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Labor Misallocation and Mass Mobilization: Russian Agriculture during the Great War

Paul Castaneda Dower
Andrei Markevich

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Paul Castañeda Dower,[a] Florida International University

Andrei Markevich, New Economic School

Abstract:

We exploit a quasi-natural experiment of military draftees in Russia during World War I to examine the effects of a massive, negative labor shock on agricultural production. Employing a novel district-level panel dataset, we find that mass mobilization produces a dramatic decrease in cultivated area. Surprisingly, farms with communal land tenure exhibit greater resilience to the labor shock than private farms. The resilience stems from peasants reallocating labor in favor of the commune because of the increased attractiveness of its nonmarket access to land and social insurance. Our results support an institutional explanation of factor misallocation in agriculture.

Keywords: factor misallocation; agricultural production; mass mobilization; World War I; Russia

JEL Codes: D24, N44, N54 O12, O17, O20

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[a] Corresponding Author: Paul Castañeda Dower, Economics Department, 11200 SW 8th Street Miami, Florida 33199. Email: pdower@fiu.edu; Tel. (305) 348-1070; Fax. (305) 348-1524. We would like to thank the editor, three anonymous referees, Güneş Gokmen, Paul Gregory, Avner Greif, Sergei Guriev, Mark Harrison, Steve Nafziger, Yannay Spitzer and Gavin Wright. We thank Evgenii Pavlov, Evgenia Kuptsova, Olga Pavlenko and Vasiliy Rusanov for excellent research assistance. Andrei Markevich thanks the Hoover Institution for generous hospitality.

Introduction

Several generations of development theories, including the celebrated Lewis model (Lewis 1954), consider persistent labor misallocation in the agricultural sector as one of the main impediments to economic growth. Indeed, in many developing economies, agriculture possesses a large share of labor but makes a less than proportionate contribution to aggregate output (Gollin et al. 2014). A principal policy implication of this view is that a coordinated reallocation of labor from traditional farms to modern firms would initiate an economic takeoff (Murphy et al. 1989, Rosenstein-Rodan 1943, Sah and Stiglitz 1984). Notable yet controversial historical examples of this development strategy are Stalin's industrialization of the Soviet Union, the Second Five Year Plan in India, and Ataturk's *etatisme* years in Turkey.

Despite extensive theoretical and policy attention, we find little rigorous empirical evidence regarding the economic impact of large-scale labor reallocation. In particular, what is the short-run impact on the traditional sector? This information is crucial for social welfare analysis and assessing popular support for the reform. To address this gap in the literature, we use the mobilization of Russian military draftees, of which the majority were rural peasants, during the First World War as a quasi-natural experiment on the short-run consequences of a massive negative labor shock for agricultural production.

Late Imperial Russia is a classic underdeveloped economy, characterized by an agricultural sector that employed over seventy percent of the workforce but produced less than half of aggregate output (Davies 1990; Markevich and Harrison 2011). A novel aspect of our analysis is to exploit the particularly rich institutional environment of the Russian Empire. Traditional farms governed by communal land tenure coexisted side-by-side farms with private tenure. The historical literature provides evidence that, ceteris paribus, private farms were relatively more

productive than commune farms (Gatrell 1986) and both historical and modern accounts blame the institution of the commune for the backwardness of Russian agriculture (Gerschenkron 1965; Acemoglu and Robinson 2012). The commune restricted property rights to land, distorting individual incentives. These same restrictions enabled the commune to ensure access to land to its members, providing social insurance. In contrast, private farms did not face such restrictions and relied on markets for insurance. Private farms managed one quarter of the cultivated grain area in an average district before the war. This share varied considerably across districts, from zero to ninety-six percent, granting an opportunity to examine how institutional frictions mediate responses to labor shocks in detail.

Employing a newly constructed district-level panel dataset on agricultural production before and during the war, we relate the cultivated area of wheat, rye, oat and barley grain crops, our measure of agricultural output, to changes in gender imbalance between 1913 and 1916. These changes were largely driven by the mobilization of about twelve million males into the army (Golovin 2001), but were also affected by other war-related changes in population composition, like flows of military prisoners and wartime refugees. The number of draftees varied substantially across districts because of the realization of complex pre-determined mobilization laws (Anfimov 1962; Sidorov 1973; Golovin 2001). Since the war held "fixed" the supply of most other productive factors, such as agricultural machines, we can attribute changes in output to changes in labor inputs. The panel structure of our data permits us to enrich the difference-in-differences approach with district-specific time trends and to account for unobservable district-level time-invariant factors that vary by farm-type.

We find that mass mobilization greatly decreases cultivated grain area in the short-run. On average, the removal of one percent of the labor force decreases a district's grain-cropped area

by around three percent and the removal of a marginal worker from a district would result in a yearly loss of 296 rubles, roughly four times the subsistence level. This large response is not explained by an inability of farms to adjust to labor removal.[1] Historical accounts describe active labor and land rental markets, in addition to the commune's allocation mechanisms, both before and during the war (Kondratiev 1922, Anfimov 1962).

Disaggregating the effect by farm type, we find that the grain-cultivated area of communal farms surprisingly responds less than private farms to the removal of labor. The mobilization of one percent of the district-wide labor force leads to only a 0.7 percent decrease in grain output by commune farms compared to a 5.1 percent decrease on private farms. We would expect private farms, as the more efficient farms, to have reduced output less, unless there were important institutional frictions.

We submit evidence that nonmarket access to land and the social insurance of the commune were prominent factors explaining the divergence between farm-types during the war. These institutional features redirected peasant labor back to the commune in response to mobilization, enabling the resilience of the commune. We show that commune resilience is greater in districts where peasant labor had better access to the private sector before mobilization. Next, we show that the resilience of the commune is inhibited by the 1906 Stolypin agrarian reform, which partially dismantled the commune's control over property rights. Finally, we establish that commune farms increased rye production, the crop largely consumed by peasants (Kondratiev 1922), relative to the production of market grain and this increase is magnified in districts where peasants had better nonmarket access to land. The resilience of commune farm production to

[1] Sen (1967) directed this criticism against Schultz's (1964) analysis of massive labor removal.

mobilization highlights an underappreciated benefit of the commune for Russian peasants, namely its social insurance.

Even though we study a short-run effect, we argue that these institutional frictions would also have had important effects on the allocation of resources before the war and, hence, our findings illuminate the persistent nature of low productivity in agriculture. As Banerjee and Moll (2010) show, a persistent productivity shock, such as the nonmarket allocation of land, is necessary for a long-run equilibrium to feature misallocation. Under the magnifying glass of mass mobilization, we demonstrate that the commune did not serve as a labor supplier when "industrial" jobs opened up and factor prices should have pushed labor out of the commune. Under more normal economic conditions, the influence of nonmarket access to land on the opportunity cost of commune land likely would have similarly affected peasants' valuation of low productivity projects, such as subsistence production, making them more desirable than optimal.

Next, we subject our quasi-experimental approach to a more thorough examination. First, we run a placebo test by allowing mobilization to occur before it actually happened. Second, we control for temperature and rainfall, since these are time-varying factors that could be correlated with mass mobilization and affect output. Third, to alleviate concerns about measurement error, other omitted variables and potential endogeneity, we construct a predicted mobilization variable using distance to the nearest military recruitment centers. Fourth, we address attrition bias in the presence of selection on observables.

While these robustness checks strengthen our evidence, several threats to identification remain. First, the war economy produced an additional factor input shock. The military conscripted 2.6 million horses (Anfimov 1962 p. 196) and any correlation between these two input shocks could bias our estimates. We find the effect of mobilization is unaffected by the

inclusion of horse mobilization. During the war, the supply of female labor could also have changed. We rely on stylized facts that the amount of female labor in agriculture did not substantially change during the war. Second, the war produced a shock to market demand. Our econometric exercise accommodates aggregate demand shocks and, in the online appendix, we examine the robustness of the results to local demand shocks. Third, since our main dependent variable, cultivated area, does not capture changes in labor inputs per plot, we explore in the online appendix the effect of mobilization using data on yields, which are of worse quality. Fourth, we provide additional evidence in the online appendix that peasants responded rationally to changes in the market environment and the price of labor.

Our results have profound implications for Russian economic development as well as for the broader development literature. First, by affecting the supply of agricultural output to the market, peasants' decision to return to subsistence production reaffirms the First World War and the commune as mutual determinants of food shortages in urban areas, a major driving force of the Russian Revolution (Kondratiev 1922). Second, agriculture's short-run response to labor reallocation is a key factor in justifying or criticizing Stalin's industrialization as a development strategy. Robert Allen's influential interpretation of Stalin's industrialization hinges on viewing collectivization as a massive reallocation of labor from the countryside without causing a fall in agricultural output (Allen 2003). Our finding of a decrease in output indicates that Stalin's industrialization imposed significant short-run costs on the Soviet economy, consistent with the findings in Cheremukhin et al. (2016). Finally, our findings point to the importance of a social insurance substitute for subsistence agriculture on the path toward structural transformation.

2. Previous literature.

Modern empirical estimates indicate large potential returns of labor reallocation from agriculture to manufacturing. Vollrath (2009) reports that between thirty and forty percent of variation in income per capita across the globe is due to factor misallocation. The literature usually emphasizes spatial misallocation due to various market imperfections such as transportation costs. Closer to our analysis, Hayashi and Prescott (2008) identify a cultural barrier to labor mobility out of the agricultural sector and explore how its removal explains post-WWII Japanese economic development. Brandt et al. (2013) also demonstrate that institutional factors can generate sizeable effects on aggregate productivity in China's non-agricultural sector.

Most of the recent firm-level evidence on factor misallocation comes from within-sector dispersion in firms' returns to capital and does not speak directly to labor misallocation in agriculture and its consequences for underdevelopment (Banerjee and Duflo 2005, Hseih and Klenow 2009). Those papers that specifically focus on factor misallocation in agriculture (Adamopolous and Restuccia 2014; Foster and Rosenzweig 2010) choose to examine the differential returns to land rather than to labor. Our findings complement these papers by showing the dependence of labor misallocation on institutional frictions in land markets.

Acemoglu et al. (2004) also use the military draft as an exogenous source of variation in labor supply during the Second World War to identify the labor supply impact on female wages in the US. The US economy in the 1940s, having already passed through its agricultural transition and with female labor primarily engaged in household production before the war, is not well suited for our research question.

The theoretical literature on factor misallocation provides some justification for why we would observe labor misallocation in the Russian countryside and why it would persist. Banerjee and Moll (2010) argue that frictions in land markets are natural candidates for causing persistent

misallocation. In addition, Restuccia and Rogerson (2008) show that permanently fixed taxes need to be strongly positively correlated with firm-specific productivity to get large effects from misallocation. In the commune, where the tax burden was shared, this avenue was also possible.

The coexistence of private and commune farms evokes a dualistic view on Russian agriculture, and there is a small industry of papers devoted to test various aspects of dualistic models versus the neoclassical counterpart (Rosenzweig 1980). The usual presentation of dual sectors as a modern, technologically superior, sector juxtaposed to a traditional one, could misrepresent the relative value of the traditional sector. In our case, even those households who made the transition to the modern sector may still prefer the traditional sector in some circumstances, an insight that goes back to Harris and Todaro (1970).

3. Historical Background: Russian Agriculture before and during the First World War

Agriculture was the largest sector of the Russian economy before the First World War, accounting for 8.3 billion rubles or 44 percent of national income in 1913 (Markevich and Harrison 2011) and employing an even larger share of workers, up to 72 percent of the gainfully employed population (Davies 1990). The average productivity of labor was only 109 rubles in agriculture, compared to 742 rubles in industry. Assuming sector-specific Cobb-Douglas aggregate production functions, the agricultural productivity gap was 6.8. This factor of seven corresponds to the upper end of modern assessments for developing countries (Gollin et al. 2014), consistent with the common belief that too many people were involved in land cultivation.

The dominant view blames the institution of the commune, and the most widespread type of the commune – the repartition commune – in particular, for this productivity gap (Gerschenkron 1965). The repartition commune held title on land and could reallocate arable plots between member-households under a two-thirds majority. Restrictive land rights in repartition communes

diminished out-migration even when the potential returns were high (Chernina et al. 2014) and likely distorted other individual choices (see section A1 of the online appendix for more details). Castañeda Dower and Markevich (2016) have shown that restrictive property rights depressed agricultural productivity; however, Nafziger (2010) argues that repartitions functioned as a market surrogate, mitigating the potential misallocation of resources. In general, communes of all types exercised considerable power to regulate agricultural production as well as guaranteed access to land through nonmarket allocation.

Private landowners did not face restrictions on rights over their land. Private farms were less credit constrained and had larger plots than peasants in the commune, and hence were in a better position to mechanize and take advantage of economies of scale (Anfimov 1962). Private landowners would either farm their land, hiring labor from peasant communes, or rent their land out to industrious peasants. The private farm functioned as an outside option for both members and deserters of the peasant commune. The flow of labor between private and commune farms occurred largely within districts (Anfimov 1961) and the cross-district migration rate was low (Trojnitskij 1900-1910).

The 1906 Stolypin agrarian reform aimed to transform the role of the commune by granting peasants the right to privatize the arable plots that they cultivated. Privatization reduced the land available to the commune for redistribution.[2] However, the implementation of the reform faltered due to bureaucratic and administrative costs and only modestly changed land tenure in the countryside. Thus, two different modes of agricultural production – traditional and modern –

[2] The reform also allowed households to consolidate their fragmented plots, which would have also inhibited the commune's ability to provide nonmarket access to land.

continued to coexist side-by-side, providing a unique laboratory to explore an institutional basis for labor misallocation and the productivity gap.

Grain was the main product of Russian agriculture and accounted for about half of agricultural output and close to ninety percent of sown area (Markevich and Harrison 2011; Davies 1990). The four main grain crops – winter and summer wheat, winter and summer rye, oat and barley – produced the bulk of cereals. Oat and barley were largely summer crops; winter rye was the most important winter crop. Winter rye was mainly grown for peasant household consumption; wheat, followed by barley, was produced for internal and external markets, and oat was mainly used for livestock feeding (Kondratiev 1922). Local climate conditions and the proximity to grain markets affected which crops dominated a given area. In terms of labor costs, all cereals were similar being less labor intensive than potatoes or flax (Strumilin 1966).

Both commune and private farm production utilized the three-field system, based on a rotation of winter crops, summer crops and then fallow on the same plot. The short growing season did not allow cultivating summer and winter crops on the same plot during the same year. In terms of labor demand, the summer season was peak and winter slack. The production technologies remained primitive. Horses provided driving power for traditional light wooden ploughs, although more complicated agricultural equipment, like seeding and reaping machines, were in use by some farms. The standard production unit was a male-female pair. Women worked in the fields together with men, exploiting comparative advantage (Knipovich 1921).

Grain productivity was higher on private land than on commune land, and both types of farms experienced growth in yields during the pre-war years. The commune compensated lower expected returns by providing extra support to its members. Nonmarket access to land was just

one form of social insurance. Other examples include commune members helping peasant *soldatki* (wives of mobilized soldiers) during the war (Kondratiev 1922, Anfimov 1962).

The Great War did not change the institutional environment in the Russian countryside. Land and labor markets continued to operate (Anfimov 1962, Gatrell 2005). While the war brought some elements of government regulation of the grain market, both commune and private farms maintained the freedom to make the major economic decisions (Litoshenko 1926 published in 2001). Farms largely felt the impact of the Great War through a huge negative shock to the labor supply. By the 1916 summer, about 12.3 million males were mobilized into the army or about forty percent of males aged 18-43. The designers of the mobilization laws, drafted in 1874 and 1912, aimed to materialize a large number of troops over a vast amount of space in a short period of time, while minimizing the expected loss of agricultural output. The implementation of these complicated mobilization laws generated variation in the share of draftees across regions (see section A2 of the on-line appendix for details). Prisoners-of-war and refugees constituted an additional source of variation in gender imbalance.[3]

Value added in agriculture in 1916 decreased by nineteen percent relative to the pre-war level (Markevich and Harrison 2011). The decrease in supply was accompanied by an increase in market demand for grain from the growing army and war refugees that migrated to cities. The urban population increased by 1.55 million people already by October 1st 1915 (Kondratiev 1922 p. 19). This increase in demand was counter-balanced by the collapse of foreign trade due to the war blockade (Litoshenko 1926 published in 2001).[4] All in all, wheat prices were about two and

[3] There were 460,900 prisoners-of-war and 354,000 refugees employed in agriculture by 1916, largely on big private farms (Sidorov 1973 p. 452; Gatrell 2005 p. 156).

[4] Grain export consisted of 9.3 percent of pre-war grain production (Kondratiev 1922 p. 16, 19).

half times higher in 1916 than in 1913 (Kondratiev 1922 p. 62). Oat prices increased the most because of the army's demand for horse feed. The army also increased relative demand for barley (Anfimov 1962).

4. Hypotheses

What were the effects of mass mobilization on agricultural output? Following historical characterizations of Russian agriculture, one might expect a rather modest response to mass mobilization relative to a frictionless neoclassical economy. The predominant estimates of "redundant" labor (Litoshenko 1926 published in 2001; Allen 2003) were larger than the labor removed.[5] However, modern models of persistent misallocation (Banerjee and Moll 2010, Hseih and Klenow 2009, Restuccia and Rogerson 2008, Hayashi and Prescott 2008) are generally consistent with a short-run decrease in output following a negative labor shock. Below, we develop hypotheses that distinguish institutional factors from behavioral frictions, short-run adjustment costs or other market frictions.

In the ideal experiment, to explore whether the effects of massive labor reallocation depend upon institutional factors, we would exogenously remove labor independently by institutional type and obtain estimates of the change in output for the commune and private agriculture separately. We face three departures from such an ideal case. First, we only observe the removal of labor at the district level in the aggregate and not by institutional type. Second, mass mobilization could affect the labor supply between commune and private farms since these two modes of agricultural production were intimately linked. Third, the variation in mass mobilization is not generated by experimental control.

[5] In 1901, a government commission estimated 51 percent of the rural labor force as surplus labor; Litoshenko (1926 published in 2001) puts this figure at about 40 percent.

What kind of differential responses of private and commune farms could we expect? Historians generally agree that private farms had higher marginal returns and were more capital-intensive (Gatrell 1986). Under the assumption of a competitive local market, all else equal, wage labor should become more attractive on two margins. On the extensive margin, the negative shock should increase the wage and encourage households to engage in wage labor. Similarly, on the intensive margin, labor should flow to the highest marginal return, which was on private farms. Mobilization, thus, should place a heavier burden on traditional farms.

The above hypothesis may not hold in the presence of nonmarket access to land. In this case, households could violate the separation property and choose to reallocate resources away from wage labor and return to self-sufficiency in the commune instead of allocating factors according to profit maximization (see Sadoulet et al. 2002 for a theoretical example of this effect).[6] Indeed, the quantity and quality of land available to a peasant household within the commune increased during the war because of the conscription of other members into the army. These changes reinforced each other and encouraged the household to withdraw from supplying labor to the market. Besides wage labor returning to the commune, peasants could rent private land. Rental prices were mostly prohibitively high before the war, with landowners holding most of the bargaining power (Anfimov 1961), likely making renting less attractive than the newly available commune land. Based on these arguments, our first main hypothesis is that commune farm

[6] There is a large literature on the failure of separability in agricultural households in developing countries (Udry 1998, Collier 1983). The standard approach concerns the connection between yield per hectare and farm size. Instead, we employ the general definition of separability for agricultural households that production decisions depend upon household endowments or preferences (Singh et al. 1986).

production should exhibit greater resilience than private farm production in response to mobilization (Hypothesis 1).

Hypothesis 1 relies on local competitive labor markets, attracting labor from the commune before the war and continuing to operate during the war. We thus could expect heterogeneous effects by factors that influenced the demand and supply of labor before the war. Districts with a greater share of private farms should have had relatively greater demand for peasant labor before the war, drawing labor out of the commune and leading to greater potential for commune resilience. Similarly, in districts with a greater supply of commune labor to the market, we would expect greater potential for commune resilience. We use commune land inequality in a district as a factor that influenced the supply of commune labor. Greater land inequality indicates that communes were less effective in securing equal access to land, pushing peasants to wage labor.

The second assumption of Hypothesis 1 is that peasants valued the commune's nonmarket access to land. We, thus, would expect to find heterogeneous effects depending on the capacity of the commune to provide such access. Since repartition communes had better capacity for nonmarket access to land, we would see greater resilience for repartition communes. Similarly, we can exploit the difference between provinces with respect to the pre-war changes in land tenure as a result of the Stolypin reform. If successfully implemented, the effects of the Stolypin reform would have been to make the economic organization of the commune similar to that of private property and would have limited the ability of the commune to provide nonmarket access to land. We note that, if the explanation for commune's resilience lies in characteristics that did not vary by commune type, like peasant household behavior, the open field system or transportation costs between the commune and private farms, we would expect similar responses in repartition and non-repartition communes.

Our second hypothesis is that mass mobilization is associated with a shift toward production of winter rye, the most important subsistence crop for peasant households (Hypothesis 2). While nominal wages on private farms increased, peasants faced uncertainty with respect to real wages, due to the increase in the demand for food by the army, inflation and other war-time factors. In order to guarantee a subsistence living, peasants could opt to smooth "income" by switching from wage labor to subsistence-oriented production (Morduch 1995). Households, whose labor supply decisions were sensitive to the commune's social insurance properties, would primarily return to the commune to engage in subsistence production.

In sum, a reallocation of labor in favor of the commune in response to mass mobilization, and the subsequent switch back to subsistence from market-oriented production, is consistent with finding relative resilience in commune production in the midst of an overall decline. This explanation for commune resilience also explains why we might observe a rather large negative effect on district aggregate production since the loss of production due to mass mobilization is compounded twice, once through the movement of labor from more to less efficient farms and once through a switch from market to subsistence production.

5. Data and Methods

We construct a district (*uezd*) level dataset to study the effect of mobilization on agriculture. The dataset includes the whole Russian Empire, excluding the Great Duchy of Finland, covering more than seven hundred districts on this territory in 1913. We use 1913 and 1914 as benchmark pre-war years (the war started at the end of the 1914 summer season) and 1916 – the last pre-revolutionary year - as a treatment year. We have fewer observations for 1916 than for 1913 and 1914 because of the occupation of western provinces by Germany and Austro-Hungary. We address concerns about attrition in subsection 6.1.

We combine various official sources to construct the dataset (see the list of our sources in the online appendix). We follow historical literature (Golovin 2001) and define our 1916 mobilization measure as the difference between 1916 and 1913 gender imbalance in the rural population (females minus males). We assign zero to the mobilization measure for 1913 and 1914 observations.[7] For cultivated area and crop yields of winter and summer rye, winter and summer wheat, oat and barley, we have two observations for each district-year: one for private land and one for commune land. Due to data availability, most potential control variables do not vary by time or by farm type.

We prefer cultivated area rather than yields as our main dependent variable because of data quality. Yield data are not an independent measure but a product of cultivated area and crop yield per hectare measured in a sample subarea and suffer heavily from attrition in 1916. In addition, yield data are much more sensitive to unobservable or poorly observable variables such as local weather that might correlate with mobilization. Cultivated area is a reasonable approximation of crop yield in terms of the agricultural production function due to the primitive state of technology. The number of laborers strongly predicts area under crops, conditional on total arable land, and cultivated area strongly predicts expected agricultural yield.

Table 1 presents summary statistics. Around 194 thousand rural citizens lived in an average district with substantial variation across districts. Sixteen thousand people, or about eight percent, were mobilized from the countryside in an average district. The mobilization measure could be negative if there were more males than females in the inflow of refugees, prisoners-of-the-war and war-time migrants and these outnumbered mobilized males. The maximum number of draftees in a district was 143 thousand males.

[7] In table 1, we report summary statistics for mobilization excluding these zeros.

The average amount of cultivated area by crop was as follows: 40.47 thousand hectares for winter rye and 1.27 thousand hectares for summer rye, 11.26 thousand for winter wheat and 33.62 thousand for summer wheat, 26.46 thousand for oats and 17.24 thousand for barley, or all in all 132 thousand hectares for these grain crops. Winter rye totaled about thirty-one percent of crops on average, but this crop was mainly concentrated in the commune.

We employ provincial autumn prices on rye, wheat, oat and barley to construct a unified price-weighted area-under-crops index. This index more closely approximates value-added and accounts for changes in grain demand by weighting the dependent variable by grain prices (normalized by wholesale foodstuffs prices). Price-weighted area under crops in a district was 90.42 on average (and 45.37 if to disaggregate by farm-type).

There were almost fifty-seven thousand horses in an average district in 1912. The 1910 agricultural machine census reports almost three thousand machines of various types and more than twenty-seven thousand units of other agricultural tools in an average district. Urbanization and literacy rates were low, thirteen and twenty-one percent on average, correspondingly (with noticeable exceptions of ninety-seven percent of urban population in Saint-Petersburg district and about eighty percent of literate citizens in Baltic districts). The average commune in European districts had about one hundred households in 1905. The repartition commune accounted for seventy-three percent of communes in European Russia. As such, land inequality was generally low; the average commune land Gini index in a district, capturing both within- and between-commune land inequality, equals 0.23.

Our estimation strategy requires an exogenous source of variation in the supply of agricultural labor in a district. Mass mobilization as such a source is attractive for a number of reasons. First, the mobilization rules generated local variation in labor removal that was arguably

orthogonal to unobservable shocks to agricultural production. The mobilization rules were predetermined decades prior to the war; the probability for a male of the age between twenty-one and forty-three to be drafted into the army during the war depended on his legal status at the age of twenty-one, i.e. several years before the actual mobilization for most draftees. Since legal status depended upon factors that were largely out of an individual household's control, the scope for manipulation according to idiosyncratic conditions was limited (see section A of the online appendix for further details). Second, conditional on the probability of being drafted, the differential impact of removing one individual versus another was minimal given the primitive technology. Third, mobilized males would have been the main demographic group employed by industrial firms and the sheer scale of mobilization simulates a policy of directed reallocation that could transform an underdeveloped economy.

We prefer to work in levels and not logs or shares for several reasons. First, due to the various competing explanations of the response to the labor removal shock, the middle-ground approach would be to use levels and not proportionate adjustments. Before the war, private farms cultivated less grain area on average than commune farms so the relative change would only magnify the resilience effect. Second, transforming the main variable of interest into shares or logs compresses this variable, something undesirable in our context where identification from either end of the distribution is as important as from the middle. In the online appendix, we explore the nonlinear effect of mass mobilization. Third, mobilization takes on zero values for all districts before the war, making estimation in logs depend upon an arbitrarily chosen constant. Fourth, the substitution towards grain crops, which were relatively less labor-intensive, from other production activities will cause more bias in relative changes than absolute changes at greater levels of labor removal.

We control for size of rural population as the main input factor besides land. We use lagged rural population since the population in 1916 would have been affected by mobilization. We take advantage of the panel structure of the data and estimate in first-differences accounting for district-specific characteristics. We argue that fixed factors absorb many of the confounding variables such as soil quality, the level of mechanization, the capital stock, transportation and other transactions costs. These variables in principle vary but were most likely fixed in the wartime environment.

To understand the short-run effects of mobilization, our basic specification is represented by the following equation:

$$\Delta Y_{it}=\alpha\Delta M_{it}+\beta\Delta P_{it}+\xi_t+\varphi_i+\varepsilon_{it} \quad (1)$$

where Δ stands for first-differences, subscript *i* indexes districts and t indexes the time period. *Y* denotes cultivated area or the price-weighted area index or grain yield, aggregated over commune and private farms, in district *i* at time *t*. *M* is the mobilization measure. *P* stands for lagged rural population. ξ_t represent year fixed effects. The time fixed effects account for contemporaneous unobservables that affect all districts, such as changes in aggregate demand. In addition we introduce district-specific linear trends (φ_i), which serve to augment the basic difference-in-differences approach by allowing for differences in pre-existing trends. All our results hold if we exclude them. The idiosyncratic error term, ε, is assumed to be uncorrelated across districts, but not necessarily within districts since we cluster standard errors at the district level and report heteroskedasticity-robust standard errors. We point out that working in first-differences alleviates some concerns about autocorrelation.

To investigate Hypotheses 1 and 2 on the institutional roots of labor misallocation, we employ the following basic equation:

$$\Delta Y_{ikt}=\alpha_p \Delta M_{it}+ \alpha_c \Delta M_{it} * C_{ik} + \beta \Delta P_{it} + \varphi_i + \xi_t + \varepsilon_{ikt} \quad (2)$$

where notation is as in (1), C stands for commune dummy, and k is an index for the farm type. As in (1) we allow errors to be correlated within districts and report heteroskedasticity-robust standard errors. The coefficient α_c corresponds to the magnitude of the differential response in output to mobilization by the commune. Thus, it governs whether or not we see greater resilience in response to the shock on commune farms than on private farms. A positive and statistically significant estimate of α_c is consistent with Hypothesis 1 since commune farms would decrease grain output less than private farms. If local labor markets are competitive, albeit imperfectly, a negative coefficient, or one that is not statistically different than zero, would reject Hypothesis 1. A similar logic applies for Hypothesis 2 with the dependent variable being winter rye production or the share of winter rye.

We modify (2) to explore whether the commune resilience (or convergence) effect of mobilization is explained by variables representing proxies for supply and demand for hired labor on private farms, commune type and size, and the Stolypin reform implementation measures. For each variable, Hypothesis 1 (or 2) is confirmed and the null is rejected if the estimate of the triple interaction term between the commune dummy, mobilization and the variable is statistically different than zero or the joint effect is statistically different than zero and of the right sign (depending on the variable "right" could be positive or negative). In this case, we can claim that part of the resilience effect is explained by the above factors.

6. Results

We begin by examining the effects of mobilization on agricultural production in a district, aggregating across both farm-types. Column (1) of Table 2 uses cropped grain area as the measure of agricultural output and the second column employs the price-weighted cultivated area

index. The negative and highly significant coefficient on the mobilization variable demonstrates that the removal of labor decreased output. The magnitude of the effect is large. According to the estimates of column (1), an increase in mobilization by one standard deviation (i.e. by 13.32 thousand males, or 6.87 percent of average rural population in a district) decreased cropped area by 14.25 thousand hectares or 10.88 percent of pre-war levels. The absolute value of this figure should be a lower bound on the magnitude of the response to purely random removal of the same number of middle-aged males since the pre-determined mobilization rules aimed to minimize expected agricultural loss. In the short-run, labor reallocation of a similar scale would impose a significant cost on the economy in terms of loss in agricultural output.

Through the lens of a production function, one can get a better sense of the magnitude of the effect, but we caution the reader on the short-run nature of our effects. One could interpret (1) as a first order approximation of a district aggregate production function if one assumes homogeneous labor and free mobility of labor within a district. In this case, one could think of α as representing the marginal productivity of labor. The estimated decline in output from column (2) implies that the marginal productivity of labor at the average level of mass mobilization was 296 rubles, which is four times higher than the minimum amount of income needed to support an average family (roughly the pre-war estimate of marginal productivity)[8] and over double GDP per capita in Russia in 1913 (Markevich and Harrison 2011). As one might expect, the massive labor removal from agriculture substantially decreased the productivity differential between

[8] According to Nefedov (2010), an individual needed about 245 kg of grain per year for subsistence. We multiply this amount by the price of rye (4.88 kopeks per kg) and by an average family size of six, to get 72 rubles per year.

manufacturing and agricultural sectors. The agricultural productivity gap narrows, at least temporarily, from 6.8 to 1.7 (see section C1 of the online appendix for details).

Turning to the central result, columns (3) and (4) report the estimates of the effect of mobilization on commune farms relative to private farms. Like in columns (1) and (2), we report the results for cropped grain area first and then for price-weighted area index. Agricultural output on commune farms responded less strongly to mobilization than private farms. The coefficients on mobilization itself and its interaction with the commune farm dummy are significant but have opposite signs, negative and positive respectively. The estimated effect of mobilization on commune farm production is positive in column (3) and negative in column (4), and both effects are statistically different than zero at the five percent level. When interpreting the positive effect in column (3) as an expansion of cultivated area, one should keep in mind the secular decline in cropped area. The coefficients in column (4) suggest that a standard-deviation increase in mobilization in a district decreased agricultural output by eleven percent of the pre-war average for commune farms and by seventy-nine percent of the pre-war average for private farms.

We interpret commune resilience as evidence of the substitution of labor between two farm types. In support of this interpretation, historical anecdotes describe peasants abandoning renting of private land in favor of farming commune land (Anfimov 1962 Pp. 163, 214-215, 222-223). In addition, peasants who were previously wage laborers but returned to the commune would likely have engaged in subsistence production, which would have caused the value-added index to experience a greater decline for commune farms.

We provide more arguments in support of this interpretation of commune resilience in the remainder of Table 2. First, we allow for the effect of mobilization to vary by share of private farm area in 1913. If there were little substitution between private and commune farms, then we

should not see a significant coefficient on this additional interaction term. In contrast, if labor substitution explains the results, then we should see a more positive effect in districts with a greater share of private farms, a proxy for labor demand. Columns (5) and (6) report a negative and significant effect of mobilization on commune farms in districts with zero private-farm grain production;[9] the coefficient on the interaction term between mobilization variable and the commune dummy is negative and highly significant. Additionally, as expected, we see greater commune resilience as the share of private farms increases. Finally, in columns (7) and (8), we account for differences in the pre-war supply of commune labor, using the commune land Gini coefficient as a proxy. The coefficients reported in columns (7) and (8) demonstrate a larger commune resilience effect for districts with greater pre-war labor supply to private farms.

We investigate the institutional roots of labor misallocation by specifically focusing on nonmarket access to land afforded to members of the commune.[10] In Table 3, we present results for four different mediating variables in pairs of columns, one for grain area under crops and one for the output price index. First, we consider the share of repartition communes in a district. Communes of this type provided better nonmarket access to land because of the institutionalized repartitioning of plots. In columns (1) and (2), we find that districts with a greater share of repartition communes experienced a greater commune resilience effect. The results also show

[9] Here, we have purposefully not demeaned private share of cultivated area in a district in 1913 in order to demonstrate the effect of mass mobilization on commune farm production in districts with no private grain production. The number of districts with no private grain production in 1913 is 38 and with less than five percent is 151.

[10] Productivity differences could explain commune resilience if a competitive labor market did not exist, but this condition goes against historical accounts as well as the results from Table 2.

that under a counterfactual of converting all repartition communes to non-repartition ones, the commune's resilience would be cut in half.

The next two variables that we consider are related to the outcomes of the Stolypin reforms (measured at the province level). The first Stolypin variable captures the instance of transformative change brought about by the reform. The designers of the reform envisioned and expected full adoption of the reform, viewing incomplete implementation as a failure. We create a dummy variable that indicates whether a district resides in a province that had incomplete implementation, defined as the majority of arable land going unaffected by the privatization reform. We expect these districts to behave qualitatively similar to the average district in the results above. In contrast, for those districts that resided in provinces that were transformed by the reform, we expect less commune resilience. In columns (3) and (4), we see that indeed districts in provinces with a minority of land area exiting the commune exhibit the commune resilience effect. Quite a different picture emerges for those districts located in provinces that were transformed by the Stolypin reform. The effects are best illustrated by the results for the price-weighted output index presented in column (4). Just as the standard model would predict for an economy with a competitive labor market, there is no effect of mobilization for private farms and a negative effect of mobilization for commune farms. This remarkable result suggests that the commune indeed harbored persistent labor misallocation. The Stolypin reform better enabled markets to determine the opportunity cost of land, directing labor to its highest valued use by making subsistence production a more costly alternative and allowing peasants to take advantage of the insurance properties of land markets.

The second Stolypin reform variable is a relative measure, designed to capture the disproportionate impact of the reform on the commune's capacity for nonmarket allocation. We

construct the amount of land exiting the commune as a result of the Stolypin reform per exited household and divide this amount by the average household allotment in the commune in a province. Higher values represented a greater impact on the commune's (in)capacity for nonmarket allocation of land.[11] The results, presented in columns (5) and (6), show that the relative adverse impact of the Stolypin reform on nonmarket allocation diminished the commune's resilience, consistent with our hypothesis.

We also consider commune size, i.e. a number of households in a commune, as a driver of heterogeneous effects. Under the logic of collective action, average commune size might inhibit collective decision-making and, consequently, the nonmarket allocation of land. However, since the commune also functioned as a factor market surrogate (Nafziger 2010), average commune size could proxy for the size of the "market", an effect running counter to the collective action one. The empirical results in column (7) provide some evidence for the factor market surrogate view, although the magnitude of the effect is small. Reducing the size of the market by one standard deviation in commune size, i.e. ninety households, leaving only fourteen households in a commune, would decrease the differential effect by just fifteen percent. The coefficients on the interaction of mobilization and the commune size and the triple interaction of mobilization, commune dummy and commune size are statistically insignificant for the price-weighted cultivated area (column 8), but have the same signs.

[11] Pallot (1999) and Williams (2006) argue that the reform created winners and losers within the commune since the actual privatized allotment could be disproportionate to a household's legitimate claim. Our variable captures this notion of within-commune winners to the extent that across commune inequality was small in a province, which it should have been.

The results on nonmarket allocation of land give persuasive evidence that the commune attracted labor and, more importantly, offer an explanation for persistent labor misallocation by demonstrating the attractiveness of the commune in the face of an apparent divergence in marginal productivity differentials across private and commune farms. To strengthen this interpretation, we turn to our second hypothesis on social insurance, presumably one of the commune's most attractive features. A return to the commune, at least for some individuals, should be associated with an increase in subsistence crop production, namely, winter rye. Table 4 presents results for the effect of mass mobilization on winter rye production, allowing for heterogeneous effects according to nonmarket access measures. The results in column (1) of Table 4 show that winter rye production increased on commune land in response to mobilization. In column (2), we verify that mobilization increased winter rye's share of grain output on commune land. Furthermore, both variables that track the demand for and supply of commune labor before the war are associated with stronger responses (columns 3 and 4).

The key test for the social insurance mechanism comes from the nonmarket access to land variables. In column (5), we see that districts with a greater share of repartition communes had a larger increase in winter rye production in response to mass mobilization. A district with the average share of repartition communes more than doubled the increase in winter rye production relative to a district with only non-repartition communes. Similarly, according to the results in columns (6) and (7), districts more heavily impacted by the Stolypin reform increased winter rye production relatively less and districts in a province with a larger privatized plot relative to the average commune plot had a diminished increase in winter rye production. The results for average commune size in column (8) are also consistent with the connection between nonmarket access to land and social insurance, but are not statistically significant.

6.1. Robustness and Threats to Identification

In this subsection, we aim to strengthen our core set of results. While the identification assumption in (1) allows for correlation between mass mobilization and pre-existing, district-level trends in agricultural output, we still perform a "pre-trend analysis" as a placebo test since we would not expect observed differences in pre-war cultivated grain area to correlate with the level of mobilization (imputed to 1914). In this placebo test, we can not implement our preferred specification that accounts for district-specific linear trends. Columns (1) to (3) of Table 5 provide the results. The coefficient on placebo mobilization in column (1) is statistically significant, although it is positive. We note that a positive pre-trend would likely work against finding a negative effect of mass mobilization. Cropped area, as opposed to yield, should not experience mean reversion. However, the results in column (1) do suggest that there is something different about more heavily mobilized districts. We suspect, and our results confirm (in columns 2 and 3), that mobilization is correlated with the pre-war growth in the stock of horses, and a corresponding expansion of cropped area for feed (oats) in a district (Anfimov 1962). Oats are also fairly robust to soil conditions and are easy to plant on new arable land, which had been expanding in the pre-war years. We use area under oats as a dependent variable in column (2) and repeat the specification presented in column (1) controlling for our pre-war measure of horses in column (3). Accounting for the 1912 stock of horses completely explains the pre-trend in oats (not shown) and for all grains (column 3). Hence, allowing for separate district trends is indeed an appropriate solution.

A second econometric concern is that our measure of mobilization suffers from measurement error. In columns (4) and (5) of Table 5, we use distance to the nearest military recruitment

center, controlling for whether or not the district is located in a frontline province,[12] to predict the level of mobilization. We then plug in predicted mobilization as a measure of mobilization into the main specification. The resulting increase in the magnitude of the effect of mobilization suggests that measurement error may play a role and our basic results are attenuated.

We also check whether weather conditions or being located in a frontline province affects the magnitude of our coefficient on mass mobilization. Both variables change over time and could have been correlated with output and mass mobilization. For weather, we use average temperature and total rainfall. The number of observations drops considerably due to incomplete weather data.[13] Nevertheless, even on this reduced sample, the coefficient on mass mobilization remains strongly negative and statistically significant.

In the last column of Table 5, we assess the extent of attrition bias (Figure A2 of the on-line appendix presents a map of the empire with the districts suffering from attrition). The F-test for the 1916 missing data indicator and its interaction with the controls rejects the hypothesis that attrition is random (F-stat of 4.86 with p-value of 0.002). We argue that the main reason for attrition is proximity to the warfront (Kondratiev 1922), i.e. selection on observables. We use inverse probability weights to correct for the potential bias (Wooldridge 2002) and construct these weights using the distance to the warfront as an excludable variable in the restricted model. We see that, if anything, attrition leads to an underestimation of the impact of mobilization.

[12] We use a dummy variable instead of distance to the front to avoid multi-collinearity with military centers that are located close to the front.

[13] We use nearest neighbor matching to weather stations. Due to the short time period and the small number of weather stations, standard errors of interpolation techniques would be too large.

Having discussed the standard threats to internal validity, we now turn to threats to identification specific to the war. Our estimates of the effects of labor removal assume that unaccounted for changes in other production inputs were orthogonal to mobilization. Horses were an important factor in production for both commune and private farms and the mobilization of horses occurred along side of mass mobilization. Working against the commune resilience effect is the fact that horse mobilization rules tended to overmobilize horses in commune farms relative to private ones (Anfimov 1962). We do not control for mobilization of horses in our main specifications because of poor pre-war data on horses. The pre-war statistics on horses are known to be under-registered and we employ a special procedure to correct them (Vainshtein 1969, see section B of the on-line appendix for details). We use both a linear and quadratic function to simulate what the real number of horses would have been if there had been better military census coverage. In contrast, figures on horses for 1916 are of reasonable quality. The first two columns of table 6 account for mobilization of horses measured as the difference between 1916 and 1912 non-adjusted figures. In the next four columns, we report the results with horse mobilization measure based on 1912 corrected figures. The inclusion of horse mobilization does not alter the effect of mass mobilization and its negligible impact on output could be explained by an overinvestment in horses by peasants (Litoshenko 2001).

Another important input that is also not well documented is agricultural equipment, statistics on which are known only for 1910. In column (7), we explore whether the pre-war amount of agricultural machines and tools (normalized by 1913 population) affects our results. The coefficient on the main variable of interest remains almost unaffected both in terms of significance and magnitude. The decrease in production is also not explained by an overall decrease in demand. Indeed, grain exports collapsed due to the war blockade; however, as

discussed in the historical section, it was fully counterbalanced by increased army and urban demand. In the online appendix, we show that our main analysis holds when we allow for the effect of mobilization to vary by the 1913 urban share of the population. Similarly, changes in female labor force could hardly explain our results since women were already involved in agriculture before the war, although we cannot observe changes in female labor.

For the interested reader, we discuss a number of additional concerns in the appendix. We show the robustness of our results to using grain yield as a dependent variable and an alternative econometric specification estimating relative changes. We present additional results regarding within- and cross-district mobility and peasant responsiveness to implicit and explicit prices.

6.2 Policy implications

The experience of Russian agriculture in the war suggests that social insurance during the time of rapid change could be an important factor for any policy of massive labor reallocation. Indeed, mass mobilization and the nonmarket allocation of land afforded by the commune could have jointly caused the sharp decrease in food availability in urban areas in the winter of 1916, one of the suspected triggers of the 1917 Russian Revolution (Kondratiev 1922; Gatrell 2005).

Our results also shed light on post-revolutionary Stalin's collectivization as a development policy. Soviet policy makers and economists, whose view has been recently reestablished by Allen (2003), argued that collectivization would shift redundant labor, estimates of which varied between five and thirty million people (Fitzpatrick 2001 p. 96), from agriculture to industry without any loss in agricultural output (Libkind 1931). The actual rural-urban reallocation of labor during the late 1920s – 1930s was twenty-three million (Kessler 2001). To this number, one could also add six or eight million victims of the famine of 1932-33 (Harrison 2008) as a special kind of labor removal caused by collectivization. In either case, collectivization removed

more people from the Russian village than mobilization did. However, according to Cheremukhin et al. (2013), who employ a two-sector growth model to analyze Stalin's industrialization and its contribution to structural change, collectivization led to smaller decrease in the labor wedge, i.e. the ratio of the marginal productivity of labor in agriculture to manufacturing minus one. According to their estimation, the labor wedge decreased from 5.9 in the late Imperial period to 3.8 after collectivization. Our analysis suggests a decrease from 5.8 to 0.7 during the First World War. In this respect, Stalin's policies appear to have performed substantially worse than mass mobilization; yet, one must keep in mind that the relatively low WWI labor wedge is associated with a large within-district shift from market to subsistence production, an unacceptable outcome for the collectivization policy. Interestingly, Cheremukhin et al. (2016) argue that agrarian institutions were not an important barrier to structural transformation, seemingly at odds with our findings. To make this argument, the authors decompose the intersectoral labor wedge into three components, consumption, production and labor mobility. In their model, the commune's influence on the economy is felt only through the labor mobility component, defined as the ratio of wages in manufacturing to agriculture. However, if households violate the separation property, then the commune's influence could be felt not only in the labor mobility component but also in the production and consumption components. Our findings are reconciled further when one considers that industrial expansion in our setting is automatic (as it comes from the rapid swelling of military activity), and industrial firms' monopoly rents were an important source of frictions in the imperial economy.

7. Conclusion

We find strong evidence that the mass mobilization of sixteen percent of the labor force into the army during the Great War caused a substantial decline in agricultural output. Finding a large

reduction in output due to mass mobilization in one of the quintessential examples of labor surplus (Gerschenkron 1965) suggests that the allocation or reallocation of resources must overcome complex and costly problems, at least in the short-run. Using data disaggregated by farm-type, we show that mobilization decreased output less on commune farms than private farms. Peasants responded to mobilization by switching back to subsistence production, which would have been an attractive option, despite rising nominal wages, due to the nonmarket allocation of land provided by the commune. In this way, the commune offered peasants social insurance, which was largely absent in urban areas, in a time of rapid change and uncertainty.

To demonstrate the importance of social insurance in the demand for commune lands, we present evidence that the commune increased subsistence production in response to mass mobilization, and did so to a greater extent in districts with a greater capacity of nonmarket allocation in the commune. The peasants' revealed preference for the commune shows that the same factors that give rise to productivity differentials may heavily constrain the economic response to policy interventions designed to correct for misallocation. Since nonmarket access to land and social insurance are often core components of agrarian institutions, these results have policy relevance for developing countries in Latin America, East Asia and Sub-Saharan Africa.

For Russia, in particular, our estimates improve the understanding of pre-revolutionary agriculture in relation to several historical debates. First, the pro-commune peasant response to labor removal supports an institutional explanation of the origins and persistence of labor misallocation and relatively low agricultural productivity in late Imperial Russia. At the same time, the results also provide justification for the designers of the Great Reforms of the 1860s, including the emancipation of serfs, which institutionalized the commune, by showing that the commune was an important source of social insurance for peasants during this time of low

market development. Second, our results have implications for the causes of the Russian Revolution in 1917, supporting the view of a mutual causation of an urban food crisis by both the First World War and the institution of the commune. Lastly, we contribute to the critical appraisal of the success of Stalin's industrialization policies, offering evidence that his development strategy likely underestimated the large short-run agricultural loss associated with massive labor removal.

Finally, there are several characteristics of Russian agriculture and rural institutions that might affect the external validity of our results. First, Russian farmers face a fairly harsh climate and short growing season, which may have caused the three-field system to persist longer than in other areas of the world. Even so, Russia has plenty of climate variation and regional weather differences, and both annual temperature and rainfall do not affect our results. Another stylized fact is the low labor-to-land ratio, which would contrast with India, for example. Again, Russia has plenty of variation with European provinces having relatively high levels of population density. Our results do not change when restricted to European provinces only. Compared to Europe, Russia had less coverage by rail and worse infrastructure. Consequently, some industry was located in rural areas, which would have soaked up agricultural labor. Once again, railroad density varied with some provinces having European levels of rail infrastructure. A more careful analysis of the dependence of agricultural productivity differentials on railroad density and industry location would be preferable in order to generalize the results. Lastly, the rural institutions of this period were a part of the response to the 1861 serf emancipation. This response surely altered the nature of labor misallocation, calling for a deeper investigation of the relationship between the legacy of serfdom and labor misallocation in agricultural production.

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Table 1: Descriptive Statistics

Variable	N	Mean	S.D.	Min	Max
Total cultivated area of the four main grains in a district (thousands of hectares)	1961	131.96	164.67	0	1853.04
Total cultivated area of the four main grains in a district and by farm-type (thousands of hectares)	3908	66.22	108.13	0	1851.37
Price-weighted cultivated area of the four main grains in a district	1961	90.42	106.58	0	929.02
Price-weighted cultivated area of the four main grains in a district and by farm-type	3908	45.37	68.14	0	809.52
Total area under winter rye in a district and by farm type (thousands of hectares)	3946	20.24	28.19	0	262.50
Mobilization by 1916 (thousands)*	586	16.16	13.32	-93.65	143.55
Rural population (thousands)	2020	193.83	126.23	0.1	1487.27
Share of private grain-cropped area in 1913	741	0.25	0.19	0	0.96
Commune land Gini coefficient in 1905**	501	0.23	0.08	0.06	0.63
Share of repartition communes in 1905**	501	0.72	0.41	0	1
Share of exited land area (normalized by cultivated grain hectares)**	520	0.265	0.268	0	1.205
Share of households that exited the commune**	520	0.166	0.154	0	0.572
Commune size in 1905 (households)**	501	104.31	88.65	0	820.64
Horses in 1912 (thousands)	588	56.84	70.68	0.08	1001.22
Agricultural Machines in 1910 (thousands)	1504	2.90	7.45	0	85.11
Agricultural Tools in 1910 (thousands)	1504	27.40	38.73	0	504.99
Distance to nearest military center	747	3.68	2.66	0.05	20.27
Front province dummy (zeroes in 1913 and 1914)	2189	0.03	0.17	0	1

Note: * - summary statistics for mobilization variable in 1916, i.e. excluding zero meaning of mobilization measure in 1913 and 1914; ** - data available on European part of the empire only.

Table 2: The Effect of Mass Mobilization on Area under Crops

Dependent Variable	Grain Area	Grain Area Autumn Price Index	Grain Area	Grain Area Autumn Price Index	Grain Area	Grain Area Autumn Price Index	Grain Area	Grain Area Autumn Price Index
Unit of observation	District-Year	District-Year	District-Farm Type-Year	District-Farm Type-Year	District-Farm Type-Year	District-Farm Type-Year	District-Farm Type-Year	District-Farm Type-Year
Estimation	FDFE	FDFE	FDFE	FDFE	FDFE	FDFE	FDFE	FDFE
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mobilization	-1.07***	-2.22***	-2.10***	-1.63***	-0.10	0.03	-1.99***	-1.43***
	[0.413]	[0.505]	[0.296]	[0.298]	[0.330]	[0.242]	[0.292]	[0.301]
Mobilization* Commune			3.14***	1.05***	-1.41***	-2.28***	3.08***	0.99***
			[0.371]	[0.231]	[0.471]	[0.268]	[0.349]	[0.208]
Mobilization* 1913 Private Share					-6.63***	-5.39***		
					[1.320]	[0.939]		
Mobilization* 1913 Private Share* Commune					14.73***	10.78***		
					[2.288]	[1.164]		
Mobilization* 1905 Commune Land Gini							-9.72***	-6.73***
							[2.029]	[1.472]
Mobilization* 1905 Commune Land Gini * Commune							16.39***	12.05***
							[3.431]	[2.546]
Rural Population	-0.36	-0.19	-0.18	-0.10	-0.18	-0.10	-0.01	-0.05
	[0.315]	[0.153]	[0.157]	[0.076]	[0.156]	[0.076]	[0.041]	[0.043]
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	3.10*	9.52***	1.88	-3.28	2.90	-3.26	0.00	-6.63
	[1.754]	[1.173]	[3.131]	[4.071]	[2.871]	[3.819]	[3.306]	[4.315]
Observations	1,201	1,201	2,389	2,389	2,381	2,381	1,890	1,890
R-squared	0.158	0.571	0.294	0.284	0.477	0.468	0.420	0.408
Number of Districts	688	688	688	688	684	684	501	501

Notes: Grain Area stands for cultivated area of summer and winter wheat, summer and winter rye, barley and oats. Grain Area Autumn Price Index stands for the cultivated area of summer and winter wheat, summer and winter rye, barley and oats, each weighted by autumn crop prices (normalized by wholesale foodstuffs prices). The unit of observation is either a District-Year, where cultivated area is aggregated across all farms in a district in a year, or a District-Farm Type-Year, where cultivated area is aggregated across private and commune farms separately in a district in a year. FDFE estimates the model in first-differences using district fixed effects. The drop in observations in columns 7 and 8 is due to the 1905 Census which covers the European part of the empire only (not including Kuban, Stavropol and Terek provinces). Robust standard errors, clustered at the district level.

*** p<0.01, ** p<0.05, * p<0.1.

Table 3: Mass Mobilization and Nonmarket Access to Land

Dependent Variable	Grain Area	Grain Area Autumn Price Index	Grain Area	Grain Area Autumn Price Index	Grain Area	Grain Area Autumn Price Index	Grain Area	Grain Area Autumn Price Index
Characteristic	Repartition Share		Minority Exits Dummy		Exits Relative Impact		Commune Size	
Estimation	FDFE	FDFE	FDFE	FDFE	FDFE	FDFE	FDFE	FDFE
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mobilization	-2.13***	-1.55***	-0.38*	0.12	-1.93***	-1.34***	-2.05***	-1.46***
	[0.257]	[0.232]	[0.204]	[0.272]	[0.291]	[0.301]	[0.338]	[0.340]
Mobilization* Commune	3.24***	1.13***	0.54***	-0.53***	3.04***	0.96***	3.12***	1.08***
	[0.330]	[0.217]	[0.161]	[0.149]	[0.361]	[0.224]	[0.369]	[0.232]
Mobilization* Characteristic	-1.73***	-1.27***	-1.88***	-1.70***	0.12***	0.11***	-0.003*	-0.001
	[0.405]	[0.317]	[0.227]	[0.158]	[0.048]	[0.038]	[0.002]	[0.001]
Mobilization* Characteristic * Commune	2.47***	0.99***	3.00***	1.81***	-0.18**	-0.12***	0.01*	0.002
	[0.641]	[0.370]	[0.442]	[0.295]	[0.074]	[0.044]	[0.003]	[0.002]
Rural Population	-0.02	-0.05	0.07	0.01	0.10	0.04	-0.02	-0.05
	[0.043]	[0.047]	[0.066]	[0.040]	[0.064]	[0.033]	[0.041]	[0.045]
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	1.39	-4.92	-1.87	-9.73**	-1.69	-8.76**	0.48	-6.70
	[3.279]	[3.239]	[3.267]	[4.272]	[3.243]	[4.285]	[3.610]	[4.654]
Observations	1,890	1,890	1,928	1,928	1,928	1,928	1,890	1,890
R-squared	0.394	0.370	0.378	0.362	0.364	0.351	0.367	0.351
Number of Districts	501	501	514	514	514	514	501	501

Notes: Grain Area stands for cultivated area of summer and winter wheat, summer and winter rye, barley and oats. Grain Area Autumn Price Index stands for the cultivated area of summer and winter wheat, summer and winter rye, barley and oats, each weighted by autumn crop prices (normalized by wholesale foodstuffs prices). The unit of observation is a District-Farm Type-Year, where cultivated area is aggregated across private and commune farms separately in a district in a year. The drop in observations in is due to the Stolypin variables and 1905 Census, which cover the European part of the empire only. FDFE estimates the model in first-differences using district fixed effects. Robust standard errors, clustered at the district level.
*** p<0.01, ** p<0.05, * p<0.1.

Table 4: Mass Mobilization and Subsistence Production

Dependent Variable	Winter Rye Area	Share of Winter Rye Area	Winter Rye Area	Winter Rye Area	Winter Rye Area	Winter Rye Area	Winter Rye Area	Winter Rye Area
Characteristic			1913 Private Area Share	1905 Commune land Gini	Repartition Share in 1905	Minority Exit Dummy	Exits Relative Impact	Commune size in 1905
Estimation	FDFE	FDFE	FDFE	FDFE	FDFE	FDFE	FDFE	FDFE
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mobilization	-0.30***	-0.00	0.01	-0.31***	-0.33***	-0.15**	-0.32***	-0.36***
	[0.060]	[0.000]	[0.055]	[0.060]	[0.077]	[0.074]	[0.074]	[0.066]
Mobilization * Commune	0.69***	0.002**	-0.12	0.80***	0.83***	0.22**	0.77***	0.86***
	[0.096]	[0.000]	[0.079]	[0.078]	[0.073]	[0.093]	[0.084]	[0.090]
Mobilization * Characteristic			-1.15***	-1.87**	-0.25***	-0.22***	0.02***	0.0005
			[0.259]	[0.905]	[0.094]	[0.070]	[0.005]	[0.0004]
Mobilization * Characteristic *Commune			2.99***	3.15***	0.54***	0.66***	-0.04***	-0.001
			[0.476]	[1.036]	[0.163]	[0.130]	[0.014]	[0.001]
Relative price		-0.05**						
		[0.025]						
Rural Population	-0.00	0.00	-0.00	-0.00	-0.00	0.00	0.01	-0.00
	[0.005]	[0.000]	[0.005]	[0.023]	[0.022]	[0.011]	[0.012]	[0.022]
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-2.84***	0.03	-2.75***	-3.66***	-3.61***	-3.34***	-3.54***	-3.46***
	[0.702]	[0.034]	[0.699]	[0.950]	[1.148]	[1.023]	[1.075]	[0.982]
Observations	2,416	2,323	2,408	1,890	1,890	1,928	1,928	1,890
R-squared	0.208	0.049	0.350	0.290	0.282	0.275	0.266	0.267
Number of Districts	688	683	684	501	501	514	514	501

Notes: Winter Rye Area stands for cultivated area of winter rye. Share of Winter Rye Area stands for the share of winter rye in the cultivated area of summer and winter wheat, summer and winter rye, barley and oats. The unit of observation is a District-Farm Type-Year, where cultivated area is aggregated across private and commune farms separately in a district in a year. FDFE estimates the model in first-differences using district fixed effects. The drop in observations in columns 4 through 8 is due to the Stolypin variables and the 1905 Census, which cover the European part of the empire only. Robust standard errors, clustered at the district level.

*** p<0.01, ** p<0.05, * p<0.1.

Table 5: Robustness checks: Pre-trends, Measurement Error, and Attrition Bias

Dependent variable	Grain Area	Oats Area	Grain Area	First stage, Mobilization	Second stage, Grain Area	Grain Area	Grain Area	Grain Area
	FD	FD	FD	OLS	FDFE	FDFE	FDFE	FDFE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mobilization	0.39*	0.22***	0.05		-2.01***	-2.10**	-1.07***	-1.11***
	[0.226]	[0.074]	[0.110]		[0.529]	[1.014]	[0.413]	[0.410]
Horses in 1912* Linear Trend			0.07***					
			[0.022]					
Total Rainfall						-0.02		
						[0.029]		
Annual Temperature						-13.90		
						[12.385]		
Front Province							11.69**	
							[4.842]	
Distance to the nearest military center				-0.30**				
				[0.137]				
Rural population	0.06	-0.00	0.05	0.08***	-0.23	0.03	-0.36	-0.33
	[0.053]	[0.021]	[0.055]	[0.003]	[0.302]	[0.117]	[0.314]	[0.309]
Distances to Moscow, St.Petersburg, Warsaw								
District Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-4.27	-2.22**	-5.20**	1.02	2.67*	23.83	3.10*	3.80**
	[3.108]	[1.026]	[2.428]	[0.718]	[1.54]	[17.757]	[1.753]	[1.883]
Observations	580	586	565	510	1,198	233	1,201	1,084
R-squared	0.043	0.109	0.093	0.562	0.204	0.114	0.160	0.158
Kleibergen-Paap				4.51**				
Number of districts					688	150	688	575

Notes: Grain Area stands for cultivated area of summer and winter wheat, summer and winter rye, barley and oats. The unit of observation is District-Year, where cultivated area is aggregated across all farms in a district in a year. FD estimates the model in first-differences. FDFE estimates the model in first-differences using district fixed effects. Column 4 shows a quasi-first-stage regression where we explain the cross-sectional variation in the number of mobilized draftees using the variable distance to the nearest recruitment center, which is excludable from the main specification. The Kleibergen-Paap rk LM test statistic is reported for the cross-section and the null hypothesis of zero rank is rejected at the 5% level. To generate the alternative mobilization measure, we use the predicted values for mobilization from the cross-section for the values in 1916 and zeros in years 1913 and 1914. Since the alternative mobilization measure is a generated regressor, we use bootstrapped standard errors in column 5. The drop in observations in column 6 is due to incomplete weather data. Robust standard errors, clustered at the district level.

*** p<0.01, ** p<0.05, * p<0.1.

Table 6: Horse Mobilization, Agricultural Equipment and Mobilization of Males

Dependent Variable	Grain Area	Grain Area	Grain Area	Grain Area	Grain Area	Grain Area	Grain Area	Grain Area
Pre-war horses	1912 Military Census	1912 Military Census	1912 Military Census linearly adjusted	1912 Military Census linearly adjusted	1912 Military Census quadraticly adjusted	1912 Military Census quadraticly adjusted		
Estimation	FDFE	FDFE	FDFE	FDFE	FDFE	FDFE	FDFE	FDFE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Horse Mobilization	0.15	0.03	0.10	0.33*	0.35*	0.44**		
	[0.252]	[0.245]	[0.149]	[0.182]	[0.186]	[0.182]		
Mobilization		-1.04**		-1.51***		-1.31***	-0.77**	-0.92**
		[0.429]		[0.547]		[0.440]	[0.373]	[0.387]
Mobilization* Agricultural machines per capita							-0.01***	
							[0.002]	
Mobilization* Agricultural tools per capita								-0.003***
								[0.001]
Rural Population	-0.38	-0.36	-0.38	-0.36	-0.37	-0.34	-0.49*	-0.46
	[0.312]	[0.315]	[0.303]	[0.293]	[0.290]	[0.290]	[0.299]	[0.313]
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-12.82***	3.17	-16.71***	0.69	-19.31***	0.38	3.60**	3.46*
	[2.076]	[6.409]	[5.443]	[7.102]	[4.226]	[6.763]	[1.753]	[1.793]
Observations	1,187	1,187	1,187	1,187	1,187	1,187	1,201	1,201
R-squared	0.122	0.159	0.123	0.187	0.157	0.216	0.207	0.196
Number of districts	688	688	688	688	688	688	688	688

Notes: Grain Area stands for cultivated area of summer and winter wheat, summer and winter rye, barley and oats. The unit of observation is District-Year, where cultivated area is aggregated across all farms in a district in a year. See the text and the on-line appendix for details on the adjustments of the pre-war number of horses in a district. FDFE estimates the model in first-differences using district fixed effects. Robust standard errors, clustered at the district level.

*** p<0.01, ** p<0.05, * p<0.1.

Online Appendix

A. Historical section.

A1. Institutional background of Russian agriculture before and during the First World War

The 1905 land census conducted in the European part of the empire provides a detailed snapshot on the allocation of land by ownership type in the beginning of the 20th century in Imperial Russia. According to the census, thirty-one percent of all land belonged to the commune. Private tenure accounted for twenty-six percent of all land and the remaining forty-three percent belonged to the state (Central Statistical Committee 1905-1907). The distribution of the types of land varied by ownership type. The state possessed almost exclusively forest land, while the commune's share of land was mostly arable land. As a result, private land represented only a quarter of all arable land under grain crops in our sample. The remaining arable land under grain crops was on commune farms.

The commune corresponded to a village community. The law required a peasant household to belong to a commune and peasant households from the same village belonged to the same unique commune (in rare cases several neighboring villages composed one commune, or there were two communes in a village). The commune held title on peasant land allocating arable land between households who cultivated plots individually. Communal meadows and forests (while there were few of them) remained in joint usage. There were two main types of commune – repartition and hereditary – that differed primarily in terms of how arable land was allocated. The repartition commune provided arable land to households temporarily and could reallocate plots between its member-households under two-thirds majority but not more often than once every twelve years. Hereditary communes assigned arable land allotments to individual households on

a permanent basis (Zyryanov 1992). Repartition communes represented seventy-three percent of all communes in the European part of the empire and possessed about the same amount of all land under communal ownership in the corresponding territory.

Communal property rights distorted peasants' incentives and occupational choices. Both hereditary and repartition communes operated under the open field system and divided household land allotments into narrow individual strips (Davydov 2010). The commune exercised considerable power to regulate agricultural production so as to coordinate the activities of commune members, i.e. restricting usage rights on land. In addition, peasants were subject to mutual responsibility of land taxes. The allocation of tax burden within the commune mirrored the land distribution. The commune also regulated long-distance migration of peasants through a passport system (Zyryanov 1992). Finally, in repartition communes, periodically redistributing land plots would have limited individual incentives to make long-term investments.

The benefit of restricted property rights for peasants was guaranteed access to land, most powerfully expressed in the repartition commune. In particular, population growth and an increase in the number of peasant households implied the need to repartition the commune's land to guarantee access to land for new commune members. In addition, the commune supported its members in various ways. For example, labor-rich households often provided labor to labor-scare farms either for free or for nonmonetary payments. There were plenty examples of such within-commune cooperation, especially in response to households that had been affected by the mobilization during the First World War (Kondratiev 1922, Anfimov 1962, Zyryanov 1992).

Private land was the land that Russian gentry, i.e. former owners of serfs, kept in their possession after the 1861 serf emancipation reform (Anfimov 1969). This land was on average of better quality because gentry had control which lands they would keep. Private land was free of

communal restrictions and could be sold, leased or used as a collateral. Commune members could and did buy or rent private land, and this practice did not change their claims to their communal plots (Anfimov 1961). Comparing results of the 1916 agricultural census and annual agricultural statistics suggests that peasants leased about a half of private land.[14] Another half was cultivated by private farms, which hired labor from peasant communes.

The 1906 Stolypin agrarian reform produced further institutional diversity in land tenure. Under the reform's decrees, peasants could exit the commune by privatizing the allotments of arable land that they had previously cultivated (non-arable land assets remained in communal ownership). In addition, the reform allowed peasants to consolidate their fragmented plots either individually, without the consent of the commune, or as part of a village-wide (final) land

[14] The 1916 agricultural census reports figures on individual farms, i.e. those where the owner personally participated in the production, and large farms rather than on farms on commune and private land. According to the census, large farms cultivated 7.9 percent of arable land and individual farms – 92.1 percent. Regular 1916 annual statistics show that about three quarters of all arable non-state land was in communal ownership and only about one quarter was in private possession. If one assumes that all commune farms were individual ones, then the share of land leased to peasants was about forty-nine percent of private land (estimated as 17.1 out of 34.7 percentage points of private land; 17.1 is a difference between 92.1 percent of land cultivated by individual farms and three quarters of commune land). According to Pershin (1966 vol. 1 p. 93), peasants rented about a quarter of all land they cultivated; within commune renting was only about one seventh of private renting. Renting between private owners was also limited; about eighty-five percent of crops cultivated by private farms were crops on own land (Anfimov 1962 P. 160).

redistribution under two-thirds majority. Initially, and during most of the reform implementation, households that wanted to consolidate had to first privatize land and, when it became possible to consolidate without exiting, households rarely took this option (Dubrovskij 1963).

Due to the government's limited capacity to carry out the reform, the ownership structure in the countryside changed only partially by the beginning of the war. Many applications to take advantage of various aspects of the reform remained unprocessed (Dubrovskij 1963; Davydov 2010). Over the years of reform implementation, 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 percent of 12.3 million households, correspondingly (Dubrovskij 1963; Davydov 2010). Both the supply of and demand for the reform generated wide variation in the intensity of its implementation across the empire. Seven out of fifty provinces converted the majority of its arable land from communal to individual title as envisioned by reformers; the remaining forty-three provinces still had a majority of arable land with communal title. On average, peasant households that chose to exit the commune did so with twenty percent larger than average allotments. In some provinces, this figure was as high as three hundred percent but, in other provinces, exiting households received considerably less than the average allotment in a province. The partial implementation of the reform could have had several confounding effects on the ability of the commune to function in general. First, there were conflicts between the reform participants and nonparticipants. Second, Chernina et al. (2014) show that the Stolypin reform increased out-migration from the European to the Asian part of the Empire, possibly putting less pressure on the commune. These effects should be second order compared to the impact of the reform on nonmarket allocation.

Importantly, even though the legal status of farms that exited the commune during the Stolypin reform was a hybrid, the official statisticians continued to classify them as commune agriculture. There was nothing similar to the 1905 land census during the post-reform, pre-war years. We know statistics on the Stolypin reform implementation at the province level for the European part of the empire (Castaneda Dower and Markevich 2015), but district level data are still unavailable.

Grain cereals, namely winter and summer rye, winter and summer wheat, barley and oats, were the main products of Russian agriculture and accounted for about a half of all value added in this sector in 1913; another twenty-eight percent came from animal husbandry, and the rest from potatoes and industrial crops (Markevich and Harrison 2011). The war changed the demand for grain but not in a tremendous way. The demand dropped because of the war blockade and collapse of the grain export; however, consumption by the military increased by nearly as much (Kondratiev 1922). On average, a unit of rye cost about eighty percent of a unit of wheat and 1.4 and 1.33 units of oats and barley, correspondingly. There was regional variation in these price ratios, but little changes in relative prices over time with an exception of the oat price that was driven up by military demand (Anfimov 1962). Grain production was relatively less labor intensive than other crops. Cultivation of one acre of winter rye cost 9.6 rubles on average (in terms of labor costs); winter wheat - 10.58; summer wheat – 8.35; oat – 8.16 and barley – 8.15 correspondingly. Production of potatoes was about twice as expensive and flax was four times more expensive (estimated from Strumilin 1966 p. 212).

Grain productivity was higher on private land than on commune land, and both types of farms experienced growth in yields during the pre-war years. Kopsidis, Bruisch and Bromley (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, but their analysis cannot establish breaks in trends.

A2. Russia's mass mobilization of military draftees for the First World War

There were 1.5 million males in the Russian army at the outbreak of the conflict and about another twelve million were drafted into the army during the first two years of the war. Official mobilization figures are not available at the district level. Instead, we employ the difference in gender imbalance between 1913 and 1916 in a district as proxy for mobilization. If one takes the average gender imbalance in a district in our balanced sample and multiplied it by the number of districts in our unbalanced sample (districts in the western provinces were occupied by Germans and 1916 figures are not available for them; there are other missing value districts as well), this gives 12.33 million people as a summary measure of mobilization between 1913 and 1916. The reconstructed figure fits well to the total number of draftees in the country by May 28, 1916 (11.915 million) known from military sources (Golovin 2001). To check the validity of the population data, we also compared our figures with the gender ratio in a district taken from the 1897 Census. The pairwise correlation between the 1897 and 1913 gender ratios is 0.89, giving confidence in the official statistics.

The 1874 and 1912 laws set up mobilization rules. They classified all males between eighteen and forty-three into four groups: in reserve (1), first- and second-class home guards (2 and 3), and exempted (4). The first three groups were subject to mobilization depending on the circumstances the military faced. Soldiers in reserves were mobilized first, then first- and second-class home guards (Golovin 2001). Mobilization targets could vary by age within each group as well as by region depending on the mobilization plans. There were a number of circumstances when the law granted an exemption. First, an individual could receive either a

complete exemption or a deferment because of his family status – the only son in a family, the non-existence of other breadwinners, the presence of a brother in the army, etc. – about fifty percent of males obtained such privileges. The law fixed an individual's family status at the age of twenty-one, i.e. the age of conscription in peace time. Importantly, this legal status remained fixed and did not evolve with an individual's family dynamics, even if the actual status of the individual had changed by the time of the draft. Second, the law granted an exemption for all non-Cossack males from two provinces in the Far East and one province in Central Asia as well as all non-Slavonic population from the Caucasus, Siberian, Kazakhstan, and Central Asian provinces. In contrast, Russian Cossacks, who were concentrated in several provinces, were subject to more extensive mobilization. Third, there were health exemptions and exemptions based on education level. Finally, additional exemptions could be granted if an individual's occupation was considered necessary for the national defense (Golovin 2001).

The rules governing the targets and exemptions guaranteed the imperial authorities the capacity to mobilize large numbers of troops in a short-period of time as well as minimize the potential losses of the draft to agricultural production and the economy as a whole. The mobilization plans themselves were fully executed with very limited societal resistance (Berkevich 1947 p. 14). It is less clear how successfully minimization of losses were realized in practice (Sidorov 1973). Figure A1 presents scale of mobilization over time. There were several military headquarters on the ground where the authorities responsible for mobilization were located. The average distance to a local military center was 368 kilometers.

Scholars agree that mobilization tightened local labor markets (Kondratiev 1922, Litoshenko 1926, Anfimov 1962, Sidorov 1973, Gatrell 2005). The nominal wages in agriculture for both males and females went up. Women were already actively involved in cereal production

before the war and could not compensate for mobilization (Knipovich 1921). However, real wages likely decreased because of war inflation and shrinking production.

B. Data construction and description

We construct our dataset employing various official statistical sources. The unit of observation is a district in a year. There are three cross-sections in our sample, two pre-war ones – 1913 and 1914 – and one war year, 1916. We have data for more than seven hundred districts for pre-war years; the number of observations is less for 1916 because the Central Powers' occupation of western provinces of the Russian empire and worse statistical reporting by local authorities during the war.

First, we construct the mobilization measure taking the difference between war and pre-war gender balance in the rural areas (defined as rural females minus rural males) estimated from the 1916 Agricultural Census conducted between May and July (Ministry of Agriculture of Russian Empire, 1916a) and 1913 official statistics (Central Statistical Committee, 1914). Second, we use data on cultivated area and crop yields of winter and summer rye, winter and summer wheat, oat and barley in 1913, 1914 and 1916 (Central Statistical Committee 1913c, 1914b, Special Food Committee 1916). For each district we have information on cultivated area and production of cereals by farm type, namely area under crops and yields on private and commune land. We use the report by the Special Food Committee rather than the agricultural census as a source for the 1916 cross-section because the census used a different classification system, distinguishing between large and household farms rather than private and commune farms. Original figures on area and crop yields are in Russian imperial units, namely in desyatinas and puds. We transform them into standard hectares and kilograms (one desyatina equals 1.0925 hectare; one pud equals 16.38 kilograms). We employ provincial autumn prices on

wheat, rye, barley and oats, (Ministry of Agriculture 1913, 1914 and 1916b) to construct a unified price-weighted area under crops index. We approximate missing values on prices in a province by prices of the same crop in neighboring provinces. We normalize grain prices by wholesale foodstuffs prices from Gatrell (2005).

We extract information to construct control variables from annual official statistical volumes (population variables, including urban population - Central Statistical Committee 1913b, 1914a), the only 1897 Imperial Population Census (district of birth and literacy figures extracted from ninety-eight province volumes), the only 1910 census on agricultural machines and tools (amount of agricultural machines – namely, seeding machines, harvesting machines, threshing machines, winnowing machines, mowing machines and horse rakes – and agricultural tools at private and commune farms in a district, reported separately, - Central Statistical Committee 1913a), and the 1905 Land Census (distribution of owners by legal status, commune type, and plot size extracted from fifty province volumes; we use this distribution by plot size within commune to construct commune land Gini index). In the Baltic provinces, where there were no communes for peasants to belong to, the legal distinction of peasant still existed and hence the commune land Gini index for these provinces is simply a peasant land Gini index. The 1905 Land Census covered only the European part of the empire, not including Kuban, Stavropol and Terek provinces. We are also able to employ the province-level dataset from Castañeda Dower and Markevich (2015) on the Stolypin reform, which was extracted from various original sources and covered the European part of the empire. We also make use of weather data – temperature and rainfall (Central Statistical Committee 1921). Weather stations tended to be located in European Russia and the published sources reported observations irregularly.

Mobilization of males was accompanied by the mobilization of 2.6 million horses that Anfimov (1962) estimate as 8 percent of their pre-war number. However, the pre-war statistics on horses, known from 1912 horse census (Central Statistical Committee 1913d) suffers from poor registration, in contrast to high quality 1916 figures known from agricultural census (Ministry of Agriculture of Russian Empire 1916a). Subtracting the 1916 official statistics from the 1912 military census yields a negative figure of -3.87 million horses mobilized! The leading expert on the subject, Vainshtein (1960), argues that an official pre-war estimate of rural (excluding urban) horses was underestimated by 16.5 per cent, and the true figure was closer to 42 million horses rather than official 35 million. There should have been 0.299 horses per capita and 0.0497 horses per capita were underreported.

We employ a special procedure to correct for the bias in pre-war horse figures. We make an assumption that the military census primarily underestimated the number of horses due to lack of personnel, measured as a number of local registration centers per capita in a district in 1912. We then regress the observed horses per capita in 1912 on the number of local registration centers per capita with no constant to keep the interpretation that with zero registration centers we would observe zero horses. The coefficient on the number of registration centers gives us a means to project the extent of underreporting. Using the estimated coefficient (2.65), we solve for the number of registration centers per capita, x, that would yield the true number of horses per capita ($2.65x=0.299$). We then obtain the unregistered number of horses estimated to be 2.65*(x - the district's actual number of registration centers per capita) multiplied by the rural population. After that we add the estimated number of unregistered horses to the official 1912 figures. We use these corrected 1912 figures as our proxy for horses in 1913 and 1914. Finally, to get the number of horses mobilized, we simply subtract the 1916 level of horses (known from

the census) from the corrected 1912 figures. We repeat this procedure using a quadratic relationship of observed horses on registration centers. The linear procedure results in 29.85 million horses added and 16.7 million horses mobilized. The quadratic procedure results in 20.06 million horses underreported and 7.94 million horses mobilized.

Table B1 provides a list of all original measures we use to construct variables in our dataset with references to the sources from which we extract original figures.

C. Additional results

C1. Mass mobilization and changes in MPL: an aggregate view

Using the results of specification (1), we could also estimate the MPL in agriculture following this massive labor removal. We prefer to rely on the results from the second column of table 3 because these estimates account for the difference in grain crops' prices. To construct MPL in 1916, we take the coefficient on mobilization (-2.22). To switch to average figures, we multiply this number by 16.16 (mobilization in an average district in thousands) and divide by 97.3 (the average price-weighted cultivated area in a district in thousand hectares before the war). Then, we divide the result (0.369) by the average share of mobilized labor force relative to the pre-war (0.162) and get 2.28 percentage decrease in output in response to a one percent decrease in labor. We obtain this figure from grain production alone and would like to convert it to aggregate terms. If peasants were able to freely allocate their labor across agricultural activities, then the estimate for grain should pin down the estimate for the aggregate. To obtain the estimate of marginal productivity of labor, we multiply 2.28 by the average value of agricultural output per district (8288/763 million rubles) and then divide by 83575, which is equivalent to taking the

marginal worker as a percentage of the (male equivalent) labor force after removal.[15] Our estimate of the marginal productivity of labor as a result of mass mobilization is then 296 rubles, which is four times higher than the estimated pre-war level as Table C1 shows.[16] We note that our estimate reflects the population of young, healthy males and it should be higher than the average MPL. Nevertheless, even though this is exactly the population that would be going into industry, a large productivity gap remains and the coefficient on mobilization is statistically distinguishable from the value of the coefficient (-3.71) that would close the gap. The agricultural productivity gap does narrow considerably from 6.8 to 1.7.

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[15] To estimate the share of mobilized labor force, we assume that the total labor force in 1913 equaled the total number of males in 1913 multiplied by the share of males of the age between 16 and 75 (known from the 1897 population census) plus the number of females of the same age (estimated in the same way) multiplied by 0.7, which reflects the relative female to male labor productivity estimated as female to male wage ration before the war (58 and 83 kopeks per day in 1913, Anfimov 1957 P. 138).

[16] An alternative way to estimate the MPL would be to treat the coefficient on mobilization as the true average effect of mobilization on agricultural output (expected yield) divided by a scalar representing the average pre-war yield per hectare. We obtain the pre-war yield per hectare, which was about 800 kilograms per hectare, from our data. We then normalize the effect of mobilization using the pre-war average price-weighted yield. Switching to units of yield by using this method gives an estimate of MPL that is 203 rubles and a labor elasticity of output that is 1.58. These figures, while smaller, are still large and does not qualitatively change our interpretation. The switch to units of yield is less because of classical measurement error.

Such a large figure for the MPL is seemingly at odds with the aggregate figures of GDP per capita and the pre-war estimates of APL and MPL in Table C1. However, a naïve comparison between our MPL estimate and the aggregate figures is misleading. First, the large estimate could reflect adjustments costs in the short-run response to mobilization. Second, the pre-war estimates of APL and MPL assume an aggregate, constant-returns-to-scale production function, for which the MPL cannot exceed the APL. The district aggregate production function could exhibit local increasing returns for a variety of reasons related to imperfect markets. For example, if households were not far from subsistence before the war and there were credit constraints, the agricultural production function could be S-shaped. Third, our estimate of MPL is taken from an average of first-order approximations, assigning equal weight to each district. It is possible that those districts that were close to the average level of mobilization do a poor job of predicting changes in output at the extremes or that less populous districts that were more intensively mobilized drive the estimated MPL upwards relative to the aggregate figures.

A benevolent policy maker could use agricultural surplus for the development of other sectors.[17] A simple back-of-the-envelope calculation based on our estimation of MPL after mobilization yields an upper bound on the amount of surplus that could be extracted from the

[17] The profession uses three notions of agricultural surplus related to labor. To avoid confusion, we use terms such as redundant or idle labor to indicate MPL = 0; agricultural productivity gap to indicate the MPL in agriculture is less than MPL in other sectors; and marketed surplus to indicate that the average productivity of labor is greater than the value of food consumption per capita. Labor misallocation refers only to the first two types. Policymakers interested in exploiting agricultural surplus to boost aggregate output would also want to consider the third type.

rural sector of 1160 rubles per reallocated worker, which would almost cover the level of capital outlay per worker in industry (1282 rubles in 1913).[18] However, such comparison between extractable agricultural surplus per mobilized worker and the necessary capital investment to expand the industrial sector sufficiently to absorb these workers should also consider two very important costs. The first is that agricultural output could not be extracted costlessly and, as the history of Stalin's industrialization associated with famine later demonstrated, this cost could be prohibitively high. The second is related to the changes in the economic organization of agricultural production in response to labor removal. Even under costless extraction, we show that the relatively large estimate of MPL in agriculture and the corresponding swelling of surplus are an illusion because of the deindustrialization of agriculture and a switch to survival strategies. As the experience of Russian agriculture in the First World War suggests, the preference for social insurance and survival strategies during the time of rapid change, which would also be a feature of any type of massive labor reallocation, is an important constraint for such a policy. Indeed, one of the suspected causes of the 1917 Russian Revolution was a sharp decrease in food availability in urban areas in the winter of 1916. Our results point to the mutual causation of mobilization for the Great War and the nonmarket allocation of land afforded by the commune as one of the potential reasons for this sharp decrease in food availability. Millar

[18] We obtain this figure by multiplying the increase in agricultural MPL in the amount of 224 rubles (taken as the difference between MPL before and after the mobilization, 296 minus 72 rubles) by the number of employees remaining in agriculture after the mobilization (63.7 million) to get total potential surplus. Then, we divide the result by the amount of mobilized draftees (12.3 million), i.e. potential industrial worker under counter-factual scenario, to switch to a per worker figure.

(1970) and Ellman (1978) were also critical of the idea of large levels of agricultural surplus available to fund Soviet investment.

C2. Additional robustness checks

We start by addressing concerns related to our dependent variable, i.e. area under crops. One concern might be that peasants could increase labor inputs per hectare to boost agricultural yields. We are looking at yields rather than at area under crops in Table C2 to deal with this criticism. The yield data are of worse quality, but they exhibit roughly the same pattern. Another robustness check reported in Table C3 is to rerun our main results using the log transformation of area under crops as a dependent variable and the share of the male labor force mobilized (taking zeroes for 1913 and 1914) as the variable of interest. We observe very similar patterns to those we find running the regressions in differences in levels. An additional check that we performed (results not reported, but available upon request) is that we dropped all observations from the 1914-year, using only the difference between the 1913 and 1916, and we get similar results.

Next, our assumption that peasant behavior responded to implicit or explicit prices merits further scrutiny according to the older literature (Chayanov 1966). In defending peasants' responsiveness to prices, both Antel and Gregory (1994) (for the early Soviet period) and Nafziger (2010) (for late Imperial Russia) precede us by providing empirical evidence of peasant household responsiveness to market and shadow prices in output and factor markets. In Table C4, we report additional evidence that peasants responded to changes in implicit or explicit prices driven by labor scarcity. We consider two types of substitution, slack (winter) season labor for peak (summer) season labor and capital for labor substitution. Since the opportunity cost of labor is higher during the peak season than the slack season, the household may choose to allocate more labor to the slack season even if labor productivity is higher during the peak

season. Under the three field system, this reallocation of labor was possible as different sets of tasks on plots at different points in the rotation overlapped in time. The typical rotation was winter, summer and then fallow. A farmer could skip the fallow period and go directly to winter crops to compensate for the lower summer yield.

In Table C4, we see that the drop due to mobilization in private farms is more pronounced for summer than for winter grains, while the opposite is true for the relative increase in commune farms. Coefficients on the mobilization variable in columns (1) and (2) (summer crops) are larger in magnitude than in columns (3) and (4) (winter crops) and the sum of coefficients on the mobilization variable and the interaction term between the mobilization variable and the commune dummy are larger for winter crops. Peasants coped with mass mobilization by substituting with labor in the slack season when labor was cheaper.

We also look at how the share of urban population in a district affects the impact of mobilization as a greater presence of urbanized population could represent a greater demand for labor as well as food (columns 5 and 6 of table C4). Areas with larger urban centers would have had greater labor or food demand outside of the commune before mobilization. The urban demand for labor did not collapse and may have even expanded since the government actively developed new industries in old urban locations during the war (Sidorov 1973). In addition, the greater urban presence meant greater food demand and better opportunities for farm production, although some scholars believe there was a collapse of urban/rural trade due to the reduction in industrial goods made to exchange for food (Broadberry and Harrison 2005). For private farms, the coefficient on the interaction term between the mobilization variable and urbanization is negative and statistically significantly different from zero (but not so in column (2) for the value index). This effect is consistent with greater urban demand for labor. The triple interaction term

between urban share, the commune farm dummy and the mobilization variable is positive, again suggesting the labor substitution story. Moreover, these findings show that the commune resilience effect is robust to allowing demand effects to be correlated with mobilization through its correlation with urban share. We also ran regressions including a separate secular change in output between 1914 and 1916 for private farms and commune farms as well as letting the secular change to depend linearly on the share of private farm area in 1913. The results (available upon request) also show that demand effects, which should have been stronger for private farms, do not appear to alter the results.

In table C5, we present more evidence on within-district labor mobility across farm types as a response to mass mobilization. To emphasize the point that mass mobilization led to a reorganization of production, we consider how mobilization affected the institutional concentration of grain production within a district, estimated as a sum of squared shares of area under crops on commune and private farms (Herfindahl index), before and during the war, and use it as a dependent variable in the specification (1). Given the results of table 3, one would expect to find institutional concentration to increase due to relatively greater production in the commune. The advantage of this dependent variable is that we can observe the movement to the commune while using district aggregate data. We report the results in column (1) of Table C5; mobilization at larger scale indeed led to greater institutional concentration in grain production. The magnitude of the effect is large. One standard deviation increase in mobilization (13.32) leads to 0.04 points or five percent increase in the institutional concentration index.[19]

[19] We stress that the law prohibited changes in legal status of arable land (Kondratiev 1922). The reduction or extension of crops on commune or private land are the only changes that drive our institutional concentration index.

Next, we provide more direct evidence concerning the commune becoming an increasingly favorable option compared to wage labor or renting private land, as the scale of mass mobilization amplifies. We exploit the wide variation in the scale of mass mobilization to allow for heterogeneity in the effect of mass mobilization according to how intensively labor was removed. Specifically, we allow the effect of mobilization to vary by interacting mobilization with dummy variables that represent different cut-off points in the share of the labor force that was mobilized. As cut-off points, we use 11 (about 15 percent of the sample have less than 11 percent of the labor force mobilized), 16 (the median), and 21 percent (about 10 percent of the sample). These values were chosen to correspond to roughly one standard deviation above and below the median. In columns 2 to 4 of Table C5, we find a negative effect of mobilization for all districts, both above and below the chosen cutoff. Interestingly, the magnitudes of the coefficients on mobilization and its interactions with the cut-off point dummies suggest a diminished effect of mobilization in more heavily mobilized districts. We first note that a pure labor surplus argument would predict an increasing relationship, as would diminishing returns to labor. To understand this result, consider the marginal laborer at different levels of mobilization. At low levels of mobilization, only those peasants in the worst positions would return to the commune and would likely return to engage in subsistence production. Since the switch to subsistence most certainly exhibits increasing returns to scale, we would expect the largest decreases in cropped area for this type of within-district across farm-type labor mobility. At higher levels of mobilization, better-off peasants, i.e. those who had been renting private land, would find it profitable to return to the commune and thus would not entail the dramatic reduction in cropped area. An additional explanation is greater labor substitution from labor-intensive production to grain production at higher levels of mobilization.

We provide more evidence that better-off peasants tend to diminish the effect of mobilization. From the 1897 population census, we take the literacy rate, which was, on average, quite low in the Russian countryside. A higher literacy rate should reduce the direct costs of mobility. As earlier, we report results in two variants for area under grain crops and price weighted area index (columns 5 and 6 of Table C5). After accounting for the costs of mobility, our main results hold. As expected, mobilization had less effect in terms of changes in output in more literate districts, but the coefficient is imprecisely measured. More literate peasants were less likely to switch to subsistence production for which the relative decrease in area under crops would have been the largest. Reinforcing this effect, mobilization rules would have given less priority to skilled (and presumably literate) labor, resulting in substitution of unskilled for skilled labor (Golovin 2001).

Finally, we analyze to what extent mobility costs could affect our results. One assumption we make is that the primary source of labor mobility is within-district across farm-type, yet our measure picks up all types of gender-biased in- or out-migration. In order to rule out that cross-district mobility explains the effects we observe, we interact mobilization with a variable that accounts for the cumulative cross-district migration up to 1897, taken from the 1897 population census (the only available measure of migration in the late Imperial Russia). This variable should track the well-established cross-district migration patterns and districts with greater cumulated migration should therefore also attract labor following mass mobilization. In columns (7) and (8), we see that the effect of mobilization is diminished in districts with better established pre-existing migration patterns. For the district with an average amount of cumulative migration in 1897, the effect of mobilization is still negative and statistically significant and roughly the same magnitude. Therefore, cross-district mobility can not explain

our results, although it appears to play a role. We see that moving from a district with an average amount of pre-war cross-district mobility to one in the 90th percentile would decrease the effect of mobilization by 75 percent for cultivated grain area in column (7) and by thirty percent for the output index in column (8).

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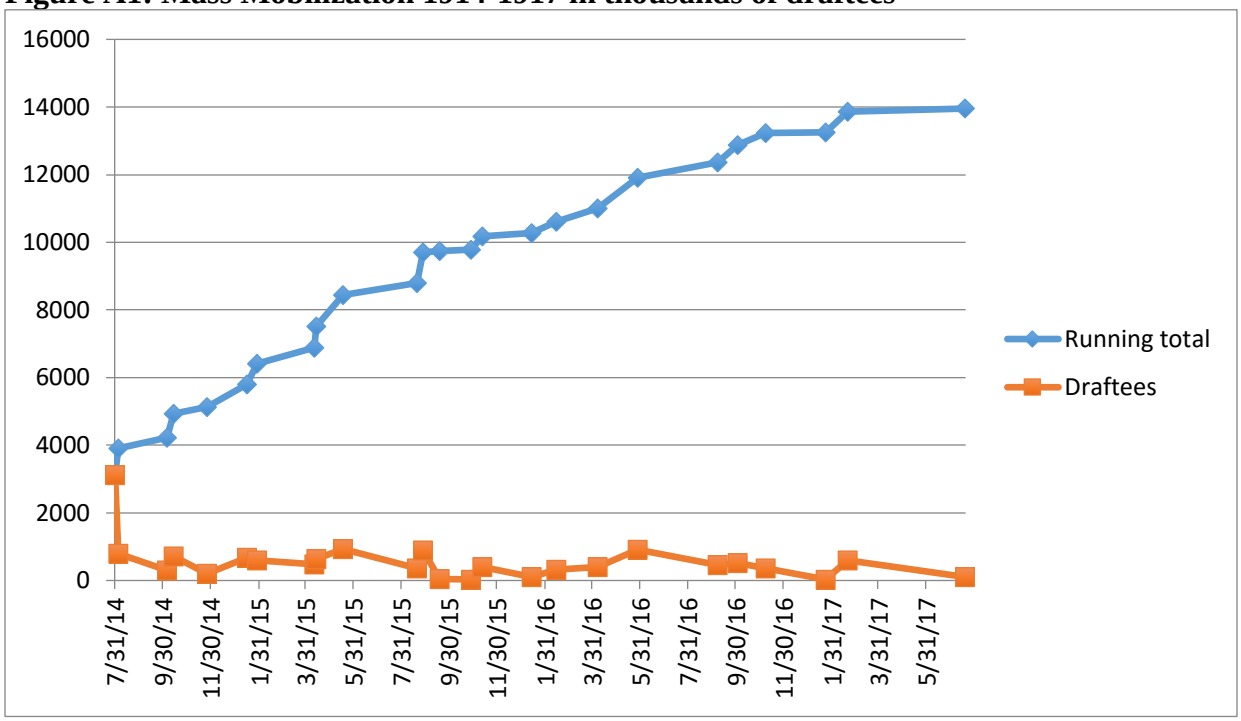
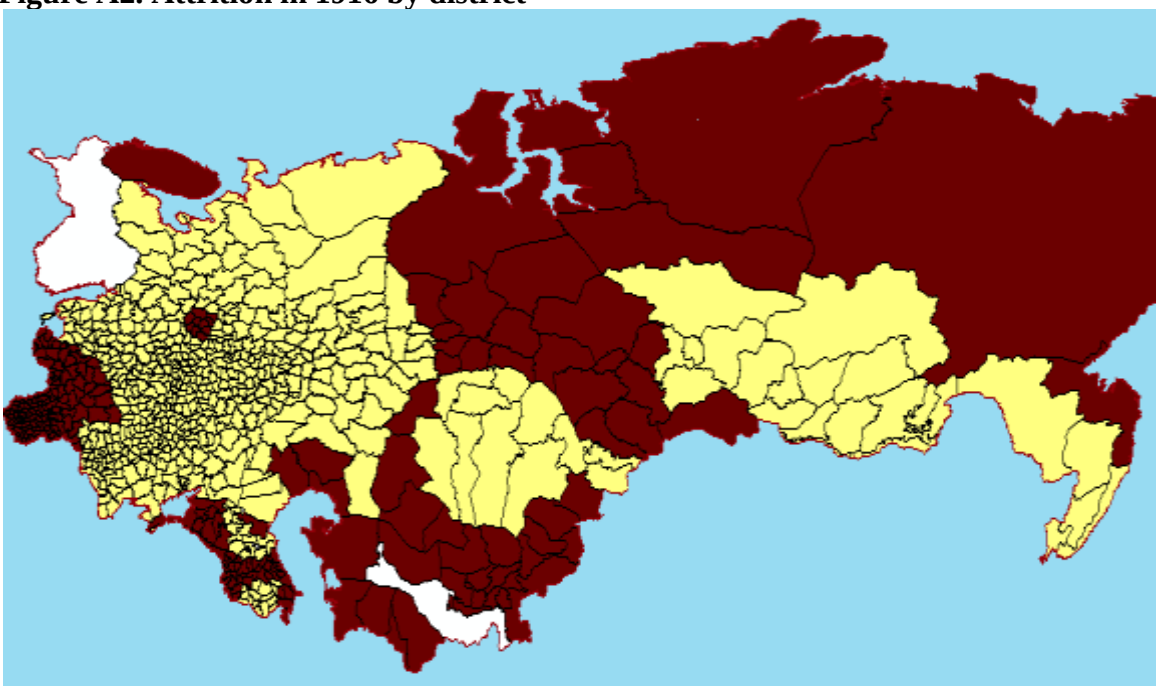
Figure A1: Mass Mobilization 1914-1917 in thousands of draftees



Source: Golovin (2001).

Figure A2. Attrition in 1916 by district



Notes: Attrited districts are in brown. Autonomous great duchy of Finland and protectorates of Khiva and Bukhara protectorates are in white. While they were part of the Russian empire, they are out of 1913-1916 sample because of data availability. Districts for which we have both pre-war and war data are in yellow.

Table B1.Variables used for the construction of the dataset and sources.

Variable:	Years:	Unit of observation:	Source:
Area under crops of winter and summer rye, winter and summer wheat, oat and barley	1913, 1914, 1916	District by farm type	Central Statistical Committee 1913c, 1914b; Special Food Committee 1916
Crop yields of winter and summer rye, winter and summer wheat, oat and barley	1913, 1914, 1916		Central Statistical Committee 1913c, 1914b; Special Food Committee 1916
Prices on wheat, rye, barley and oats	1913, 1914, 1916	Province	Ministry of Agriculture 1913, 1914 and 1916b
Male and female rural population	1913, 1916	District	Central Statistical Committee, 1913b; 1914a; Ministry of Agriculture of Russian Empire, 1916a
Rural and urban population	1913, 1914, 1916	District	Central Statistical Committee 1913b, 1914a
Agricultural machines and tools	1910	District by farm type	Central Statistical Committee 1913a
Horses	1912, 1916	District	Central Statistical Committee 1913d; Ministry of Agriculture of Russian Empire 1916a
Temperature and rainfall	1913, 1914,	Weather	Central Statistical Committee

	1916	station	1921
Number of land owners by legal status, commune type, and plot size	1905	District	Central Statistical Committee, 1905-1907
Commune size	1905	District	Central Statistical Committee, 1905-1907
Number of households exited the commune because of the Stolypin reform and exited land area	1906-1913	Province	Castañeda Dower and Markevich 2015
District of birth	1897	District	Trojnitskij, 1900-1910
Literacy	1897	District	Trojnitskij, 1900-1910

Table C1: Productivity before and during the First World War

	Output (million rubles)	Labor (million)	APL (rubles)	MPL (rubles)	Agricultural Productivity Gap
Industry, 1913	5933	8	741.6	494.4	…
Agriculture, 1913	8288	76	109.1	72.7	6.8
Agriculture, 1916	…	…	…	295.8	1.7

Notes: for 1913 figures, output is from Markevich and Harrison (2011); labor is from Davies, Wheatcroft and Harrison, (1994 p. 82); APL is estimated as Output/Labor ratio and MPL - as (1-a)*APL under an assumption of a standard Cobb-Douglas production function and of a=1/3.
Agricultural productivity gap is estimated as a ratio of pre-war MPL in industry to MPL in agriculture.
The post-mobilization 1916 MPL in agriculture comes from our district-level regression analysis. The coefficient on mobilization in the preferred specification is -2.22. To switch to average figures, we multiply this number by 16.16 (mobilization in an average district in thousands) and divide by 97.3 (the average price-weighted cultivated area in a district in thousand hectares before the war). Then, we divide the result (0.369) by the average share of mobilized labor force relative to the pre-war (0.162) and get 2.28 percentage decrease. We multiply this figure by 8288/763 million and divide by 83575, which is equivalent to taking the marginal worker as a percentage of the labor force times the average value of agricultural output in a district. To estimate the share of mobilized labor force, we assume that the total labor force in 1913 equaled the total number of males in 1913 multiplied by the share of males of the age between 16 and 75 (known from the 1897 population census) plus the number of females of the same age (estimated in the same way) multiplied by 0.7, which reflects the relative female to male labor productivity estimated as female to male wage ration before the war (58 and 83 kopeks per day in 1913, Anfimov 1957 P. 138).

Table C2: The effect of mass mobilization on crop yields

Dependent Variable	Summer Wheat Yield	Summer Wheat Yield	Winter Rye Yield	Winter Rye Yield	Barley Yield	Barley Yield	Oats Yield	Oats Yield
Estimation	FE	FE	FE	FE	FE	FE	FE	FE
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mobilization	-2.01***	-2.55***	0.23**	0.52**	-0.21*	-0.52	-0.16**	0.05
	[0.483]	[0.485]	[0.093]	[0.205]	[0.126]	[0.545]	[0.076]	[0.088]
Rainfall		-0.03**		0.01		-0.01		0.00
		[0.014]		[0.007]		[0.005]		[0.004]
Annual Temperature		4.57		2.38		-3.25		-2.87**
		[6.064]		[2.492]		[3.783]		[1.411]
Rural Population	-0.06	0.00	-0.01	-0.02	-0.05*	-0.06	0.05**	0.06***
	[0.074]	[0.051]	[0.010]	[0.024]	[0.028]	[0.043]	[0.024]	[0.019]
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	40.07***	38.04	36.98***	-0.42	27.81***	61.99**	15.49***	20.61
	[14.824]	[42.547]	[2.104]	[17.791]	[5.654]	[31.497]	[4.631]	[13.556]
Observations	1,714	515	1,879	537	1,905	564	1,951	567
R-squared	0.212	0.427	0.035	0.084	0.087	0.157	0.128	0.206
Number of districts	745	295	750	295	762	301	762	301

Notes: FE estimates a model with district fixed effects. Robust standard errors, clustered at the district level in brackets.

*** p<0.01, ** p<0.05, * p<0.1.

Table C3: The relative effects of mass mobilization (logs)

Dependent Variable	Grain Area	Grain Area Autumn Price Index	Grain Area	Grain Area Autumn Price Index	Summer Grain Area	Summer Grain Area Autumn Price Index	Winter Grain Area	Winter Grain Area Autumn Price Index
Estimation	FDFE	FDFE	FDFE	FDFE	FDFE	FDFE	FDFE	FDFE
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mobilization	-0.86	-1.80*	-5.04***	-6.13***	-4.66***	-6.59***	-3.48***	-3.87***
	[0.900]	[1.032]	[0.954]	[1.119]	[0.935]	[1.313]	[0.731]	[0.689]
Mobilization* Commune			8.36***	8.66***	8.03***	8.12***	8.46***	8.37***
			[0.449]	[0.441]	[0.444]	[0.435]	[0.431]	[0.426]
Rural Population	0.05*	0.05*	0.05*	0.05*	0.05**	0.06***	0.03	0.02
	[0.028]	[0.027]	[0.028]	[0.027]	[0.025]	[0.022]	[0.025]	[0.025]
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.56***	-0.84***	-0.56***	-0.84***	-0.78***	-1.40***	-0.85***	-0.91***
	[0.155]	[0.175]	[0.155]	[0.175]	[0.154]	[0.203]	[0.130]	[0.119]
Observations	2,389	2,389	2,389	2,389	2,483	2,483	2,402	2,402
R-squared	0.084	0.229	0.276	0.402	0.273	0.510	0.211	0.249
Number of Districts	688	688	688	688	728	728	688	688

Notes: Grain Area stands for cultivated area of summer and winter wheat, summer and winter rye, barley and oats. Grain Area Autumn Price Index stands for the cultivated area of summer and winter wheat, summer and winter rye, barley and oats, each weighted by autumn crop prices and normalized by wholesale foodstuffs prices. Summer Grain Area stands for cultivated area of summer wheat, summer rye, barley and oats. Summer Grain Area Autumn Price Index stands for the cultivated area of summer wheat, summer rye, barley and oats, each weighted by autumn crop prices and normalized by wholesale foodstuffs prices. Winter Grain Area stands for cultivated area of winter wheat and winter rye. Winter Grain Area Autumn Price Index stands for the cultivated area of winter wheat and winter rye, each weighted by autumn crop prices and normalized by wholesale foodstuffs prices. The unit of observation is a District-Farm Type-Year, where cultivated area is aggregated across private and commune farms separately in a district in a year. FDFE estimates the model in first-differences using district fixed effects. Robust standard errors, clustered at the district level.

*** p<0.01, ** p<0.05, * p<0.1.

Table C4: Mass Mobilization and Peasant Behavior

Dependent Variable	Summer Grain Area	Summer Grain Area Autumn Price Index	Winter Grain Area	Winter Grain Area Autumn Price Index	Grain Area	Grain Area Autumn Price Index
Estimation	FDFE	FDFE	FDFE	FDFE	FDFE	FDFE
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Mobilization	-1.76***	-1.06***	-0.39***	-0.36***	-1.91***	-1.56***
	[0.274]	[0.261]	[0.086]	[0.075]	[0.312]	[0.279]
Mobilization* Commune	1.47***	0.37**	1.15***	0.59***	2.77***	0.80***
	[0.455]	[0.185]	[0.117]	[0.076]	[0.399]	[0.250]
Mobilization* Urban Share					-2.23*	-0.98
					[1.300]	[0.769]
Mobilization* Urban Share*Commune					4.30	2.90**
					[2.675]	[1.418]
Relative price	17.34	14.96	6.82	-6.08*		
	[11.710]	[9.575]	[4.303]	[3.627]		
Rural Population	-0.19	-0.12*	0.01	0.02*	-0.18	-0.07
	[0.144]	[0.068]	[0.020]	[0.011]	[0.171]	[0.081]
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes
District Trends	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-6.05	-15.97**	-11.35***	1.57	1.87	-3.23
	[10.406]	[7.901]	[3.465]	[3.075]	[3.139]	[3.945]
Observations	2,483	2,483	2,402	2,402	2,389	2,389
R-squared	0.165	0.218	0.264	0.229	0.314	0.302
Number of Districts	728	728	688	688	688	688

Notes: Summer Grain Area stands for cultivated area of summer wheat and summer rye, barley and oats. Summer Grain Area Autumn Price Index stands for the cultivated area of summer wheat and summer rye, barley and oats, each weighted by autumn crop prices and normalized by wholesale foodstuffs prices. Winter Grain Area stands for cultivated area of winter wheat and winter rye. Winter Grain Area Autumn Price Index stands for the cultivated area of winter wheat and winter rye, each weighted by autumn crop prices and normalized by wholesale foodstuffs prices. The unit of observation is a District-Farm Type-Year, where cultivated area is aggregated across private and commune farms separately in a district in a year. FDFE estimates the model in first-differences using district fixed effects. Robust standard errors, clustered at the district level.

*** p<0.01, ** p<0.05, * p<0.1.

Table C5: More Evidence on Labor Mobility

Dependent Variable	Institutional Concentration Index	Grain Area	Grain Area	Grain Area	Grain Area	Grain Area Autumn Price Index	Grain Area	Grain Area Autumn Price Index
Estimation	FDFE	FDFE	FDFE	FDFE	FDFE	FDFE	FDFE	FDFE
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mobilization	0.003***	-3.22***	-3.96***	-3.13***	-0.86*	-2.00***	-1.00**	-2.19***
	[0.001]	[0.984]	[0.574]	[0.371]	[0.442]	[0.515]	[0.432]	[0.521]
Mobilization* Indicator of above 11% of the labor force		0.32						
		[0.873]						
Mobilization* Indicator of above 16% of the labor force			1.35***					
			[0.420]					
Mobilization* Indicator of above 21% of the labor force				1.64***				
				[0.260]				
Mobilization* Literacy in 1897					2.63	1.14		
					[2.245]	[1.618]		
Mobilization* Mobility in 1897							16.00*	14.82**
							[9.098]	[5.974]
Rural Population	-0.00	-0.18	-0.18	-0.22	-0.34	-0.18	-0.36	-0.20
	[0.000]	[0.155]	[0.144]	[0.136]	[0.317]	[0.151]	[0.313]	[0.152]
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.01**	5.70	9.62	5.95	3.55	-7.56	3.60	-6.71
	[0.003]	[5.462]	[5.913]	[5.329]	[6.298]	[8.151]	[6.280]	[8.223]
Observations	1,194	1,201	1,201	1,201	1,183	1,183	1,197	1,197
R-squared	0.618	0.610	0.635	0.630	0.167	0.580	0.160	0.571
Number of districts	683	688	688	688	679	679	686	686

Notes: Institutional Concentration Index is the sum of squared shares of cultivated area for each farm type. Grain Area stands for cultivated area of summer and winter wheat, summer and winter rye, barley and oats. Grain Area Autumn Price Index stands for the cultivated area of summer and winter wheat, summer and winter rye, barley and oats, each weighted by autumn crop prices (normalized by wholesale foodstuffs prices). The unit of observation is District-Year, where cultivated area is aggregated across all farms in a district in a year. FDFE estimates the model in first-differences using district fixed effects. Robust standard errors, clustered at the district level.

*** p<0.01, ** p<0.05, * p<0.1.