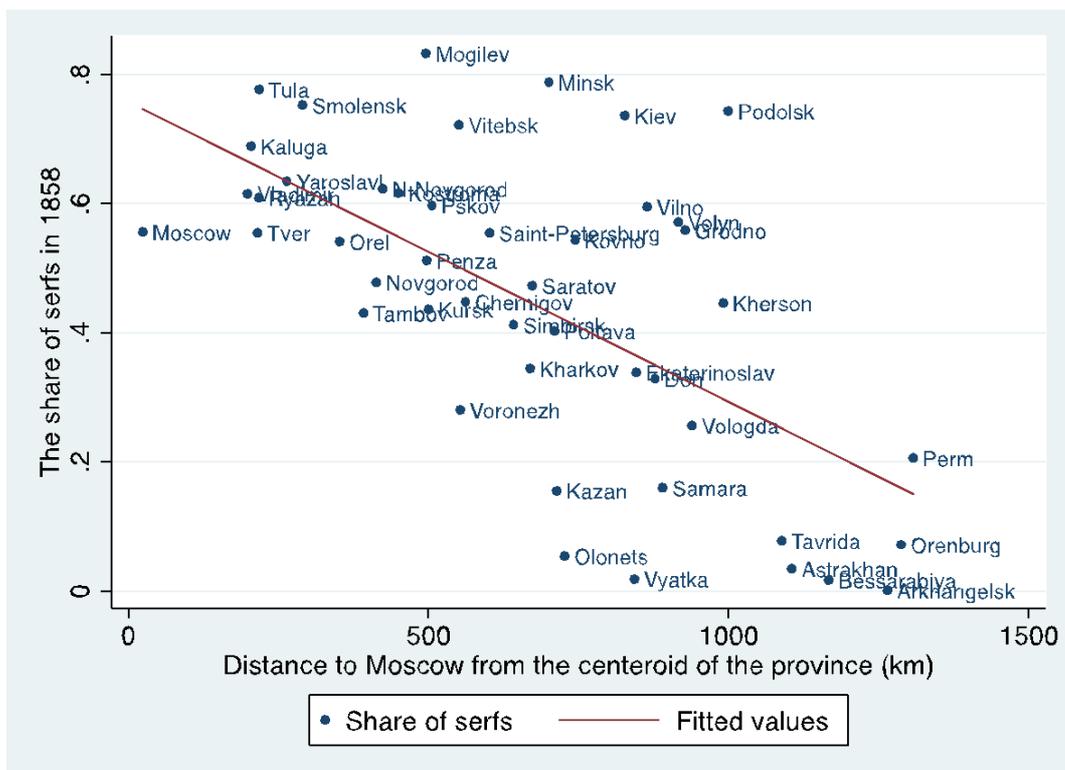
## Appendix Figures

Figure A1. The results of a survey conducted in 1872 by a special government commission to evaluate the results of the abolition of serfdom (% of respondents with each answer)



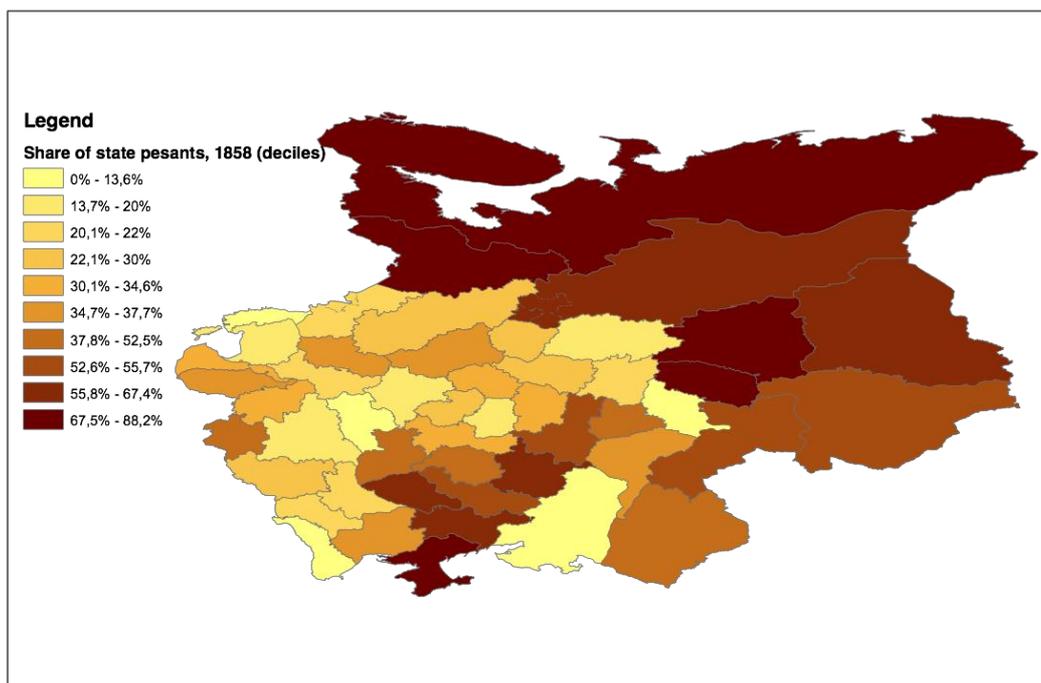
Source: Mironov B.N. (2010). p. 551.

Figure A2. Geography of serfdom: the share of serfs in 1858 and the distance from Moscow

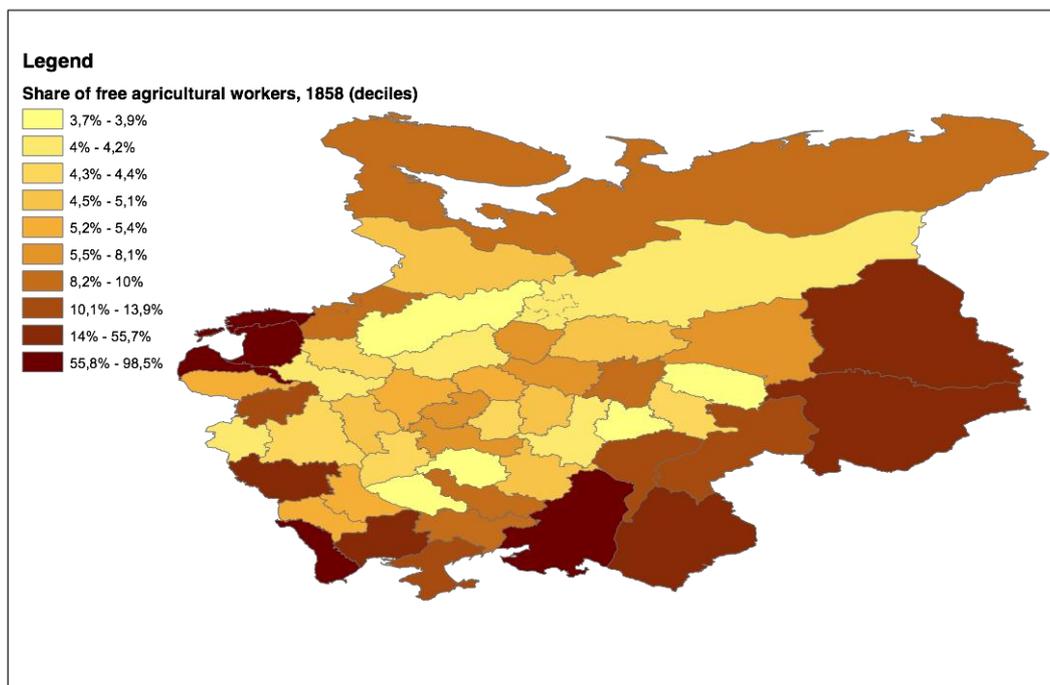


Coef: -0.0005; SE=0.00009; R<sup>2</sup> =0.36.

Figure A3. Geography of free labor: state peasants and free agricultural workers  
Panel A. State peasants in 1858 as a share of rural population

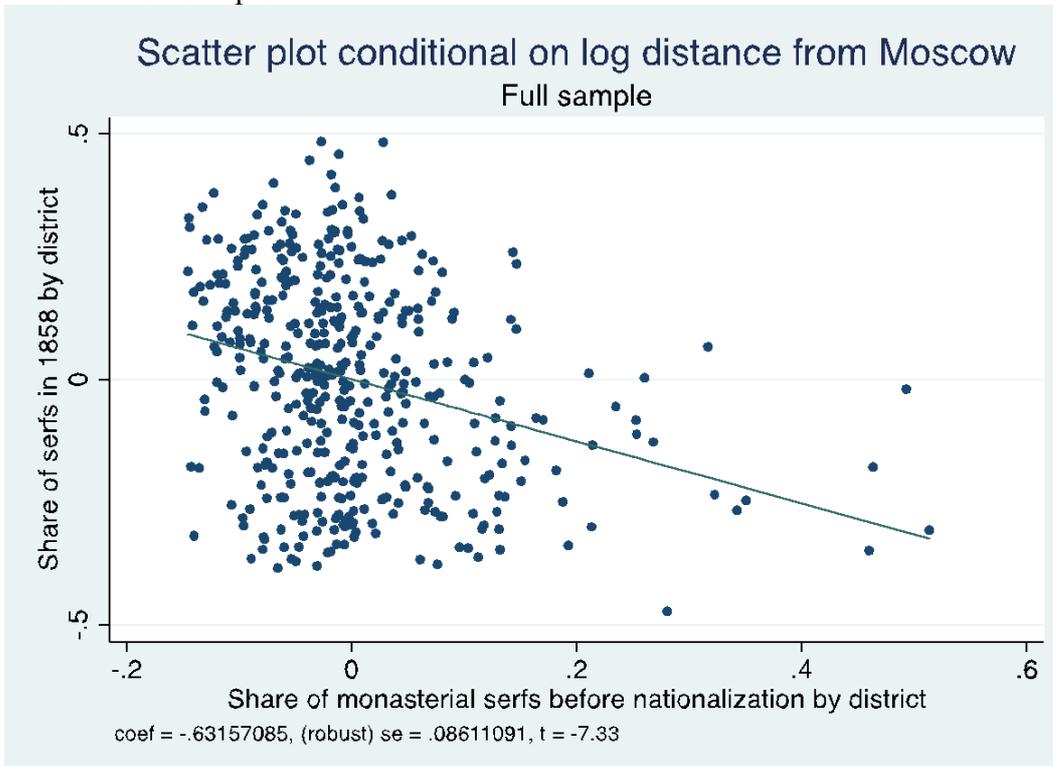


Panel B. Free agricultural workers in 1858 as a share of rural population



Notes: 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.

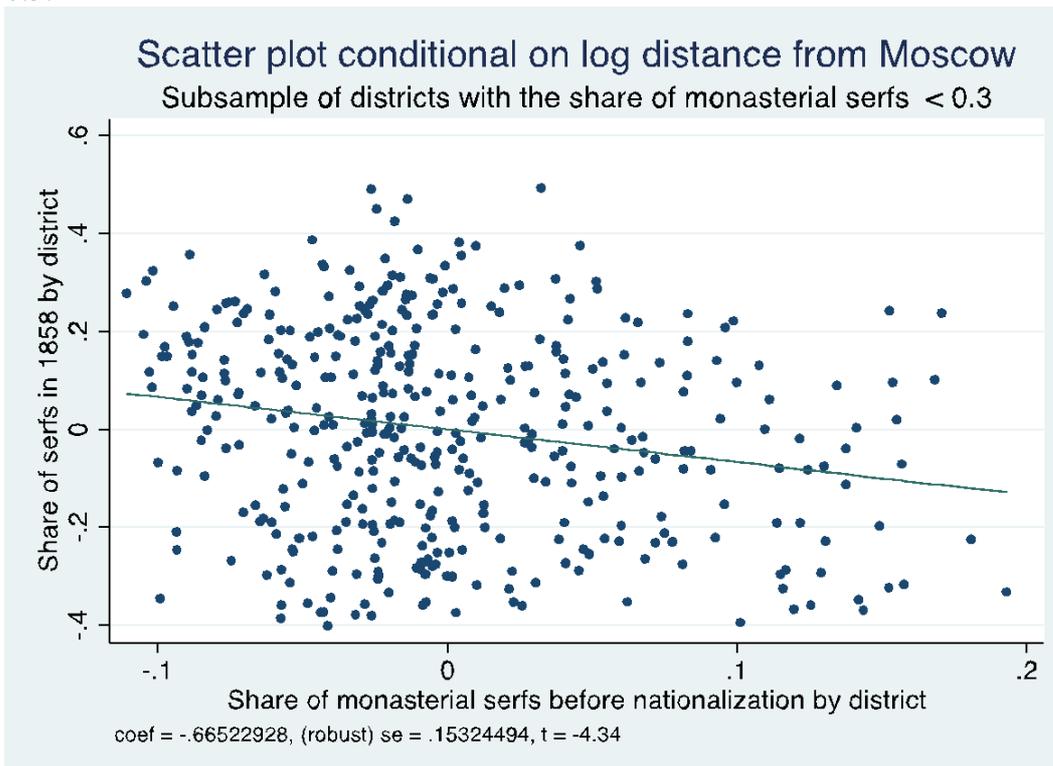
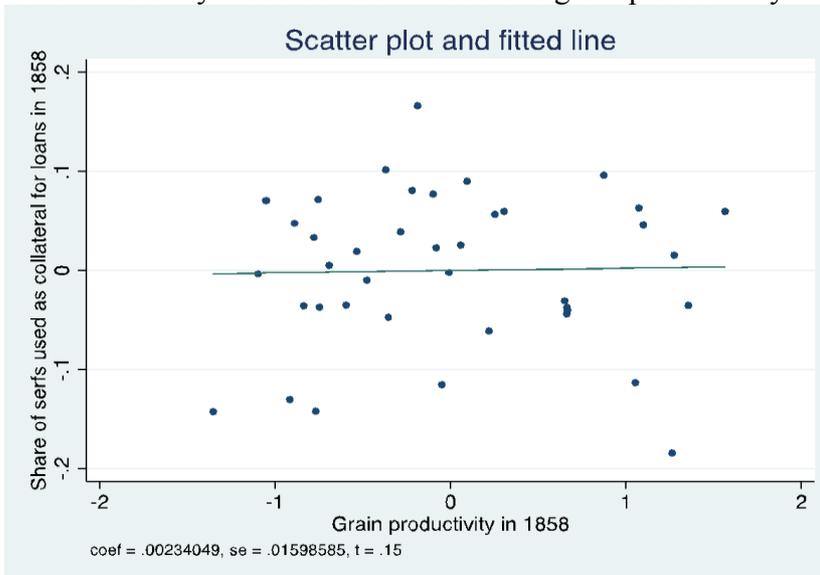
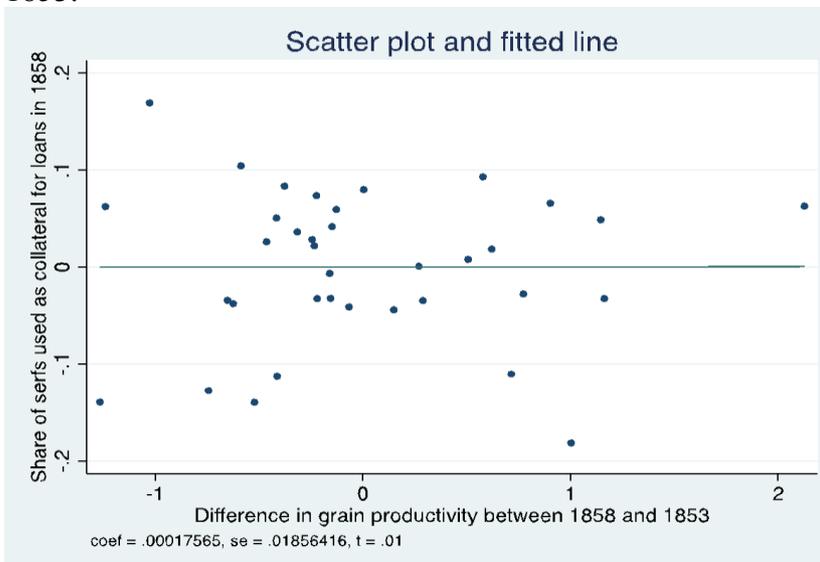


Figure A5. Illustration of the relationship between gentry indebtedness and grain productivity. Panel A. Gentry indebtedness in 1858 and grain productivity in 1858.



Panel B. Gentry indebtedness in 1858 and changes in grain productivity between 1858 and 1853.



Panel C. Gentry indebtedness in 1858 and the share of serfs on corvee in 1858

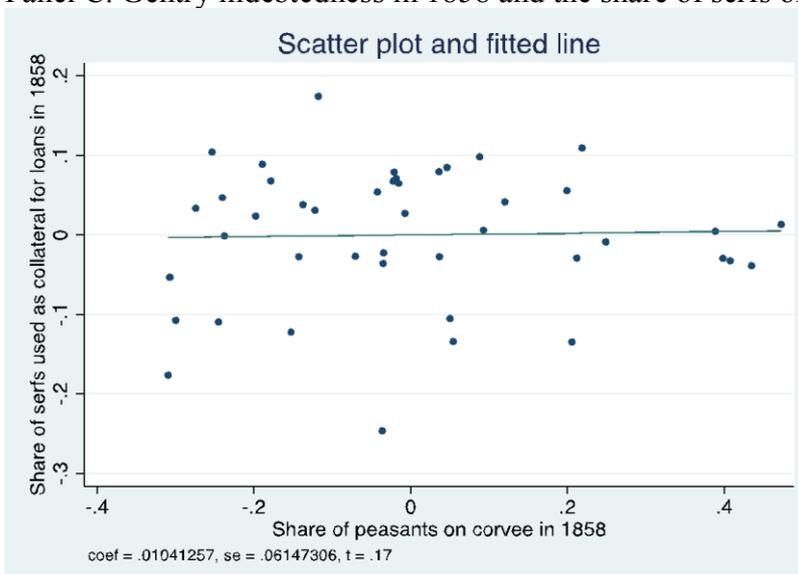


Figure A6. Cross-sectional relationship between prevalence of serfdom and the growth in grain productivity between before and after the emancipation

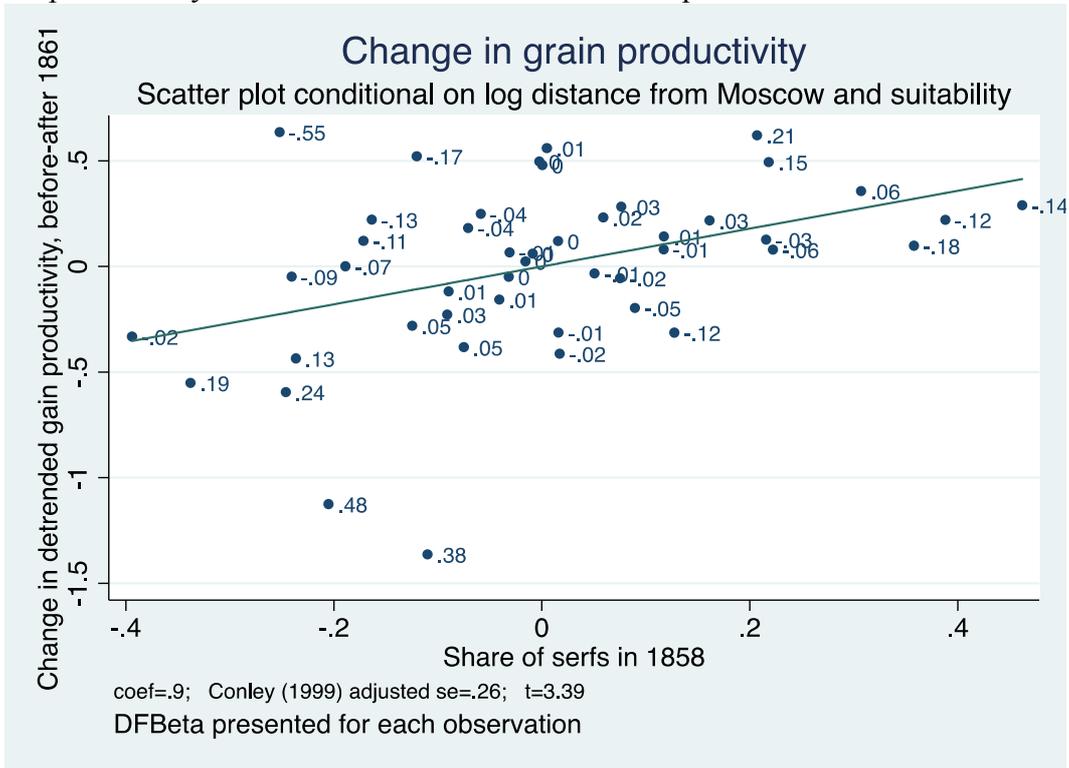
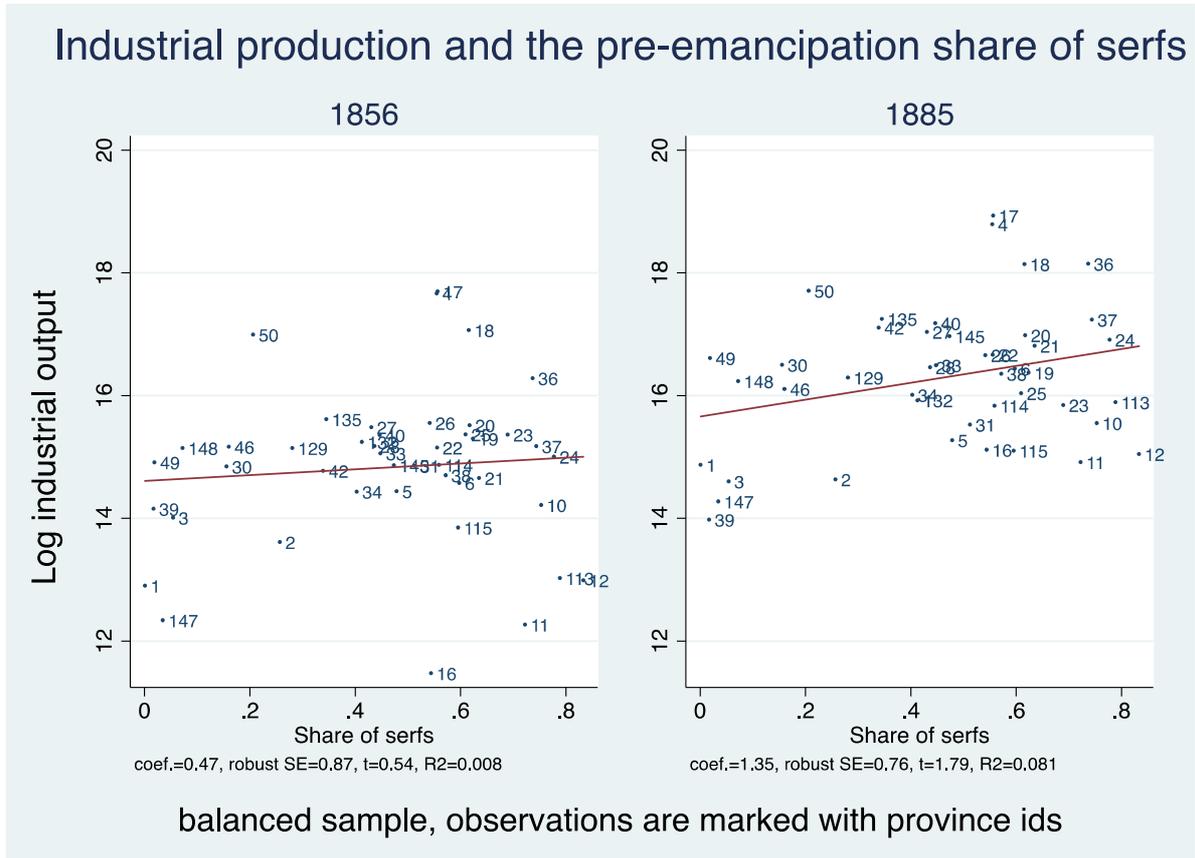


Figure A7. **Industrial output and the share of serfs pre- and post-emancipation**



*Notes:* The figure presents unconditional scatter plots among with the linear fit between log industrial output and the share of serfs across provinces on the same sample at two points in time: 1856 and 1885.

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

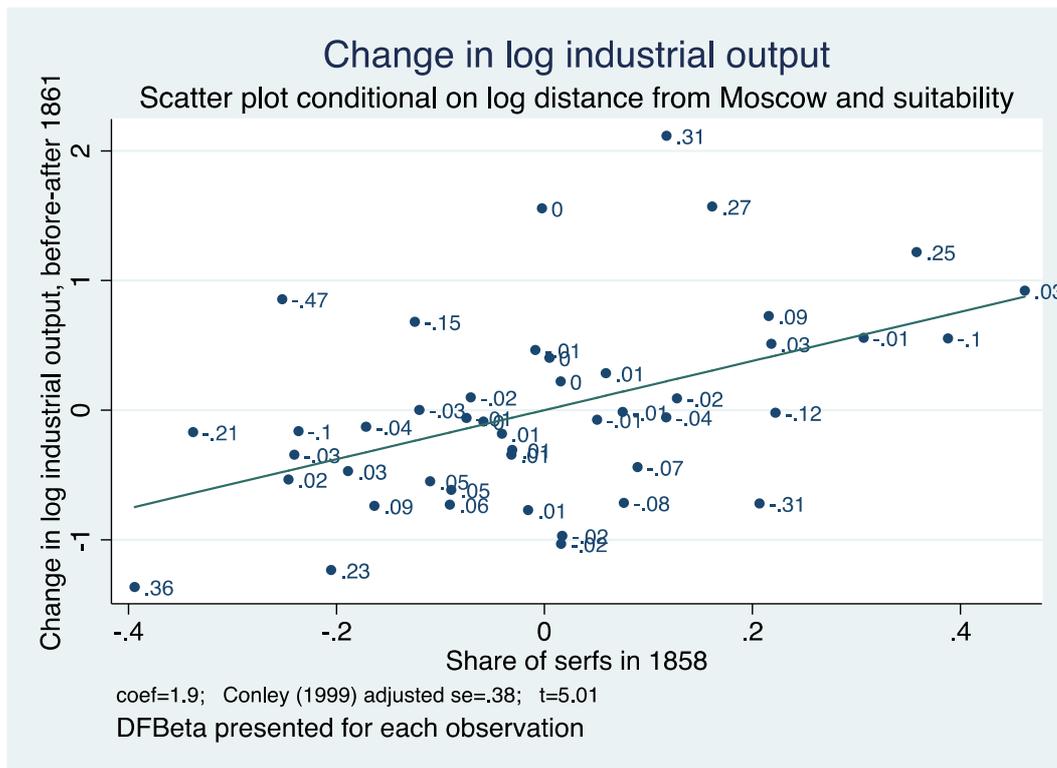
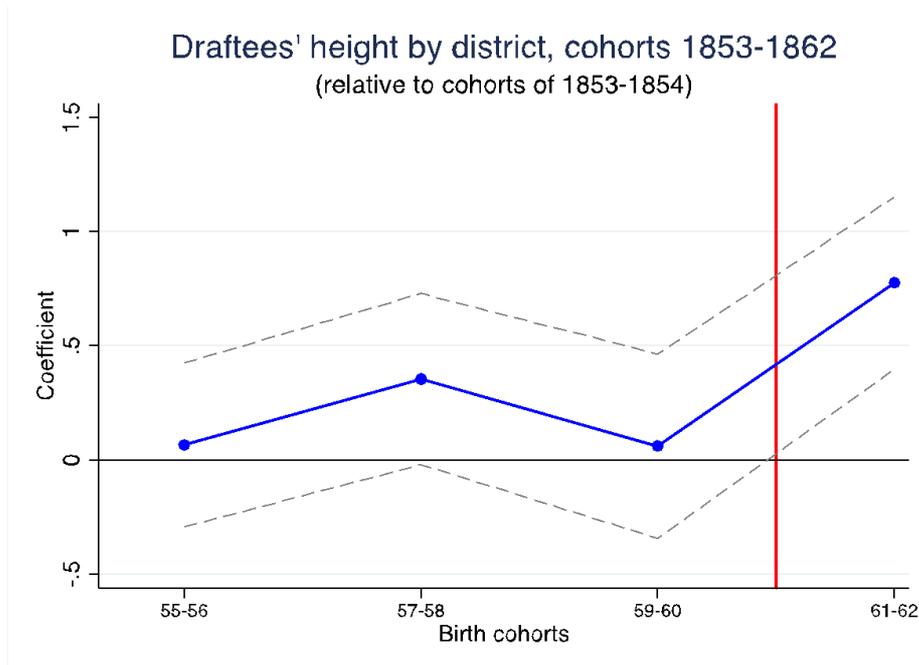


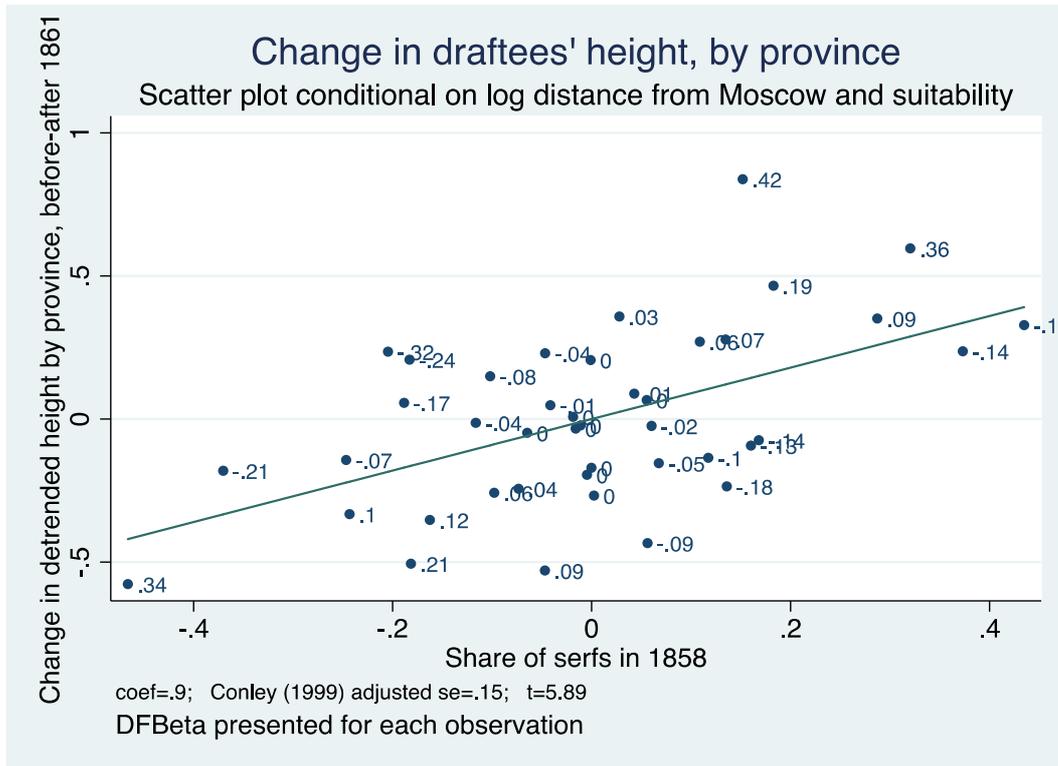
Figure A9. **The time-varying effect of emancipation: draftees' height (district-level).**



*Notes:* The figure presents coefficients (along with their 90% confidence interval) in the regression of the height of draftees on 2-year interval dummies for birth cohorts born around the emancipation interacted with the share of serfs in a district, district and birth-cohort fixed effects, and controls for demeaned suitability interacted with the post-emancipation dummy, and demeaned distance from Moscow interacted with the post-emancipation 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 4 of Table A3 in the online appendix.

Figure A10. 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

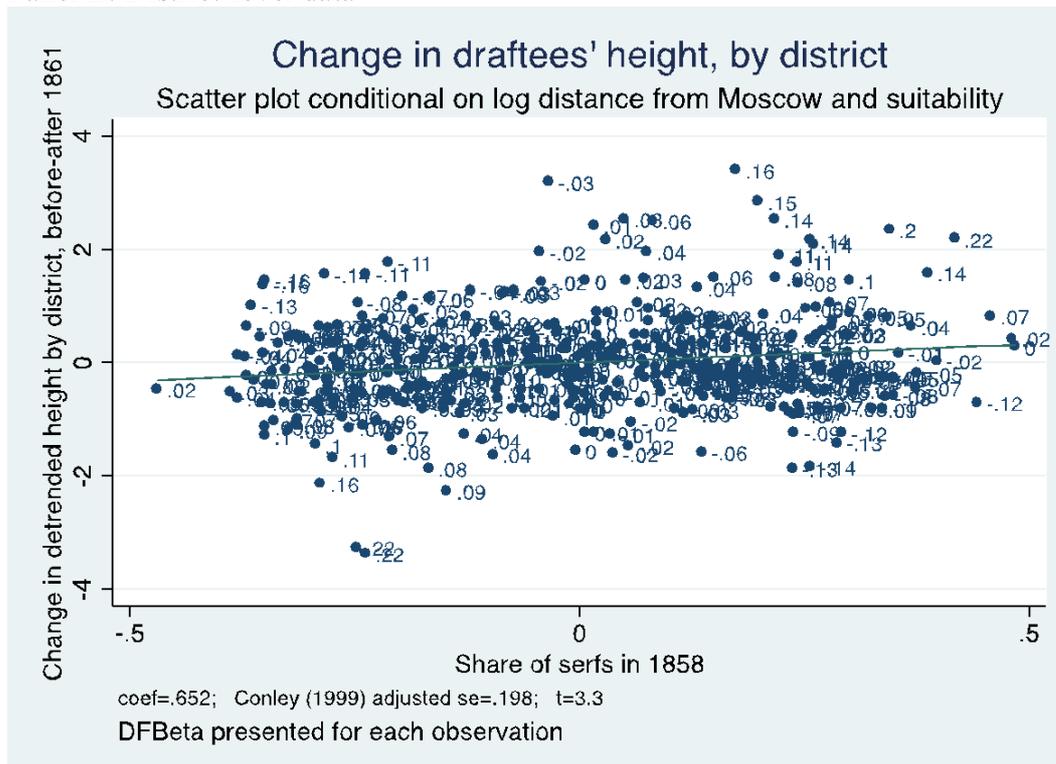


Figure A11. Placebo dates for the emancipation reform



Notes: The figure reports the  $\beta^T$  coefficients along with their 95% confidence intervals against year  $T$  from a series of regressions of the following form on the sample of years before 1861:

$$Y_{it} = \beta^T \text{ShareSerfs}_i \times \text{Post-}T_t + \mathbf{X}_{it}^T \gamma + \psi_i + \Theta_t + \varepsilon_{it},$$

where  $\text{Post-}T_t$  is a dummy, which switches on in year  $T$  and  $\mathbf{X}_{it}^T$  is a vector comprised of the interactions of the log distance from Moscow and of land suitability with the  $\text{Post-}T_t$  dummy.  $\psi_i$  and  $\Theta_t$  are the province and year fixed effects.

## Appendix Tables

Table A1. Data sources and time span of the data

Variable:	Years:	Source:
Grain productivity	1795	Rubinshtein (1957), Kessler and Markevich (2015)
	1800s-1820s, 1840s by decade	Koval'chenko (1959)
	1851, 1856	Commission ... (1873)
	1852-1855, averages for 4 years <sup>A1</sup>	Commission ... (1873), Kessler and Markevich (2015), Koval'chenko (1959), Vilson (1869)
	1857, 1859-1863 by year	Vilson (1869)
	1858	Kessler and Markevich (2015)
	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)
Height of draftees	1853-1862 by year	Vseobshchaya ... (1886)
	1863-1864 by year	Sbornik ... (1887)
	1865-1866 by year	Sbornik ... (1890)
Industrial output	1796	Kessler and Markevich (2015)
	1849	Statisticheskii ... (1852)
	1856	Statisticheskii ... (1858)
	1858	Kessler and Markevich (2015)
	1882, 1883	Sbornik ... (1884)
	1885	Statisticheskii ... (1887)
	1897	Kessler and Markevich (2015)
Winter and spring grain seeds planted for the harvest of the corresponding year	1849	Statisticheskii ... (1852)
	1851, 1856, 1861, 1871	Commission ... (1873)
	1858	Kessler and Markevich (2015)
	1864-1866 by year	Obruchev (1871)
	1883, 1893-1900 by year	Urozhaj v ... (1889-1901)

<sup>A1</sup> Estimated from averages for the decade of the 1850s (Koval'chenko 1959) and annual figures for 1851, 1856 (Commission ... 1873), 1857, 1859, 1860 (Vilson 1869) and 1858 (Kessler, Markevich 2015).

...Continued from the previous page.

World prices of rye and wheat (Netherlands)	1800-1900 by year	van Reil (2016)
Russian prices of rye and oat (by region)	1800-1900 by year	Mironov (1985)
Cultivated land	1800, 1858	Kessler and Markevich (2015)
	1871, 1877	Statistika ... (1880-1886)
Distribution of rural population by status: serfs, state, royal peasants, and free agricultural workers	1858 1857	Bushen (1863), Troinitskii (1861) 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)
Land cuts (in percentage to peasants land before the emancipation)	1863	Zajonchkovskii (1960)
Re-partition commune dummy	1905	Durbrovskii (1963)
Zemstvo expenditures	Averages for 1868, 1871, 1876, 1880, 1885, 1890, 1895, 1903	Veselovskii (1909)
Court reform	1864-1896 by year	Ministry of Justice (1902)
Railways density	1795-1900 by year	Sollogub (1874), Sbornik ... (1884), Kessler and Markevich (2015)
Crop 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 by year	The Global Land Surface Databank (Rennie et al., 2014)

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Table A2. Data availability and agricultural productivity.

	(1)	(2)	(3)	(4)	(5)	(6)
	Dummy on availability of annual X-sections on grain productivity (0=no data; 1=data available)			Dummy on availability of annual X-sections on industrial output (0=no data; 1=data available)		
Detrended grain productivity (national level), quadratic fit	0.022 [0.086]	0.054 [0.127]	0.054 [0.129]	-0.033 [0.052]	0.044 [0.059]	0.044 [0.057]
Detrended grain productivity (national level), quadratic fit X Post-emancipation		-0.071 [0.169]	-0.074 [0.173]		-0.17 [0.105]	-0.17 [0.103]
Time trend			-0.0008 [0.001]			0.0018** [0.001]
Constant	0.81*** [0.040]	0.81*** [0.040]	2.31 [2.062]	0.070*** [0.026]	0.067*** [0.024]	-3.31** [1.439]
Observations	100	100	100	100	100	100
R-squared	0.001	0.003	0.006	0.004	0.030	0.073

Notes: 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 A3. Dynamics of the results of the abolition of serfdom

Dependent var: Grain productivity		Dependent var: log industrial output		Dependent var: Draftees' height		Dependent var: Draftees' height	
Sample:	provinces	Sample:	provinces	Sample:	provinces	Sample:	districts
Share of serfs X (years 1840s)	0.01 [0.473]	Share of serfs X (year 1849)	0.68 [0.759]	Share of serfs X (cohorts 1855-1856)	0.27 [0.293]	Share of serfs X (cohorts 1855-1856)	0.07 [0.219]
Share of serfs X (years 1850-1855)	-0.51 [0.530]	Share of serfs X (years 1856, 1858)	0.80 [0.831]	Share of serfs X (cohorts 1857-1858)	0.47* [0.267]	Share of serfs X (cohorts 1857-1858)	0.35 [0.229]
Share of serfs X (years 1856-1860)	-0.17 [0.504]	Share of serfs X (years 1882, 1883)	2.51*** [0.762]	Share of serfs X (cohorts 1859-1860)	0.30 [0.341]	Share of serfs X (cohorts 1859-1860)	0.06 [0.246]
Share of serfs X (years 1861-1865)	0.67 [0.476]	Share of serfs X (year 1885)	2.70*** [0.768]	Share of serfs X (cohorts 1861-1862)	0.95*** [0.269]	Share of serfs X (cohorts 1861-1862)	0.776*** [0.230]
Share of serfs X (years 1866-1870)	0.66 [0.577]	Share of serfs X (year 1897)	2.17** [0.901]	Share of serfs X (cohorts 1863-1864)	1.20*** [0.253]	Dmnd log distance from Moscow X Post-emancipation	0.18*** [0.0560]
Share of serfs X (years 1871-1875)	1.36** [0.560]	Dmnd log distance from Moscow X Post-emancipation	0.34 [0.459]	Share of serfs X (cohorts 1865-1866)	1.40*** [0.320]	Dmnd crop suitability X Post-emancipation	0.08*** [0.0242]
Share of serfs X (years 1876-1880)	1.98*** [0.722]	Dmnd crop suitability X Post-emancipation	0.10 [0.061]	Dmnd log distance from Moscow X Post-emancipation	0.73*** [0.178]		
Share of serfs X (years 1881-1885)	0.77 [0.668]			Dmnd crop suitability X Post-emancipation	0.15*** [0.022]		
Share of serfs X (years 1886-1890)	1.28** [0.605]						
Share of serfs X (years 1891-1895)	0.58 [0.663]						
Share of serfs X (years post 1895)	1.14* [0.663]						
Dmnd log distance from Moscow X Post-emancipation	-0.66* [0.333]						
Dmnd crop suitability X Post-emancipation	0.07* [0.044]						
Share of state peasants X Post-1866	Yes	Share of state peasants X Post-1866	Yes	Share of state peasants X Post-1866	No	Share of state peasants X Post-1866	No
Share of royal peasants X Post-1859	Yes	Share of royal peasants X Post-1859	Yes	Share of royal peasants X Post-1859	No	Share of royal peasants X Post-1859	No
Province and year FEs	Yes						
Region-specific trends	Yes	Region-specific trends	Yes	Region-specific trends	No	Region-specific trends	No
Observations	1,831	Observations	343	Observations	584	Observations	4,437
R-squared	0.390	R-squared	0.892	R-squared	0.228	R-squared	0.732
Comparison X-sections	1795-1829	Comparison X-sections	1795	Comparison X-sections	1853-1854	Comparison X-sections	1853-1854

Notes: Standard errors are clustered by province or by district separately before and after 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 A4. The effect of the abolition of serfdom on productivity in agriculture differentially depending on the distance from Moscow

	(1)	(2)
Dependent var:	Grain productivity	
Model:	OLS	OLS
Share of serfs X Post-emancipation	1.11*** [0.227]	1.33*** [0.225]
Share of serfs X Demeaned log distance from Moscow X Post-emancipation	-1.07* [0.607]	-1.02* [0.605]
Demeaned crop suitability X Post-emancipation	0.06 [0.040]	0.05 [0.038]
Year and province fixed effects	Yes	Yes
Province-specific trends	Yes	Yes
Share of state peasants X Post-1866	No	Yes
Share of royal peasants X Post-1859	No	Yes
Observations	1,835	1,835
R-squared	0.402	0.403

*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 A5. Robustness to using WLS by log grain output: the effects of the abolition of serfdom on productivity in agriculture

Panel A: Panel data estimation							
Dependent var: Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	WLS	WLS	weighted IV, 2nd stage	WLS	Grain productivity		weighted IV, 2nd stage
Share of serfs X Post-emancipation	0.79*** [0.252]	0.87** [0.431]	1.44** [0.731]	1.38*** [0.498]		2.13*** [0.581]	3.17*** [1.082]
Share of serfs X 1861-1870					0.80* [0.417]		
Share of serfs X 1871-1900					1.18** [0.509]		
Share of peasants with signed buyout contracts						-1.09*** [0.325]	-1.11*** [0.368]
Demeaned log distance to Moscow X Post-emancipation		-1.42** [0.589]	-1.02 [0.733]	-1.24** [0.598]	-1.42** [0.585]	-0.31 [0.590]	0.35 [0.853]
Demeaned crop suitability X Post-emancipation		0.21*** [0.074]	0.19*** [0.072]	0.19** [0.074]	0.21*** [0.073]	0.21*** [0.078]	0.18** [0.077]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	No	Yes	Yes	Yes	Yes	Yes	Yes
State and royal peasant reforms	No	No	No	Yes	No	No	No
Observations	1,443	1,443	1,443	1,443	1,443	1,403	1,403
R-squared	0.512	0.535	0.535	0.536	0.535	0.543	0.543

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

Dependent var: Model:	(3)	(7.1)	(7.2)
	Share of serfs X Post- emancipation weighted IV, 1st stage	Share of serfs X Post- emancipation weighted IV, 1st stage	Share of peasants with signed buyout contracts weighted IV, 1st stage
Share of nationalized monasterial serfs X Post-emancipation	-1.29*** [0.303]	-1.30*** [0.308]	-1.66*** [0.364]
Interpolation b/w (1-indebtedness) and 1 in the interval 1862-1882		0.14 [0.156]	2.95*** [0.185]
Controls as in respective column of Panel A	Yes	Yes	Yes
Observations	1,443	1,403	1,403
F, monasterial serfs instrument	18.22	17.86	20.89
F, indebtedness instrument		0.760	252.9

*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. 1861-1870 and 1871-1900 time dummies equal to 1 in corresponding years and 0 otherwise. 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 there is a discrete jump in this variable to the share of serfs in 1863. Indebtedness is the ratio of serfs in the province used as collateral in landlords' debt contracts in 1858 to the total rural population in the province

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

Table A6. The effect of the abolition of serfdom on cultivated lands

Dependent var:	(1)	(2)	(3)	(4)
	Ln (cultivated land) OLS	Share of serfs X Post-emancipation IV, 1st stage	Ln (cultivated land) IV, 2nd stage	Ln (cultivated land) OLS
Share of serfs X Post-emancipation	-0.16 [0.203]		0.23 [0.347]	0.70 [0.994]
Share of nationalized monasterial serfs X Post-emancipation		-1.05*** [0.312]		
Demeaned log distance from Moscow X Post-emancipation	0.37* [0.197]	-0.94*** [0.103]	0.66** [0.259]	0.49** [0.192]
Demeaned crop suitability X Post-emancipation	0.02 [0.032]	0.03* [0.019]	0.02 [0.029]	0.03 [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	191	191	191	191
F, monasterial serfs instrument		11.38		
R-squared	0.381	0.964	0.947	0.385

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 A7. Robustness of the effect of the abolition of serfdom on height of draftees at district level: samples excluding Moscow and Saint Petersburg districts.

Panel A: Panel data estimation			
	(1)	(2)	(3)
Dependent var:	Draftees' height (cohorts 1853-1862)		
Data set:	District-level data		
Sample:	Without Moscow and St.Petersburg		
Model:	OLS	OLS	IV, 2nd stage
Share of serfs X Post-emancipation cohorts	0.42*** [0.141]	0.66*** [0.156]	0.81* [0.485]
Demeaned log distance from Moscow X Post-emancipation		0.18*** [0.053]	0.21** [0.095]
Demeaned crop suitability X Post-emancipation		0.08*** [0.023]	0.08*** [0.025]
Birth cohort and province or district fixed effects	Yes	Yes	Yes
Province-specific trends	No	No	No
Observations	4,427	4,427	4,347
R-squared	0.559	0.561	0.730
Panel B: First stages of the corresponding 2SLS panel regressions			
Dependent var:		(2)	Share of serfs X Post-emancipation cohorts
Model:			IV, 1st stage
Share of nationalized monasterial serfs X Post-emancipation cohorts			-0.65*** [0.074]
Controls as in respective column of Panel A			Yes
Observations			4,347
F, excluded instrument			76.09

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 A8. Chest of orthodox males measured in the age of 21 in Bobruisk district (cohorts 1853-1878) by height groups

Chest of ortodox males measured in the age of 21 in Borujsk district (cohorts 1853-1878) by height groups

Height (centimeters)	Chest size (centimeters)		N of males
	Min	Max	
Height: 153.4 -155.6	72.8	94.5	612
Height: 155.6 -160	71.1	95	3570
Height: 160 - 164.5	75.6	98.3	4929
Height: 164.5 -168.9	72.2	98.3	5318
Height: 168.9 -173.4	76.7	100	3440
Height: 173.4 -177.8	78.9	101.1	1377
Height: 177.8 -182.2	80.6	102.2	312
Height: 182.2 -186.7	77.2	97.8	48
Height: 186.7 - 188.9	85.6	92.8	4

Source: Gorskii P.A. (1910). K kharakteristike phizicheskogo razvitiya naseleniya Bobrujskogo yezda Minskoj gubernii. Po dannim prizyvnykh spiskov voinskogo prisutstviya za 1874-1899. Dissertatsiya na stepen doktora meditsyny. [On characteristics of physical anthropology of citizens of Borujsk district of Minsk province. Based on conscription lists of the district conscription commission, 1874-1899. Ph. D. dessirtation in medicine]. Saint-Peterburg: Trej. Appendix. Table VIII.

Table A9. Draft reforms of chest-to-height minimum, the geography of serfdom and draftees' height

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent var:	Draftees' height			Unadjusted draftees height		
Sample:	Cohorts born in 1861-1863	Cohorts born in 1862-1866	Cohorts born in 1861, 1864-1866	Cohorts born in 1861-1863	Cohorts born in 1862-1866	Cohorts born in 1861, 1864-1866
Model:	OLS	OLS	OLS	OLS	OLS	OLS
Share of serfs X Post-1862	0.10 [0.278]			0.12 [0.257]		
Share of serfs X Post-1864		0.57 [0.376]	0.59 [0.458]		0.56 [0.363]	0.61 [0.442]
Demeaned Log Distance from Moscow and suitability interacted with the respective placebo reform	Yes	Yes	Yes	Yes	Yes	Yes
Birth cohort and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	No	No	No	No	No	No
Observations	126	168	168	126	168	168
R-squared	0.223	0.192	0.275	0.323	0.306	0.461

*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. The 1883 reform of chest-to-height minimum affected cohorts born in 1862 and 1863. The 1885 reform of chest-to-height minimum affected cohorts born in 1864 and latter.

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

Table A10. The abolition of serfdom and peasant living standards: draftees' height (original figures, non-adjusted for 1882 reform of chest-to-height minimum which affected the cohort born in 1861)

Panel A: Panel data estimation

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent var:	Unadjusted draftees' height (cohorts 1853-1866)			Unadjusted draftees' height (cohorts 1853-1862)		
Data set:	Province-level data			District-level data		
Model:	OLS	IV, 2nd stage		OLS	IV, 2nd stage	
Share of serfs X Post-emancipation cohorts	0.76*** [0.155]	0.91*** [0.127]	0.76** [0.309]	0.41*** [0.128]	0.61*** [0.143]	0.89* [0.459]
Demeaned log distance from Moscow X Post-emancipation		0.69*** [0.170]	0.60*** [0.230]		0.14*** [0.049]	0.19** [0.089]
Demeaned crop suitability X Post-emancipation		0.15*** [0.021]	0.16*** [0.022]		0.08*** [0.021]	0.09*** [0.023]
Birth cohort and province or district fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	No	No	No	No	No	No
Observations	584	584	584	4,437	4,437	4,357
R-squared	0.199	0.291	0.857	0.592	0.594	0.591
F, excluded instrument			17.32			72.12

Panel B: Exactly the same as in Table 5

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	0.89*** [0.154]	0.65*** [0.132]	0.61*** [0.196]	0.43*** [0.133]
Log distance from Moscow, crop suitability	Yes	Yes	Yes	Yes
Observations	42	39	447	438
Adj R-squared	0.554	0.511	0.047	0.046

Notes: In Panel A 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.

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

Table A11. Controlling for potentially confounding factors in the estimation of the effect of the abolition of serfdom on grain productivity

Dependent var:	(1)	(2)	(3)	(4)	(5)
	Grain productivity				
	OLS	OLS	OLS	OLS	OLS
Share of serfs X Post-emancipation	0.83*** [0.259]	0.88*** [0.258]	1.05*** [0.262]	0.90*** [0.281]	0.54* [0.290]
Ln(railways)	0.037** [0.014]				0.038** [0.016]
Temperature		-0.16** [0.061]			-0.17*** [0.064]
Court reform			0.050 [0.160]		0.11 [0.154]
Zemstvo expenditures per capita in 1868-1903 X Post-1864				-0.15 [0.115]	-0.20 [0.121]
Demeaned log distance from Moscow X Post-emancipation	-0.83** [0.383]	-0.84** [0.368]	-0.82** [0.377]	-1.01*** [0.373]	-0.85** [0.408]
Demeaned crop suitability X Post-emancipation	0.01 [0.040]	0.01 [0.037]	0.06 [0.040]	0.05 [0.036]	-0.05 [0.039]
Share of state peasants X Post-1866	Yes	Yes	Yes	Yes	Yes
Share of royal peasants 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	1,794	1,775	1,835	1,835	1,734
R-squared	0.411	0.411	0.404	0.404	0.420

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. Controlling for potentially confounding factors in the estimation of the effect of the abolition of serfdom on industrial output

Dependent var:	(1)	(2)	(3)	(4)	(5)
	Ln (industrial output)				
	OLS	OLS	OLS	OLS	OLS
Share of serfs X Post-emancipation	1.38** [0.573]	1.49*** [0.345]	1.37** [0.576]	0.58 [0.553]	0.52 [0.460]
Ln(railways)	0.00014 [0.024]				-0.029 [0.023]
Temperature		0.029 [0.040]			0.057 [0.038]
Court reform			0.025 [0.119]		0.11 [0.137]
Zemstvo expenditures per capita in 1868-1903 X Post-1864				-0.45*** [0.110]	-0.49*** [0.112]
Demeaned log distance from Moscow X Post-emancipation	0.52 [0.449]	0.48 [0.515]	0.53 [0.446]	-0.09 [0.468]	-0.14 [0.516]
Demeaned crop suitability X Post-emancipation	0.12* [0.066]	0.06 [0.067]	0.13* [0.065]	0.11* [0.061]	0.05 [0.065]
Share of state peasants X Post-1866	Yes	Yes	Yes	Yes	Yes
Share of royal peasants 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	347	308	347	347	308
R-squared	0.887	0.873	0.887	0.893	0.882

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. Controlling for potentially confounding factors in the estimation of the effect of the abolition of serfdom on the height of draftees

Dependent var:	(1)	(2)	(3)	(4)	(5)
	OLS	Draftees' height (cohorts 1853-1866) OLS	OLS	OLS	OLS
Share of serfs X Post-emancipation	0.91*** [0.125]	0.89*** [0.127]	0.92*** [0.130]	0.78*** [0.147]	0.72*** [0.143]
Ln(railways)	0.01 [0.016]				0.01 [0.016]
Temperature		0.03 [0.032]			0.03 [0.031]
Court reform			0.05 [0.109]		0.07 [0.112]
Zemstvo expenditures per capita in 1868-1903 X Post-1864				-0.12 [0.086]	-0.13 [0.086]
Demeaned log distance from Moscow X Post-emancipation	0.74*** [0.183]	0.67*** [0.181]	0.75*** [0.180]	0.65*** [0.186]	0.60*** [0.200]
Demeaned crop suitability X Post-emancipation	0.15*** [0.021]	0.15*** [0.022]	0.15*** [0.022]	0.15*** [0.022]	0.15*** [0.022]
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes
Province-specific trends	No	No	No	No	No
Observations	584	579	584	584	579
R-squared	0.218	0.204	0.217	0.224	0.213

*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 A14. Re-estimation of Table 2 in the subsample excluding the provinces of the former Polish-Lithuanian Commonwealth before 1843, i.e., before the year of nationalization of lands with catholic monasteries

Panel A: Panel data estimation							
Dependent var:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Sample:	Excluding the provinces of the former Polish-Lithuanian Commonwealth before 1843						
Model:	OLS	OLS	IV, 2nd stage	OLS		OLS	IV, 2nd stage
Share of serfs X Post-emancipation	0.84*** [0.230]	0.72*** [0.218]	1.25** [0.457]	0.97*** [0.219]		0.87*** [0.330]	2.69*** [0.633]
Share of serfs X 1861-1870					0.69*** [0.213]		
Share of serfs X 1871-1900					0.84** [0.371]		
Share of peasants with signed buyout contracts						-0.33 [0.257]	-1.15*** [0.333]
Demeaned log distance from Moscow X Post-emancipation		-1.03*** [0.336]	-0.64 [0.422]	-0.97*** [0.333]	-1.02*** [0.337]	-0.78* [0.406]	0.53 [0.495]
Demeaned crop suitability X Post-emancipation		0.07* [0.040]	0.06 [0.043]	0.06 [0.038]	0.07* [0.040]	0.07* [0.039]	0.06 [0.047]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	No	Yes	Yes	Yes	Yes	Yes	Yes
State and royal peasant reforms	No	No	No	Yes	No	No	No
Observations	1,828	1,828	1,828	1,828	1,828	1,773	1,773
R-squared	0.368	0.404	0.533	0.405	0.404	0.404	0.539

Panel B: First stages of the corresponding 2SLS panel regressions				
Dependent var:	(3)	(7.1)	(7.2)	
Model:	Share of serfs X Post-emancipation	Share of serfs X Post-emancipation	Share of peasants with signed buyout contracts	
	IV, 1st stage	IV, 1st stage	IV, 1st stage	
Share of nationalized monasterial serfs X Post-emancipation	-1.24*** [0.290]	-1.27*** [0.291]	-1.32*** [0.268]	
Interpolation b/w (1-indebtedness) and 1 in the interval 1862-1882		0.19 [0.187]	2.76*** [0.271]	
Controls as in respective column of Panel A	Yes	Yes	Yes	
Observations	1,828	1,773	1,773	
F, monasterial serfs instrument	18.29	19.09	24.44	
F, indebtedness instrument		1.027	104.2	

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. 1861-1870 and 1871-1900 time dummies equal to 1 in corresponding years and 0 otherwise. The 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 all the non-western provinces this happened by 1882, and in western provinces there was a jump in this variable to the share of serfs in 1863. Indebtedness is the ratio of serfs in the province used as collateral in landlords' debt contracts in 1858 to the total rural population in the province.

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

Table A15. Robustness of the effect of the land reform to the sample restricted to the provinces where the land reform was governed by the same law, i.e., the Great Russia, New Russia and a part of Belorussia

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample:	the Great Russia, the New Russia and a part of Belorussia provinces					Full Sample		
Dependent var:	Grain productivity	Share of serfs	Share of serfs with X Post-emancipation signed buyout contracts	Grain productivity		Grain productivity		
	OLS	IV, 1 stage	IV, 1 stage	IV, 2nd stage	OLS	OLS	OLS	OLS
Share of serfs X Post-emancipation	1.26*** [0.381]			2.72*** [0.637]	1.29*** [0.386]	1.04*** [0.333]	0.90** [0.364]	1.16*** [0.340]
Share of peasants with signed buyout contracts	-0.56 [0.382]			-1.39*** [0.489]	-0.51 [0.388]	-0.38 [0.276]	-0.43 [0.260]	-0.48* [0.260]
Land cuts X Post-1863					0.00071 [0.006]	0.0016 [0.005]		
Share of serfs X Large Avreage Estate Dummy							0.16 [0.228]	
Share of pesants on quitrent X Post-emancipation								-0.78** [0.367]
Share of nationalized monasterial serfs X Post-emancipation		-0.99*** [0.319]	-1.12*** [0.323]					
Interpolation b/w (1-indebtedness) and 1 in the interval 1862-1882		-0.33** [0.166]	2.15*** [0.301]					
Demeaned log distance from Moscow X Post-emancipation	-0.40 [0.535]	-1.00*** [0.108]	-0.74*** [0.116]	0.70 [0.602]	-0.67 [0.540]	-0.80* [0.449]	-0.69 [0.454]	-1.02** [0.459]
Demeaned crop suitability X Post-emancipation	0.01 [0.046]	0.03* [0.018]	0.03 [0.018]	0.01 [0.051]	-0.01 [0.047]	0.04 [0.038]	0.06 [0.040]	0.06 [0.038]
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,359	1,385	1,359	1,359	1,300	1,682	1,780	1,709
F, monasterial serfs instrument		9.579	12.13					
F, indebtedness instrument		4.014	50.89					
R-squared	0.407	0.981	0.962	0.526	0.417	0.420	0.403	0.417

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. The 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 all the non-western provinces, this happened by 1882, and in the western provinces there was a jump in this variable to the share of serfs in 1863. Indebtedness is the ratio of serfs in the province used as collateral in landlords' debt contracts in 1858 to the total rural population in the province. Large average estate dummy equals one to provinces with an average estate of a hundred of serfs or more in 1858. Share of peasants on corvee equals to share of serfs with obligations of payments in labor in 1858.

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

Table A16. Robustness to deflation by rye prices using: the abolition of serfdom and industrial development

Panel A: Panel data estimation				
Dependent var:	(1)	(2)	(3)	(4)
	Ln (industrial output deflated by local rye prices)			
	OLS	OLS	IV, 2nd stage	OLS
Share of serfs X Post-emancipation	0.80** [0.320]	1.14*** [0.330]	3.68*** [1.368]	1.44*** [0.467]
Demeaned log distance from Moscow X Post-emancipation		0.96** [0.441]	2.77** [1.112]	1.07** [0.460]
Demeaned crop suitability X Post-emancipation		0.12* [0.064]	0.13 [0.077]	0.13* [0.064]
Year and province fixed effects		Yes	Yes	Yes
Region-specific trends		Yes	Yes	Yes
State and royal peasant reforms		No	No	Yes
Observations	347	347	347	347
R-squared	0.754	0.852	0.923	0.855

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	-1.02*** [0.260]
Controls as in respective column of Panel A	Yes
Observations	347
F, excluded instrument	15.42

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 A17. Robustness to using 1857 tax census data: the effect of the abolition of serfdom on grain productivity

Panel A: Panel data estimation							
Dependent var: Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	OLS	OLS	IV, 2nd stage	OLS	Grain productivity	OLS	IV, 2nd stage
Share of serfs (according to 1857 tax census data) X Post-emancipation	0.90*** [0.238]	0.92*** [0.267]	1.51** [0.566]	1.19*** [0.277]		1.14*** [0.363]	3.04*** [0.746]
Share of serfs (according to 1857 tax census data) X 1861-1870					0.88*** [0.262]		
Share of serfs (according to 1857 tax census data) X 1871-1900					1.06*** [0.397]		
Share of peasants (according to 1857 tax census data) with signed buyout contracts						-0.41 [0.258]	-1.17*** [0.328]
Demeaned log distance from Moscow X Post-emancipation		-0.93** [0.377]	-0.50 [0.483]	-0.87** [0.374]	-0.92** [0.376]	-0.64 [0.431]	0.71 [0.537]
Demeaned crop suitability X Post-emancipation		0.09** [0.042]	0.09* [0.043]	0.09** [0.039]	0.09** [0.042]	0.09** [0.041]	0.09* [0.047]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	No	Yes	Yes	Yes	Yes	Yes	Yes
Share of state peasants (according to 1857 tax census data) X Post-1866	No	No	No	Yes	No	No	No
Share of royal peasants (according to 1857 tax census data) X Post-1859	No	No	No	Yes	No	No	No
Observations	1,758	1,758	1,758	1,758	1,758	1,715	1,715
R-squared	0.372	0.411	0.545	0.413	0.411	0.410	0.548

Panel B: First stages of the corresponding 2SLS panel regressions				
Dependent var: Model:	(3)	(7.1)	(7.2)	
	Share of serfs X Post-emancipation IV, 1st stage	Share of serfs X Post-emancipation IV, 1st stage	Share of peasants with signed buyout IV, 1st stage	
Share of nationalized monasterial serfs X Post-emancipation	-1.03*** [0.266]	-1.07*** [0.272]	-1.16*** [0.249]	
Interpolation b/w (1-indebtedness) and 1 in the interval 1862-1882		0.08 [0.166]	2.59*** [0.241]	
Controls as in respective column of Panel A	Yes	Yes	Yes	
Observations	1,758	1,715	1,715	
F, monasterial serfs instrument	15.11	15.37	21.77	
F, indebtedness instrument		0.221	115.7	

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. 1861-1870 and 1871-1900 time dummies equal to 1 in corresponding years and 0 otherwise. The 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 all the non-western provinces this happened by 1882, and in western provinces there was a jump in this variable to the share of serfs in 1863. Indebtedness is the ratio of serfs in the province used as collateral in landlords' debt contracts in 1858 to the total rural population in the province.

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

Table A18. Robustness to using 1857 tax census data: the mechanisms behind the effects of the land reform and the emancipation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent var:	Grain productivity		Share of winter crops seeded at t-1 in total winter and summer crops seeded at [t-1;t] production cycle				
	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Share of serfs (according to 1857 tax census data) X Post-emancipation	0.92** [0.356]	1.92*** [0.446]	-0.11*** [0.029]	-0.04*** [0.016]	-0.10*** [0.029]	-0.03 [0.022]	-0.13*** [0.033]
Share of peasants (according to 1857 tax census data) with signed buyout contracts	0.18 [0.302]	-0.51** [0.258]					
Share of peasants (according to 1857 tax census data) with signed buyout contract X repartition commune dummy	-0.77** [0.360]						
Share of serfs (according to 1857 tax census data) X Post-emancipation X Implicit contracts		-1.71*** [0.573]					
Demeaned temperature (t-1)			0.004 [0.003]		0.003 [0.003]		0.004 [0.003]
Share of serfs (according to 1857 tax census data) X Post-emancipation X Demeaned temperature (t-1)			0.01** [0.004]		0.01* [0.004]		0.01*** [0.005]
Share of serfs (according to 1857 tax census data) X Post-emancipation X Demeaned rye-to-wheat world price ratio (t-1)				-0.42*** [0.097]	-0.37*** [0.100]		
Share of serfs (according to 1857 tax census data) X Post-emancipation X Demeaned rye-to-oat local price ratio (t-1)						-0.10** [0.043]	-0.11*** [0.042]
Share of serfs (according to 1857 tax census data) X Demeaned rye-to-oat local price ratio (t-1)						0.02 [0.046]	0.03 [0.043]
Demeaned rye-to-oat local price ratio (t-1)						0.02 [0.019]	0.01 [0.017]
Demeaned log distance from Moscow X Post-emancipation	-0.96** [0.458]	-0.80* [0.435]	-0.03 [0.020]	0.02 [0.017]	-0.02 [0.020]	0.02 [0.020]	-0.04* [0.022]
Demeaned crop suitability X Post-emancipation	0.07* [0.040]	0.06* [0.036]	0.002 [0.002]	0.0004 [0.002]	0.001 [0.002]	0.001 [0.003]	0.003 [0.002]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,715	1,644	761	765	761	729	721
R-squared	0.411	0.428	0.833	0.832	0.839	0.825	0.835

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

Panel A: Panel data estimation

	(1)	(2)	(3)	(4)
Dependent var:		Ln (industrial output)		
	OLS	OLS	IV, 2nd stage	OLS
Share of serfs (according to 1857 tax census data) X Post-emancipation	0.54 [0.344]	0.60 [0.461]	3.11* [1.552]	1.19* [0.710]
Demeaned log distance from Moscow X Post-emancipation		0.32 [0.465]	2.11* [1.224]	0.41 [0.468]
Demeaned crop suitability X Post-emancipation		0.12* [0.066]	0.15** [0.073]	0.14** [0.065]
Year and province fixed effects	Yes	Yes	Yes	Yes
Region-specific trends	No	Yes	Yes	Yes
Share of state peasants (according to 1857 tax census data) X Post-1866	No	No	No	Yes
Share of royal peasants (according to 1857 tax census data) X Post-1859	No	No	No	Yes
Observations	340	340	340	340
R-squared	0.797	0.884	0.931	0.886

Panel B: First stage of the corresponding 2SLS panel regression

Dependent var:	(3) Share of serfs X Post-emancipation
Model:	IV, 1st stage
Share of nationalized monasterial serfs X Post-emancipation	-0.84*** [0.234]
Controls as in respective column of Panel A	Yes
Observations	340
F, monasterial serfs instrument	12.81

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 A20. 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)		
Data set:	Province-level data		
Model:	OLS	OLS	IV, 2nd stage
Share of serfs (according to 1857 tax census data) X Post-emancipation cohorts	0.67*** [0.159]	0.96*** [0.139]	0.99** [0.388]
Demeaned log distance from Moscow X Post-emancipation		0.76*** [0.193]	0.78*** [0.296]
Demeaned crop suitability X Post-emancipation		0.17*** [0.024]	0.17*** [0.023]
Birth cohort and province fixed effects	Yes	Yes	Yes
Province-specific trends	No	No	No
Observations	570	570	570
R-squared	0.104	0.222	0.858

Panel B: First stage of the corresponding 2SLS panel regression

	(3)
Dependent var:	Share of serfs X Post-
Model:	IV, 1st stage
Share of nationalized monasterial serfs X Post-emancipation cohorts	-1.07*** [0.283]
Controls as in respective column of Panel A	Yes
Observations	570
F, excluded instrument	14.22

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 A21. The effect of the abolition of serfdom on grain productivity in the subsample with data from governor reports only

Panel A: Panel data estimation							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent var:	Grain productivity						
Sample:	Data on grain productivity from governor reports only						
Model:	OLS	OLS	IV, 2nd stage	OLS		OLS	IV, 2nd stage
Share of serfs X Post-emancipation	1.08*** [0.167]	0.70*** [0.246]	1.90*** [0.504]	0.90*** [0.259]		0.55 [0.350]	2.74*** [0.639]
Share of serfs X 1861-1870					0.67*** [0.247]		
Share of serfs X 1871-1900					0.87** [0.332]		
Share of peasants with signed buyout contracts						0.14 [0.248]	-0.82* [0.442]
Demeaned log distance from Moscow X Post-emancipation		-0.58* [0.334]	0.25 [0.382]	-0.55* [0.329]	-0.58* [0.336]	-0.75* [0.410]	0.76 [0.503]
Demeaned crop suitability X Post-emancipation		0.02 [0.036]	0.02 [0.046]	0.02 [0.035]	0.02 [0.037]	0.01 [0.037]	0.01 [0.054]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	No	Yes	Yes	Yes	Yes	Yes	Yes
Share of state peasants X Post-1866	No	No	No	Yes	No	No	No
Share of royal peasants X Post-1859	No	No	No	Yes	No	No	No
Observations	1,010	1,010	1,010	1,010	1,010	955	955
R-squared	0.238	0.289	0.500	0.293	0.289	0.300	0.515

Panel B: First stage of the corresponding 2SLS panel regression				
	(3)	(7.1)	(7.2)	
Dependent var:	Share of serfs X Post-emancipation	Share of serfs X Post-emancipation	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	-1.45*** [0.318]	-1.45*** [0.332]	-1.38*** [0.293]	
Interpolation b/w (1-indebtedness) and 1 in the interval 1862-1882		0.05 [0.188]	2.37*** [0.318]	
Controls as in respective column of Panel A	Yes	Yes	Yes	
Observations	1,010	955	955	
F, monasterial serfs instrument	20.88	19.09	22.12	
F, indebtedness instrument		0.0689	55.16	

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. 1861-1870 and 1871-1900 time dummies equal to 1 in corresponding years and 0 otherwise. The 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 all the non-western provinces this happened by 1882, and in western provinces there was a jump in this variable to the share of serfs in 1863. Indebtedness is the ratio of serfs in the province used as collateral in landlords' debt contracts in 1858 to the total rural population in the province.

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

Table A22. The effect of the abolition of serfdom on grain productivity in the sample including the Baltic provinces

Dependent var:	(1)	(2)	(3)	(4)
	OLS	Grain productivity OLS	OLS	OLS
Share of serfs X Post-emancipation	0.85*** [0.242]	1.01*** [0.258]		
Share of non-Baltic serfs X Post-1861			0.79*** [0.248]	1.02*** [0.254]
Share of Baltic serfs X Post 1820			1.11 [0.736]	0.99 [0.759]
Demeaned log distance from Moscow in non-Baltic provinces X Post-1861	-0.89** [0.353]	-0.88** [0.355]	-0.94** [0.361]	-0.88** [0.361]
Demeaned log distance from Moscow in Baltic provinces X Post-1861	3.42 [2.438]	2.63 [2.458]	3.24 [2.505]	2.64 [2.544]
Demeaned crop suitability in non-Baltic provinces X Post-1861	0.06 [0.041]	0.06 [0.039]	0.07 [0.041]	0.06 [0.039]
Demeaned crop suitability in Baltic provinces X Post-1861	0.22 [0.135]	0.30** [0.142]	0.22* [0.133]	0.30** [0.140]
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	1,944	1,944	1,944	1,944
R-squared	0.395	0.397	0.395	0.397

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 A23. Robustness to using WLS with weights by log provincial population: the effects of the abolition of serfdom on productivity in agriculture

Panel A: Panel data estimation							
Dependent var:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
					Grain productivity		
Model:	WLS	WLS	weighted IV, 2nd stage	WLS		WLS	weighted IV, 2nd stage
Share of serfs X Post-emancipation	0.81*** [0.231]	0.80*** [0.256]	1.34*** [0.461]	1.03*** [0.263]		1.04*** [0.350]	2.79*** [0.614]
Share of serfs X 1861-1870					0.75*** [0.243]		
Share of serfs X 1871-1900					0.98** [0.375]		
Share of peasants with signed buyout contracts						-0.41 [0.252]	-1.20*** [0.320]
Demeaned log distance from Moscow X Post-emancipation		-0.95** [0.369]	-0.57 [0.421]	-0.88** [0.369]	-0.95** [0.362]	-0.64 [0.427]	0.60 [0.467]
Demeaned crop suitability X Post-emancipation		0.06 [0.041]	0.06 [0.044]	0.06 [0.039]	0.06 [0.041]	0.06 [0.040]	0.05 [0.048]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	No	Yes	Yes	Yes	Yes	Yes	Yes
State and royal peasant reforms	No	No	No	Yes	No	No	No
Observations	1,835	1,835	1,835	1,835	1,835	1,780	1,780
R-squared	0.509	0.536	0.536	0.537	0.406	0.545	0.541

Panel B: First stages of the corresponding 2SLS panel regressions				
Dependent var:	(3)	(7.1)	(7.2)	
	Share of serfs X Post-	Share of serfs X Post-emancipation	Share of peasants with signed buyout contracts	
Model:	weighted IV, 1st stage	weighted IV, 1st stage	weighted IV, 1st stage	
Share of nationalized monasterial serfs X Post-emancipation	-1.24*** [0.290]	-1.28*** [0.293]	-1.33*** [0.272]	
Interpolation b/w (1-indebtedness) and 1 in the interval 1862-1882		0.12 [0.174]	2.70*** [0.257]	
Controls as in respective column of Panel A	Yes	Yes	Yes	
Observations	1,835	1,780	1,780	
F, monasterial serfs instrument	18.29	19	24.02	
F, indebtedness instrument		0.464	110.4	

*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. The 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 all the non-western provinces this happened by 1882, and in western provinces there was a jump in this variable to the share of serfs in 1863. Indebtedness is the ratio of serfs in the province used as collateral in landlords' debt contracts in 1858 to the total rural population in the province.

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

Table A24. Robustness to using WLS with weights by log provincial population: the mechanisms behind the effects of the land reform and the emancipation

Dependent var:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Grain productivity		Share of winter crops seeded at t-1 in total winter and summer crops seeded at [t-1;t] production cycle				
	WLS	WLS	WLS	WLS	WLS	WLS	WLS
Share of serfs X Post-emancipation	0.84** [0.339]	1.75*** [0.437]	-0.07*** [0.017]	-0.05*** [0.017]	-0.07*** [0.018]	-0.04* [0.022]	-0.08*** [0.020]
Share of peasants with signed buyout contract	0.11 [0.271]	-0.51** [0.255]					
Share of peasants with signed buyout contract X repartition commune	-0.71** [0.341]						
Share of serfs X Post-emancipation X Implicit contracts		-1.58*** [0.537]					
Demeaned temperature (t-1)			0.01* [0.003]		0.003 [0.003]		0.01* [0.003]
Share of serfs X Post-emancipation X Demeaned temperature (t-1)			0.01** [0.004]		0.01** [0.004]		0.01*** [0.005]
Share of serfs X Post-emancipation X Demeaned rye-to-wheat world price ratio (t-1)				-0.50*** [0.124]	-0.45*** [0.123]		
Share of serfs X Post-emancipation X Demeaned rye-to-oat local price ratio (t-1)						-0.10** [0.044]	-0.11*** [0.043]
Share of serfs X Demeaned rye-to-oat local price ratio (t-1)						-0.01 [0.049]	0.01 [0.045]
Demeaned rye-to-oat local price ratio (t-1)						0.03 [0.023]	0.02 [0.020]
Demeaned log distance from Moscow X Post-emancipation	-0.93** [0.446]	-0.79* [0.428]	-0.03 [0.020]	0.02 [0.018]	-0.02 [0.020]	0.02 [0.021]	-0.04* [0.023]
Demeaned crop suitability X Post-emancipation	0.04 [0.040]	0.04 [0.036]	0.001 [0.002]	-0.001 [0.002]	0.0004 [0.002]	-0.001 [0.002]	0.002 [0.002]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,780	1,726	792	796	792	755	751
R-squared	0.545	0.554	0.931	0.931	0.934	0.928	0.933

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. The 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 all the non-western provinces this happened by 1882, and in western provinces there was a jump in this variable to the share of serfs in 1863.

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

Table A25. Robustness to using WLS with weights by log provincial population: the effects of the abolition of serfdom on industrial output

Panel A: Panel data estimation				
	(1)	(2)	(3)	(4)
Dependent var:		Ln (industrial output)		
	WLS	WLS	weighted IV, 2nd stage	WLS
Share of serfs X Post-emancipation	0.78** [0.335]	0.71* [0.424]	2.60* [1.225]	1.38** [0.621]
Demeaned log distance from Moscow X Post-emancipation		0.33 [0.474]	1.67* [1.002]	0.49 [0.479]
Demeaned crop suitability X Post-emancipation		0.12* [0.070]	0.12* [0.070]	0.12* [0.070]
Year and province fixed effects	Yes	Yes	Yes	Yes
Region-specific trends	No	Yes	Yes	Yes
State and royal peasant reforms	No	No	No	Yes
Observations	347	347	347	347
R-squared	0.897	0.941	0.935	0.942

Panel B: First stages of the corresponding 2SLS panel regressions	
Dependent var:	(2) Share of serfs X Post- emancipation
Model:	weighted IV, 1st stage
Share of nationalized monasterial serfs X Post-emancipation	-1.02*** [0.261]
Controls as in respective column of Panel A	Yes
Observations	347
F, excluded instrument	15.41

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 A26. Robustness to using WLS with weights by log provincial population: the effects of the abolition of serfdom on height

Panel A: Panel data estimation			
	(1)	(2)	(3)
Dependent var:		Draftees' height (cohorts 1853-1866)	
Data set:		Province-level data	
Model:	WLS	WLS	weighted IV, 2nd stage
Share of serfs X Post-emancipation cohorts	0.76*** [0.163]	0.91*** [0.134]	0.77** [0.316]
Demeaned log distance from Moscow X Post-emancipation		0.72*** [0.182]	0.64*** [0.235]
Demeaned crop suitability X Post-emancipation		0.16*** [0.023]	0.16*** [0.023]
nth cohort and province or district fixed effects	Yes	Yes	Yes
Province-specific trends	No	No	No
Observations	584	584	584
R-squared	0.834	0.854	0.853
Panel B: First stages of the corresponding 2SLS panel regressions			
			(2)
Dependent var:			Share of serfs X Post-emancipation cohorts
Model:			weighted IV, 1st stage
Share of nationalized monasterial serfs X Post-emancipation cohorts			-1.28*** [0.305]
Controls as in respective column of Panel A			Yes
Observations			584
F, excluded instrument			17.56

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

## Appendix Sections

### A. Historical background

#### **A1. Contemporaries on the economic consequences of the abolition of serfdom**

The abolition of serfdom gave rise to a debate among contemporaries about the impact of the reform on the growth of Russian agriculture and on the living standards of former serfs.

On the one hand, halfway through the implementation of the land reform, the government formed the special commission to evaluate the development of Russian agriculture and agricultural productivity after the abolition of serfdom, the so-called Valuev commission, named after its chair, the minister of internal affairs, Pyotr Valuev. In 1872 the commission conducted a detailed survey of about one thousand experts in forty-one European provinces of the empire and published the survey responses (see Commission on development of agriculture and agricultural productivity in Russia, 1873a,b). Survey participants were drawn from different social strata and occupations: landowners, local officials, peasants, agricultural specialists, and priests. The survey sample was not random, but the experts were chosen to cover as many regions as possible (Mironov 2010). Questions covered respondents' assessment of the effect of the abolition of serfdom on the productivity and efficiency of agricultural farms and on peasants' living standards during the 1860s and the first two years of 1870s. Respondents gave answers to a set of questions in a free form and could choose which questions to answer. Mironov (2010) classified the answers into three groups: positive, negative and neutral effect of the abolition of serfdom on several outcomes related to the economic performance of peasants' and gentry's farms as well as peasants' living standards. Figure A1 in this online appendix reports Mironov's classification of the answers. For each outcome under consideration, the positive evaluation of the impact of the abolition of serfdom was given by the largest group of respondents. For example, 55% of respondents positively evaluated the impact of the abolition of serfdom on the economic performance of peasants' farms and 63% on peasants' living standards. Less than a third of respondents evaluated the effects of the abolition of serfdom as negative irrespective of the outcome. The 1872 commission concluded, "*positive consequences of the reform are more or less clear ... Living standards of the rural population substantially increased; rural citizens became owners of their labor and could choose how to use it*" (Commission on development of agriculture and agricultural productivity in Russia, 1873a p. 40).

Those survey respondents who noticed improvements in Russian agriculture, directly linked them to the abolition of serfdom, arguing that former serfs became more productive workers because of better incentives after the emancipation. Peasants "*got a feeling that they are independent producers*"; they "*became full owners of their time*" and "*could decide how to allocate it*" (Commission on development of agriculture and agricultural productivity in Russia, 1873b, vol. 6 part 1, p.95 and vol. 6, part 2, p.16). Survey respondents stressed better incentives for peasants to exert effort, invest in land, and use new, more productive crops, for example: "*The situation of peasants recently has improved considerably because, having received their plots, peasants try to improve the land as much as possible, fertilize it and take care of it, so the land produces more than ever before,*" (Commission on development of agriculture and agricultural productivity in Russia, 1873b, vol. 6 part 1. p. 28).

However, many contemporaries and historians have argued that the government commission may have had incentives to misrepresent the real outcomes of the reform and that

former serfs did not gain much from the emancipation (e.g., Kornilov 1905, Lyashchenko 1913, Titov 1907, Yanson 1877). For example, Pyotr Struve, argued that the way in which the emancipation and the subsequent land reform were conducted, caused an “agrarian crisis” in rural areas that had long-lasting negative implications. Struve (1913) did acknowledge the apparent growth in the second half of the 19th century but argued that the only reason why there was no substantial decrease in output following the abolition of serfdom was the railway construction (p. 110). However, he also acknowledged the relatively low productivity of serf labor as compared to free labor (p. 91). In contrast, the critics of ‘agrarian crises’ hypothesis argued that Valuev’s commission collected reasonable evidence, which portrayed the improvement of peasants’ well-being (Bogushevich 1881).

## **A2. Legal status of Russian peasants, whom we characterize as (relatively) free population**

**State peasants:** Formerly, state peasants (40.4% of the rural population in 1858) were free individuals living and working on land belonging to the state. By law, they had personal and property rights and could change their occupation and place of living (Svod ... 1857, vol. 9). The required administrative procedure for moving was so complicated, however, that few actually did this.<sup>67</sup> State peasants had to pay a lease payment (in the form of a quitrent) to the state in an 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 the living standards of state peasants were higher, individual land plots were larger, 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 minimum amount of land 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 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 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 (Kandaurova 1990).

**Free agricultural laborers:** Free peasants with or without land titles constituted 12.6% of the rural population in 1858. The free peasant population was present in all provinces in small numbers and consisted of former retired soldiers (including soldiers in reserve and soldiers’ children, so called cantonists) and colonists invited by the government during the 18<sup>th</sup> century and the first half of the 19<sup>th</sup> century under special arrangements.<sup>68</sup> There were three provinces

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<sup>67</sup> Note that state peasants were free only relative to serfs. In the 18<sup>th</sup> century, the tsars often granted state lands with state peasants on these lands to nobility as private estates; in that case, state peasants acquired the status of serfs. 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).

<sup>68</sup> The bulk of immigration of colonists took place under the rule of Elizabeth the First (1741-1761) and Catherine the Second (1762-1796), i.e., before the period of our study. There are no data on the colonization after 1800, however, it is known that the number of immigrants was low. Between 1804 and 1819, the law allowed accepting no more than 200 migrant families per year in the empire; after 1819, every case of immigration was regulated by a special decree signed by the emperor. This happened very rarely. The 1851

on the outskirts of the empire where the free peasant population constituted the majority of the population. Cossacks in the Don region were free because, in the 17<sup>th</sup> century, the government needed them to protect the country against nomadic invaders from the south. The state also granted free status to local non-Russians in the Volga region after the conquest of this region in order to avoid rebellion by the new imperial subjects. Similarly, the peasants of Bessarabia (*tsaryane*) were granted a special status as a (relatively) free rural population after the conquest of this province in 1811. “*Tsaryane*” were free because they could move between landlords’ estates; where they cultivated land in return for an obligation to the landlord (Antsupov 1978). In addition, after the 1819 reform, the largely landless peasants in the three Baltic provinces became free laborers.

**Royal peasants:** Royal (“appanage,” *udel’nye*) peasants constituted another, much less numerous, group of the (relatively free) peasantry. Formally, they were serfs on quitrent who belonged to the royal family. However, they were managed by a special ministry (Ministry of Appanages), which made them *de facto* very similar to state peasants under fixed land lease. They were formally emancipated in 1858-1859 and got land reform in 1863 (Istoriya ... 1901).

### **A3. The reasons geographical concentration of serfdom in the center of the empire**

In the 16<sup>th</sup> and 17<sup>th</sup> centuries, being short of cash, the government gave out state lands with peasants to the gentry in return for their military service. The government transferred lands to the gentry more often in regions closer to Moscow for two reasons: 1) the gentry had to be mobilized to the capital quickly in case of war; and 2) the government had more power nearby the capital to enforce serfdom (Semevskij 1881, pp. 29-30). Over time, due to a short supply of remaining state lands in the old regions and the colonization of new territories, the state transferred more distant lands with peasants to the gentry as well. The government continued this practice of transfers throughout the 18th century (even after instituting the regular army in 1704). In particular, Catherine II (1762-1796) transferred 800,000 state peasants to private owners; Pavel I (1796-1801) transferred another 400,000 (Semevskij 1881, 1901, 1906). Only Alexander I, who assumed the throne in 1801, ordered a stop of the practice of transfers of state lands. Alexander I and his successor, Nicolas I, however, exchanged state peasants in some provinces for a similar number of royal peasants in other provinces in order to have a more compact spatial distribution of royal peasants (Nifontov 1974 P. 100; Crisp 1976).

In addition, gentry often illegally captured state lands with state peasants on them, eventually legalizing their titles. Using the 1684-1686 household tax census data, Vodarskij (1988) estimates that 36 percent of all privately owned estates were on captured lands. This share was higher in the “black earth” region where soil was most fertile; the state was too weak to enforce state ownership of these lands. Tsars only managed to keep the very best lands in their own personal ownership as royal estates (Indova 1964).

### **A4. The nationalization of monasterial lands**

The royal family and individual landowners had granted lands to the Orthodox Church since the Christianization of Russia in the 10<sup>th</sup> century. The bulk of church lands belonged to monasteries, which accumulated most of their property in the 15<sup>th</sup> and 16<sup>th</sup> centuries (Vodarskii 1988), i.e., before the start of serfdom in Russia. With the establishment of serfdom in the late 16<sup>th</sup> – mid-17<sup>th</sup> century, peasants who lived on church lands became serfs belonging to the Russian Orthodox Church. The church owned about 2 million serfs or about

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decree allowed a hundred of German families to move into Samara province; the 1860 decree allowed Slaves from Turkey to move into Russia (Colonists in Entciklopedicheskii ... 1890—1907, vol. XXIVa, 1898).

14.1% of the population of the empire at the moment of the nationalization of church property in the second half of the 18<sup>th</sup> century. About one half of all monasteries had serfs (Zakharova 1982). In addition, in provinces of the Russian empire that were added as a result of the partitions of Polish-Lithuanian Commonwealth at the end of the 18<sup>th</sup> century there were serfs that belonged to the Roman and Eastern Catholic churches (Zinchenko 1985).

Church serfs faced the same constraints as other privately owned serfs and used similar agricultural technologies and practices (Gorskaya 1977; Zakharova 1982). Historians do not find any evidence of any systematic difference in the quality of land between monasteries and private estates, in the literacy rates between monasterial and other private serfs, or in the level of religiosity between monasterial serfs and other Russian peasants (Buligin 1977, Gorskaya 1977).<sup>69</sup>

The rise of the modern state in Russia in the 18<sup>th</sup> century was associated with the accumulation of absolutist political power in the hands of the monarchs, which allowed them to progressively confiscate Church property. First, 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 the revenue from its property. Second, Catherine the Great nationalized Church property (Shchapov 1989). This nationalization took place in 1764 in the core part of the Russian Empire and between 1786 and 1788 in the Ukrainian provinces and Southern Russian provinces (Kursk and Voronezh). The nationalization of the property of the Roman and Eastern Catholic churches in provinces integrated into the empire as a result of the partitions of Poland took longer. The first wave of nationalizations of such estates took place immediately after the second and the third partitions of the Polish-Lithuanian Commonwealth in 1793-1795 and affected the monasteries and bishops who took an active anti-Russian position. Similarly, the 1830 Polish rebellion led to the closing of 191 catholic monasteries (out of 304) and the confiscation of their 204 estates (Zinchenko 1985). In 1822, the Russian government abolished the order of Jesuits and confiscated its property (Zinchenko 1983). Between 1828 and 1839, all monasteries of the Eastern Catholic churches, which owned 23,000 serfs, were closed. The nationalization of Catholic Church property was completed by the government in 1841-1842, when it nationalized the last five hundred church estates with about 100,000 serfs on them (Zinchenko 1985). Former monasterial serfs got the legal status of state peasants as a result of these reforms (Shchapov 1989). The vast majority of the former monasterial serfs retained the status of state peasants until the emancipation reform. The government avoided granting former monasterial estates to gentry in order not to provoke additional conflict with the church (Zakharova 1982).

#### **A5. The timing of the abolition of serfdom**

The Russian government started to discuss the emancipation reform long before the abolition of serfdom actually happened in 1861, in the late 18<sup>th</sup> – early 19<sup>th</sup> centuries (Dolgikh 2006). Alexander I (1801-1825) considered the introduction of various restrictions of landlords' authority over serfs, including the abolition of serfdom altogether. He was influenced by the spread of the ideas of the Enlightenment and the emancipation reforms in the Habsburg and Prussian empires (in 1781 and 1809, respectively). However, the vast majority of the considered measures were not adopted. 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 at their private will, or the 1809 prohibition on

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<sup>69</sup> It is the religiosity of landowners (rather than peasants living on these lands) was the overriding motive behind the flow of testaments and private donations of land to the Church.

landlords penalizing serfs by sending them to penal works in Siberia. Alexander's successor, Nicolas I (1825-1855) also considered an emancipation reform. During his reign he organized a number of secret committees to discuss it, none of which resulted in a political action (Mironenko 1990; Zajonckovskij 1968).

The gentry's opposition to emancipation was the main political obstacle 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 the 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. In the 1840s and 1850s, the prices of licenses 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 (Dormar and Machina 1984).

The defeat in the Crimean War (1853-1856) demonstrated that Russia lagged behind the most developed countries in terms of economic and technological development. This convinced the skeptics of the necessity of structural 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).

## **A6. Details of the land reform**

The government defined the rules of the future land reform in 1861 in a series of decrees issued together with the emancipation manifesto of February 1861 (Polnoe ... 1863, vol. 36, part 1). The law obliged emancipated serfs to buy out the land from the landlord but the timing and the precise conditions of the land reform (the land plots and the price) in each particular estate were a subject of negotiations between the landlord and his former serfs.<sup>70</sup> If an agreement was not reached, the law prescribed the terms of the fallback deal. Four emancipation statutes governed local parameters of the bargaining menus in different parts of the empire. The main statute regulated the abolition of serfdom in the core provinces of the empire, i.e., the Great Russia, New Russia and the Eastern part of Belorussia, i.e., the thirty-five out of forty-six provinces. In the western provinces (for instance, the right-bank Ukraine, Byelorussia and Lithonia), the menus were less favorable for gentry, and the parties were given less time to implement the land reform.<sup>71</sup> The land reform took place between 1862 and 1882 with varying speed in different provinces. In western provinces, where land reform was the fastest, the legislation mandated that peasants and landlords sign the buyout contract in 1863, following the Polish rebellion. The land reform transferred property titles on peasant land to the commune rather than to individual households, which empowered the commune making it the most important institution in the Russian village after the abolition of serfdom.<sup>72</sup>

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<sup>70</sup> The law explicitly prohibited peasants from quitting the countryside without buying out the land before 1870 (Polnoe ... 1863, vol. 36, part 1). After 1870, in order to quit their villages without buying the land, peasants had to satisfy a number of restrictive conditions. In practice, less than one percent of peasants chose quitting without exercising the buyout of land (Litvak 1972).

<sup>71</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>72</sup> The landlords constrained the power of the commune before the emancipation (Semevskii 1903). They continued to counterbalance the power of the commune during the transition period. In particular, during the first eight years post-emancipation the landlord had a legal right to reallocate communal and landlord plots within the estate without peasants' consent. The landlord kept some administrative power over former serfs until 1870. It was only the signature of the buyout contract that made the commune a full owner of the peasant land completely removing the landlord from bargaining process. Importantly, The abolition of serfdom did not affect

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).

**The first stage of the land reform.** 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 lease they had to pay in exchange for the use of the land during the transition period, before the signature of the buyout contract.<sup>73</sup> The landlord was supposed to produce a draft of the charter, which the peasants could accept or reject. The charter had to be authorized by a local official, called a "peace arbitrator" (*mirovoj posrednik*), and if there was no agreement, the local official had to produce the fallback document on his own, following the law (Easley 2008). It was easier to reach an agreement if landlords did not revise peasants' obligations under serfdom, in such cases, regulatory charters often closely followed the terms of the previously existing implicit contract between the landlord and the peasants. Litvak (1972) argued that that the changes in land use (either in terms of the amount of land or the amount of payments for the land use) were the most often the reason why peasants in the Black Earth region turned down regulatory charters. Rozov (1998) made similar conclusions on studying the elaboration of regulatory charters in Novgorod province. This is why we use the share of serfs who signed regulatory charters as a proxy for implicit long-term contracts under serfdom.

Other factors, like the attitude and the skills of the local peace arbitrators as well as local conditions, could affect peasants' decision to sign or reject suggested drafts of the charters. However, a systematic bias in our measure of the implicit contracts under serfdom is unlikely. The central government deliberately set up an institution of peace arbitrators as an independent institution from both the local gentry and the local bureaucracy. Only nobles with a certain level of wealth could be appointed as peace arbitrators. Nonetheless, the number of volunteers, who applied for this job, exceeded the number of open positions. The gentry tried to lobby for the right of local landlords to appoint peace arbitrators, but these attempts failed. Formally, the governors appointed peace arbitrators. However, the central authorities selected the candidates. The central government's aim was to select people with pro-emancipation views. Historians, who studied peace arbitrators (Easley 2008, Ustyantzeva 1992) claim that this aim was accomplished, at least in the case of the peace arbitrators appointed in 1861, i.e., those who actually arbitrated the signing of the regulatory charters. Peace arbitrators were appointed for three years and could not be fired, which made them immune to local pressures. They were directly subordinated to the Senate in Saint Petersburg rather than to local governors (Easley 2008, Ustyantzeva 1992).

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 the minimum amount of land that peasants could get as a result of the land reform and outlined the peasants' obligations per unit of land (Polnoe ... 1863, vol. 36, part 1).<sup>74</sup> After the

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the types of the communes. Whether the communes were re-partition or hereditary was determined by the tradition formed long before the abolition of serfdom (Zajonckovskij 1968).

<sup>73</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. The law required monetary quitrent to be paid in the same amount as before the emancipation, abolished some types of in-kind payments and reduced payments in labor (Polnoe ... 1863, vol. 36 part 1).

<sup>74</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

emancipation, the land became the main asset of the landlords, and they tried to keep as much land in their possession as possible. On average, peasants got less land as a result of the reform than they cultivated before the reform (while in some provinces they got more).<sup>75</sup> According to calculations by Soviet historians, land-cuts were up to one-third of all peasant pre-reform land as a result of the first stage of the land reform. The size of such land cuts was the largest in the Great Russian provinces (Litvak 1972; Zajonckovskij 1968).

Formally the level of temporary obligations of the emancipated serfs to their landlords, which was fixed by the reform, could not exceed the pre-emancipation level (Polnoe ... 1863, vol. 36 part 1). Historians, however, argue that these legal restrictions were not always implemented in practice. For example, a leading Soviet historian of serfdom, Zajonckovskij (1968, p. 244), argued that the abolition of serfdom led to a decrease in labor payments (corvee) of former serfs, whereas the in-kind and monetary payments per unit of land (quitrent) could go both up and down depending on the land redistribution between the landlords and peasants as a result of the reform. Gerschenkron believed that "*it is unlikely that the aggregate annual burden was higher than the previous quitrent*" (Gerschenkron 1965 p. 741). He, however, did not say anything about the changes in labor obligations.

**The second stage of the land reform.** Once the charter was produced, the buyout contract could be signed by mutual agreement between the landlord and the peasants. The signature of the buyout contract marked the second (and final) stage of the land reform, i.e., the transfer of land ownership to the peasant commune 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. The buyout contract determined the amount that peasants needed to pay to buy out the land into the communal ownership.<sup>76</sup> 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 determined as a capitalized quitrent (or corvee equivalent) fixed in the charter. Peasants paid up to twenty percent of the land price (either momentarily or as an "additional series of payments" that were stretched over a longer period), 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 (Polnoe ... 1863, vol. 36, part 1).

In the event that there was no mutual agreement, the buyout operation could be initiated at the request of either the landlord or the peasants under the terms specified by the law (Polnoe ... 1863, vol. 36, part 1). 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 land they cultivated under serfdom, and they did not get a loan from the government. If the landlord launched the operation, peasants did not pay the initial twenty percent of the land price. Potential losses forced both peasants and landlords to search for mutual agreement, postponing the signature of the buyout contract and providing substantial

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peasants had less land than the legal minimum, the law mandated that 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 (Polnoe ... 1863, vol. 36, part 1).

<sup>75</sup> 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.

<sup>76</sup> In the event 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 (Polnoe ... 1863, vol. 36, part 1). About a million peasants, or about 4% of former serfs, got gifted pauper plots as a result of the land reform (Zajonckovskij 1968).

sources of variation in the timing of the completion of the land reform. Landlords unsuccessfully lobbied for the abolition of the twenty-percent-reduction rule in the case of the launch of the buyout operation by the landlord (Lyashchenko 1913). For fifteen percent of former serfs, the signature of the buyout contract was postponed until the very end, i.e., till 1881, when a new law mandated an obligatory signature of the buyout contract no later than the beginning of 1883 for all peasants who had not yet done so (Polnoe ... 1885, vol. 1). Historians (e.g., Zajonckovskij 1968) argue that the landlords had more bargaining power in bargaining over the precise terms of the land reform and land buyout contracts because of their monopsony power in local labor markets. Thus, landlords' incentives rather than those of peasants affected the speed of the implementation of the land reform. The gentry's indebtedness was an important factor that determined the landlords' incentives to postpone the reform.<sup>77</sup>

## A7. Gentry's indebtedness

The government had provided credit to Russian gentry starting in the late 18<sup>th</sup> century. The landlords had the privilege of taking long-term loans, with serfs as collateral, from a state bank and other state financial institutions, which had the right to issue loans and take deposits (so called *Zaemni bank*, *Sokharnnaya kazna* and *prikazi obshchestvennogo prizreniya*).<sup>78</sup> These organizations were the main source of credit due to the poor development of financial market. In total, about 44,000 thousand estates had debts, and about 7.1 million male serfs (about 63% of all serfs) were used as collateral by 1858 (Skrebitskii, 1862-1866 vol. 4). In an average province in our sample, this number is 59%.

On both the supply and the demand sides, the loans given to gentry were unrelated to economic performance. On the supply side, the government viewed credit as a means of securing the political loyalty of the gentry (Borovoj 1958). The enforcement of repayment was very mild. Gentry often successfully renegotiated the terms of their loans ex post. Borovoj (1958) reports many examples of refinancing and renegotiation of the terms of loans in favor of the gentry and only few examples of sales of estates because of bankruptcy. On the demand side, the gentry widely used state loans for status consumption (such as real estate in the capital cities, imported luxury goods, etc.) rather than for investment in production within their estates (Korf 1906). The number of landlords who used loans to invest into gentry' farms was negligible (Borovoj 1958). For example, according to Koval'chenko (1959), before the emancipation, there were only one hundred out of 8.5 thousand landlords in Ryazan and Tambov provinces, who invested into "modernization" of their estates. These two provinces were situated in the main grain producer region, where landlords mostly ran their own farms and demanded payments from their serfs in labor (corvee) rather than in kind (quitrent). Thus, it is likely that in other provinces, the share of landlords who invested into modernization of

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<sup>77</sup> State peasants, who were formerly free, were subjected to a land reform in 1866. The local authorities issued special commune land title documents (*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 the western provinces, redemption payments for former state peasants were introduced in 1867. 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 went through the 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.

<sup>78</sup> *Zaemni bank* (1786-1860), *Sokharnnaya kazna* (1762-1860), and *Prikazi obshchestvennogo prizreniya* (1775-1864) were state banks. The state provided capital to them (Borovoj 1958). *Zaemni bank* operated in Saint Petersburg. Its main purpose was crediting gentry. *Sokharnnaya kazna* had offices in Moscow and Saint Petersburg. It took deposits from the public and provided loans to gentry. *Prikazi obshchestvennogo prizreniya* (1775-1864) were provincial institutions with primary aim of providing finance to local schools, hospitals, orphanages, and prisons. They financed their primary activity from the interest they earned on loans issued to gentry. The estates were used as collateral for loans by state bank to gentry.

grain production was even smaller. Borovoj (1958) in his study of the history of credit and banking in 19<sup>th</sup> century Russia concluded: “*the loans, which the gentry got, were almost never spent to improve the productivity of estates, but were spent on consumption needs*” (Borovoj 1958 p. 181). He argued that the “*careless gentry*” composed the majority of those who got state loans (Borovoj 1958 p. 184). Overall, the special committee on the gentry’s loans concluded in 1856 that “*the amount of loans in a province did not depend on its economic prospects ... the amount of loans was in direct relation with the amount of exemptions, privileges, repayment relief, etc. granted to a province at various moments in the past*” (cited in Borovoj 1958 p. 204). Importantly, these privileges were granted regardless of the local economic conditions. For example, the minister of internal affairs Sergei Lanskoï pointed out in 1856 that the gentry in Saratov province had the same amount of loans as the gentry in Vitebsk province while their economic development and prospects were very different (Borovoj 1958 p. 203).

The terms of credit for the gentry improved throughout the first half of the 19<sup>th</sup> century (Borovoj 1958). Four years before the emancipation of the serfs, the state decreased the interest rate for the gentry from five to four percent. In 1859, unexpectedly for the gentry, the government stopped issuing new loans because of financial problems caused by the defeat in the Crimean War (Lositskii 1906).<sup>79</sup>

As noted above, during the land reform, 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 land buyout was obligatory. The state paid landlords directly with special bonds that had a 5% 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 before the buyout operation. Thus, for the landlords with debts, the buyout operation meant a drop in revenues, as the interest rate on the state loans, as a rule, was lower than the profitability of the gentry’s estates both before and after the emancipation (Gur’ev 1904). By postponing the signature of the buyout contract, the indebted landlords gained a flow of revenue consisting of the difference between the interest rate on their loans to the state and the quitrent (lease) payments from emancipated peasants for the land, which the peasants had to pay before the buyout contract was signed. Lyashchenko (1913) provides examples of lobbying by gentry for the change in the regulation in order to abolish the obligatory deductions of the debts at the start of buyout operation. However, they managed to cancel this rule only in 1882, i.e., when the decision about the obligatory start of buyout operation by 1883 in all estates had been already taken (Lyashchenko 1913). The state provided loans to landlords with fixed maturity and stopped refinancing after 1859. As a result, the pool of indebted landlords who could enjoy this flow of revenue shrank over time. This practice ended in 1881, when the government obliged all landlords to sign buyout contracts with their serfs during the following two years.

#### **A8. The qualitative accounts of changes in the Russian countryside that occurred right after 1861 reform**

The abolition of serfdom changed the Russian countryside. However, most changes took time. For instance, the implementation of land reform took up to twenty years, during which peasants had to fulfill “temporally” obligations to their former masters. It is important to understand which changes occurred right after the emancipation. Contemporaries described

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<sup>79</sup> The government used private deposits in state financial institutions to finance loans. Following the rise in the budget deficit caused by the Crimean war, the Minister of Finance Piotr Brok lowered the interest rate on these deposits, which caused a run on state banks and resulted in inability to issue new loans (Borovoj 1958).

which changes occurred right after 1861 despite the fact that many landlords tried to prolong the “temporarily” transitional regime as long as possible.

The two key features distinguished this “temporarily” post-1861 regime from serfdom. First, the temporary regime was regulated by the government in the sense that the obligations of former serfs under the temporary regime were fixed and landlords could not change them. Article 4 of the emancipation Manifesto stated that peasants “*had to fulfill fixed obligations for landlords in the amount specified by Local Statutes either in labor or in money*” (Polnoe ... 1863). This change affected the incentives of both landlords and serfs. From the serfs’ standpoint, Vetrinskij (1913) described a tale of a fugitive serf, Nikolaj Shipov, who decided to flee because his owner arbitrarily increased quitrent payments. The importance of fixed peasants’ obligations from gentry’s standpoint becomes clear from the attempts of landlords to postpone the elaboration of the regulatory charters, which fixed the former serfs’ obligations (Kornilov 1905). Druzhinin (1966) provides an example from Kaluga province in 1862 where local authorities recognized that “a number of landlords declared to the local peace arbitrator (*mirovoj posredniks*) that they would present their drafts of regulatory charters no earlier than on the last day provided by the law because they wanted to use forced labor of their former serfs as long as possible.”

Second, landlords lost their coercive power. After the emancipation landlords could no longer whip or physically abuse in any other way their former serfs. Physical punishments of serfs by landlords were widespread before 1861 (Kornilov 1905). According to a case study by Hoch (1986), 20 percent of male serfs were subject to whipping at least once a year. Article 25 of the emancipation Manifesto stated that “*peasants could not be punished other than by the state authorities following a court decision*” (Polnoe ... 1863). Landlords filed many complaints to authorities after 1861 about the difficulties in forcing peasants to fulfill their temporary obligations without the threat of physical punishment (Druzhinin 1966). Because of these difficulties, landlords had to move away from corvee to put their former serfs on fixed quitrent payments (Khorun 2003, Kornilov 1905, Druzhinin 1966, Tsagalov 1956). Thus, landlords’ farms based on landlords’ coercive power must have suffered from the emancipation. In contrast, the efficiency of peasant farms must have improved. Historical narrative (Druzhinin 1966, Najdenov 2003) and the materials of the Valuev commission (cited above) provide very few examples of successful landlords’ farms based on free labor after the emancipation. Thus, the reorganization of landlords’ farms is unlikely to be a driver of the increase in agricultural productivity documented in this paper. Some contemporaries correctly foresaw such outcome. For example, one of the thick journals of landowners, *Zhurnal zemlevladeltsev*, [The magazine of landowners] published a prediction that the liberated serfs would get most benefits from the emancipation and that it would be difficult for private landlord farms to reorganize their business in a new environment (Tsagalov 1956).

Importantly, one needs to note that there was a rise of peasant unrest in the years following the emancipation. However, this unrest was driven by peasants’ discontent with the suggested post-emancipation distribution of land between peasants and landlords, i.e., the land reform, rather than the emancipation per se, which peasants highly appreciated (Kornilov 1905; Zajonchkovskij 1973).

## **A9. Procedures for statistical data collection in the Russian empire of the 19th century**

Provincial governors had to collect statistics on the economic and social development of their provinces, including figures on grain productivity and industrial output, since the late 18th century. The government formalized the procedure and obliged the governors to submit reports annually in 1802 (Minakov 2013; Prantsuzova et. al. 2016). Each governor's report consisted of two parts: a description and a statistical appendix.

According to Nifontov (1974), the official procedure for data collection was very detailed and deliberate. Governors relied on local officials and landlords on the ground to collect initial raw data at the district and sub-district levels. These data were aggregated into average provincial figures. The procedure required a lot of cross checking by various authorities. The central government carefully monitored the implementation of the data collection because the data were subsequently used to calculate tax redemptions and state transfers.

For statistics on grain yield, provincial administrations collected information on the amount of seeds put into the ground and organized so-called test threshing in a sample of estates to learn grain productivity per fixed amount of seeds. The provincial administration organized test threshing in each district of the province and in villages of all types, i.e., populated by serfs, state and royal peasants as well as free citizens. Nifontov (1974) pointed out that while the precise number of estates used for test threshing in each particular province in each particular year is unknown, it included several dozen estates. In their reports, governors included the total amount of seeds put into the ground and the total yield estimated as a product of the total amount of seeds put into the ground and grain productivity measured by test threshing. In our analysis, we use grain productivity, which is the ratio of estimated total grain yield to total seed.

As mentioned in the main text, Nifontov (1974) verified that the time-series of grain yields from the alternative sources, e.g., the reports on yields at state peasant farms from the Ministry of State Property, which are considered as a good-quality source, are highly correlated with those based on the governors' reports. Similarly, Fortunatov (1893) noted already in 1893 that data on yields from governors' reports are correlated with figures deduced from archives of individual estates. Litvak (1977) showed that the data on grain yields and on grain reserves are consistent. He argued that the data on grain reserves should be reliable because both central and local authorities paid a lot of attention to the question of food security, which was politically important as famines could trigger a revolt. In particular, he described how the Minister of Internal Affairs issued reprimands to governors and vice-governors for supplying poor-quality data on grain reserves.

One might argue that governors had incentives to underestimate the true grain output and productivity in order to get financial support for their provinces from the government. Even if that was the case, these incentives were uniform across governors and should not depend on the share of serfs in the province. Moreover, there is no reason to believe that governors' incentives changed with the abolition of serfdom. In addition, the rules for the data gathering procedures remained the same after the abolition of serfdom (Nifontov 1974, Minakov 2013). In 1864-1865, the central statistical committee considered reforming the data gathering procedure in favor of direct questioning of all owners of farms about their output. However, after a consideration, the committee rejected this idea because of the low potential quality of such data (TsSK MVD 1883). Governors' reports remained the main source on grain output and productivity statistics until 1883 when the Central Statistical Committee adopted a new system, under which local statistical offices gathered data on cultivated lands, the amount of seeds put into the ground and productivity (the latter was still based on sample estimates) (TsSK MVD 1883). Litvak (1977) hypothesized that the quality of grain yield data improved with the introduction of zemstvos in thirty-four out of forty-six provinces after 1864. Table A13 shows that our results hold if we control for the zemsto expenditures.

## **A10. Agricultural technologies in the 19th century Russia**

Technologies used in Russian agriculture in the 19th century were relatively primitive. Light wooden ploughs driven by horses were the dominant grain-production technology. The only fertilizer was manure, the supply of which was limited; according to agricultural specialists, the level of peasants' use of manure was one half of the amount that would maximize the grain output (Fedorov 1974). Agricultural machines, such as seeding and reaping machines, appeared in the Russian countryside in significant numbers only at the end of the 19th century (Fedorov 1974, Nifontov 1974). Machines and manure were simply too expensive for peasant farms. Individual landlords did try to employ machines and to expand the use of fertilizers in their estates before the abolition of serfdom (Department of agriculture, 1849). However, historians argue that their number was very small (Fedorov 1974). For example, Koval'chenko (1959) reported that about one hundred out of 8,500 landlords (i.e., 1.2% of landlords) in Ryazan and Tambov provinces tried to "*modernize their estates*" in various ways, including by adoption of new technologies. Koval'chenko concluded that these attempts did not affect the level of development of agriculture (1959 p. 112; 1967 p. 75).

Strumilin (1960) reports the labor inputs in the number of working days per unit of land (desyatina = 1.0925 hectare) for growing winter rye in European Russia at three points in time: the 1850s, 1885-1889, and 1890-1917. Labor inputs per unit of land without a horse increased by 1.4% from the 1850s to 1885-1889, and by 4.45% from the 1850s to 1890-1917. With horse power, the labor input actually decreased by 16.3% from the 1850s to 1885-1889 and by 10.2% from the 1850s to 1890-1917 (Strumilin (1960, p.146). This evidence suggests that the effects we found in this paper could not have been driven by the increase in the labor input alone.

The 19th century agricultural handbooks (e.g., Mordvin 1839, Usov 1840, Dmitriev 1844, Ungern-Shterenberg 1848) shed light on the kind of technological improvements that were 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.<sup>80</sup> Adaptation of these technological improvements did not require investments but did require exerting effort and care to make the adjustments. Mordvin (1839) singled out fifteen reasons for poor harvests, with six of them related to low effort. Ignatovich (1925) cited opinions of contemporaries and concluded that serfs worked poorly without constant monitoring, but even with monitoring they were about one quarter to one third less productive compared to free labor in terms of time required for any particular task (p. 160).

## **A11. The rules of universal military conscription and the data on height**

In 1874, after several years of discussion, the government introduced universal military conscription. The new rules of military draft replaced the old system based on periodical levies of recruits from localities, where the localities were responsible for choosing who should serve (Beskrovnij 1973). The new law postulated that every male subject of the empire had a duty to defend the country and, therefore, could be drafted to the army (Rediger 1900).

***Ethnic exemptions.*** There were few exceptions to this rule of the universal conscription. In particular, a number of ethnic minorities (non-Russians) mainly residing in the outskirts of empire were completely exempt from military service. In the European part of the country, only kalmyks and native nomads in Astrakhan' province and native non-Russians in Mezen'

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<sup>80</sup> Over the second half of the 19th century, there was a gradual shift away from the three-fields system (an annual rotation of spring crops, winter crops, and fallow on the same plot) to multi-field crop rotation systems (Nifontov 1974).

district of Arkhangelsk province were exempt (Polnoe ... 1874). In addition, the law stipulated different draft rules for Cossacks who had longer terms of military service in special Cossack regiments. Cossacks composed a substantial share of population only in Don and Orenburg provinces in the European part of the empire. According to 1897 population census, 40.2 percent of the population were Cossacks in Don province and 22.9% in Orenburg province (Trojnitskij 1905).

***The size of the draft.*** In an average peaceful year, the size of the draft required for the imperial Russian army was less than one third of all males in the cohort of 21-year-olds. In the first decade after the introduction of the universal conscription (1874-1883), the population eligible for conscription varied between 0.75 and 0.84 million males in different years, whereas only about 27% of all 21-year-old males were annually drafted into the army (Vseobshchaya ... 1886).

***The procedure of the draft.*** The main steps of the procedure of the military draft, according to the 1874 law, were: universal male registration, the determination of exemptions based on family status and based on the result of a medical exam, and the conscription lottery among all eligible 21-year-olds for military service. The details of each of these steps were as follows:

- 1) All males had to register in the conscription lists at the age of 16. Local police was in charge of registration procedure. Failure to be registered by the age of 20 was a criminal and administrative offence. Unregistered males could not marry or become a public employee (Polnoe ... 1874). According to the official sources, the number of males who managed to avoid registration was negligible (Vseobshchaya ... 1886).
- 2) At the time of registration, exceptions based on family status were granted. They depended on the numbers of disabled and breadwinners in the household. There were three types of exceptions (ranked according to their strength). Family exemption of the first class gave a complete release from the military service, it was granted if the registered male was: the only son of a disabled father or a widowed mother; the only brother of an orphan minor; the only grandson of a disabled grandfather or a grandmother without other relatives; the only son in the family. The second-class family exemptions were granted to the only able sons with able fathers and with minors or disabled brothers in the family. The third-class family exemptions were granted to brothers of drafted soldiers currently in the military service or of those who died in the army. The exemptions of the second and the third class were not absolute; the state could decide to draft individuals in these classes if needed (Polnoe ... 1874). In practice, they were not drafted during the period that we study (i.e., before draft year of 1888) (Gorskij 1910; Rediger 1900; Zajonchkovskij 1973). In an average province, there were 27.3, 19.6, and 5.7 percent of males with family exemptions of the first, second and third class, respectively. Altogether, they constituted 52.6% of all males registered males in the conscription lists. Rules of family-based exemptions did not change during the period we study.
- 3) In the fall of each year, all registered males, who turned 21 years old that year and who were not granted family exemptions were subjected to a medical examination, which included measuring height and chest size. On the basis of the results of these examinations, additional exemptions were granted, including those based on

the requirements for height and chest size. We provide details of the medical exemptions below. A total of 14.7% of males got various medical exemptions.

- 4) Finally, all eligible 21-year-old males (i.e., after all possible exemptions had applied) participated in a lottery. The lottery determined individuals, who were drafted in each particular year. The total size of the draft was determined according to the military needs. The draft targets for provinces were proportional to the provincial male population.<sup>81</sup> Each individual was assigned a number according to a random draw. If the number of an individual was lower than a certain threshold (set by the authorities in each province according to the draft target), this individual was drafted to the army. The number of deserters was very low. For example, during the first decade of the universal conscription, below 3% of eligible males did not show up for the medical examination and conscription lottery (Vseobshchaya... 1886; Fedorov 1959).

**Medical exemptions.** The rules stipulated required minimum height, which did not change over time during the period under study, and the required minimum chest size, which did change over time. The chest-size cut-offs depended on the height through a formula at every point in time.

The law defined the minimum height as 2 *arshins* and 2.5 *vershoks*, which is equal to 153.35 centimeters (Polnoe ... 1874).<sup>82</sup> The minimum was lower than in other European countries in the same period. i.e., 160 in England, 162 in Germany, 154 in France, 155.3 in Austria, 156 in Italy (Rediger 1900; Gorskij 1910). In the first decade of the implementation of the universal conscription, only 1.49% of males in the empire and 1.45% in the European Russia were exempted from the military duty because of low height (Vseobshchaya... 1886).

The rules about the minimum ratio of chest size changed several times. These rules (as well as other details of medical examinations of the draftees) were set by the Ministry of Internal Affairs. The rules for the minimum chest requirements were as follows (Ministry of Internal Affairs 1877a, 1887; Sobranie ... 1883; Rediger 1900):

Years of draft:	Birth cohorts:	Minimum chest-size requirement:
1874-1881	1853-1860	$\frac{1}{2}$ height - $\frac{1}{2}$ <i>vershoks</i> = $\frac{1}{2}$ height - 2.2225 cm
1882	1861	$\frac{1}{2}$ height + $\frac{1}{2}$ <i>vershoks</i> = $\frac{1}{2}$ height + 2.2225 cm
1883-1884	1862-1863	$\frac{1}{2}$ height + $\frac{1}{4}$ <i>vershoks</i> = $\frac{1}{2}$ height + 1.11125cm
1885-1897	1864-1876	$\frac{1}{2}$ height - $\frac{3}{8}$ <i>vershoks</i> = $\frac{1}{2}$ height - 1.666875 cm
1898 and after	1877 and after	no chest-size requirement

In addition to family status and medical exemptions, there were special rules of draft for males currently in school above primary, there were also exceptions for those under criminal investigation and based on occupation. Participation in the lottery could be postponed until graduation from high school and middle school. (In 1874, this partial exception applied to 1.1% of males (Fedorov 1959).<sup>83</sup> Clergy, teachers, and doctors were

<sup>81</sup> The Ministry of War assigned regional conscription targets proportionally to the size of provincial male population, excluding males with privileges of the first class (Vseobshchaya ... 1886; Rediger 1900). Within a province, local authorities also assigned draft targets proportionally to the number of males in the conscription lists (Polnoe ... 1874; Ministry of Internal Affairs, 1877b).

<sup>82</sup> *Arshin* equals to 71.12 centimeters or 16 *vershoks*; *vershok* equals to 4.445 centimeters.

<sup>83</sup> Draftees with a high-school degree had to serve only for 6 months and draftees with middle school degree had to serve only for 18 months compared to the 6-year length of service for everybody else.

except from military service completely (Polnoe ... 1874). Males under criminal investigation and could not serve in the military, this applied to 0.16% of all males.

***Original data on the height of draftees and challenges of identification.*** Military officials published data on height of males, who were drafted into the army and therefore passed medical examination. These data did not include Cossacks. The data were published for the years of draft: 1874-1887 and 1894, i.e., for each cohort born between 1853-1866 and the one born in 1873 (Vseobshchaya ... 1886; Sbornik ... 1887, 1890, 1897). We do not use data for 1873 cohort because these data are not comparable with data for 1853-1866 cohorts due to a change in reporting rules, on which there is a controversy about how to interpret it (e.g., Nefedov and Ellman 2016). Official volumes reported the number of draftees by nine height categories (eleven categories for a subset of years).<sup>84</sup>

The data report height of those, who were drafted into the army, i.e., those who considered eligible for the military service as a result of the medical examination. However, in order to construct a proxy for nutrition, we need to calculate a measure of height of *all* males, including those, who were exempt from military service because they did not pass medical requirements, e.g., had too low height or chest size. As we do not observe the height (or chest size) of those who were not eligible to military service, the average height by province calculated from official military height data may be biased. If this bias is different in provinces with different prevalence of serfdom, this would create a selection problem.

The minimum height requirement for draftees, in particular, could bias the estimation of the effect of the emancipation on height downward if, as one would expect, serfs were shorter than state peasants or free people and the emancipation led to closure of this gap. The reason for a negative bias is that before the abolition of serfdom, one should expect higher number of exemptions due to insufficient height in provinces with higher number of serfs before the abolition of serfdom, and therefore, upward bias in the measure of height in provinces with higher prevalence of serfdom before the emancipation. If abolition of serfdom led to an improvement in nutrition and, therefore, an increase in height, one should expect a decrease in medical exceptions due to insufficient height in provinces with a large number of serfs, and therefore, a smaller selection problem after the emancipation; which in turn would lead to estimates biased against finding a positive effect of emancipation of height.

The same logic would have applied to a minimum-chest-size requirement, if it were formulated in absolute terms, as height and chest size are positively correlated. However, the requirement for the chest size was formulated relative to height (as we described above), which may lead to biases going in different directions. Already in the late 19<sup>th</sup> and the early 20<sup>th</sup> century, medical literature established that, while the absolute chest size is increasing with height, the chest size relative to height is decreasing with height (Anuchin 1889, Gorskiy 1910, Levitskij 1901, Sokolov 1903). Consider a possible effect of the change in the minimum-chest-size requirement that took place in 1882 and affected the cohort born in the year when serfdom was abolished on the height of draftees who passed medical exam and were considered eligible for service. If cohorts born before the emancipation were indeed higher on average in provinces with fewer serfs, the increase in the minimum chest-to-height requirement could have affected them more negatively, which would have resulted in a positive differential effect of the 1882 draft reform on height. In other words, the formulation of the minimum-chest-size requirement in terms of height could have potentially led to a bias

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<sup>84</sup> These nine height categories are defined with a bit of ambiguity in the original sources and there is debate in the historical literature about how one should calculate the average height of draftees from them (Mironov 2000, 2003, 2013; Nefedov and Ellman 2016). We rely on the definition of categories provided by General Rediger (1900), who was one of the designers of the 1874 military draft reform. We have studied this literature and concluded that Rediger (1900) is the best available source.

in favor of finding a positive effect of emancipation of height, which is particularly problematic, if one does not correct for this bias.

***Data on chest size and height distribution and the calculation of the average height of draftees by province corrected for biases created by medical exemptions.*** To address these identification concerns, outlined above, we studied the late 19<sup>th</sup> and early 20<sup>th</sup> century literature on anthropometric characteristics of Russian males and found disaggregated data on height and chest (Anuchin 1889, Gorskij 1910, Kupriyanov 1891, Levitskij 1901, Oranskij 1911, Sokolov 1903).

The most detailed data come from a Ph.D. dissertation of Gorskij (1910). He reports data on all males who were subjected to a medical examination in order to assess their fit for military service in Bobrujsk district each year in 1874-1899. The data include the distributions of chest size (including, minimum, maximum and average) by height groups. Importantly, these data include all those who were exempt from military service because of the insufficient height or chest size. Gorskij compiled these data from original individual conscription documents of 45,879 males measured during the medical examinations in 1874-1899. There were 1,166 males who were measured during the medical examination in 1874; and 2,145 in 1899. The data are reported by religion. Among the 45,879 males considered for military service in Bobruisk district, 69.3% were Orthodox Christians, 23.5% were Jews, 4.4% - Catholics, 2.6% - Old Believers, and 0.2 – Protestants. The share of Jews was particularly high because the district was located in the Pale of Settlement of the Russian empire. We use data for Orthodox Christians because the height of an average Orthodox Christian from the Bobruisk district (164.5 centimeters, Gorskij 1910) was close to the average height of males in the European Russia (164.2 centimeters, Anuchin 1889).

Table A8 in this online appendix reports the minimum and maximum chest sizes of males by height categories that satisfied the minimum height requirement for military service (i.e., taller than 153.3525 centimeters). We assume that there is a one-to-one correspondence between chest size and height in each height category such that: the smallest individual in each category has both the minimum chest size and the minimum height in that category; the biggest individual has both the maximum chest size and maximum height in that category; and there is a linear relationship between chest size and height of all other individuals each category. Under these assumptions, we estimate the share of males in each height category, who did and who did not satisfy the minimum chest requirement under each version of the minimum-chest rules (i.e., those affecting cohorts born before 1861, born in 1861, in 1862-1863, and 1864-1876). Using these figures, we adjust the average height of draftees in each category and overall for the potential effects of the minimum-chest regulations. In the baseline estimation, we use the adjusted height figures. In Table A10 in this online appendix, we report results for the unadjusted height figures. (The results are robust, which suggests that the selection issue is not important in practice). However, one needs to be cautious in interpretation of the results, as our correction of the height measures for a possible selection is based on the assumption that the relationship between chest size and height of Orthodox males in the district of Bobruisk is representative of this relationship in all European provinces of the Russian Empire.

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## **B. Additional information about the data and the construction of variables**

### **B1. Governor reports:**

Original copies of governor reports are available in the archives. The government and historians published grain productivity and industrial output figures based on these reports for selective years. Table A1 lists all years for which we have grain and industrial output figures. For grain productivity, we do not have data in the following years: 1796-1800, 1830-1839, 1867-1869, and 1877-1882. The selection of the sample is not driven by poor or good harvests. The list of famine years does not correlate with the years of missing data: 1812, 1833, 1839-1840, 1844-1846, 1867, 1872-1874, 1891-1892, 1897-1900 (Golodi, 1868; Egorishev, 1985). We do not have data for two out of sixteen famine years.

### **B2. Formula for the land reform implementation proxy:**

The land reform implementation variable is the ratio of the estimated number of (former) serfs who signed buyout contracts and the total rural population. We estimate the number of (former) serfs who signed buyout contract in the following way.

a. For years 1862-1876 and provinces outside former Polish-Lithuanian Commonwealth:

$$Peasants\_with\_signed\_buyout\_contract_{it} = \frac{Total\_Redemption\_Payments_{it}}{Redemption\_Payment\_Per\_Serf_i}$$

where  $i$  indexes provinces;  $t$  indexes years;

$Peasants\_with\_signed\_buyout\_contract_{it}$  is a proxy for the number of (former) serfs who signed buyout contracts;

$Total\_Redemption\_Payments_{it}$  is the redemption payments per province and year from the redemption payment statistics;

$Redemption\_Payment\_Per\_Serf_i$  is the average redemption payment per (former) serf in 1877; it is calculated as follows:

$$\begin{aligned} Redemption\_Payment\_Per\_Serf_i &= \\ &= \frac{Projected\_Total\_Redemption\_Payments_{i,1877}}{Peasants\_with\_signed\_buyout\_contract_{i,1877}} \end{aligned}$$

where  $Projected\_Total\_Redemption\_Payments_{i,1877}$  is the linear projection of total redemption payment per province from 1870-1876 data;

$Peasants\_with\_signed\_buyout\_contract_{i,1877}$  is the number of (former) serfs who signed buyout contract by 1877 from official statistics.

b. For the year 1877 and provinces outside former Polish-Lithuanian Commonwealth:

We take these data from official statistics.

c. For the years 1878-1882 and provinces outside former Polish-Lithuanian Commonwealth:

We make a linear projection by province from the estimates of 1870-1877.

d. For the years starting with 1883 and all provinces:

The number of (former) serfs who signed buyout contracts is equal to the number of former serfs.

e. For the former Polish provinces:

In the year 1862, for Kovno, Vilno, Grodno, Minsk, Kiev, Mogilev, Podolsk, Vitebsk, and Volhyn, the number of (former) serfs who signed buyouts contract is estimated in the same way as for non-Polish provinces (see above) and, from year 1863 onwards, it is set to the number of former serfs.

**B3. The construction of the variable for the number of monasterial serfs:**

Beskrovonii et al. (1972) report the number of various subcategories of monasterial and clerical serfs by districts in all provinces of the Russian empire, including the provinces of the former Polish-Lithuanian Commonwealth, in 1796 and 1814, i.e., for the 4th and 5th tax censuses. (Such data do not exist in the later censuses, whereas the earlier censuses did not cover the provinces of the former Polish-Lithuanian Commonwealth because they were not a part of the empire at that time). We combine all these subcategories to estimate the average shares of such serfs in each district and each province between in 1796 and 1814. We do that in 1858 district borders, matching 1796 and 1814 districts with 1858 districts by the location of their capital towns in 1858. For a number of provinces and districts, we do not have data for one of the two years, 1796 or 1814. Most of the time, this occurs because the source reports some subcategories of former monasterial serfs together with state peasants. In these cases, we use the year for which the data are available for the corresponding location.

**B4. Data on inputs into the agricultural production:**

There are no data on labor inputs for agriculture in the 19th century. Employment in agriculture is known only for the 1897 population census year. The figures for the population with rural legal status (even if these people worked in cities) are known only for tax census years (1795, 1811, 1816, 1851, and 1858). Data on cultivated land are available for 1800, 1858, 1871, and 1877. There are no data on investments into land.

**B5. The definition of the 14 regions:**

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, Ryzan', 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 and Moldova: Kiev, Podoliya, Volyn' and Bessarabiya provinces;
10. South: Kherson, Tavrida, Ekaterinoslav and Don provinces;
11. Low Volga: Saratov and Samara provinces;
12. South-East: Astakhan' and Orenburg provinces;
13. Urals:, Vyatka and Per'm provinces;
14. Capitals: Moskovskaya and Saint-Peterburgskaya.

In addition, Estlyandiya, Lifyandiya and Kurlyandiya provinces composed the Baltic region.

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