From sickle to hammer: the decline of production frictions and the industrialization of Russia

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Abstract

Cheremukhin et al. (2017) suggest that a reduction in frictions in the production process accounted for most of the structural change experienced by the Russian economy in 1885–1940. Yet, what was responsible for this reduction? In this paper, we first reconstruct an annual time series of production frictions in 1885–1940, complementing the data provided by Cheremukhin et al. (2017). Then, we verify whether the trends in such frictions are consistent with the set of policies implemented by the different governments (Tsarism, War communism, the New Economic Policy, and Stalin's policies) by using a decomposition and regression analysis. Our findings, though speculative, indicate that the reduction in production frictions correlates with the implementation of Stalin's industrial policies, i.e., high level of investments, lax provision of bank credit to the heavy industry state-owned enterprises, and high production objectives.

Keywords: Russia, industrialization, frictions, wedge accounting analysis.

JEL Codes: N13, N14, E6, O4.

1. Introduction

The objective of this paper is to contribute to the analysis of the industrialization and structural transformation of Russia between 1885 and 1940. Historians and economists have suggested that market frictions – deviations from perfect competition in production, consumption, and labor markets – were the most critical obstacle to Russian economic development. Indeed, it has been shown that the reduction in such frictions (particularly in the pro-

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duction processes) accounted for most of the structural change under Stalin's rule and made a considerable contribution to the rise in GDP per capita (Cheremukhin et al. 2017). In this article, we contribute to and reinforce the findings in this literature, by providing empirical evidence buttressing the historical narrative in Cheremukhin et al. (2017) and extending the examination of frictions to the period from WWI to 1927, which was missing in the previous study. We also deepen Cheremukhin et al.'s (2017) analysis by decomposing the change of the most significant component of the frictions into the changes of its sub-components and the historical and economic dynamics of the whole period analyzed. Finally, econometric tests (though still speculative) are also applied to explore possible competing theories on the reduction of production frictions.

Between 1885 and 1913, the Russian economy grew at 3.3 percent per annum and was characterized by rising investment rates (Gregory 1972; Cheremukhin et al. 2017). Nevertheless, in 1913 the peasantry still formed 82 percent of the population, a modest reduction from 1860 levels, and the agricultural sector still accounted for almost two-thirds of the economy (Cheremukhin et al. 2017). Consequently, many questions arose regarding why and how Russia was developing at such a lethargic pace. Gerschenkron (1965) pointed out that "Russia was not so much demand-constrained, and therefore, in need of a substitute market as it was constrained by institutions and policies". Lenin (1894, pp. 74-75) and Gerschenkron (1965), among others, suggested that the main impediment to development was the archaic agricultural institutions of Tsarist Russia (the *obshchina* or *mir*, commune), which increased labor-market frictions, augmenting the cost of acquiring human capital and introducing barriers to labor mobility between rural and urban areas.[1] Nonetheless, this view can be challenged since, in 1905, the communes accounted for only 35 percent of the total land, and the work of Cheremukhin et al. (2017) showed that barriers to labor mobility played a limited role in preventing economic development. Nafziger (2010) provides further evidence, indicating that peasant households did have substantial flexibility when it came to allocating their land and labor holdings. Moreover, according to Allen (2003), Stolypin's reforms, which had a noticeable effect on weakening the communes, did not have any major effect on the reduction of labor-market frictions.

On the other hand, many historians (Crisp 1978; Davies 1994; Parente and Prescott 1999) claimed that barriers to entry and market power – frictions in the production process, and not those in labor mobility – were the most important obstacle to economic development at the turn of the nineteenth century. Indeed, the historical evidence points to the role of *monopoly capitalism*.

1. A similar situation happened in Japan before WWII (Hayashi et al. 2008).

This friction was caused by the privileges that manufacturing companies enjoyed from 1895 until 1914 (McCaffray 1996; Gregg 2020). Russian tsars were suspicious of free-market-oriented institutions, considering them a threat to their autocracy. This may be seen in Tsarist Russia's corporate legislation, which demanded a special authorization from the tsar for the notarization of any joint-stock company (Gregg 2020). This concession system and the direct issue of special favors (monopoly rights) promoted the prevalence of *sindikaty*, or syndicates (Owen 1991, p. 19), cartel agreements that involved the sale of their participants' products through a single sales agency set up in the form of a joint stock or a limited liability company. Additionally, the cartels were able to determine the sales quotas for their members and the wholesale prices (Davies et al. 1994, p. 2).[2] Overall, due to the barriers of entry and the derived monopoly power, these *sindikaty* were able to maintain high markup-to-marginal cost ratios, obtaining large profits. Consequently, this monopolistic power led to inefficient low investments in the manufacturing sector and low demand for labor (Cheremukhin et al. 2017).

Overall, the barriers to entry and the consequent production frictions in the manufacturing sector were one of the main factors explaining the slow development of Russia at the turn of the twentieth century. Similarly, also between 1920 and 1938, the Soviet economy was unsuccessful in productivity terms, in both the manufacturing and the agricultural sectors. Indeed, the manufacturing total factor productivity (TFP) diminished by 20 percent from 1928 to 1932 (Cheremukhin et al. 2013).[3] Nevertheless, Russia showed rapid structural change and GDP growth, as over 20 percent of workers transitioned from agricultural to non-agricultural jobs. Traditionally, it has been argued that Russia's industrialization was the consequence of the "Big Push" model implemented to reach Stalin's economic goals, known as "five-year plans" (Murphy et al., 1989). However, this has been proved inaccurate, since the Big Push approach produced opposite results to what should have been expected theoretically. Murphy et al.'s (1989) formalization of the Big Push model predicts that any policy that would shift the economy from the non-optimal equilibrium (underutilization of capital and labor) to the optimal one would increase the efficiency of factors utilization. Hence, these types of policies would cause an increment in manufacturing productivity. This is incon-

2. According to Davies et al. (1994), in the 1890s the power of these cartels significantly increased, and they started to dominate most industries such as iron, steel, oil, coal, and railway engineering. Mau and Drobyshevskaya (2013) show that an alliance of distillery companies was responsible for 80 percent of production in the sector and that the Society of Cotton Cloth Manufacturers and the Special Office for Allocating Orders in the match industry were responsible for 95 percent of output.

3. There is not enough data available to estimate TFP for the period covering the October (Bolshevik) Revolution, the Civil War, War Communism, and the New Economic Policy (NEP), but it is not unreasonable to assume declining or stagnating TFP.

sistent with the declining trends in the manufacturing TFP observed in the Russian economy during this period (Cheremukhin et al. 2017).

The apparent paradox of growing GDP and declining TFP can instead be explained by the substantial decline of market frictions. As Cheremukhin et al. (2017) showed, such a reduction in distortions is attributable mostly to a dramatic decline in the production process frictions, driven by the decrease in markups in the manufacturing sector. This was facilitated by Stalin's state-led system of economic organization, which had a major difference in comparison to firms in a capitalist system. In the latter, companies would solely hire new workers if this would generate enough revenue to cover their salaries, i.e., when the marginal product is greater than the workers' marginal cost or wage. Nonetheless, in the Soviet Union output could be augmented by contracting new workers with a positive marginal product even if it was less than the wage (or the marginal cost). Indeed, the main objective of state-owned enterprises was to maximize output rather than profits, according to the production objectives imposed by the state during the five-year plans by the Gosplan.[4] The system was funded and facilitated by the Gosbank, the Soviet Central Bank, offering very abundant credit that state-owned enterprises could borrow due to their soft-budget constraints. Under these policies, companies were forced to increase their production to achieve the output objectives established by the five-year plans, and their markup-to-marginal cost ratios diminished. Furthermore, the price scissors policy (see section 2) permitted obtaining the necessary funds for heavy-industry investment but also caused incentives for the population to emigrate to the industrial areas due to the pressure on their wages – one of the main components in the production frictions.

Overall, the evidence suggests that frictions in the production process accounted for most of the structural change and economic growth (or lack thereof) of Russia between the late nineteenth century and the beginning of WWII. Cheremukhin et al. (2017) evaluate the role of such frictions through a "wedge accounting" methodology, derived from Chari et al. (2007). In their framework, the effect of different policies can be represented as a change in a set of wedges or frictions in a neoclassical growth model.[5] Inefficient policies can be seen as deviations from the values of the optimality conditions in the model. Thus, an efficient economy would generate no or low frictions, permitting an optimal allocation of resources across sectors within the country. Moreover, the model allows the authors to directly measure the level of dis-

4. The State Planning Committee, commonly known as *Gosplan, was* the agency responsible for central economic planning in the Soviet Union from 1921 until 1991.

5. Chari et al. (2007) also showed that an economy with credit market frictions, considered by Carlstrom and Fuerst (1997), is equivalent to a growth model with investment wedges, and that an economy with unions and antitrust policy shocks, like that of Cole and Ohanian (2004), is equivalent to a growth model with labor wedges.

tortions, finding a high level of friction in the Russian economy. Furthermore, they discover that these distortions were predominantly influenced by the frictions in the production process as the marginal product of labor in the manufacturing sector was substantially higher than the workers' earnings, indicating significant markups in the non-agricultural sector.

Analyzing trends, Cheremukhin et al. (2013; 2017) discuss the evolution of the production frictions estimated through their wedge accounting methodology in relation to Russian policies in the 1885–1913 and 1928–1940 periods. Nevertheless, they do not provide formal tests and exclude the 1914–1927 period from the analysis. In this paper, we aim to contribute to this literature by verifying empirically whether the trends in frictions are consistent with the policies implemented by the different governments for the entire 1885–1940 period (Tsarism, War communism, The New Economic Policy, and Stalin's five-year plans).

To do so, we reconstruct an annual time series of production frictions experienced by the Russian economy between 1885 and 1940. We complement the data provided by Cheremukhin et al. (2017) for the periods 1885–1913 and 1928–1940, by estimating frictions for the missing years (1914–1927), including WWI, the Russian Civil War, and the period of the New Economic Policy. We apply the wedge accounting methodology of Cheremukhin et al. (2017) to data from secondary sources (Allen 2003; 2020; Davies 1994; Drummond 1976; Gregory 1982; Gregory and Sailors 1976; Markevich and Harrison 2011) and primary sources (*IstMat*, *Istoricheskiye Materialny,* and the Russian Statistics Library). Moreover, for the whole period of analysis (1885–1940), new time series on literacy rates, inflation (Banerjee and Russell 2002), and population have also been constructed (see Appendix A).

As expected, we find no positive impact of the Tsarist policies period, as the production frictions remained constant and high during that time, deterring industrialization. Frictions in the production process increased dramatically during war communism due to the policies that were carried out. These extreme measures included forced nationalization of firms, collectivization of lands, and seizing of private property. However, this must be also contextualized given the extreme times of the Russian Civil War, which worsened the situation. The subsequent reduction in production frictions is correlated with Stalin's policies during the first five-year plan, particularly the lax provision of bank credit to the heavy industry state-owned enterprises along with high production objectives and soft budget constraints, which permitted Russia to industrialize.

The structure of the rest of the paper is as follows. Section 2 describes the historical context of the period under study, providing an overview of policies and economic events that affected Russia between 1885 and 1940. Section 3 introduces the theoretical framework and the data used to estimate pro-

duction frictions. Section 4 provides an in-depth decomposition analysis of the production frictions components' trajectory and describes the empirical approach to estimating the correlation between policies and production frictions, presenting the results. The last section concludes.

2. Historical background

The outcome of the Crimean War (1854–1856), initiated under Tsar Nikolay I and finished under Tsar Aleksandr II (1855–1881), showed Russia the potential dangers of the growing divergence with the West, resulting in a resurgence of interest in promoting industrialization. One attempt in this direction was the abolition of serfdom[6] in 1861, when the serfs gained the rights[7] of full citizens in exchange for redemption payments (in the form of additional taxes). Nonetheless, the land, known as "allotment land", was given to the *obshchiny,* the agricultural communes*,* rather than transferred to private households. Individual peasants would have rights to strips of land that were assigned to them under the open field system. Unfortunately, a peasant could not sell or mortgage his land, so in practice, he could not renounce his rights to his land, and thus he would be required to pay his share of redemption dues to the village commune (Nafziger 2010). Moreover, the peasants were not given enough land to provide for their needs. Hence, in the words of Allen (2003):

> This policy slowed economic growth by reinforcing communal ownership, preventing the emergence of a labor market, and by reducing the demand for manufactures since self-sufficient peasants bought few commodities.

This claim is further supported by Markevich and Zhuravskaya (2018), who argued that the negative effects of the land reform were most likely caused by the increase of the *obshchiny*'s repartition power. In addition to abolishing serfdom, Tsar Aleksandr II also proceeded with other reforms, in an attempt to avoid depending on land aristocracy and made an effort to foster Russia's industrial development and exploitation of natural resources, by incentivizing the construction of a railway network.

6. 20 million of privately held serfs were involved.
7. Such as: the right to marry without having the consent, to own property, and to own a business.

2.1. Tsarism (1885-1917)

In 1881, Tsar Aleksandr III succeeded his father on the throne (1881–1894), initiating a reign of counter-reforms. However, some liberal financial reforms were introduced, in an attempt to ameliorate the poor living conditions of the peasantry. One of these reforms was the abolition of the poll tax, to accelerate the legal transfer of the land allotted to peasants by the abolition of serfdom. Moreover, the royal lands became available for leasing or acquisition on favorable terms. However, these reforms were countered by the increase in other taxes that worsened overall the conditions for the peasantry (Allen 2003). Nonetheless, the Tsar also contributed to the development of the railroad network, increasing its extension by 1154 km per annum (Allen 2003). Moreover, his finance minister, Ivan A. Vyshnegradsky,[8] encouraged an import substitution industrialization policy by establishing the Mendeleev tariff in 1891. This tariff was levied mainly on agricultural imports, and secondly on manufactured goods (Chuchko 2021), channeling the gains towards the industry and the railroads. Furthermore, he promoted the nationalization of the least profitable companies.

In 1894, Alexander III was succeeded by his son, Nikolay II. Under his reign, the industrialization of Russia began to become significant. However, the country remained rural.[9] The Russian monarchs remained vigilant against any possible attack on their absolute power from the new capitalist institutions. Hence, promoting Russian industrialization was left to the initiative of Count Sergey Witte, who was the thirteenth finance minister (1892–1903) and the first prime minister of the Russian Empire (1905–1906). Russian economic development in the late nineteenth century was led by the combination of domestic market integration,[10] increases in agricultural productivity, and integration in the world economy. Cultivation was expanded to the steppes of the south of Russia and extended into western Siberia. Nonetheless, the speed of industrialization was not fast enough to generate a structural change in the economy. In general, with the possible exception of St. Petersburg, there was little growth in real wages by any measure between 1853 and 1913 due to the

8. Ivan Alexeyevich Vyshnegradsky, 1832, Vyshny Volochyok–1895, St. Petersburg.

9. For similar GDP per capita levels in Russia and Japan in 1900, 80 percent of the Russian labor force was working in the agricultural sector, whereas in Japan it was 60 percent (Fukao et al. 2017).

10. Market integration was caused by the growth in the transportation network, especially through railroad expansion, which increased by 1942 km per annum until 1917. Nevertheless, as stated by Cheremukhin et al. (2017), "different regional markets were poorly integrated and that many Russian farmers were 'subsistence-oriented', producing only a small fraction of their income for commercial sale".

rising prices of food (Allen and Khaustova 2018).[11] In addition, in the countryside, the rental prices of land also rose, but most non-government-owned farmland in the Empire was held by the *obshchiny*. Thus, even if the peasants were doing better, they were still poor (Allen 2003). As a finance minister, Count Witte attempted to stabilize the exchange rate of the ruble through a major monetary reform, allowing Russia to join the international gold standard in 1897, leading to an increase in investment activity and the inflow of foreign capital (Drummond 1976). Moreover, his policies also aimed to promote the expansion of domestic heavy industry by maintaining an aggressive import substitution policy. His protectionist trade policy further included the implementation of high protective tariffs, profit guarantees, tax reductions, and exemptions (Chuchko 2021). Indeed, the implemented tariffs primarily protected food agricultural products and secondly manufactured goods (Chuchko 2021). However, tariffs on most industrial products were high from the 1880s through WWI (Chuchko 2021) and higher prices for manufactured consumer goods contributed to stagnating real wages (Allen, 2003).

In addition, the consequences of the applied policies created a very rapid production concentration (Mau and Drobyshevskaya 2013). Moreover, the Russian commercial legal system suffered from severe elitism, and the Russian government allowed owning stock of companies in the same industry (Gregg 2020; Shepelev 1973).[12] Consequently, powerful monopolies or cartels (*sindikaty)* started to appear in most industries, such as iron, steel, oil, coal, and railways, determining the wholesale prices based on sales quotas for the cartel members (Mau and Drobyshevskaya 2013). Henceforth, the manufacturing sector in Russia at the end of the nineteenth century was comparatively small and it was characterized by the prevalence of monopolies, implying important barriers to entry (Cheremukhin et al. 2017). In 1914, Russia only had 2,263 corporations in comparison to 5,488 in Germany or 65,700 in England (Shepelev 1973, p. 232).

After the defeat in the Russo-Japanese War (1904–1905) and the consequent dramatic "Bloody Sunday",[13] the 1905 Revolution erupted, paralyzing Russia. This revolt was economically motivated, to a certain extent, by the poor living conditions of the peasantry, who earned too little, faced high food prices, and were not allowed to sell or mortgage their allotted land (Ascher

11. Food prices were rising as a consequence of the government's fiscal policy of indirect taxation and the high prices of imported goods following the imposition of the protectionist tariff.

12. Shepelev (1973, pp. 233, 283-284) also argues that the Russian government was perfectly aware of the growth of monopolies and did not act in consequence, in contrast to the US Congress anti-trust policy (1890's Sherman Act).

13. Father Grigori Gapon led an enormous crowd to the Winter Palace in, at the time, Petrograd to present a petition to the Tsar. When the procession reached the palace, soldiers opened fire on the crowd, killing hundreds.

2002). Simultaneously, new ideas spread, opposing the archaic social institutions of the Empire – such as socialism, anarchism, and liberalism – and generating the ideological seed that would trigger the following revolutions (Ascher 2002). In the aftermath of the Revolution,[14] the government presented some timid reforms by establishing a "constitutional order" (Ascher 2002). In addition, in 1906, Pyotr A. Stolypin[15] became the third prime minister of Russia (1906–1911). Under his ministry, Stolypin issued a series of decrees and undertook a new land reform, in an attempt to undermine the *obshchiny* by allowing individual sales of land and encouraging the peasants to convert land from communal to hereditary tenure and to exchange their scattered strips in the village fields for consolidated and enclosed farms, facilitating the exit from communes (Castañeda and Markevich, 2013).

After Stolypin's assassination in 1911, the reform effort stopped. Yet, according to Allen (2003), Stolypin reforms that were implemented had a noticeable effect in weakening the communes, through the consolidation of land and changes in peasant de facto land usage rights (Castañeda and Markevich 2013), since the proportion of peasants in communes declined from 71 percent in 1905 to 61 percent in 1915 – a migration of 2.5 million peasants leaving the *obshchiny*. In addition to these results, Castañeda and Markevich (2013) argued that the reforms also increased agriculture productivity by 14 percent nationwide, and in Siberia by 25 percent. Russia's grain exports in 1912 exceeded by 30 percent those of Argentina, the US, and Canada combined. Indeed, Castañeda and Markevich (2013) found a large positive effect of land consolidations on agricultural productivity. In 1820, Russian income per head was $749 (1990 dollars), which was on a par with the less developed countries of Asia and Latin America, significantly behind Western Europe. Hence, although GDP per capita in the 1880s was barely 3 percent higher than in the 1690s, this was not the result of continuous stagnation, but rather periods of growth followed by periods of shrinking, or growth reversals (Broadberry et al. 2022). Nonetheless, by 1913 its income had risen to $1488 per head. However, the West was a moving target, and on a percentage basis, Russia was farther behind in 1913 than it had been in 1820 (Cheremukhin et al. 2017).

14. On 9 October 1905 Witte told 'with brutal frankness' the Tsar that the country was on the verge of a catastrophic revolution, which he said 'would sweep away a thousand years of history'. He presented the Tsar with two choices: either appoint a military dictator, or to agree to broad and major reforms.

15. Pyotr Arkadyevich Stolypin (14 April 1862 - 18 September 1911). He became the 3rd Prime Minister of Russia and simultaneously Minister of Internal Affairs of the Russian Empire. He is considered one of the last major statesmen of Imperial Russia with clearly defined reforming policies.

In August 1914, Nikolay II started the mobilization of troops in defense of Serbia against Austria. Later, the system of European alliances would provoke the outbreak of WWI. Military reversals and shortages among the civilian population increased the discontent in society. By the middle of 1915, agricultural output decreased drastically, since the peasants left to the front, and inflation exploded (Allen 2003). Consequently, strikes rose among low-paid factory workers, and social unrest became common. Eventually, the Russian Empire was overthrown before WWI ended, with the February Revolution in 1917. This was followed by the October Revolution of the Bolsheviks, leading to the Russian Civil War. Overall, WWI and the Civil War led to an economic and demographic collapse. Hence, as Broadberry et al. (2022) stated, the late industrialization of the 1890s was followed by another phase of shrinking following the Bolshevik Revolution of 1917 and it was only after Stalin's industrialization of the 1930s that GDP per capita gains were permanently consolidated.

2.2. War communism (1918–1921)

With the outbreak of the Russian Civil War, Russia was divided into two differentiated zones controlled by the White Army or the Red Army. The territory in the hands of the proletarian army applied what would be known as war communism. Under this economic regime, Lenin decreed the nationalization of all the land. This policy reversed Stolypin reforms and the open fields were reassembled and regained by communes (Bartlett 1990). Economic problems became particularly serious due to the Civil War, as grain requisitions and the disruption of commercial patterns reduced the incentives to sow. Consequently, in 1921, millions perished in a famine. Because of the conflicts and the economic policy, the urban economy almost vanished for good. The industrial workforce fell from 2.6 million in 1917 to 1.2 million in 1920 (Davies 1990). In 1926, the peasantry accounted for 82 percent of the Russian population in comparison to 72 percent in 1917 (Davies 1990). In 1919, a nationalization decree was issued where first large-scale and then small-scale firms were taken under Soviet control. Later, in 1921, the economy was intensively disrupted. The *Bolsheviky* were in control of the whole country and hyperinflation was rampant. Davies (1990) reported that the grain output was 56 percent below its 1913 level, livestock was 73 percent down, and industrial production had dropped by 70 percent.

2.3. The New Economic Policy, NEP (1922–1927)

As a consequence of the hard economic times and general discontent, Lenin introduced the New Economic Policy.[16] In this new economic approach, the Soviets changed the requisitioning of food for moderate taxation, factory industry functioned on a commercial basis, organized as profit-maximizing trusts, private trade was permitted and economic exchanges between peasants, urban residents, and industry were conducted as market transactions (Allen 2003). In addition, a monetary reform introduced a new currency backed by the Gold Standard, the *chervonets*, bringing stability and effectively cutting the rampant hyperinflation (Efremov 2012). Industry and agriculture recovered and, at the end of the 1920s, output was at its 1913 level. Nevertheless, the renewed communes of the NEP could constrain farm-size growth by limiting the capacity to achieve economies of scale and the mechanization of the Russian fields.

2.4. Stalinism (1928-1940)

In 1924, Lenin died and a battle for power arose. Yosif Stalin, Kamenev, Bukharin, and Zinoviev took control of the Communist Party against the party's left wing, led by Leon Trotsky. In 1928, Yosif Stalin, after becoming the sole paramount leader, replaced the NEP with a centralized planned economy applied through five-year economic plans, which dictated the economic strategy that the country's economy had to follow. The institution in charge of carrying out the application of the economic objectives was the *Gosplan.*

During the first three five-year plans (1928–1940), economic development was quite rapid, industrial output increased by 11 percent per year, and GDP grew at 5.3 percent per annum (Allen 2003). During the pre-WWII Stalinism, a price scissors policy was enforced. This policy consisted in obtaining grain at below-market prices and selling it in the cities above market prices to fund investment in heavy industry. The burden fell on the back of the more prosperous peasants, the *kulaks*. At the beginning of the 1930s, Stalin sought to prohibit private markets of agricultural products and to socialize livestock. Moreover, all members of the peasantry were forced to join the recently formed *kolkhoz* (collective farms).[17] This policy was known as "collectivization" and provoked agricultural production to plummet, creating, conse-

16. An economic system proposed by Vladimir Lenin following Karl Marx's precepts that a nation must first reach "full maturation of capitalism as the precondition for socialist realization".

17. The dekulakization campaign of 1929–1931 affected around six million peasants where the most prosperous were expropriated, exiled to Siberia, or executed (Davies et al. 1994, p. 68).

quently, the harsh famine of 1932–1933 (Allen 2003). The famine and the reduction in agricultural income also caused a massive migration from the countryside to the cities.

Despite the high human costs, collectivization had only a limited positive effect on the industrialization of Russia (Allen 2003; Cheremukhin et al. 2017). Industrialization was then sought through investment in heavy-industry and manufacturing production. During the five-year plans, the government nationalized trade and introduced price controls. Furthermore, under the new economic system, Soviet state-owned enterprises were provided with easy credit from the *Gosbank,* and the requirements for the revenues covering the costs were relaxed (soft-budget constraints). Besides, the state-owned enterprises had the objective of maximizing output, to reach the ambitious targets imposed by the *Gosplan*, rather than profits. These policies caused the companies to vastly expand their factors of production, effectively mobilizing otherwise unemployed workers, but at productivity levels far below the optimal (Allen 2003). The objectives and quotas of production were rarely met but provided the basis for the industrialization of the USSR through labor hiring and input expansion.

3. Estimating frictions

3.1. Theoretical framework

Based on this account, we expect production frictions to be relatively high and constant during the Tsarist period, potentially increasing during war communism and the period of the NEP, to then decline with the implementation of the five-year plans under Stalin.

To check this, we estimate frictions by following Cheremukhin et al. (2017). A friction can be defined as any departure from the ideal of perfect competition, which therefore interferes with economic agents. In a standard neoclassical growth model, with no frictions, in equilibrium, the price would be equal to the marginal cost for each firm and product, and resources would be efficiently allocated across sectors. On the other hand, an inefficient allocation of resources across sectors can be explained by the presence of frictions (or wedges) which in turn may be affected by institutions and economic policies (Chari et al. 2007; Cole and Ohanian 2004).

It should be stated that applying a neoclassical growth model to a centrally planned economy might raise some skepticism. Nevertheless, as mentioned by Barry Ickes (2010):

> A neoclassical model based on a perfect functioning economy [efficient allocation of resources] can provide a good insight into the distortions of centrally planned economies.

Furthermore, Hunter and Szyrmer (1992) use a multi-sector model to evaluate the implications of various policies applied during the Soviet period. The methodology of Cheremukhin et al. (2017) is closely related to this previous work. It can indeed be argued that, in centrally planned economies, economic equilibrium still exists, and neoclassical models could allow us to identify the difference between the optimal equilibrium, where the resources are allocated efficiently, and the one existing in the planned economy. Finally, the Soviet statistical agencies required economic data to assess the government's economic objectives. Even if such data might have suffered from inaccuracies and asymmetries, Gregory and Harrison (2005), based on recently available information from Stalin's archives, argue in favor of the overall rationality of price setting by Soviet firms. In a similar spirit, Harrison (1998) suggested that prices in the Soviet economy played an essential function in the allocation of resources and were established, not arbitrarily, but as a result of a decentralized negotiation process between Soviet firms and the government.

Cheremukhin et al. (2017) developed their version of the neoclassical growth model from Herrendorf, Rogerson, and Valentiyi (2013). From this model, the authors define the inter-sectoral labor wedge $\tau_{w,t}$ as a measure of the inefficiency in the allocation of labor:

$$1 + \tau_{W,t} = \underbrace{\frac{(U_{M,t}/\rho_{M,t})}{(U_{A,t}/\rho_{A,t})}}_{\text{consumption}} \times \underbrace{\frac{(\rho_{M,t} F_{M,t}/w_{M,t})}{(\rho_{A,t} F_{A,t}/w_{A,t})}}_{\text{production}} \times \underbrace{\frac{w_{M,t}}{w_{A,t}}}_{\text{labor mobility}} \qquad (1)$$

where U_M and U_A are the marginal utility in the manufacturing (M) and agricultural (A) sectors, F_M and F_A are the marginal products of labor, $p_{M,}$ and p_A are the prices, and w_M and w_A are the wages in the two sectors. The subscript t indicates the year.

When there are no frictions, $\tau_{w,t}$ is equal to zero and the right-hand side of the equation would be equal to one. As can be observed, the right-hand side can be divided into three components. The first one, on the left, is the consumption component corresponding to the consumers' optimality condition that represents frictions in consumer markets, such as poorly integrated markets. The second, in the middle, is the production component, which is the optimality condition of competitive price-taking firms. This wedge represents the market frictions in the production process, such as those due to monop-

oly power or barriers to entry. The third component, on the right, represents frictions in the labor market, such as labor mobility impediments or high costs to obtain human capital, and relates to the capability of workers to freely choose in which sector of the economy to work. Hence, frictions exist when the value of any of the three components is not equal to one, and this is a symptom of economic policies or institutions preventing an efficient allocation of resources in consumer markets, production, or labor markets.

Of the three components, the production wedge was the most significant, accounting for about 50 percent of the labor wedge in 1885–1913 (Cheremukhin et al. 2017). According to their findings, the main impediment to Russia's industrialization was frictions in the production process, as measured by the production component of the inter-sectoral labor wedge, due to the existence of monopoly power and barriers to entry. This conclusion is consistent with the findings of Amanda Gregg (2020) regarding the capital constraints and legal barriers that companies suffered due to the difficulty of obtaining corporate charters and the capital scarcity that the Russian economy suffered.

3.2. Data

Production frictions V can be expressed as the middle component of equation (1):

$$V = \frac{\rho_{M,t} F_{M,t} / w_{M,t}}{\rho_{A,t} F_{A,t} / w_{A,t}} \qquad (2)$$

To estimate this expression, we use data from several sources. For the periods 1885–1913 and 1928–1940, we directly use the estimates provided by Cheremukhin et al. (2017), but slightly modify them for the 1885–1913 period by re-estimating the population to account for the territorial changes and war losses (see Appendix A). They obtained data for 1885–1913 from Strumilin (1960; 1982) and Gregory (1982), who, in turn, acquired the statistical figures from a variety of historical sources, based mainly on the official Tsarist publications. Evaluating the quality of the data, Moscow State University scholar Timur Valetov, working on projects collecting Russian historical statistics, stated that the Tsarist Statistical Yearbooks – available at the National Library of Russia and published yearly until 1915 – include detailed data of reasonably high quality. Consequently, data from Strumilin (1960; 1982) have also been used in recent works, such as in Allen (2020).

For the period 1928–1940, Cheremukhin et al. (2017) took much of their data from Moorsteen and Powell (1966), which is widely used by historians.

In particular, they used the 1926 and 1939 censuses and Soviet employment records to construct the sectoral employment shares. Moorsteen and Powell's (1966) estimates were revised by historians after the opening of the Soviet archives, but no major inconsistencies were found (Davies et al., 1994, pp. 115-117). Overall, as stated by Allen (2003, p. 212), "the consensus is that the published Soviet figures for output were basically reliable". To estimate producer prices, Cheremukhin et al. (2017) used the industrial and agricultural prices from Allen (1997). Moreover, to determine the relative wages, they use Allen's (2003) estimated consumption per head in 1928–1939 from agriculture and non-agriculture sectors.

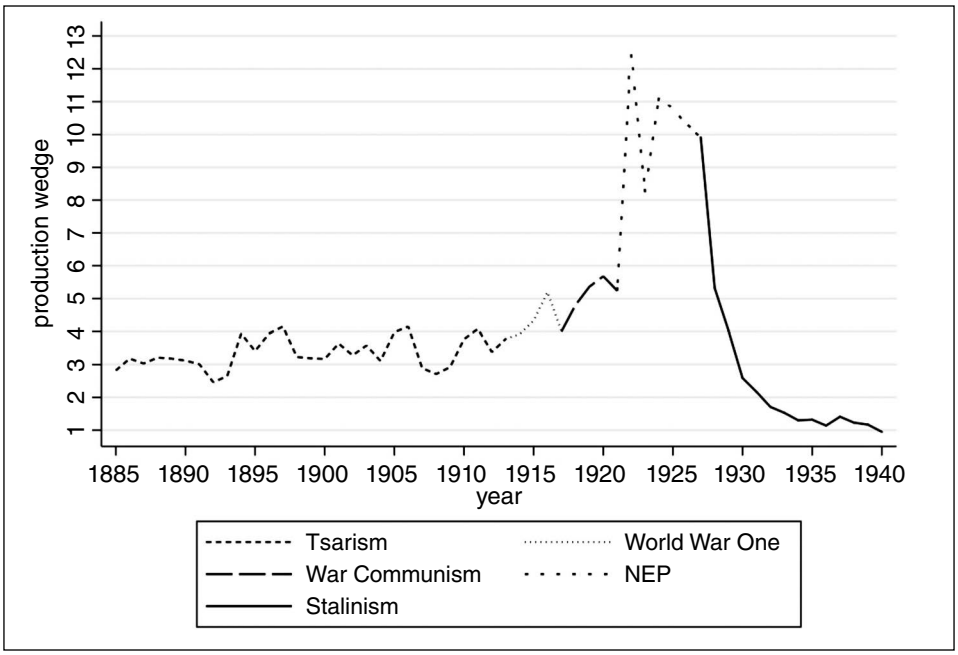
For 1914–1927, we compute production frictions using the middle component of equation (1). The underlying data have been taken from Markevich and Harrison (2011), who provide a valuable reconstruction of the data for this turbulent period. Statistical figures were also acquired from the available yearbooks and statistical compilations available at the *IstMat (Istoricheskiye Materialni)*,[18] and the Russian Statistics Library. The official statistics of the 1920s, especially from the first half of the decade, are regarded as of generally high quality but not perfect (Markevich and Harrison 2011). Furthermore, prices and wages for the missing period were taken from Allen et al. (2020), Timoshenko (1936), Lih (1990), Gatrell (2014), and Wollenberg (1936). In addition, we verified that the estimated interpolated data in our research matched the historical accounts in the secondary literature. For example, the estimations for the evolution of production during the war period were checked with the statistical book by Kafengaus (1994) with a satisfactory outcome. Besides, Allen (2003) agreed with the consensus regarding the general reliability of the Soviet figures. Please check Appendix A for a detailed and comprehensive explanation of the reconstruction of the data.

4. Policies and production frictions

Figure 1 reports the estimates of production friction for the full period under analysis 1885–1940, including the years that were previously missing in the literature. Frictions were relatively high and stable during the Tsarist period, increased substantially in the 1910s and early 1920s, and declined since the mid-1920s.

18. Russian project between economics and history professors with the aim of gathering and developing the historical data for Russia.

FIGURE 1 ▪ *Production frictions*



Sources: Own elaboration, and from Cheremukhin et al. (2017), refer to the Appendix for the data.
Notes: A value of 1 represents the absence of frictions.

4.1 Decomposition analysis

To explore whether such changes in production wedges were due to movements in relative prices, wages, or productivities, we perform a decomposition analysis. The annualized change C between year 0 and year t in the production component of wedges V can be written as $C=(1/t)\ (ln\ (V_t)-ln\ (V_0))$. Thus, the change in production wedges can be decomposed as in equation (3), where the first element of the right-hand side represents the part of the total production wedge change attributable to a change in (relative – i.e., manufacturing vs agriculture) prices, the middle element the one attributable to a change in (relative) productivities, and the last element the share of change due to movements in (relative) wages:[19]

$$C = \underbrace{\frac{1}{t}\left[\ln\left(\frac{\rho_{M,t}}{\rho_{A,t}}\right) - \ln\left(\frac{\rho_{M,0}}{\rho_{A,0}}\right)\right]}_{\text{price change}} + \underbrace{\frac{1}{t}\left[+\ln\left(\frac{F_{M,t}}{F_{A,t}}\right) - \ln\left(\frac{F_{M,0}}{F_{A,0}}\right)\right]}_{\text{productivity change}} - \underbrace{\frac{1}{t}\left[\ln\left(\frac{w_{M,t}}{w_{A,t}}\right) - \ln\left(\frac{w_{M,0}}{w_{A,0}}\right)\right]}_{\text{wage change}} \quad (3)$$

19. The full derivation is reported in Appendix B.

Table 1 shows the results. We analyze the full 1885–1940 period, as well as the different sub-periods characterized by the implementation of the different policies. The table reports the total annualized change in production wedges, the changes in relative wages, prices, and productivities, and their percentage contribution to the change in production wedges. We discuss these results and speculate on their potential relationship with the implemented policies in the following paragraphs.

TABLE 1 ▪ *Frictions trends and decomposition*

	Period		Annualized change				Contribution to change		
	initial year	final year	**prod. wedge**	pM/ pA	FM/ FA	wM/ wA	pM/ pA	FM/ FA	wM/ wA
Full period	1885	1940	**–2.0%**	–1.7%	0.0%	0.3%	85%	1%	14%
Tsarism	1885	1913	**1.0%**	0.3%	0.2%	–0.6%	25%	21%	54%
World War One	1913	1917	**1.4%**	6.5%	4.5%	9.6%	448%	314%	–662%
War communism	1917	1921	**6.8%**	1.0%	–19.9%	–25.6%	15%	–295%	380%
NEP	1921	1927	**10.6%**	–1.2%	17.1%	5.3%	–11%	161%	–50%
Stalinism	1927	1940	**–18%**	–9.4%	–3.7%	4.9%	52%	21%	27%

Sources: Own elaboration, refer to Appendix A and B for the data.

Notes: The initial year is the year before the implementation of the policy, to measure the change during the entire period of the policy.

Production frictions during Tsarism (1885–1913/1917)

In the Tsarist economy, the production wedge remained relatively stable at high levels, as depicted in Figure 1 and Table 1. To better understand this phenomenon, Table 1 subdivides this period into two distinct sub-periods, 1885–1913 and 1914–1917, aimed at eliminating WWI influence and accurately gauging the evolution of production frictions. Between 1885 and 1913, the production wedge exhibited an average annual increase of 1 percent, with 54 percent of this rise attributed to a decline in relative wages. This likely indicates a significant under-utilization of labor in the manufacturing sector, a trend supported by existing literature highlighting the presence of monopoly powers and cartels (Cheremukhin et al. 2017). Notably, imperial factory reports reveal that the average annual factory wage in 1904 was 257 rubles (Allen 2003; Strumilin 1960), implying a total wage bill that accounted for less than 20 percent of total factory-added value (Cheremukhin et al. 2017). Thus, policies aimed at encouraging manufacturing producers to expand output could have reduced not only manufacturing sector markups but also eased production barriers by reallocating labor from agriculture to manufacturing.

Moreover, while Witte's railroad expansion contributed to the integration of commodity markets and the reduction of agricultural prices' interregional dispersion, market integration remained relatively low by the period's end (Gregory 1994; Metzer 1974). The 1896 monetary reform likely boosted investment activity and foreign capital inflow, theoretically leading to a reduction in the production wedge. Nevertheless, the gradual implementation of tariff reforms starting in 1891, characterized by the involvement of business circles in virtually all stages of the tariff's development (Chuchko 2021), probably diminished competition and entrenched the monopoly power of firms and *syndikaty.* This aligns with the rise in production frictions in 1895. Hence, this factor plausibly deterred production expansion, by decreasing incentives to produce, thus contributing to the persistent increase in manufacturing prices during this period.

Conversely, as Gregory (1994) noted, the technological revolution exerted a greater impact on Russian factory production than on agricultural output. Although railroad expansion helped to lower transportation costs for bulk agricultural products, the agricultural sector's labor productivity growth lagged behind (Gregory 1994). In contrast, the manufacturing sector experienced relatively faster productivity growth due to the expansion of heavy industry (Gregory 1994). Despite this fact, non-agricultural productivity only saw overall modest gains, most probably due to the manufacturing sector's continued concentration in "backward" industries like food products and textiles, rather than machinery (Gregory 1994). Moreover, Castañeda and Markevich (2019) demonstrated that the Stolypin reform had a positive effect on agricultural productivity. However, their incomplete implementation and the persistence of non-privatized and non-consolidated land plots, coupled with limited Russian economic integration likely led to the widening labor productivity gap between industry and agriculture from 1885 to 1913, since both productivities slightly increased, but manufacturing productivity did so by a larger amount.

During the 1913–1917 period, production frictions escalated, influenced by war and scarcity. However, the effects of the conflict were still relatively less noticeable at that stage compared to when the Russian Civil War occurred. This situation could be attributed to the smaller impact of WWI on the Russian national territory in comparison to the Civil War. As Table 1 illustrates, frictions during this sub-period frictions rose at an average annual rate of 1.4 percent.

Production frictions during War communism (1918–1921)

This period was characterized by the increase and later sharp surge in production frictions, peaking in 1922 with a production wedge of 12.44, significantly deviating from the optimal neoclassical benchmark of 1. Notably, although the New Economic Policy (NEP) was in effect by 1922, the substantial increase and sustained prominent levels of production frictions during this era were possibly a direct consequence of the preceding war communism period. Throughout these years, frictions experienced an average annual growth of 6.8 percent. Yet, untangling the distinct impacts of the applied policies from the cumulative destructive aftermath of the First World War and the concurrent Russian Civil War proves to be an intricate endeavor.

On one side, the trajectory of the production wedge's evolution is consistent with the official decrees that aimed to channel industrial production toward munitions and weaponry, consequently favoring heavy-industry manufacturing. This emphasis most probably triggered a surge in wages within the heavy industry sector due to increased demand and diminished labor supply. These labor supply shifts could be explained by the loss of city dwellers during the conflicts and their migration to rural areas when food scarcity struck. Notably, Davies et al. (1990) documented staggering population reductions of 70 percent in St. Petersburg and more than 50 percent in Moscow between 1918 and 1920. However, this change in wages probably affected heavy industry workers predominantly, whereas Russia's manufacturing sector was mainly composed of labor from non-heavy industries (Gregory 1994), a fact reflected in our data for this period. Indeed, with urban conditions deteriorating and the demand for these professions plummeting disproportionately compared to supply, manufacturing wages experienced a more pronounced decline.

In agriculture, large-scale migration should have led to a drop in agricultural wages. However, a substantial portion of urban emigrants settled in rural areas, engaging in subsistence production outside the official market. As per Davies et al. (1990), the illicit market accounted for 70 percent of the food supply. Therefore, the movement of people from urban centers to the countryside most probably did not entirely translate into an increase in the agricultural labor supply. Additionally, the Soviet authorities imposed mandatory labor duty on non-working classes, which likely also contributed to the milder decline in agricultural wages relative to manufacturing. Hence, the increase in the production wedge could be mainly linked to the larger decrease in the agricultural production frictions due to the relatively smaller decrease in agricultural wages. Indeed, our data supports this claim, suggesting that changes in relative wages played a pivotal role in driving the production wedge's expansion during that period (see Table 1).

Furthermore, the migration to rural areas might have been further propelled by the consequences of policies during the war communism era, which culminated in the devastating Russian famine of 1921–1922. Indeed, one such policy was the *prodrazvyorstka*, involving requisitioning of agricultural output to distribute meager resources among the populace, particularly the military. Hence, the combined impact of warfare and food requisitioning might have induced a contraction in agricultural and industrial output. Furthermore, the surge in manufacturing prices, attributed to war-induced destruction, the inefficient nationalization of industries, and the prohibition of private enterprise outpaced the price evolution in agriculture. Nevertheless, the influence of price trends on the production wedge increase during this period appears to have been relatively minor, as evidenced by our data (see Table 1).

Production frictions during the NEP (1922–1927)

The era of the New Economic Policy (NEP) was characterized by a prevalence of high production frictions, a legacy from the preceding period (Figure 1). In 1922, the prevailing economic circumstances prompted Lenin to shift economic policy, transitioning from war communism to the NEP. However, it should be said that fully understanding the role of NEP policies for this period is difficult, given the substantial inherited frictions. Notwithstanding, our data (Table 1) points out a consistent annual increase of more than 10 percent in production frictions throughout this period. Additionally, it reveals that this escalation in production frictions could be entirely attributed to the rise in manufacturing productivity relative to agriculture, with the potential for an even greater increment were it not for countervailing influences on wages and prices.

Over this period, manufacturing productivity increased faster than productivity in agriculture. Plausibly, this phenomenon can be explained by the Soviet government's departure from the complete nationalization of specific industries and the fostering of more open markets, which brought foreign investment and technology (Bandera 1963). Another likely contributing factor to the manufacturing sector's productivity raise was the prevalence of small-scale and light industries primarily in the hands of private entrepreneurs or cooperatives, which would concurrently foster an expansion in manufacturing output. Moreover, NEP labor reforms attempted to tie labor to productivity, incentivizing the reduction of costs (Allen 2003).

Collectively, during the NEP, despite contending with severe events and substantial distortions from the preceding period and wars, an economic recovery was achieved. In fact, by 1928, both agricultural and industrial production had been restored to 1913 (pre-World War I) levels (Allen 2003). Nevertheless, the faster increase in manufacturing productivity compared

to agriculture, most probably stemming from the NEP policies and industrial recovery, appears to have driven the persistence of elevated production frictions.

Production frictions during Stalinism (1928–1940)

During Stalinism, the production component of the labor intra-temporal wedge fell relative to their average Tsarist levels (Figure 1). Indeed, over the whole Stalinist period, there was an average annual reduction of 18 percent in production frictions (Table 1). By 1935 – in the middle of the second five-year plan – the production component had nearly converged with the optimal neoclassical benchmark without frictions. This was a remarkable transformation from the higher level that prevailed prior to Stalin's first five-year plan. In delving into this transformation, the behavior of production frictions during 1928–1935 could be understood by considering the potential role played by the implemented policies during those years – collectivization and forced state industrialization.

On one hand, beginning in 1928, the collectivization policy in the agricultural sector dramatically reduced prices paid to peasants for their agricultural produce (Allen 2003). The state paid prices below market levels to peasants and then sold their agricultural products in the urban areas at higher-than-market prices, channeling the surplus towards the establishment of heavy-industry factories. Additionally, state-operated collective farms were introduced, coupled with the appropriation of the agricultural production surplus through *prodrazvyorstka*. The introduction of state farms likely amplified the monopsony power over the peasants, since the only direct buyer was the state, increasing markups in agriculture (Cheremukhin et al. 2017). Collectively, these policies most probably precipitated the significant decline in agricultural output and the pronounced upswing in local agricultural market prices, contributing to the Russian famine of 1930–1933. This famine, in turn, spurred migration from rural areas to urban centers, thereby augmenting the urban labor supply and decreasing urban wages (Allen 2003). Nevertheless, the famine mortality rates and the outflow of people most likely explain the increase in agricultural wages. Notably, a local minimum in 1933 is observable, aligning with the pinnacle of this economic shock. Consequently, the Soviet agricultural policies seemingly contributed to diminishing production frictions by bolstering the agricultural component of the production wedge.

On the other hand, the Soviet government incentivized factory managers to attain ambitious output targets rather than maximizing profits. Additionally, large investments were funneled into manufacturing, especially heavy industry (Cheremukhin et al. 2017). This impetus most plausibly led to the expansion in industrial output, to the considerable influx of labor in the manufacturing sec-

tor, and, subsequently, to the reduction in the production component of the inter-sectoral labor wedge, through the reduction of relative prices in the non-agricultural sector. However, these policies seemingly contributed to an overall decline in sector productivity, as much of the output resulted from labor rather than mechanization (Davies et al. 1994), although the latter was not entirely inexistent. This newly hired labor primarily consisted of relatively inexperienced, low-skilled workers who emigrated from rural areas (Davies et al. 1994). Contrastingly, agricultural productivity performed positively but poorly, particularly during the first five-year plan, with a meager increase of 0.1 percent. Davies et al. (1994) argued that the state's grain expropriation policy from peasants instigated dramatic disruptions to agricultural output, dampening the incentives for working on collectivized lands and disrupting the crop rotation system. Furthermore, the dekulakization policy resulted in a reduction of skilled farmers (Davies et al. 1994).

Hence, despite successfully reallocating resources into the industrial sector, the Soviet economy fell short of establishing optimal conditions for the efficient utilization of these resources in both sectors. Moreover, our data decomposition corroborates the arguments prevalent in the literature: 52 percent of the total reduction in production frictions is accounted for by the decrease in relative prices (Table 1), influenced by the evolution of total production in both sectors, and, most likely, the state interventions in pricing aimed at fueling industrialization during this period. These findings, though speculative, further reinforce the argument that policies fostering manufacturing expansion significantly shaped inter-sectoral resource allocation.

4.2. Regression analysis

The decomposition analysis performed in the previous section suggests that the reduction in production frictions might have been related to the implementation of policies during Stalinism. However, even if we observe a decline in the production wedge during Stalinism, this could be due to factors other than the new policies. The literature – Davies et al. (1990), Galor and Moav (2004), Peterson (2017), Lagakos and Waugh (2013), Yang and Zhu (2008) – suggests, in fact, that human capital, trade, demographic shocks or inflation might contribute to explaining the trend in wedges. For example, demographic shocks created by famines or wars might have a direct effect on sectoral wages by creating scarcity in the labor supply and drastically changing the composition of the demand (Peterson et al. 2017). In this direction, Galor and Moav (2006) stated that capital accumulation in industrialization processes can gradually intensify the demand for skilled labor. Consequently, it would be translated into higher wages in the sector that traditionally has required higher specialization, the manufacturing sector.

A regression analysis allows us to control for these factors, checking whether the reduction in production frictions was linked to the timing of policies or to the other factors highlighted by the literature. To formally check this, in Table 2, we regress the log of production frictions (wedge) on dummy variables indicating the different political periods (war communism from 1917 to 1921, the New Economic Policy (NEP) from 1922 to 1927, and Stalin's five-year plans from 1928 to 1940) and a vector of control variables. The reference category is the Tsarist period from 1885–1916. As the log of production frictions, as well as other variables, are non-stationary, we run the regression in first-differences. The analysis does not directly imply a causal link between the reduction of production frictions and different policies, but it highlights the potential role that changes in policy might exert on frictions while controlling for other features, thus backing up the narrative evidence discussed in the previous section.

The results in column (1) suggest that production frictions were lower under Stalin's period. In column (2), we control for trade (proxied by manufacturing imports), human capital (proxied by literate population), the size of

TABLE 2 ▪ *Periods and frictions*

	(1)	(2)
War communism	–0.018 (0.079)	–0.235 (0.162)
NEP	0.086 (0.171)	0.211 (0.169)
Stalin	–0.200*** (0.063)	–0.219*** (0.069)
Δ Ln (manufactures imports)		–0.103 (0.111)
Δ Ln (literate population)		–1.115 (1.542)
Δ Ln (population, 000s)		–4.760 (4.641)
Inflation		–0.002 (0.003)
R2	0.173	0.263
Breusch-Godfrey LM test for autocorrelation (p-value)	0.08	0.19
White's test for heteroskedasticity (p-value)	0.01	0.08
N	55	55

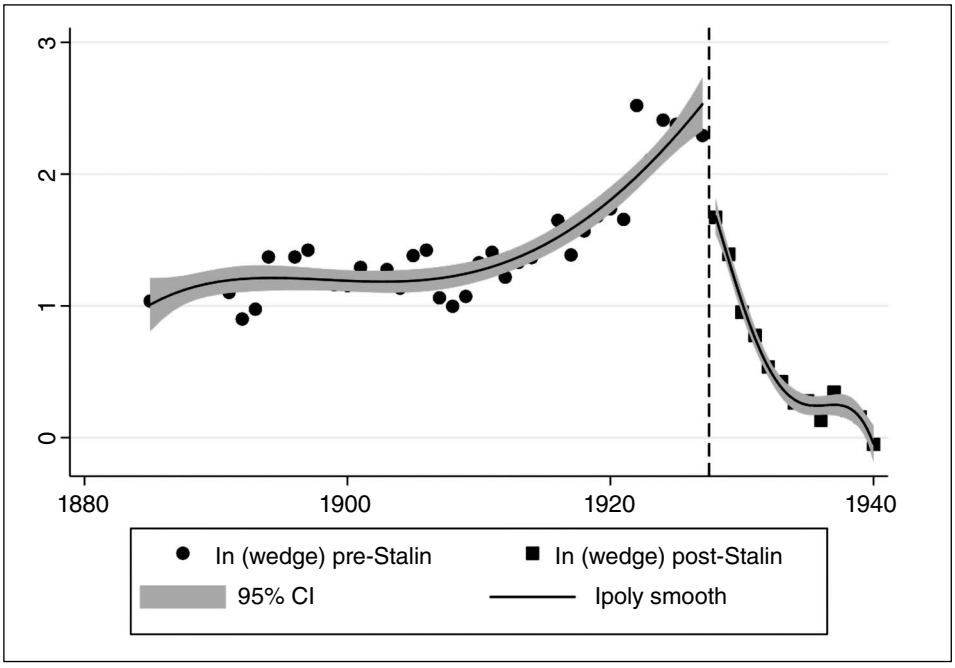
Sources: Own elaboration.

Notes: The dependent variable is Δln (production wedge).
*** p<0.01, ** p<0.05, *p<0.10. Robust standard errors are reported in parenthesis.

the labor force (proxied by total population), and the inflation rate, using first differences for all non-stationary variables.[20] See Appendix A for a comprehensive description of the data sources and the reasoning behind adding these controls. Controlling for these factors, the overall fit of the regression improves, and the Stalin period dummy is still highly significant and negative. According to the estimates, during the Stalin period, production frictions were reduced by about 20 percent relative to the Tsarist period.[21]

As an additional strategy, we check for the presence of a discontinuity in the production wedge time series at the time of the Stalin period in 1928. Figure 2 shows that this discontinuity is present.

FIGURE 2 ▪ *Stalin period discontinuity*



Sources: Own elaboration, and from Cheremukhin et al. (2017), refer to the Appendix for the data.
Notes: A value of 0 in ln (wedge) represents the absence of frictions.

20. The Dickey-Fuller test for unit root suggests that, taking first-differences, all non-stationary variables become stationary.

21. Even if the Breusch-Godfrey LM test suggests absence of serial correlation, the results are also robust to the inclusion of the lagged dependent variable and of a linear time trend.

5. Conclusion

Frictions in the production process, due to the presence of monopolies and barriers to entry, have been considered one of the most important obstacles to Russian industrialization during the Tsarist period. Indeed, it seems that the reduction in these frictions can account for most of the structural change that the Russian economy experienced in 1885–1940. In this paper, by applying the wedge accounting methodology of Cheremukhin et al. (2017), we have estimated a new time series of production frictions in 1885–1940 and have attempted to explain its trend.

Our findings are in line with the historical literature and economic growth theory. We found that the reduction in the production wedges is consistent with the timing of the policies carried out during Stalin's five-year plans. With these, the central government encouraged state-owned firms to meet output goals rather than maximize profits. Through the provision of easy credit, the *Gosbank* funded heavy industries which, in turn, could substantially expand their production and factor inputs. Hence, the acquisition of labor and capital became rampant. It would not matter whether the marginal product of labor was greater than the marginal cost or not, since input growth was promoted and extensively funded. Thus, the rapid Soviet industrialization was accomplished by growing through employment expansion, which, in turn, reduced production frictions. On this, it is important to remark that Stalin did not reduce the production frictions *per se* or voluntarily. The reduction was rather the effect of a set of policies that avoided market allocation through direct planning, suffering, consequently, from low productivity and overmanning.

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Author contribution statement

Guillem Blasco-Piles: framework, methodology, software, investigation, dataset, writing. Federico Tadei: framework, methodology, software, formal analysis, writing, visualization.

References

Allen, Robert C. 1997. 'Agricultural Marketing and the Possibilities for Industrialization in the Soviet Union in the 1930s', *Explorations in Economic History*, 34 (4): 387-410.

Allen, Robert C. 2003. *Farm to Factory: A Reinterpretation of the Soviet Industrial Revolution.* Princeton: Princeton University Press.

Allen, Robert C., and Ekaterina Khaustova. 2019. 'Russian real wages before and after 1917', *Explorations in Economic History,* 72: 23-37.

Ascher, Abraham. 2002. *P. A. Stolypin: The Search for Stability in Late Imperial Russia*. Stanford: Stanford University Press.

Bandera, Vladimir N. 1963. 'New Economic Policy (NEP) as an Economic Policy', *Journal of Political Economy*, 71 (3): 265-279.

Banerjee, Anindya, and Bill Russell. 2002. 'Inflation and Measures of the Markup'. Working Paper 15/2002. EUI Working Papers ECO. Florence: European University Institute, Department of Economics.

Broadberry, Steven, and Elena Korchmina. 2022. 'Catching-up and falling behind: Russian economic growth, 1690s-1880s'. Working Paper 626/2022. CAGE Online Working Paper Series. Warwick: University of Warwick.

Castañeda Dower, Paul, and Andrei Markevich. 2013. 'Land Tenure and Productivity in Agriculture: The Case of the Stolypin Reforms in Late Imperial Russia'. Working Paper 0202/2013. CEFIR/NES Working Paper series. Moscow: New Economic School (NES).

Chari, Varadarajan, Patrick Kehoe, and Ellen McGrattan 2007. 'Business Cycle Accounting', *Econometrica*, 75 (3): 781-836.

Cheremukhin, Anton, Mikhail Golosov, Sergey Guriev, and Aleh Tsyvinski. 2013. 'Was Stalin Necessary for Russia's Economic Development?'. CEPR Discussion Paper 9669. Paris and London: Center for Economic Policy Research (CEPR).

Cheremukhin, Anton, Mikhail Golosov, Sergey Guriev, and Aleh Tsyvinski. 2017. 'Industrialization and Economic Development of Russia through the Lens of a Neoclassical Growth Model', *Review of Economic Studies*, 84 (2): 613-649.

Chuchko, Marina. 2021. 'Business representation in an autocratic regime: Tariff policy and exchange committees in late Tsarist Russia', *Economic History Review,* 75 (3): 801-829.

Crisp, Olga. 1978. 'Labour and Industrialization in Russia'. In *The Cambridge Economic History of Europe*, *Vol. VII: The Industrial Economies: Capital, Labour and Enterprise, Part 2: The United States, Japan and Russia*, edited by P. Mathias and M. M. Postan, 308-415. Cambridge: Cambridge University Press.

Davies, Robert W., Mark Harrison, and Stephen G. Wheatcroft. 1994. *The Economic Transformation of the Soviet Union 1913-1945.* Cambridge: Cambridge University Press.

Drummond, Ian M. 1976. 'The Russian Gold Standard, 1897-1914', *The Journal of Economic History,* 36 (3): 663-688. Cambridge: Cambridge University Press.

Efremov, Steven. 2012. 'The Role of Inflation in Soviet History: Prices, Living Standards, and Political Change'. Electronic Theses and Dissertation, Paper 1474. Tennessee: School of Graduate Studies, East Tennessee State University.

Fukao, Kyoji, Naofumi Nakamura, and Masaki Nakabayashi, eds. 2017. *Iwanami Koza Nihon Keizai no Rekishi Dai kan, Kindai 2 Dai Ichiji Sekai Taisen kara Nicchu Senso Mae (1914–1936)* [Iwanami Series on the History of the Japanese Economy, Volume 4, Modern Times 2: From the First World War to the Eve of the Sino-Japanese War (1914–1936)]. Tokyo: Iwanami Shoten

Galor, Oded and Omer Moav. 2006. 'Das Human-Kapital: A Theory of the Demise of the Class Structure'*, Review of Economic Studies,* 73 (1): 85-117.

Gerschenkron, Alexander. 1965. 'Agrarian Policies and Industrialization, Russia 1861–1917'. In *The Cambridge Economic History of Europe, Vol IV: The Industrial Revolutions and After, Part II: Incomes, Population and Technological Changes*, edited by M. M. Postan and H. J. Habakkuk, 706-800. Cambridge: Cambridge University Press.

Gregg, Amanda G. 2020. 'Factor Productivity and the Concession System of Incorporation in Late Imperial Russia*,* 1894-1908', *American Economic Review*, 110 (2): 401-427.

Gregory, Paul, and Joel W. Sailors. 1976. 'Russian Monetary Policy and Industrialization, 1861-1913', *The Journal of Economic History,* 36 (4); 836-851.

Gregory, Paul. 1982. *Russian National Income, 1885–1913.* New York: Cambridge University Press.

Gregory, Paul. 1994. *Before Command: The Russian Economy From Emancipation to Stalin*. Princeton: Princeton University Press.

Hayashi, Fumio, and Edward Prescott. 2008. 'The Depressing Effect of Agricultural Institutions on the Prewar Japanese Economy', *Journal of Political Economy,* 116 (4): 573- 632.

Herrendorf, B., R. Rogerson, and Akos Valentinyi. 2014. 'Growth and Structural Transformation'*, Handbook of Economic Growth,* 2: 855-941.

Hunter, Holland, and Janusz M. Szyrmer. 1992. *Faulty Foundations: Soviet Economic Policies, 1928-1940*. Princeton: Princeton University Press.

Ickes, Barry W. 1990. 'Do Socialist Countries Share a Common Business Cycle?', *Review of Economics and Statistics*, 72 (3): 397-405.

Kafengaus, Lev Borisovich. 1994. *Evolyutsiya promyshlennogo proizvodstva Rossii (Poslednayaya tret' XIX v. - 30-ye gody XX v.)*. [The evolution of industrial production in Russia (the last third of the 19th century - the 30s of the 20th century).] Epifaniya Series: Pamyatniki Ekonomicheskoy Mysli. ["Monuments of economic thought"].

Laue, Theodore. 1963. *Sergei Witte and the Industrialization of Russia.* Columbia: Columbia University Press.

Lenin, Vladimir Ilych. 1894. 'The Development of Capitalism in Russia'. In *Lenin Collected Works*, edited by USSR Foreign Languages Press, 3: 74-75. Moscow: Progress Publishers.

Markevich, Andrei, and Mark Harrison. 2011. 'Great War, Civil War, and Recovery: Russia's National Income, 1913 to 1928', *The Journal of Economic History,* 71 (3): 672-703.

Markevich, Andrei, and Ekaterina Zhuravskaya. 2018. 'The Economic Effects of the Abolition of Serfdom: Evidence from the Russian Empire', A*merican Economic Review*, 108 (4-5): 1074-1117.

Mau, Vladimir, and Tatiana Drobyshevskaya. 2013. 'Modernization and the Russian Economy: Three Hundred Years of Catching Up'. In *The Oxford Handbook of the Russian Economy,* edited by Michael Alexeev and Shlomo Weber, 29-51. Oxford: Oxford University Press.

McCaffray, Susan P. 1996. *The Politics of Industrialization in Tsarist Russia: The Association of Southern Coal and Steel Producers, 1874-1914.* Chicago: Northern Illinois University Press.

Metzer, Jacob. 1973. 'Some Economic Aspects of Railroad Development in Tsarist Russia', *The Journal of Economic History,* 33 (1): 314-316.

Mironov, Boris N. 1991. 'The Development of Literacy in Russia and the USSR from the Tenth to the Twentieth Centuries', *History of Education Quarterly*, 31 (2): 229-252, Cambridge: Cambridge University Press.

Murphy, Kevin M., Andrei Shleifer, and Robert W. Vishny. 1989. 'Industrialization and the Big Push'*, Journal of Political Economy*, 97 (5): 1003-1026.

Nafziger, Steven. 2010. 'Peasant communes and factor markets in late nineteenth-century Russia'*, Explorations in Economic History,* 47 (4): 381-402.

Owen, Thomas. 1991. *The Corporation under Russian Law, 1800-1917.* Cambridge: Cambridge University Press.

Parente, Stephen, and Edward Prescott. 1999. 'Monopoly Rights: A Barrier to Riches', *American Economic Review*, 89 (5): 1216-1233.

Peterson, E. Wesley F. 2017. 'The Role of Population in Economic Growth', *SAGE Open*, 7 (4). SAGE Publications Inc.

Shepelev, Leonid E. 1973. *Aktsionernye Kompanii v Rossii.* [Stock companies in Russia]. Leningrad: Nauka.

Strumilin, Stanislav. 1960. *Ocherki Ekonomicheskoi Istorii Rossii.* [Essays in Russian Economic History]. Moscow: Izdatel'stvo sotsial'no-ekonomicheskoi literatury [Publishing house of socio-economic literature].

Strumilin, Stanislav. 1982. *Problemy Ekonomiki Trud*a [The Problems of Labor Economics]. Moscow: Nauka.

Wollenberg, Erich. 1936. 'Wages and prices in the Soviet Union', *New International*, 3 (3): 70-72.

Appendices

Appendix A: Data

A1. Production frictions

To reconstruct production frictions for the missing period (1914–1927), we needed to obtain the relative prices, wages, and marginal productivities of labor MPLs (Marginal Productivity of Labor) for both sectors in the model (see eq. 2).

Marginal productivity of labor (MPL)

The MPLs can be decomposed as the ratio between the labor share of the production functions (α) times the value-added production over the labor force (employment), for each sector. Labor shares are obtained from Cheremukhin et al. (2017) for the whole period.

To calculate the added-value in agriculture for 1885–1913, Cheremukhin et al. (2017) obtained values from Gregory (1982, Table 3.2, D.3). On the other hand, added-value in manufacturing was obtained by subtracting agriculture's added value from the GNP. This, in turn, was obtained from Gregory (1982, Tables 3.1, 3.2). For the 1928–1940 period, the GNP and agricultural added-value were obtained from Davies et al. (1994, Table 1) and Moorsteen and Powell (1966, Table T-47), respectively. As for the previous period, the added value in the manufacturing sector was computed by subtracting the added value in agriculture from the GNP. To obtain the added value of the agricultural and manufacturing sectors for the years not included in Cheremukhin et al. (2017), we interpolated the values from Table A11 and A12 in Harrison and Markevich (2011). The authors, in turn, obtained the values from Prokopovich (1917) for the agricultural production, and from Boiarskii (1975) for the manufacturing added-value. These tables provide the production in agriculture and manufacturing weighted by added value for the whole missing period.

To compute the labor force, we first re-estimated the population data (see Appendix A3). To estimate the workforce in agriculture and manufacturing, Cheremukhin et al. (2017) constructed employment by using the imperial population census of 1897 and Gregory's estimates (1982) of the sectoral employment growth rates over 1885–1913. On the other hand, for 1928–1940, they used the 1926 and 1939 censuses and Soviet employment records to build up sectoral employment shares. Hence, we applied the sectoral employment rates from Cheremukhin et al. (2017) to our new population estimates. For

the missing period 1914–1927, we applied to population estimates the rural-urban ratios (as a proxy for the agricultural-manufacturing dichotomy in a two sectors model) – obtainable in the population census of 1920, the Statistical Yearbooks (S*tatisticheskiy ezhegodnik* [1918–1924]) and the Labor Reports of the Soviet Union Information Bureau, available at the *IstMat.*

Relative Prices

We obtained the data for relative prices of manufacturing to agriculture from Cheremukhin et al. (2017) for 1885–1913 and 1928–1940. For the pre-WWI period, they computed the relative prices by dividing production in current prices by production in 1913 prices for both sectors. On the other hand, for the 1928–1940 period, they used the wholesale price ratio obtained from Allen (1997, Table A2). Data from 1933 to 1937 were interpolated.

For 1914–1921, we proxied the current agricultural prices from the evolution of rye flour prices from Allen (2020). Rye accounted for one of the most important items in the agricultural sector in the consumption basket (ibid). Additional current prices for rye missing from Allen (2020) were taken from Lih (1990, Table 4) and were afterward converted into 1913 prices. For the missing manufacturing prices in 1914–1921, Gatrell (2014, Table 6.8) provided the wholesale prices for the industry in percentages of 1913. For 1922–1927 for both sectors, we directly obtained the relative prices from Timoshenko (1931), where the author provided the ratios of the index of wholesale agricultural prices to the index of wholesale industrial prices.

Relative wages

To determine relative wages, we obtained data from Cheremukhin et al. (2017) for 1885–1913 and 1928–1940. For the Tsarist period, the authors used the data on wages in both sectors from Strumilin (1960; 1966; 1982). The Soviet scholar, using the Tsarist administrative records, estimated the working days/year and the annual factory wage until 1914.

For 1928–1940, Cheremukhin et al. (2017) took the data from Allen (2003, Table 7.4), using estimates of agricultural and non-agricultural consumption per person. Allen (2003) evaluated income in-kind including cash and deducted taxes. Furthermore, he assumed that there were no savings (all income was spent on consumption), as assumed by Cheremukhin et al. (2017). Nevertheless, for 1929–1931, data are interpolated and 1940 is assumed to be the same as 1939.

For the missing period (1914–1927), we observed from Borodkin et al. (2008) that the wages for carpenters in St. Petersburg evolved with remarkably similar trends and levels to those of industrial workers. Moreover, it can

be seen that the wage for a laborer is almost 100 percent correlated with the one of a rural peasant. Therefore, we used the trends in the wages for a carpenter in St. Petersburg – as a proxy for the manufacturing wage – and the wages for a laborer in Kursk – as a proxy for wages in agriculture – from Allen (2020). Kursk is a better representative of the city population's structure in European Russia (Population Censuses). Furthermore, the city's industry was primarily based on food processing, as in the other major regional cities. Nevertheless, the years from 1918 to 1922 were missing. The manufacturing series could be completed by using the average industrial wages index of Wollenberg (1936) for those years (percentages of 1913). On the other hand, the agricultural wages for 1918–1922 could be obtained from *Sel'skoye khozyaystvo Rossii v XX veke (Sbornik statistiko-ekonomicheskikh svedeniy za 1901-1922 gg),* available at *IstMat*.

Sources

Borodkin, Leonid, Brigitte Granville, and Carol S. Leonard. 2008. 'The rural/urban wage gap in the industrialization of Russia, 1884-1910', *European Review of Economic History*, 12: 67-95.

Boyarskiy, Aron Ya. 1948. 'K voprosu o estestvennom dvizhenii naseleniia v Rossii i v SSSR v 1915-1923 gg [On the issue of natural population movement in Russia and the USSR in 1915-1923]'. In *Uchenyye zapiski Moskovskogo Ekonomicheskogo Statisticheskogo Instituta* [Scientific notes of the Moscow Economic Statistical Institute]. Moscow: Economic Statistical Institute.

Gatrell, Peter. 2014. *Russia's First World War. A Social and Economic History*. London: Routledge.

Gregory, Paul. 1983. 'Soviet theories of economic demography: A survey', *Journal of Comparative Economics*, 7 (2): 105-113.

Kondratiev, Nikolay D., and Nikolay P. Oganovsky. 1924. 'Sel'skoye khozyaystvo Rossii v xx veke [Russian agriculture in the 20th century]'. In *1922 Sbornik statistiko-ekonomich-eskikh svedeniy za 1901-1922 gg* [Collection of statistical and economic data for 1901-1922]. Moscow: Nauka.

Lih, Lars T. 1990. *Bread and Authority in Russia, 1914-1921.* Berkeley: University of California Press.

Prokopovich, Sergey N. 1918. *Opyt ischisleniia narodnogo dokhoda 50 gubernii evropeiskoi Rossii v 1900-1913 gg* [The Experience in calculating the national income of 50 provinces in European Russia, 1900-1913]. Moscow: Sovet Vserossiiskikh Kooperativnykh S'ezdov [All-Russian Cooperative Congresses Council].

Prokopovich, Sergey N. 1917. *Voina i narodnoe khoziaistvo* [War and the national economy]. Moscow: Delo.

Prokopovich, Sergey N. 1931. 'The National Income of the U.S.S.R.', *Memorandum,* 3. Birmingham: University of Birmingham.

Siegelbaum, Lewis H. 1992. *Soviet State and Society between Revolutions, 1918-1929.* Cambridge: Cambridge University Press.

Timoshenko, Vladimir P. 1931. 'The New Agricultural Policy of Soviet Russia', *American Journal of Agricultural Economics*, 13 (2): 280-304.

Tsentralnoye Statisticheskoye Upravleniye. 1926. *Statisticheskiy ezhegodnik 1918-1924* [Statistical Yearbooks 1918-1924]. Moscow: Tsentralnoye Statisticheskoye Upravleniye, TsSU [Central Statistical Administration].

Wollenberg, Erich. 1936. 'Wages and prices in the Soviet Union', *New International*, 3 (3): 70-72.

A2. Inflation

Price changes, or the lack thereof, were a crucial factor in determining living standards and influencing politics throughout the history of the Soviet Union. Indeed, the Soviet Union was created and dissolved amid high inflation. In the first case, the Bolsheviks took over after high food prices helped bring down the Tsarist and Republican governments. However, their initial policies led to Russia's first hyperinflation and domestic unrest, so they had to stabilize the ruble and the economy to remain in power. After Stalin took charge, the Soviet economy struggled with inflation for two decades, until the 1947 currency reform finally established a monetary system based on fixed prices. Although price controls prevented inflation, they also created persistent shortages of food and consumer goods, which were the most common complaints about the economy by Soviet citizens (Efremov 2012).

The Russian monetary and fiscal policy during the last decade of the nineteenth century made a positive contribution to the industrialization of the country since Russia's currency was pegged to the Gold Standard from 1897 to 1913. This exchange rate imposed costs, since it obliged the state to use resources for the provision of gold coins, gold reserves, and relatively low-yielding reserves of foreign exchange. On the other hand, by adopting the Gold Standard the state may have improved the connections between the Russian and Western capital markets, allowing Russian governments and private borrowers to obtain funds more plentifully, more cheaply, or both (Drummond 1976). International comparisons for the year 1913 reveal that domestic savings proportions in Russia were quite high for a low per capita income country (over 9 percent of the net national product, NNP). Indeed, only wealthy nations such as Germany, the U.K., and the U.S. had higher domestic savings proportions than Russia. Actually, the German and the U.S. investment rates were the only ones that exceeded those of Russia in 1913. Whether these high domestic and foreign savings rates can be attributed to the Witte System cannot be determined with certainty, however, in the ab-

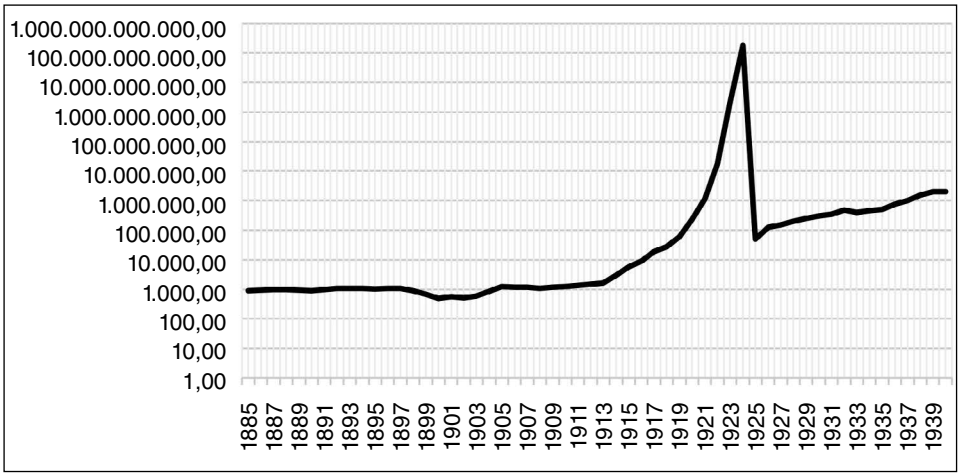
sence of an alternative viable explanation, the probability is relatively high (Gregory and Sailors 1976).

Inflation first started in the Russian Empire during the First World War and led to higher food prices in the cities, and this was a major factor in creating urban discontent and bringing down both the Imperial and Republican governments. However, when the Bolsheviks took over, they made living conditions even worse by trying to create a moneyless economy. This attempt, known as war communism, created hyperinflation, a major famine, shortages of goods, and rebellions by peasants and sailors. The hyperinflation connoted seven years of uncontrollable spiraling inflation until the reestablishment of the Gold Standard with the introduction of the *chervonets*, where they managed to stabilize the ruble, also by balancing their budget. The economy made an astounding recovery in the 1920s under the New Economic Policy, but industrial prices rose much faster than agricultural prices in the open market. Consequently, the Bolshevik leaders responded by crowding out private merchants and re-imposing price controls. They also continued the "price scissors" policy, which consisted in purchasing grain from the peasants at artificially low rates and selling it at higher ones. These factors inspired the decision to proceed with full-scale state industrialization and collectivization. During the Stalin years, the Russian economy had different types of stores with varying degrees of price controls and inflation. Strict price controls were in place in most state stores and co-operatives, while others were allowed to sell at higher regulated rates. While these stores had low prices, they also suffered shortages and a poor selection of products. In contrast, collective farm markets were completely free to set their prices according to market forces, but their prices were usually much higher. As mentioned before, it would not be until 1944 that inflation started to decline after the Soviet government balanced its budget, and it was eliminated after the currency reform of 1947.

Data: The values for price indexes, CPI evolution, or inflation are non-existent or incomplete for the whole period of analysis. As an alternative, we take the amount of currency in circulation (in millions of rubles) as a proxy for inflation. The main reason supporting this assumption lies in the fact that, for the Imperial period, financial markets in Russia were not developed enough and suffered from backwardness in comparison to the English, German, or French financial systems, as stated by Allen (2003). Besides, the velocity of money was not a highly determinant factor for the period except during WWI (Efremov 2012). Moreover, for the Soviet period, the official inflation may not indicate the real one, since the monetary restructures, the ban on foreign exchange rates and the prices policies (scissors policies) would lead to the existence of repressed inflation not represented in the official accounts. Consequently, a conversion of the Soviet ruble is carried out, to provide faithful accountancy for the currency in circulation, expressing the subjacent in-

flation for the whole period studied. In addition, it should be mentioned that, for a significant number of years, the currency was pegged to the Gold Standard, 1897–1914 and 1922–1930 (the latter with the *chervonets*). To proceed with the extrapolation of the data, the values have been extracted from Drummond (1976). Indeed, the author provided the amount of currency in circulation in 1913 rubles (₽) for 1885–1914. For the previously missing data from WWI, the data was taken from Markevich and Harrison (2011), where the estimated values for the 1914–1924 lapse are provided in 1913 rubles. For the 1924–1940 period, the amount of currency in circulation was taken from the pages of the archives of the Bank of the Russian Federation, particularly from the figure for "Cash issued in circulation, by issue balance sheets at the end of the year, million ₽" (Rus.: наличные деньги, выпущенные в обращение, по эмиссионным балансам на конец года, МЛН. ₽.). Nonetheless, due to the monetary reform initiated in 1922 and completed in 1924 by the *Gosbank*, we obtained the established 1924 conversion rate to be able to compute the amount of cash and banknotes in 1913 values. The 1924 currency was exchanged for 50,000 rubles of the 1923 issue or 5 million rubles of 1922. Consequently, the exchange would be 1₽ of 1924 = 50,000,000,000₽ of the issues before 1922 (1893–1922). Hence, we applied it to the existing data to find accurate estimates. The resulting estimation fits well with the literature on inflation during the studied period.

FIGURE A2 ▪ *Currency in circulation (1885–1940)*



Source: own elaboration.

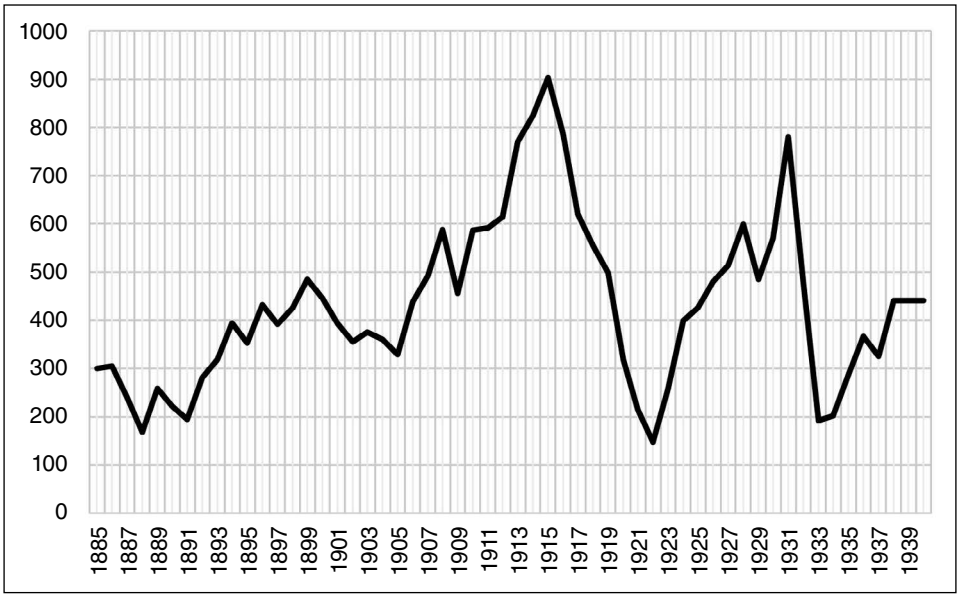
A3. Manufacturing net import and protectionism

Under the reign of Nikolay II, Sergei Witte started a trade policy of import substitution in 1891. Tariffs were levied on manufactured imports in an attempt to grant that the Russian industry would "smelt the iron ore, roll the rails, and forge the locomotives for the country" (Allen 2003). Indeed, they channeled the demand for railroads and locomotives to Russian producers. Industrial output shifted, with producer goods comprising an unusually large share of the total, in particular the outcome was a ninefold increment in the output of heavy industry. However, other circumstances emerged with the textiles, protectionism was also applied at the raw material stage (raw cotton, iron ore…) and the higher prices for the manufactured goods languished real wages. Indeed, as a result of this system, where Russian companies were also protected from external competition, Russia closed itself in its domestic market. The future did not seem promising since the wheat boom was running out of steam. Indeed, the tariffs were called "monster tariffs" by Laue (1974). This name was given due to the high rate that they had from 1880, since Russian prices were superior to world prices by a premium that remained for most goods until WWI. Cheremukhin et al. (2017) argue that: "The impact was substantial: while terms of trade improved for agriculture by about 30 percent in 1890–1913, due to tariffs, retail non-agricultural prices rose so much that relative food/non-food retail prices did not change". It should be mentioned that during the time of the Soviet Union, the government always held a monopoly on all foreign trade activity until Yosif Stalin died in 1953. The Bolshevik ideology opposed external economic control and they refused to pay WWI debts. As a consequence, trade was kept at the minimum required level. However, during the NEP, the regime permitted other organizations to deal directly with foreign partners. Nonetheless, with the first five-year plan trade was restricted once again (Socialism in One Country) to the essential factory equipment for industrialization.

Data: Exports and imports data for Tsarist Russia come from Gregory (1982). Moreover, the data from Davies (1990, Table 56) is used to find the composition of exports and imports for 1913. Kitanina (1995) demonstrated that the composition of commerce changed extremely slowly from 1899 to 1913, hence it is assumed that the same composition maintains in 1885–1913. The net exports of agricultural goods and net imports of non-agricultural goods are computed. On the other hand, exports and imports for the USSR in 1928–1938 are computed by applying the index of exports and imports relative to 1913 from Davies et al (1994) to the volume of trade in 1913 from Gregory (1982). Cheremukhin et al. (2017) impute the values for 1939 and 1940 by assuming that they remain at the 1938 level. For the missing period (1914–1927), we use the import trends and trade composition from Vale-

tov (2017) until 1917. In the remaining years, 1918–1924, the data is taken from the *Statisticheskiy ezhegodnik 1918-1924* trade section, developed by the *People's Commissariat for Foreign Trade.* From 1924–1927 the data are interpolated.

FIGURE A3 ▪ *Manufacturing imports (1885–1940)*



Source: own elaboration.

A4. Population

Demographic shocks created by famines or wars have been common throughout the history of Russia; sometimes these features have led to economic instability, social unrest, and political crisis. Generally, these periods of extreme violence, aggression, destruction, and mortality have huge implications for the country's society and, as a consequence, for the economy. It is well-known that there is a relationship between population and economic growth (Peterson 2017). A war can strike against the most prepared people of a country, or it can make an economic or social system collapse. Moreover, it can also affect the different sectors of an economy, creating a scarcity of labor supply. Indeed, in 1891–1892, during the last years of Vyshnegradsky's government, a famine occurred starting in the Volga River. This famine caused 425,000 deaths, reduced the production of cereals, and induced a negative budget balance. Moreover, the famine reactivated populists and

Marxist movements. This social unrest blooming can be traced back to the public's anger at the Tsarist government's management.

Later on, the tumultuous and agonizing transformation of the Russian Empire and the USSR in the first half of the 1900s brought about dramatic changes in the structure of the economy. In 1905, a wave of massive political and social unrest spread through the Russian Empire. This Revolution was the first big political revolution in the Russian Empire, and the precedent of the 1917 one, and consequently it would be expected to observe distorted output and influenced market frictions through the restriction of food availability (relative wages).

In 1917, the February and October revolutions succeeded each other. Consequently, the Russian Empire ceased to exist, and in 1922 the Soviet Union was formed. As Markevich and Harrison (2011) stated: "Wars and revolutions can wreak havoc on modern societies. Nesting one inside the other, Russia's Great War and Civil War led to economic disaster and demographic tragedy". The scale of losses translated into the worst economic disaster until that time. The deaths amounted to around sixteen million and the Civil War caused many skilled people to flee the lands of the former empire. However, the Russian economy suffered less in the Great War than in the Civil War (Markevich and Harrison 2011). War deaths and economic devastation persisted into peacetime and were not fully restored under the New Economic Policy. Simultaneously, in 1921–1922, as a result of the economic disturbance of war communism, the Povolzhye Famine killed five million people.

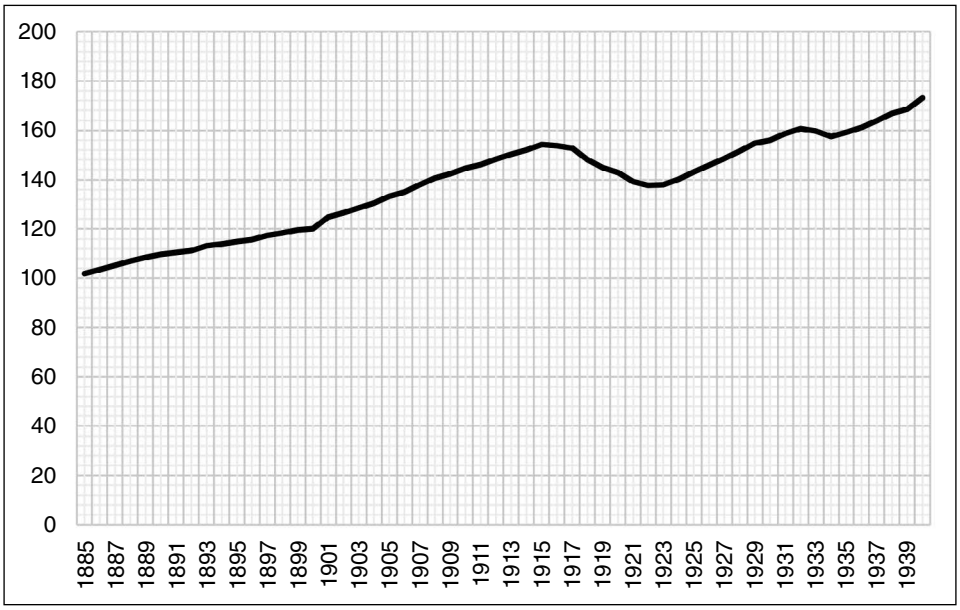
The second biggest demographic shock emerged as a consequence of the famine (*Holodomor*)[22] and the repression (Great Purge) under the rule of Yosif Stalin. Their origin was the forced industrialization carried out during the first five-year plan in which the collectivization of agriculture was carried out. The total number of deaths amounted to 8.5 million in 1927-36 (Davies et al. 1994).

Data: Population data are taken from Cheremukhin et al. (2017). The authors took the values from Gregory (1982, Table 3.1), and Davies (1994, Table 7). However, some modifications were taken into account to improve the accuracy and reliability of the data. Indeed, the only Imperial population census was held in 1897 and, in the following years, the authorities registered the deaths and births more precisely. Nonetheless, they did not account for the out-migration of peasants to cities or Siberia. and they simultaneously calculated these migrants at their new residences. Therefore, the data was erroneously gathered, creating a double counting that overstated the real population. Moreover, the convention for calculating the Russian Empire's population consisted of deducting the population of Finland from the Empire. It should

22. Ukr.: Голодомо́р, derived from морити голодом, *moriti golodom*. (Trans.:"to kill by starvation").

be mentioned that Finland was incorporated into the Russian Empire in 1809, as the Grand Duchy of Finland, and became independent in 1917. Hence, it did not form part of the USSR and it was also a different entity during the Empire. In addition, it has been considered, in this research, that the population of Poland (*Privislinsky Krai* or Vistula Country) was also to be subtracted. The logic behind this was that Poland belonged to Russia only until 1918. Hence, the changes in population due to the unrest of that period could have seemed even bigger than the actual ones. Consequently, the population on the eve of the First World War was estimated by primarily using data from the registration of births and deaths for the years 1897–1914. Moreover, the missing period's population was extracted from Markevich and Harrison (2011, Table 3 and A9), where the authors provide statistics from 1913 to 1928, excluding Poland and Finland.

FIGURE A4 ▪ *Population, in thousands (1885–1940)*

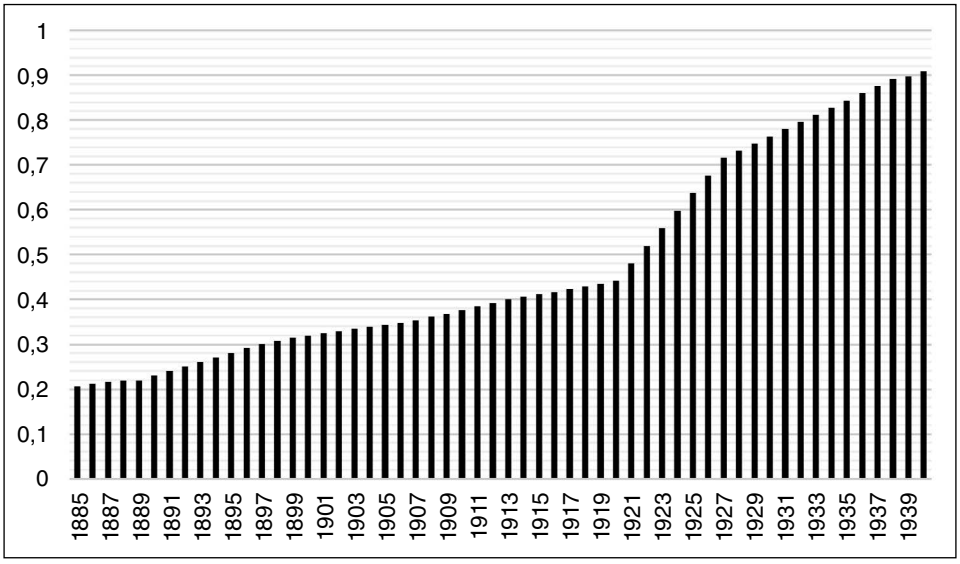


Source: own elaboration.

A5. Literacy rate

Many studies have emphasized the importance of education as a determinant of economic growth in the twentieth century (Galor and Moav 2006; Peterson 2017). Indeed, in 1913, the literacy rate in Russia was 39 percent, ranking ahead of the least developed Asian countries, but close to the last of the Latin American countries and far behind the developed countries (Russia 39 percent, Argentina 64 percent, Brazil 35 percent, U.S. 90 percent).[23] It should be mentioned that a great advance had been made since 1886, when just 21 percent were literate. Nevertheless, the difference was still considerable. Moreover, as Galor and Moav (2006) stated, "capital accumulation in the process of industrialization gradually intensified the relative scarcity of skilled labor and generated an incentive for human capital accumulation". Consequently, as the literacy rates increased in Russia due to the reforms under the reign of Nikolay II or the *Likbez* program[24] of Lenin, a higher demand for skilled labor would have been observed, through the relative wages, and consequently gradual industrialization by hiring new workers.

FIGURE A5 ▪ *Literacy rates (1885-1940)*



Source: own elaboration.

23. UNESCO; 1953, p.55; 1957, pp. 86, 50; 1975, pp. 89, 108, 121; Brooks (1982).

24. Trans: Elimination of Illiteracy, Abbreviation from *Likvidatsiya Bezgramotnosti,* in Rus.: ликвида́ция безгра́мотности. Abbr. in Rus.: ликбе́з. This program consisted in a campaign of eradication of illiteracy in the Soviet Union between 1920 and 1930, by compelling people from 8 to 50 years old to be illiterate in their mother tongue.

Data: The literacy rate for the Russian Empire was estimated by using Tables 3 and 5 from Mironov (1991), who computed the average rate for the whole Russian population by decades (men, women, rural, and urban), from 1717 until 1979. Hence, in our study, the literacy growth rate has been interpolated from the averaged decades. Moreover, from the different population censuses and data available from the Russian Statistics Library and the *IstMat* (*Istoricheskiye Materialny*), we could obtain the literacy rates for specific years in the most turbulent times – *Statisticheskiy ezhegodnik 1918–1924*.

Appendix B: Decomposition of production friction change

Define the production friction V at time t as:

$$V = \frac{\rho_{M,t} F_{M,t} / w_{M,t}}{\rho_{A,t} F_{A,t} / w_{A,t}} \qquad \text{B1}$$

Its annualized change C between year 0 and year t can be written as:

$$C = \frac{1}{t}[ln(V_t) - \ln(V_0)] \quad \text{B2}$$

Substituting (B1) in (B2), we get:

$$C = \frac{1}{t}\left[\ln\left(\frac{\frac{\rho_{M,t} F_{M,t}}{w_{M,t}}}{\frac{\rho_{A,t} F_{A,t}}{w_{A,t}}}\right) - \ln\left(\frac{\frac{\rho_{M,0} F_{M,0}}{w_{M,0}}}{\frac{\rho_{A,0} F_{A,0}}{w_{A,0}}}\right)\right] =$$

$$= \frac{1}{t}\left[\ln\left(\frac{\frac{\rho_{M,t} F_{M,t}}{\rho_{A,t} F_{A,t}}}{\frac{w_{M,t}}{w_{A,t}}}\right) - \ln\left(\frac{\frac{\rho_{M,0} F_{M,0}}{\rho_{A,0} F_{A,0}}}{\frac{w_{M,0}}{w_{A,0}}}\right)\right] =$$

$$= \frac{1}{t}\left[\ln\left(\frac{\rho_{M,t}}{\rho_{A,t}}\right) + \ln\left(\frac{F_{M,t}}{F_{A,t}}\right) - \ln\left(\frac{w_{M,t}}{w_{A,t}}\right) - \ln\left(\frac{\rho_{M,0}}{\rho_{A,0}}\right) - \ln\left(\frac{F_{M,0}}{F_{A,0}}\right) - \ln\left(\frac{w_{M,0}}{w_{A,0}}\right)\right] =$$

$$= \frac{1}{t}\left[\ln\left(\frac{\rho_{M,t}}{\rho_{A,t}}\right) - \ln\left(\frac{\rho_{M,0}}{\rho_{A,0}}\right) + \ln\left(\frac{F_{M,t}}{F_{A,t}}\right) - \ln\left(\frac{F_{M,0}}{F_{A,0}}\right) - \left(\ln\left(\frac{w_{M,t}}{w_{A,t}}\right) - \ln\left(\frac{w_{M,0}}{w_{A,0}}\right)\right)\right]$$

Thus, we can rewrite the annualized change C as:

$$C = \frac{1}{t}\left[\ln\left(\frac{\rho_{M,t}}{\rho_{A,t}}\right) - \ln\left(\frac{\rho_{M,0}}{\rho_{A,0}}\right)\right] + \frac{1}{t}\left[\ln\left(\frac{F_{M,t}}{F_{A,t}}\right) - \ln\left(\frac{F_{M,0}}{F_{A,0}}\right)\right] - \frac{1}{t}\left[\ln\left(\frac{w_{M,t}}{w_{A,t}}\right) - \ln\left(\frac{w_{M,0}}{w_{A,0}}\right)\right] \quad \text{B3}$$

Appendix C: Production frictions

Year	Production frictions	Year	Production frictions	Year	Production frictions
1885	2.82	**1907**	2.89	**1929**	4.02
1886	3.18	**1908**	2.71	**1930**	2.59
1887	3.03	**1909**	2.92	**1931**	2.17
1888	3.21	**1910**	3.77	**1932**	1.71
1889	3.18	**1911**	4.08	**1933**	1.53
1890	3.12	**1912**	3.38	**1934**	1.30
1891	3.01	**1913**	3.78	**1935**	1.32
1892	2.46	**1914**	3.92	**1936**	1.14
1893	2.65	**1915**	4.33	**1937**	1.41
1894	3.94	**1916**	5.20	**1938**	1.23
1895	3.41	**1917**	4.00	**1939**	1.17
1896	3.94	**1918**	4.80	**1940**	0.95
1897	4.15	**1919**	5.36		
1898	3.23	**1920**	5.68		
1899	3.19	**1921**	5.24		
1900	3.17	**1922**	12.44		
1901	3.64	**1923**	8.25		
1902	3.28	**1924**	11.14		
1903	3.58	**1925**	10.79		
1904	3.11	**1926**	10.29		
1905	3.98	**1927**	9.91		
1906	4.15	**1928**	5.32		

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De la falç al martell: la disminució de les friccions de producció i la industrialització de Rússia

Resum

Cheremukhin et al. (2017) suggeriren que una reducció de les friccions en el procés de producció podria explicar gran part del canvi estructural experimentat per l'economia russa durant l'etapa de 1885-1940. Tanmateix, quina fou la causa d'aquesta reducció? Els autors d'aquest article, d'entrada reconstrueixen una sèrie temporal anualitzada de les friccions a la producció per al període de 1885-1940 que complementa les dades subministrades per Cheremukhin et al. (2017). A més, comproven si les tendències d'aquesta sèrie són coherents amb el conjunt de les polítiques implementades pels diferents governs (polítiques tsaristes, comunisme de guerra, Nova Política Econòmica (NEP) i polítiques de Stalin) mitjançant una descomposició analítica i una regressió. Les seves troballes, tot i que són especulatives, indiquen que la reducció de les friccions en la producció està correlacionada amb la implementació de les polítiques industrials de Stalin, és a dir, amb un alt nivell d'inversions, una prestació laxa de crèdit bancari a les empreses estatals de la indústria pesada i objectius de producció elevats.

Paraules clau: Rússia, industrialització, friccions, anàlisi comptable de tascons.

Codis JEL: N13, N14, E6, O4.

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De la hoz al martillo: la disminución de las fricciones productivas y la industrialización de Rusia

Resumen

Cheremukhin et al. (2017) sugirieron que una reducción de las fricciones en el proceso de producción podría explicar gran parte del cambio estructural experimentado por la economía rusa durante la etapa de 1885-1940. Asimismo, ¿cuál fue la causa de esta reducción? Los autores de este artículo, en primer lugar, reconstruyen una serie temporal anualizada de las fricciones de producción para el periodo 1885-1940, complementando los datos proporcionados por Cheremukhin et al. (2017). Además, comprueban si las tendencias de esta serie son coherentes con el conjunto de las políticas implementadas por los diferentes gobiernos (políticas zaristas, comunismo de guerra, Nueva Política Económica (NEP) y políticas de Stalin) mediante una descomposición analítica y una regresión. Sus hallazgos, aunque de carácter especulativo, indican que la reducción de las fricciones en la producción está correlacionada con la implementación de las políticas industriales de Stalin, es decir, con un alto nivel de inversiones, una prestación laxa de crédito bancario a las empresas estatales de la industria pesada y altos objetivos de producción.

Palabras clave: Rusia, industrialización, fricciones, análisis contable de cuñas.

Códigos JEL: N13, N14, E6, O4.