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How Bad Is Labor Market Concentration? Evidence From Soviet (Urban) Satellites

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Abstract

Absent exogenous variation, the casual effect of labor market concentration on wages is hard to identify. A quasi-natural experiment rooted in the practice of urban planning of the Soviet Union, however, provides us with such a variation. Soviet planners developed green-field urban satellites and industrial plants hand-in-hand as independent and closed, large, lumpy units. However, sometimes they happened to be spatially close to each other. Today, with labor mobility, such close-by satellites form common labor markets and the number of nearby satellites creates concentration variations in a quasi-random fashion. We find a 10% increase in the number of firms improves wages by 3.4%.

Keywords: Labor Market Concentration, Wages, Local Labor Markets, Quasi-natural Experiment

JEL codes: E24, J31, J42, R23

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1 Introduction

Labor market concentration and associated wage-setting power of employers are often neglected in economic modeling and policy discussion. However, it might be a valuable factor behind the fall in the labor share, an observed decoupling of wage and productivity, and the inflation-less recovery after the Great Recession.[1] To assess these statements, it is paramount to understand the causal effects of labor market concentration, in particular, how it affects wages.

The existing empirical studies find that more concentrated labor markets have lower wages on average, but the magnitude of the effect is small. Nonetheless, to identify the effect's magnitude, one needs to take carefully into account that concentration is endogenous. Some local labor markets become concentrated because their largest firm is very productive. Yet, for the same reason, that firm pays high wages. It means that a simple ordinary least squares regression potentially underestimates the causal effect of concentration. And it is only possible to get an unbiased estimate of it if one can get a variation in concentration levels that is independent of firms' productivity.

An ideal experiment for the identification would, therefore, randomize levels of concentration of labor markets keeping the average firms' productivity constant. For example, an experimenter could build several experimental towns, each alongside a random number of plants. Yet, it is hard to imagine the implementation of an experiment akin to this, except in a centrally planned economy. Indeed, the practice of the Soviet Union urban and industrial planning was close to the described setup. And it provides the reguired exogenous variation in concentration that can inform the sicussion in its casual effect.

Of course, Soviet urban planning was not entirely random, but ideology led to lumpiness, which created randomness in the labor concentration of the Soviet-built

[1] See Benmelech et al. (2018); Krueger and Posner (2018). For the theoretical link between concentration and labor share, see Berger et al. (2019); Jarosch et al. (2019). Jarosch et al. (2019) also shows that concentration is behind lower labor share in Austria.

cities. The Soviet planners designed the industrial development of the USSR in a set of numerous green-field projects. A prototypical project was a large-scale plant with a joined urban settlement providing a labor force. Some of them happened to be close to each other, so now they form a joint labor market. Surely, this would not help with identification would the resulting structure of the labor markets not at least in part persist into Russian labor markets of today. But because Soviet urban settlements were planned together with large-scale plants, it makes a substantial difference to the concentration level now if a labor market consists of one, two, or ten of them. This quasi-natural experiment I exploit in the paper.

To identify the effect of labor market concentration causally, I use the number of original Soviet urban settlements forming a modern labor market as an instrument for its concentration level. I estimate the effect of concentration on an average wage level in industrial sectors and find that its magnitude is at least four times bigger than a naïve OLS estimation would suggest. A 10% increase in the effective number of employers leads to a 3.4% growth of a wage level, with the respective prediction of the OLS being 0.5% wage growth.

My results show a more pronounced effect of concentration than the existing studies report. The estimates in the literature are more similar to my OLS estimates. Most studies find that a 10% decrease in concentration index leads to a wage effect between 0.5% to 1.5%. The difference in the magnitude comes from the fact that the OLS mixes productivity and concentration effects on wages, which counterbalance each other. The more concentrated labor markets are also more productive markets on average. The instrument isolates those effects since it measures concentration as predetermined by Soviet planning that is orthogonal to modern productivity.

I treat the set-up with extra caution to make sure that the identification comes from randomness created by lumpiness in planning, not from some confounding factor. I sample only the labor markets wholly shaped by Soviet planning and exclude urban places that existed before the Soviet period. Thus, I rule out the influence of extra productivity or attractiveness of naturally developed traditional cities. For this reason, I compare to each other only places similar in that they were all developed from scratch by Soviet planners. And the difference in their urban-industrial structure creates a difference in today's labor market concentration.

Since the source of the difference is planning lumpiness, it should be orthogonal to other unobserved labor market characteristics, exept the concentration level.

To substantiate this identifying assumption, I show that the history of Soviet urban planning explains concentration only in industrial sectors and has no explanatory power for neither services nor forestry and agriculture. It proves that the instrument influences the concentration level via inherited capital and not via any other variable. Assume it is the opposite, i.e., the urban history matters for the concentration because it correlates with factors related to labor productivity (e.g., population density, or human capital level, or some geographical characteristics of a place). Then, the number of Soviet settlements should have had a similar effect on concentration within all industries. This is not the case in the data. Therefore, it is the link between Soviet urban development and large-scale industrial projects that drives the results.

It is also essential for the exclusion restriction that I count original Soviet settlements, not inherited industrial plants itself. More productive industrial units (both locations and plants) got more investments in the Soviet times. So the size distribution of Soviet plants might show a similar pattern of concentration influenced by productivity levels as in market economy data. However, the initial placements of settlements reflect the intentions of Soviet planners before they got any additional information on places' and projects' productivity levels. In the absence of information on economic rationale, the defense and ideological considerations were driving the choice of settlements' locations.[2]

In addition, I provide robustness checks on instrument definitions and sample restrictions. For example, one might assume that non-economic reasoning drove an urban-industrial development the most during Stalin's period. So I repeat the estimation on a sub-sample of labor markets settled in this period and instrument nowadays concentration with Stalin's time urban structure. But this exercise still confirms that concentration significantly hurts wages and productivity masks the true magnitude of the effect.

Finally, I use a propensity-score matching method to control non-linearly fo

[2]Those considerations included preferences toward the equal spatial distribution of urban population and industrial activity, dislike of large cities, local authorities' political ambitions, and so on (Smolinski, 1962; Josephson, 1995; Bond, 1987; Bond et al., 1990).

potential confounding effecs of observed differences in the distribution of covariates across different levels of the instrument. For example, places with more settlements on average have more population or are closer to Moscow, and this might bias the estimate. But the rebalanced sample only enforces my results on a sound effect of labor market concentration.

This paper adds to the literature measuring the wage effect of labor market concentration, springing after the working papers by Azar et al. (2017) and Benmelech et al. (2018). I follow the prevailing approach in the literature that relies on a simple oligopsony model outlined in Boal and Ransom (1997) as a theory background.[3] It assumes that concentration affects wage level because firms internalize their wage-setting power, which depends on market shares. The model serves as a simple yet helpful framework to hypothesize on the confounding factors for the regression. And researchers have incorporated many of them in the estimation, for example, labor market size (Lipsius, 2018; Qiu and Sojourner, 2019), product market concentration (Qiu and Sojourner, 2019), or human capital level (Hershbein and Macaluso, 2018).

The approach of this paper is different because I rely on a quasi-natural experiment setting to get exogenous variation in concentration. I use a specification shared by most of the papers (Azar et al., 2017; Rinz, 2018; Hershbein et al., 2019; Qiu and Sojourner, 2019) and apply it to the Russian data with a novel historical instrument for the concentration level.

Other researchers pointed out the importance of an exogenous variation in concentration for the identification too. But the lack of a historical narrative or experimental setting limits a set of potential candidates for the instrument. The literature typically uses an average concentration level across all other labor markets but the one at hand (Qiu and Sojourner, 2019; Rinz, 2018; Azar et al., 2017). This instrument has the advantage of being available for any data with a cross-sectional dimension. But it assumes orthogonality of local productivity shocks to national concentration changes. Unfortunately, given the widespread presence of multi-establishment firms across several labor markets (see Hershbein

[3]The notable exceptions are Jarosch et al. (2019) and Berger et al. (2019), who both develop theoretical models of strategic interactions of granular employers and use data to verify those models.

and Macaluso, 2018; Rinz, 2018), the assumption appears difficult.[4]

My instrument relies on a different assumption. Namely, it assumes that the productivity of modern Russian firms is independent of the number of plant-and-settlement units that the Soviets constructed nearby. Thus, my results are complementary to the results of other researchers, pointing to valuable interactions between productivity and concentration.

The rest of the paper is organized as follows. In section 2, I provide a schematic theory background and explain the identification challenges. Section 3 gives the historical background. In section 4, I describe the data. Section 5 describes the empirical strategy and discusses the results. And section 6 concludes.

2 Theory Background

To organize ideas and highlight the identification problem for the effect of labor market concentration on wages, we start with the most basic labor market model. Assume a Cournot oligopoly at the labor market. Each firm chooses its employment level and pays the market wage.

The firm problem is:

$$\max_{L_i} R_i(L_i) - w(L_i + \bar{L}_i)L_i$$

where L_i is a firm's employment level, $\bar{L}_i$ is employment level of all other firms, $R_i(L_i)$ is a revenue function, and w is a market wage.

The first order condition for the optimal labor demand implies:

$$\frac{MRPL_i - w}{w} = \varepsilon^{-1}(1 + \lambda_i)\frac{L_i}{L},$$

where $\varepsilon^{-1} = \frac{dw}{dL}\frac{L}{w}$ is the inverse labor supply elasticity and $\lambda_i = \frac{d\bar{L}_i}{dL_i}$ is a parameter of other firms' employment level reaction.

So a firm chooses its share at the labor market based on its productivity, with

[4]Another example of the instrument used in the literature is exposure to competition with import from China in Benmelech et al. (2018). But here, the author himself does not believe that the exclusion restriction holds because wages can be affected directly through a decline in demand for labor.

a more productive firm getting a larger share. And every firm's wage wedge is proportional to its share in the labor market. Now, if all firms react similarly, i.e., $\lambda_i = \lambda$, then the market average wage wedge Δ_w is proportional to market concentration level measured by the Herfindahl-Hirschman index:

$$\overline{\Delta_w} := \frac{\overline{MRPL} - w}{w} = \varepsilon^{-1}(1+\lambda)\sum_{i=1}^{n}\left(\frac{L_i}{L}\right)^2 = \varepsilon^{-1}(1+\lambda)HHI$$

where $HHI = \sum_{i=1}^{n}\left(\frac{L_i}{L}\right)^2$ is the Herfindahl-Hirschman index of labor market concentration .

Thus, the higher the labor market concentration level is, the bigger the average wage wedge is. It follows then that the market wage, given the average productivity, decreases with the wedge and thus with the concentration level:

$$w = \frac{\overline{MRPL}}{1 + \overline{\Delta_w}(HHI)}$$

Now imagine that the most productive firm in a labor market gets more productive. Then average productivity increases, and as a result, wages increase too. However, the concentration also goes up because the firm will hire more workers after its productivity grows. In the data, we would then observe an increase in wages that is accompanied by an increase in the concentration index. By contrast, if it is the least productive firm that gets more productive, then the concentration index will decrease while wages still go up. But most of the growth in wages is induced by an increase in productivity, and only part of it is caused by a change in concentration.

Therefore, any regression of wage on the concentration index is biased because concentration is determined simultaneously with wages and average productivity. In alternative models, the concentration may also affect wages via employers' bargaining power, a probability of getting an outside offer, or a job arrival rate. However, the productivity effect confounds the identification in those cases too.

Thus, to get correct estimates of concentration effect on wages, we need a variation in concentration that does not depend on productivity, as the Soviet urban planning policies generate for today's Russia.

3 Historical Background

The legacy of the USSR determines the urban and industrial landscape of Russia until now. During the Soviet period, the agrarian Russian Empire changed into a heavily industrialized and urbanized economy. The urbanization level grew from 13% in 1897 to 73% in 1989, where it remains until now (Becker et al., 2012). Figure 1 gives a perspective on a scale of Soviet urbanization. In 1897, only Moscow and St. Petersburg exceeded 1 million citizens; all other urban centers, mostly based in the central European part of Russia, were much smaller than 100 thousand people. By 1989, not only the pre-existed urban centers considerably grew in size, but the Soviet Union also built several hundreds of new towns both in the European and the Asian part of the country.

Respectively, most modern Russian cities and towns were established by the Soviet government in a centrally planned way, and only a small share of today's cities existed as the centers of economic activity at the time of the Russian Empire. Out of 2,276 modern towns and cities identified in the Municipalities Database of the Federal Statistics Service of Russia, only 344 are present in the Census of 1897 as urban centers. The others are Soviet-built locations.

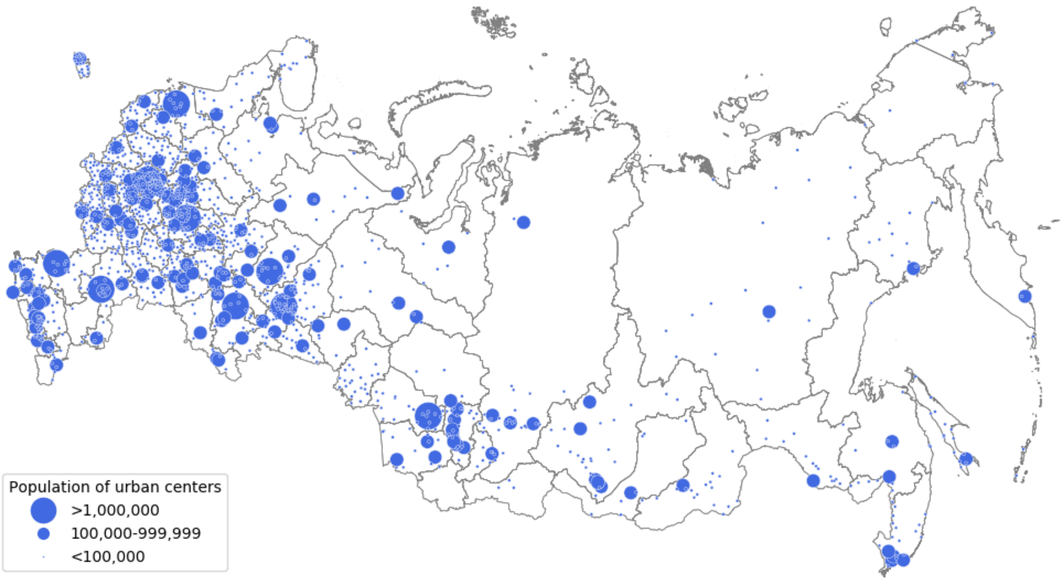
All the cities and towns, built during the USSR period, followed the construction of green-field industrial projects. Moreover, a settlement was considered 'urban' if and only if it was industrial. Soviet urbanization was a byproduct of industrial planning, and any urban development was happening only because of industry growth.[5][6] There are many well-known examples: like Magnitogorsk, a city of 450 thousand citizens, developed in the 1930s alongside its enormous steelworks, or Norilsk, the second-largest city above the arctic circle, that was built in

[5] This was rooted in the Marxist ideology, which emphasized the role of industrial development and neglected all other sectors. So, the planners considered urban development as a sub-task of the 'location of productive forces' (Huzinec, 1978).

[6] Lewis and Rowland (1969) confirm the close connection between urbanization and industrialization in Soviet Russia. They show that the regions with a higher increase in urbanization level between 1926 and 1959-61 were also the regions with higher growth in the share of industrial employment. The correlation between urbanization and industrialization levels, insignificant in 1897, grew up to 0.828 in 1959-61.

Figure 1: Distribution of urban centers in Russia

(a) 1897



(b) 1989

Notes: The figure plots, within modern Russian boundaries, cities and towns listed in the Census of the Russian Empire of 1897 and the USSR Census of 1989. The radius of dots shows population size in 1897 and 1989, respectively.

1935 for mining and smelting of nickel ore.

Furthermore, the planners' approach to urban and industrial projects had two important features: industrial gigantomania and a preference toward small and medium urban settlements. Both features came from the ideology and specificity of a centrally planned economy rather than a productivity rationale. And in conjunction, they lead to a prevailing "one town - one plant" structure and discreteness in planning.

The first feature, gigantomania, is the propensity to construct large-scale industrial units. It meant that the planners preferred one gigantic plant to a few smaller ones. The formal argument for it was an emphasis on increasing returns to scale in industrial production as one interpretation of the Marxist theory. The self-imposed competition with the USA was another reason (Smolinski, 1962; Josephson, 1995). Also, gigantomania let the Soviets have a smaller number of productive units that eased the centralized planning and administration. Aside from the lumpy industry structure, gigantomania led to a strong path-dependence and persistence of spatial capital distribution. Most of the Soviet super-enterprises dominate product and labor markets still nowadays, simply because of enormous capital costs for constructing a potentially competitive plant.

The second feature is the preference for medium-size urban locations. The Soviet urban theories claimed the optimal size of an urban settlement to be between 50-350 thousand people (Huzinec, 1978; Markevich and Mikhailova, 2013). Such size should have helped to economize on amenities and transportation. Small and medium locations were also better from an ideological perspective. And defense considerations added to the preference too, as it favored dispersed urban and industrial structure. The optimal size concept was the grounds for city-growth restrictions policy, including industry investment restrictions and construction ban in cities above a specific size.[7]

The combination of those features created a discreteness, a natural numbers problem, in planning. Because of commitment to large-scale projects, once a plant was operating close to full capacity, the output of its kind could be increased only

[7]Studies of the urban hierarchy in Russia show that those policy restrictions worked. The major cities of the USSR were growing slower than it would be in the absence of such restrictions. And the USSR had an extra mass of small and medium cities (Becker et al., 2012)

in a big discontinuous jump by constructing another plant (Dobb, 2012). And for an ideological bias toward small and medium locations, planners preferred to start a new plant together with a new settlement or within a small one. For example, for the period 1967-1970, 70% of all industrial units were planned for construction in urban centers with a population below 100 thousand people (Lewis and Rowland, 1969).

As a result, the locations built by the Soviets had a particular prevailing structure of factory-and-settlement complexes, i.e., in most cases, a new city had one large-scale industrial unit with most of the population being related to it. Such a unit is called a city-forming enterprise, and its existence is a unique feature of Soviet urbanization. Even until now, monotowns - urban locations based on a single industry or even a single plant - comprise about 40% of all Russian cities and towns (Becker et al., 2012). Because of this structure, one can track the geography of the Soviet industrialization by following the creation of urban settlements.

So, in the stylized version of the Soviets' approach to urban-industrial development, they were placing urban-industrial units, comprising a large-scale plant and a medium-sized city, randomly in space aiming to get a uniform distribution of industry and population across the territory. The choice of location was independent of actual productivity and rates of return, with proximity to mineral resources being the only economic-related factor.[8] Then, if a few such urban-industrial units were close to each other, the joint labor market they form, including all city-forming enterprises, was less concentrated than a labor market of a single settlement. And the difference in concentration resulted from urban planning. Later, during the USSR period or after the collapse of the USSR, the industrial composition could change. But because of the prevailing large scale of industry projects, the initial effect of urban structure on labor market concentration persists till now.

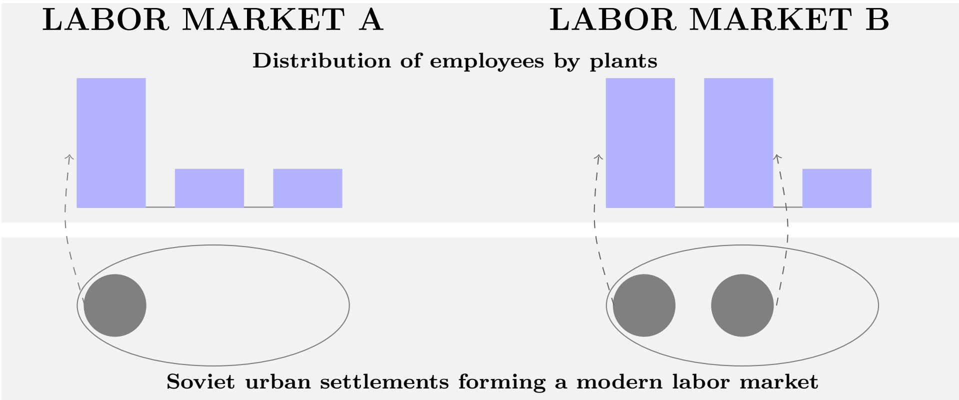
And this is how the instrument works. I count the Soviet settlements existed at the territory of a modern labor market (a city or a commuting zone). Every such settlement represents its city-forming enterprise, which was a reason for a Soviet government to establish the settlement. The number of city-forming enterprises

[8]Note, that costs of labor relocation were relatively low, because of surpluses of rural labor force wishing to migrate to cities and because of forced labor, plus they economize on urbanization level.

correlates with the number of major employers nowadays, and thus correlates with the concentration level. Because of the scale, it makes a difference to inherited concentration level whether a modern labor market comprises one, two, or ten of Soviet factory-and-settlement complexes. The bigger the number of Soviet urban settlements existed at the territory of a municipality, the more plants operated there, and the less concentrated the labor market is then.

This idea is illustrated at the Figure 2. A labor market "A" was formed by a single Soviet urban settlement. Thus, its employment distribution nowadays is dominated by a city-forming enterprise that gave a start to this settlement, and the labor market is extremely concentrated. In contrast, a labor market "B" has a less concentrated labor market because it inherited two large-scale plants from Soviet planning.

Figure 2: Stylized scheme of the instrument effect on the labor market concentration



Notes: The figure illustrates how the number of Soviet settlements within a modern labor market affects the nowadays concentration level. Every Soviet settlement is associated with a large-scale industrial project that persists till now. If a labor market has more of such inherited large-scale projects, then the concentration is lower today.

The advantage of the instrument is that it is orthogonal to productivity changes caused by the growth of the most productive plants. It is so because the Soviet urban settlements represent their city-forming enterprises at the commencement of production, before any changes caused by realized productivity. It is the core assumption behind the exclusion restriction.

The second component of the exclusion restriction is the principles of spatial allocation of urban centers that the Soviet planners followed. We need to be sure that the instrument does not correlate with productivity in any other way. I.e., the labor markets that comprise the bigger number of settlements should not be the most or the least productive.

So, the question is why some places had more neighboring settlements than the others. One explanation is just by chance. The spatial allocation principles suggest that the Soviets were placing industrial projects independent of the implied productivity, or at least not related to the factors determining place productivity nowadays.[9] Circumstantial evidence for it is that the cities' growth rates during the Soviet period are unrelated to population changes after the collapse of the USSR (Becker et al., 2012). Also, central planning was an outcome of a variety of agents deciding on spatial resource allocation (Hardt and Modig, 1968; Bond et al., 1990). So the exact placing of the projects was a matter of chance.

Some settlements were located close by because they formed a vertically integrated industrial complex. But the number of neighboring settlements is unrelated to productivity in this case, as it depends rather on the number of separable steps in a technological process than on the productivity of an entire complex or a place.

Yet, there is one case of many neighboring settlements that I should treat with caution, as it might correlate with productivity. It is when satellite towns appeared in suburbs of a core city that had faced city-growth restrictions. Then, satellites are the consequence of the high potential for the economic development of the core city. Here, the more productive places are the places with most of the satellites. However, the cities facing growth restrictions were mostly the traditional cities that existed before the USSR. So, this is one more reason why I exclude them from the sample. Also, many of them had diversified industry structure from the start and thus did not follow the logic of the instrument.[10]

[9] One might interpret it as if the Soviets invested in less productive territories. But if it were true, it would mean that the instrument correlates negatively with productivity. Then, I would see a different direction of the coefficient change in my results.

[10] Also, there is evidence that the investment ban in big cities and size restrictions did not work fully. The big cities, which local authorities had enough political power, could overcome investment restrictions. Via political bargaining, they got new industrial projects at their territory and kept expanding (Huzinec, 1978). But this disparity is helpful for identification. It suggests that whenever additional industrial treatment potentially correlates with the place quality, which might matter till now, e.g., city-size effect, it would not appear in the urban structure instrument.

My identification strategy exploits the peculiarities of the Soviet development mentioned above. I take only locations founded during the USSR period and exclude all traditional places of economic activity. Thus, I got a link between labor market concentration and industry structure, and ensure orthogonality to productivity through a choice of location. I count the number of urban settlements, not the industrial projects themselves. And this helps me to escape a correlation with productivity through enterprises' growth. Additionally, I experiment with sample selection and different instrument definitions as a robustness check (e.g., consider only urban planning of the Stalin period). I do this to ensure that changes in planning principles do not affect my estimation.

Surely, for the exclusion restriction, some other assumptions should hold. Besides the Soviet planning, the development during the post-Soviet transition should not link the number of original urban settlements to labor productivity within a labor market. Also, there should be no geographical sorting of workers or any other distortions to the human capital level correlated with the instrument. And finally, industry composition and product market power of enterprises should not depend on the urban structure.

Though there is no apparent reason to doubt those assumptions, some confounding factors (like industry effects, city-size, or geographical location) could violate them. Thus, I control for city-size, place locations, and industry effects, and other place and industry characteristics. Also, as a robustness check, I rebalance the sample by the propensity score matching method to correct for differences in those characteristics between different levels of the instruments. More details on the approach and data follow in the next sections.

4 Data

4.1 Data sources

For my analysis, I compile together firm-level and municipality-level data. And I add historical data from the Soviet Censuses for the IV identification.

1. Municipality-level data. The source of municipality-level data is the Database of Municipalities' Indicators (DMI) by the Federal State Statistics Service of Russia.

The DMI data is the official publicly available statistics on Russian municipalities. It provides the data on municipalities' average wages and the total number of employees by broad industry groups (manufacturing, mining, agriculture, trade).

The first year of the data is 2006, but the coverage until 2008 is low. Section 1 of Table 1 shows that the data covers roughly 40%-45% of the total Russian employment, depending on the year.

2. Firm-level data. The source of the firm-level data is the Ruslana database by Bureau van Dijk.[11] I have access to the data spanning from 2008 to 2015. I use it to construct a concentration measure and proxies of firms' productivity level (e.g., revenue per employee and capital intensity). I use data on firms' employment (number of employees) and the balance sheet information. However, the database does not provide information on wages, so I only can rely on the wage data from the DMI. I also use firms' addresses and industry codes to match firm-level information to municipality-level data.

3. Historical data. The data on the instrument comes from the Russian Empire Census of 1897 and the Soviet Censuses of 1939, 1959, 1970, 1979, and 1989 years. I use data on the urban population Censuses, which includes data on every urban settlement that existed by the time of the Census. I make a list of pre-Soviet cities and towns based on the Russian Empire Census of 1897. I use it to exclude those locations from the sample for estimation later. And for every

[11] I thank the Center for Economic and Financial Research at New Economic School and its Policy Director, Natalia Volchkova, for the help with the data.

Soviet urban settlement, I collect information on changes of the official name and merges with other settlements. This matching exercise gives me the number of Soviet urban settlements that existed at the territory of a modern municipality at the moment of every Census.

4. Geographical controls. Finally, I use data on municipalities coordinates to construct the geographical controls: latitude, longitude, distance, and direction from Moscow.

4.2 Matching, aggregation, and sample selection

The DMI provides me with data on a level of an industry within a municipality. I match it with firm-level data from Ruslana based on the firms' addresses and industry codes. Then, I add data on Soviet urban settlements to modern municipalities in DMI, taking into account information on changes of their official names. And I include data on geographical controls for municipalities' locations. As a result, I get a panel of municipality×industry-level data, with some variables being municipality specific. The data span is from 2008 to 2015.

During the matching, I drop observations with lacking information or unrealistic values on key variables. I keep only urban centers and drop rural areas. Locations left in the dataset cover about 45% of total employment in Russia, and data on matched firms explain from 1/3 to 2/3 of it (see sections 2 and 3 of the Table 1).

I also drop observations (year×industry×municipality) if the number of employees of matched firms sums up to less than 50% or over 125% of industry employment according to the DMI data. It removes approximately 15% of observations.[12] Figure 3 shows how the sum of employment of matched firms relates to the employment level according to the DMI dataset for observations left in the sample. On average, the Ruslana dataset gives information on the distribution among firms of 60% of workers within a municipality.

At the next step, I aggregate municipalities into commuting zone proxies to get geographical borders of labor markets. The administrative division of mu-

[12]The results are robust to changing those cutoffs. Though, making the cutoffs too strict decreases the sample dramatically.

nicipalities from the DMI does not offer a good basis for it, as municipalities of different regions of Russia are too heterogeneous in terms of population, area, and spatial structure. Also, the official borders are unstable and were changing during the period. Finally, given the logic of the instrument, it is natural to count the Soviet settlements within labor markets spanning equal territories. Otherwise, the instrument might be spuriously correlated with the area, and thus with geographical factors (e.g., Siberian municipalities are bigger than in other regions).

There is no official division of commuting zones, so I define them as a municipality and its close neighbors. As a result, I have overlapping geographical borders of the labor markets, in a spirit of (Manning and Petrongolo, 2017). I pick the 30 km between centers of cities as a cutoff for close neighbors. The choice of the cutoff is partly guided by anecdotal cases of reasonable commuting distance in Russia, and also by estimates of the size of local labor markets in (Manning and Petrongolo, 2017). Thereby, I treat as potential employers not only firms within a municipality but within neighboring cities within a 30 km radius too. The resulted borders can be viewed as a set of potential choices for a representative worker, living in the center of a municipality. I define a labor market as an industry within such a commuting zone.[13]

Using the matched and aggregated data, I compute the labor market level (industry×commuting zone) variables. I recalculate the values from the DMI as sums (e.g., for population, total employment) or population-weighted averages (for average wage level). And for firm-related variables, I use data on all matched firms within a commuting zone radius. Such variables are the total employment of all matched firms, the average size of a firm, average revenue per employee, capital intensity, and a concentration measure.

My measure of concentration is the logarithm of the Herfindahl-Hirschman index, $\log(HHI)$. Where the HHI is:

$$HHI_{ijt} = \sum_{n=1}^{N_{ijt}} (S_{nijt})^2$$

[13]I drop municipalities that are much bigger than my definition of a commuting zone.

$$S_{nijt} = \frac{l_{nijt}}{L_{ijt}}$$

Here, i is a municipality index, j is an industry index, n is a firm index, and t is a year of observation. N_{ijt} is the number of firms within a labor market, l_{nijt} is an employment level of a firm, and S_{nijt} is a firm share in total employment.

The $\log(HHI)$ takes values from 0 to minus infinity. A value of 0 means that there is only one employer within a market (a corresponding value of HHI is 1). The lower the index is, the lower is the market concentration. And a perfect competition limit is minus infinity ($HHI = 0$), with all firms being infinitesimal.

Because of the instrument I use, I leave in the sample only industries that have a legacy from the Soviet times, i.e., mining, manufacturing, and electricity and water production. Those industries have important properties, strengthening my identification strategy. First, they have relatively high entrance costs and require a significant amount of physical capital. Thus employers' concentration within a local labor market for those industries is a slow-moving variable. Therefore, the historical instrument has good explanatory power for the current concentration level. Second, the Soviet central planning system put excessive emphasis on the development of those industries. As a result, the production capacity of many of those industries was in relative surplus. So the geographical pattern of plant allocation has changed little.

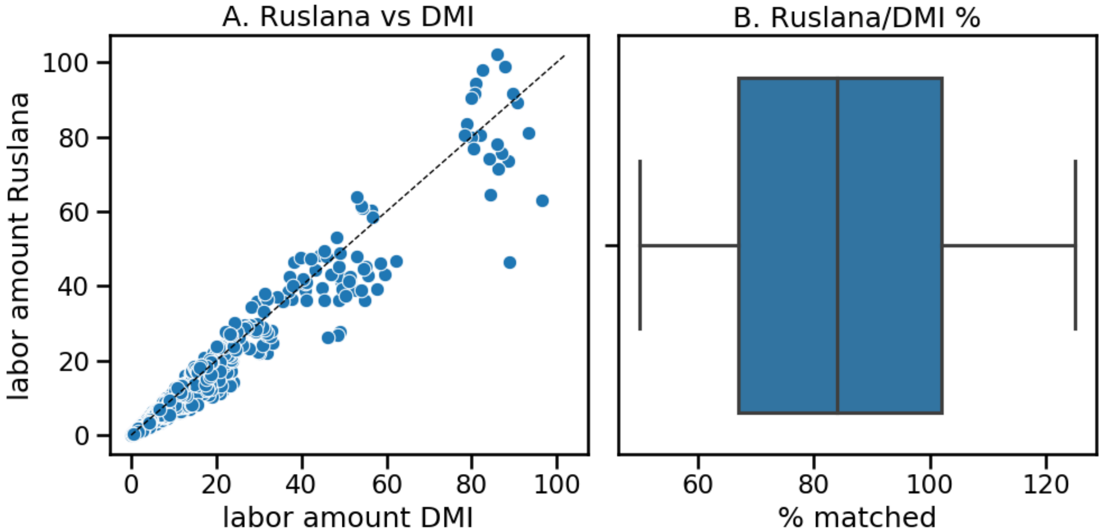
The nature of my instrument also dictates the sample selection principle I use. As I rely on socialistic industry planning driven by factors unimportant for the market economy, I exclude commuting zones with pre-Soviet cities and towns. The final sample includes only locations that emerged during the USSR period.

Table 1: Data coverage, number of employees (millions)

year	2008	2009	2010	2011	2012	2013	2014	2015
Russian total	49.4	47.4	46.7	45.9	45.9	45.8	45.5	45.1
1. DMI on cities/towns	9.9	20.9	20.7	21.1	21.6	20.4	18.3	17.7
as % of total	20.1	44.0	44.4	45.9	47.0	44.5	40.2	39.3
# municipalities	608	1292	1355	1379	1421	1211	484	484
# of Regions	42	71	73	74	76	75	77	75
2. DMI on matched cities/towns	8.5	17.3	17.6	17.9	18.2	16.7	15.4	14.5
as % of total	17.1	36.5	37.6	39.1	39.6	36.6	33.9	32.2
# municipalities	364	792	812	848	875	765	380	370
# of Regions	41	69	71	71	73	71	74	71
3. Matched firms (Ruslana)	10.2	11.1	11.1	13.8	14.1	16.1	17.6	17.0
as % of total	20.6	23.3	23.7	30.0	30.7	35.1	38.6	37.6
# municipalities	1212	1206	1199	1237	1216	1217	1205	1199
# of Regions	76	75	76	77	77	77	77	76

Notes: The table demonstrates the coverage of the constructed dataset by comparing it to the aggregated official data on Russian employment. The row "Russian total" gives the total number of employees of all enterprises, except for small and medium ones. The block "DMI on cities/towns" is the total number of employees in cities and towns covered by the Database of Municipalities' Indicators (DMI), excluding Moscow and St.Petersburg. The block "DMI on matched cities/towns" gives the total number of employees in cities and towns covered by the DMI that also have firms presented in the Ruslana database. The block "Matched firms (Ruslana)" gives the total number of employees in matched firms from the Ruslana database.
Within every block, the first row gives the total number of millions of employees. The second row is a percentage of the Russian total. The row "# municipalities" states the number of cities and towns in the data, and the row "# of Regions" gives the number of regions in the sample.

Figure 3: Comparison of total employment according to municipality-level data (DMI) and firm-level data (Ruslana) at city-industry level



Notes: The subplot A compares employment at municipality-industry-level ("labor amount DMI") with the total employment of matched firms ("labor amount Ruslana"). The dashed line represents the identity of two numbers, i.e., for any observation at the line, the sum over matched firms gives exactly the official employment number. Any point below this line means that firm-level data does not cover all the employees within a labor market, while any point above means that the summation over matched firms exceeds the official totals.
Subplot B illustrates the distribution of the ratio of employment of matched firms and total employment according to DMI. The value of 100% means a perfect match.

5 Results

5.1 Specification

To explore the relation between average wage and labor market concentration, I estimate IV regression with a set of controls for labor productivity and labor supply elasticity. My data has a panel form, with an individual observation being an industry j within a commuting zone i at year t.

The baseline regression specification for the main equation is

$$\log(w_{ijt}) = \beta_{HHI} \log(HHI_{ijt}) + \theta X_{ijt} + \phi Y_i + \gamma_t + \gamma_j + \epsilon_{ijt} \tag{1}$$

where w_{ijt} is an average real wage, HHI_{ijt} is a Herfindahl-Hirschman index, X_{ijt} is a vector of controls, γ_j and γ_t are industry and time fixed effects, and Y_i is a set of geographical controls.

The vector of controls, X_{ijt}, includes logarithms of average capital intensity, average revenue per employee, and the total number of employees. I use capital intensity and revenue per employee to capture labor productivity effects on wage levels. The total number of employees is a control for the market size wage premium.

I use geographical controls, Y_i, instead of location fixed effects to proxy location-specific determinants of wage level. I can not use the commuting zone fixed effects, γ_i, because the historical instrument is constant for every location i, so the fixed effects will absorb it. The geographical controls are latitude, the intersection of direction and distance to Moscow, administrative status of a central city, and the total urbanized area within a commuting zone. Latitude captures variation in the costs of living associated with the average temperature. The distance to Moscow is a good proxy for the level of economic development given a location size effect. And the total urbanized area and administrative status are additional ways to control for the city-size effect.

The coefficient of the interest is β_{HHI}, the elasticity of average wage to concentration level. In the absence of a correlation between concentration and productivity, it shows how changes in concentration move wedge between wage and productivity. But as has been discussed before, in the data, productivity and concentration are always correlated. Thus, the HHI_{ijt} needs to be instrumented, that I do with my historical instrument.

The specification for the first stage is:

$$\log(HHI_{ijt}) = \alpha_Z Z_i + \alpha X_{ijt} + \phi Y_i + \phi_t + \phi_j + u_{ijt} \quad (2)$$

where Z_i is the instruments, X_{ijt} is a set of controls, ϕ_t is a time fixed effects, and Y_i is geographical controls.

The baseline version of the instrument is the number of Soviet urban settlements ever existed within a modern commuting radius, irrespectively of the time of a settlement foundation and its further development. For the robustness checks, I redefine the instrument using only Soviet settlements that existed by the time of a particular Census. I also add to an instrument list a dummy for being a location that developed from a single Soviet urban settlement, because labor markets there seem to be a distinct group in terms of nowadays concentration given other observables.

5.2 First stage results

The essential part of the identification strategy is the instrument that allows me to separate the effect of concentration from productivity confounding. Thus, it is crucial to study the relationship between the Soviet urban history of the location and its nowadays concentration level.

Figure 4 shows the distribution of current concentration levels depending on the maximal number of Soviet urban settlements that existed at the territory of a labor market. The number varies in the sample from 1 to 30 units. And the average concentration level decreases with this number, together with maximal and minimal concentration levels.

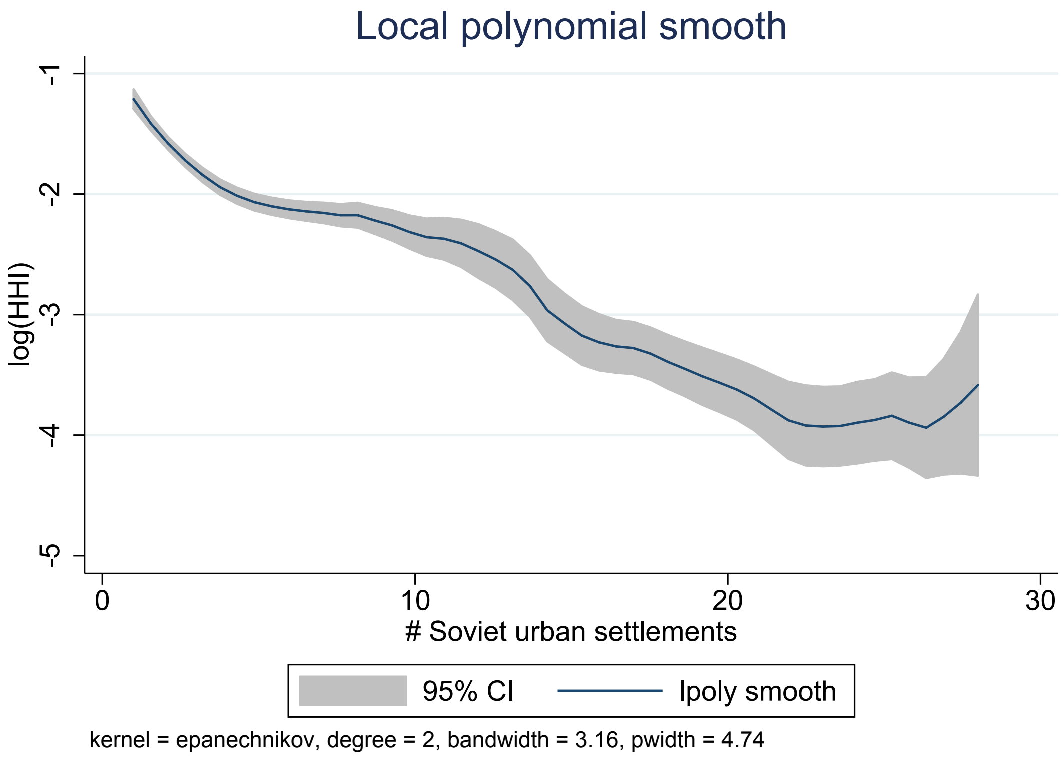
However, while the visual pattern exists for all sectors, the relationship is significant only for the industries prioritized in the USSR. Table 2 shows it by estimating the first stage equation (2) for different industry groups. It includes two forms of the instrument: the maximal number of Soviet urban settlements that existed within a modern commuting zone, and a dummy that this number is over one. Both variables are significant only for concentration in industrial sectors (mining, manufacturing, production of water and electricity), and they have no explanatory power for services and agriculture. Only the regression for industrial sectors passes the F-test for strong identification.

Noticeably, all other control variables behave alike across industry groups. Bigger cities have less concentrated markets. Larger and more capital intensive labor markets are less concentrated too. The last effect is more pronounced for services than for manufacturing. The revenue per employee seems to be unrelated to the concentration level, except for industrial sectors, where less concentrated markets have with higher revenue level.

The concentration level decreases in the settlement number. A labor market within a commuting zone formed by several Soviet urban settlements is less concentrated, and its concentration index, $\log(HHI)$, decreases by 0.08. For a mean labor market, it falls from -1.6 to -1.7, which is equivalent to having seven equal firms instead of five. Every additional Soviet settlement decreases the concentration index further by 0.04. Given that we can interpret the inverse HHI as the number of equally sized firms in the market, this coefficient means that every additional Soviet settlement decreases a representative employer share by 4%.

The fact that only industrial sectors strongly depend on the number of the settlements reassures not only the validity of the instrument but an exclusion restriction too. It confirms that settlements' number is informative about large-scale industrial projects inherited from the USSR, which influence current concentration via slow-adjusting capital. It does not hold for services because it neither was a subject to the Soviet gigantomania nor depends on capital formation. Moreover, if the Soviet urban structure affected the concentration level via some confounding factors related to place-specific productivity, e.g., population density or location properties, then its effect would be similar for all industries, including services. But the differential results show that the instrument works through the inherited capital channel.

Figure 4: Concentration decreeses with number of settlements



Notes: The figure shows local polynomial smooth of current concentration levels depending on the maximal number of Soviet urban settlements that existed at the territory of a labor market.

Table 2: 1st stage results for concentration level, $log(HHI)$, by industry groups

VARIABLES	(1) industrial	(2) services	(3) other
of >1 USSR settlements	-0.0629	-0.242**	-0.118
	(0.106)	(0.101)	(0.156)
# Soviet urban settlements	-0.0542***	-0.0244**	-0.00567
	(0.00973)	(0.0102)	(0.0189)
log(labor amount)	-0.0690	-0.293***	-0.323***
	(0.0506)	(0.0847)	(0.0623)
log(pop)	-0.321***	-0.258*	-0.200***
	(0.0690)	(0.145)	(0.0756)
log(capital intensity)	-0.0237	-0.0125	-0.0403
	(0.0165)	(0.0209)	(0.0252)
log(revenue/employee)	-0.0415	0.0212	-0.0548
	(0.0511)	(0.0408)	(0.0524)
Observations	1,200	1,283	472
Geo controls	✓	✓	✓
Industry FE	✓	✓	✓
Year FE	✓	✓	✓
Clustered errors	✓	✓	✓
F-test for weak instrument	16.36	5.860	0.480

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: The table estimates the first stage equation for concentration level as in equation 2 for different industry groups. The first column does it for industrial sectors (mining, manufacturing, and production of water and electricity). The second column repeats the exercise for services, and the third column does so for agriculture. The main instrument is the maximal number of USSR's urban settlements that existed at the territory of a labor market. It also includes a dummy variable for this number being over one. F-statistics is for weak instrument test.

5.3 Second stage results

The core result of the paper is the magnitude of the actual effect of the concentration level on an average market wage. I repeat the estimation of equation (1) by OLS with actual HHI values and by IV with equation (2) as a first stage. Once I instrument the concentration with historical urban structure, I get the estimate of the elasticity of wage to concentration level, β_{HHI}, almost five times as big.

An average real wage decreases in labor market concentration, i.e., with higher values of $log(HHI)$. It holds for every individual industry in the sample (see Figure 5). But the observed effect is modest without an exogenous variation, as seen with an OLS estimation of this relation (see column 1 of Table 3).

The OLS estimate of the coefficient of the interest, β_{HHI}, is equal to -0.059. It means that moving from a pure monopsony to a duopoly increases wages by 4.2%.[14] The same change happens after a doubling of the number of employers within any labor market. Expanding the number of employers from one to five equal firms, i.e., going from monopsony to an average labor market with $\log(HHI) = -1.6$, raises wages further by 6.0% (10.2% in total). If a labor market with an average level of concentration would have one more average size firm, a wage level there would increase by 1.1%.

This magnitude of the effect is in line with the literature. The typical estimates of the elasticity lie between -0.05 and -0.15. And this range of the estimated elasticities is stable irrespective of a labor market definition.[15] So, the OLS does not show any particularities of Russian labor markets in terms of wage and concentration level correlation, comparing to the results for the US data.

However, once I instrument the concentration level, the result changes dramatically (see Table 3). The point estimate of the elasticity of wage to concentration is -0.35. This value means that moving from a monopsony to a case of two equal

[14]Monopsony concentration level is $\log(HHI) = 0$. And a duopoly with two equal firms means $\log(HHI) = \log(0.5^2 + 0.5^2) \approx -0.7$. Then, $4.2\% = (\exp\{-0.059 \cdot [0.7 - 0]\} - 1) \cdot 100\%$

[15]In principle, the looser is the definition of the labor market (i.e., broader industry groups and larger geographical borders), the less pronounced is the concentration effect (Jarosch et al., 2019). Thus, it comes with no surprise that my results with the OLS are of the smaller values. The literature also implies that the effect is more pronounced for more concentrated markets (Rinz, 2018; Jarosch et al., 2019). As Russian markets are more concentrated on average, the effect is still there despite a loose labor market definition.

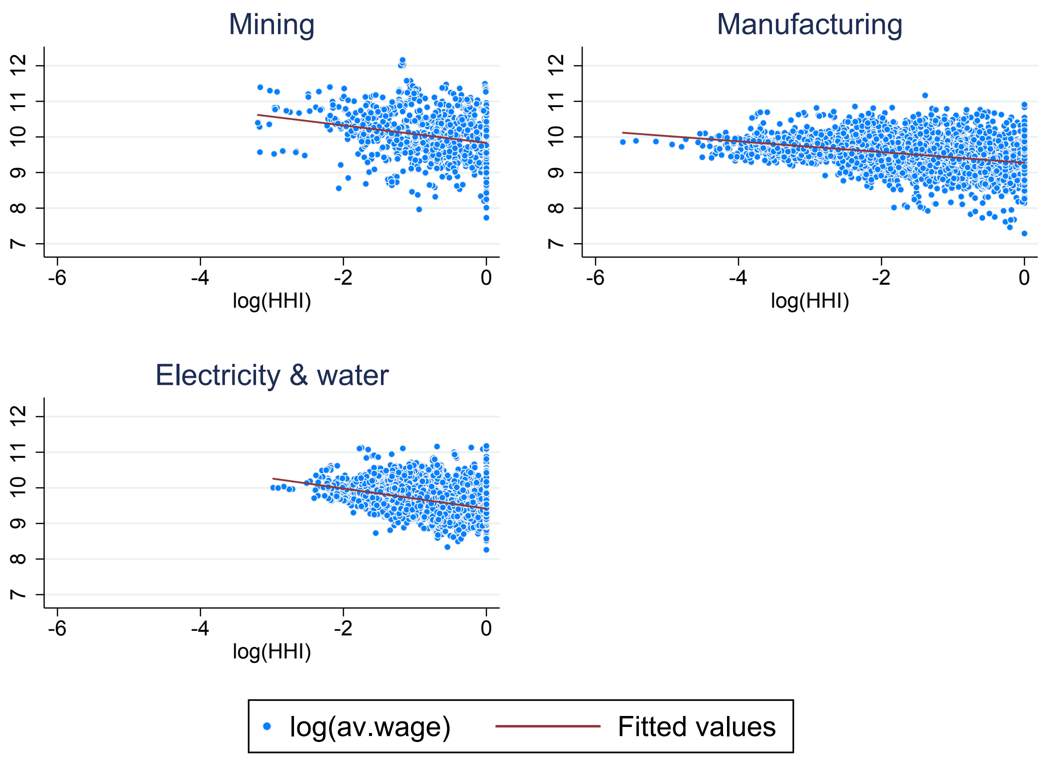
firms gives a 27.5% increase in wages.[16] And the same happens with any doubling of employer number within a labor market. And a further decrease of concentration to the level of an average labor market, $\log(HHI) = -1.6$, means an additional 50.1% of wage increase (77.5% in total). One more additional employer within an average labor market increases the wage level of a mean market by 6.4%.

While this change seems to be large, it fits the spatial wage dispersion. A doubling number of employers is roughly a difference between the median ($\log(HHI) = -1.5$, 4.5 equal employers), and the 25th percentile ($\log(HHI) = -2.3$, 9.7 equal employers) of concentration distribution. And a corresponding increase in wages is comparable to a 30% difference between a median and the 75th percentile of average wage distribution across Russian labor markets.

Those numbers are much higher than any estimates in the literature. And the contrast between coefficients' values suggests that differences in productivity linked to the changes in concentration masks a significant fraction of firms' wage-setting power. In the absence of external variation of concentration level, we underestimate how much market structure matters for the labor market outcomes.

[16] $27.5\% = (\exp\{-0.35 \cdot [0.7 - 0]\} - 1) \cdot 100\%$

Figure 5: Average real wage and labor concentration by industry



Notes: The plot shows the relation between the logarithm of average real wage and the concentration index by industry. Every point is a local labor market defined as an industry within a commuting zone. The higher values of $\log(HHI)$ mean a more concentrated labor market. The 0 value of $\log(HHI)$ is the highest possible level of concentration, i.e., there is only one employer within this labor market. If a labor market is equally divided between two firms, the value of the concentration index is $\log(HHI) = -0.7$. And a market with 7 or 8 almost equal firms has $\log(HHI) = -2$. The value of -4 is equivalent to 55 equally sized firms.
The negative slope of the fitted line indicates that wages decrease in concentration.

Table 3: OLS and IV estimation of concentration effect on wages

VARIABLES	(1) OLS log(av.wage)	(2) IV 1st stage log(HHI)	(3) IV 2nd stage log(av.wage)
of >1 USSR settlements		-0.063	
		(0.106)	
# Soviet urban settlements		-0.054***	
		(0.010)	
log(labor amount)	0.047**	-0.069	0.034
	(0.020)	(0.051)	(0.025)
log(pop)	-0.003	-0.321***	-0.136***
	(0.027)	(0.069)	(0.042)
log(capital intensity)	0.003	-0.024	0.006
	(0.010)	(0.017)	(0.011)
log(revenue/employee)	0.130***	-0.042	0.128***
	(0.028)	(0.051)	(0.030)
log(HHI)	-0.071***		-0.342***
	(0.023)		(0.071)
Observations	1,200	1,200	1,200
R-squared	0.296		0.009
F-test for weak identification		16.36	
AR F-test of significance of end.regs		15.99	
AR F-test p-value		0	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: The table compares the effect of concentration on wages estimated with OLS and IV approaches. It restricts the sample to industrial sectors within locations that became urban settlements during the USSR.

The column (1) repeats estimates of equation 1 with OLS. The column (2) estimates the first stage equation for concentration level as in equation 2. The main instrument is the maximal number of USSR's urban settlements that existed at the territory of a labor market. It also includes a dummy variable that this number is more than one. The column (3) reports the second stage coefficients of equation 1 with the level of concentration estimated by regression of the column (2).

The effect of concentration on wages is given by coefficients in the row $log(HHI)$. A negative value means that an increase in concentration level decreases average wages.

5.4 Robustness checks

Since the estimates of IV are so much bigger than a benchmark magnitude in the literature, it is crucial to see how robust the results are.

The first thing to check is the effect of how I define the instrument. My baseline approach is to count the maximal number of Soviet urban settlements that existed within a territory of a modern commuting zone. So, I don't distinguish projects of different subperiods. Though, each of them could have some nuances in planning practice crucial for the identification.

For example, one might argue that the number of settlements in 1989 is a better predictor for the current concentration level. It is closer in time, so it counts the projects, which are more likely to be active till now. Also, this number does not include abandoned settlements or projects closed yet in Soviet times. So, the instrument defined this way is less noisy. Indeed, the F-statistics value in Table 4 is the highest for this definition of the instrument. The point estimate of the elasticity coincides with the baseline result.

Alternatively, one might believe that planning during Stalin's period at the office satisfies the exogenous restriction better because it is the least related to modern productivity. First, the urban planning of this period is more likely to be driven by defense and ideological considerations. Second, the planners had no experience in green-field projects development and had little information on the potential productivity of places and projects. So, given an authoritarian and centralized decision-making process, choices of the exact project location were often random. Third, some neighboring settlements were not considered that way back in the 1930s-1940s because the travel speed and perception of distance were different. So one should be less worried about synergy or vertical integration complexes being the cause for the closeness of settlements.

For this period, I have Censuses of 1939 and 1959 as the sources of information on urban settlements. The urban projects, started by 1939, might be the most randomly located since it was the first years of the planning system, and all arguments on lacking experience apply here the most. The urban settlements of the 1959 Census include some post-Stalin developments. But they also reflect changes in Soviet industrial and urban geography that happened during and right after the

Second World War. And it was an enormous shock, as the Soviets had to move most of the industry away from the war front.

Both those definitions of the instrument give an almost identical estimate of the concentration effect. The estimated elasticity is −0.59, which is even bigger than a baseline estimate (see Table 4). However, the strength of this instrument is lower, and standard errors increase.

Also, I adjust the sample together with the instrument definition. The baseline specification includes all locations. But the instrument value is zero for the number of the settlements in 1939 and 1959 if a city started later. So the instrument partially correlates with the age, e.g., it is lower for newer industries and plants, which are potentially more productive. To avoid this correlation, I keep in the sample only locations started by the time of the respective Census.

Additionally, one may assume that Soviet settlements started by 1939 or 1959 are a more homogeneous group than the sample of all Soviets locations. Thus, a bias caused by confounding factors related to locations' heterogeneity should be smaller for this subsample. So I repeat the estimation with a baseline definition of the instrument for those subsamples.

As a result of those exercises, the estimate of the elasticity increases even further, reaching −0.7 for the 1939 settlements (see Table 4). But because of the smaller sample, the strength of the instrument decreases too much, and the standard errors doubles. So I would take the point estimates with caution. But the exercise shows that the more random variation in concentration leads to the bigger wage response.

Another issue is the sample imbalances across the level of the instrument. Especially commuting zones started from a single settlement tend to be smaller and further from Moscow. It might cause the first stage of IV to be biased and thus affect the second stage. To address the issue, I use a propensity score matching to remove the difference in the distribution of covariates across the level of the instrument.

The Table 5 shows the result of the propensity score-matched adjusted IV estimation procedure. The first column estimates the probability that a location developed from several Soviet settlements given the observed parameters. It shows that labor markets developed from multiple towns tend to be larger and have firms with lower average revenue per employee. Then it means that the original sample is unbalanced on those covariates. Since a larger labor market size is associated with higher average wages, the differences in sample shares bias the estimates upwards. Analogously, a higher revenue per employee implies a higher wage level, but also fewer soviet settlements and thus more concentration. And this might bias the coefficient for concentration downwards. So I match the sample on a propensity score to correct for these potential biases.

After this rebalancing, I run the same IV identification as in Table 3. The coefficients of the first stage barely change after this. But the estimate of the effect of concentration increases to the value of -0.48.

The coefficient value means that if a labor market of a mean concentration level $\log(HHI) = -1.6$, i.e., approximately five equal firms, would have one more average size firm, a wage level there would increase by 8.8%. A doubling the number of employers (e.g., moving from a monopsony to a duopoly) gives a 39.0% increase in wages.

I also repeat the robustness checks with the subsamples and the instrument. The results are in Table 6. The results for samples restricted to Soviet locations founded by 1939 or 1959 changes the least after rebalancing the sample. That shows that those samples are a more homogeneous group than all Soviet settlements. Also, point estimates of all instruments and sample definitions get closer to each other with an average size around the baseline value.

Table 4: Concentration effect on wages under different samples and instrument definitions

	OLS	IV with different instrument definition			
		baseline	in 1939	in 1959	in 1989
Sample	(1)	(2)	(3)	(4)	(5)
All Soviet locations	-0.071***	-0.342***	-0.482***	-0.498***	-0.343***
	(0.023)	(0.071)	(0.089)	(0.088)	(0.071)
		16.36	14.19	16.67	16.90
Only founded before 1959	-0.066***	-0.473***		-0.616***	
	(0.025)	(0.114)		(0.128)	
		12.63		14.93	
Only founded 1939	-0.043*	-0.609***	-0.591***		
	(0.024)	(0.187)	(0.157)		
		7.970	8.590		

Robust standard errors in parentheses and F-statistics for week identification below standard errors
*** p<0.01, ** p<0.05, * p<0.1

Notes: The table reports estimates of β_{HHI} coefficient in equation (1). The first column report OLS estimates, and columns from (2) to (5) report IV estimates with different definitions of the instrument. Column (2) uses the maximal number of settlements that existed at the territory of a labor market during the entire USSR period. The columns (3) to (5) counts the number of settlements at the date of a particular Soviet Census.
The rows present estimation results for various subsamples of locations. The first row uses all Soviet-built urban places, i.e., all Russian cities and towns excluding existed before the USSR. The next rows restrict the sample to Soviet locations with at list one urban settlement founded there by the date of the 1939 or 1959 Censuses.

Table 5: Propensity score matched IV results

VARIABLES	(1) logit of >1 USSR settlements	(2) 1st stage matched log(HHI)	(3) 2nd stage matched log(av.wage)
of >1 USSR settlements		-0.027	
		(0.159)	
# Soviet urban settlements		-0.044***	
		(0.010)	
log(labor amount)	0.279***	-0.076	0.016
	(0.106)	(0.048)	(0.037)
log(pop)	1.539***	-0.405***	-0.236***
	(0.171)	(0.065)	(0.084)
log(capital intensity)	-0.068	-0.032	-0.002
	(0.045)	(0.020)	(0.016)
log(revenue/employee)	-0.559***	-0.017	0.127***
	(0.125)	(0.063)	(0.043)
Pearson residual		0.003	0.010
		(0.039)	(0.018)
log(HHI)			-0.480***
			(0.128)
Observations	1,158	1,784	1,784
R-squared			-0.412
F-test for weak identification		10.64	
AR F-test of significance of end.regs		21.03	
AR F-test p-value		0	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: The table reports the results of propensity score-matched IV. It restricts the sample to industrial sectors within locations that became urban settlements during the USSR.
The column (1) estimates a logit model for a labor market spanning more than one Soviet urban settlement. I use this equation for balancing the sample by estimated propensity scores.
The column (2) estimates the first stage equation for concentration level as in equation 2 based on a sample balanced by propensity scores. The main instrument is the maximal number of USSR's urban settlements that existed at the territory of a labor market. It also includes a dummy variable that this number is more than one, which is a treatment variable used to balance the sample.
The column (3) reports the second stage coefficients of equation 1 with the level of concentration estimated by regression of the column (2).
The effect of concentration on wages is given by coefficients in the row $log(HHI)$. A negative value means that an increase in concentration level decreases average wages.

Table 6: Concentration effect on wages under different samples and instrument definitions

	baseline	PSMIV with different instrument definition		
		in 1939	in 1959	in 1989
Sample	(1)	(2)	(3)	(4)
All Soviet locations	-0.480***	-0.598**	-0.531***	-0.487***
	(0.128)	(0.299)	(0.122)	(0.126)
	10.64	3.370	16.37	11
Only founded before 1959	-0.468***		-0.590***	
	(0.119)		(0.170)	
	11.72		12.38	
Only founded 1939	-0.558***	-0.369***		
	(0.156)	(0.091)		
	11.33	22.02		

Robust standard errors in parentheses and F-statistics for week identification below standard errors
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Notes: The table reports estimates of β_{HHI} coefficient in equation (1) on a sample balanced by propensity score. The columns from (1) to (4) report IV estimates with different definitions of the instrument. Column (1) uses the maximal number of settlements that existed at the territory of a labor market during the entire USSR period. The columns (2) to (4) counts the number of settlements at the date of a particular Soviet Census.
The rows present estimation results for various subsamples of locations. The first row uses all Soviet-built urban places, i.e., all Russian cities and towns excluding existed before the USSR. The next rows restrict the sample to Soviet locations with at list one urban settlement founded there by the date of the 1939 or 1959 Censuses.

6 Conclusion and discussion

The history of Soviet industrial and urban development provides exogenous variation in local labor markets' concentration levels in modern Russia. In this study, I use this variation to estimate the causal effect of concentration on the wage level. And the results show that the decrease in concentration causes a tremendous increase in average wages. A labor market with one additional average employer has the wage level higher by 6.4%, compared to a mean labor market with a concentration level equivalent to five equal employers. If the employment share of every employer decreases by a factor of two, then the average wage increases by 27.5%.

The historical instrument is crucial for the identification because a simple OLS underestimates the actual magnitude of the effect. The correlation between concentration and labor productivity masks most of the wage-setting power that firms have within concentrated labor markets. The source of the increase in concentration is the growth of more productive firms, and that generates the correlation. Since I use the concentration variation independent of firms' productivity growth, I get the magnitude of a causal effect of concentration on wage level.

The baseline estimate of the elasticity of wage to labor market concentration is 0.35. To put this number into perspective, let us assume it is externally valid. Benmelech et al. (2018) measures the average HHI of the US local labor markets to increase from 0.698 in 1977-1981 to 0.756 in 2002-2009. The estimated elasticity implies that wages get lower by 3%-4% over the period because of the change in the HHI, keeping labor productivity constant.

The estimated effect is much larger than the literature usually assumes. Thus, it is important to discuss whether some peculiarities of the Russian labor markets make it bigger, and therefore, whether the results are externally valid. Some characteristics of the Russian labor markets explain high coefficients, at least partially. But none of them seems to be able to invalidate the main conclusion.

First, the Russian labor markets are smaller and more concentrated on average. It is especially true for the labor markets of the Soviet-based locations left in my sample. And the concentration-effect might be nonlinear in market size and concentration level, with smaller and more concentrated labor markets being more sensitive to concentration changes (Rinz, 2018; Jarosch et al., 2019). Thus, the estimates for an average Russian labor market cannot apply to the average US or European labor market, but it represents the most concentrated of them. Also, it still holds that the true magnitude of the concentration-effect for a mean labor market is higher than we can observe without exogenous variation in concentration.

Second, the labor supply elasticity might be lower for Russian local labor markets. That might be the case because of both high migration costs and institutional features. And the labor supply elasticity matters for the strength of the concentration effect. If a labor supply were perfectly elastic, then any firm would be a price-taker irrespectively of a concentration level. So if a typical labor supply elasticity is lower in Russia, the implied effect of concentration is higher than for other economies with the more mobile labor force.

One more feature of Russian labor markets is the lower importance of non-wage compensation. Qiu and Sojourner (2019) show that the concentration matters for the probability of an employer to provide health insurance to its workers. Given that the costs of employees' health insurance equal about 11% of wage and salary costs in the US, the elasticity of labor costs to concentration should be higher than just wage elasticity. But in Russia, non-wage benefits make up a smaller share of labor compensation Juurikkala and Lazareva (2012), so a larger part of the concentration's effect translates into the elasticity of wages.

However, all those factors do not cancel the fact that the observed correlation between wages and concentration shows only a small part of the actual concentration effect. In my case, only 15% of the wage response is visible, and 85% stays unobserved in the absence of an exogenous source of variation. So, we underestimate the wage-setting power of firms because contemporaneous productivity changes always mask the concentration effect.

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Table 7: Summary statistics of data

	All	Pre-Soviet	All Soviet	Soviet pre-1939	Soviet pre-1959
Count	1802	597	1205	881	1061
log(HHI)	-1.8	-2.0	-1.8	-1.9	-1.9
log(wage)	9.7	9.7	9.8	9.7	9.7
# Soviet urban settlements	4.6	3.8	5.0	5.9	5.4
log(labor amount)	8.4	8.9	8.1	8.4	8.3
log(capital intensity)	-2.8	-2.4	-3.0	-2.9	-2.9
log(revenue/employee)	0.4	0.5	0.4	0.3	0.4
Industrial share	17.9	16.0	18.8	18.7	18.4
Population	349.6	428.6	310.4	376.1	342.0
Central	19.2	27.1	15.3	20.3	16.9
Far_Eastern	8.7	4.0	11.0	5.9	9.4
North_Caucasian	5.7	4.7	6.2	7.8	7.1
Northwestern	10.2	7.9	11.4	6.6	11.4
Siberian	13.2	13.4	13.0	11.9	10.9
Southern	5.3	1.8	7.0	9.1	7.9
Ural	17.3	10.4	20.7	20.9	19.9
Volga	20.5	30.7	15.4	17.5	16.5
Mining	9.0	7.9	9.5	8.1	8.5
Manufacturing	54.1	51.3	55.4	58.0	56.6
Electricity & water	37.0	40.9	35.0	33.9	35.0

Notes: The table reports summary statistics for different samples, depending on foundation date of a location.

Table 8: Summary statistics of data

	All Soviet	1 settlement	≥ 2 settlements	≥ 5 settlements	≥ 10 settlements
Count	1205	266	939	418	135
log(HHI)	-1.8	-1.0	-2.0	-2.4	-3.3
log(wage)	9.8	9.8	9.7	9.8	10.1
# Soviet urban settlements	5.0	1.0	6.1	10.0	17.8
log(labor amount)	8.1	6.9	8.5	9.1	9.8
log(capital intensity)	-3.0	-3.6	-2.8	-2.6	-2.0
log(revenue/employee)	0.4	0.3	0.4	0.4	0.5
Industrial share	18.8	19.3	18.6	18.0	15.4
Population	310.4	60.3	381.3	605.3	1133.2
Central	15.3	6.4	17.8	28.7	68.9
Far_Eastern	11.0	25.9	6.7	3.6	0.0
North_Caucasian	6.2	3.0	7.1	8.9	0.7
Northwestern	11.4	9.4	11.9	7.4	0.0
Siberian	13.0	16.9	11.9	9.3	0.0
Southern	7.0	15.4	4.6	4.5	0.0
Ural	20.7	13.2	22.9	27.3	29.6
Volga	15.4	9.8	17.0	10.3	0.7
Mining	9.5	12.0	8.8	9.6	4.4
Manufacturing	55.4	48.9	57.3	55.0	54.1
Electricity & water	35.0	39.1	33.9	35.4	41.5

Notes: The table reports summary statistics for different samples used in the estimation.

Table 9: Summary statistics of data

	All Soviet	1 settlement	2-4 settlements	5-9 settlements	≥ 10 settlements
Count	1205	266	521	283	135
log(HHI)	-1.8	-1.0	-1.7	-2.0	-3.3
log(wage)	9.8	9.8	9.7	9.7	10.1
# Soviet urban settlements	5.0	1.0	3.0	6.3	17.8
log(labor amount)	8.1	6.9	8.0	8.8	9.8
log(capital intensity)	-3.0	-3.6	-2.9	-2.9	-2.0
log(revenue/employee)	0.4	0.3	0.3	0.4	0.5
Industrial share	18.8	19.3	19.1	19.3	15.4
Population	310.4	60.3	201.6	353.4	1133.2
Central	15.3	6.4	9.0	9.5	68.9
Far_Eastern	11.0	25.9	9.2	5.3	0.0
North_Caucasian	6.2	3.0	5.8	12.7	0.7
Northwestern	11.4	9.4	15.5	11.0	0.0
Siberian	13.0	16.9	14.0	13.8	0.0
Southern	7.0	15.4	4.6	6.7	0.0
Ural	20.7	13.2	19.4	26.1	29.6
Volga	15.4	9.8	22.5	14.8	0.7
Mining	9.5	12.0	8.3	12.0	4.4
Manufacturing	55.4	48.9	59.1	55.5	54.1
Electricity & water	35.0	39.1	32.6	32.5	41.5

Notes: The table reports summary statistics for different samples used in the estimation.

Table 10: Summary statistics by federal districts

	All Soviet	Central	Far_Eastern	North_Caucasian	Northwestern	Siberian	Southern	Ural	Volga
Count	1205	184	132	75	137	157	84	250	186
log(HHI)	-1.8	-2.8	-1.0	-1.7	-1.7	-1.5	-1.9	-1.6	-1.9
log(wage)	9.8	9.9	9.9	9.3	9.8	9.8	9.5	9.9	9.6
# Soviet urban settlements	5.0	11.5	2.1	4.5	3.0	3.5	2.7	5.7	3.5
log(labor amount)	8.1	8.8	6.6	8.0	7.7	7.9	8.2	8.3	8.8
log(capital intensity)	-3.0	-2.5	-4.3	-2.2	-3.2	-2.9	-2.9	-2.7	-2.9
log(revenue/employee)	0.4	0.4	0.0	0.3	0.4	0.5	0.3	0.4	0.4
Industrial share	18.8	18.4	18.1	25.1	18.3	16.5	13.3	20.1	20.0
Population	310.4	646.0	72.5	304.5	162.1	242.8	422.1	280.3	306.0
Mining	9.5	1.1	17.4	6.7	9.5	11.5	8.3	13.6	7.0
Manufacturing	55.4	58.2	43.9	58.7	45.3	56.7	61.9	49.6	71.0
Electricity & water	35.0	40.8	38.6	34.7	45.3	31.8	29.8	36.8	22.0

Notes: The table reports summary statistics for different samples used in the estimation.

Table 11: Summary statistics by industry

	All industries pooled	Mining	Manufacturing	Electricity & water
Count	1205	115	668	422
log(HHI)	-1.8	-1.0	-2.1	-1.5
log(wage)	9.8	10.1	9.6	9.9
# Soviet urban settlements	5.0	4.1	4.9	5.3
log(labor amount)	8.1	7.2	8.6	7.6
log(capital intensity)	-3.0	-3.6	-2.6	-3.4
log(revenue/employee)	0.4	0.8	0.4	0.1
Industrial share	18.8	21.4	18.9	17.8
Population	310.4	240.2	297.5	350.0
Central	15.3	1.7	16.0	17.8
Far_Eastern	11.0	20.0	8.7	12.1
North_Caucasian	6.2	4.3	6.6	6.2
Northwestern	11.4	11.3	9.3	14.7
Siberian	13.0	15.7	13.3	11.8
Southern	7.0	6.1	7.8	5.9
Ural	20.7	29.6	18.6	21.8
Volga	15.4	11.3	19.8	9.7

Notes: The table reports summary statistics for different industries.

Table 12: Summary statistics by years

	All years	2008	2009	2010	2011	2012	2013	2014	2015
Count	1205	7	116	169	203	193	185	176	156
log(HHI)	-1.8	-1.9	-1.6	-1.8	-1.7	-1.8	-1.6	-1.9	-1.9
log(wage)	9.8	9.7	9.7	9.7	9.7	9.8	9.7	9.9	9.8
# Soviet urban settlements	5.0	3.0	3.6	5.7	5.3	5.2	3.9	5.4	5.3
log(labor amount)	8.1	8.9	8.0	8.2	8.1	8.3	7.8	8.1	8.1
log(capital intensity)	-3.0	-2.6	-3.3	-3.1	-3.3	-2.7	-2.9	-2.6	-2.9
log(revenue/employee)	0.4	0.8	0.3	0.4	0.3	0.4	0.3	0.4	0.4
Industrial share	18.8	19.6	19.8	20.7	21.2	19.5	17.5	16.3	16.1
Population	310.4	190.5	250.7	349.3	292.4	336.6	239.7	353.1	345.0
Central	15.3	0.0	6.0	20.7	17.7	17.6	6.5	18.2	17.9
Far_Eastern	11.0	0.0	14.7	11.2	9.9	11.4	11.4	8.5	11.5
North_Caucasian	6.2	0.0	4.3	6.5	7.9	4.7	8.1	6.2	5.1
Northwestern	11.4	0.0	14.7	11.2	8.4	9.8	14.1	11.9	11.5
Siberian	13.0	0.0	12.9	10.1	10.8	11.4	15.1	17.0	14.7
Southern	7.0	0.0	14.7	7.7	6.4	8.3	5.9	4.0	4.5
Ural	20.7	0.0	18.1	17.2	23.2	23.3	23.2	19.9	19.2
Volga	15.4	100.0	14.7	15.4	15.8	13.5	15.7	14.2	15.4
Mining	9.5	0.0	9.5	11.2	10.8	9.8	13.5	6.8	4.5
Manufacturing	55.4	85.7	55.2	55.6	55.2	54.4	51.4	58.5	57.1
Electricity & water	35.0	14.3	35.3	33.1	34.0	35.8	35.1	34.7	38.5

Notes: The table reports summary statistics for different years.