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

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This draft: January 27, 2017

Abstract

We document very large increases in agricultural productivity, peasants' living standards, and industrial development in Imperial Russia as a result of the abolition of serfdom in 1861. A counterfactual exercise suggests that if serfs were freed in 1820, by 1913 Russia would have been about 50% richer compared to what it actually was. We construct a novel province-level panel dataset of development outcomes and conduct a difference-in-differences analysis of the effects of the abolition of serfdom, relying on cross-sectional variation in the shares of serfs and the timing of the different stages of reform, controlling for unobserved variation across provinces and over time and province-specific trends. We disentangle the two stages of the abolition of serfdom: the emancipation of serfs and land reform, and find that, in contrast to a large positive effect of emancipation, land reform negatively affected agricultural productivity. We provide evidence that better incentives resulting from the cessation of the ratchet effect in the landlord-peasant relationship is a likely mechanism behind the positive effect of emancipation, and the increase in the power of the re-partition peasant commune is a mechanism behind the negative effect of the land reform.

1. Introduction

The effect of slavery and serfdom on economic efficiency and growth has been the subject of a long-lasting debate.[1] Despite many scholars who view both slavery and serfdom as inefficient production systems with distorted incentives and suboptimal resource allocation (see, e.g., Cairnes 1862, Williams 1944, North and Thomas 1973, Anderson and Gallman 1977, Acemoglu and Robinson 2012, Ogilvie 2013), there is no clear theoretical argument for why slave and landowners failed to provide efficient incentives to their workers. Furthermore, the literature provides many case studies of highly efficient slave systems. For example, the abolition of slavery in the US south saw a sharp decline in output per person and the stagnation of the southern economy for generations (e.g., Fogel 1989; Atack and Passell 1994).[2] 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).[3] 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 a very large positive effect of the abolition of serfdom on agricultural productivity, peasant nutrition, and industrial development in the 19th century Russian empire. The magnitude of the effect can be illustrated

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

[2] In part, this effect was due to fewer hours of work per person.

[3] 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.

with a counterfactual exercise, which, under a set of important assumptions discussed below, yields the result that Russia would have been about 50% richer by 1913 had it conducted its major emancipation reform in 1820, as Alexander I had considered, instead of 1861.

During serfdom, Russia's serfs were the property of the gentry, who had formal usage and transfer rights over them. The abolition of serfdom, triggered by the exogenous shock of Russia's defeat in the Crimean War (1853-1856), involved two distinct stages: 1) the emancipation of serfs, which instantaneously granted personal freedom to 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.[4] 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.

The emancipation of serfs marked a sharp change in the growth rate of Russian agricultural productivity, as illustrated in Figure 1.[5] Our goal is to test whether this was causal and to measure the impact of the abolition of serfdom on agricultural productivity, peasant living standards, and industrial development. To conduct this analysis, we assembled a unique province-level panel data on development outcomes for the European Russia between the end of the 18th and throughout the 19th centuries. Our empirical strategy is difference-in-differences, with controls for province and time fixed effects and province-specific trends. We estimate the change in the provincial development trends at the time of the emancipation of the 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-

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[4] Baltic provinces are the exception: serfs in the Baltics were emancipated between 1816 and 1819.
[5] 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.

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

Serfs constituted only 43% of all rural residents in European Russia in 1858. The formally free rural population consisted 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.[6]

Our results are as follows: First, the abolition of serfdom caused a large and statistically significant increase in agricultural productivity measured as the ratio of grain yield to seed (henceforth referred to as *grain productivity*). In an average province, the abolition reform led to a 16.5% increase in grain productivity, above the overall province-specific development trend. The magnitude of this effect is comparable to 39 years of aggregate development. Grain productivity on average increased by 4% per decade in 19th century Russia. The quality of the data on agricultural productivity also allows us to disentangle the effects of the two components of the abolition of serfdom: the emancipation of serfs per se and the subsequent land reform. We find that the positive effect of the abolition on agricultural productivity is entirely due to emancipation. Obtaining personal freedom by serfs boosted growth in productivity, whereas the land reform significantly slowed it down, cancelling out nearly one half of the overall effect.

Second, we examine the mechanism behind these effects. Consistent with Gerschenkron's (1965) arguments, we show that the roots of the inefficiency of land reform lay in the re-partition peasant commune, which severely undermined peasant incentives to invest in

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[6] 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.

land. We also provide evidence consistent with the idea that the change in peasants' incentives stemming from the cessation of the ratchet effect in the relationship between peasants and landlords was an important mechanism behind the immediate effect of the emancipation. In particular, we show that the emancipation increased agricultural productivity only in provinces (which constitute the majority) where landlords were unable to commit to long-term implicit contracts regulating the level of serfs' obligations, and thus, where the ratchet effect was present. In addition, we find that the production choices (i.e., which crops to seed, which to sell, and which to consume) were better adapted to climatic and market conditions following the emancipation in provinces with a larger share of serfs. These pieces of evidence indirectly indicate an increase in peasant effort post-emancipation and suggests that 1) peasants' incentives played an important role in production and 2) the monitoring costs were too large for serf owners to ensure efficiency.

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

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

The results proved to be robust to a battery of sensitivity tests. We test for and find no evidence of pre-trends. We also verify that our results cannot be driven by an underestimation of standard errors due to the presence of spatial and overtime correlation (Conley 1999, 2008). The results are also robust to controlling for a large number of potential confounds as well as

an alternative data source for the prevalence of serfdom and using more granular district-level panel data for draftees height.

Our paper relates to several strands of economic and historical 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 and 2014b) who portray serfdom as a dynamic institution that sustained a considerable rate of economic development, pointing out the following advantages of serfdom: landlords' guaranteed and enforced social order, accumulated resources to launch new projects when access to credit was limited, provided minimum food consumption to peasants during famines, and adopted new technologies. The literature, prior to our paper, was based primarily on sporadic anecdotal evidence with the important exception of Nafziger (2013) and Buggle and Nafziger (2015), who study the long-term effects of serfdom and document a negative cross-sectional relationship between the prevalence of serfdom and the long-term land inequality and wellbeing. The results of our paper combined with the findings of Buggle and Nafziger (2015) suggest that serfdom had a negative effect on development overall and that the emancipation reversed a substantial part of this influence.[7] Finally, our work is related to the literature on

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[7] Buggle and Nafziger (2015) were the first to use an exogenous variation prevalence of serfdom coming from the nationalization of the monasterial lands a century before the emancipation of serfs. We also rely on the historical distribution of monasterial serfs for our instrumental variable strategy, but our identification assumptions are substantially weaker due to the panel nature of the data we use, which allows controlling for province fixed effects and province-specific trends. Other relevant contributions to the empirical literature on the history of the Russian

land reforms 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 may have 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.

2. Hypotheses

The effects of the abolition of serfdom on agricultural productivity, peasants' wellbeing, and industrial development 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. Due to asymmetries of information, one could expect severe distortions in the effort of serfs as well as in production and investment decisions. The lack of credible commitment on the part of the landlord not to revise the size of peasants' obligations in the future must have reduced peasant effort 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. However, in theory, due to differences in the reservation utility of agents, the use of coercion on forced labor could also increase effort compared to free labor relations (Acemoglu and Wolitzki 2010).[8] 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, as it changed the status of serfs from being an agent to being a principal, owning their own human capital and labor.

Empire are: Mironov and A'Hearn (2008); Nafziger (2012), Finkel et al. (2015) Castañeda Dower et al. (2015), Chernina et. al. (2014), Castañeda Dower and Markevich (2016).
[8] Hoch (1986) presented a case-study of an estate where the landlord used coercion to incentivize serfs.

However, we do not expect most of these changes to take place instantaneously. By contrast, the emancipation did instantaneously solve the ratchet effect problem by fixing the level of quitrent for all (former) serfs.

Incentive problems are just a part of the story. Serfdom could have had efficiency advantages compared to post-emancipation production because of economies of scale, access to finance, and access to new technologies and new production practices, which most probably were better realized in the large estates of the gentry compared to the small entrepreneurial farms of emancipated peasants.

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).[9] For example, the so-called re-partition communes, which were the dominant form of land use in most parts of the empire, periodically redistributed land among households for fairness reasons despite the perverse effect on incentives to invest in land.

It is also *a priori* not clear whether one should expect peasant nutrition to be affected by the emancipation. Serfs were a 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. Peasants may have also had lower incentives to feed children under serfdom, as peasants' children belonged to the gentry.

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)

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[9] 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).

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 their agricultural production. Second, personal freedom given to serfs by the emancipation reform also may 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 tax responsibility within the commune (Gerschenkron 1965).

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

Serfdom was one of the key institutions in Russian history. It existed in its most severe form between 1649 and 1861 (i.e., 212 years). Originally, Russian peasants were free and could migrate across estates. The government began to limit the right of migration in the late 15th century. The 1649 Code of Law (*Sobornoye Ulozhenie*) proclaimed that peasants were the property of their estates and made migration a criminal offence. Peasants became attached to the land and had to obey the orders of their landlords. Serfs had to fulfill obligations in the form of in kind payment (quitrent) or labor (corvee) for their landlords. The landlords had (almost) full discretion over the amount and the form of these obligations. The landlords also had the right to sell, to buy, or to lease their serfs (Svod … 1857, vol. 9, articles 208, 1027, 1029, 1037, 1047, 1048, 1068).[10]

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. The map is presented 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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[10] 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.[11]

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.[12] 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.[13] Figure 3 presents the spatial distribution of serfs across provinces in 1858.[14] 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.[15]

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

Discussions of a potential emancipation reform within the Russian empire began in the late 18th century – early 19th 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.[16]

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[11] 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.

[12] 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.

[13] See online appendix section A3 for details.

[14] 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).

[15] 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 18th – the first half of the 19th century. We describe the historical details of the nationalizations of the church lands in the online appendix section A4.

[16] 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. [17] Emancipated serfs were obligated by law to buy out the land from the landlords. Peasants (as a commune) and their landlords had to negotiate the precise terms of this buyout, namely, the plots, the price, and the exact timing of the transaction.

The land reform was gradual and proceeded in two stages. The first stage regulated the peasant-landlord relationship in the form of a *regulatory charter* during the transition period, i.e., before the *buyout contract* was signed. The second stage marked the actual transfer of ownership over the land in exchange for an immediate payment, the terms of which were regulated by the buyout contract between the landlord, the peasant commune, and the state. The regulatory charters had to be signed by 1863; they fixed the amount of the lease payment (in the form of a quitrent) 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 just formalized the previously existing implicit contract (Zajnchkovskij 1968).

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 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

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[17] 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).

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 wrote the debt off, leaving the landlord without money and land lease payments. Importantly, as a rule, lease payments were higher than the interest on the state loans. In contrast, landlords without debt got the full value of the land sold to former serfs at the signing of the buyout contract. The state unexpectedly closed special credit lines for gentry two years before the emancipation.[18]

4. Data

We combine various published and archival sources to construct a unique province-level panel dataset on the development of forty-six European provinces of the Russian Empire in the 19th century. 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-19th 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.[19] The methodologies of the data collection were different before and after 1883, but the same within each of these periods irrespective of prevalence of serfdom in a province.[20] The quality of the late imperial statistics and governor

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[18] We describe the details of the land reform and the determinants of gentry indebtedness in the online appendix sections A6 and A7, respectively.

[19] For governor reports, we rely on the secondary published sources based on original archival documents.

[20] Governor reports provide only aggregated figures on all cereals. We aggregate data on rye, oat, wheat, barley, and buckwheat for the post-1883 period to construct comparable measures. In Section 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 A8 (on the methodology of data collection in the Russia empire) and section B (on the variables used in the paper).

reports is rather high (Koval'chenko 1979; Nifontov 1974 pp. 35-46).[21] The nutrition of peasants is proxied by an average height of draftees by birth cohort in each province, drafted at the age of 21 years old, reported by the Ministry of Defense of the Russian Empire.[22] Industrial development is measured by log industrial output in constant rubles of 1895.[23] These data also come from the governor reports and official statistical volumes published by the Central Statistical Committee. All outcomes are available at the province level; in addition, the average height of draftees by cohort is available at the sub-province (district) level, with 466 districts in the baseline sample.

Different numbers of snapshots over time are available for different outcomes. The largest number of over-time observations is 43 for grain productivity. The number of cross-sections for the industrial output is 8. As there are time gaps in the data for agricultural productivity and for 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 before and after the abolition of serfdom.[24] 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 number of cohorts with data on height is 15 at the province level and 10 at the district level; these are consecutive years and there are no missing observations within each cohort.

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[21] 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 (see on-line appendix section A8 for details).

[22] Rural citizens were the main source of draftees for the army (Beskrovnii 1973). All height data were collected by the military authorities for all draftees, who were chosen at random from the population of registered men eligible for the army service as soldiers under the universal conscription laws introduced by the 1874 military reform. The population of registered men was close to the total male population because the law prohibited unregistered males to marry. Eligibility rules were the same across provinces in each given year. The draft affected about 30% of each cohort (27.12% in 1874-1883 decade in the European provinces of the empire, Vseobshchaya … 1886, p. XI). Drafts happened in the end of a calendar year, i.e. the bulk of the draftees were 21 years old at the moment of draft (Mironov 2010 p. 188). The draftees' cohorts between 1874 and 1881 were born before the emancipation.

[23] We use the Mironov (2010) index to deflate industrial output reported in current rubles in the original sources.

[24] 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 19th century.

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).[25] The data on the number of serfs by district in 1858 come from Trojnitskii (1861); to get the share of serfs by district, we divide their number by district population in 1858 from Bushen (1863).

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

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[25] 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, foreigners in rural areas, non-Russians in rural areas*. Taken together, the latter eight groups comprise the free rural population in our classification. We verified that our results are robust to using 1857 tax census data (Kabuzan 1971) as a source of data for the composition of the peasantry by type instead of Bushen (1863) (see section 7 below for details).

the total rural population to be equal to the total share of former serfs from 1882 onwards.[26] 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).[27] 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 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 (details 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.[28]

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[26] We provide the exact formula for the land reform implementation variable in the online appendix section B.

[27] 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.

[28] 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

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 summer 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 summer crops we use the time series of the relative price of rye (the main winter crop) to wheat (the main summer crop) in the Netherlands goods exchange from van Reil (2016), as the Netherlands was one of the most important export markets for Russian grain in the 19th century.

5. Empirical methodology

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

$$Y_{it} = \alpha\, ShareSerfs_i \times PostEmancipation_t + \mathbf{X_{it}}'\, \gamma + \psi_i + \sigma_t + t\delta_i + \varepsilon_{it},$$

(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. The baseline sample consists of 46 European provinces of the Russian empire.[29] We consider the following outcomes, denoted by Y: grain productivity (yield/seed ratio) and log(industrial output) in province i at time t and the mean height of draftees in centimeters in province i in a cohort born at t. *ShareSerfs* denotes the share of privately owned serfs in a province in 1858. *PostEmancipation* denotes a dummy indicating the time after the emancipation of serfs, i.e., 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 α 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

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communes (e.g., Dubrovsky 1963). As there are no systematic data on actual redistributions of land, we rely on the legal distinction between the repartition and hereditary communes, as the first approximation to the actual practices.

[29] 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 below.

trends. ψ_i and σ_t are the province and year fixed effects. As different provinces are expected to have different development trajectories, we control for 46 province-specific linear trends ($t\delta_i$).

To account for the correlations between the share of serfs with the distance 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 $\mathbf{X_{it}}$.[30]

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.[31]

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_i*) with the post-emancipation dummy by a series of interactions of *ShareSerfs_i* with a number of dummies indicating different pre-reform and post-reform time periods.

We follow Bertrand, Duflo, and Mullainathan (2004) and cluster error terms within each province separately before and after the emancipation of 1861. This system of clusters accounts for autocorrelation in residuals within each province. However, it does not account for spatial correlation. This is potentially problematic because the share of serfs is spatially correlated as can been seen in Figure 3. To verify that we do not underestimate standard errors due to the presence of both the spatial and over-time correlation in residuals, we collapse the panel data to a single cross-section, in which we explicitly account for spatial correlation. In particular, we de-trend each outcome of interest by taking residuals from regressing it on time dummies and province-specific linear trends and take the difference between the mean of de-trended outcome before and after the emancipation separately in each province. As a result, we get the province-

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[30] The means are subtracted in order for α to estimate the effect of the abolition of serfdom at the mean levels for the distance from Moscow and land suitability.

[31] To be precise, the post-1866 dummy switches on in 1866 and post-1859 switches on in 1859.

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).[32]

As data on the height of draftees by cohort also exists at the district level, for this outcome, we also estimate an analogue of equation 1 with year and district fixed effects and province-specific trends as well as a cross-sectional specification that relates the average change in the height of draftees by district between cohorts born before and after the emancipation to the share of serfs across districts.[33]

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 before their nationalization as a source of exogenous variation in the share of serfs in 1858. In order to avoid a conflict between the crown and the church, monasterial lands nationalized by the state were less likely to be subsequently redistributed to gentry than other state lands (Semevsky 1906) and, therefore, peasants who lived on these lands were less likely to become private serfs after the nationalization of church property. Figure 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

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[32] 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.
[33] At the district level, we cannot control for the reforms affecting state and royal peasants, as data on state and royal peasants are not available at district level.

emancipation at the province level; it presents the conditional scatter plot between the share of former monasterial serfs (which is denoted by *MonastShare$_i$*) and the share of serfs in 1858 conditional on log distance from Moscow and land suitability across provinces.[34] We instrument *ShareSerfs$_i$ × PostEmancipation$_t$* with *MonastShare$_i$ × 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 number of former serfs who signed buyout contracts as a share of 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 who signed buyout contracts in a particular year in a particular province with a synthetic variable which predicts the progress of land reform based on the pre-reform indebtedness of estates in a province. In particular, to construct the predicted land reform variable we assume that landlords without debts initiated the 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.[35] Thus, we construct the IV for the land reform as an interpolation between (1-indebtedness) and 1 in the

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[34] 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%.

[35] See on-line appendix section A7 for details.

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. 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 (former serfs) 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). 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). 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.

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

6.1. *Productivity of Russian agriculture*

Table 2 presents the estimated effect of the abolition of serfdom on the productivity of Russian agriculture. The results yield strong and robust evidence of a large positive effect of the abolition of serfdom on 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.[36] In all specifications we find a positive and statistically significant average effect of the abolition of serfdom, estimated by the coefficient on the interaction term between the share of serfs and post-emancipation dummy. The 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. 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.[37]

The estimated effect is substantial. A one standard deviation increase in the share of serfs in a province before the emancipation (i.e., an increase of the share of serfs in rural population of 24 percentage points) led to an increase in grain productivity of 0.31 after the emancipation or 8.8% from the mean 1858 level of 3.5 (according to the estimate in column 3 of Panel A). These are large effects, as compared to the aggregate trend in grain productivity, which, on average, increased by 4% per decade in the 19th century. For an average province,

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[36] 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.

[37] 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.

where serfs constituted 45% of the rural population, the abolition of serfdom led to a 16.5% increase in grain productivity from the 1858 level, on top of the overall development trend. We find that the coefficient on the distance from Moscow interacted with post-emancipation dummy is negative and significant, thus these magnitudes refer to provinces with the mean log distance from Moscow.[38]

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). 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-specific trends, each of which groups together several provinces that are commonly considered to have similar development trajectories.[39] 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 6 visually represents the results by plotting the coefficients on these interactions along with their 90% confidence intervals by time period.[40] The results indicate the absence of pre-trends, as there are no significant effects before the emancipation reform.[41] An increase in grain productivity occurred immediately after the emancipation. The coefficients for the periods 1861-1865 and 1866-1870 are positive and statistically different from each of the three coefficients estimated for the period before the emancipation: 1841-1850, 1851-1855, and

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[38] 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.

[39] We provide the precise list of the regions and the provinces they are comprised of in the online appendix section B.

[40] Column 1 of Table A3 in the online appendix presents the entire regression output.

[41] 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.

1856-1860. The effect during the immediate aftermath of the emancipation is not statistically different from zero, but it is significantly larger than the effect for the 1840s, which itself is positive and insignificant. The reason for this is that the data on grain productivity from before 1840 are noisier than for the later period. Figure 6 also shows that the grain productivity in the provinces with emancipated serfs continued to rise throughout the 1870s. The effect twenty years after the reform is three times as large as five years after. Thus, these results provide only a partial support for the claims of historians that the realization of the positive effects of the emancipation was slow because of the slow institutional adjustments and associated transaction costs (Gerschenkron 1965, Nifontov 1974). We also find a decrease in grain productivity in the late 19th century compared to the peak attained by 1876-1880. The coefficients on the interactions of the share of serfs with the five-year-period dummies after 1881 are substantially smaller (but remain positive and jointly statistically significant). In the reminder of this sub-section, we investigate the reason for this partial setback.

In columns 5 and 6 of Table 2, we 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 5 presents OLS estimates and column 6 – IV estimates. In the 2SLS estimation, we instrument both the emancipation (as above, with the share of nationalized monasterial serfs) and the land reform. The instrument for the land reform, as described in the methodology section, is the 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 (column 6 vs. column 3). IV estimates imply that a full implementation of the land reform from affecting zero to affecting all former serfs in an average province led to a decrease in grain productivity by 0.54 or 15.4% from the mean 1858 level, whereas the emancipation led to an increase in grain productivity by 1.24 or 35.3% from the mean 1858 level (column 5). Importantly, these IV estimates are valid under the assumption of the excludability of the synthetic indebtedness instrument. We provide anecdotal evidence in the online appendix in support of this assumption, as it cannot be verified directly. The IV estimates suggest that the land reform substantially slowed down the growth in agricultural productivity, which was initially boosted by the emancipation: the net effect of the abolishment of serfdom would have been 77% larger if not for the setback caused by the inefficiency of the land reform, provided that our instrument for the land reform is valid.[42]

6.1.1. 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 5 of Panel A of Table 2. We find that the average negative effect of the land reform is entirely due to the negative effect of land reform under the re-partition commune. We run OLS specification only because we do have a credible instrument for the re-partition commune dummy. Judging by the analysis presented above, the OLS estimates underestimate the negative effect of the land reform. An additional source of bias could arise from the endogeneity of the re-partition communes if it had a direct non-linear effect on dynamics of agricultural productivity at the

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[42] The 77% figure comes from the following calculation: 1.24 /(1.24-0.54)=1.771, where 1.242=0.45*2.76 and 0.54=0.45*1.20; 0.45 is the mean share of serfs in a province and 2.76 and -1.20 are the point estimates from column 6 of Table 2.

time of the reform, which is unlikely, but not impossible. Thus, these results should be interpreted with caution. We find that the full implementation of the land reform in an average province with re-partition communes was associated with a decrease in grain productivity of -0.25 (or 7%). The effect of the land reform in the hereditary commune is positive albeit not statistically significant. (The difference between the two effects is significant, as reflected in the negative significant coefficient on the interaction between the share of peasants with signed buyout contracts and the re-partition commune dummy). These results suggest that the inefficient re-partition commune was the reason for the setback in the reform progress after 1882— the year, when the land reform was completed.

What was the mechanism behind the positive effect of the emancipation reform? A large and immediate effect may seem puzzling because most changes induced by the reform must have taken time, and many were expected to have a sluggish effect on agricultural productivity. For example, one could expect an increase in human capital investment (as a result of granting personal freedom to serfs) and an increase in investment in land in hereditary communes (as a result of the change in property rights); however, these investments could have had an effect on productivity only with a considerable lag. It is also possible, although historians argue against it, that productivity increased because of an increase in capital inputs after the reform (as a result of the acquisition of agricultural machinery) and because of new technologies (i.e., a shift to more productive seed varieties).[43] These changes also could not have happened overnight.

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

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[43] 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 (1960) 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 A9 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 A5 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.

(Polnoe … 1863, vol. 36, part 1). This change could have had an immediate positive effect on peasants' incentives, as they became residual claimants of the proceeds of their labor, provided that serf owners were not able to commit to a fixed level of serfs' obligations under serfdom. Importantly, many contemporaries believed that an increase in peasant effort and care was what was needed to boost agricultural productivity.[44] Therefore, we expect an immediate positive effect of the emancipation on peasants' effort and, consequently, productivity, if serfdom was subject to a ratchet effect. This hypothesis is not testable directly because there are no data on peasant effort. We test it indirectly.

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

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[44] 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.

improvements as a result of the emancipation. The share of serfs under implicit long-term contracts varies across provinces from 2% to 85%, with the median province at 45%. The productivity increase due to the abolition of serfdom (taking into account the countervailing effects of the emancipation and the land reform) was positive and statistically significant in 25 provinces where the share of serfs subject to implicit long-term contracts with landlords was below 50.5%. In all other provinces, the change in productivity as a result of the abolition of serfdom was insignificant; and in all but one province, where the prevalence of the implicit long-term contracts attained its maximum, it was positive.

Second, we can observe whether peasants made adjustments to the choice of crops to seed instead of sell or to consume depending on the climatic and market conditions. As effort and care are needed to make such adjustments, we expect peasants to chose more appropriate crops for cultivation with regard to climatic and market conditions after the emancipation. Due to the technology that prevailed at the time, each plot was divided roughly into three parts: for winter grains, summer grains, and fallow. The peasants could change the relative sizes of the three parts depending on what made more sense in terms of climatic and price shocks. In particular, colder temperatures were associated with higher failure of winter crops relative to summer 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 summer crops in the spring of year t. The decision of how much to allocate to winter vs. summer grains was taken in the fall of the year t-1 (when the winter crops were seeded). Market conditions also mattered for the choice of what shares of each type of crop to seed. Since price fluctuations allowed at most an imperfect forecast of the relative price of winter to summer 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 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 column 4, we explore the choice between the winter and summer crops to be seeded depending on their relative price. Again, as expected, we find that the emancipated serfs sold a larger share of the more expensive crops (leaving cheaper crops for seeds and own consumption): an increase in the relative world price of rye (the main winter crop) made peasants seed a relatively lower share of winter rye, because they sold a larger share of it on the market. In column 5, we combine the interactions with temperature and with the relative price in one regression and get the same result.[45]

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

6.2. *Peasants' nutrition*

We proceed by estimating the effect of the abolition of serfdom on draftees' height as a measure of nutrition. As nutrition affects adult height primarily in the first three years of life starting with time in utero (Costa 2015), the effect of reform is expected to be almost immediate and, thus, we compare the average height of cohorts born before and after the reform and relate this difference to the variation in the prevalence of serfdom. Table 4 presents the results: we find a large and immediate positive effect of the emancipation on the height of draftees. The structure of the table is similar to that of Table 2. In particular, in Panel A, we present the results of the panel estimations; Panel B presents the first stages for the corresponding 2SLS regressions presented in the Panel A; and Panel C presents the cross-sectional results for first differences with standard errors adjusted for spatial correlation in error terms with a cut off at 900 km. As described above, we have used two sources of data: average height of draftees by province and by district. Let us first discuss the panel results. Columns 1 to 3 present the province-level results: the baseline OLS and IV, as well as OLS with controls for reforms affecting state and royal peasants, respectively. Columns 4 and 5 present the OLS

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

and IV results at the district level.[46] The coefficient on the main variable of interest is large and statistically significant irrespective of specification, and the first stages are sufficiently strong not to worry about a weak instrument problem. The point estimate of the main parameter of interest is somewhat larger in the IV regressions compared to the OLS regressions. In province-level regressions, both IV and OLS point estimates are within the confidence interval range of the other estimate. In district-level regressions, the confidence intervals of the two estimates overlap. Importantly, the district level and province level IV estimates are very close in magnitude. As with grain productivity, the most plausible explanation for this difference is the measurement error, which is larger at the district level, as the shares of serfs are calculated based on a smaller population and are therefore more susceptible to idiosyncratic shocks over time.

Since both serfs and free peasants had the same chance to be drafted and serfs constituted 45% of the total population in an average province and 41% in an average district, the abolition of serfdom in an average province led to an increase in the height of draftees by 0.61 centimeters (0.39=1.35*0.45) and in an average district by 0.49 (=1.21*0.41) centimeters (according to the IV specifications). An important reason why the point estimates are slightly smaller in the district-level analysis compared to the province-level analysis is that there are only two cohorts born after the emancipation in the district-level data as compared to seven post-emancipation cohorts in the province-level data, whereas the height in adulthood is affected by nutrition of the mother while the child is in utero and up to age three (e.g., Costa 2015). As the draftee's height is an individual characteristic (rather than a characteristic of the economy), we can interpret the results one to one: IV estimates imply that the abolition of serfdom led to an increase in the height of a (former) serf by 1.35 centimeters on average according to province-level results and by 1.21 centimeters according to district-level results.

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[46] In the district-level panel, we omit one covariate, namely, the interaction between land suitability and the dummy for cohorts born post-emancipation, as we have only two cohorts born post-emancipation in the district-level data set and there is a multicollinearity in the IV district-level panel regressions if we include both distance from Moscow and suitability interacted with post-emancipation cohorts in addition to our main regressor. As a baseline, we report district-level results excluding the Moscow district because this observation is an outlier in the cross-sectional regression. We verify that the panel regression results with district fixed effects are robust to excluding both the Moscow and Saint-Petersburg districts (we report these results in Table A6 in the online appendix).

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 (164.34 cm) implies an income per capita of 586.42$ (in 1970 U.S. $) and the average height of emancipated peasants, according to our estimates (165.69 cm=164.34+1.35) implies an income per capita of 804.84$; i.e., the emancipation was associated with an increase in wellbeing comparable to a 37.2% increase in per capita income at that level of development. [47] 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 occurred as a result of emancipation, when the peasants' obligations to landlords were fixed.[48]

As with grain productivity, to test for pre-trends and to study the dynamics of the effect, we estimate an event-study regression at the province level interacting the share of serfs separately with the dummies for each cohort born around the emancipation for which we have the height data: 1858-1866 and 1875 (leaving cohorts born between 1853 and 1857 as the comparison group). Figure 7 reports the results in a graphic form, and column 2 of Table A2 in the appendix reports the regression output. The coefficients on interactions with pre-1861 cohort dummies are very close to zero in magnitude and not statistically significant. Thus, we conclude that there is no pre-trend. In contrast, the coefficients on the interactions with the post-1861 cohort dummies are positive and statistically significant (with the exception of the last 1875 snapshot, where the effect is imprecisely estimated). The bulk of the positive effect of the emancipation on height was realized immediately after the reform, consistent with the

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[47] The first two rows of Table 5 in Steckel (1995) and of column 3 in Table 3 in Floud (1990) imply 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: $Y = (H-160.7)*5000/31$.

[48] 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 Entciklopedicheskii … 1890-1907, vol. 37, 1903; Arkhangelskii 1874). In addition, the immediate effect of the abolition of serfdom on height that we uncover is inconsistent with this potential mechanism because any changes in access to healthcare for serfs would have required time.

finding in the health literature of the effect of nutrition on height in early infancy (Costa 2015).[49]

In Panel C of Table 4, we present cross-sectional regressions with standard errors corrected for spatial correlation for both province and district-level data. As above, we de-trend the outcome by regressing it on time dummies and province-specific trends, take averages of the de-trended outcome over time for each province and district, respectively, separately before and after the reform, take a difference and regress it on the pre-emancipation share of serfs. We also repeat this exercise, excluding the most influential observations at the province and at the district level.[50] The results prove to be robust to accounting for a spatial correlation of errors and to excluding outliers, as we find a positive and significant coefficient on the share of serfs in these regressions.

6.3. Industrial development

In Table 5, we estimate the effect of the abolition of serfdom on log industrial output. The three panels of the table have the same structure as Tables 2 and 4. The main difference between this analysis and the province-level analysis presented above is that the time dimension of the data for industrial output is substantially shorter (eight snapshots) and, as a consequence, we do not have enough statistical power to control for trends specific to each province, thus, instead, we control for 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., OLS with and without controls for state and royal peasants, as presented in columns 1 and 3 of Panel A of Table 5, respectively, and IV, as presented in column 2 of the

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[49] We also test for and find no evidence of pre-trends at the district level by estimating an equation interacting dummies for the pairs of consecutive birth cohorts with the share of serfs by district controlling for district fixed effects and province-specific trends holding the first two cohorts, i.e., those born in 1853 and 1854, as the comparison group. We take two-year intervals in contrast to the pre-trend analysis at province level because district level data are noisier and, as a result, the coefficients at the birth cohort interactions with the share of serfs at district level are less precisely estimated. The only significant coefficient is for the two cohorts born after the emancipation. We illustrate the results in Figure A7 and present the regression output in column 3 of Table A3 in the online appendix.

[50] At the province level, as above, we set the cut off for influential observations at |DFBeta|=0.3; at the district level, the cut off is set for 0.15, as the highest value for |DFBeta| is 0.22. Due to a larger number of observations at 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 A8 in the online appendix, in which we indicate DFBeta for each observation. In order to illustrate that the panel results at the district level are not driven by the exclusion of the control for suitability interacted with the post-emancipation cohorts, in cross-section at district level, we report results conditional on both log distance from Moscow and land suitability.

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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.[51]

As far as the magnitude of the estimated effect is concerned, in contrast to the results for grain productivity and the height of draftees, there is a substantial difference in the size of point estimates of the effect of the abolition of serfdom on industrial output between OLS and IV specifications: 0.73 vs. 2.6. This implies the following magnitudes: a one standard deviation increase in the share of serfs before the emancipation increased industrial output by 19% according to the OLS specification and 86% according to the IV specification. In an average province, industrial output increased by 39% 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, while having a uniform effect on agricultural productivity or nutrition is that the reform affected agriculture directly by changing the incentive structure, whereas it affected industry mostly through labor market spillovers, which could only occur in places where peasants were tied to large landlords' farms.

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[51] Figure A9 in the online appendix illustrates the cross-sectional relationship presented in Panel C of Table 5 with an indication of DFBeta for each observation.

The large magnitude of the effect on industrial development that we find is in line with recent findings on the substantial level of labor migration within provinces from villages into the provincial industrial sector after the emancipation in spite of the constraints erected by the peasant commune (Borodkin et al. 2008, Burds 1998, Crisp 1976, and Nafziger 2010). Similar to Figures 6 and 7, Figure 8 presents the estimates of the dynamics of the effect of the abolition of serfdom on industrial output, confirming the absence of pre-trends.

7. A counterfactual exercise

Our estimates imply that, as a result of the reform, the annual value added in agriculture increased by 16.5% and in industry by 38.5% (using the ATE estimate), on average. Using the composition of the value added across sectors in the Russian empire (Goldsmith 1961) and assuming that the service sector grew at the same rate as the rest of the economy on average— which is a reasonable assumption given that 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—the (immediate) increase in GDP as a result of the abolition of serfdom amounted to 18%. Using this figure and making an assumption about the counterfactual growth rates, we can construct a counterfactual growth trajectory for the Russian economy until 1913 if serfdom had been abolished in 1820 instead of 1861. We consider three alternative scenarios for the average counterfactual growth rate between 1820 and 1913 to be equal to: (1) the actual growth rate of the Russian economy between 1820 and 1913, which is likely an understatement because the abolition of serfdom changed the development trajectory as can be seen in Figure 1; (2) the average growth rate after the abolition of serfdom, i.e., between 1870 and 1913; and (3) the average growth rate between 1820 and 1913 of other East-European countries that abolished serfdom circa 1820. Table A22 in the online appendix reports the values for counterfactual per capita GDP under different scenarios and the online appendix section C describes assumptions behind these calculations in detail. In 1913, according to Maddison (2007), Russia's GDP per capita was $1,488 measured in 1990 US dollars. The calculations yield that the abolition of serfdom in 1820 would have resulted in per capita GDP in 1913 in a range between $2,179 and $2,340 (depending on whether we apply growth rates according to scenarios 2 or 3, respectively), i.e., Russia would have become about one and a half times richer than it actually was. Thus, by 1913 Russia would have had a level of GDP per capita

comparable to Finland ($2,111) or Norway ($2,447).[52] We also calculate the lower bound for the counterfactual per capita GDP at $1,759 (the value generated under the extremely conservative assumption of scenario 1, i.e., that the instantaneous jump of 18% persisted over time and the abolition of serfdom did not affect the subsequent growth rates).[53]

8. 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 re-estimate equation 1 for grain productivity, height and industrial output, including the following potentially confounding factors in the list of covariates: 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. 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 A7, A8, and A9 in the online appendix report 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

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[52] Finland was a part of the Russian Empire, but had a considerable degree of political and economic autonomy, including an independent monetary policy.

[53] Table A21 in the online appendix also reports counterfactual figures under the assumption that the service sector did not jump as a result of the abolition of serfdom in order to illustrate the sensitivity of the estimates to the assumption of instantaneous growth in the service sector together with aggregate demand as a result of the abolition of serfdom. We find that the resulting range of the estimates for the counterfactual per capital GDP, 138%-149% of the actual value, is not that different from the one received under the baseline assumption about the growth in the service sector, i.e., 146%-157%.

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. The absence of the data for industrial output for the years after the emancipation and before the launch of the *zemstvo* reform does not allow us to estimate the effect of the emancipation on this outcome precisely if *zemstvo* expenditures are included in the set of covariates.

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. We do this to rule out a potential concern that the results might be driven by the 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 find that the results are robust as reported in Table A10 in the online appendix. We further verify that the results are robust to restricting the sample to only to the core provinces of the empire, i.e., Great Russia, New Russia and the Eastern part of Belorussia, i.e., the thirty-five out of forty-six provinces, where the rules of the land reform were regulated by the same local emancipation statute (Polnoe … 1863, vol. 36, part 1).[54] Columns 1 to 4 of Table A11 in the online appendix report the results of regressions estimated on the restricted sample using specifications reported in columns 5 and 6 of table 2. In the last two columns of Table A11, we 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.[55] 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.

Next, we re-estimate the main specifications using 1857 tax census data on the share of serfs across provinces (Kabuzan 1971) instead of the 1858 data from Bushen (1863). Tables A12-A15 show that the results are robust. The point estimates have similar magnitude to the

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[54] 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 peasant households could get as a result of the land reform (Polnoe … 1863, vol. 36, part 1).
[55] On average, peasants got less land in ownership than they cultivated under serfdom (Zajonchkovskij 1968).

baseline. The precision of estimates, however, goes down. In one out of 16 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.

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. Table A16 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 1-4). In columns 5 and 6, 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 6). 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).

Next, we study the robustness of our results to the inclusion of Baltic provinces into the sample. In this enlarged sample, 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$_i$* 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 A17 present the results. We find a positive and significant effect of emancipation on grain productivity. In columns 3 and 4 of Table A17, 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.

We also verify the robustness of the results to weighting observations by log provincial population. The results are presented in Tables A18 to A21 of the online appendix; these tables have the same structure as Tables 2 to 5 of the main text. We find that the point estimates are similar in magnitude and are statistically significant.

Finally, we run a series of placebo tests 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 years before and after 1861. We present the estimated coefficients along with their confidence intervals graphically on Figure A10 in the online appendix. The largest coefficient is on the interaction with the post-1862 dummy (i.e., the dummy that switches on in 1862). This is not surprising, as the reform was announces in February 1861, i.e., at a time when some important decisions about the agricultural production (such as the seed of winter crops) had already been made. The point estimates at the placebo interactions decrease almost monotonically as one moves away from the time of the onset of the reform in both directions.

9. Conclusions

The abolition of serfdom had a large positive effect on agricultural productivity, peasants' living standards, and industrial development in 19th century Russia. Overall, it led to an instantaneous jump in Russia's GDP of about 18%. Under a counterfactual scenario in which serfdom in the Russian empire was abolished 40 years earlier than in reality, assuming that Russia would have sustained a growth rate similar to other East-European countries after the abolition of serfdom or to its actual growth following the abolition reform, by 1913 Russia would have been about one-and-a-half times richer compared to its actual level of development at that time.

Our evidence suggests that a primary reason for the large effect of the abolition of serfdom 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 main mechanism behind the negative effect of the land reform.

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Figure 1. Dynamics of agricultural productivity in the Russian Empire
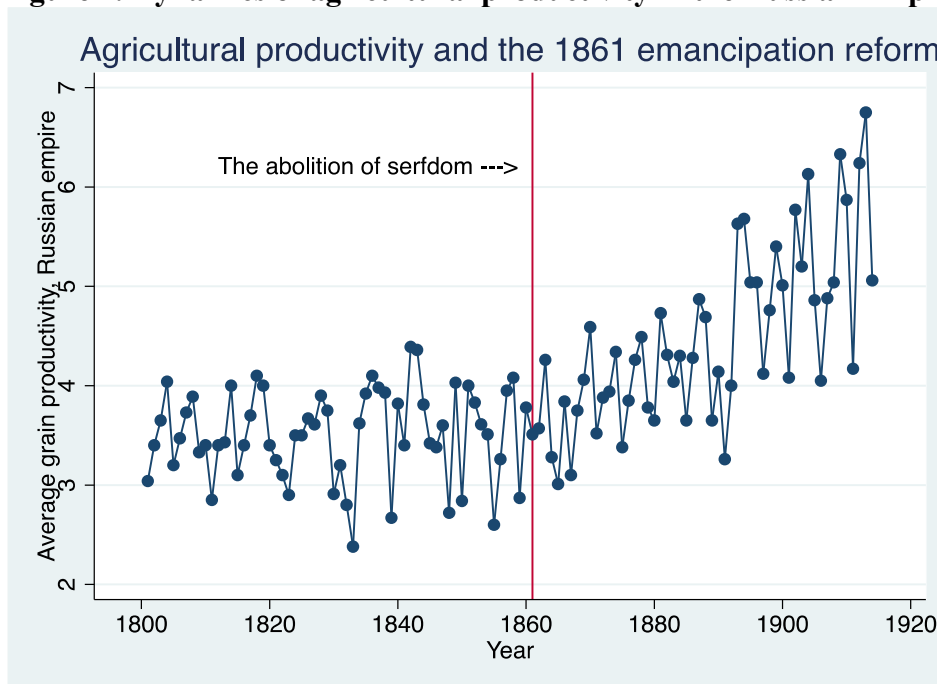
Note: The vertical line indicates the 1861 Emancipation reform.
Source: Mikhajlovskij V.G. (1921). *Urozhai v Rossii, 1801-1914 gg.* [Grain productivity in Russia, 1801-1914], *Bulleten Tsentralnogo Statisticheskogo Upravleniya* [Bulletins of the Central Statistical Administration], 50.

Figure 2. European provinces of the Russian Empire
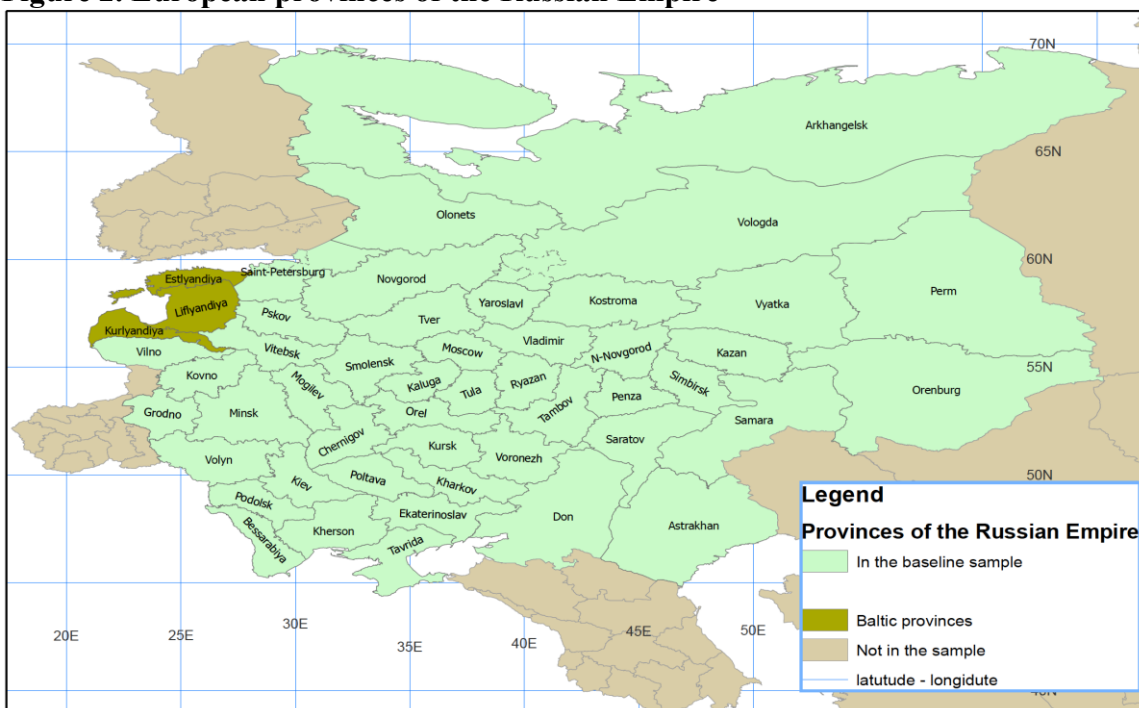
Note: Equirectangular projection used. Serfs in the Baltic provinces, Estlyndiya, Liflyandya, and Kurlyandia, were liberated 40 years before the emancipation of serfs in the rest of the empire. We run regressions both with and without the Baltic provinces in the sample. The baseline sample excludes them.

Figure 3. Geography of serfdom: serfs in 1858 as a share of rural population
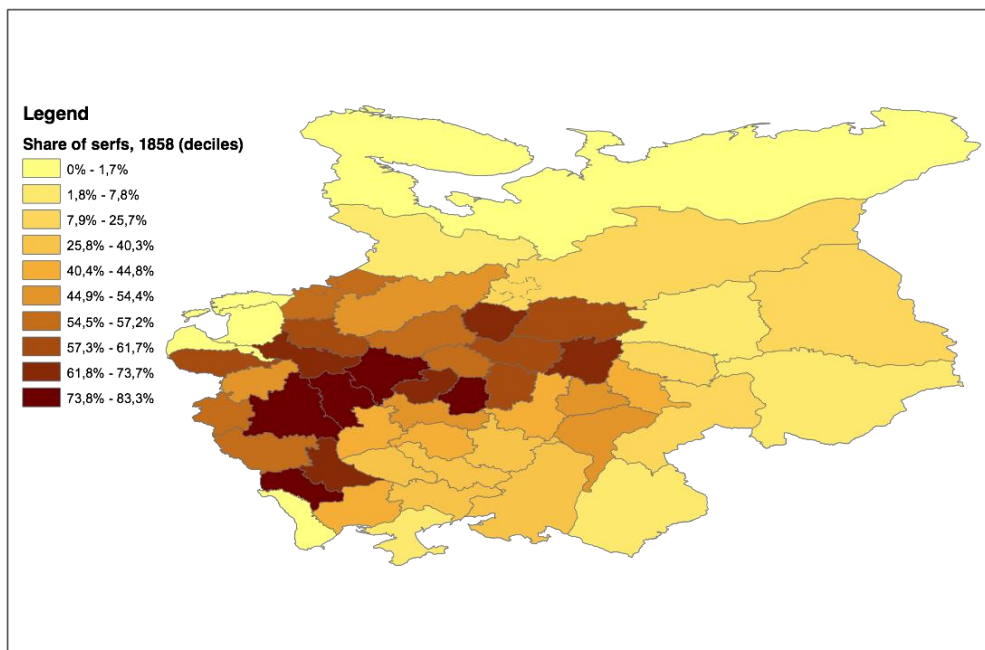
Note: Equirectangular projection used.

Figure 4. Monasterial serfs before nationalization and private serfs in 1858 across provinces
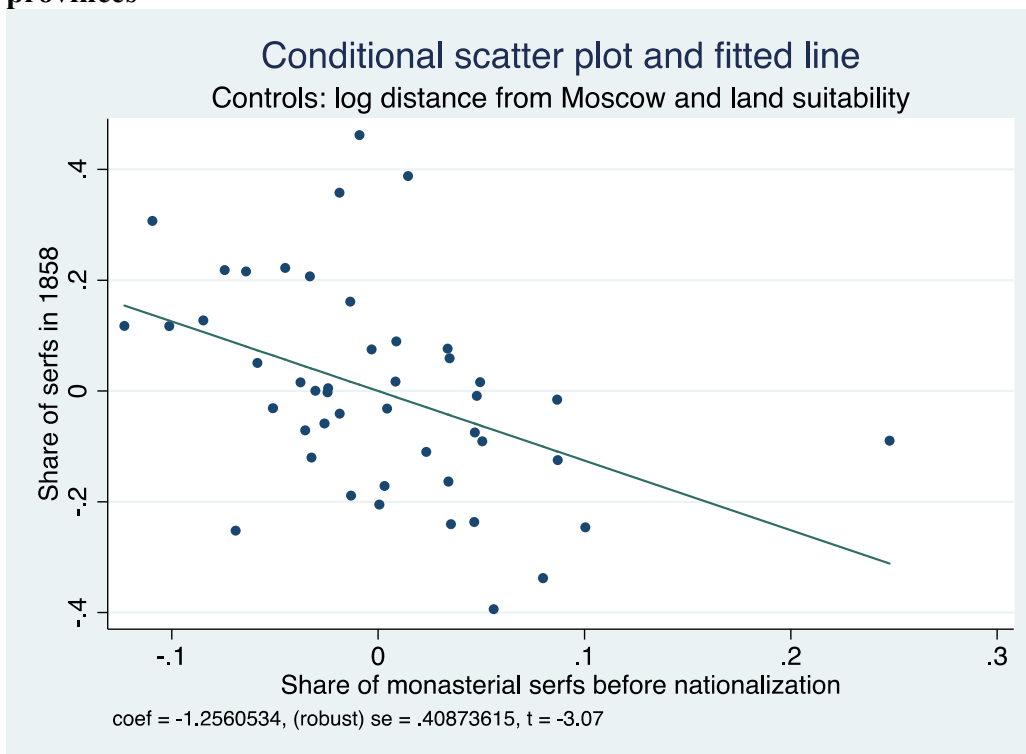
Figure 5. The progress of land reform and the land reform instrument in 1872, i.e., halfway through land reform implementation, across provinces
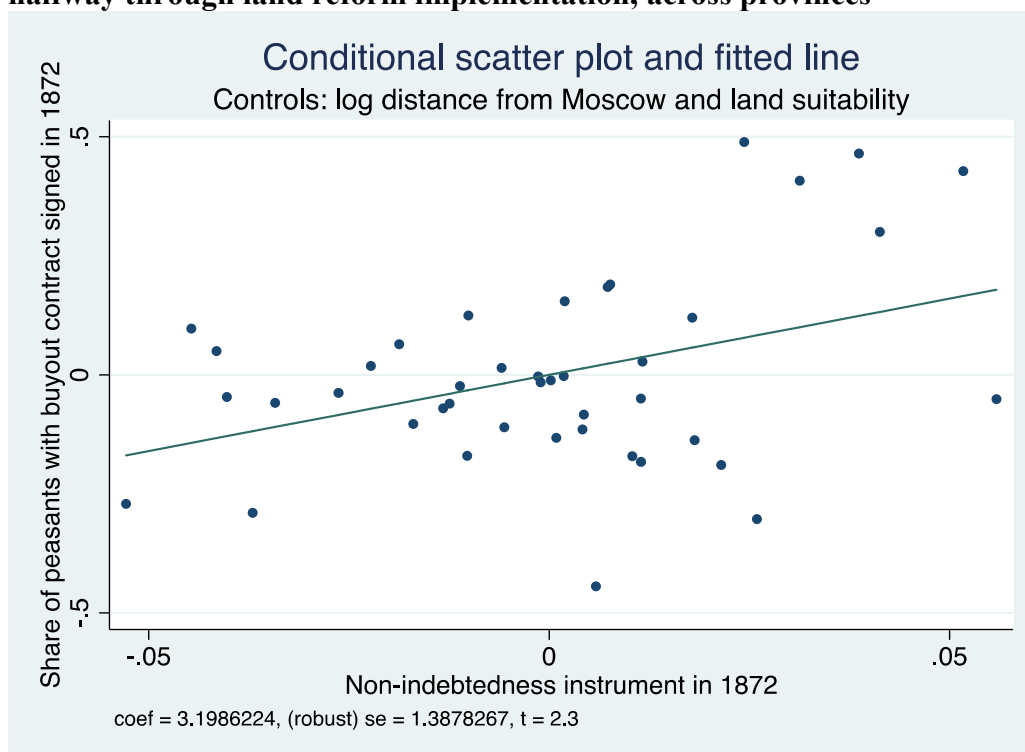
Figure 6. The time-varying effect of emancipation: grain productivity
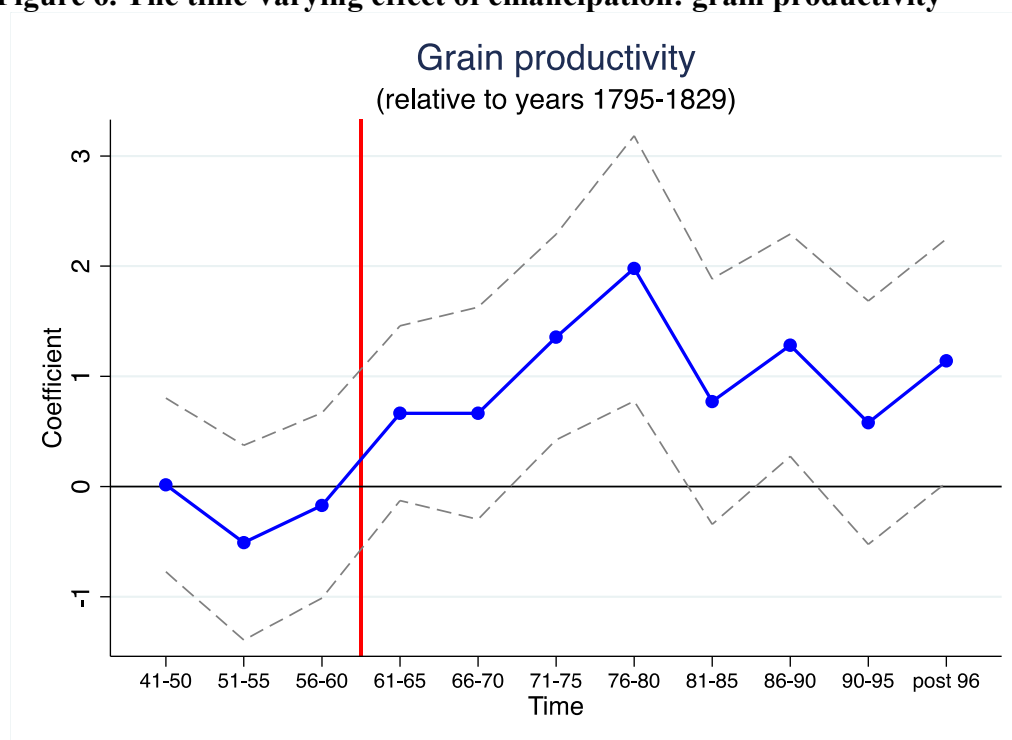
Note: The number of cross-sections within five-year intervals varies because of missing data for 1867-1869 and 1877-1882. The figure presents coefficients (along with their 90% confidence interval) in the regression of grain productivity on 5-year interval dummies interacted with the share of serfs in 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 7. The time-varying effect of emancipation: draftees' height by province
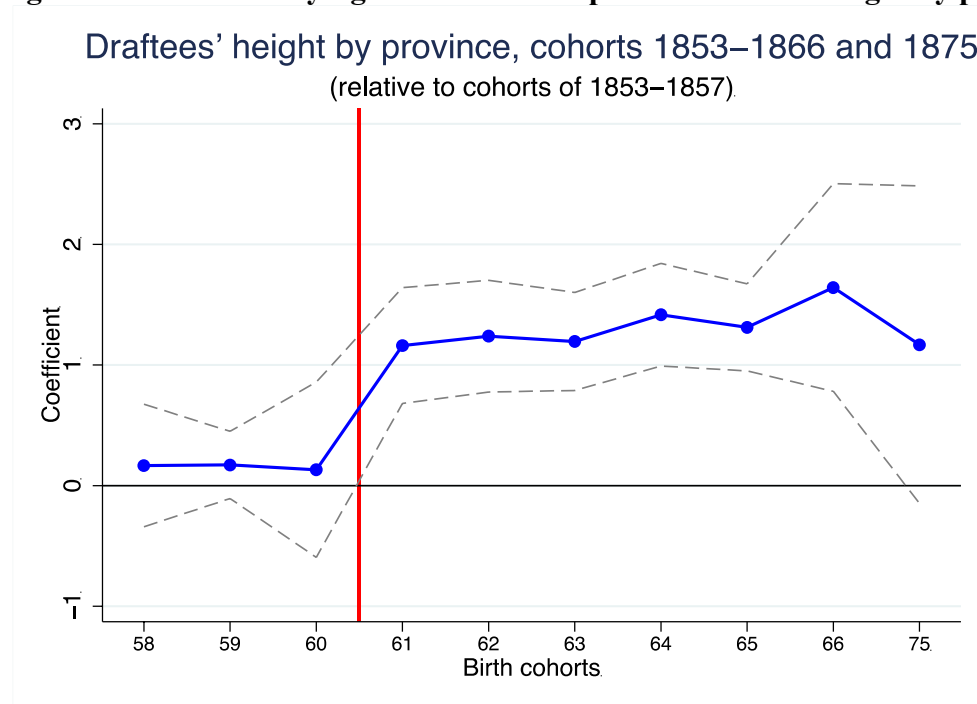
Draftees' height by province, cohorts 1853–1866 and 1875
(relative to cohorts of 1853–1857)

Note: The figure presents coefficients (along with their 90% confidence interval) in the regression of the height of draftees on dummies for each cohort born around the emancipation interacted with the share of serfs in a province, province and birth-cohort 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. Five cohorts between 1853 and 1857 are held as the comparison group. The vertical red line marks the timing of the emancipation. The table-form representation of the results of this estimation is presented in column 2 of Table A2 in the online appendix.

Figure 8. The time-varying effect of emancipation: industrial output
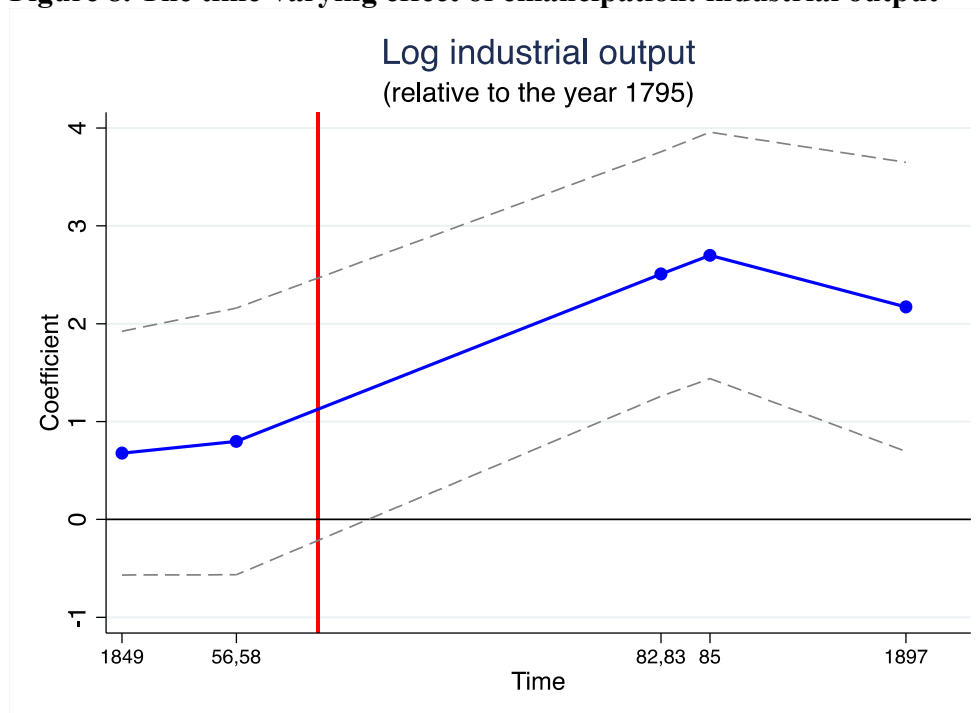
Log industrial output
(relative to the year 1795)

Note: 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 FEs, region-specific linear trends, and controls for demeaned suitability and demeaned distance from Moscow interacted with the post-emancipation dummy, the share of state peasants and the share of royal peasants interacted with the dummies for the onset of their reforms. 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 4 of Table A2 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)	466	0.41	0.24	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	12.3
Height of draftees, centimeters (by province & birth cohort)	686	164.31	1.02	161.86	168.15
Height of draftees, centimeters (by district & birth cohort)	4628	164.08	1.38	159.17	171.32
Log industrial output, mln 1895 rubles (by province & year)	347	15.46	1.67	9.75	19.63

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)	458	0.09	0.11	0	0.69
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
Repartition 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 from Moscow, km (by province)	46	666	323	24	1307
Distance from Moscow, km (by district)	466	621	318	42.7	1609
Crop suitability index (by province)	46	2.17	1.33	1	5
Crop suitability index (by district)	466	2.25	1.38	1	7
Average annual temperature, C (by province & year)	1765	5.02	2.62	-1.92	11.62
Rye-to-wheat world price ratio (by year, for the years with data on the composition of crops)	18	0.73	0.073	0.58	0.85

Note: The summary statistics are reported for the baseline sample without the Baltic provinces.

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

Panel A: Panel data estimation

Dependent var:	(1)	(2)	(3)	(4) Grain productivity	(5)	(6)
Model:	OLS	OLS	IV, 2nd stage	OLS	OLS	IV, 2nd stage
Share of serfs X Post-emancipation	0.81*** [0.226]	0.80*** [0.248]	1.29*** [0.478]	1.04*** [0.254]	1.03*** [0.342]	2.76*** [0.635]
Share of peasants with signed buyout contracts					-0.40 [0.249]	-1.20*** [0.335]
Demeaned log distance from Moscow X Post-emancipation		-0.93** [0.361]	-0.58 [0.443]	-0.86** [0.361]	-0.63 [0.418]	0.61 [0.491]
Demeaned crop suitability X Post-emancipation		0.07 [0.040]	0.06 [0.045]	0.06 [0.038]	0.06 [0.040]	0.06 [0.050]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	No	Yes	Yes	Yes	Yes	Yes
State and royal peasant reforms	No	No	No	Yes	No	No
Observations	1,835	1,835	1,835	1,835	1,780	1,780
R-squared	0.368	0.403	0.533	0.404	0.402	0.539

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

Dependent var: Model:	(3) Share of serfs X Post-emancipation IV, 1st stage	(6.1) Share of serfs X Post-emancipation IV, 1st stage	(6.2) Share of peasants with signed buyout IV, 1st stage
Share of nationalized monasterial serfs X Post-emancipation	-1.25*** [0.293]	-1.29*** [0.296]	-1.34*** [0.274]
Interpolation b/w (1-indebtedness) and 1 in the interval 1862-1882		0.12 [0.173]	2.70*** [0.256]
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

Dependent var: Model: Sample:	(1) The change in detrended grain productivity b/w pre- and post-emancipation OLS spatial HAC full	(2) OLS spatial HAC |DFBeta|<0.3
Share of serfs	0.90*** [0.264]	0.76*** [0.233]
Log distance from 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. 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 3. The mechanisms behind the effects of the land reform and the emancipation

Dependent var:	(1)	(2)	(3)	(4)	(5)
	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
Share of serfs X Post-emancipation	0.83** [0.331]	1.73*** [0.429]	-0.064*** [0.016]	-0.053*** [0.017]	-0.078*** [0.019]
Share of peasants with signed buyout contracts	0.11 [0.267]	-0.50* [0.254]			
Share of peasants with signed buyout contract X repartition commune dummy	-0.70** [0.337]				
Share of serfs X Post-emancipation X Implicit contracts		-1.56*** [0.532]			
Demeaned temperature (t-1)			0.0052* [0.003]		0.0043 [0.003]
Share of serfs X Post-emancipation X Demeaned temperature (t-1)			0.0101*** [0.004]		0.0997** [0.004]
Share of serfs X Post-emancipation X Demeaned rye-to-wheat world price ratio (t-1)				-0.35*** [0.119]	-0.31*** [0.116]
Demeaned log distance from Moscow X Post-emancipation	-0.92** [0.438]	-0.79* [0.420]	-0.03 [0.020]	0.02 [0.017]	-0.03 [0.020]
Demeaned crop suitability X Post-emancipation	0.04 [0.039]	0.04 [0.035]	0.001 [0.002]	-0.001 [0.002]	0.001 [0.002]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes	Yes	Yes
Observations	1,780	1,726	793	800	793
R-squared	0.403	0.420	0.792	0.787	0.796

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

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

Panel A: Panel data estimation

	(1)	(2)	(3)	(4)	(5)
Dependent var:	Draftees' height (cohorts 1853-1866, 1875)			Draftees' height (cohorts 1853-1862)	
Data set:	Province-level data			District-level data	
Model:	OLS	IV, 2nd stage	OLS	OLS	IV, 2nd stage
Share of serfs X	0.99***	1.35**	0.95***	0.33*	1.21***
Post-emancipation cohorts	[0.333]	[0.630]	[0.344]	[0.172]	[0.341]
Demeaned log distance from Moscow X	0.47	0.74	0.45	0.036	0.281***
Post-emancipation	[0.335]	[0.605]	[0.330]	[0.075]	[0.081]
Demeaned crop suitability X	0.16***	0.15***	0.16***		
Post-emancipation	[0.050]	[0.053]	[0.049]		
Birth cohort and province or district fixed effects	Yes	Yes	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes	Yes	Yes
Reforms for state and royal peasants	No	No	Yes	No	No
Observations	686	686	686	4,628	4,548
R-squared	0.765	0.900	0.766	0.069	0.592

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

	(2)	(4)
Dependent var:	Share of serfs X Post-emancipation cohorts	Share of serfs X Post-emancipation cohorts
Model:	IV, 1st stage	IV, 1st stage
Share of nationalized monasterial serfs X	-1.26***	-0.52***
Post-emancipation cohorts	[0.320]	[0.052]
Controls as in respective column of Panel A	Yes	Yes
Observations	686	4,548
F, excluded instrument	15.44	97.22

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	0.95***	0.70***	0.63***	0.40***
	[0.204]	[0.156]	[0.209]	[0.136]
Log distance from Moscow, crop suitability	Yes	Yes	Yes	Yes
Observations	46	42	466	457
Adj R-squared	0.378	0.417	0.044	0.041

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.

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

Table 5. The abolition of serfdom and industrial development
Panel A: Panel data estimation

Dependent var:	(1)	(2)	(3)
		Ln (industrial output)	
	OLS	IV, 2nd stage	OLS
Share of serfs X Post-emancipation	0.73* [0.384]	2.60* [1.397]	1.38** [0.571]
Demeaned log distance from Moscow X Post-emancipation	0.36 [0.437]	1.70 [1.152]	0.52 [0.443]
Demeaned crop suitability X Post-emancipation	0.13* [0.064]	0.13 [0.080]	0.12* [0.063]
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
R-squared	0.885	0.934	0.887

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

	(2)
	Share of serfs X
Dependent var:	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

Panel C: Cross-sectional estimation robust to spatial correlation

	(1)	(2)
Dependent var:	The change in detrended log industrial output b/w pre- and post-emancipation	
Model:	OLS spatial HAC	
Sample:	full	|DFBeta|<0.3
Share of serfs	1.90*** [0.379]	2.02*** [0.394]
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.
*** indicates p-value <0.01, ** p-value <0.05, * p-value<0.1

Online Appendix

Contents:

A. <u>Historical background</u>

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 affaires, 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 of 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 chose 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 have argued that the government commission may have had incentives to misrepresent the real outcomes of the reform. 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).

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.[56] 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 18th century and the first half of the 19th century under special arrangements.[57] There were three provinces on the outskirts of the empire where the free peasant population constituted the majority of the

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[56] Note that state peasants were free only relative to serfs. In the 18th 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 18th century: "*we are not free, we belong to the state*" (Crisp 1976 p. 76).
[57] 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 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).

population. Cossacks in the Don region were free because, in the 17th 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 16th and 17th 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 10th century. The bulk of church lands belonged to monasteries, which accumulated most of their property in the 15th and 16th centuries (Vodarskii 1988), i.e., before the start of serfdom in Russia. With the establishment of serfdom in the late 16th – mid-17th century, peasants who lived on church lands became serfs belonging to the Russian Orthodox Church. The church owned about 2 million serfs or about 14.1% of the population of the empire at the moment of the nationalization of church property in the second half of the 18th century. About one half of all monasteries had serfs (Zakharova 1982). In addition, in provinces of the Russian empire, that were obtained as a result of the partitions of Polish-Lithuanian Commonwealth at the end of the 18th 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).[58]

The rise of the modern state in Russia in the 18th 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 18th – early 19th 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 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; Zajonckkovskij 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

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[58] 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.

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.[59] 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.[60] 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.[61]

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.[62]

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[59] 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).

[60] 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.

[61] 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 the types of the communes. Whether the communes were repartition or hereditary was determined by the tradition formed long before the abolition of serfdom (Zajonckovskij 1968).

[62] 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).

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 (*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. 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).[63] After the emancipation, the land became the main asset of the landlords, and they tried to keep as much land in their possession as possible. 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).[64] 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).

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.[65] 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 twenty percent of the land price, and the state provided a loan for the other eighty percent of the

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[63] The maximum and the minimum varied across provinces. They were equal to about 3 and 7 *desyatinas* per male, respectively, in Russia's non-"black earth" regions, and about 2 and 6 *desyatinas,* respectively, in the black earth regions. (*Desyatina* is a measure of area: 1 *desyatina* = 0.37 acre.) "Step" provinces represented an exception, where the law determined the precise size of the peasant plot. If peasants cultivated more land before the emancipation than the legal maximum stipulated, the landlord had to cut both their plots and obligations. If peasants had less land than the legal minimum, the law 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).

[64] 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.

[65] 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).

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 sources of variation in the timing of the completion of the land reform. 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.[66]

A7. Gentry's indebtedness

The government had provided credit to Russian gentry starting in the late 18th 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 *Zaemnii bank, Sokharnnaya kazna* and *prikazi obshchestvennogo prizreniya*).[67] 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: there are 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 (Borovoj 1958). 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). Borovoj (1958) in his study of the history of credit

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[66] 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 though 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.

[67] *Zaemnii bank* (1786-1860), *Sokharnnaya kazna* (1762-1860), and *Prikazi obshchestvennogo prizreniya* (1775-1864) were state banks. The state provided capital to them (Borovoj 1958). *Zaemnii 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.

and banking in 19th 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 Lanskoi 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 19th 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).[68]

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. 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. 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 (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.

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[68] 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).

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 of the Ministry of State Property, are highly correlated with those based on the governors' reports.

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). 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).

A9. 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. Agricultural machines, such as seeding and reaping machines, appeared in the Russian countryside in significant numbers only at the end of the 19th century (Nifontov 1974). Machines were simply too expensive for peasant farms. Individual landlords did try to employ machines in their estates before the abolition of serfdom (Department of agriculture, 1849). However, historians argue that their number was very small. For example, Kovalchenko (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. Kovalchenko 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. [69] 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.

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B. Additional information about the data and about 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:

$$Redemption\_Payment\_Per\_Serf_i =$$

$$= \frac{Projected\_Total\_Redemption\_Payments_{i,1877}}{Peasants\_with\_signed\_buyout\_contract_{i,1877}}$$

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:
Beskrovnii et al. (1972) report the number of various subcategories of monasterial and clerical serfs 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, Ryasan', Orel, Tambov, Kursk, Voronezh provinces;
7. Middle Volga: Kazan', Penza and Simbirsk provinces;
8. Left Bank Ukraine: Chernigov, Poltava and Khar'kov provinces;
9. Right Bank Ukraine 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, Liflyandiya and Kurlyandiya provinces composed the Baltic region.

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C. **Counterfactual scenarios for Russia's GDP had serfdom been abolished in 1820**

To illustrate the magnitude of the overall effect of the institution of serfdom on economic development, we estimate the per capita income in Russia in 1913 under three alternative counterfactual scenarios. For each, we set the counterfactual date for the abolition of serfdom to 1820 instead of 1861. We consider 1820 as the year of the early abolition of serfdom in the counterfactual scenarios because of a serious political debate in Russia about emancipation reform under the rule of Alexander I (1801-1825) (Dolgikh 2006). The emancipation of serfs in Prussia occurred just 13 years before (in 1807) our proposed counterfactual year. Table A21 summarizes our counterfactual estimates. Here we describe the derivation of these figures.

Our starting point is Maddison's (2007) estimate of Russia's GDP in 1820: $37,678 in 1990 USD. We assume that the sectoral composition of the Russian economy was approximately stable before Russia's industrialization in the late 19th century and estimate the value added in agriculture, industry, and services in 1820. In order to do this, we apply data on the sectoral composition of Russia's GDP as of 1860, which is the earliest available date for these figures. The shares of each of the three sectors—agriculture, industry, and services—in value added in 1860 are obtained from Goldsmith (1961): they are 59.3%, 5.1%, and 35.6%, respectively. Using these shares and the Maddison's estimate of Russia's GDP in 1820, we get the estimates of the value added in agriculture, industry, and services in 1820.

We obtain the counterfactual estimates of sectorial value added in 1820 by momentarily increasing the level of output in each sector. For agriculture and industry, we take our estimates. In particular, we increase the agricultural value added by a factor of 1.165 because grain was the main product of Russian agriculture of the 19th century and our estimates imply that the abolition of serfdom increased agricultural productivity by 1.165.[70] For industry, we increase the value added by a factor of 1.385, which is the estimated effect on the industrial output according to the OLS specification.[71] We assume that serfdom affected the service sector to the same extent it affected the rest of the economy, i.e., the increase in services equaled the increase in demand from the other two sectors, i.e., we take the average multiplier for agriculture and industry, weighted by the relative size of these sectors.[72]

As the next step, we sum the counterfactual values of the value added in each sector to get a counterfactual GDP in 1820; it amounts to $44,549 million in 1990 USD. We divide this figure by the Maddison's estimate of the total population in 1820 (54.765 million people) to get the counterfactual level of GDP per capita in 1820: $813 in 1990 USD.

Finally, we allow GDP per capita to grow between 1820 and 1913 at a rate based on one of the following three scenarios: (1) the lower bound is the actual growth rate of the Russian economy between 1820 and 1913[73]; (2) the average growth rate after the abolition of serfdom, i.e., between 1870 and 1913[74]; and (3) the average growth rate between 1820 and 1913 of other East-European countries that abolished serfdom circa 1820 for which Maddison provides data

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[70] To get 1.165, we take the estimated coefficient for the effect of the abolition of serfdom on grain productivity from column 3 of table 2 (1.288), multiply it by the share of serfs in 1858 in an average province (0.448) and divide by average grain productivity in 1858 (3.5) and add one.

[71] To get 1.385, we take the estimated coefficient for the effect of the abolition of serfdom on log industrial output from column 1 of table 5 (0.728) and multiply it by the share of serfs in 1858 in an average province (0.448), first. Then, we raise e to the power of the obtained figure. Note that we use the OLS rather than the IV estimate because, as mentioned above, the IV estimate is likely to reflect the local average treatment effect, where as OLS reflects the global average effect.

[72] An alternative assumption (which most likely understates the effect of the reform) is that service was unaffected by the reform. We report estimations under this scenario in the last column of table A21.

[73] Figure 1 shows that the abolition of serfdom changed the development trajectory of the main sector in Russia.

[74] 1870 is the closest year to 1861 for which Maddison provides an estimate of GDP.

that abolished serfdom circa 1820 (i.e., Prussia, Austria, and Bohemia).[75] As all Eastern European countries that abolished serfdom in the late 18th – early 19th century had increasing growth rates throughout the 19th century, Scenario 1 most likely led to an underestimation of Russia's level of development in 1913. In Table A21 we report the results.

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[75] Maddison reports the figures for Germany, Austria, and Czechoslavakia with territories only partially corresponding to the territories of polities with emancipation reforms in the late 18th – early 19th centuries, i.e., Prussia, Austria, and Bohemia.

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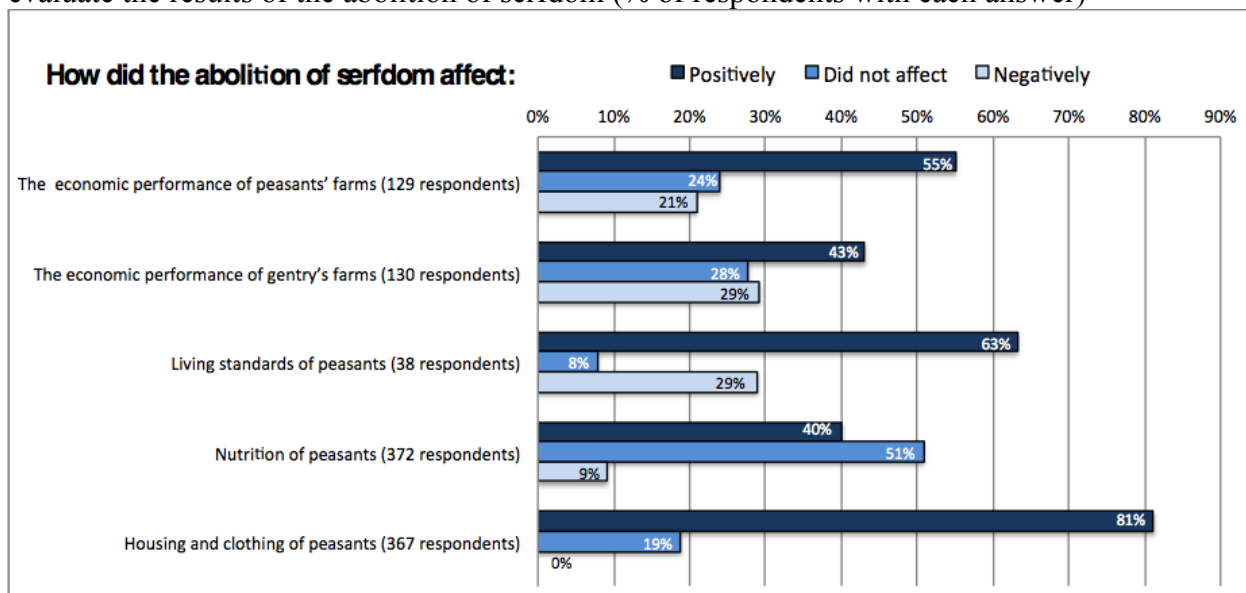
Source: Mironov B.N. (2010). p. 551.

Figure A2. Geography of serfdom: the share of serfs in 1858 and the distance from Moscow
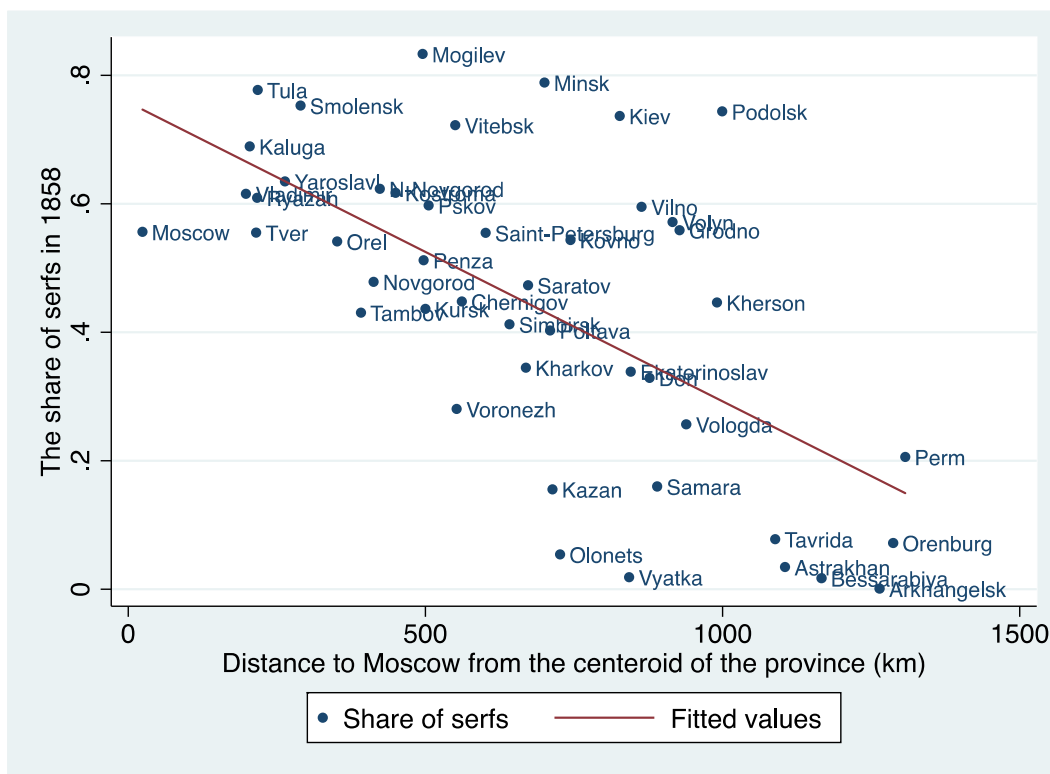
Coef: -0.0005; SE=0.00009; R^2 =0.36.

Figure A3. Geography of free labor: state peasants and free agricultural workers
Panel A. State peasants in 1858 as a share of rural population
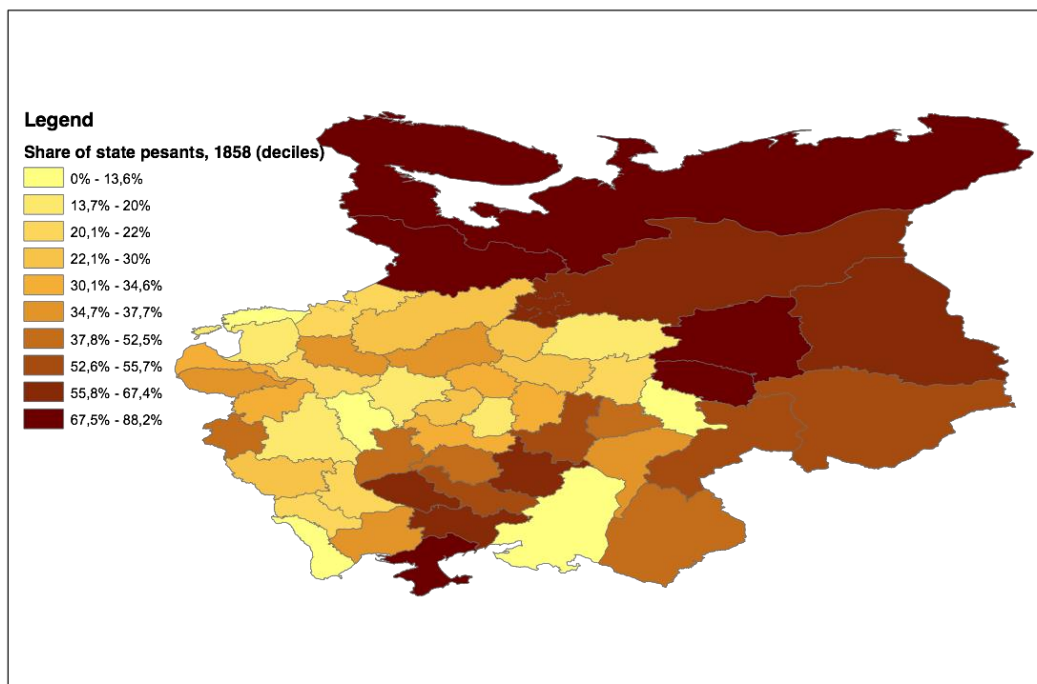
Panel B. Free agricultural workers in 1858 as a share of rural population
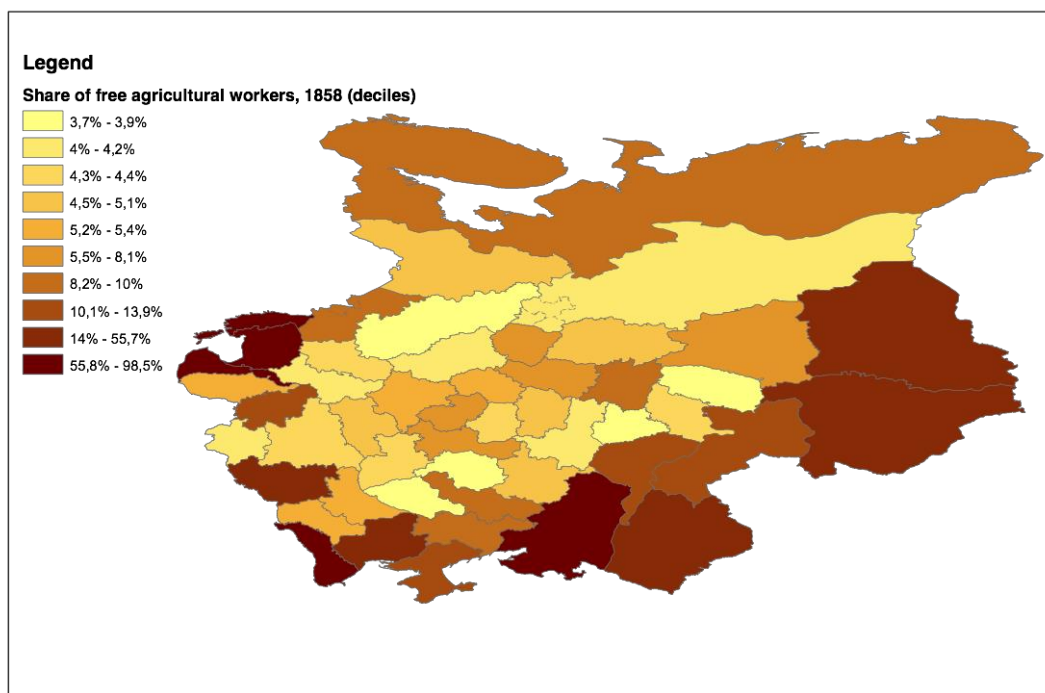
Note: Equirectangular projection used.

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

Scatter plot conditional on log distance from Moscow
Full sample

coef = -.55964075, (robust) se = .07319432, t = -7.65
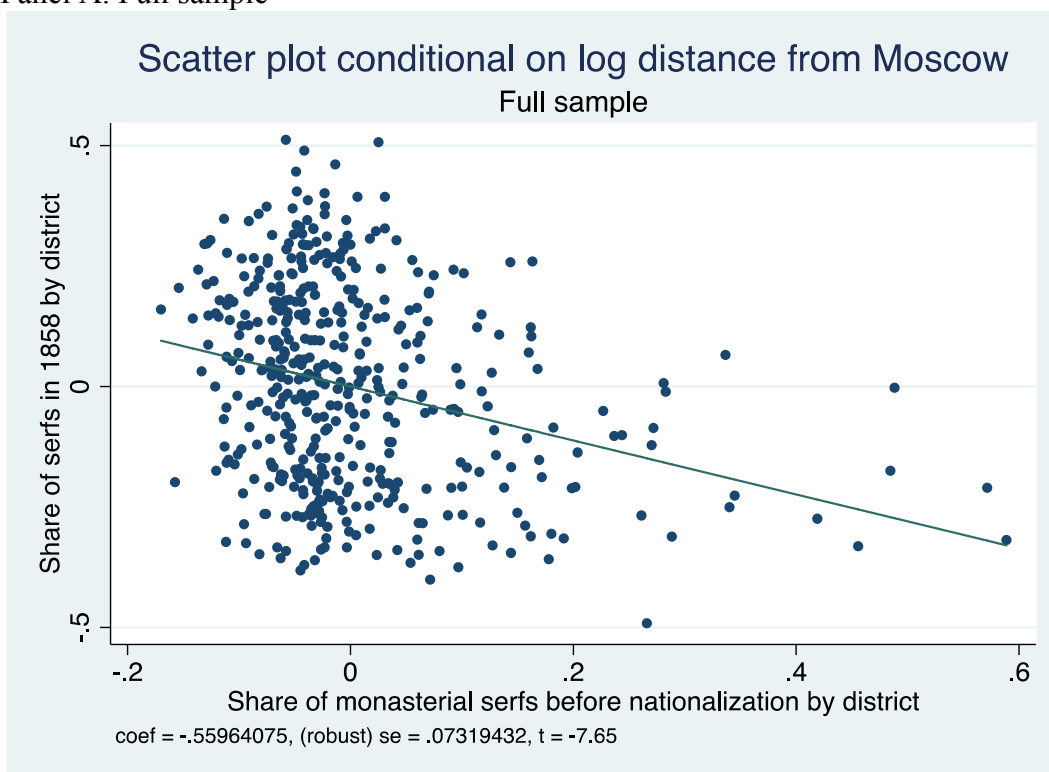
Panel B. Sample restricted to districts with the share of nationalized monasterial serfs below 0.3.

Scatter plot conditional on log distance from Moscow
Subsample of districts with the share of monasterial serfs < 0.3

coef = -.55907361, (robust) se = .1436224, t = -3.89
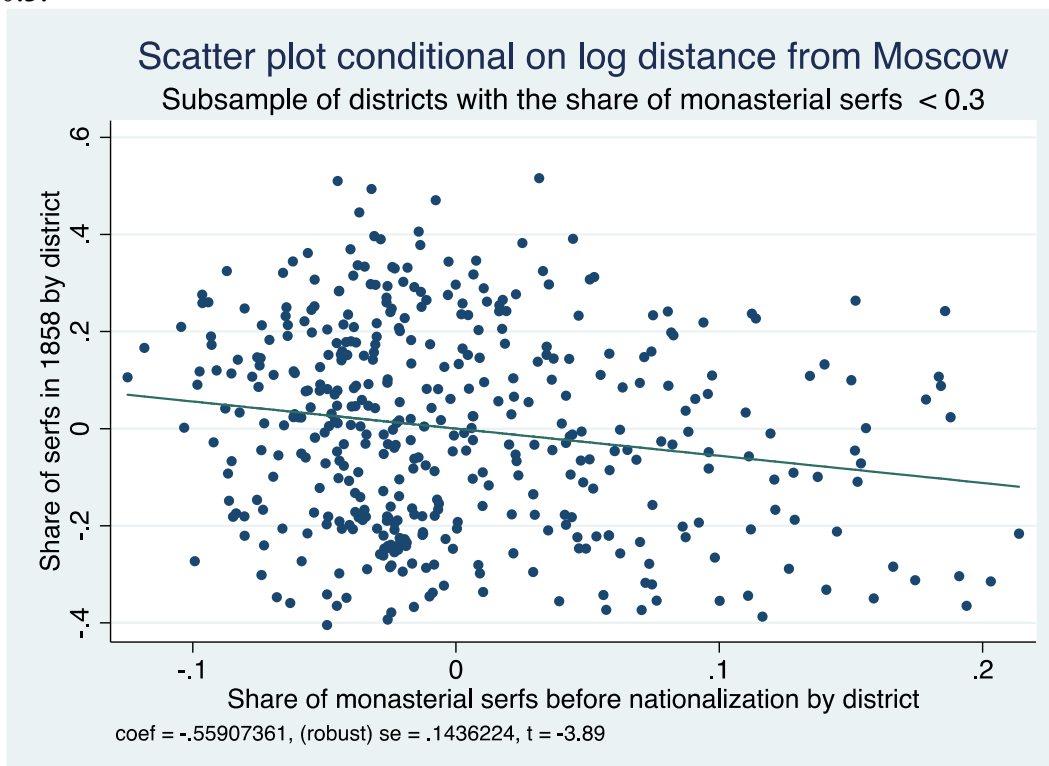
Figure A5. Illustration of the relationship between gentry indebtedness and grain productivity.
Panel A. Gentry indebtedness in 1858 and grain productivity in 1858.
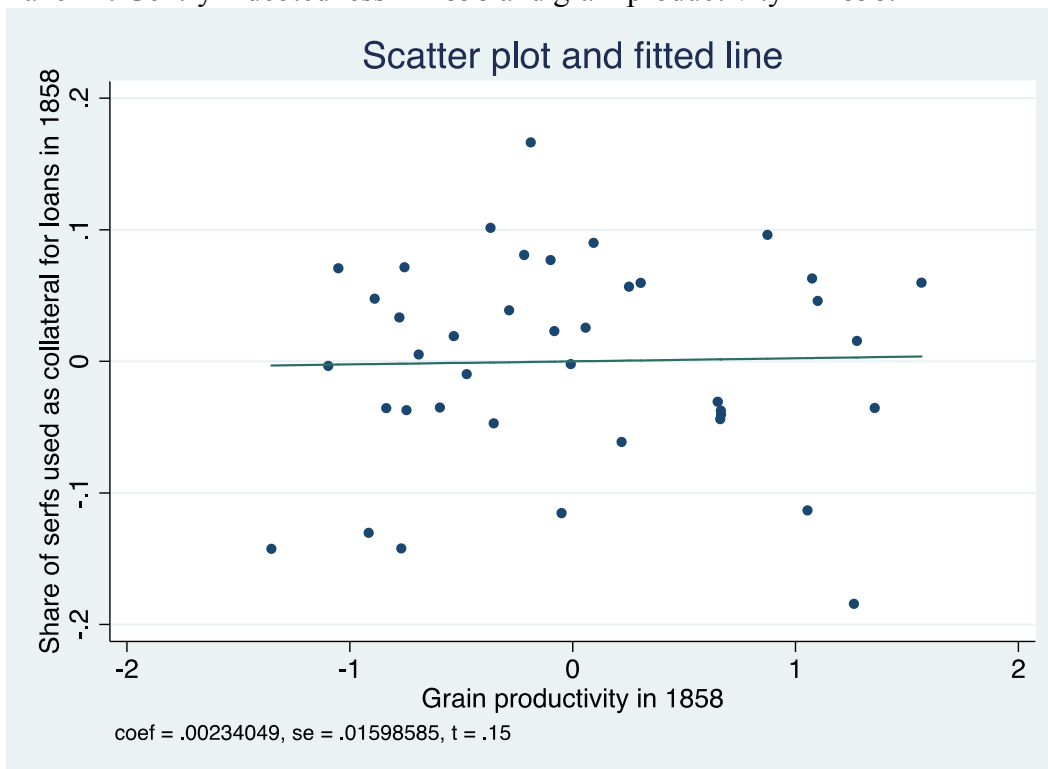
Panel B. Gentry indebtedness in 1858 and changes in grain productivity between 1858 and 1853.
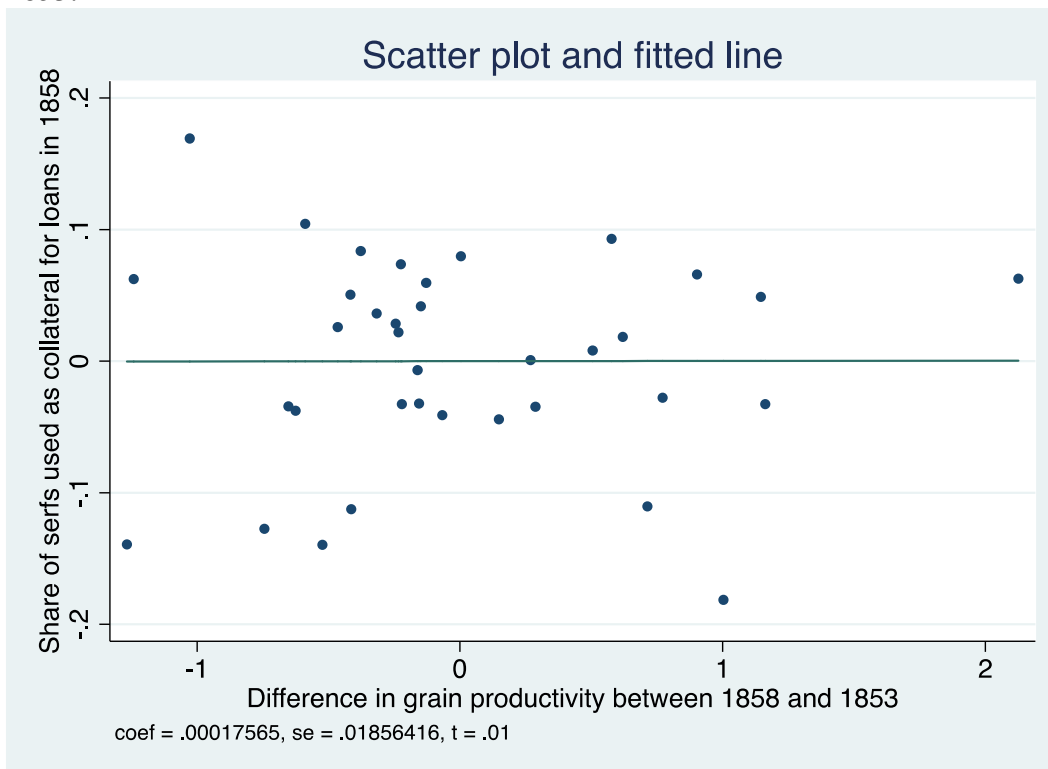
Figure A6. Cross-sectional relationship between prevalence of serfdom and the growth in grain productivity between before and after the emancipation
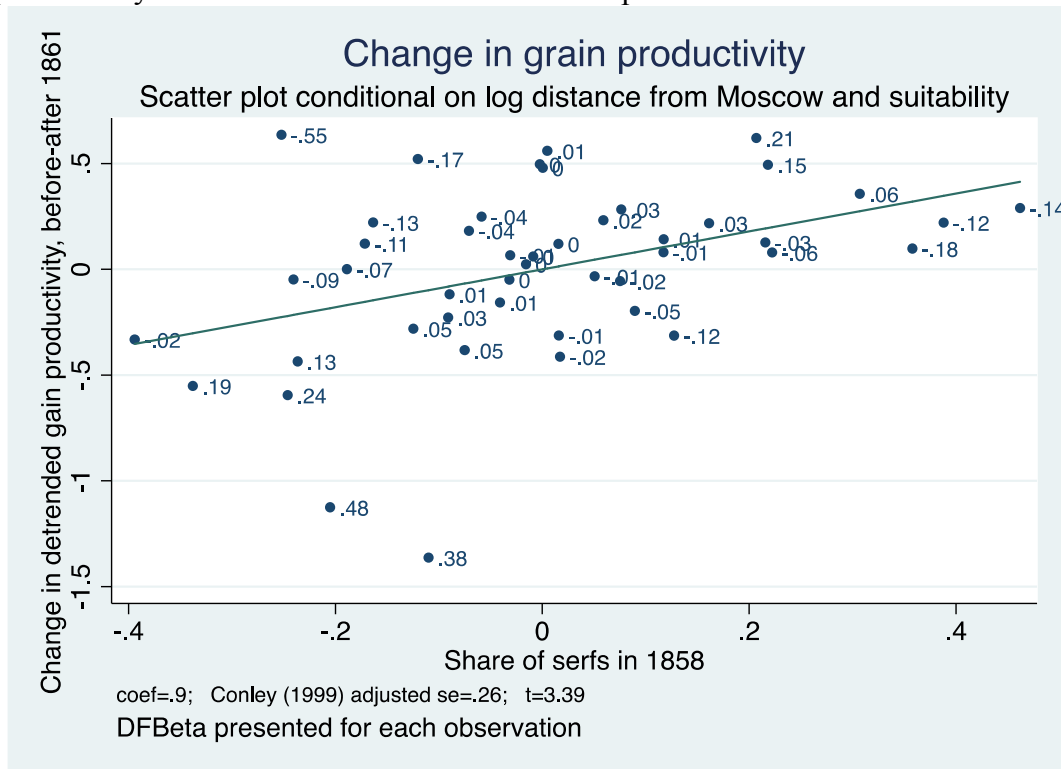
Figure A7. **The time-varying effect of emancipation: draftees' height by district**
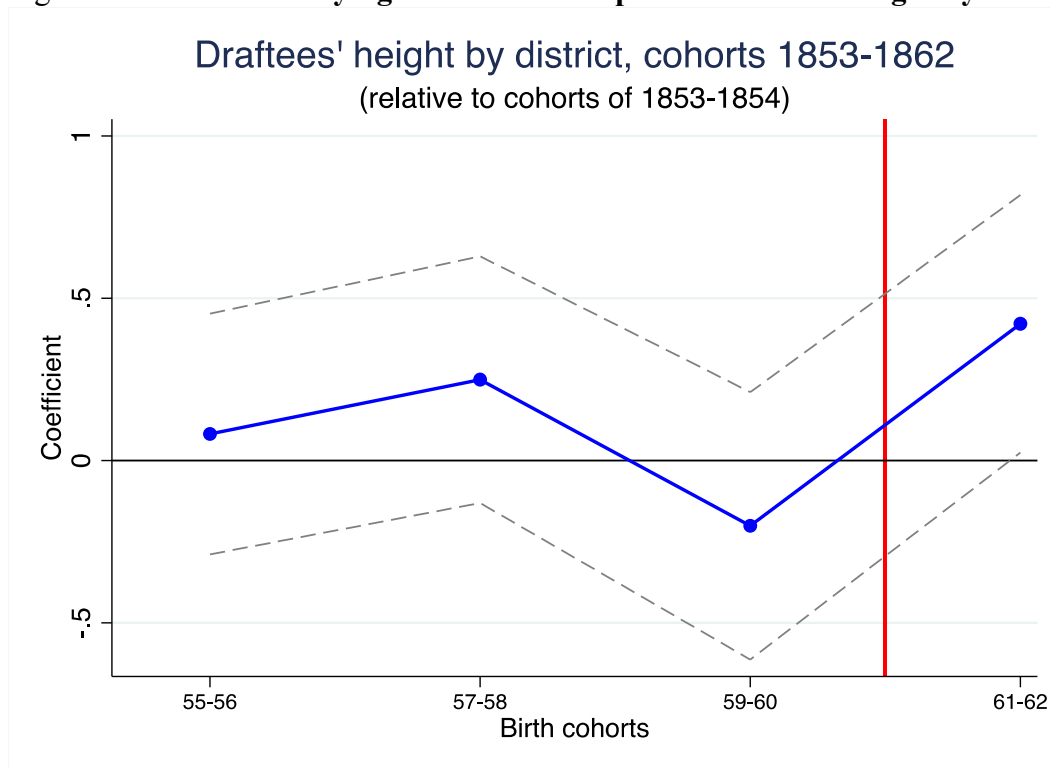
Draftees' height by district, cohorts 1853-1862
(relative to cohorts of 1853-1854)

Note: The figure presents coefficients (along with their 90% confidence interval) in the regression of height on 2-year interval dummies for birth cohorts, district and birth-cohort fixed effects, and province-specific linear trends. Two cohorts of 1853 and 1854 are held as the comparison group. The vertical red line marks the timing of the emancipation. The full regression output is presented in column 3 of Table A3 in the online appendix.

Figure A8. 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
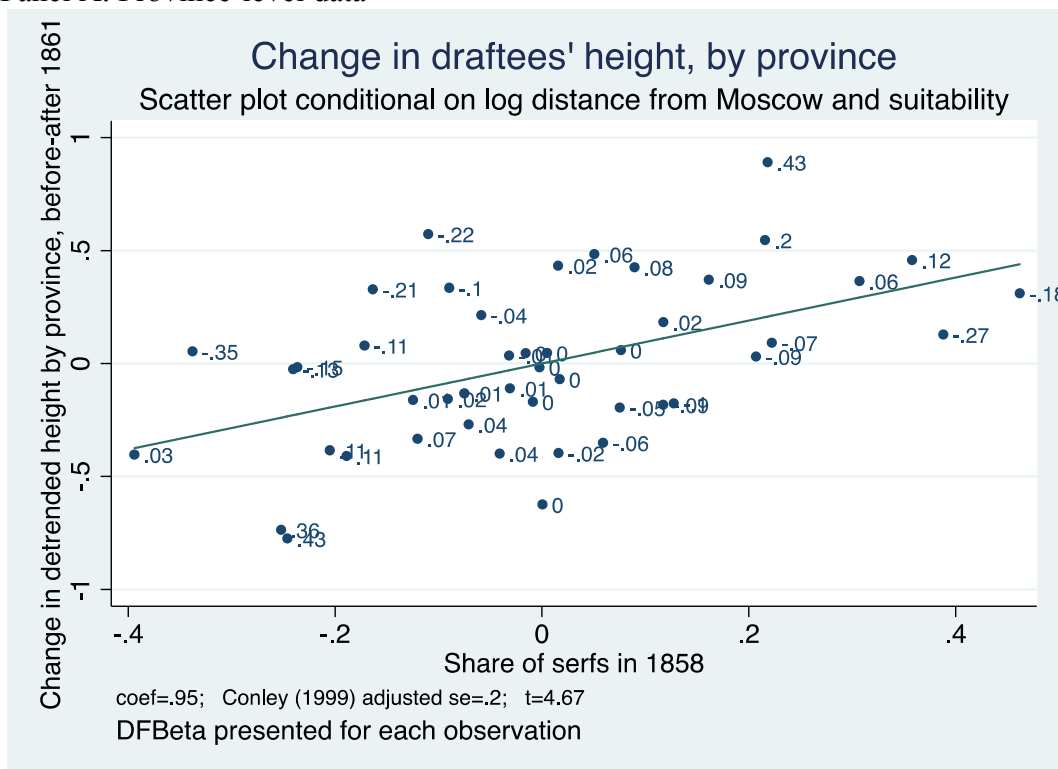
Panel B. District-level data
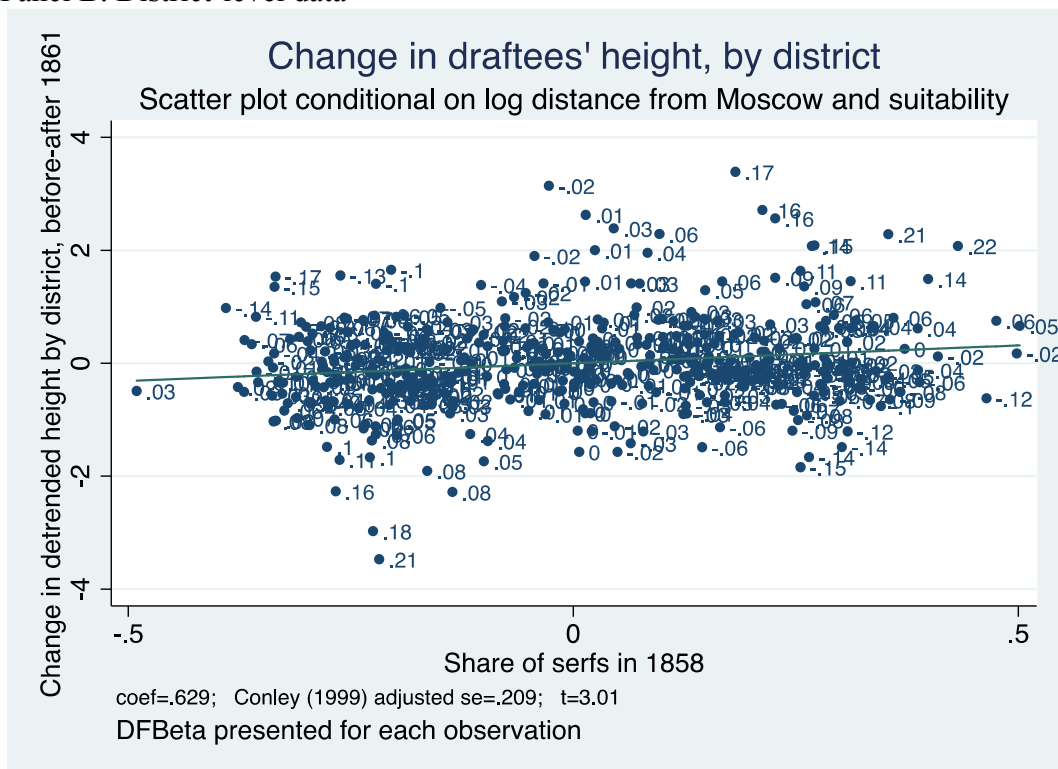
Figure A9. Cross-sectional relationship between prevalence of serfdom and the growth in industrial output between before and after the emancipation
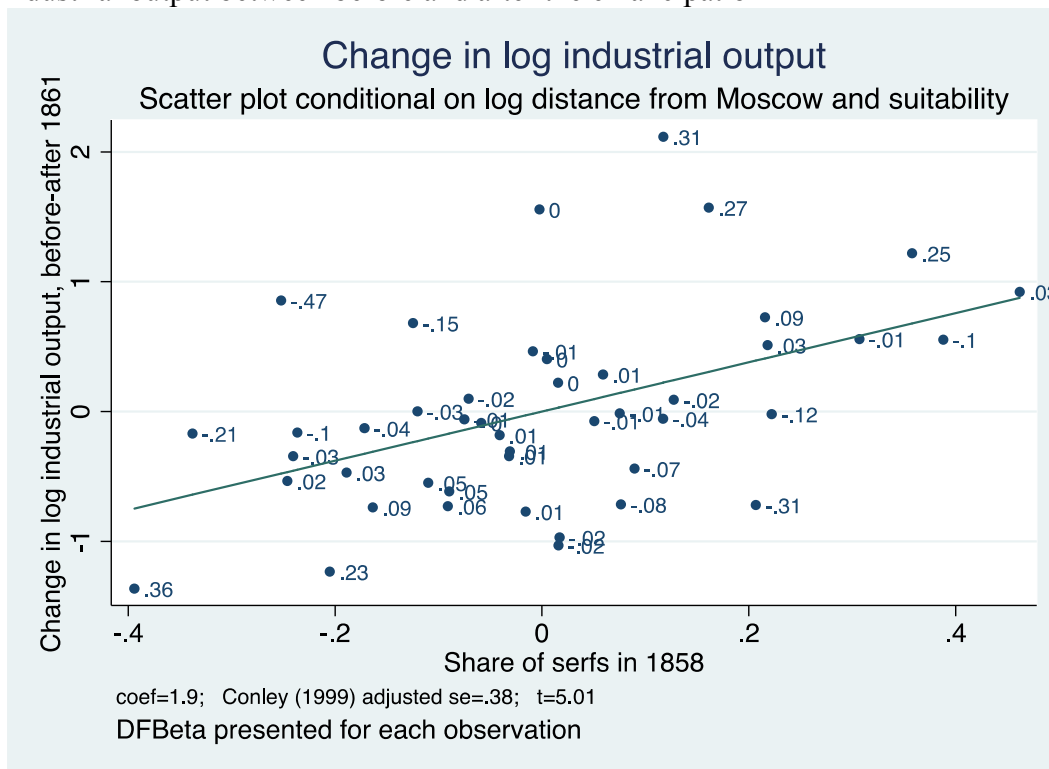
Figure A10. Placebo dates for the emancipation reform
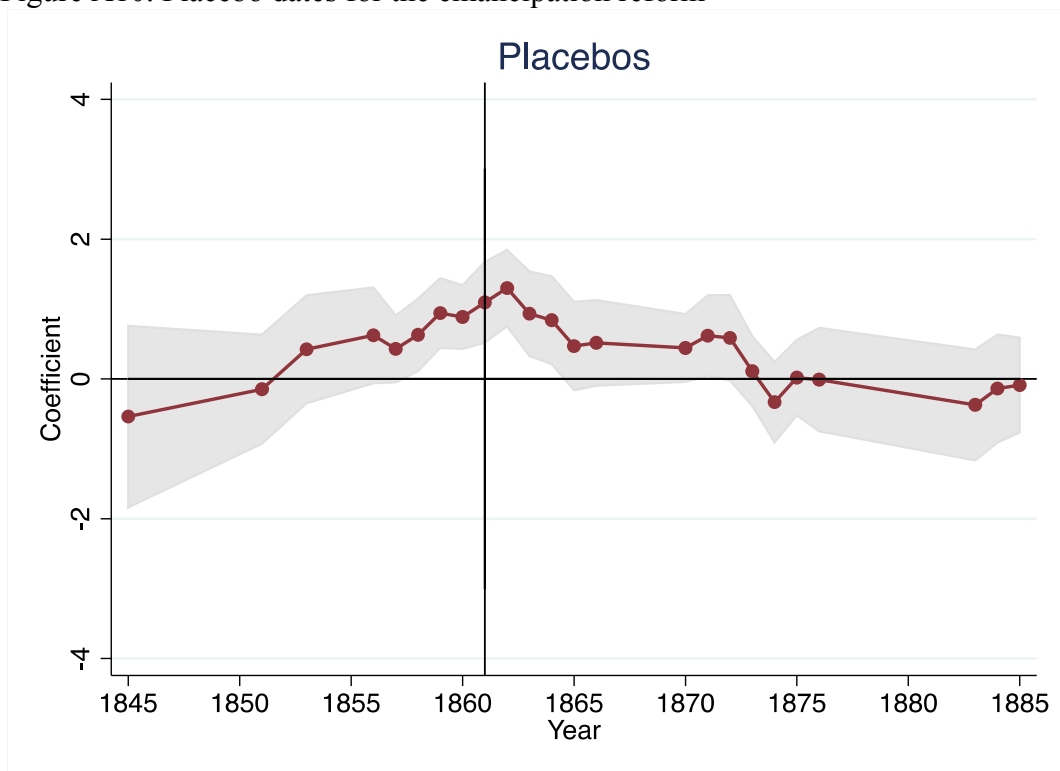
Note: The figure reports the β^T coefficients along with their 95% confidence intervals against year T from a series of regressions of the following form:

$$Y_{it} = \beta^T\, ShareSerfs_i \times Post\text{-}T_t + \mathbf{X^T_{it}}'\, \gamma + \psi_i + \sigma_t + t\delta_i + \varepsilon_{it},$$

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

E. **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 and 1840s by decade	Koval'chenko (1959)
	1851, 1856	Commission … (1873)
	1852-1855, averages for 4 years[*]	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)
	1875	Sbornik … (1897)
Industrial output	1796	Kessler and Markevich (2015)
	1849	Statisticheckie … (1852)
	1856	Statisticheckie … (1858)
	1858	Kessler and Markevich (2015)
	1882, 1883	Sbornik … (1884)
	1885	Statisticheckii … (1887)
	1897	Kessler and Markevich (2015)
Winter and summer grain seeds planted for the harvest of the corresponding year	1849	Statisticheckie … (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)
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	Bushen (1863), Troinitskii (1861)
	1857	Kabuzan (1971)
Redemption payments	1862-1876 by year	Vilson (1878)
Monasterial and clergy serfs	1796 and 1814	Beskrovnii et al. (1972)
Gentry debts and mortgages	1858	Skrebitskii (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: http://www.gaez.iiasa.ac.at/
Temperature	1795-1900 by year	The Global Land Surface Databank (Rennie et al., 2014)

* estimated from averages for the decade of the 1850s (Kovalchenko 1959) and annual figures for 1851, 1856 (Commission … 1873), 1857, 1859, 1860 (Vilson 1869) and 1858 (Kessler, Markevich 2015).

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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: Draftees' height		Dependent var: Draftees' height		Dependent var: log industrial output
Sample:	provinces	Sample:	provinces	Sample:	districts	Sample:	provinces
Share of serfs X (years 1840s)	0.01	Share of serfs X (year 1858)	0.17	Share of serfs X (years 1855-1856)	0.082	Share of serfs X (year 1849)	0.68
	[0.481]		[0.310]		[0.226]		[0.759]
Share of serfs X (years 1850-1855)	-0.51	Share of serfs X (year 1859)	0.17	Share of serfs X (year 1857-1858)	0.25	Share of serfs X (years 1856, 1858)	0.80
	[0.539]		[0.170]		[0.232]		[0.831]
Share of serfs X (years 1856-1860)	-0.17	Share of serfs X (year 1858)	0.13	Share of serfs X (year 1859-1860)	-0.20	Share of serfs X (years 1882, 1883)	2.51***
	[0.512]		[0.443]		[0.251]		[0.762]
Share of serfs X (years 1861-1865)	0.67	Share of serfs X (year 1860)	1.16***	Share of serfs X (year 1861-1862)	0.42*	Share of serfs X (year 1885)	2.70***
	[0.484]		[0.293]		[0.242]		[0.768]
Share of serfs X (years 1866-1870)	0.66	Share of serfs X (year 1861)	1.24***	Dmnd log distance from Moscow X Post-emancipation	0.11	Share of serfs X (year 1897)	2.17**
	[0.587]		[0.282]		[0.0673]		[0.901]
Share of serfs X (years 1871-1875)	1.36**	Share of serfs X (year 1862)	1.20***			Dmnd log distance from Moscow X Post-emancipation	0.34
	[0.569]		[0.248]				[0.459]
Share of serfs X (years 1876-1880)	1.98***	Share of serfs X (year 1863)	1.42***			Dmnd crop suitability X Post-emancipation	0.10
	[0.734]		[0.260]				[0.061]
Share of serfs X (years 1881-1885)	0.77	Share of serfs X (year 1864)	1.31***				
	[0.679]		[0.220]				
Share of serfs X (years 1886-1890)	1.28**	Share of serfs X (year 1865)	1.64***				
	[0.615]		[0.525]				
Share of serfs X (years 1891-1895)	0.58	Share of serfs X (year 1866)	1.17				
	[0.673]		[0.803]				
Share of serfs X (years post 1895)	1.14*	Dmnd log distance from Moscow X Post-emancipation	0.83***				
	[0.674]		[0.287]				
Dmnd log distance from Moscow X Post-emancipation	-0.66*	Dmnd crop suitability X Post-emancipation	0.10**				
	[0.339]		[0.040]				
Dmnd crop suitability X Post-emancipation	0.07*						
	[0.045]						
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	Yes
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	Yes
Province and year FEs	Yes	Province and year FEs	Yes	Province and year FEs	Yes	Province and year FEs	Yes
Region-specific trends	Yes	Region-specific trends	Yes	Region-specific trends	Yes	Region-specific trends	Yes
Observations	1,831	Observations	686	Observations	4,628	Observations	343
R-squared	0.524	R-squared	0.721	R-squared	0.603	R-squared	0.892
Comparison X-sections	1795-1829	Comparison X-sections	1853-1857	Comparison X-sections	1853-1854	Comparison X-sections	1795

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***	1.33***
	[0.227]	[0.225]
Share of serfs X Demeaned log distance from Moscow X Post-emancipation	-1.07*	-1.02*
	[0.607]	[0.605]
Demeaned crop suitability X Post-emancipation	0.06	0.05
	[0.040]	[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. The effect of the abolition of serfdom on cultivated lands

Dependent var:	(1) Ln (cultivated land)	(2) Share of serfs X Post-emancipation	(3) Ln (cultivated land)	(4) Ln (cultivated land)
	OLS	IV, 1st stage	IV, 2nd stage	OLS
Share of serfs X Post-emancipation	-0.17 [0.203]		0.23 [0.439]	0.41 [0.979]
Share of nationalized monasterial serfs X Post-emancipation		-1.05*** [0.312]		
Demeaned log distance from Moscow X Post-emancipation	0.39* [0.198]	-0.94*** [0.103]	0.68** [0.328]	0.48** [0.191]
Demeaned crop suitability X Post-emancipation	0.02 [0.032]	0.03* [0.019]	0.02 [0.036]	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		11.37		
R-squared	0.316	0.964	0.947	0.319

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 A6. Robustness of the effect of the abolition of serfdom on height of draftees across at district level: samples excluding Moscow and Saint-Petersburg districts.

Panel A: Panel data estimation

	(1)	(2)
Dependent var:	Draftees' height (cohorts 1853-1862)	
Data set:	District-level data	
Sample:	Without Moscow and S.-Petersburg	
Model:	OLS	IV, 2nd stage
Share of serfs X	0.33*	1.131***
Post-emancipation cohorts	[0.173]	[0.329]
Demeaned log distance from Moscow X	0.037	0.23***
Post-emancipation	[0.075]	[0.076]
Birth cohort and province or district fixed effects	Yes	Yes
Province-specific trends	Yes	Yes
Reforms for state and royal peasants	No	No
Observations	4,618	4,538
R-squared	0.069	0.593

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

	(2) Share of serfs X Post- emancipation cohorts
Dependent var:	
Model:	IV, 1st stage
Share of nationalized monasterial serfs X	-0.52***
Post-emancipation cohorts	[0.052]
Controls as in respective column of Panel A	Yes
Observations	4,538
F, excluded instrument	100.8

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. 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 A8. 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)
	Draftees' height (cohorts 1853-1866, 1875)				
	OLS	OLS	OLS	OLS	OLS
Share of serfs X Post-emancipation	0.95***	0.92***	0.93***	0.92***	0.84**
	[0.345]	[0.346]	[0.341]	[0.343]	[0.340]
Ln(railways)	-0.040*				-0.047**
	[0.023]				[0.023]
Temperature		0.016			0.020
		[0.033]			[0.033]
Court reform			0.13		0.19
			[0.140]		[0.139]
Zemstvo expenditures per capita in 1868-1903 X Post-1864				-0.12	-0.14*
				[0.074]	[0.072]
Demeaned log distance from Moscow X Post-emancipation	0.38	0.43	0.43	0.43	0.27
	[0.340]	[0.332]	[0.325]	[0.332]	[0.342]
Demeaned crop suitability X Post-emancipation	0.18***	0.15***	0.15***	0.16***	0.17***
	[0.052]	[0.049]	[0.049]	[0.049]	[0.049]
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	686	680	686	686	680
R-squared	0.768	0.762	0.766	0.767	0.768

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 A9. 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 A10. 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

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent var:				Grain productivity		
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** [0.480]	0.97*** [0.219]	0.87*** [0.330]	2.69*** [0.666]
Share of peasants with signed buyout contracts					-0.33 [0.257]	-1.15*** [0.350]
Demeaned log distance from Moscow X Post-emancipation		-1.03*** [0.336]	-0.64 [0.444]	-0.97*** [0.333]	-0.78* [0.406]	0.53 [0.520]
Demeaned crop suitability X Post-emancipation		0.07* [0.040]	0.06 [0.046]	0.06 [0.038]	0.07* [0.039]	0.06 [0.050]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	No	Yes	Yes	Yes	Yes	Yes
State and royal peasant reforms	No	No	No	Yes	No	No
Observations	1,828	1,828	1,828	1,828	1,773	1,773
R-squared	0.368	0.404	0.533	0.405	0.404	0.539

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

	(3)	(6.1)	(6.2)
Dependent var:	Share of serfs X Post-emancipation	Share of serfs X Post-emancipation	Share of peasants with signed buyout contracts
Model:	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. 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 A11. 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)
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
Share of serfs X Post-emancipation	1.26*** [0.381]			2.72*** [0.671]	1.29*** [0.386]	1.04*** [0.333]
Share of serfs with signed buyout contracts	-0.56 [0.382]			-1.39*** [0.515]	-0.51 [0.388]	-0.38 [0.276]
Land cuts X Post-1863					0.00071 [0.006]	0.0016 [0.005]
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 [0.635]	-0.67 [0.540]	-0.80* [0.449]
Demeaned crop suitability X Post-emancipation	0.01 [0.046]	0.03* [0.018]	0.03 [0.018]	0.01 [0.054]	-0.01 [0.047]	0.04 [0.038]
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,359	1,385	1,359	1,359	1,300	1,682
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

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

Table A12. Robustness to using 1857 tax census data: the effect of the abolition of serfdom on grain productivity

Panel A: Panel data estimation

Dependent var:	(1)	(2)	(3)	(4) Grain productivity	(5)	(6)
Model:	OLS	OLS	IV, 2nd stage	OLS	OLS	IV, 2nd stage
Share of serfs X Post-emancipation	0.90*** [0.238]	0.92*** [0.267]	1.51** [0.595]	1.19*** [0.277]	1.14*** [0.363]	3.04*** [0.784]
Share of peasants with signed buyout contracts					-0.41 [0.258]	-1.17*** [0.345]
Demeaned log distance from Moscow X Post-emancipation		-0.93** [0.377]	-0.50 [0.507]	-0.87** [0.374]	-0.64 [0.431]	0.71 [0.565]
Demeaned crop suitability X Post-emancipation		0.09** [0.042]	0.09* [0.045]	0.09** [0.039]	0.09** [0.041]	0.09* [0.049]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	No	Yes	Yes	Yes	Yes	Yes
Share of state peasants X Post-1866	No	No	No	Yes	No	No
Share of royal peasants X Post-1859	No	No	No	Yes	No	No
Observations	1,758	1,758	1,758	1,758	1,715	1.715
R-squared	0.372	0.411	0.545	0.413	0.410	0.548

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

Dependent var:	(3) Share of serfs X Post-emancipation	(6.1) Share of serfs X Post-emancipation	(6.2) Share of peasants with signed buyout
Model:	IV, 1st stage	IV, 1st stage	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. 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 A13. Robustness to using 1857 tax census data: the mechanisms behind the effects of the land reform and the emancipation

Dependent var:	(1)	(2)	(3)	(4)	(5)
	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
Share of serfs X Post-emancipation	0.92** [0.356]	1.92*** [0.446]	-0.11*** [0.029]	-0.047*** [0.018]	-0.12*** [0.031]
Share of peasants with signed buyout contracts	0.18 [0.302]	-0.51** [0.258]			
Share of peasants with signed buyout contract X repartition commune dummy	-0.77** [0.360]				
Share of serfs X Post-emancipation X Implicit contracts		-1.71*** [0.573]			
Demeaned temperature (t-1)			0.0039 [0.003]		0.0032 [0.003]
Share of serfs X Post-emancipation X Demeaned temperature (t-1)			0.0094** [0.004]		0.092** [0.004]
Share of serfs X Post-emancipation X Demeaned rye-to-wheat world price ratio (t-1)				-0.30** [0.128]	-0.29** [0.127]
Demeaned log distance from Moscow X Post-emancipation	-0.96** [0.458]	-0.80* [0.435]	-0.03 [0.020]	0.02 [0.017]	-0.03 [0.020]
Demeaned crop suitability X Post-emancipation	0.07* [0.040]	0.06* [0.036]	0.0015 [0.002]	0.00032 [0.002]	0.0015 [0.002]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes	Yes	Yes
Observations	1,715	1,644	762	769	762
R-squared	0.411	0.428	0.833	0.828	0.836

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

Panel A: Panel data estimation

	(1)	(2)	(3)
Dependent var:	Draftees' height (cohorts 1853-1866, 1875)		
Data set:	Province-level data		
Model:	OLS	IV, 2nd stage	OLS
Share of serfs X	1.02***	1.12***	0.94**
Post-emancipation cohorts	[0.373]	[0.320]	[0.380]
Demeaned log distance from Moscow X	0.61*	0.69**	0.58*
Post-emancipation	[0.344]	[0.274]	[0.341]
Demeaned crop suitability X	0.15***	0.11***	0.15***
Post-emancipation	[0.051]	[0.031]	[0.051]
Birth cohort and province fixed effects	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes
Share of state peasants X Post-1866	No	No	Yes
Share of royal peasants X Post-1859	No	No	Yes
Observations	656	656	656
R-squared	0.768	0.865	0.769

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

	(2)
Dependent var:	Share of serfs X Post-emancipation cohorts
Model:	IV, 1st stage
Share of nationalized monasterial serfs X	-1.04***
Post-emancipation cohorts	[0.290]
Controls as in respective column of Panel A	Yes
Observations	656
F, excluded instrument	12.93

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

Table A15. Robustness to using 1857 tax census data: the effect of the abolition of serfdom on industrial output

Panel A: Panel data estimation

Dependent var:	(1)	(2)	(3)
		Ln (industrial output)	
	OLS	IV, 2nd stage	OLS
Share of serfs X	0.60	3.11*	1.19*
Post-emancipation	[0.461]	[1.768]	[0.710]
Demeaned log distance from Moscow X	0.32	2.11	0.41
Post-emancipation	[0.465]	[1.394]	[0.468]
Demeaned crop suitability X	0.12*	0.15*	0.14**
Post-emancipation	[0.066]	[0.083]	[0.065]
Year and province fixed effects	Yes	Yes	Yes
Region-specific trends	Yes	Yes	Yes
Share of state peasants X Post-1866	No	No	Yes
Share of royal peasants X Post-1859	No	No	Yes
Observations	340	340	340
R-squared	0.884	0.931	0.886

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

	(2)
	Share of serfs X
Dependent var:	Post-emancipation
Model:	IV, 1st stage
Share of nationalized monasterial serfs X	-0.84***
Post-emancipation	[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 A16. 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)
Dependent var:				Grain productivity		
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*** [0.544]	0.90*** [0.259]	0.55 [0.350]	2.75*** [0.694]
Share of serfs with signed buyout contracts					0.14 [0.248]	-0.82* [0.479]
Demeaned log distance from Moscow X Post-emancipation		-0.58* [0.334]	0.25 [0.412]	-0.55* [0.329]	-0.75* [0.410]	0.76 [0.546]
Demeaned crop suitability X Post-emancipation		0.02 [0.036]	0.02 [0.049]	0.02 [0.035]	0.01 [0.037]	0.01 [0.059]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	No	Yes	Yes	Yes	Yes	Yes
Share of state peasants X Post-1866	No	No	No	Yes	No	No
Share of royal peasants X Post-1859	No	No	No	Yes	No	No
Observations	1,010	1,010	1,010	1,010	955	955
R-squared	0.238	0.289	0.500	0.293	0.300	0.515

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

	(3)	(6)	(6)
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. 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 A17. The effect of the abolition of serfdom on grain productivity in the sample including the Baltic provinces

Dependent var:	(1)	(2)	(3)	(4)
	Grain productivity			
	OLS	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 A18. Robustness to using WLS 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)
				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*** [0.484]	1.03*** [0.263]	1.04*** [0.350]	2.79*** [0.646]
Share of peasants with signed buyout contracts					-0.41 [0.252]	-1.20*** [0.337]
Demeaned log distance from Moscow X Post-emancipation		-0.95** [0.369]	-0.57 [0.442]	-0.88** [0.369]	-0.64 [0.427]	0.60 [0.492]
Demeaned crop suitability X Post-emancipation		0.06 [0.041]	0.06 [0.046]	0.06 [0.039]	0.06 [0.040]	0.05 [0.050]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Province-specific trends	No	Yes	Yes	Yes	Yes	Yes
State and royal peasant reforms	No	No	No	Yes	No	No
Observations	1,835	1,835	1,835	1,835	1,780	1,780
R-squared	0.509	0.536	0.536	0.537	0.545	0.541

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

Dependent var:	(3) Share of serfs X Post-	(6.1) Share of serfs X Post-emancipation	(6.2) 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 A19. Robustness to using WLS by log provincial population: the mechanisms behind the effects of the land reform and the emancipation

Dependent var:	(1)	(2)	(3)	(4)	(5)
	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
Share of serfs X Post-emancipation	0.84**	1.75***	-0.065***	-0.053***	-0.079***
	[0.339]	[0.437]	[0.017]	[0.018]	[0.019]
Share of peasants with signed buyout contract	0.11	-0.51**			
	[0.271]	[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)			0.0052*		0.0043
			[0.003]		[0.003]
Share of serfs X Post-emancipation X Demeaned temperature (t-1)			0.065**		0.010**
			[0.004]		[0.004]
Share of serfs X Post-emancipation X Demeaned rye-to-wheat world price ratio (t-1)				-0.38***	-0.36***
				[0.119]	[0.117]
Demeaned log distance from Moscow X Post-emancipation	-0.93**	-0.79*	-0.03	0.03	-0.03
	[0.446]	[0.428]	[0.020]	[0.018]	[0.021]
Demeaned crop suitability X Post-emancipation	0.04	0.04	0.00	-0.00	0.00
	[0.040]	[0.036]	[0.002]	[0.002]	[0.002]
Year and province fixed effects	Yes	Yes	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes	Yes	Yes
Observations	1,780	1,726	793	800	793
R-squared	0.545	0.554	0.931	0.929	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 20. Robustness to using WLS 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, 1875)		
Data set:	Province-level data		
Model:	WLS	weighted IV, 2nd stage	WLS
Share of serfs X Post-emancipation cohorts	0.98*** [0.339]	1.33** [0.626]	0.94*** [0.353]
Demeaned log distance from Moscow X Post-emancipation	0.47 [0.344]	0.73 [0.596]	0.45 [0.338]
Demeaned crop suitability X Post-emancipation	0.16*** [0.051]	0.15*** [0.052]	0.16*** [0.050]
rth cohort and province or district fixed effects	Yes	Yes	Yes
Province-specific trends	Yes	Yes	Yes
Reforms for state and royal peasants	No	No	Yes
Observations	686	686	686
R-squared	0.901	0.901	0.902

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	-1.25*** [0.317]
Controls as in respective column of Panel A	Yes
Observations	686
F, excluded instrument	15.55

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

Panel A: Panel data estimation

	(1)	(2)	(3)
Dependent var:		Ln (industrial output)	
	WLS	weighted IV, 2nd stage	WLS
Share of serfs X Post-emancipation	0.71* [0.424]	2.60* [1.397]	1.38** [0.621]
Demeaned log distance from Moscow X Post-emancipation	0.33 [0.474]	1.67 [1.142]	0.49 [0.479]
Demeaned crop suitability X Post-emancipation	0.12* [0.070]	0.12 [0.080]	0.12* [0.070]
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
R-squared	0.941	0.935	0.942

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

	(2)
Dependent var:	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 A22. Counterfactual estimates of Russian economic development in the case of earlier abolition of serfdom, 1820-1913 (in 1990 USD)

		Agriculture	Industry	Service	All sectors	
					scenario: services were not affected by the emacipation	scenario: services grew at the same rate as the rest of the economy on average as a result of the emancipation
a.	GDP per capita in 1820 from Maddison (2007)				688	
b.	Sectorial shares in value added in 1860 from Goldsmith (1961)	59.3 [I]	5.1 [I]	35.6 [I]		
c.	Value added in 1820	22343 [II]	1922 [II]	13413 [II]	37678 [III]	
d.	The multiplier effect due to the abolition of serfdom	1.165 [IV]	1.385 [IV]	range: 1-1.18 [V]	1.12 [VI]	1.18 [VI]
e.	Counter-factual estimates of value added in 1820 (mln USD 1990)	26027	2662	range: 13413-14989	42103	44549
f.	Counter-factual estimates of GDP per capita in 1820				769	813
g.	Counter-factual estimate of GDP per capita in 1913 (scenario: average growth rate in Russia 1820-1913)				1662	1759
h.	Counter-factual estimate of GDP per capita in 1913 (scenario: average growth rate in Russia 1870-1913)				2059	2179
l.	Counter-factual estimate of GDP per capita in 1913 (scenario: East-European average growth rate 1820-1913)				2211	2340
	Actual GDP per capita in 1913 from Maddison (2007)				1488	

Note: (I) – from Goldsmith (1961); (II)=(I)*(III)/100; (III) - from Maddison (2007); (IV) from the estimation in this paper; (V) = range from zero effect to the effect equal to weighted average effect on agriculture and industry; (VI) = weighted average of growth of the three sectors. Row e = row d* row c. Row f = row e divided by population (54,765m) in 1820 from Maddison (2007). Annual growth rates applied: row g: growth rate = 0.008326279; row h: growth rate = 0.01064965; row i: growth rate =0.011424605.