# Was Stalin Necessary for Russia's Economic Development?*

Anton Cheremukhin, Mikhail Golosov, Sergei Guriev, Aleh Tsyvinski

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**Abstract**

This paper studies structural transformation of Soviet Russia under Stalin in 1928-1940 from an agrarian economy to an industrialized power. We analyze this change through the lens of a two-sector neoclassical growth economy. We construct a dataset allowing a comprehensive comparison of Soviet Russia in 1928-1940 with Tsarist Russia in 1885-1913. We then estimate the distortions, the wedges, in the capital, labor, and product markets as well as the intertemporal investment wedges. We find that in 1928-35 the wedges dramatically increased and the sectoral TFP precipitously fell compared to those of Tsarist Russia. The peak of the wedges and the bottom of TFPs coincide with the peak of Stalin's policies. In the late 1930s, we show that the frictions, most importantly, the labor barrier and the investment friction declined. However, the sectoral TFP performed poorly. We extensively connect the history of policies and institutional frictions to the wedges. Finally, we show that Stalin's policies led to a short-term welfare losses of 24 percent of consumption in 1928-1940 compared to the projected behavior of the economy under tsarist frictions. The long run effects, post 1940 and assuming no World War II, are more sensitive to the assumptions on the long-term performance of the TFPs. Under our benchmark comparison, the reduction of barriers outweighs the lackluster performance of TFP and leads to 16 percent welfare gain post-1940. Alternative growth scenarios we consider may deliver a slightly higher gain or a significant welfare loss in the long run.

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# 1 Introduction

In 1962 a prominent British economic historian Alec Nove in his article "Was Stalin Really Necessary?" (Nove 1962) posed a question whether in the absence of Stalin's economic policies during of late 1920s and 1930s Russia would be able to industrialize. The transformation of Soviet Russia from a backward agrarian economy to an industrialized superpower is one of the most significant economic and political events of the 20th century. Industrialized Soviet Russia was instrumental in the victory in World War II over Nazi Germany, reshaped the post-war world, and continued to be one of the two main superpowers for almost fifty years. The economics behind this transformation is therefore of profound interest.

This question of Stalin's industrialization is also of academic importance for three reasons. First, from the point of view of development economics – these policies are one of the most important examples of structural transformation implemented from the top. Soviet industrialization inspired countless others development models, most importantly in Nehru's India and in Mao's China. Certainly, even in the US caught in the pains of the Great Depression, growth of the Soviet Russia in the 1930s made it less clear whether a market economy would be able to compete with the centralized Soviet economy. Second, ours is the first modern neoclassical analysis of the socialist economy. In the spirit of Cole and Ohanian (2004) who used the tools of modern macroeconomics to comprehensively analyze the Great Depression, we develop a model of structural transformation and growth of Soviet Russia and map policies into distortions. Third, our analysis sheds light on what type of policies might have contributed to the structural transformation of Soviet economy. Specifically, we are interested in delineating the validity of Big Push theories in which TFP improves by reallocating resources (e.g., Murphy, Schleifer and Vishny, 1989) versus the view of Acemoglu and Robinson (2012) that Stalin's policies lead to removal or reduction of barriers to effective allocation of resources.

The proponents and the critics of Stalin's policies generally refer to Figure 1 which shows Russian per capita output and labor force composition between agricultural and non-agricultural activities. Both sides of the debate generally agree that Stalin's economic policies of late 1920s and 1930s were harsh. The proponents, however, point out to the rapid growth in 1928-1940 and to the fast reallocation of labor from agriculture to non-agriculture. This view holds that, although excessively brutal, Stalin's policies allowed Russia to develop a strong modern economy that sustained a successful war effort in 1941-1945 and propelled Russia into a position of a dominant power after WWII.[1] Critics of Stalin's policies argue that rapid growth before WWII may simply be a result of Russia catching up to is pre-WWI trend and point out that by 1940 GDP per capita in Stalin's USSR is not very different from the projected tsarist trends.

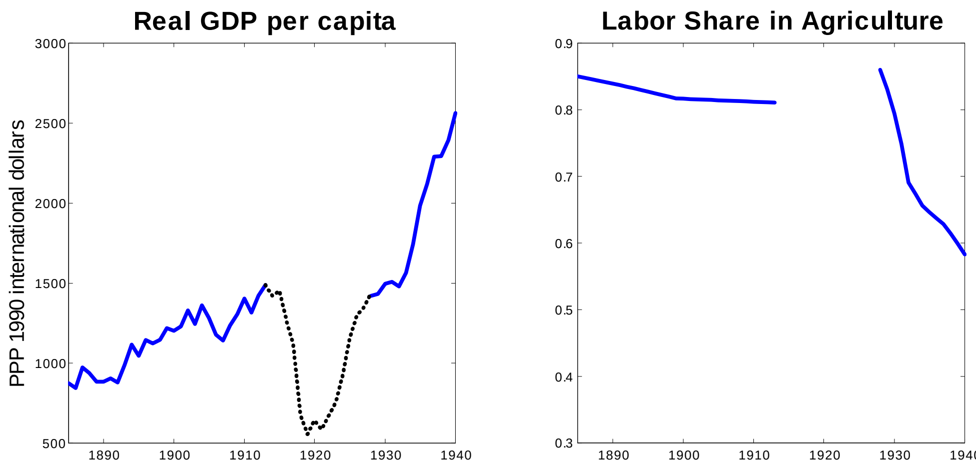


Figure 1: Real GDP and sectoral labor share in Russia and Japan

Both arguments have weaknesses. Figure 1, for example, does not allow to distinguish whether Soviet Russia merely returns to its pre-WWI trend or transitions to a higher level, which is being interrupted by WWII. Figure 1 also says little about welfare. Real GDP, for example, is computed holding relative prices fixed. A rapid reallocation of resources from a sector which has low relative prices to a sector with high relative prices creates an impression of fast real GDP increase.[2] However, changes in relative prices may offset some of the gains for the consumers and even make them worse off if, for example, the reallocation of resource from agriculture to manufacturing leads to a famine.

We use a standard two-sector neoclassical growth model which has been extensively em-

[1]For example, according to Allen (2003) "In the absence of the communist revolution and the Five Year Plans, Russia would have remained ... backward... This fate was avoided by Stalin's economic institutions. They were a further installment of the use of state direction to cause growth in an economy that would have stagnated if left to its own devices". Similarly, Acemoglu and Robinson (2012), while overall critical to Stalin's policies, note that "there was ... huge unrealized economic potential for reallocating ... labor from agriculture to industry. Stalinist industrialization was one brutal way of unlocking this potential".

[2]When substantial structural transformation takes places, it is usually accompanied by a major change in relative prices (this is so called "Gershenkron's effect" due to Gershenkron, 1947). Thus, it matters whether GDP is calculated using the relative prices from the beginning or the end of the period.

ployed in the literature to analyze industrialization and structural change in other contexts.[3] We follow the insights of Cole and Ohanian (2004) and Chari, Kehoe, and McGrattan (2007) that any set of policies can be mapped into a set of distortions, or wedges, in a neoclassical growth models. We systematically study these wedges and connect them to the policies and frictions in the economy under the tsarist regime in 1885-1913 and under the Soviet regime in 1928-1940[4]. We then compare a simulated Russian economy with tsarist wedges after WWI to the actual and projects Stalin's economy.

To the best of our knowledge, there exists no dataset of comparable sectoral variables for tsarist and Soviet economies. We overcome this difficulty by creating consistent measures of Russian sectoral output, capital stock, government expenditures and private consumption for 1885-1913 and 1928-1940. This novel dataset allows us to compute a consistent set of wedges for the two time periods.

The tsarist Russia in 1885-1913 was a rather ordinary agrarian economy with a variety of wedges and frictions. The average TFP annual growth was 1.45 percent in agriculture and 0.66 percent in non-agriculture. International trade was important as tsarist Russia exported about 10 percent of its agricultural production, and imported primarily manufacturing. The most important feature of the economy was that about 85 percent of working age Russian population and 50 percent of value added were in agriculture. By 1913, the role of agriculture declined only insignificantly. We find a sizeable inter-sector labor wedge distorting the movement of labor from agriculture. The frictions that we find are consistent with several institutional and policy features of tsarist Russia. The labor wedge is consistent with the institutions of *obschina*. Obschina prescribed communal ownership of land and severely restricted the exit from the commune. Additionally, obschina featured only a temporary ownership of land and decreased incentives to improve or invest in the land – likely contributing to low levels and slow growth of agricultural TFP. We then discuss the reforms of the Finance Minister Sergei Witte and argue that they provide evidence that is consistent with intertemporal investment and financial frictions. Additionally, we discuss the role of foreign cartels in manufacturing, credit constraints in agriculture, and tariffs.

[3] See, for example, Stokey (2001), Buera and Kaboski (2009), and Hayashi and Prescott (2008), among many others.

[4] We chose these periods because there is little reliable economic data before 1885 and between 1913 and 1928.

We now turn to Stalin's economy. The capital stock in 1928 and population in 1928-1940 are significantly below the trend of the tsarist economy. The economy with tsarist wedges but initial capital stock and population from 1928 USSR would experience a rapid growth as it would accumulates capital and would have a higher marginal product of labor in agriculture due to decreasing returns. This is consistent with a view of Stalin's critics that some of the growth in 1928-1940 came from reverting back to the tsarist trend.

We find that the time series for wedges show two distinct sub-periods. In the first sub-period, from 1928 to 1936, most wedges exhibit dramatic changes with the peak of the wedges coinciding with the peak of the intensity of Stalin's policies. TFP falls precipitously in both sectors from 1928 to 1933: by almost 20 percent from 1928 to 1932 in agriculture and by 36 percent in non-agriculture. We now discuss how policies during that time may be connected to our estimates of the wedges. The first significant policy we focus on is the policy of "price scissors" that expropriated the agricultural surplus. The state forced the peasants to sell the agricultural output at prices which were substantially below the prices for the same output in cities. The counterpart to this policy is a price scissor wedge, the ratio of the consumer and produced prices, that jumps fiftyfold. The intuition behind the behavior of the wedges is as follows. There is substantial drop in agricultural output, together with substantial reallocation of labor force from agriculture to non-agriculture. This coincides with a substantial decrease in the ratio agricultural to manufacturing prices, which is consistent with the policy of price scissors. The response of the economy under Stalin's policy to a drop in agricultural output is exactly the opposite from the predictions of a frictionless neoclassical growth model. In the frictionless two sector growth model non-homotheticity in consumption of agricultural goods implies that in response to a drop in agricultural TFP (and, hence, a fall in production and consumption of agricultural goods) relative prices of agricultural goods increase by more than the fall in TFP. This creates incentives to reallocate labor into agriculture to increase the output of food which became more valuable. Stalin's policy of price scissors lead to the opposite effect. By keeping producer prices of agriculture artificially low, he created incentive for labor to move from agriculture, exacerbating the food problem. The effect of price scissors is so large that the labor wedge had to increase to partially offset the effect of price scissors.

We further discuss a variety of historical evidence on how details of policies may led to the changes in wedges consistent with our estimates. Extraction of grain that disrupted production, dekulakization that exiled or killed the most productive peasants from the villages, the fall in the livestock due to extraction of grain that decreased the horse power contributed to the drop in the agricultural TFP. The poor quality of workers moving from agriculture, inefficient diversion of resources to production of agricultural machinery, and the purges of the engineers and the specialists contributed to the drop in non-agricultural TFP. Moreover, the simplest reason for the fall in the measured TFP can be seen in massive expansion of inputs without the matching increase in the output.

By 1936, the dramatic changes in the wedges subsided, and the economy entered a more stable period which ends with the last year before the invasion of the Nazi Germany. By 1940, the level of TFP in agriculture is 22 percent higher than in the tsarist economy in 1913 and 37 percent higher than in 1928. The TFP in non-agriculture is slightly below that in the tsarist economy in 1913 and 25 percent lower than in 1928. The average value of the labor distortions is about 40 percent lower than the average value of that wedge in the tsarist economy, the average value of the intra-sector capital wedge is about 35 percent lower than the average value of that wedge in the tsarist economy. There is a significant (by 60 percent) decrease in the average investment wedge compared to the average value of that wedge in the tsarist economy. Overall, there is strong evidence that the barriers both intratemporal and the intertemporal were significantly reduced in this period. However, the TFP in agriculture increased only insignificantly while TFP in non-agriculture was lower than the tsarist trend – this rejects the version of the Big Push theories which would imply that reallocating resources from agriculture would increase TFP.

Having analyzed the behavior of the wedges in the Tsarist and Stalin's economy, we turn to the welfare analysis and the counterfactual of how Russia would develop under alternative history scenarios. Our counterfactual comparison with the tsarist economy consist of two parts. First, we use average tsarist wedges from 1885 to 1913 and extrapolate them until 1940. We then compare economic outcomes in that simulation to the actual performance of the economy under Stalin in 1928-1940. Conceptually we think about this exercise as how Russian economy would have developed if all tsarist distortions remained unchanged. Second, we study the question how Russia would have developed under both Stalin and tsarist distortions after 1940 in the absence of WWII[5]. One of the common arguments is that Stalin's

[5]USSR entered the war with Nazi Germany on June 22, 1941. The official victory day is May 9, 1945. This

reforms improve economic efficiency to successfully fight in the WWII and project economic and political dominance after WWII. Comparing the economic outcomes under Stalin's and tsarist's distortions allows us to assess this argument.

Our welfare assessment results are as follows.[6] Stalin's policies led to the short run costs (1928-1940) amounting to astonishing 24.1 percent of consumption. However, in the long run the generation born in 1940 reaps the benefits of the reduction of frictions and yields a 16.5 percent lifetime gain. Welfare of a representative infinitely-lived consumer born in 1928 is 1 percent lower under Stalin's policies than in the economy with tsarist wedges. In the short run (1928-1940), the largest effect on welfare is due to the effects of the fall in TFP, with the bulk of the TFP losses coming from the drop in the agricultural TFP. The effects of price scissors and the wage distortions largely canceled each other out. In the short run, the policy of price scissors was perhaps too "successful" in moving people from agriculture so that the labor wedge had to increase to negate it. The reduction in trade pushing labor out of villages was another significant factor. The long-run predictions (post-1940) are sensitive to the assumptions on the long term growth of TFP, in the absence of the WWII. For our benchmark computation, we assume that the growth rates of sectoral TFPs post-1940 are equal to the projected rates of growth of the tsarist economy. We find that the welfare of the generation born in 1940 is higher under Stalin's policies by 16 percent. For a generation born in 1940, the three key factors of the welfare difference are the combined effect of the price scissors and the labor wedge leading to the reduction of labor mobility barriers, the negative reduction in non-agricultural TFP, and the reduction of the intertemporal investment wedge. In short, Stalin's policies of breaking the labor barriers and reducing the intertemporal investment frictions did succeed in the long run. The main negative effect both in the short and in the long run was the significant fall of TFP.

We then proceed with two additional alternative scenarios. First, we compare Stalin's policies with those in Japan, excluding the effects of trade and population.[7] We find that compared to the benchmark the welfare losses in the short run are drastically larger (43 percent

period is often referred to as the Great Patriotic War in Russia.

[6] We view this analysis as a lower bound on welfare losses under Stalin's policies. The representative consumer framework ignores the fact that different parts of population borne very different consequences of Stalin's economic policies (for example, it was the rural population which mainly suffered from famine in 1932-34) and repressions (which are reflected, in part, in lower population numbers). Taking these policies into account is likely to significantly increase welfare losses under Stalin.

[7] For Japan's economy our starting point is Hayashi and Prescott (2008). We construct the data for Japan to allow for the comparison with Russia and compute the wedges following the same procedure as in our paper.

of consumption), and that there are significant losses also in the long run (18 percent of consumption). Second, we consider two alternative scenarios for the growth rates of Stalin's economy assuming that the entry into WWII did not happen. They show that even if Stalin's policies eventually lead to somewhat faster TFP growth, it was not fast enough to produce sizable welfare gains.

The rest of the paper is structured as follows. Section 2 contains a brief overview of main events in Russian economic history of 1885-1940 to provide a context for further analysis. In Section 3, we present the theoretical model. In Section 4, we discuss data and calibration. In Section 5, we describe the wedges and the relationship between government policies and wedges. In Section 6 we provide a benchmark comparison of the actual and projected Stalin's policies with the projected tsarist's economy. Section 7 provides alternative counterfactuals: comparison with Japan and different assumptions on long-term growth rates. Section 8 describes robustness of our results. Section 9 concludes.

## 2 Historical overview

Because consistent annual time series on Russia start only in 1885, we limit our analysis to 1885-1940. This period can be roughly divided into three subperiods: first, the tsarist years 1885-1913, then the World War I, revolution and reconstruction 1913-1928, and Stalin's industrialization 1928-1940.[8]

In the first subperiod, Russia was a developing country agrarian economy attempting to industrialize. Russia was significantly lagging behind advanced capitalist economies, US and UK, but its industrialization was proceeding at a speed similar to some other industrializing economies in particular, Japan. The industrialization started with the abolition of serfdom in 1861 but was slowed down by certain remaining non-market institutions. Most importantly, as noted by Gerschenkron (1962) reallocation of labor to industry was hindered by the prevalence of communal rather than individual ownership of land (we discuss this barrier to mobility in Section 5.1). This institution was only attempted to be reformed in 1906-1910 during Stolypin's reform.

[8] In Chapter 1 of Davies, Harrison and Wheatcroft (1994), Davies uses four periods: Tsarist economy, War Communism (1917-20), New Economic Policy (1921-28), and Stalin's administrative economy (1928-40). But since we focus on the pre-revolutionary trends and on industrialization in 1928-40, we consider 1913-28 as a single subperiod. We do not use 1913-28 years for calibration as there is no data on capital.

The World War I, the subsequent Communist Revolution in 1917, and the ensuing Civil War (1918-22) led to a significant fall in output and destruction of capital stock (see Davies, Harrison and Wheatcroft, 1994, for a detailed account of this period). As shown in Markevich and Harrison (2011), Russian GDP in 1918 was 50 percent lower than in 1913.

In 1917, Bolsheviks came to power and abolished all major capitalist institutions. In particular, the new government confiscated land holdings and industrial capital from private owners. Also, during the following Civil War, the so called War Communism policies involved requisitioning 70 percent of agricultural output. After the disastrous 1921-22 famine, the War Communism policies were replaced by the New Economic Policy which reintroduced limited market mechanisms, even including foreign concessions. The following reconstruction period brought the economy back to the pre-WWI level of GDP per capita in 1928 in both the agricultural and non-agricultural sectors (Markevich and Harrison, 2011).

In 1928, Stalin ended the New Economic Policy with a Great Turn (or a Great Break[9]) starting Five-Year Plans and collectivization of land. The Great Turn followed the struggle in the highest echelons of power (Khlevnyuk, 2009). In 1927, Stalin expelled his archrival Leon Trotsky, and Trotsky's allies Zinoviev and Kamenev, from Politburo and from the Communist Party. His next rival was Bukharin who – unlike Trotsky's Left Opposition – was supporting the New Economic Policy and an even broader use of market mechanisms. The Great Turn was a bold step against Bukharin and his Right Wing and helped Stalin complete consolidating power within Politburo.

Collectivization was essential to Stalin's industrialization policies as those were based on confiscation of "agricultural surplus" to subsidize the industrialization and to move labor out of agriculture. Importantly, Stalin introduced price scissors forcing the peasants to sell grain to the state at below-market prices; the state subsequently sold the grain to industrial workers at higher prices or exported grain to pay for imports of industrial equipment. The burden of the price scissors is best reflected in the level of violence that had to be involved to implement those policies. In 1929, there were 1300 peasant riots with more than 200 thousand participants (Khlevnyuk, 2009). This was a significant increase compared to the New Economic Policy period when the total number of riots for the two years of 1926-27 was just 63. In March 1930 alone, there were more than 6500 riots with 1.4 million peasants participating.

[9] The term (*Velikiy Perelom* in Russian) is due to Stalin's article "Year of the Great Turn" published in 1929.

Industrialization was carried out in a centralized way. The central planning was introducing prescribing quantitative production and investment targets at plant level. The first three five-year plans starting in 1928, 1933, and 1938, respectively, were not fulfilled (see Gregory and Harrison, 2005, for evidence from recently declassified archives). However, as shown in Figure 1, during 1928-40, the industrialization and collectivization did succeed in moving tens of millions of people from villages to cities and to triple industrial production in constant prices.

# 3 Main Idea and Theoretical Framework

Our analysis builds on a standard multi-sector neoclassical growth model. Versions of this model have been used extensively to study industrial revolutions in England (Stokey 2001), USA (Caselli and Coleman 2001, Buera and Kaboski 2009, Herrendorf, Rogerson and Valentiny 2009, among others), Japan (Hayashi and Prescott 2008). We first characterize the frictionless model. We then describe the accounting procedure determining wedges following Cole and Ohanian (2004) and Chari, Kehoe, and McGrattan (2007).

## 3.1 Model

There are two sectors in the economy, agricultural ($A$) and non-agricultural ($M$). Output in sector $i \in \{A, M\}$ is produced according to the Cobb-Douglas production function

$$Y_t^i = F_t^i\left(K_t^i, N_t^i\right) = A_t^i\left(K_t^i\right)^{\alpha_{K,i}}\left(N_t^i\right)^{\alpha_{N,i}}, \tag{1}$$

where $A_t^i$, $K_t^i$, and $N_t^i$ are, respectively, total factor productivity, capital stock, and labor in sector $i$; $\alpha_{K,i}$ and $\alpha_{N,i}$ satisfy $\alpha_{K,i} + \alpha_{N,i} \leq 1$. We denote by $F_{K,t}^i$ and $F_{N,t}^i$ the derivatives of $F_t^i$ with respect to $K_t^i$ and $N_t^i$.

Economy is populated by a continuum of identical agents with preferences

$$\sum_{t=0}^{\infty} \beta^t U\left(c_t^A, c_t^M\right), \tag{2}$$

where

$$U\left(c_t^A, c_t^M\right) = \eta \log\left(c_t^A - \gamma^A\right) + (1-\eta)\log c_t^M,$$

$c_t^A$ is consumption of agricultural goods and $c_t^M$ is consumption of non-agricultural goods.[10] Subsistence consumption level of agricultural goods is denoted by $\gamma^A \geq 0$. The discount

[10] In the model, we use terms "non-agriculture" and "manufacturing" interchangeably. In the data, $c_t^M$ corresponds to the private consumption of all non-agricultural goods and services.

factor is $\beta \in (0,1)$. Each agent is endowed with one unit of labor services which he supplies inelastically. We use notation $U^i_{c,t}$ to denote the derivative of $U$ in period $t$ with respect to the consumption good $i \in \{A, M\}$.

Population growth is exogenous. The total population in period $t$ is denoted by $N_t$. The fraction of total labor allocated to agricultural and non-agricultural sector in period $t$ are denoted, respectively, by $N^A_t + N^M_t$. The feasibility constraint for labor is

$$N^A_t + N^M_t = \chi_t N_t \tag{3}$$

where $\chi_t$ is exogenously given fraction of working age population.

We assume that the new capital $I_t$ can only be produced in non-agricultural sector. Capital can be allocated in any sector. The aggregate capital in period $t$ is denoted by $K_t$. Capital allocated in period $t$ to agricultural and non-agricultural sector is denoted, respectively, by $K^A_t + K^M_t$. The law of motion for total capital is given by

$$K_{t+1} = I_t + (1-\delta) K_t, \tag{4}$$

where $\delta$ is the depreciation rate. The capital is allocated to sectors according to

$$K^A_t + K^M_t = K_t. \tag{5}$$

We assume that there exists an exogenous sequence of government consumption of non-agricultural goods, $G^M_t$. Let $ex^A_t$ and $ex^M_t$ denote net exports of agricultural and non-agricultural goods in period $t$, and let $q_t$ be exogenous terms of trade for those goods.

The feasibility conditions in the two sectors are

$$N_t c^A_t + ex^A_t = Y^A_t, \tag{6}$$

and

$$N_t c^M_t + ex^M_t + G^M_t + I_t = Y^M_t. \tag{7}$$

Throughout the paper we assume that the trade balance is zero in all periods, so that the net exports satisfy

$$q_t ex^A_t + ex^M_t = 0. \tag{8}$$

In formulating trade (exports $ex_t^i$) exogenously we follow, for example, Stokey (2001). Stokey (2001) studied the industrial revolution in Britain treating British exports (manufacturing) and terms of trade $q_t$ as exogenously given and finding quantities of imports from (8).

In summary, equations (2)-(8) provide a complete description of our setup.

### 3.2 Frictionless benchmark

We proceed now to characterize a standard social planner's problem. The optimality conditions are as follows:

the intratemporal capital allocation condition across sectors is given by

$$1 = \frac{U_{c,t}^M}{U_{c,t}^A} \frac{F_{K,t}^M}{F_{K,t}^A}, \tag{9}$$

the intratemporal labor allocation condition is given by

$$1 = \frac{U_{c,t}^M}{U_{c,t}^A} \frac{F_{N,t}^M}{F_{N,t}^A}, \tag{10}$$

and the intertemporal (Euler) condition is given by

$$1 = \left(1 + F_{K,t+1}^M - \delta\right) \beta \frac{U_{c,t+1}^M}{U_{c,t}^M}. \tag{11}$$

The solution to this social planner's problem coincides with and can be decentralized as competitive equilibrium. We omit the formal definition of the competitive equilibrium as it is standard. In the competitive equilibrium all agents pool their income and maximize their utility (2) subject to a budget constraint in each period

$$\begin{aligned} & p_t^A N_t c_t^A + N_t c_t^M + K_{t+1}^A + K_{t+1}^M \\ = \; & w_t^A N_t^A + w_t^M N_t^M + \left(1 + r_t^A - \delta\right) K_t^A + \left(1 + r_t^M - \delta\right) K_t^M + \Pi_t^M + \Pi_t^A - T_t, \end{aligned}$$

where $w_t^i, r_t^i, \Pi_t^i$ are, respectively, the wage, the rate of return on capital, and the profit in sector $i$; $p_t^A$ is the price of agricultural goods in terms of non-agricultural goods; and $T_t$ is the lump sum taxes.

Firms in sector $i$ hire capital and labor to maximize profits

$$\Pi_t^i = \max_{\left\{K_t^i, N_t^i\right\}} p_t^i A_t^i \left(K_t^i\right)^{\alpha_{K,i}} \left(N_t^i\right)^{\alpha_{N,i}} - w_t^i N_t^i - r_t^i K_t^i,$$

where $p_t^M = 1$.

Maximization behavior of the firms implies that $w_t^i$ and $r_t^i$ are equal to the marginal product of capital and labor in sector $i$ in each period. Maximization behavior of consumer implies that $w_t^i$ and $r_t^i$ are equalized across sectors.

We will show that data rejects the implications of this frictionless competitive equilibrium.

### 3.3 Wedges accounting

Our description of Russian economy showed a large number of institutional frictions and government policies that distorted households and firms decisions. Modeling each of these frictions explicitly is difficult as there was a large number of such frictions, and because there is not enough data to realistically estimate the magnitude of each of them. Instead we follow a different path. We use the insights of Cole and Ohanian (2004) and Chari, Kehoe and McGrattan (2007) that any policies can be mapped into wedges in a prototype competitive equilibrium model. Policies and frictions manifest themselves in different wedges, and by studying these wedges we can identify likely sources of these distortions.

Specifically, we define three wedges, each equal to deviations in the right hand side of equations (9), (10), and (11) from 1. These three wedges correspond to the intratemporal distortions in capital and labor allocations between sectors and to the intertemporal distortion.

In addition to these three wedges, we also explicitly focus on one of the most important Stalin's economic policies – price scissors, discussed in Section 2. This policy introduces a wedge between the relative prices that producer of agricultural goods faces, and the prices that consumers are willing to pay. Specifically, if producer of agricultural goods faces a price $p_{A,t}$ and consumer faces a price $\tilde{p}_{A,t}$, then the *price scissor wedge*, $1+\tau_{C,t}$, is given by $1+\tau_{C,t} = \tilde{p}_{A,t}/p_{A,t} = \frac{U_{c,t}^A}{p_{A,t}U_{c,t}^M}$. Thus, using additional data on the producer relative prices (for the first three wedges), we define four wedges, $\tau_{R,t}, \tau_{W,t}, \tau_{C,t}$ and $\tau_{K,t+1}$ as follows

$$
\begin{aligned}
1+\tau_{R,t} &\equiv \frac{F_{K,t}^{M}}{p_{A,t}F_{K,t}^{A}}=\frac{r_t^M}{r_t^A}, \\
1+\tau_{W,t} &= \frac{F_{N,t}^{M}}{p_{A,t}F_{N,t}^{A}}=\frac{w_t^M}{w_t^A}, \\
1+\tau_{C,t} &= \frac{U_{c,t}^{A}}{p_{A,t}U_{c,t}^{M}}, \\
1+\tau_{K,t+1} &= \left(1+F_{K,t+1}^{M}-\delta\right)\frac{\beta U_{c,t+1}^{M}}{U_{c,t}^{M}}.
\end{aligned} \tag{12}
$$

Note that the intratemporal distortions for capital and labor implied by the right hand side of expressions (9) and (10) are given by $(1+\tau_{R,t})\,/\,(1+\tau_{C,t})$ and $(1+\tau_{W,t})\,/\,(1+\tau_{C,t})$. These normalized wedges (as well as the intertemporal wedge) do not require knowledge of the prices.

The normalized intratemporal labor wedge, for example, implies that reduction is misallocation of labor between agriculture and manufacturing can be achieved either by reducing the wedge $\tau_{W,t}$, which is determined by the ratio of the wages paid in the two sectors and in many models is often related to the size of barriers to labor mobility or by *increasing* $\tau_{C,t}$, which measures distortions between consumer and producer prices. This distinction helps us to evaluate the effect of different policies.

Additionally, one can also think of $\left\{A_t^M, A_t^A, ex_t^i, G_t^M\right\}_{t=0}^T$ also as wedges. We want to emphasize that our analysis is essentially an accounting procedure. Given initial $K_0$, competitive equilibrium allocations with wedges $\left\{A_t^M, A_t^A, \tau_{R,t}, \tau_{W,t}, \tau_{C,t}, \tau_{K,t}, ex_t^i, G_t^M\right\}_{t=0}^T$ match data exactly. This allows to compute the marginal contribution of each wedge to the deviations of data from undistorted allocations.

# 4 Data and calibration

In this section we discuss the construction of the data for a systematic comparison of the structural transformation during Stalin years and during tsarist years.[11] To our knowledge this comprehensive construction of the data is novel as most importantly it details the sectoral variables, calculation of capital series, and recalculation of GDP in market prices of 1913.

[11] We refer the reader to the Appendix for the complete treatment.

### 4.1 Data sources and construction of the data

The principal source of economic data for output, consumption and investments for Russia in 1885-1913 is Gregory (1982). Gregory compiled data on net national income and its component using a variety of historical sources, most of which coming from the official tsarist statistical publications. His data is sufficiently disaggregated and allows us to construct series for consumption and investments for agricultural and non-agricultural sector and to use a perpetual inventory method to impute capital stock. Unfortunately, he does not provide enough information to separate residential housing stock and non-residential capital in agriculture. This leaves us no choice but to include rural residential housing stock in our measure of agricultural capital. For the reasons explained in the Appendix, we exclude urban residential capital from any measure of capital stock. The data on value added by sector is scanter – we have those estimates only for a few select years.

We obtain Soviet economic data from Moorsteen and Powell (1966). They use official Soviet data to construct sectoral outputs, capital stock, and value added according to Western definition. Although the official price series may not be representative of true market clearing prices, there seems to be a consensus among economic historians that the underlying quantities are generally reliable (see, e.g., a discussion in Appendix A of Allen 2003). Using data in Moorsteen and Powell (1966), as well as additional data from Allen (1997), Davies (1990), and Davies et. al. (1994) we compile sectoral outputs, investment, capital stock, and consumption for agricultural and non-agricultural sectors in Soviet 1937 prices. To convert these values to 1913 prices, we use Markevich and Harrison (2011) estimates of Soviet sectoral value added in 1928 in 1913 prices. That is, we implicitly assume that intra-sectoral prices remain unchanged, and infer sectoral relative price conversion from their data. The details are in the Appendix.

Since the role of government changed dramatically between 1913 and 1928, we define government purchases narrowly as military spending. We count all other government expenditures as non-agricultural consumption.

Calculating sectoral employment or even the labor force is difficult both for tsarist and for Soviet periods. Unlike data on economic aggregates, there is little reliable data on sectoral employment before 1913. Tsarist Russia conducted only one national census in 1897. There are employment records from the administrative data in some heavy industries but for the rest of the economy there are only sporadic surveys. For this reason Gregory (1982) does not provide annual employment numbers but only his estimates of growth rates of labor force for agriculture, manufacturing and services for 1883-87 to 1897-1901 and for 1883-1897 to 1909-1913. An early Soviet economic historian Gukhman used census and archival data to estimate composition of labor force in 1913, which was then reproduced in Davies (1990). As in census as well as Gukhman and Davies, we define sectoral employment for each worker according to self-reported primary occupation. This definition seems to be the only way to obtain a consistent definition of sectoral labor force for tsarist Russia, Soviet Union, and Japan. It almost certainly overestimates the true employment in agriculture and underestimates employment in manufacturing. There is substantial evidence that agricultural workers spent a part of their time in non-agricultural activities, such as seasonal manufacturing work in the city and self-employed *promysly*. As a robustness check, we recompute our wedges under assumption that 10 percent of time of agricultural workers is spent on non-agricultural activities, which is consistent with estimates of Moorsteen and Powell (1966) for the Soviet period. The results of this robustness check are reported in the online appendix.

We also need to take a stand on how to treat employment of women. The available employment records before 1913 are from select heavy industries which predominantly employed men. As non-agricultural sector expanded dramatically after 1928, so did the fraction of women in non-agricultural employment. Based on this evidence one may be tempted to conclude that female labor force participation significantly increased. At the same time, there is evidence that before 1913 female labor force participation in agriculture was very high, as women had to replace men who were employed as migrant workers in urban industries. For example, Crisp (1978) in her study of Russian labor markets pre-WWI points out that although in factory industry there were only 800,000 women compared to several million men, in peasant farms "the proportion of women undoubtedly exceeded that of male, especially if all-year-around averages are taken into account". Since there are no reliable figures about female labor force participation, we do not treat women and men differently and assume that all working age population is a part of the labor force.

We have data series for real GDP growth in 1913 rubles for Russia. We also have real GDP in 1990 international dollars for 1913. To construct real GDP per capital, we use real GDP per capita in international dollars for 1913, and then apply real GDP growth rates (in constant rubles and dollars) to construct real GDP in international dollars for other years in 1885-1913. This series may differ slightly from real GDP in international dollars for other years as relative prices might have changed. However, our index captures well the general patterns. The fraction of agricultural value added measures the ratio of agricultural value added in 1913 prices to real GDP in 1913 prices. Sectoral net imports and exports are shown relative to the sectoral value added.

## 4.2 Summary of the data

Figures 2 and 3 show aggregate and sectoral, agricultural and non-agricultural, data for both tsarist and Soviet Russia.

### 4.2.1 1885-1913

Russian economy in 1885-1913 grew rather significantly, with the average rate of growth of real GDP per capita of 1.91 percent. However, the economy did not experience structural transformation from agriculture. About 85 percent of working age Russian population have their primary occupation in agriculture in 1885, and this fraction declines very slowly, only to 81 percent in 1913. The role of agriculture in the economy was also very important, with about 53 percent of value added being produced in agriculture in 1885, declining only to 46 percent in 1913. International trade was rather important – tsarist Russia exported about 10 percent of its agricultural production, and imported primarily manufacturing goods.

### 4.2.2 Soviet Russia (1928-1940)

The level of GDP per capita and the structural composition of Russian economy in 1928 is approximately the same as it was in 1913.[12] This reflects the years of turmoil following the fall of tsarist Russia and the subsequent years under the communist rule.

We now turn to Russia in 1928-1940. Growth in real GDP (measured in 1913 rubles) is very rapid. This coincides with a rapid increase in investments and reallocation of labor from agriculture to non-agriculture.

[12] We do not report the data for Tsarist Russia during World War I (1914-1917) or for the period following February Revolution (1917) to 1927. This period covers October (Bolshevik) Revolution, the Civil War, War Communism, and the New Economic Policy (NEP). The main reason is that the issues of availability and quality of the data do not allow us to construct the dataset comparable to the one we constructed. Even though Markevich and Harrison (2011) provide many time series for this period, there is still no data on capital. That is why, we are not able to estimate TFP and wedges for those periods.

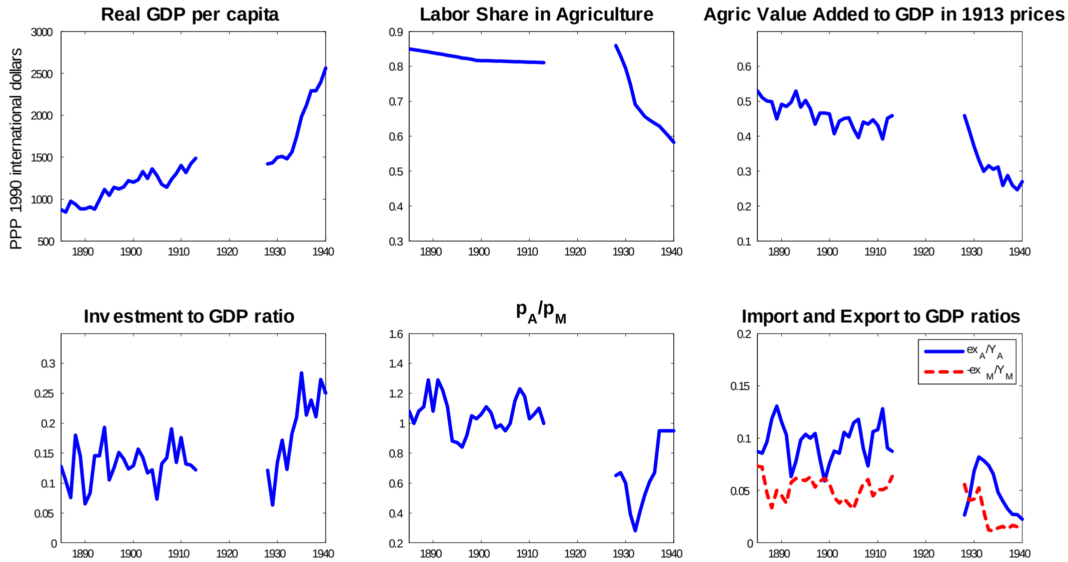


Figure 2: Aggregate economic indicators in Russia in 1885-1940.

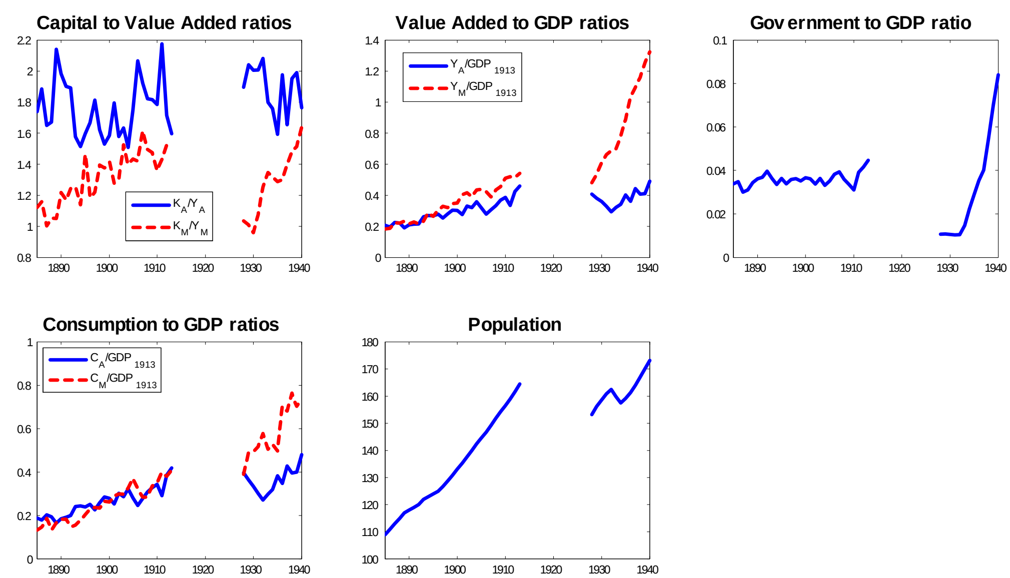


Figure 3: Sectoral economic indicators, government and population in Russia.

The bottom row shows agricultural and non-agricultural per capita value added in 1913 prices, capital stock, and government expenditures. Non-agricultural value added shows remarkable growth. Agricultural value added drops during collectivization in 1928-1933 then returns towards its trend. The capital stock in 1928 is approximately the same in agriculture as it was in 1913, and is significantly smaller in non-agriculture. The military expenditures in Soviet Russia were generally low in the late 1920s and early 1930s followed by a significant military build up starting from mid 1930s.

A special discussion of price series is needed for Soviet Russia. While in market economies various price series (e.g. retail, wholesale prices or official procurement prices) are highly correlated, it is not the case for the Soviet Russia. After 1928 there is a host of different official prices set by the state which often diverge substantially from each other. For most of our analysis this is not an issue since we measure quantities in 1913 prices. Price information is needed only to construct the price scissor wedge $\tau_{C,t}$.[13] This wedge captures the terms of trade for the producer of agricultural goods. We follow Allen (1997) and define this relative price as a ratio of official procurement prices of agricultural goods relative to the free retail non-agricultural consumption basket. Allen argues that this is the best measure to capture the terms of trade that a private agricultural producer faced after 1928.

### 4.3 Calibration

To calibrate the model we need to choose values of eight parameters and the initial value of capital. Technology parameters include the elasticities of production functions in the agricultural and manufacturing sectors, $(\alpha_{Ki}, \alpha_{Ni})$, and the depreciation rate, $\delta$. Preference parameters include the discount factor, $\beta$, the asymptotic agricultural consumption share, $\eta$, and the subsistence level in agriculture, $\gamma^A$.

Some parameters that we choose are rather uncontroversial, we draw on Hayashi and Prescott (2008) for them and provide extensive robustness in the Appendix. The depreciation rate is set to $\delta = 0.05$, and the discount factor is set to $\beta = 0.96$. The asymptotic consumption shares of agricultural and non-agricultural goods are set to $\eta = 0.15$ and $1 - \eta = 0.85$ correspondingly. One difference between our model and the model of Hayashi and Prescott is that we do not have intermediate goods. We account for this difference by assuming that all

[13] Prices also feature in our definitions of $\tau_{W,t}$ and $\tau_{R,t}$. The prices drop out, however, if we consider normalized intra-sectoral labor and capital distortions, $(1 + \tau_{W,t}) / (1 + \tau_{C,t})$ and $(1 + \tau_{R,t}) / (1 + \tau_{C,t})$.

intermediate goods used in the production of manufacturing goods represent labor. We set the corresponding elasticities for the manufacturing sector to $\alpha_{K,M} = 0.3$ and $\alpha_{N,M} = 0.7$. Instead, we assume that all intermediate goods used in the production of agricultural goods represent land. We set the remaining capital and labor elasticities to $\alpha_{K,A} = 0.14$ and $\alpha_{N,A} = 0.55$. The values for the production elasticities are also similar to values adopted by Caselli and Coleman (2001) calibrated using direct estimates for the U.S. economy.[14]

We choose the initial capital stock to match the observed level of capital in 1885. We do not have data needed to directly determine the subsistence parameter, $\gamma^A$. We set the subsistence level to 28 rubles per capita per year in 1913 prices. This subsistence level accounts for 72 percent of agricultural consumption per capita in 1885. If we were to set it higher than 81 percent of consumption of 1885 the simulated economy would go below the subsistence level during tsarist years. As we discuss in the online appendix, our main results are robust to alternative values of $\gamma^A$ below this value. Finally, for $\chi_t$, the fraction of labor force in population we set $\chi_t = 0.53$ for all $t$, which is the fraction in the Russian census of 1897. This number is slightly higher than fraction of labor force from 1926 and 1939 censuses, but fitting those numbers produce only small differences for the analysis.

# 5 Wedges

We now proceed with the calibrated model to compute wedges using (12)[15]. Figure 4 shows wedges for Russia with solid lines and their average level (or trends, for the case of TFPs) with dashed lines.

The behavior of the wedges can be grouped in three main periods. The first is tsarist Russia (1885-1913). The second is the initial period of industrialization and collectivization (1928-1935) when the wedges exhibited dramatic changes. The third period is that of the stabilization of wedges (1936-1940) that ends with the entry of Russia into the WWII .[16] We

[14] Caselli and Coleman (2001) use the values $\alpha_{K,M} = 0.6$, $\alpha_{N,M} = 0.34$, $\alpha_{K,A} = 0.21$ and $\alpha_{N,A} = 0.6$.

[15] The wedge $\tau_{K,t}$ can only be computed up to 1939 using available data. Wedge $\tau_{K,1940}$ is determined by the expected consumption in 1941, for which we do not have data. To impute $\tau_{K,1940}$ we assume that expected consumption growth in 1940 is the average of expected consumption growths in 1937-1940.

[16] Davies (1998) adopts a slightly more nuanced view of the sub-phases of economic development in 1928-41: 1928-30; 1930 spring/summer-1932; 1933; 1934-1936; 1937-June 22, 1941. His description of the periods up to and including 1933 fits our initial period identically. We could have started "stabilization period" from 1934. However, we view 1934-1935 as the recovery from the low base of the disaster of the initial phase of Stalin policies. Starting stabilization period from 1935 (rather than 1936) changes our results only insignificantly.

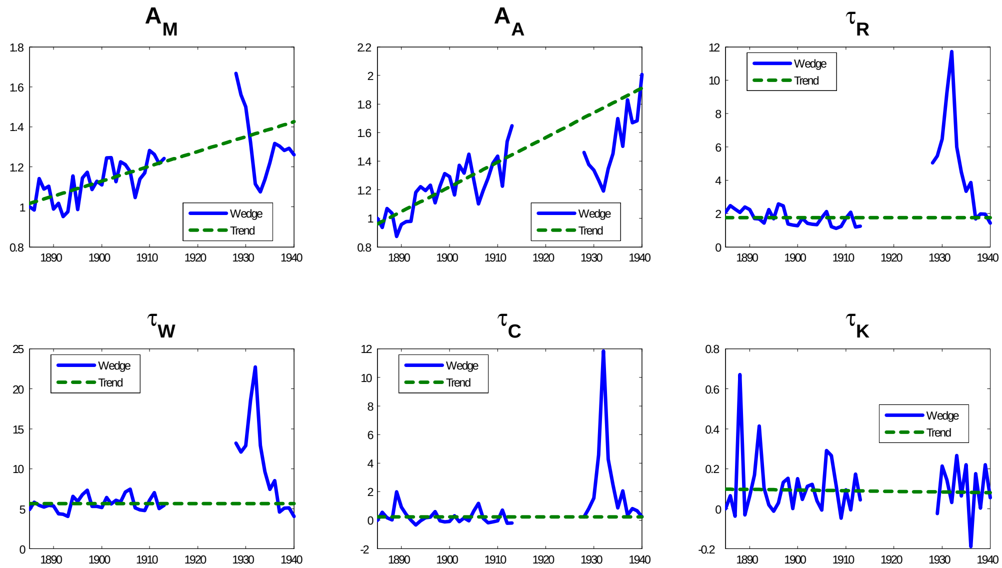


Figure 4: Russia: Wedges vs. Trends based on pre-1913 simulation.

present the average wedges for different periods in Table 4 in the appendix.

## 5.1 Wedges in 1886-1913 (Tsarist Russia)

The first period is tsarist Russia. The TFP and the wedges exhibit some fluctuations and noise but are certainly less variable than during Stalin's period. The average TFP annual growth is 1.45 percent is agriculture and 0.66 percent in non-agriculture. The four wedges defined in (12) are noisy but do not exhibit any trend in 1885-1913. Observing these wedges it becomes evident that Russia faced significant distortions in its economy. The average normalized intratemporal (inter-sector) labor wedge, $(1+\tau_{W,t})\,/\,(1+\tau_{C,t})$, is equal to 5.9. The average normalized intratemporal (inter-sector) capital wedge, $(1+\tau_{R,t})\,/\,(1+\tau_{C,t})$, is equal to 2.4. The average intertemporal (investment) wedge is equal to 0.11. The average size of the intratemporal labor wedge in Russia is higher than in Caselli and Coleman (2001) who report the ratio of the farm wage to the manufacturing wage to be 0.20 in the USA in 1880, so that the wedge is equal to 4.

**Connecting wedges to the policies/distortions**

*Intratemporal labor wedge.* The large size of the intratemporal labor wedge stands out. This is consistent with the view of Gerhenkron (1962) that the unusually slow decline of the share of agriculture in GDP in Tsarist Russia can be explained by the barriers to the rural-urban migration, in particular, by the institutions of obschina. This institution of obschina effectively prescribed communal ownership of land and existed in 38 out of 50 European provinces of Russia (Chernina et al., 2011). In other provinces either there were no communes or those were hereditary communes (with individual ownership of land). The hereditary commune allowed for exit – as long as the exiting individual or household could sell to an individual or household within the commune. In the repartition communes (peredelnaya obschina), exit required the consent of the commune; there was no right to sell land and get compensation. At the beginning of the twentieth century most of the peasant households lived in the commune (Davies 1998, p. 8).

There was another feature of the communal land ownership in Russia that was particularly important: the individual peasant strips were subject to repartition and redistribution. This temporary character of land ownership, as argued by Gershenkron (1965), significantly decreased incentives to improve the land or invest in it. In our setup, this aspect of obschina likely represents itself in the low agricultural TFP levels and growth rates.

*Reforms of Witte and Stolypin and the behavior of the wedges.* Several issues with the structure of the tsarist economy and the policies are also important to note.[17] The study of Von Laue (1963) on Finance Minister Sergei Witte, shows how he persuaded the Tsar Nicholas II that state-encouraged industrialization was needed for the survival of the political regime. The main elements of the Witte's reform were: an introduction of gold standard, state support (significant allocations from the state budget to build the railroads) and financing for expanding the railway network (the state arranged and guaranteed foreign loans), encouragement of foreign investment (especially in the iron and steel industries). Von Laue's and Gerhenkron's (Gerhenkron 1965) opinion was that the state played an important role in Russia's industrialization. This view was challenged in an influential study by Kahan (1967) who argued that the taxes and other state intervention, as well as introduction of the gold standard, outweighed the benefits of the state interventions. Our calculation of the wedges does not give a clear answer and the resolution to these debates. Likely, there is truth in both sides of the argument.

[17] The discussion of the literature and the assemsent of the state of the debate that follows in this section is based on an excellent summary of the tsarist economy in the book by Davies (1998).

What we take from this debate is that there were likely very significant distortions to financing that necessitated state's involvement either through facilitating loans or channeling resources in construction of railroads and in encouraging foreign investment in heavy industries that we discuss next. These financial frictions coupled with generally low level of development of Russian financial markets lead us to believe that the intertemporal wedge that we find in our analysis was indeed quite significant.

Following the revolution of 1905, tsarist government started a major agrarian reform. The Prime Minister Stolypin's reform (a series of decrees issued in 1906-1910) allowed individual sales of land and greatly facilitated exit from the repartition communes. The main goal of the policy was encouragement of the villagers to leave the commune and establish their separate individual holdings. However, Davies argues (1998, p.10) that by 1914 the reforms have not affected a significant portion of the village households[18]. It is not surprising in light of this evidence that we do not observe a major change in the labor barriers.

*Cartels, credit constraints, tariffs.* Another interesting aspect of Russian economy was the eminence of cartels (*syndikaty*), especially post 1899-1902 recession, in the capital goods industries (steel, coal, iron, railroad engineering). These cartels were to a large extent foreign owned. Syndikaty established the prices and the market quotas. The cartelization of an important part of the heavy industries likely played an additional role in restricting the size of the manufacturing sector compared to the situation of the competitive market. Cole and Ohanian (2004) argue for the importance of the cartels in the slow recovery from the Great Depression in the US. In their model with endogenous labor, cartels appear as the labor wedge. In our two sector economy, the cartels would appear as a part of the intratemporal labor and capital allocation wedge, decreasing the capital and labor inputs to the manufacturing sector compared to the competitive markets. Allen (2003, p. 45) also argues for significant credit constraints, especially strongly affecting agriculture, citing the findings of the government committee on farm credit which found that the existing credit institutions were inadequate. In our model, this friction can be modeled as the intratemporal credit wedge distorting allocation of capital to the agriculture.

We briefly note that tsarist Russia imposed steep tariffs on food imports and also used

[18] Chernina et al. (2011) show that over 1906-1915, 22% of eligible households privatized their land (14% of eligible communal land).

tariffs to protect and encourage infant manufacturing industries (for example, on textiles). These tariffs would likely have opposing effect on intratemporal wedges (food tariffs encouraging allocation of resources to agriculture; manufacturing tariffs encouraging the allocation to industry). Likely, also the tariffs had the usual effect of restricting competition and thus potentially decreased the size and the TFP of the affected sectors.

### 5.2 Wedges 1928-1935

From 1928 to approximately 1935, most wedges exhibit quite dramatic changes. TFP falls precipitously in both sectors from 1928 to 1933. TFP in agriculture decreases by almost 20 percent from 1928 to 1932. TFP in non-agriculture decreased by 36 percent between 1928 and 1933. The TFP then bounces back but reaches the level of 1928 only in 1934 for agriculture, but in manufacturing does not achieve the level of 1928 TFP even by 1940.

Wedges $\tau_{R,t}$, $\tau_{W,t}$ and $\tau_{C,t}$ also follow the same patterns, first increasing dramatically, then decreasing. The peak of all increase coincides with the peak of collectivization policies. From 1928 to 1932 we observe the following behavior of the wedges. The price scissor wedge jumps tenfold. The intrasectoral labor wedge and the intrasectoral capital wedge double. The normalized labor wedge decreased tenfold and the normalized intersector capital wedge almost became zero. There is no discernible pattern in terms of the intertemporal capital wedge.

To understand this pattern, it is useful to think about the implications for wedge decomposition of the behavior of the sectoral data in Figure 2. This figure shows a substantial drop in agricultural output, together with substantial reallocation of labor force from agriculture to non-agriculture. This coincides with a substantial decrease in $p_{A,t}/p_{M,t}$ ratio, which is consistent with the policy of price scissors. The response of the economy under Stalin's policy to a drop in agricultural output is exactly the opposite from the predictions of a frictionless neoclassical growth model. In the frictionless two sector growth model non-homotheticity in consumption of agricultural goods implies that in response to a drop in agricultural TFP (and, hence, a fall in production and consumption of agricultural goods) relative prices of agricultural goods increase by *more* than the fall in TFP. This creates incentives to reallocate labor *into* agriculture to increase the output of food which became more valuable. Stalin's policy of price scissors lead to the opposite effect. By keeping producer prices of agriculture artificially low, he created incentive for labor to move from agriculture, exacerbating the food problem.

The effect of price scissors is so large that the labor wedge $\tau_{W,t}$ had to increase to partially offset the effect of price scissors.

**Connecting wedges to the policies**

We now further elaborate on the connection of the policies to the wedges[19].

We first note that it is not surprising that the wedges change dramatically during those periods and that the wedges fluctuate so significantly. The policies of industrialization and collectivization were overwhelmingly significant and at the same time quite erratic. In 1929, the drive to collectivize started with exceptionally ambitious plans to completely restructure the economy. Stalin calls 1929 the year of the Great Break (Stalin, November 7, 1929) and a "decisive advance" on the way to industrialization "leaving behind Russian backwardness". On March 2, 1930 Stalin publishes an article in Pravda "Dizziness from Successes", signifying a partial retreat from the first push of collectivization. Davies (p. 15-17 in Davies, et. al 1994) describes the 1928-1930's period as that of "Utopian concepts of the emerging socialist order prevailing in official circles", period of Spring/Summer 1930-summer 1932 as that when period of "economic policy and practice were confused and ambitious" with greater realism settling in, and only by late 1933 the realism (but not the brutality of the policies) prevails.

*Policies and the fall in agricultural TFP.* We now proceed to describe evidence that is consistent with the drastic fall of the agricultural TFP that we observe in the data. We argue, that while TFP is often thought as exogenous, Stalin's policies were the main culprit behind the "endogenous" fall in TFP. Davies and Wheatcroft (Chapter 6 in Davies, et. al. 1994) describe key factors affecting agricultural production in these years. First, the state exaction of grain from peasants on its own created dramatic disruption in agricultural production. There was virtually no incentives to work on the collectivized land. The system of crop rotation was severely disrupted and not restored even by 1935 when crop rotation was used only on 50 percent of the sown area. The grain requisition lead to drastic fall in livestock because of lack of feed. This fall in quantity, exacerbated by the careless application of the available manure, in turn lead to a significant reduction of manure to fertilize the land and again lowered its productivity. Second, the dekulakization campaign of 1929-1931 affected five to six million peasants, one million out of 25 million peasant households (Wheatcroft and Davies, p. 68 in Davies et al 1994). These most successful and knowledgeable peasants were in the best case

[19] For a significant part of the discussion here, we follow Davies, et al 1994.

exiled, and in the worst case executed. Third, there was a significant decline in skills and technical training. A part of this can be attributed to dekulakization itself. Another part was due to the lack of experience on the side of the urban workers who were sent to run the collectivized farms. Additionally, the purges of the "bourgeois" elements bled the agricultural (as well as non-agricultural) sector of the trained specialists. Fourth, the system of centralized control and planning lead to a variety of erroneous decisions made. Neither Stalin and the top brass of the Soviet elite, nor the regional party secretaries had experience in agriculture. Wheatcroft and Davies (p. 124 in Davies et al 1994) argue that the positive elements of the centralized planning (economy of scale, some new advanced farming methods, increase in mechanization, etc.) were outweighed by the "great disadvantages ... from the ignorance of politicians". Finally, as mentioned above the fall in livestock itself decreased productivity. Partially, within the confines of the model the fall in the livestock resulted in decrease in the agricultural capital. However, horses were also used as the main draught power and the decline in number of horses significantly worsened the productivity of agriculture. By July 1933, the available horsepower dropped to 16 million horses from 27 million in 1928. The tractors in 1933 only amounted to 3.6-5.4 million horsepower equivalents. These five key factors very much coincide with the assessment of Nove (1992, p. 176) who concludes that the "... peasants were demoralized. Collective farms were inefficient.. [there were] appallingly low standards of husbandry with 13 percent of the crop remaining unharvested as late as mid-September in the Ukraine, and some of the sowing delayed till after June 1". For completeness, we also mention that one exogenous factor in the agricultural TFP is weather. However, Wheatcroft and Davis (p. 128 in Davies et al 1994) argue that throughout 1930s, weather was not a major factor behind low agricultural yields and certainly much smaller factor than the policies.

*Price scissors and the labor wedge.* As discussed in Sah and Stiglitz (1984) and Allen (2003), price scissors were an important policy for expropriating the “agricultural surplus”. The state forced the peasants to sell the agricultural output at prices which were substantially below the prices for the same output in cities.

The magnitude of price scissors was substantial. Based on Barsov (1969), Ellman (1975, Table 6) shows that black market prices for grain were more than twice as high as the state procurement prices in 1929. In 1930, the difference was 4.5 times, in 1931 – 7 times, and in 1932 – 28 times! This mechanism is consistent with the traditional historical narrative of collectivization (see, e.g. Conquest, 1986). The consensus is that the price scissors policies certainly went too far even for their own sake. Millar (1974) calls these policies an "unmitigated economic policy disaster": attempting to expropriate agricultural surplus, price scissors and mass collectivization destroyed the surplus resulting in the decline of agricultural output and eventually a great famine (costing several millions of lives). Millar argues that the food production declined so much that peasants slaughtered livestock decreasing the traction power (see the numbers above); instead of investing in industrial capital stock, the state had to produce or import tractors for restoring the traction power. This further reduced net agricultural surplus.

However, the huge decrease in rural living standard did accelerate rural-urban migration. As Davies and Wheatcroft (2004) note "by the autumn of 1932 peasants were moving to the towns in search of food." The growth of urban population ceased, and was partially reversed, only as a result of restrictions on movement and the introduction of an internal passport system" (p. 407). The introduction of the passport system can be viewed as providing evidence for the increase in the labor wedge that we already discussed.

Realizing the fact that price scissors were too high, after 1932 the government decreased them substantially. Moreover, in 1932, the state legalized agricultural markets (so called collective farm markets, *kolkhoznye rynki*) where peasants could freely sell output that they produced in excess of their planned delivery quotas; the quotas were also relaxed (Davies et al., 1994, p.16). This allowed the peasants to reap at least some benefits of the high market prices for food but also reduced incentives to migrate to the cities.

*Policies and the non-agricultural TFP.* We now turn to the behavior of the non-agricultural TFP[20]. Some factors that we already described in the case of the fall and fluctuations of agricultural TFP are also relevant for the case of the non-agricultural TFP, specifically, wild swings in policies and the repression against "bourgeois" specialists. We now present other evidence supporting our findings of the impact of Stalin policies on the non-agricultural TFP during those years. We also discussed already the fall in the number of horses and the urgent need to produce tractors. This led to inefficient and rush diversion of resources to industries producing mechanized equipment from agriculture. Davies (p.153) argues that in 1932 half

[20] We closely follow the discussion of the chapter "Industry" by Davies in Davies, et. al. 1994. All pages refer to that chapter unless otherwise noted.

of the high quality steel produced in the country was used in production of tractors. The capacity of iron and steel plants diverted to tractors could be used to finish the overambitious construction projects started earlier. The food crisis of 1932-1933 also forced to reduce the number of workers in construction. In other words, both the price scissors and the fall in agricultural TFP also represented themselves in the fall of non-agricultural TFP. This initial period of industrialization did indeed bring importation of the foreign technology and practices but it was still quite limited (we expand on this in the next section) and unlikely to affect the non-agricultural TFP significantly at the aggregate level.

An important factor was the overall poor quality of the workers moving from agriculture. Nove (1992, p. 198-199) details the issue and argues that outside the machinery and the metal-working sector, the productivity gains were very low and possibly negative. The massive move of the peasants to industry required massive acquisition of the new skills. It was difficult or impossible to retrain such large numbers in such a short period but this was exacerbated by the shortage of the qualified engineers and technicians. An interesting fact reported by Nove is that to achieve this objective the whole system of secondary education was disrupted. The number of students in secondary schools drops from about 1 million in 1928-30 to 300 thousand in 1931-32 to merely 4,234 students in 1931-32 before increasing to 1.2 millions in 1932. These "missing" students were converted to "emergency" technicians going through crash courses. Yet, even those emergency measures "could barely touch the millions who were recruited, or fled, from the country side" (Nove 1992, p.199). The vast unfinished construction projects, massive influx of unskilled labor, diversion of the resources to fight agricultural crises, exacerbated by repressions against the skilled personnel not surprisingly led to a large drop in the industrial TFP.

The simplest argument, however, to see why there is a drop in manufacturing TFP is to consider the labor and capital inputs in manufacturing. From 1928 to 1933 (trough of the manufacturing TFP), capital grew by a factor of 1.88, labor grew by a factor of 2.4 while the output grew only by a factor of 1.45. From 1928 to 1935, capital grew by a factor of 2.3, labor grew by a factor of 2.6 while the output grew only by a factor of 1.8. We further comment on this issue in the next section.

### 5.3 Wedges 1936-1940

By 1936, the dramatic changes in the wedges subsided, and the economy entered a more stable period. By 1940, the level of TFP in agriculture is 22 percent higher than in the tsarist economy in 1913 and 37 percent higher than in 1928. The TFP in manufacturing is slightly below that in the tsarist economy in 1913 and 25 percent lower than in 1928. The average value of the normalized labor wedge is about 40 percent lower than the average value of that wedge in the tsarist economy (3.8 vs. 5.9). The average value of the intrasector capital wedge is about 35 percent lower than the average value of that wedge in the tsarist economy (1.8 vs. 2.4). There is a significant (by 60 percent) decrease in the average investment wedge compared to the average value of that wedge in the tsarist economy (0.038 vs. 0.085). Overall, there is strong evidence that the barriers both intratemporal and the intertemporal were significantly reduced in this period. This provides strong support to the view of Allen (2003) or Acemoglu and Robinson (2012) that Stalin's policies removed barriers in the Soviet economy. However, the TFP in agriculture increased only insignificantly while TFP in manufacturing is lower.

**Connecting wedges to the policies**

*Manufacturing TFP.* We now continue our discussion in the previous section of why the TFP estimates for non-agricultural sector we obtain are lower in 1940 than in 1928. The key force is the significant expansion of inputs. From 1928 to 1940, capital in non-agriculture grew by a factor of 4.4, labor in non-agriculture grew by a factor of 3.7 while the output grew only by a factor of 2.75. We proceed with further discussion of changes in Soviet technology which is based on Lewis (Chapter "Industry" in Davies, et al. 1994). Our estimates of the slow growth of TFP are consistent and are directly supported with the summary of the data by Moorsteen and Powell, by Bergson, by Khanin, and by Seton (Lewis, p 195-196 and Figure 15, Table 41 therein). The main conclusion of these studies is that TFP growth had an insignificant impact on growth compared to the growth in inputs. Moreover, Moorsteen and Powell also point out that the TFP growth in non-agriculture was lower than in the economy as a whole.

On one hand, there were two main positive factors that lead to increase in productivity. First, there certainly were important technological advances. The scale and efficiency in many industries significantly increased (for example, the new and larger blast-furnaces in iron and steel industry or use of explosions and pneumatic picks in coal mining). Soviet Russia was a technological leader in airframe manufacturing and had no equals in the world in design of tanks. Imported technology was introduced and became operational such as Gorkii car plant (based on Ford plant) and the giant Magnitogorsk iron and steel combine (modeled on US Steel in Gary Indiana). By 1940, Soviet Russia caught up with Western Europe in high energy transmission. The second positive factor was improvement in the quality of the labor force. The peasants who joined industry in 1928 by 1940 became quite seasoned and trained workers, some became managers with years of experience in rapid industrialization. Moreover, there was a marked increase in incentives with campaigns on "socialist competition" and Stakhanovite movement of rewarding over-achievers and production stars (see an extensive discussion on these improvements in labor force in Nove 1992, p. 234-235)

On the other hand, Lewis (p. 196) lists five key factors that support his conclusion that "the role of technology in the Soviet growth during the years after 1928 was not as great as might be assumed from a listing of the technological developments of the period". First, the most modern technology was concentrated only in some sectors while the rest of the economy lagged significantly behind (for example: construction overwhelmingly used brick and timber rather than concrete; steam power was still the main source of power in railways). Second, the vertical integration developed to overcome the poor cross-industry planning lead to most of the industries and even large plants operating as self-contained empires. Many of the inputs, related materials and spare parts were produced "in house" often inefficiently and with technology lagging behind the flagship product of those industries. Third, overmanning of the industry was a norm. Forth, after the first wave of foreign technology was put in operation there was a slowdown of import of technology and, importantly, the use of the foreign specialist. Finally, *gigantomania* with the giant factories and production sites often led to inefficient application of the foreign technology designed for much smaller operations as well as presented often insurmountable organizational and business practice projects.

*Agricultural TFP.* Most of the negative TFP effects of the first wave of collectivization were still present in this period: removal and destruction of the most productive class of peasants, poor incentive structure to produce in the collective farms, and poor management. However, the scale effects of the large collective farms and an increase in mechanization (e.g., tractors increased to 10.3 million hp by 1940) had their effects in growing productivity.

*The Great Purge and Gulag prison labor.* Another factor that certainly had a negative effect on TFP (both in agriculture and manufacturing) was the terror of Great Purges[21]. The peak of the repressions was the 1937-38 wave of mass arrests of members of the party and the professional elite. Nove (1992, p. 239) argues that not only the direct effect of arrests, incarceration and executions of the managers, specialists, and civil servants were important but also the terror imposed on the rest of the workforce were a slightest mistake or initiative could be claimed to be act of sabotage or treason punished by death.

An important question to ask is whether forced labor was important for Stalin's economy and whether we should consider this separately. Recent studies (e.g., Wheatcroft and Davis in Davies at. al. 1994 and Allen 2003, p.107-108) place the consensus number of the prisoners of Gulag (including exiles) close to 3 million people in 1937-39. Allen (p. 108) cites Jasny (1951, p. 418) that "somewhat more than two concentration-camp inmates were needed to do the work of one free laborer". He then concludes that the convicts comprised only 1.5 million "free men equivalents" (about 2 percent of labor in the whole economy, 5 percent of the civilian, non-farm labor) and thus "these fractions were not large enough to be decisive". As most of these prisoners were employed in the non-skilled labor we concur with this assessment and conclude that the main effect of the Great Purge was on TFP.

*Intersector labor and capital barriers.* The collectivization drive succeeded in that it mostly destroyed the institute of commune that we argued was an important factor precluding labor mobility in tsarist Russia. Nove (1992, p. 243) concludes that by 1935 the shape of kolkhoz as an institution was "more or less settled ... and ... remained [the same] well into sixties".

*Price scissors.* As argued above, the state learned the cost of excessive price scissors and reduced them in 1933. Through legalizing collective farm markets, government also de facto increased the average price for grain that farmers obtained. Further more, instead of setting the below-market procurement prices for grain, the government introduced a sales tax on food which drove a wedge between what workers paid for food and what farmers received (Allen, 2003, p. 101). Therefore the price scissors remained but were was much lower than in the previous period.

*Big Push or Removal of Barriers.* We conclude this section by stating that one of our important findings is that we find no evidence that supports theories of the Big Push. Stalin's

[21] A variety of repressions and purges were a fact of life under Stalin throughout the whole period that we study (1928-1940), and also during the WWII and up to Stalin's death. We already talked about the effects of the purges of the specialists in the beginning of industrialization and of dekulakization.

policy of industrialization and collectivization are often thought of as the first and the quintessential example of so called Big Push – a coordinated investment across interlinked sectors undertaken by a central planner. While Allen (2003) tracks the idea of the Big Push to Soviet economists Preobrazhensky (1965, first published in 1926 in Russian) and Feldman (published in Russian in 1928), the modern concept of the Big Push was conceptualized by Rosenstein-Rodan (1943) and formalized by Murphy, Shleifer, and Vishny (1989). The main idea of the Big Push model is as follows. While industrialization raises aggregate output and income, it requires coordinated decision-making across producers; in a decentralized market equilibrium, the individually optimal choice for each firm or household is to stick to the agrarian technology so that industrialization does not occur. On the other hand, once the investment in industrial technology is forced by the central planner, everybody is better-off. In terms of our model, the Big Push should have shown in a significant increase in TFP. However, we extensively argued above that even 12 years after the start of the big push, in 1940, there is no evidence of the significantly increased TFP. If anything, Stalin's Big Push lead to a drastic drop in TFP in the first years of this policy, and led to lower manufacturing TFP by 1940.

# 6 Russia without communist revolution: benchmark scenario

This section develops our benchmark counterfactual of how Russia would develop under alternative history scenarios. In the next section, we consider other scenarios.

Our counterfactual on comparison with the tsarist economy consist of two parts. First, we use average tsarist wedges from 1885 to 1913 and extrapolate them until 1940. We then compare economic outcomes in that simulation to the actual performance of the economy under Stalin in 1928-1940. Conceptually we think about this exercise as how Russian economy would have developed if all tsarist distortions remained unchanged.[22] Second, we study the question how Russia would have developed under both Stalin and tsarist distortions after 1940 in the absence of the WWII. One of the common arguments is that Stalin's reforms improve economic efficiency to successfully fight in the WWII and project economic and political dominance after the WWII. Comparing the economic outcomes under Stalin's and tsarist's distortions allows

[22] This analysis ignores a potentially destructive effect of WWI which tsarist Russia would have experienced. To the extend that we can think of the war damage as a destruction of physical capital, this is not a substantial issue. If we exogenously introduce a reasonable drop in capital stock in 1918, the economy converges back to its pre-war path by 1928.

us to assess this argument.

### 6.1 "Tsarist" economy versus Stalin economy

For our analysis we need to take a stand on how fast population in tsarist Russia would grow. Since we have a decreasing returns to scale technology, faster population growth leads to lower per capita output and welfare. As Figure 3 indicates, there was a very substantial slow down in population growth in Russia after the communist revolution of 1917, a large part of which was caused by wars, famines, and repressions. In order to not count these towards welfare gains for Stalin, we assume that the actual population in Russia under tsarist distortions would be the same as population in the data.

Another issue is how to treat the initial capital stock for Stalin. As we see from Figure 3, the capital to output ratio in 1928 was substantially below its pre-WWI trajectory. We report how our results would change if we take the economy with tsarist wedges and endow it with Stalin's 1928 initial capital stock.

Finally we discuss how to treat projection of Stalin's wedges past 1940. As we have seen from our wedge decomposition in the previous sections, Stalin's distortions mostly stabilize at their new levels around 1936-37. For $\tau_{W,t}, \tau_{R,t}$, $\tau_{C,t}$ we take the average values of these variables for 1937-1940 and extrapolate them into the future. We similarly extrapolate trade ($ex_t$, $im_t$) and government expenditures $G_t$. We use a different strategy for $A_t^A$ and $A_t^M$. The growth rates of these variables ultimately drive welfare and output in the long run. From Figure 4 one can see that it is difficult to say whether there was a shift in the growth rates in Soviet Russia in 1936-1940 compared to the tsarist economy. The TFP levels in both sectors are lower than tsarist trend. The somewhat faster growth rate of TFP in agriculture under Stalin could simply be a result of a catch up to the tsarist trend. For this reason we assume that both $A_t^A$ and $A_t^M$ grow with tsarist trend after 1940 (the next section provides calculations for two alternative scenarios for the projected growth rates of TFP). We take, as a starting point for 1941, the average detrended level of $A_t^A$ and $A_t^M$ from 1937-1940. Finally, we chose the level of $\tau_{K,t}$ after 1940 to ensure that the simulated model with Stalin's wedges matches the data exactly for 1928-1940. The resulting value of $\tau_{K,t}$ is very similar to the average pre-WWII level of this distortion.[23] The specifics of the projection are in Table 4 . [24]

Figure 5 plots actual and projected wedges from 1928 to 1960. Figure 6 plots actual and simulated sectoral value added, consumption, the capital stock, and the labor composition for 1928-1960. We now briefly make several observations. Consumption of agricultural goods is significantly lower under Stalin than under the tsarist distortions in 1928-1940. Consumption of non-agricultural goods is also significantly lower except for the last several years when non-agricultural consumption in the data is slightly higher. Since consumption is a sufficient statistic for the welfare in our economy, these graphs clearly indicate that the welfare under the Soviet distortions is significantly lower than under the tsarist distortions during the 1928-1940 period.

The situation reverses after 1940. The lower wedges in the Stalin's economy contribute to a larger accumulation of capital. As a result, both the output and consumption in both sectors under the Stalin's distortions overtake the output and consumption under the tsarist's distortions soon after 1940. Therefore, the welfare becomes higher after 1940.

To formally measure the welfare gains (losses) we find a fraction of consumption which needs to be added (or subtracted) to make the household indifferent between the simulated consumption stream and the observed consumption stream. Thus, the welfare gain in units of consumption, $\phi$, solves

$$\sum_{t=T_0}^{T_1} \beta^t U\left(c_t^A, c_t^M\right) = \sum_{t=T_0}^{T_1} \beta^t U\left(\left(1+\phi\right)\hat{c}_t^A, \left(1+\phi\right)\hat{c}_t^M\right),$$

where $\hat{c}_t^i$ denotes the observed consumption streams and $c_t^i$ represents the simulated consumption stream obtained from the counter-factual exercise.

Table 1 shows decomposition of the contribution of various wedges to welfare. Specifically, we start with the projected tsarist economy and replace one-by-one each tsarist wedge with the corresponding Stalin's wedge in the order given in the table.[25] A negative number shows

[23] We project all the wedges and simulate the economy for the period 1941-2000. We choose the terminal condition for expected consumption in the year 2000 which implies stable rates of investment throughout the projected period. We allow the wedges in the tsarist projection to converge to Stalin's values between 1990 and 2000. This allows us to keep the terminal condition fixed across all counterfactual exercises.

[24] We estimate linear trends for sectoral TFPs of the Tsar and extrapolate these trends post 1913. Because the base for the later period is higher, the implied growth rate is lower. If we estimated a log-linear rather than a linear trend for TFP, we would get unreasonably high values of GDP per capita by extrapolating the economy of the Tsar.

[25] Alternative decompositions give similar results.

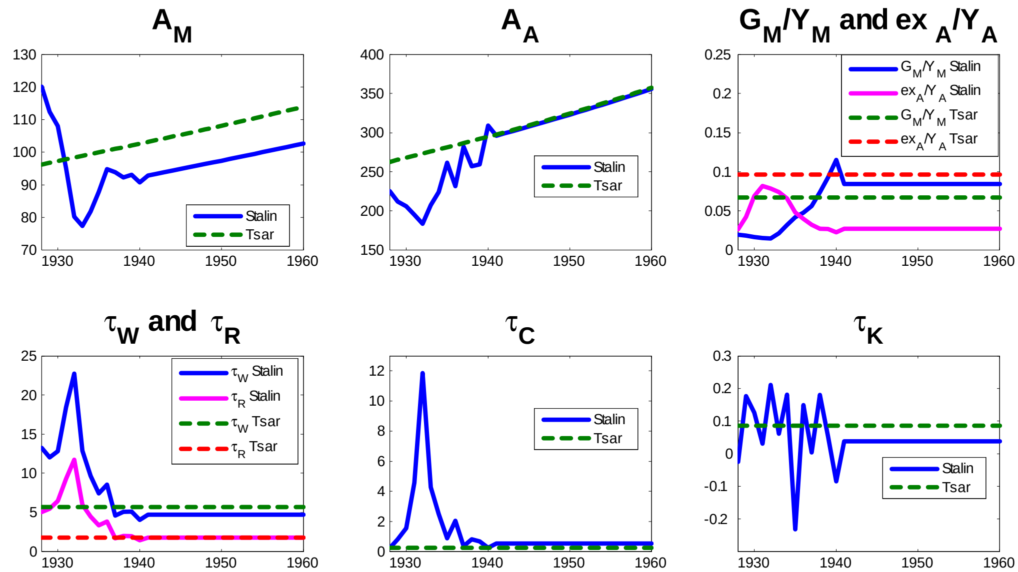


Figure 5: Extrapolated Wedges for Stalin and Tsar

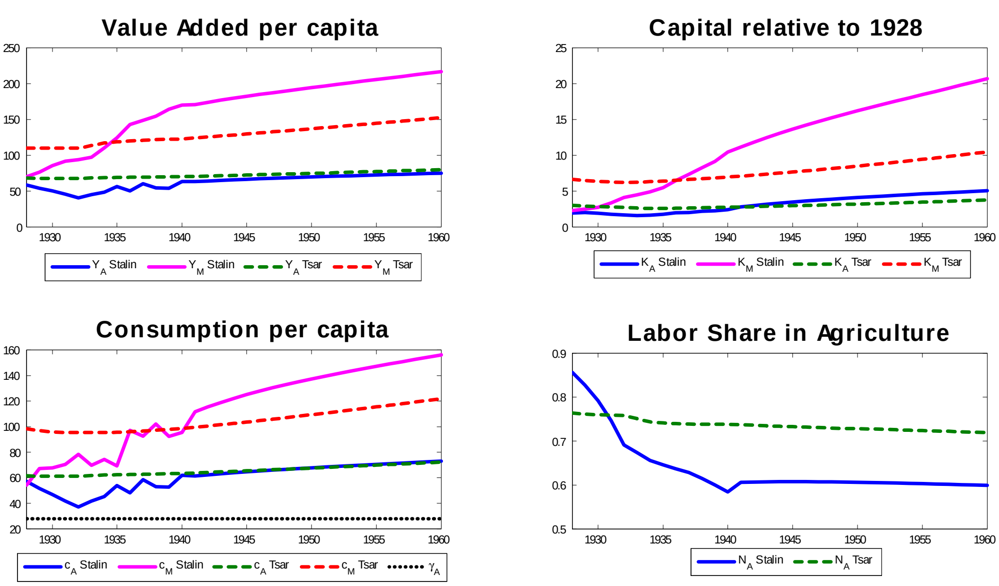


Figure 6: Predicted Economic Indicators for Stalin and Tsar

by how much the welfare decreases with the Stalin's wedge, a positive number indicates an increase. When we replace all tsarist wedges with their Stalin's counterparts, we replicate data for 1928-1940, and provide the total welfare gains. The second from the bottom line (*Total*) reports the welfare numbers net of the effects of population. The last line (*Total net of* $K_{1928}$) reports the welfare numbers if, in addition, we assume that the tsarist economy starts with the Soviet capital stock in 1928.

The first three columns correspond to welfare from 1928 to 1940 (measured as discounted utility over those periods), to welfare from 1928 to infinity (which represents a lifetime utility of a representative consumer born in 1928); and welfare from 1940 to infinity (which represents a lifetime utility of a representative consumer born in 1940). The forth column isolates the contribution of the wedges after 1940 to the welfare after 1940. The wedges in 1928-1940 affect the welfare and the output after 1940 by affecting the level of capital, $K_{1940}$. To abstract from the effect of those policies, the forth column compares welfare under tsarist and Soviet wedges after 1940, keeping the capital stock $K_{1940}$ the same for both economies.

Our main findings for welfare are as follows.

Consider the effects of wedges on the welfare of the generation born in 1928 (the second column of the table). The three largest wedges affecting welfare are, in order of significance: the fall of TFP, price scissors, and in about equal measures the effects of trade and reduction of the capital wedge. The decline in TFP in both sectors resulted in welfare losses subtracting approximately 14 percent (the sum of -6.6 percent and -7.4 percent). The drop in the foreign trade partially compensated for this decline by pushing people from the villages to the cities, and accounted for 5.4 percent. The reduction in the capital wedge sped up capital accumulation and led to the faster long run growth which accounted for another 4.7 percent welfare gain. The effects of government spending and the intersector rate distortion jointly account for only the 0.9 percent welfare gain.

Now consider the effects of the wedges on the welfare of generation born in 1928 in period 1928-1940 (the first column of the table). The effects of the TFP fall are slightly larger: -17.3 percent with the bulk of the TFP losses coming from the drop in the agricultural TFP. The effects of price scissors and the wage distortions largely canceled each other out in the short run (1928-1940). The effect of trade remains about the same (5.5 percent). In the short run, the policy of price scissors was perhaps too "successful" in moving people from agriculture so

| | Gain from policy for | | | |
|---|---|---|---|---|
| Policy | [28-40] | [28-$\infty$] | [40-$\infty$] | [40-$\infty$], $K_{1940}$ |
| $\tau_K$ | -2.2% | 4.7% | 9.9% | 7.6% |
| $\tau_C$ | 11.4% | 13.0% | 9.9% | 7.3% |
| $\tau_W$ | -10.1% | -4.6% | 3.6% | 5.4% |
| $G_M$ and $\tau_R$ | 2.6% | 0.9% | -0.3% | -1.0% |
| $A_M$ | -1.9% | -6.6% | -10.2% | -9.2% |
| $A_A$ | -15.4% | -7.4% | -1.3% | -0.1% |
| $ex$ and $q$ | 5.5% | 5.4% | 5.3% | 5.0% |
| Total | -24.1% | -1.0% | 16.5% | 14.9% |
| Total net of $K_{1928}$ | -10.1% | 5.3% | 16.9% | 14.9% |

Table 1: Welfare Decomposition: Stalin vs Tsar

that the labor wedge had to increase to negate it.

For generation born in 1940, the three key factors of the welfare gain are the combined effect of the price scissors and the labor wedge (15.5 percent), reduction in manufacturing TFP (-10.2 percent), and the reduction of the capital wedge (9.9 percent). The effect of trade remains about the same (5.3 percent). In short, Stalin's policies of breaking the labor barriers and reducing the intertemporal investment frictions did succeed in the long run. The main negative effect both in the short and in the long run was the fall of TFP.

The total effect of Stalin's policies for generation 1928 adds up to a 1.0 percent loss of consumption (net of population effects). However, the short run costs (1928-1940) amounted to 24.1 percent of consumption. Generation born in 1940 reaps the benefits of the reduction of frictions and yields a 16.5 percent lifetime gain.

Table 2 provides a similar decomposition of the role of the wedges on the difference between the share of agricultural labor force under Stalin and under the tsarist policies for 1945[26]. The share of the labor force in agriculture is 12.6 percentage points lower under Soviet wedges than under tsars'. This table shows that about 7.1 percentage points are explained by the reduction in the normalized labor wedge $(1 + \tau_{W,t}) / (1 + \tau_{C,t})$, which is represented as the sum of $\tau_{C,t}$ and $\tau_{W,t}$. The difference in this wedge explains more than half (55 percent) of the difference. The reduction in the capital wedge contributes 2.7 percentage points of the change. These two results are consistent with the view (e.g., Acemoglu and Robinson 2012) that Stalin's policies broke barriers on labor mobility between villages and cities and resulted in reduction of the

[26] These are the same scenarios for which the welfare decomposition was computed. We chose 1945 for this comparison so that it captures the long-run change in the labor share in agriculture.

| Policy | $\Delta\left(\frac{N_A}{N}\right)$ in 1945 | Contribution |
|---|---|---|
| $\tau_K$ | -0.027 | 23 % |
| $\tau_C$ | -0.031 | 24 % |
| $\tau_W$ | -0.040 | 31 % |
| $G_M$ and $\tau R$ | -0.003 | 3 % |
| $A_M$ | 0.004 | -4 % |
| $A_A$ | -0.002 | 2 % |
| $ex$ | -0.026 | 21 % |
| Total | -0.126 | 100 % |

Table 2: Contributions of Wedges to the Long-Run Change in Labor Share in Agriculture

investment friction.

Table 5 in the Appendix provides a further decomposition of the effects of wedges on the labor share, capital, and the output for 1928-36, 1937-40, and for 1945.

# 7 Alternative counterfactuals

In this section, we consider two alternative counterfactuals. First, we compare Stalin's policies with those in Japan, excluding the effects of trade and population. We find that compared to the benchmark the welfare losses in the short run are drastically higher and that there are significant losses also in the long run. Second, we consider two alternative scenarios for the growth rates of Stalin's economy if the WWII did not happen.

## 7.1 Stalin's policies versus Japanese policies

For the data on Japan we mainly rely on Hayashi and Prescott (2008) and their original data sources from the *Long Term Economic Statistics* publications edited by Ohkawa and Rosovsky (1973). We re-construct all series so that they are all measured in the same way as the corresponding series for Russia. Hayashi and Prescott cover the same 1885-1940 period for Japan as we do for Russia.

Figure 7 shows that while both the growth rate and the level of real GDP per capita is roughly the same in Russia and in Japan in 1885-1913, the structural composition of the two economies is quite different. The fraction of labor force employed in non-agricultural sector in Japan is significantly smaller than in Russia and declines steadily throughout the sample period. The role of agriculture in the economy is also much less important than in Russia, with

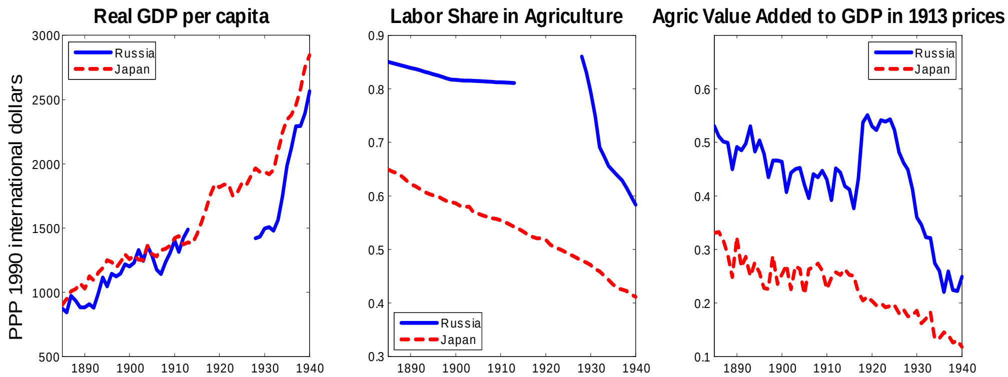


Figure 7: Comparison of Economic Indicators for Russia and Japan

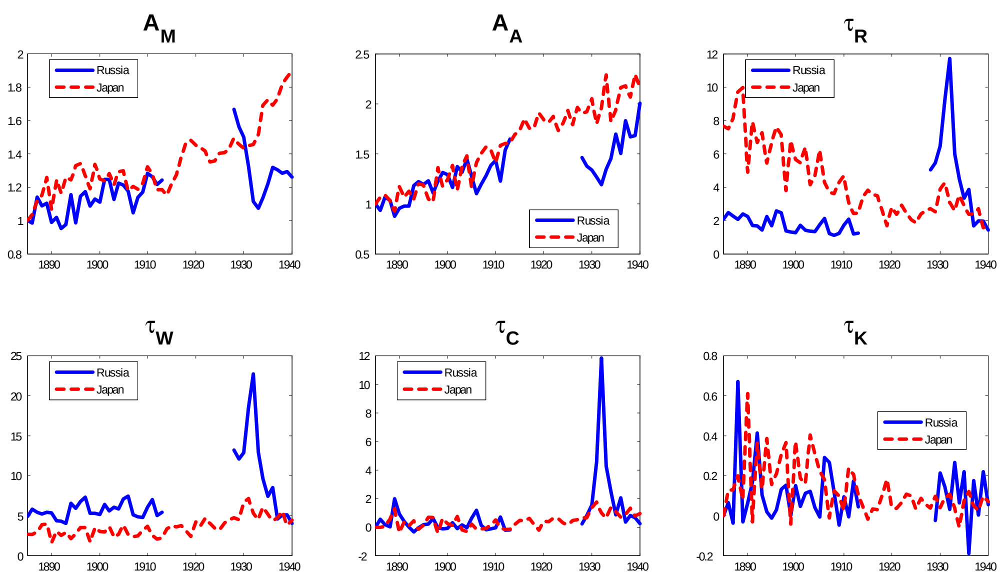


Figure 8: Wedges and sectoral TFPs in Russia and Japan.

only about 25 percent of value added being produced in agriculture. A part of this difference can be explained by the international specialization whereas Japan imports agricultural goods. After WWI Japan mostly follows its pre-war pattern of development, with some acceleration in the GDP per capita growth rate after 1933.

We start by comparing the wedges for Russia, both under the Tsars and under Stalin, with those in Japan. This comparison is presented in Figure 8. The tsarist economy and the economy of Japan were quite similar before 1913. Russia lagged Japan in terms of manufacturing TFP in the 1890s but then by and large caught up in the first decade of 1900s. The average manufacturing TFP growth for the pre-1913 period was 0.66 percent for Russia and 0.86 percent for Japan. Russia and Japan had essentially equal agricultural TFP. The intersectoral capital distortion was significantly higher in Japan before 1913 but declined significantly throughout the period. The intersectoral labor distortion was lower in Japan – this likely reflects the fact that the institution of obschina in Russia was much more distortionary than the barriers for labor mobility in Japan that Hayashi and Prescott (2008) focused on. There is no significant difference in the pattern of the intertemporal wedge.

After 1913, Japanese wedges and the sectoral TFP growth rates largely followed the behavior from the previous period. This is in sharp contrast with Stalin's Russia that experienced dramatic changes in wedges and TFP since 1928.

Our counterfactual exercise envisions the path of the Russian economy under the assumption that after 1913 the Tsar would (in absence of World War I, the Revolution and the Civil War) continue implementing policies similar (apart from trade) to those adopted by the Japanese government. Specifically, we measure the trends in all Japanese wedges except population and trade and input these wedges into the Tsarist simulation from 1913 onwards. The values of the wedges for this simulation are reported in Table 4. Some of the Japanese distortions are higher than under the Tsar ($\tau_C, \tau_R, G_M$), others are lower ($\tau_K, \tau_W$), and the TFP growth is higher in Japan than under the baseline projection for the Tsarist economy. Regarding the projection of the growth for the sectoral TFP after 1940 – we assume that this counterfactual Tsarist economy with the Japanese wedges has the projected Japanese growth rates.[27]

We then compute the welfare decomposition in Table 3 (an analogue of Table 1 for this

[27] The online appendix also presents the calculation where this counterfactual economy is compared with the Stalin's economy for which the post-1940 projected sectoral TFP growth rates are equal to the Japanese projections. The main results of the exercise change insignificantly.

| Policy | Gain from policy for [28-40] | [28-$\infty$] | [40-$\infty$] | [40-$\infty$], $K_{1940}$ |
|---|---|---|---|---|
| $\tau_K$ | -2.6% | 0.6% | 3.1% | 0.4% |
| $\tau_C$ | -8.1% | 1.0% | -0.9% | -3.7% |
| $\tau_W$ | -4.9% | -9.5% | -4.0% | -2.2% |
| $G_M$ and $\tau_R$ | 5.3% | 3.0% | 1.2% | 0.6% |
| $A_M$ | -6.0% | -12.2% | -16.9% | -16.0% |
| $A_A$ | -20.1% | -10.8% | -3.6% | -2.5% |
| $ex$ and $q$ | 5.5% | 5.4% | 5.3% | 5.0% |
| Total | -43.2% | -28.4% | -16.4% | -18.4% |
| Total net of $K_{1928}$ | -30.8% | -22.6% | -15.9% | -18.3% |

Table 3: Welfare Decomposition: Stalin vs. Japan

counterfactual).

It is evident that imposing the Japanese wedges substantially improves the Tsarist counterfactual simulation. TFP grows even faster, while distortions are mostly lower. The main result is that imposing the Japanese policies have such a profound total positive effect on the Tsarist economy, that Stalin's policies are vastly inferior in essentially all dimensions both in the short and long run. Now, Stalin's economy lead to a stunning -43.2 percent loss in welfare for the years 1928-40 and to the loss of -18.4 percent for the generation born in 1940 compared to this version of Japanese policies.

### 7.2 Alternative post-1940 growth scenarios

One projection for which long-term values are of particular interest are the growth rates of TFP in the two sectors. Recall that the benchmark counterfactual assumed that the sectoral TFP growth rates post-1940 for the Stalin's economy are equal to those for the Tsarist economy. We now provide a calculation for two additional alternative scenarios.

The first scenario uses for the projection of the sectoral TFP growth under Stalin post 1940 the trend of the sectoral TFP growth in 1937-1940 (that is, the regression line drawn through these values). This approach implies a continued decline in manufacturing TFP but a speed-up in agricultural TFP growth. Table 15 in the online appendix shows that the adverse effect on manufacturing TFP far outweighs the favorable effect on agricultural TFP. The net effect of this alternative path comes at an additional welfare cost of around -4.5 percent of consumption for the generation born in 1928, and an additional cost of -7.8 percent for the generation born in 1940.

The second scenario aims to answer the question: what would the growth rates of TFPs in Stalin's economy be in the absence of the WWII.

One way of obtaining estimates of TFP growth is targeting the levels of TFP for the end of Stalin's rule. We use data produced by Moorsteen and Powell (1966) to compute estimates of all the wedges except trade for Stalin's economy for the period 1945-1953. This exercise shows that after a recovery period from the WWII, the wedges in the Soviet economy stabilized around 1950. We use average values of the wedges for the period 1950-1953 reported in Table 4 instead of the projected wedges for Stalin's economy. We use levels of sectoral TFP's for 1953 to compute growth rates of TFP for the post-1940 period and use these growth rates in the second alternative scenario.

Table 17 in the online appendix reports the impacts of this alternative scenario on the baseline welfare decomposition. We find that most of the wedges take values close enough to our baseline simulation. As a result, their impact is minimal. The largest changes come from faster TFP growth in the manufacturing sector, and higher prices scissors, which each produce approximately 2 percent extra welfare gains in the long-run. This robustness exercise leads us to think that our baseline scenario identifies well the long-run values of distortions and trends of TFP and, thus, gives a conservative estimate of both welfare losses and the speed of transition.

For completeness, we also note another possible alternative scenario that may be considered. The excellent book by Allen (2003), extensively cited in this paper, provides a comparison of a simulated Stalin's economy with a Soviet economy with the main features of NEP (New Economic Policy). Allen's chapter on counterfactual simulations builds on a model of the Soviet economy due to Feldman (1928) with about fifty variables, several of which following an exogenous law of motion. For out model, we are limited by the availability of the sectoral data for the main variables for the NEP period and therefore do not provide such comparison.

# 8 Robustness

We prepared an extensive online appendix that provides a comprehensive set of robustness exercises. This appendix also contains the details of a variety of alternative assumptions already mentioned in the paper. We now briefly summarize the main implications of robustness.

First, we assess the sensitivity of our estimates of the wedges to measurement error in the data by conducting a Monte-Carlo exercise as follows. We create artificial data series by adding 1 percent log-normal random disturbances to the original data series. We use this artificial data to compute pseudo-series for the wedges. Using 1000 such pseudo-series for the wedges we compute percent standard deviations of the pseudo-wedges for the whole period and for sub-periods. The elasticities of the wedges with respect to measurement error are computed as the ratios of the percentage standard deviations of the pseudo-wedges to the percentage measurement errors. We find that 1 percent measurement error artificially introduced into the data leads on average to 1-5 percent changes in the values of the wedges. We then proceed with finding the standard errors for the decomposition of the welfare (Table 1).

We find that the standard errors are relatively low, as even two standard deviations, in most cases, do not significantly alter our main conclusions. The same is true for the standard errors in the paths of the manufacturing labor share, total capital and total GDP in 1913 prices achieved by Stalin's policies compared to the potential path coming from a continuation of Tsarist policies.

Second, we provide a sensitivity analysis with respect to calibrated parameters. In each exercise one of the parameters $\{\alpha_{A,K}, \alpha_{A,N}, \alpha_{M,K}, \alpha_{M,N}, \gamma, \eta\}$ is changed. For each alternative calibration new time series for wedges are recovered from the data. These new wedges are used to evaluate the welfare gains of policies and the effects on key variables. Most of these effects are small. The largest change comes from varying the subsistence level $\gamma^A$. However, even a 10 percent decrease in subsistence leaves the signs and the magnitudes of most of our results intact, while a 10 percent increase would only reinforce our conclusions.

Third, we provide a sensitivity analysis with respect to projections of the wedges into the future. In each exercise one of the projected long-term values for the wedges is changed to its alternative value reported. Each alternative wedge value is used to evaluate welfare gains of policies and the effects on key variables coming from alternative assumptions about future fundamentals. Specifically, we proceed as follows. We first report an effect of a 1 percent change in a fundamental. If we believed that the data has a 2 percent std measurement error, and that each 1 percent change in a wedge translated into 2-3 percent std of the wedge, then we multiply all numbers in the 1 percent change calculation by a factor coming from the impact of this 2-3 percent std change. This would give us an approximate standard deviation of the confidence bounds on our main estimates due to potential measurement errors in the data. We find that these confidence bounds are quite narrow.

## 9 Conclusion

We started this paper with a question: "Was Stalin necessary?". Tsarist economy, even in our conservative version assuming that it would not experience any decline in frictions, would have achieved a rather similar structure of the economy and the levels of production as Stalin's economy. However, this structural transformation would be achieved at a significant cost in terms of economic welfare measured in consumption equivalents. The short-run (1928-1940) costs of Stalin's policies are very significant for an economy in a peaceful period. Our comparison with Japan leads to astonishingly larger welfare costs of Stalin's policies.

Our projections post 1940 are more speculative. Our conservative benchmark estimates (giving perhaps undue credit to Stalin's TFP projections) point to a long-term welfare gain coming from the reduction of the frictions that outweigh the lackluster performance of TFP.

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# 11 Appendix A: Construction of data

## 11.1 Capital stock

### 11.1.1 Russia 1885-1913

For Russia in 1885-1913 all data is from Gregory (1982) and it is computed in 1913 prices. Capital in agriculture is a sum of value of livestock (table H.1), accumulated agricultural equipment (table I.1) and net capital fixed capital stock in agriculture (table J.1). Agricultural structures include rural residential structures and Gregory does not provide a separate estimate of those. Gregory provides estimates of livestock and net capital stock, but gives investment in agricultural equipment. We derive the stock of agricultural equipment with perpetual inventory method by assuming a 5 percent depreciation.

Capital stock in non-agriculture is defined as the value of accumulated industrial equipment (table I.1), net stock of industrial structures (table J.1), industry inventories (table K.1), railroads (table L.1). The values for the stock of structures, inventory, railroads and urban housing are taken directly from Gregory, while the stock of accumulated industrial equipment is obtained by perpetual inventory method assuming a 5 percent depreciation.

This definition of capital stock includes rural residential housing into agricultural capital stock but does not include urban residential housing in any measure of capital stock. The reason for this is as follows. Ideally, following Hayashi and Prescott (2008) we would like to exclude housing stock from all measures of capital. Gregory does not provide a breakdown of rural capital between residential and nonresidential. We do not include urban residential housing into non-agricultural capital stock since the estimates of urban capital stock differ dramatically for pre 1913 and post 1928 Russia, which we view as unrealistic.

Total capital stock is defined as a sum of capital stock in agriculture and non-agriculture.

We computed investments in each sector from the series of capital stocks assuming a 5 percent depreciation.

### 11.1.2 Russia 1928-1940

For Russia in 1928-1940 we use data from Moorsteen and Powell (1966). All data is in 1937 prices.

We use the data on the composition of gross residential fixed capital stock (table 3-3) to find the fraction of urban residential capital stock in gross residential fixed capital stock. We assumed that the same ratio holds for net residential capital stock (table T-15) to find the value of net urban residential capital stock.

We define non-agricultural capital stock as net nonresidential, nonagricultural capital stock (table T-25). This definition includes industrial fixed structures, equipment and inventories.

We define agricultural capital stock as net fixed capital stock minus net nonresidential nonagricultural capital stock and minus the value of urban residential housing.

Total capital stock is defined as a sum of capital stock in agriculture and non-agriculture.

## 11.2 Exports and international prices

The data for total volume of exports and imports for tsarist Russia is from Gregory (1982), Table M-1. We use the data from Davies (1990), Table 56, to find composition of exports and imports for 1913. We assume that the same composition holds for 1885-1913 and compute net exports of agricultural goods and net imports of non-agriculture goods.

The data for volume of exports and imports for the USSR from 1928 to 1938 is from Davies et al (1993). The provide index of exports and imports relative to 1913 and we use the numbers for 1913 trade from Gregory (1982) to obtain volume of trade in 1913 prices. We impute the values for 1939 and 1940 by assuming that the remain at the 1938 level. We use the data from Davies (1990), Table 58, to find composition of exports and imports for 1927/1928. We assume that the same composition holds for 1928-1940 and compute net exports of agricultural goods and net imports of non-agricultural goods.

We use data on Soviet terms of trade from Davies et al (1993), table 50. Unfortunately we found no comparable numbers for tsarist period.

As a proxy for the international prices of Russian exports we take New York state price of wheat. The dollar prices for wheat are from Jacks (2005). The nominal prices deflated by the US CPI are from the NBER Macrohistory Database.

## 11.3 Output, consumption and investment by sector

### 11.3.1 Russia 1885-1913

We computed investments in each sector from the series of capital stocks assuming a 5 percent depreciation. We computed GNP from NNP series in Gregory (1982), Table 3.1 by adding a 5 percent depreciation to the total capital stock.

We did not find reliable data for value added in manufacturing and agriculture for all years. Gregory (1982) in Table 3.6 reports that in 1913 50.7 percent of value added is produced in agriculture. He also provides numbers for retained consumption of agricultural goods which were not marketed by the peasants (Table M.1) for all time period. We assume that fraction of value added of agricultural production to the retained consumption is at the same level as in 1913 to obtain the estimate of the value added in agriculture during 1885-1913. The value added in manufacturing is obtained by subtracting the value added in agriculture from GNP.

Gregory reports breakdown of imperial and local government expenditures for selected years (Tables F.4 and G.4). For the benchmark analysis we took defence expenditures as our measure of government sector and we checked the robustness of our conclusion by added administrative expenditures. The data for the missing years was obtained by linear interpolation.

To obtain relative prices, we computed nominal value added of agriculture following the same steps as we did for the value added in agriculture in 1913 prices. The ratio of the two gives us a price deflator for agriculture. Gregory in Tables 3.1 and 3.2 reports net investments in current prices and 1913 prices, which allow us to compute investment price deflator and depreciation in current prices. Using Gregory's estimates of National income in current prices and our estimates of depreciation in current prices we obtain GNP in current prices. By subtract value of agriculture in current prices we obtain the value of manufacturing in current prices and price deflator for manufacturing goods. The ratio of the price deflator for agricultural goods to the price deflator of manufacturing goods yields relative price of agricultural goods.

### 11.3.2 Russia 1928-1940

Moorsteen and Powell (1966), Table P.1 provide estimates of GNP and production by sector in 1937 prices. We measure agricultural sector as total output in agriculture, and manufacturing as GNP minus agricultural sector.

Moorsteen and Powell also provide a breakdown of government expenditures in the same table. For the benchmark analysis we took defence expenditures as our measure of government sector and we checked the robustness of our conclusion by added administrative expenditures.

Finding appropriate series for relative prices is particularly challenging. Many official prices are not allocative and they do not necessarily reflect the shadow prices and costs that economic agents face. We rely on the work of Allen (1997) who constructs transaction prices (Table A2) which he argues are the best measure of the prices that peasant faced. These prices are constructed as a ratio of free retail non-food prices to wholesale agricultural prices.

## 11.4 Population and labor force

### 11.4.1 Russia 1885-1913

The data for population is from Gregory (1982), Table 3.1. He reports of the data for the territory of Russian empire excluding Finland and we follow his convention.

We obtain composition of labor force from Davies (1990) and Gregory's estimates. Davies (1990), Table 3 provides estimate of the composition of labor force by sector in 1913. Gregory (1982), Table 6.3 reports growth rates for labor force by sector in for different time periods during 1885-1913. We use these growth rates to backtrack labor force for years before 1913.

### 11.4.2 Russia 1928-1940

It is difficult to obtain reliable data for the composition of labor force. There have been three censuses in Russia, in 1926, 1937 and 1939, but the results of the 1937 are mostly unpublished and many historians question reliability of 1939 census. There are official numbers for employment in various non-agricultural sectors of the economy for select years (Davies et al (1994), table 12). Comparing to the Census data, they do not cover all of the non-agricultural labor force, but give reasonably good approximation of the growth rate of the non-agricultural labor force over the entire time period. According to the census data, non-agricultural labor force increased by a factor 3.37 between 1926 and 1939, while official survey numbers show an increase of 3.19 between 1928 and 1940. We try to use a procedure that follows our estimate of tsarist labor force as closely as possible.

We use population numbers from Davies et al (1994), Table 1. From 1926 census (Davies et al (1994), Table 11) we obtain composition of labor force by sector. We assume that each sector covered by the survey data growths at the same rate as implied by the surveys. This gives us an estimate of non-agricultural labor force for each year. The implied increase in the labor force is 3.36, which closely matches the implied growth of non-agricultural labor force from 1939 census. To find agricultural labor force we assume that labor force participation in all years is the same as in 1926, and find agricultural labor force as a residual.

This procedure implicitly assumes that fraction of labor force to population did not change between 1926 and 1939. This assumption approximately holds in the data. Ratio of labor force to population is 49 percent in 1926 and 50 percent in 1939.

## 11.5 Adjustment for border changes, conversion prices

Using procedure above we obtained two data sets, one for Russia in 1885-1913 in 1913 borders (excluding Finland) and 1913 prices and the other on for the USSR in 1928-1940 in pre-1940 borders and 1937 prices. In this section we discuss conversion of all prices and quantities to have comparable units.

The territory of Russian empire excluding Finland is 21,474 sq km, while the territory of the USSR in pre-1940 borders is 21,242 sq km (Markevich and Harrison (2011), Table 2). Thus the areas of the two territories are quite similar and therefore we assume that land endowments are the same in the two periods and do not make any border adjustments.[28]

Markevich and Harrison (2011) also report that NNP in 1913 prices in Russia decreased from 20,266 mln rubles to somewhere between 15,600 and 17,600 mln rubles in 1928. We take the average of the two numbers and assume that NNP in Russia in 1928 is 16,600 mln rubles in 1913 prices. Markevich and Harrison (2011b) report (Table A10) that fraction of agriculture in NNP in Russian Empire excluding Finland was 44.3 percent in 1913 (50.9 percent if forestry, fishing and hunting is included in definition of agriculture) and in USSR interwar borders was 44.4 percent (50.8 percent with forestry, fishing and hunting). Therefore we assume that fraction of agriculture in GDP is the same in 1913 and 1928. Since all these numbers are given in 1913 prices, they imply that quantities of agricultural and nonagricultural goods decreased proportional to the decrease in the NNP. This gives us a relationship

$$p_{1913}^A Y_{1913}^A \frac{Y_{1928}^A}{Y_{1913}^A} = p_{1913}^A Y_{1928}^A = \frac{p_{1913}^A}{p_{1937}^A} p_{1937}^A Y_{1928}^A,$$

which implies that

$$\frac{p_{1937}^A}{p_{1913}^A} = \frac{p_{1937}^A Y_{1928}^A}{p_{1913}^A Y_{1913}^A} \frac{20,266}{16,600}.$$

We find $p_{1937}^M / p_{1913}^A$ analogously.

[28] While land endowment remained the same, Russian empire lost richer territories (Finland, Poland, Western Belarus and Ukraine, Causasus) and gained poorer territories in Central Asia. Tsarist NNP in 1913 measured in USSR interwar boarders would decrease from 22 mln rbl to 16.5 mln rbl (Markevich and Harrison (2011), Table 1). In the context of our model this differences will be reflected in TFPs and therefore we do not recompute tsarist output in Soviet borders.

## 12 Appendix:Tables

Table 4 shows a variety of values which the wedges take for different periods and in different scenarios. The first three columns of Table 4 show the average values of the wedges measured for three subperiods: 1885-1913, 1928-1936 and 1937-1940. The next two columns show projected values for the wedges used in the two baseline counterfactual simulations: for Stalin and for Tsar. Columns "Japan" and "50-53" show the average values for the wedges inferred from Japanese data for the period 1914-1940 and for the USSR after World War II for the period 1950-1953.

Table 5 is the analogue of Table 2 in the main body of the paper. We measure the effect of different wedges on the behavior of the variables. The third column of the table is exactly the first column of Table 2.

| | Period Average | | | Projection | | | |
|---|---|---|---|---|---|---|---|
| Wedge | [85-13] | [28-36] | [37-40] | Stalin | Tsar | Japan | [50-53] |
| $N_t$ | 1.0 | 0.78 | 0.78 | 0.78 | 1.0 | — | — |
| $\tau_K$ | 0.085 | 0.066 | 0.038 | 0.038 | 0.085 | 0.059 | 0.045 |
| $\tau_C$ | 0.24 | 3.19 | 0.52 | 0.52 | 0.24 | 0.66 | 0.89 |
| $\tau_W$ | 5.66 | 13.11 | 4.71 | 4.71 | 5.66 | 4.35 | 4.61 |
| $\tau_R$ | 1.75 | 6.18 | 1.76 | 1.76 | 1.75 | 2.75 | 1.29 |
| $(1+\tau_W)/(1+\tau_C)$ | 5.89 | 4.76 | 3.80 | 3.80 | 5.89 | 3.29 | 3.02 |
| $(1+\tau_R)/(1+\tau_C)$ | 2.41 | 2.34 | 1.83 | 1.83 | 2.41 | 2.39 | 1.22 |
| $G_M$ | 0.067 | 0.024 | 0.085 | 0.085 | 0.067 | 0.11 | 0.090 |
| $A_M$ | 1.0 | 0.97 | 0.91 | 0.90 | 1.0 | 1.07 | 0.94 |
| $A_A$ | 1.0 | 0.79 | 0.95 | 0.995 | 1.0 | 1.05 | 1.01 |
| $A_M$ growth | 0.66% | -2.95% | -1.12% | 0.61% | 0.61% | 0.70% | 1.23% |
| $A_A$ growth | 1.45% | 0.35% | 3.05% | 0.97% | 0.97% | 1.21% | 0.70% |
| $ex$ | 0.096 | 0.058 | 0.027 | 0.027 | 0.096 | — | 0.033 |
| $q$ | 0.66 | 1.07 | 1.58 | 1.58 | 0.66 | — | 1.65 |

Table 4: Average and Projected Wedges

| | Labor Share | | | Capital | | | Output | | |
|---|---|---|---|---|---|---|---|---|---|
| Policy | 28-36 | 37-40 | 1945 | 28-36 | 37-40 | 1945 | 28-36 | 37-40 | 1945 |
| $\tau_K$ | 1.2% | 4.2% | 2.7% | 3.7% | 26.6% | 37.0% | 2.3% | 11.6% | 13.7% |
| $\tau_C$ % | 16.1% | 1.7% | 3.1% | 24.0% | 38.8% | 14.0% | 32.2% | 12.3% | 8.3% |
| $\tau_W$ | -14.2% | 5.1% | 4.0% | -46.9% | -29.1% | -0.0% | -36.0% | -0.9% | 4.8% |
| $G_M$ and $\tau_R$ | 2.2% | 0.2% | 0.3% | 14.5% | 10.0% | 3.1% | 5.2% | 3.2% | 1.3% |
| $A_M$ | 0.3% | -0.4% | -0.4% | 3.0% | -14.2% | -15.8% | -3.3% | -11.2% | -12.2% |
| $A_A$ | -5.9% | -0.8% | 0.2% | -11.4% | -14.1% | -4.6% | -20.7% | -6.4% | -1.2% |
| $ex$ and $q$ | 1.5% | 2.8% | 2.6% | 3.2% | 2.6% | 3.5% | 3.7% | 4.1% | 4.2% |
| Total | 2.8% | 13.2% | 12.6% | -49.3% | 15.3% | 36.2% | -23.9% | 11.5% | 18.7% |

Table 5: Effects on Labor Share, Capital and real GDP