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The Stolypin Reform and Agricultural Productivity in Late Imperial Russia

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The Stolypin Reform and Agricultural Productivity in Late Imperial Russia.

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Abstract

We study the effect of improvements in peasants' land tenure, launched by the 1906 Stolypin reform, on agricultural productivity in late Imperial Russia. The reform allowed peasants to obtain land titles and consolidate separated land strips into single allotments. We find that consolidations increased land productivity. If the reform had been fully implemented, it would have doubled grain production in the empire. We argue that an important factor determining the positive impact on productivity is a decrease in coordination costs, enabling peasants to make independent production decisions from the village commune. In contrast, the titling component of the reform decreased land productivity and we present evidence that transaction costs explain this short-run decline.

JEL Codes: N43, N53, O43, Q15.
Keywords: land tenure, peasant commune, Stolypin reform, Russia

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1. Introduction

The 1906 Stolypin reform, one of the largest property rights reforms in Russian history, instituted a legal vehicle of dramatic change to peasants' land tenure in the commune, an institution that dominated the Russian agricultural landscape after the emancipation of the serfs in 1861. The commune placed restrictions on peasant households' property rights and the reform offered an opportunity for peasants to gain greater individual control over the land that they farmed. The reform enabled a household to exit the commune, a procedure that involved a switch from communal to individual land ownership through the privatization of a household's communal land allotments. In addition to privatization, a household could request the consolidation of its land strips that had been scattered across the commune's open fields into one allotment. Over the years of reform implementation (1907-1915), about two million peasant households decided to exit the commune and to privatize their plots and over 1.2 million households managed to consolidate their plots, or about sixteen and ten per cent of 12.3 million households in the European part of the Russian empire correspondingly (Dubrovskij 1963; Davydov 2010).

The historical and economic literatures exhibit a longstanding debate on the effects of the commune and the Stolypin reform on the development of agriculture in late Imperial Russia. The standard argument, attributed to Alexander Gerschenkron (1965), is that communal ownership, because of restricted individual property rights, created disincentives for peasants and harmed land productivity, which was almost three times lower in Russian than in England in the early twentieth century (Anfimov 1980 p. 80; Brassley 2000). Under this view, the reform removed these limitations and contributed to the rapid economic development of Russian agriculture during the years before the First World War. The reform would have had an even larger impact but it was impeded by the slow implementation of the reform (Tukavkin 2001, Williamson 2006, Davydov 2010). Critics, however, argue that, in practice, the commune was a quite flexible institution, able to overcome legal restrictions and produce substantial growth of agricultural output already before the reform (Gregory

1982, 1994; Bideleux 1990; Nafziger 2008, 2010; Kospidis et al. 2015). Under this view, the slow take-up of the reform was due to demand and peasants' limited willingness to participate in it (Anfimov 1980, Koval'chenko 1991, Pallot 1999).

Using province level data for the European part of the Russian empire, regularly published by imperial authorities, this paper undertakes an econometric approach to this debate on the effects of the reform on land productivity. We analyze how changes in land tenure initiated by the reform – both land privatization and land consolidations – affected grain output per hectare. We focus our analyses on land productivity rather than on TFP or labor productivity because of poor quality or lack of data on labor and capital inputs. Since the reform was terminated with the start of the First World War, nine years after its launch, our results are short-run effects and we can only speculate about the long-run impact due to changes in agricultural organization following the war.

A major econometric concern with the estimation of the impact of the reform is the voluntary nature of reform participation. The reform afforded individual peasant households autonomy in making a decision on the form of their land tenure and plot consolidation. In addition, some features of the reform available to individual households required the cooperation of other households in the commune. Since our data are aggregated at the province level, we face selection on unobservables, both at the individual and commune level, for the variables of interest that track the impact of the reform – exits and consolidations. To remedy this selection bias, we take advantage of bureaucratic red tape associated with the reform and the limited supply of land survey engineers as sources of exogenous variation in the speed of reform implementation.

We find that the consolidation component of the reform indeed caused an increase in land productivity, as supporters of the reform argued. At the same time, we find that the effect of land title conversions from communal to individual tenure, represented by exits from the commune, onto land productivity was negative, as reform skeptics believed. The

overall effect of the reform was positive; according to our estimations, land productivity more than doubled because of the reform.

Why do we see these large effects on productivity? Changes in land tenure could alter transaction costs of various types, including agency and coordination costs (see Alston and Gillespie, 1989, for a detailed discussion of the different types of transaction costs). The historical peculiarities of the Stolypin reform allow us to verify these channels of impact. First, both exiting from the commune and land consolidations offer privatized returns to investment and similar levels of tenure security, alleviating the agency costs of communal land ownership. However, an exiting household would have to consolidate its land in order to gain some independence from the commune's production process. Exiting without consolidating, as we will argue below, would do little to alleviate the coordination costs associated with the interdependencies of production in the commune. Second, the reform permitted individual households to apply for land consolidation even if the rest of the commune did not, which we refer to as singular land consolidations. The alternative and preferable form of land consolidations occurred when every member of the commune consolidated in unison and we label these village-wide consolidations. Although both types of consolidations reduced coordination costs, village-wide consolidations were more effective since, under a singular consolidation, the separating household likely continued operating amidst commune farm production and could face de facto restrictions on production decisions. Thus, if land consolidations, and, in particular, village-wide ones, increase productivity, then we attribute at least part of the effect to a decrease in coordination costs.

We find that the positive effect of consolidations on land productivity is driven by village-wide consolidations. To bolster our claim that we identify an effect of changes in coordination costs, we verify that a relaxation of these costs corresponds to changes in production techniques and crop production. Specifically, we find that land consolidations in the previous year predict the inflow of agricultural machines and that land consolidations

lead to greater specialization in crop production once we account for size of consolidated plots.

The positive effect on land consolidations, and village-wide consolidations, in particular, is conditional on a household exiting the commune. For those households, which did not manage to consolidate, but obtained individual land title, the effect of reform on land productivity was negative. Unfortunately, due to data limitations, we are not able to present conclusive evidence about the channel of this influence. We do, however, find some evidence that is consistent with the burden of transaction costs related to the implementation of the reform, including both direct and indirect costs, negatively impacting peasant productivity. Clearly, less aggregated data would provide a clearer picture but this evidence is an important step in trying to understand the effects of the Stolypin reforms.

The outline of the paper is as follows: first, we provide the necessary details of the institutional setting in the Russian village before the reform; then we discuss details of the Stolypin reform and its possible effects on agricultural productivity; third, we describe the data, the dynamics of the reform implementation and our estimation approach; fourth, we present the results and then discuss sensitivity tests. In the last section, we conclude.

2. Peasants' property rights before the Stolypin reform: the commune

Before the Stolypin reform, peasant land belonged to the commune rather than to individual households. According to the 1905 land census, communal land accounted for thirty-one percent of all land in the European part of the empire, but in terms of arable lands more than two-thirds were under communal tenure (Central Statistical Committee 1905-1907).[2] The commune divided arable land into parcels and distributed them to individual

[2] Private tenure accounted for twenty-six percent of all land and the remaining forty-three percent belonged to the state. The distribution of the types of land varied by ownership type. The state possessed almost exclusively forest land or land non-suitable for agriculture. Forest and meadow shares were larger for lands under private rather than commune tenure. Commune's lands were mostly arable lands. Private land was the land that Russian gentry, i.e. former owners of serfs, kept in their possession after the 1861 peasant emancipation reform. Private land was free of communal restrictions and could be sold, leased or used as a collateral regardless of social status, i.e. a part of these land was possessed or cultivated by

households for cultivation, while meadows, pastures and forests usually remained in common usage. A typical household cultivated several narrow and long strips of arable land scattered around the village and surrounded by the land plots of other commune members. The number of strips per household depended on local conditions. To compensate for heterogeneity in land quality, the commune allocated a greater number of land strips to each household, decreasing the variance in total yield but shrinking the average strip size. The land strips of an individual household could be located several dozen kilometers from each other, implying sizeable transportations costs. In extreme cases, the most remote strips remained uncultivated (Zyryanov 2002 p. 170). Peasants cultivated their arable plots as open fields, jointly using their land for grazing animals after the harvest gathering.

The open field system necessitated coordinating production plans among peasants and strict regulation of land use. For this type of agricultural production, the commune was an effective institution in regulating the production decisions of individual households and enforcing cooperation (Tukavkin 2001 pp. 169-180). However, a drawback of these restrictions is that any change in production plans would likely involve a complex bargaining process and may even prove to be infeasible depending on the exact allocation of land across commune members. Hence, individual peasant households would find it prohibitive costly to make an independent decision on what to cultivate, when to seed, when to harvest and whether to introduce a new technology. Many historians argue that the commune complicated the introduction of innovations and was one of the major factors in persistence of open field and crop rotation system in the Russian village (Williams 2006, p. 54-55). In addition, the narrowness of strips, some of which were only half a meter wide, made an uncoordinated switch to new techniques and technologies impossible.

Before the reform, peasants' individual rights in land varied by the type of commune, either repartition or hereditary land tenure. In repartition (*peredel'naya*) communes, which

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the commune members by the start of the Stolypin reform. The latter did not change individual responsibilities and claims in respect to the commune. In this paper we restrict our analysis to commune land only.

accounted for about eighty percent of all communes in European part of the empire (Tukavkin 2001, p. 77), peasants could not sell, lease, mortgage or transfer legally their strips. These restrictions were in place to permit the periodic redistribution of allotments among commune members by a qualified majority decision.[3] The repartitioning of commune plots aimed to distribute land equally according to a household's working capacity to secure tax payments, for which the commune was jointly responsible. In contrast, there were no land redistributions in hereditary (*podvornaya*) communes and land plots passed down within the family. Hereditary communes still imposed restrictions on rights to land (Korelin 2002, pp. 244-245). In particular, a transfer in the hereditary commune required an individual either inside or outside the commune willing to take the tax obligations related the allotment (an outsider would be required to become a commune member, Williams 2003, p. 65).

Peasants of both types were tied to their communes and could not exit or even leave them temporarily without the commune's consent.[4] Before the Stolypin reform, peasants in repartition communes did not get any compensation for land they cultivated if they managed to receive the commune's consent. Seasonal workers or migrants to urban areas had to get passports from local communal authorities. They remained responsible for paying commune taxes even though their access to land, especially in repartition communes, could be limited. Since land was a valuable asset, most of these workers made the effort to remain in good standing in their home villages (Greschenkron 1965).

While the commune imposed many legal constraints on peasants, there are debates in historical literature to what extent these restrictions were enforceable and binding for

[3] A general (*korennoj*) repartition implied a redistribution of all land. The commune could also implement a partial reallocation of land parcels between commune households (*skidki-nakidki*). The law prescribed general repartitions not more often than once every twelve years. Partial reparations could occur more often.

[4] After the emancipation, an exit from the repartition commune and a shift to an individual tenure was possible if the household paid off its corresponding share of land redemption fees imposed on peasants by the emancipation law. Very few households did this in practice. The 1893 law closed this option requiring the consent of the commune to exit (Williams, 2003 p. 67).

peasants in practice. Indeed, almost forty per cent of repartition communes did not implement repartitions since emancipation (Dubrovskij 1963). There is also evidence that communes introduced compensation for land improvements as well as allowed informal land renting within the commune (Gregory 1994; Tukavkin 2001; Zyryanov 2002). Analyzing micro-level data in Moscow province, Nafziger (2008, 2010) argues that one explanation of the negative correlation between the number of repartitions and agricultural productivity is that repartitions themselves were endogenous, responding to shocks in productivity and substituting for undeveloped factor markets. At a more aggregate level, Kopsidis et al. (2015) argue that "crop yields on peasant allotments evolved similarly to those on private land during the years 1892–1913", comparing regional trends in productivity growth.

3. The Stolypin reform: potential prospects and costs for land productivity

The decree of November 9, 1906 launched the Stolypin reform granting peasants a possibility to choose among different organizations of land tenure. First, peasants in repartition communes received the right to exit the commune with the arable land that they had cultivated under the most recent repartition, i.e., to privatize land in their possession, converting titles from communal to personal property. After exiting from the commune, the law guaranteed reform participants access to non-arable commune resources. The reform allowed households with "extra" land in use to privatize this land either for free or paying below-market price, creating winners and losers of the reform. (Williams 2006, p. 148). Those households that expected a land reduction under the next repartition had the strongest incentive to participate in the reform. Peasants could sell or lease privatized allotments of arable land but only to other peasants, although the law did constrain how much former commune land one peasant household could possess (Korelin 2002 p. 279).[5] Second, the reform opened an opportunity for peasants in both types of commune to consolidate their

[5] Similar, peasant mortgage opportunities were legally constrained to the State Peasant Bank. In practice very few peasants got credits with land as a collateral. Their number did not exceed 2,500 per year for the whole empire (Zak 1911, Dubrovskii 1963).

privatized strips of land into larger allotments. Either a commune could vote with two-thirds majority for general redistribution of land into separate, consolidated allotments (village-wide consolidation), or a household could demand for the consolidation of its land strips individually (singular consolidation). The law prescribed that the commune must satisfy individual requests; an 'impossible' or 'inconvenient' consolidation should be satisfied with monetary compensation. On top of exits and consolidations, the reform granted peasants opportunities to request for other types of land title specification works such as demarcation of land cultivated by two neighbouring communes or a commune and a private owner.

The reform implementation procedure was as following. Within one month of submitting the application, a household applying for land privatization had first to reach a consensus with the commune about the precise terms of its exit and land privatization. If the commune refused to find such consensus and approve the application, the household was free to appeal to a local land-captain (*zemskii nachalnik*), who was empowered to solve such disputes between the commune and the applicant and to arrange the privatization of the household's strips even without commune's consent. The final exit decision had to be approved by local peasant courts (*uezdnij krestyanskii sezd*). Similarly, the commune could try to block an individual request for singular consolidation.

Local authorities (local land settlement commissions – *zemleustroitelnie komissii*) were in charge of resolving disputes and could override a commune's discontent. The commune as well as households consolidating their plots could appeal to the higher bodies if they were unsatisfied with the consolidation decisions of local authorities. The financial burden of these procedural costs was more substantial for households that chose to exit rather than to consolidate. Various governmental subsidies and loans covered a large share of the costs for consolidators. In particular, all land works associated with land consolidation were free for peasants being covered by the government (Dubrovskij 1963). In addition, the government provided subsidies in cash and in kind (access to state forests and wood

materials) in the amount of up to 150 rubles for a household that requested consolidation (Klimin 2002).

The government updated the initial 1906 reform decree with the 1910 and 1911 laws. The law of June 14, 1910 simplified the initial exit procedure, decreasing transaction costs, by making the local land settlement commission the single supervision agency (Williams 2006, p. 153). The law also allowed households in communes for which there had been no repartitions during last fifty years to receive a private title (*udostoveritel'nii akt*) for lands in their possession without any discussion with the commune. The law of May 29, 1911 changed the pre-requisite for singular consolidations by no longer requiring households to first exit the commune. The new law also limited the commune's legal options to block individual requests for consolidation; in particular, if at least twenty per cent of households in the commune wished to consolidate, these singular consolidations became obligatory (Korelin 2002, p. 279; Williams 2006, p. 154).

Only a quarter of exiting households managed to reach an agreement with the commune on the precise conditions of their exits and about two hundred and fifty thousand withdrew their applications and terminated the exiting procedure, presumably under pressure from the commune (Korelin 2002, p. 283). Consolidations, mainly singular ones, had the potential to create even more tensions. Some historians argue that local authorities often chose the best land to offer to households requiring singular consolidations to promote the reform take-up, which could have deepened protests and tensions associated with this type of consolidations (Kovalchenko 1991, Pallot 1999). Conflicts rarely were openly violent; the government was quite effective in preventing such type of clashes (Pallot 1999). Communes primarily chose weapons of the weak by sabotaging consolidations and preventing the normal operations of households that demanded them. One strategy was to block access to commune pasture and forest. These blockades were illegal but many communes organized them in practice. At a later stage of the reform, under the 1911 law, peasants could include non-arable lands into consolidated allotments (under both singular and village-wide

consolidations), limiting such a strategy to impose costs on those that chose to consolidate (Korelin 2002, p. 279). Other common anti-enclosure actions were pasturing livestock on consolidated plots. By their nature, the majority of such counter-actions remained unregistered in contrast to carefully registered complaints to the authorities on consolidation decisions (Pallot 1999; Klimin 2002).

In the long run, better property rights in land should strengthen peasants' incentives and increase land productivity. In the short run, the only effect that we observe, the impact could be ambiguous. There are a few reasons why one might find no immediate effect or even a short-run negative one. First, time could be needed to observe the benefits of the improvement in property rights. While a land title converted to individual tenure protected the household's land against future repartitions, an 1893 law already had prohibited repartitions more often than once in a twelve-year period. Thus, only longer-run investments in land would have been affected by the reform. Additionally, transaction costs associated with the implementation of the reform could result in negative effects on agricultural productivity in the short-run. The reform's bureaucratic and technical procedures were complex and required substantial effort, putting a strain on peasants' time and financial resources.

Second, even though an individual title allowed a peasant household to sell or to lease its allotment, improving the allocative efficiency of land, the legal market of (former) commune lands did not exist before the reform and restrictions imposed by the reform law on commune land transfers would have also slowed down the reallocation of land to the most efficient farmers.

Third, the better asset liquidity that comes with land privatization also changed the household's opportunity costs and eased financial constraints. Peasants could explore other economic activities without losing income from land. Indeed, Chernina et al. (2014) find a positive impact of the Stolypin reform onto internal migration. In terms of land productivity, however, out-migration could result in lower land productivity if the reduction in labor input

is not compensated by improvements in the allocative efficiency of land. An increase in the marginal productivity of labor could be accompanied by a decrease in land productivity if the amount of land under cultivation remained the same. Newly privatized land could also be withdrawn from production if labor was only allocated to this land to strengthen the household's claim to it. Exiting the commune but not consolidating the land could be associated with households that intend to leave the land idle or devote more labor to other production activities.

Land consolidations differed substantially from mere exits in terms of their impact on coordination costs. As discussed, exiting without consolidating did not free an individual household's production decisions from the commune. The commune's land still surrounded the strips of an exited household, forcing it to follow the rotation of crops established by the commune (Korelin 2002, P. 285). The commune's influence decreased only after consolidation. Indeed, the 1913 survey documented shifts to highly productive crops and many-field system (instead of the traditional three-field system) as well as an increase in use of agricultural machines and hired labor among those who consolidated their plots (Tukavkin 2001, p. 209). The decrease in coordination costs was more pronounced in village-wide land consolidations. In the case of singular consolidation, a separator continued to live in the commune environment and had to deal with his commune neighbors on a daily basis, and this increased the costs of making independent production plans relative to households with village-wide consolidations. Singular consolidations or exiting without consolidating could even have introduced a new source of coordination costs relative to village-wide consolidations or the status quo. The reorganization of agricultural production would have changed the whole way of life in the Russian village, implying substantial social costs and tensions between those peasants who participated in the reform and those who decided to stay in the commune. In village-wide consolidations, there was no potential for a clash between these two groups within the village.

Consolidations could increase productivity because of scale effects and the reduction in transportation costs, a type of intra-household coordination cost. The many scattered strips of land that peasant households cultivated before the reform were on average too narrow to adopt agricultural machines. Their distant location from each other required significant travel time, which was costly in the short growing season. According to some estimates, time spent travelling to strips located more than six kilometers from the peasant house was equal to time spent on land cultivation (Tukavkin 2001, p. 207). Since both types of consolidations would benefit from these effects, any additional impact of village-wide consolidations could be attributed to the change in inter-household coordination costs.

4. Data and Econometric Specification

We construct a provincial level dataset on the implementation of the Stolypin reform, agricultural output and other development indicators of provinces in the European part of the Russian empire in the early 20th century before and during the reform, combining several official statistical volumes. Table A1 of the appendix provides a full list of our sources.

Data availability determines the number of observations in our dataset. We have information on forty-five European provinces of the empire, namely on forty-four out of fifty, so called Russian European provinces (Arkhangelsk, Chernigov, Estlyandiya, Kherson, Olonetz and Yaroslavl are missing), plus Stavropol province in the North Caucuses. We construct a panel with eight time period cross-sections, two before and six after the reform: 1905, 1906, 1907, 1908-1909, 1910-1911, 1912, 1913 and 1914. The availability of statistics on exiting households, published irregularly, determines the reform periods.[6] All figures are normalized to annual averages to make them comparable over time.

Table 1 presents summary statistics of our dataset. Land productivity in European Russia was about seven hundred and seventy kilograms of grain per hectare of peasant land, where grain stands for the sum of the four cereals – rye, wheat, barley and oats. During the

[6] Because of data availability, we use data on exits from the commune since November, 6 1906 (the date when the government issued the reform decree) till January, 31 1908 for the 1907 period and since February, 1 1908 till December 31 1909 for the 1908-1909 period.

period under study, the average productivity increased from about seven hundred per hectare in 1905 to almost nine hundred and fifty in 1913. We employ rural population and livestock (cows and horses) figures to proxy for labor and capital inputs. An average density was about forty-six rural citizens per square kilometer; there was less than one cow and half a horse per hectare in an average Russian province in that time. We also have figures on the inflow of agricultural machines (we lack data on the stock of the machines) delivered to a particular province by railroads as another proxy for capital-intensity of Russian agriculture. We use the amount of credit that peasants received under the central government's rural finance program as a proxy for peasants' access to credit (Korelin 1988). The spread of credit by this program was very limited, about two rubles per thousand hectares only; however, peasants did not have other credit options besides savings and informal borrowing.

Table 1 somewhere here

Rural wages during harvest season, share of urban population and rural-rural migration to the Asian part of the empire represent controls for the three main alternatives to farming in the commune, namely becoming a hired worker either in agriculture or in a city, or migrating to Southern Siberia for its virgin land. Rural wages during peak harvest time were about ninety-six kopeks per day, i.e., up to thirty rubles per month or about a quarter of 1913 GDP per capita (Markevich and Harrison 2011). Urban settlements in the empire were rapidly growing in the beginning of the 20th century but their average share was only about thirteen percent. The level of migration to Siberia was high, about three million people over ten years, but less impressive in relative terms; roughly one household per thousand hectares migrated to Siberia annually.

The presence of the repartition commune and local self-governance (*zemstvo*) are two other important characteristics of Russian European provinces. We consider a province as a province with repartition communes if at least five percent of peasants belonged to them

before the reform.[7] By construction, this dummy does not vary over time. We view the *zemstvo* dummy as an important determinant of agricultural productivity in a province because *zemstvo* initiated various programs aimed to develop peasant agriculture (Tukavkin 2001). In particular, they invested into disseminating of advanced agricultural knowledge and techniques as well as elementary education. The 1864 law established *Zemstvo*s in about half of all European provinces. The tsars increased the number of provinces with *Zemstvo* several times after that, including one expansion during the period under study, in 1911.

We report variables characterizing the implementation of the Stolypin reform in per hectare terms. Seven households per thousand hectares exited repartition communes and obtained individual land titles in an average province in an average year during the period under consideration; in addition, about two households per thousand hectares exited in communes where there were no actual reparations since the emancipation, i.e. following a simplified exiting procedure under the 1910 law. The number of consolidations was substantially smaller. Only about two and a half households per thousand hectares consolidated their allotment in an average province in an average year during the period under study. Almost two of them did this via village-wide consolidations, and a bit more than a half of household on average did this via singular consolidations. An average size of a consolidated plot was almost six hectares. State grants and subsidies for households requesting consolidations were about twenty kopeks per cultivated hectare on average.

The variation in reform implementation across provinces and over time was substantial. Figure 1 presents annual dynamics of exits and consolidations. About one hundred and fifty thousand households left the commune in an average year with a spike of seven hundred thousand during the first two years after the start of reform. On top of that,

[7] According to such definition, non-repartition provinces were Vilno, Kovno, Grodno, Minsk, Podolia and Volin' provinces with hereditary communes and the Baltic provinces (Lifliandia, Estliandia, Kurliandia) where were no communes. We classify Kiev, Poltava, and Bessarabiya provinces and Don and Orenburg Cossack provinces as repartition provinces because peasant repartition communes accounted for more than fiver per cent of rural citizens there. In the rest thirty-four out of forty-five provinces in our dataset, almost all communes were repartition ones (Durbrovskij 1963, pp. 570–573).

about eighty thousand households acquired titling certificates under the 1910 law per year. The number of households consolidating their strips was steadily increasing up to 1910 and remained roughly at the same level afterwards. After 1910, there were about sixty thousand singular consolidations per year and about one hundred households consolidating their allotments under the village-wide procedure.

Figure 1 somewhere here

Figures 2 and 3 represent the spatial distribution of the reform implementation. In terms of geography, the number of exits per province increased moving from north to south with the exception of western provinces where there were few repartition communes, i.e., exits were not possible. Other exceptions are Cossack Don province and Astrakhan province with limited amount of arable land suitable for grain production. The geography of consolidations mirrored the geography of exits increasing from north to south. Based on this geography, one might conjuncture that the reform implementation was correlated with unobservable geographical characteristics of provinces. We account for these time invariant characteristics using the panel structure of our data. It is unlikely that time variant characteristics of provinces such as weather shocks drove the geography of the reform. Droughts – the main shock for Russian agriculture in that time (Tukavkin 2001, p. 72) – normally affected the whole territory of European Russia when they happened (Wheatcroft 1977).

Figures 2 and 3 somewhere here

The demand for the reform was higher than the supply. The number of applications both to exit and to consolidate was larger than the actual number of applications to exit that were approved by local courts and the number of consolidations undertaken in practice. For example, by late 1915 around 1.2 million households consolidated their plots although more than six million had applied for consolidations (Volkov 1999; Davydov 2010).

Chernina et al. (2014) argue that red tape was one of the main determinants of exiting dynamics. Local officials were poorly educated, ill-prepared for the reform and

overburdened with other responsibilities. Land-captains were appointed to their positions during the decade before the reform when the state policy was pro- rather than anti-commune. Candidates for these positions were limited in supply. Initially, the government planned to employ only local gentry, but had to extend the pool of candidates to retired military officers, graduates of Orthodox divinity schools, and other non-gentry, middle-class citizens, with the only exception of peasants (B.Zh., 1898). Few land-captains were added after the start of the reform; there were 2615 land-captains in 1913 and 2604 in 1906 (Central Statistical Committee of the Ministry of Interior Affairs, 1907, 1914). In addition, approval of an exiting application required local land records, including documents on previous repartitions; these records were of poor quality and inhibited an exit (Maksimov, 1999, p. 95). The central government acknowledged the slow pace of approving exit applications and tried to improve it. It opened two-month courses for current local officials in 1908, and employed a career incentive scheme for them (decree of the Ministry of Internal Affairs issued December 30, 1909, and June 14, 1910 Ministry of Internal Affairs 1910, Vol. 1, p. 15; 1912, Vol. 3, p. 106) but without success (Maksimov 1999, p. 96). In particular, the government failed to fire poorly performing officials if they were from noble families or had connections (Dubrovskij, 1963, pp. 167–174).

Similarly, lack of land survey engineers slowed down the consolidation procedure. It was an old problem inherited from the previous decades. The shortage of land engineers had limited land cadastre reforms that was a reason why designers of the land reform associated with the emancipation chose to employ communal instead of individual tenure for emancipated serfs (Davydov 2010, Khristoforov 2011). By the beginning of the Stolypin reform, only one institute of high education and five schools in the whole country prepared land engineers and their assistants. There were only six hundred land engineers in 1906 in Russia (Volkov 1999). The government opened a number of new schools and extended enrollment into the old ones after the start of the reform but the demand for land survey engineers continued to outpace the supply. The number of land survey engineers swelled to

a still meager 3300 in 1914, plus about 7000 assistants (Volkov 1999). The lack of specialists resulted in an average time of consolidation to take up to two years; the procedure was a bit faster for village-wide consolidations because of economies of scale and fewer within-commune disagreements to resolve (Tukavkin 2001).

We employ these supply shifters as exogenous source of variation in the implementation of the reform by constructing instrumental variables. We compute the exit confirmation rate (the ratio of actual exits to the stock of exiting applications) and the consolidation implementation rate (the ratio of actual consolidations, either singular or village-wide or their sum to the annual number of corresponding applications to consolidate).[8] The average exit confirmation rate ratio was only about twenty-one percent and the average consolidation implementation rates were about twenty-eight, thirty-nine and twenty-five percent for all consolidations, village-wide consolidations and singular consolidations, correspondingly. We assume these rates are exogenous to land productivity. They were mainly defined by local supply-related conditions, rather than by household or village characteristics or the policy of the central government. In particular, neither rate is correlated at a statistically significant level with the share of private land in a province, known from the 1905 land census (Central Statistical Committee of the Ministry of Interior Affairs 1907). We should expect the opposite if the central government had some geographical preference in the reform implementation because of its political aim to spread private landholdings.

Our main dependent variable is grain yield per hectare rather than yield per worker or TFP because of data limitations. Our main explanatory variables track the implementation of the land titling and consolidation components of the Stolypin reform, namely number of

[8] We do not use the ratio of actual consolidations to the stock applications to consolidate, like in the case of exit confirmation index, because of a weak instrument problem. Our consolidation implementation indexes could be negative if peasants withdrew more applications than they submitted during a year. Similar, they might be larger than one if there were more actual consolidations than applications to consolidate during a year, i.e., applications from previous years were realized in a scale larger than the new demand for consolidations.

exits from the repartition commune that led to title conversions and the number of land consolidations by type. We employ variables of reform implementation in the current year because we are interested in the short-term effect of the reform. We normalize these variables and our (non-categorical) control variables by lagged area under grain crops. We do not use area under grain crops in a current year because the reform could affect cultivating area.

We use panel data techniques to explore the impact of the Stolypin reform on peasant agriculture and estimate our regression model in first differences with year fixed effects. We employ region specific linear trends as well as repartition province and zemstvo linear trends. We prefer the first difference model rather than panel fixed effects specification to address potential problem of serial correlation in yield levels. To be precise, we estimate the following equation:

$$\Delta\ Yieldperhectare_{it} = \alpha + \beta * \Delta\ Exits_{it} + \Omega * \Delta\ (Consolidations_{it}) + \delta * \Delta\ (Controls_{it}) + (Region_i) + (Year_t) + (Repartition_i) + (Zemstvo_i) + \varepsilon_{it} \quad (1)$$

where subscripts *i* and *t* index provinces and years, respectively. *Yieldperhectare* is the output of grain per hectare; *Exits* and *Consolidations* are variables of the reform implementation measured per hectare. Estimating (1), we cluster standard errors at the province level and compute heteroskedasticity-robust standard errors.

We are mainly interested in exits under the 1906 decree, i.e., excluding exits under the 1910 law from repartition communes that never had an actual repartition, since the latter likely did not change households' property rights. In different specifications, *Consolidations* is either the total number of households that consolidated their plots (per hectare), or contains both types of consolidations separately, singular consolidations per hectare and village-wide consolidations per hectare. We also control for the number of land title specification works per hectare conducted in a province. Our other *controls* are as discussed in the data section – proxies for inputs, access to credit, outside peasant options etc. We account for *Zemstvo* linear trend because of the discussed Zemstvo role in agriculture

promotion. Further, since exits and land privatization were unnecessary in provinces without repartition communes, we add a separate linear trend for these provinces. We employ twelve regional linear trends, $Region_t$ to account for the difference in regional development patterns. Each of twelve regions stands for a group of neighboring provinces. We control for year fixed effects, $Year_i$ to account for macroeconomic indicators.

The primary concern with (1) is potential endogeneity because of selection of various types. We address this problem by taking advantage of the constrained supply of the reform due to red tape and the shortage of land survey engineers, which we discussed above. We employ a 2SLS approach, instrumenting either for number of exits or consolidations with exit confirmation rate and consolidation implementation rate, correspondingly. The first differences specification accounts for any time invariant factors that might be correlated with the confirmation and implementation rate and agricultural productivity in levels, such as the general quality of governance or provincial institutions. Thus, the 2SLS estimates should not suffer from any bias based on selection into the reform or other unobservable factors.

5. Analysis of results

Table 2 reports our baseline results of estimates of the specification in (1). While these results suffer from endogeneity concerns, they provide a useful starting point. We first regress yield per hectare on our measures of exits and consolidations without distinguishing consolidations by type (column 1). According to this specification, the overall changes in land productivity associated with the reform were substantial. One standard deviation increase in exits per hectare (0.019) is associated with eighteen kilograms decrease in land productivity, roughly 2.3 per cent. For consolidations, one standard deviation increase (0.004) is associated with an increase in land productivity of forty-six kilograms or six percent. The estimated coefficients suggest that if one percent of households (123 thousand households or in per hectare terms about 0.0025 households per hectare) exited and then consolidated, there would be an increase in grain yield per hectare of about 3.4 percent. The

net effect associated with the reform implementation – sixteen per cent of exits and ten per cent of consolidations – would then be a thirty-three per cent increase in grain productivity.

Table 2 somewhere here

Most of our controls have intuitive signs. The coefficient of rural density per hectare, a proxy for labor, is positive and significant at the one per cent level. The coefficient on cows per hectare, a proxy for capital, is positive while imprecisely estimated. The coefficient on horses per hectare is negative, a seemingly puzzling result; however, this negative relationship is justified by historical accounts of peasants overinvesting in horses due to market imperfections. Rural wages were higher in provinces where agriculture was more productive. The coefficients on urban share, credit cooperative loans per hectare and other land title specification works per hectare are not statistically different from zero.

In column 2 of table 2, we separate consolidations into singular consolidations and village-wide consolidations. The positive association of consolidations is driven by village-wide consolidations, while the coefficient on singular consolidations is negative but insignificant. We add a control for the total amount of subsidies and grants per hectare that households received from the government as a part of the reform in column 3. The authorities used these payments as an incentive at the margin to influence individual households to participate in the reform. The coefficient is negative, suggesting a progressive transfer, but statistically insignificant (possibly because we have relatively few observations for subsidies).

We address endogeneity and selection concerns using an instrumental variables approach. In table 3, we report the first stage for each reform variable. The coefficients on the instrumental variables have the right signs. Exit confirmation rate was positively associated with actual exits, and actual consolidations of both types as well as their sum were positively correlated with corresponding consolidation implementation rates. F-tests suggest there is enough explanatory power to run the second-stage regressions.

In table 4, we report the second stage results. In the first three columns, we instrument for exits and land consolidations separately and then together. The last three columns instrument for singular and village-wide consolidations separately and then all together with exits in the final column. The instrumented coefficients of the variables of interest are similar in magnitude in all specifications. We discuss the coefficients from column 6 in more detail. The effect of exits and changes in land tenure is negative and significant and increases in magnitude relative to the naïve estimate from table 2. Negative selection does not drive the results for exits. An increase of one standard deviation in exits per hectare leads to a decrease in 0.052 tons per hectare, almost one-fifth of a standard deviation.

A comparison of coefficients on singular and village-wide consolidations from tables 2 and 4 also show evidence of selection. Once selection is taken into account, the coefficient on singular consolidations is positive although insignificant, and the coefficient on village-wide consolidations remains positive, significant and increases in magnitude. One standard deviation increase in the number of households consolidated village-wide leads to an increase in land productivity of one hundred and eighty kilograms or twenty-four per cent. The estimated coefficients confirm the view shared by many officials responsible for the reform, including Stolypin himself, that the final goal of the reform should be land consolidation (Dubrovskij 1963). Officials considered that privatization of separated scattered strips without land consolidation would not overcome the commune's restrictions on production decisions and the coordination costs that they implied. Interestingly, some reformers also had the correct intuition about the superiority of village-wide consolidations over singular ones. Andrei Kofod – a leading official in the Chief Administration of Land Works and one of the initiators of the reform – originally argued that the reform should only allow village-wide consolidations because singular consolidations would be difficult to implement in practice due to ensuing complex relationship between the separator and those who remained in the commune (Tukavkin 2001, Pp. 199-200).

Tables 3 and 4 somewhere here

The difference in the effects of village-wide and singular consolidations suggests that a reduction in transportation costs does not explain the increase in productivity, a view held by many historians (Tukavkin 2001 p. 207, Korelin 2002). Because of the same difference, economies of scale could hardly explain the increase in productivity, especially since the average size of plots in a singular consolidation was larger than an average plot size obtained under village-wide consolidations. We explore the scale effect hypothesis in column 1 of table 5 further. We include the size of an average consolidated plot and the interaction term between the plot size and number of consolidations per hectare. We do not find evidence in support of a general scale effect on land productivity. The coefficients on average consolidated plots are both insignificantly different from zero and the interaction term is even negative.

Table 5 somewhere here

In remaining part of table 5, we provide further evidence that overcoming coordination costs was the dominant channel for increasing land productivity. First, historians have shown that households, who consolidated their land, quickly started to mechanize and shifted to new agricultural techniques in the absence of the commune regulation (Tukavkin 2001, p. 209). To measure changes in mechanization, we regress the inflow of agricultural machines into a province on the lagged reform implementation measures. Reported in column 2, the coefficient on village-wide consolidations is positive and statistically significant. One standard deviation increase in this type of consolidations yields a thirty-five per cent increase in the inflow of agricultural machines in the following year. The magnitude of the effect increases once we instrument for the reform implementation variables (column 3).

To measure changes in agricultural techniques, we construct a concentration index over the four main cereals – computed as Herfindahl index using rye, wheat, oats and barley shares of total area under grain crops – and regress this index on the reform variables.

Reported in column 4, all coefficients on the reform implementation measures are positive, and the coefficient on exits reaches statistical significance at the one percent level. The instrumental variables estimates (column 5) show that these associations are not robust, although the coefficient on village-wide consolidations is positive. If we allow for the effect to vary by the scale of the consolidate plot (column 6), both types of consolidations are positively correlated with higher grain concentration indices for provinces with larger consolidated plots on average, and the coefficient on village-wide consolidations is statistically different from zero at the ten per cent level. These results fit the idea that a decrease in coordination costs leads to more specialization when the benefits of specialization are high enough. Positive coefficients on plot size (especially statistically significant coefficient on singular consolidations) suggest that direct scale effect also contributed to specialization.

Finally, in table 6, we explore whether transaction costs, specifically, the implementation costs of the Stolypin reform, influenced the observed differences in land productivity. We explore the effects of implementation costs with respect to consolidations in the first three columns and then in respect to exits in the last free columns. In column 1 we add the amount of complaints on consolidation decisions per hectare as a proxy for the costs of implemented consolidations. Because of higher potential returns to complaints in more productive areas, the positive and significant coefficient on this variable may reflect a reverse association. Importantly, however, the inclusion of the complaints variable does not alter the coefficients on the reform implementation measures. We add interactions of complaints with consolidation measures in the next column (column 2). The coefficient on singular consolidation is not negative anymore, while statistically insignificant; and the coefficient on village-wide consolidations remains positive and highly significant. Thus, once we account for complaints, the difference in the coefficients on village-wide and singular consolidations remains. The coefficients on the interaction terms are negative and statistically significant giving some evidence that worse implementation of the reform

depressed the gains to productivity. Consolidations that were accompanied by a large number of complaints are less positively correlated with land productivity.

Table 6 somewhere here

Historians (Pallot 1999) argue that the larger part of tensions within the Russian village during the Stolypin reform was unobservable to the authorities. We use changes in the legislation to try to account for these "weapons of the weak" as another type of implementation costs. The 1911 law allowed consolidating non-arable commune resources and prevented the commune to block access to communal forests, pasture etc. In column 3 of table 6, we allow the effects of consolidations to vary by time periods, before and after the 1911 adjustment in legislation. The negative effect of singular consolidations comes from the earlier period of the reform; the coefficient for the later years is positive but imprecisely estimated. This evidence supports the hypothesis that peasant resistance to the reform worked against the benefits of the reform and were an important type of costs associated with implementation of the reform. For both periods, the coefficients on the village-wide consolidations are positive and statistically significant. The difference in the effects of singular and village-wide consolidations remains after 1911 and provides further evidence of the importance of coordination costs.

In the last three columns of table 6, we investigate the hypothesis that transaction costs associated with the implementation of the reform explain the negative relationship between exits and land productivity. Indeed, privatizing land by exiting the commune was costly and could have negatively impacted agricultural productivity temporarily because peasants faced financial and time constraints. To explore this possible channel, we distinguish between exits under the 1906 decree and under the special exit procedure allowed for repartition communes that did not have a repartition since the emancipation (made possible only under the 1910 law). Implementation costs were lower in repartition communes without actual repartitions since there were no land transfers within the commune to complicate the tracing of claims to land. Column 4 shows that 1906 exits variable has a

negative coefficient as before, while the no repartition exits variable has a positive one. The switch in sign is generally consistent with the implementation costs explanation, although both coefficients are imprecisely estimated.

The reform had another built-in feature, which created variation in the transaction costs of exiting. After the 1910 decree, transaction costs decreased for all types of exits in the commune, both with and without actual repartitions, so we can test the hypothesis that transaction costs associated with the implementation of the reform explain the negative effect of exits under 1906 decree by focusing on exits before 1910. Column 5 reports that exits before 1910 fully explain the negative effect that we observe. Finally, in column 6, we include lagged exits to see if the negative effect is merely temporary as one would expect. The coefficient on the lagged share of exits is positive but insignificant, supporting the temporary nature of the negative effect of exiting. To summarize, we find some weak evidence to confirm that transaction costs associated with the implementation of the Stolypin reform explain the negative effect. However, due to poor data on inputs, we cannot rule out that exiting households decreased land and labor inputs on the farm as an explanation of the negative effect.

5. Sensitivity tests

We conducted several sensitivity tests to understand how robust our findings are to alternative specifications, measurement issues and sub-samples.[9] First, we construct a pseudo-TFP measure using a reduced-form approach and explore the effect of the reform on this measure.[10] For the baseline specification, we find similar results. The coefficient on share of exits is negative but not statistically different from zero. The coefficient on the share of village-wide consolidations is positive and significant, and the coefficient on

[9] We do not report results here to economies of space. They are available from the authors by request.

[10] Specifically, we regress in first differences yield taken in logs on area under crops, rural population, cows, horses, rural wage – all six taken in logs – regional trends, repartition province and zemstvo trends and time period dummies. Then, we take the residuals as a pseudo-TFP measure, which we regress on the differenced reform variables in per capita terms, repartition province trend and period effects.

singular consolidations is negative and statistically significant. Second, we introduce rural population as a proxy for labor inputs and estimate whether labor productivity was affected by the reform. Our main result on the effect of village-wide consolidations holds. Third, we replace our main measure of exits (per hectare) by a sum of exits and exits in no repartition communes that became possible under the 1910 law (also measured per hectare) and repeat out analysis. The negative effect for exits holds. Finally, we check whether dropping the Baltic provinces, where there were no communes and the Stolypin reform did not apply, affects our results and it does not.

6. Conclusion

We find a large, positive impact of the Stolypin reform on agricultural productivity, reestablishing a pessimistic view on the impact of the commune. We provide evidence that the commune's open field system of agricultural production depressed agricultural productivity. The reform radically changed the coordination costs of agricultural production, allowing peasant farmers greater de jure and de facto independence to make changes in production decisions. Importantly, these results are consistent with a view of the commune as a flexible institution, adjusting to economic changes and peasants' demands *within* a particular crop-production activity. Indeed, studies have shown that the commune had substitutes for factor markets and peasants were able to respond to explicit and implicit prices (Gregory 1980, Nafziger 2010, Castañeda Dower and Markevich 2016). However, our results demonstrate that the restrictive land rights imposed by the commune severely limited rural households' production functions in general. The institution of the commune did not provide enough flexibility to allow farmers to coordinate changes in their production plans once more intensive, specialized or alternative methods of production became profitable.

These results are one step toward bringing the underrepresented Russian case to the debate on the economic impact of enclosure. A comparative study would provide an

excellent opportunity to better understand the role of institutions in establishing the effects of the technology of the open-field system on development.

We can also speculate about a widespread criticism of the reform that, by increasing the level of conflicts, it led the Russian countryside on a path towards revolution. We do observe some evidence that the implementation costs of the reform indeed moderated the positive effect of the reform. However, to what extent the reform itself contributed to an increase in conflicts and tensions in the Russian countryside and how this affected the 1917 revolution are questions, which require further research. At the same time, since we find an overall positive impact on productivity of peasant farms, welfare of an average household most likely increased as a result of the reform. Had the reform been fully implemented, perhaps the general increase in welfare would have diminished popular support for revolution. On the other hand, the average increase could be accompanied by an increase in income polarization in the countryside, invigorating the call for revolution.

Beyond these historical debates, our results contribute to the literature on property rights and agricultural development (Deininger and Feder 2009). Coordination costs operate as de facto restrictions on usage rights, a neglected aspect of property rights in this literature.[11] Our results give further evidence that property rights matter for agricultural production beyond simply their impact on tenure security or asset transferability (Besley 1995). Even though the commune was successful at governing certain types of agricultural production, an unintended consequence of this mode of governance was the imposition of barriers to change in production techniques and crop specialization.

[11] One exception is Markussen et al. (2011), who show that restrictions on usage rights are indeed binding and result in inefficiencies for commune farm production in modern Vietnam.

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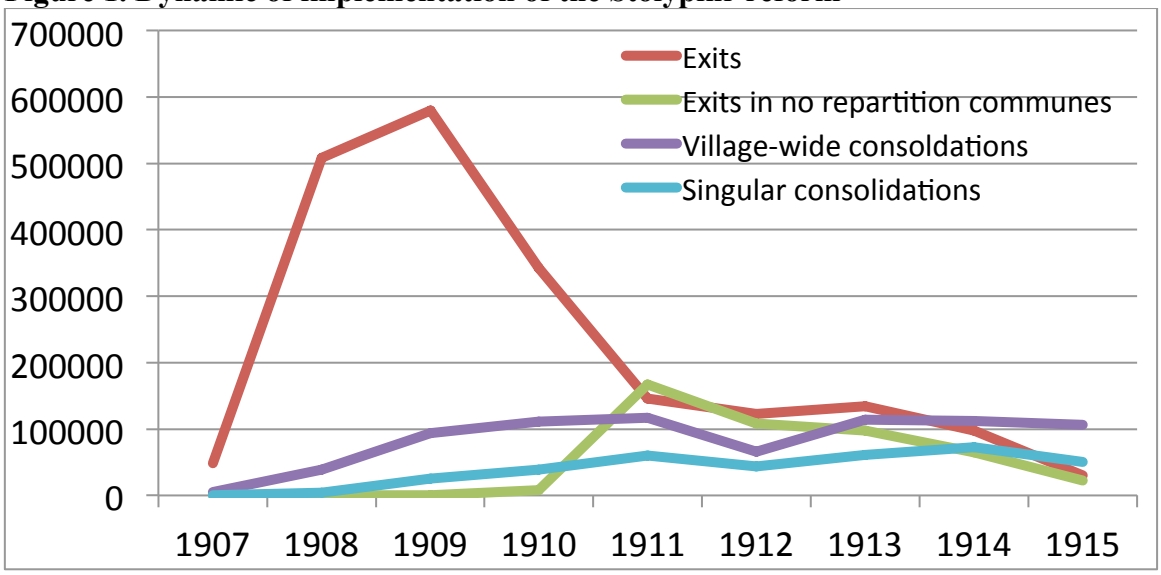
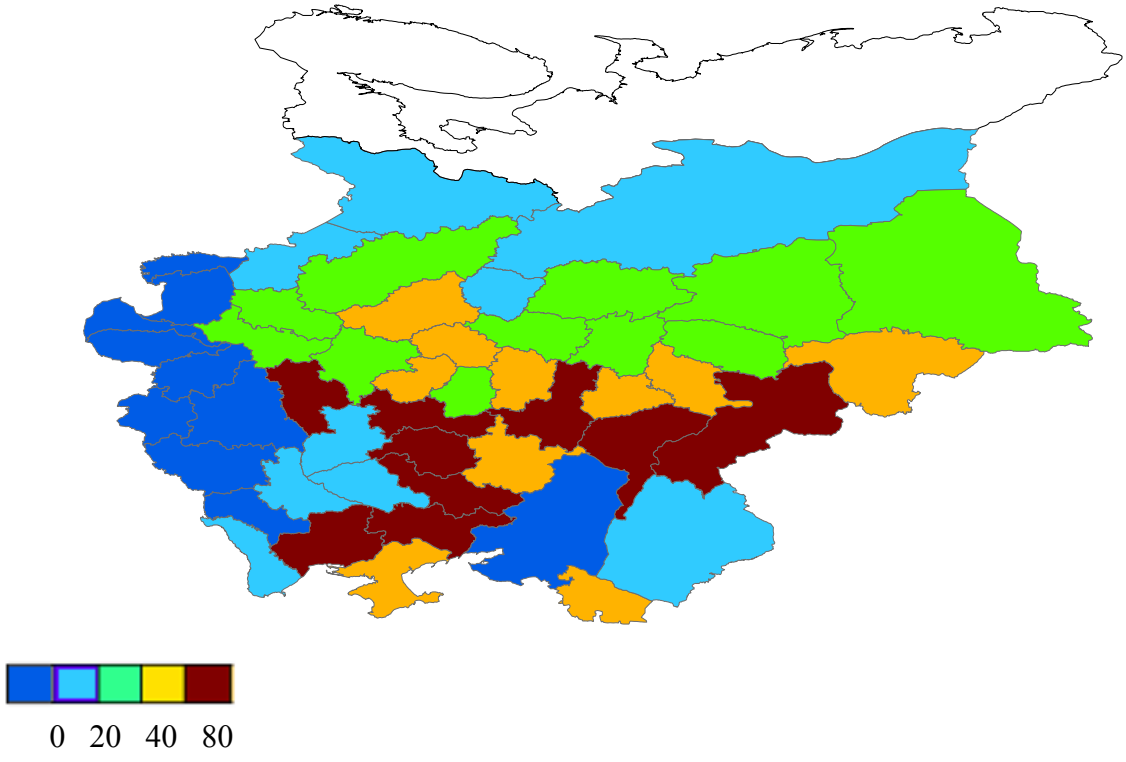
Figure 1. Dynamic of implementation of the Stolypinr reform



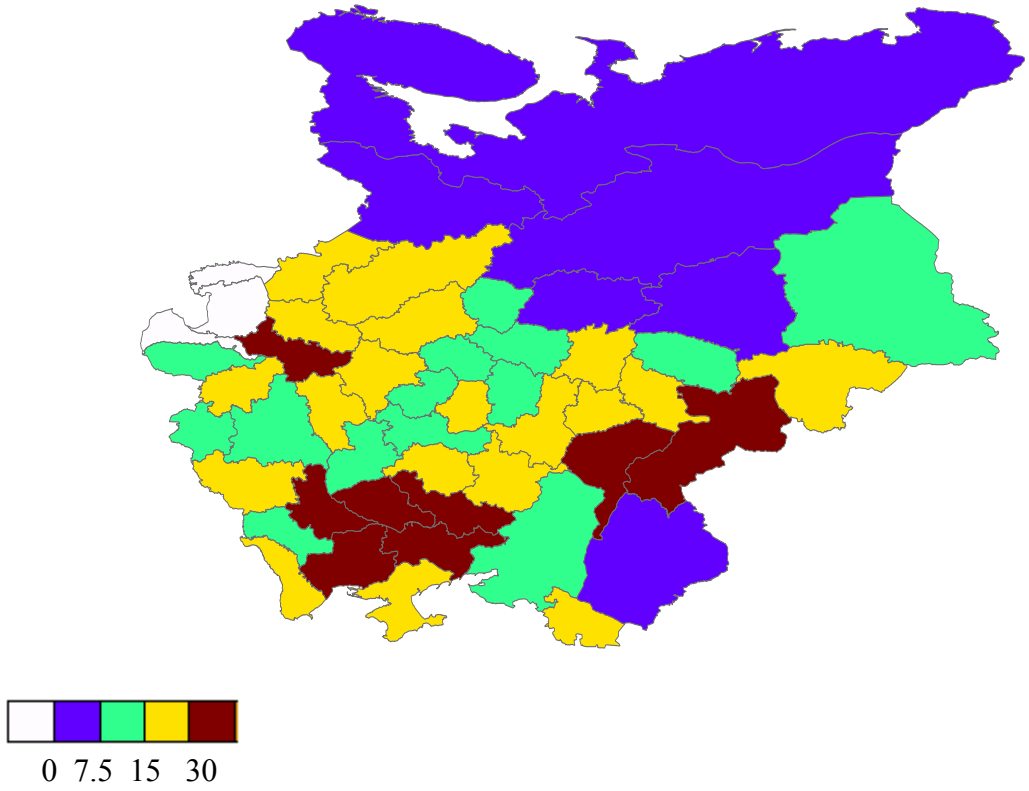
Sources: *Dubrovksy (1963);* Annual reports of the chief administration of agriculture and land engineering (Various titles and years).

Figure 2. Distribution of exits over space



Note: Exits are in thousands of households. Dark blue provinces are provinces with zero exits from repartition commune. There were either no communes there (three Baltic provinces), either all peasants belonged to hereditary communes (provinces in the west of the Empire) or Cossack land tenure dominated (Don province in the south). There is no data for Archangelsk province in the North that is left blank.

Figure 3. Distribution of consolidations of all types over space.



Note: Consolidations are in thousands of households. Three Baltic provinces with zero consolidations because of the lack of the commune are in white.

Table 1. Summary statistics

Variable	Mean	Std. Dev.	Min	Max	N
Peasant grain yield, tons per hectare	0.767	0.274	0.069	1.6103	360
Peasant area under grain crops, hectares	981000	768000	174000	5430000	360
Grain area Herfindahl index	0.456	0.108	0.268	0.914	360
Total Population, thousands	2427.77	881.15	708.70	4792.5	360
Rural density per square km	45.73	22.28	4.55	114.03	360
Number of cows per hectare	0.915	0.529	0.150	5.2969	360
Number of horses per hectare	0.557	0.218	0.060	1.9972	360
Amount of small credit loans per hectare, rubles	0.002	0.004	0	0.025	357
Rural daily wage in harvest season, kopeks	96.24	30.15	45	234	354
Urban share	0.126	0.118	0.006	0.743	360
Migrants per hectare	0.001	0.002	0	0.019	357
Local self-government dummy (zemstvo)	0.733	0.443	0	1	360
Repartition province dummy	0.8	0.4	0	1	45
Number of hhs exited per hectare	0.007	0.019	0	0.264	358
Number of hhs exited per hectare in no repartition communes	0.002	0.004	0	0.042	324
Number of hhs consolidated land per hectare (total)	0.0027	0.0040	-0.0018	0.0262	360
Number of hhs consolidated land per hectare in a village-wide manner	0.0019	0.0035	-0.0018	0.0229	360
Number of hhs consolidated land per hectare individually	0.0007	0.0012	0	0.006	360
Number of hhs participated in other land title specifications works per hectare	0.003	0.006	-0.006	0.054	360
Reform subsidies and grants per hectare, rubles	0.376	0.666	0	5.0076	342
Average size of consolidated plot, hectares	5.855	6.441	-5.499	30.895	360
Exit confirmation rate	0.167	0.218	0	0.980	358
Consolidation implementation rate	0.237	0.281	-0.152	2.432	360
Village-wide consolidation implementation rate	0.269	0.392	-0.273	3.597	360
Singular consolidation implementation rate	0.173	0.248	0	1.293	360
Complaints on consolidation decisions per hectare	0.0018	0.003	0	0.027	360

Table 2. The effect of exits and consolidations on agricultural grain productivity

Dependent Variable=	Grain Yield per Hectare First Differences		
	(1)	(2)	(3)
Exits per hectare	-0.951**	-1.067**	-1.114**
	[0.398]	[0.409]	[0.450]
Consolidations per hectare	11.533***		
	[4.263]		
Village-wide consolidations per hectare		16.335***	17.879***
		[5.330]	[5.898]
Singular consolidations per hectare		-25.132	-24.226
		[16.197]	[16.404]
Other land title specification works per hectare	-2.171	-1.121	-1.187
	[3.036]	[2.723]	[2.617]
Rural Density	0.008***	0.008***	0.009***
	[0.002]	[0.002]	[0.002]
Cows	0.085	0.086	-0.002
	[0.057]	[0.060]	[0.128]
Horses	-0.184	-0.184	-0.029
	[0.136]	[0.143]	[0.202]
Rural wage	0.003***	0.003***	0.003***
	[0.001]	[0.001]	[0.001]
Urban Share	0.482	0.627	0.884
	[1.177]	[1.164]	[1.270]
Small credit loans per hectare	-3.866	-5.554	-6.471
	[5.488]	[3.990]	[4.144]
Subsidies and grants per hectare			-0.016
			[0.020]
Regional Trends	Yes	Yes	Yes
Repartition Province and Zemstvo Trends	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes
Observations	296	296	280
R-squared	0.411	0.426	0.426

The dependent variable is peasant grain one of the reform variables, exits or consolidations per hectare. The estimation is performed using first differences. Cows and horses are in hundreds per hectare units. Clustered-robust standard errors are in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 3. First-stage Results

Dependent Variable=	Exits Per hectare	Consolidations per hectare	Village-wide consolidations per hectare	Singular consolidations per hectare
	First Differences			
	(1)	(2)	(3)	(4)
Exits confirmation rate	0.080***			
	[0.023]			
Consolidation implementation rate		0.005***		
		[0.001]		
Village-wide consolidation implementation rate			0.001***	
			[0.000]	
Singular consolidation implementation rate				0.002***
				[0.001]
Exits per hectare		0.028***	0.026***	0.001
		[0.008]	[0.007]	[0.001]
Consolidations per hectare	2.087			
	[1.896]			
Village-wide consolidations per hectare				0.004
				[0.019]
Singular consolidation per hectare			-0.043	
			[0.183]	
Controls	Yes	Yes	Yes	Yes
Regional Trends	Yes	Yes	Yes	Yes
Repartition Province and Zemstvo Trends	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes
F-stat of excluded instrument	11.83	23.91	9.70	12.09
Observations	295	296	296	296
R-squared	0.527	0.606	0.467	0.459

The dependent variable is one of the reform variables, exits or consolidations per hectare. The estimation is performed using first differences. The basic set of control variables contains rural population density, the number of credit cooperatives per hectare, cows (hundreds per hectare), horses (hundreds per hectare), urban share of the population and land title specification works per hectare. Clustered-robust standard errors are in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 4. IV Estimates of the effect of exits and consolidations on agricultural grain productivity

Dependent Variable=	Grain yield per hectare First Differences					
	(1)	(2)	(3)	(4)	(5)	(6)
Exits per hectare	-1.987**	-1.372***	-2.238**	-2.079***	-1.067***	-2.733**
	[0.958]	[0.430]	[1.024]	[0.674]	[0.360]	[1.205]
Consolidations per hectare	14.158***	27.608**	26.953**			
	[5.124]	[12.893]	[12.716]			
Village-wide consolidations per hectare				55.464**	16.084***	52.072**
				[22.293]	[4.901]	[22.228]
Singular consolidations per hectare				-27.708*	7.723	0.446
				[15.077]	[28.378]	[32.169]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Regional Trends	Yes	Yes	Yes	Yes	Yes	Yes
Repartition Province and Zemstvo Trends	Yes	Yes	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	295	296	295	296	296	295
R-squared	0.402	0.387	0.382	0.304	0.416	0.312

The dependent variable is peasant grain yield per hectare. The estimation is two-stage least squares performed using first differences. The basic set of control variables contains rural population density, the number of credit cooperatives per hectare, cows (hundreds per hectare), horses (hundreds per hectare), urban share of the population and land title specification works per hectare. Clustered-robust standard errors are in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 5. Land consolidations and coordination costs

Dependent Variable=	Grain Yield per Hectare	Inflow of Agricultural Machines per Hectare		Grain Area Herfindahl Index		
		First Differences	IVFD	First Differences	IVFD	First Differences
	(1)	(2)	(3)	(4)	(5)	(6)
Exits per hectare	-0.975**					
	[0.417]					
Consolidations per hectare	10.384					
	[8.891]					
Avg. size of consolidated plot	-0.001					
	[0.004]					
Avg. Size*Consolidations per hectare	0.151					
	[0.818]					
Lagged Exits per hectare		-0.009*	0.001			
		[0.005]	[0.013]			
Lagged village-wide consolidations per hectare		0.342***	0.553***			
		[0.100]	[0.202]			
Lagged singular consolidations per hectare		-0.064	-0.206			
		[0.224]	[0.412]			
Exits per hectare				0.129***	-0.083	0.104***
				[0.031]	[0.160]	[0.026]
Village-wide consolidations per hectare				0.523	7.592	-1.019
				[0.359]	[5.513]	[0.816]
Singular consolidations per hectare				0.570	-0.974	-0.688
				[1.090]	[3.055]	[2.875]
Avg. size of village-wide consolidated plot* village-wide consolidations per hectare						0.188*
						[0.098]
Av. size of singular consolidated plot* singular consolidations per hectare						0.062
						[0.327]
Av. size of singular consolidated plot						0.000*
						[0.000]
Av. size of village-wide consolidated plot						0.000
						[0.000]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Regional Trends	Yes	Yes	Yes	Yes	Yes	Yes
Repartition Province and Zemstvo Trends	Yes	Yes	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes
Lagged Ag. Machines	No	Yes	Yes	No	No	No
Observations	296	210	209	296	295	296
R-squared	0.411	0.928	0.915	0.168	-0.096	0.175

The dependent variable in column 1 is grain yield per hectare. In columns 2 and 3, it is the inflow of agricultural machines by railways per hectare. In columns 4, 5 and 6, the dependent variable is a Herfindahl index, computed using the share of total area under grain crops by grain crop. The estimation is performed using first differences. The basic set of control variables contains rural population density, the number of credit cooperatives per hectare, cows (hundreds per hectare), horses (hundreds per hectare), urban share of the population, and land title specification works per hectare. Clustered-robust standard errors are in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 6. Land consolidations, exits and implementation costs

Dependent Variable=	Grain Yield per Hectare					
	(1)	(2)	(3)	(4)	(5)	(6)
Exits per hectare	-1.044**	-1.126**	-1.040**	-0.452		-0.902***
	[0.428]	[0.433]	[0.401]	[0.461]		[0.310]
Consolidations per hectare				5.506	11.307**	12.613**
				[3.753]	[4.507]	[4.815]
Village-wide consolidations per hectare	14.172***	15.733***				
	[5.191]	[5.819]				
Singular consolidations per hectare	-27.821*	1.138				
	[16.276]	[24.948]				
Complaints on consolidations per hectare	8.429**	22.7***				
	[3.514]	[5.174]				
Complaints on consolidations per hectare* village-wide consolidations per hectare		-876.0**				
		[426.008]				
Complaints on consolidations per hectare *singular consolidations per hectare		-7,386.9***				
		[2,284.390]				
Singular consolidations per hectare pre 1911			-41.381**			
			[16.231]			
Singular consolidation per hectare post 1912			5.269			
			[23.556]			
Village-wide consolidations per hectare pre 1912			17.756***			
			[5.116]			
Village-wide consolidations per hectare post 1912			8.645*			
			[5.056]			
Exits per hectare in no repartition communes				6.266		
				[3.864]		
Exits per hectare post-1910					-0.120	
					[2.744]	
Exits per hectare pre-1910					-0.948**	
					[0.404]	
Lagged Exits per hectare						0.309
						[0.458]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Regional Trends	Yes	Yes	Yes	Yes	Yes	Yes
Repartition Province and Zemstvo Trends	Yes	Yes	Yes	Yes	Yes	Yes
Period Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	296	296	296	238	306	259
R-squared	0.433	0.450	0.443	0.447	0.407	0.436

The dependent variable is peasant grain yield per hectare. The estimation is performed using first differences. The basic set of control variables contains rural population density, the number of credit cooperatives per hectare, cows per hectare, horses per hectare, urban share of the population and land title specification works per hectare. Clustered-robust standard errors are in brackets. *** p<0.01, ** p<0.05, * p<0.1

Appendix.
Table A1. Data sources.

Variable name	Variable definition	Source
Exits	Number of households exited the commune under the 1906 decree	Ministry of Internal Affairs (1908-1914)
Exits in no repartition communes	Number of households exited the commune under the 1910 law (in communes without actual repartitions)	
Singular consolidations	Number of households consolidated land individually	Chief Administration of Agriculture and Land Engineering (1908-1914)
Village-wide consolidations	Number of households that consolidated land when every member of the commune consolidated in unison	
Consolidations	Number of households that consolidated land either in individual or village-wide manner	
Subsidies and loans	Amount of subsidies and loans provided to peasants that consolidated land	
Average size of consolidated plot	Average size of individually consolidated plot	
Complaints on consolidations	Peasant complaints on consolidation decisions	
Exit confirmation rate	Ratio of actual exits to the stock of exiting applications	Ministry of Internal Affairs (1908-1914)
Consolidations implementation rate	Ratio of actual consolidations to the annual number of applications to consolidate	Chief Administration of Agriculture and Land Engineering (1908-1914).
Grain yield	A total yield of rye, wheat, barley and oats	Central Statistical Agency of the USSR(1928)
Grain area	Area under four cereals – rye, wheat, barley and oats	
Population	Population on January, 1st of each year	Central Statistical Committee of the Ministry of Interior Affaires (1905–1916)
Urban share	Share of urban population	
Horses	Number of horses	
Cows	Number of cows	
Zemstvo dummy	Dummy equaled one for provinces with self-elected local governments	
Repartition dummy	Dummy equaled one for provinces with at least five percent of repartition communes share	Durbrovskij (1963)
Inflow of agricultural machines	Agricultural machines supplied to a province by railroads	Davydov (2010)
Rural wage	Daily earnings of rural workers in harvest season	Ministry of Agriculture (1906-1914)
Rural credit supply	Amount of small credit loans	Department of Small Credit (1905-1915)
Migrants	Number of migrant families moved to Siberia	Turchaninov N. (1910, 1915)

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