Gulag, WWII and the long-run patterns of Soviet city growth

Tatiana Mikhailova*

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Preliminary and incomplete

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1 Introduction

This paper analyzes geographical patterns of city growth in the Soviet Union and Russian Federation in connection with Stalinist policies of 1930s-1950s and the events of WWII. I construct and use the unique dataset on location of GULAG camps and evacuation of industrial enterprizes during the WWII on the low level of geographical aggregation. I am able to match GULAG camps and evacuated enterprizes to closest urban settlements. To my knowledge, this is the first paper that looks at GULAG and wartime events in the context of regional population growth in the USSR.

The main finding is that presence of a GULAG labor camp nearby is a strong predictor of future population growth in Soviet cities. Cities where camps were located grow significantly faster than the average. WWII events (fighting on the front, evacuations) also affect local population growth, but their impact diminishes with time and disappears after 20-25 years. In contrast, GULAG camps have long-lasting (in some cases permanent) effect on city size.

I add to two strands of literature. First strand is literature on population geography and industrial location in the USSR and Russian Federation. A number of papers analyzed regional investment patterns and population growth in different periods of Soviet history. Hooson (1968) describes patterns of city growth prior to and after the October revolution. Harrison (1990) and Harrison (1988) looked at reallocation of Soviet industry to the east prior and during the WWII. Ideological principles of Soviet location policy and actual realization of them were discussed among others in Dienes (1972), Dyker (1983), Huzinec (1977), and Rodgers (1974).

Existing literature on Stalin's industrialization period, WWII, and Soviet location policies relies mostly on region-level data analysis. This paper works with city-level data, which allows me to investigate spatial patterns of development on a much finer scale. Indeed, city growth in USSR was highly heterogeneous even within the same

region. What is the contribution of the Soviet investment decisions and policies into this heterogeneity is an open question.

City-level analysis of Soviet population dynamics includes the work of Gang & Stuart (1999). They study the growth of cities in connection with migration restrictions in the USSR. They find little or no effect of these restrictions on population growth. I confirm their results for the bigger sample of cities and more recent data.

Several studies looked at spatial population dynamics in modern Russian Federation. Iyer (2003) looked at dynamics of city growth in Russia after transition and found increasing concentration of urban population – which I also confirm. Andrienko & Guriev (2004) and Kumo (2006) studied interregional migration flows in Russia after transition.

Second strand of literature deals with dynamics of population and industry in a series of historical "natural experiments". Davis & Weinstein (2002) and Davis & Weinstein (2008) investigate long-term dynamics of population and industry location after a shock of WWII destruction in Japan on city-level data. Brakman, Garretsen & Schramm (2004) and Bosker, Brakman, Garretsen & Schramm (2007) look at German cities after the WWII. Miguel & Roland (2011) look at Vietnam regions and investigate their recovery after the U.S. bombing campaign.

Looking at wartime and post-war data allows researchers to observe how population and industrial geography changes after a significant shock. Theoretical models of New Economic Geography since Krugman (1991) predict a possibility of multiple stable equilibria in spatial economy. Yet stability of equilibria imply that once an agglomeration is formed in one location, it is difficult to change the spatial pattern, even if an alternative location is equally (or more) suitable for concentrated economic activity. But large shocks to the spatial structure of the economy have potential to trigger a switch between equilibria.

One common finding is that wartime destruction has little or no effect on regional patterns of population growth, industrial geography, regional development in long run. Population levels tend to recover after 15-25 years. This is true for Japan, Vietnam. West Germany also exhibits reversion (though incomplete) to the pre-war levels. The robustness of this result suggests that multiplicity of equilibria is either purely theoretical notion that does not normally occur in reality, or that even drastic wartime shocks are not large enough for equilibrium switch.[1]

On the other hand, Redding, Sturm & Wolf (2007) finds the evidence of multiplicity of equilibria in industrial location, where a switch of equilibrium was triggered by the post-WWII division of Germany, but the reversal was not triggered by the reunification of Germany in 1990. Redding & Sturm (2008) find persistent long-term negative effects of Germany division for the West German cities near the newly established border with the Eastern Germany. Redding et al. (2007) point out that Germany division was a profound event, and that at the time it was perceived as permanent. Only such long-lasting shocks to the spatial structure of the economy were found to be cause of permanent changes to a spatial economy landscape. Soviet regional policy is another example of such significant impact that was planned as permanent.

The rest of the paper is organized as follows. Section 2 gives a historical account of Soviet population and industrial geography. Section 3 describes data. Section 4 gives the results. Section 5 concludes.

[1]Interestingly enough, East Germany does not exhibit mean reversion, presumably due to heavy influence of socialist planning after WWII. See Brakman et al. (2004) for more details.

2 History of spatial evolution of Soviet economy, Stalin's industrialzation and WWII

(To be written)

3 Data

Population

Population and basic demographic data come from population censuses in Russian Empire (1897), USSR (1926 - 1989), and Russian Federation (2002, 2010). In all the years the sample includes all population centers with city status. 2002 and 2010 cross-sections include all urban population centers (cities and urban-type settlements) and rural settlements of 15000 or more. Panel is unbalanced, sample size grows from 534 cities (*uezdnye goroda*) in 1897 to 2002 cities and sizable rural settlements in 2010. 34 small towns drop from the sample for 1926-1979. Data for the census years 1959 and 1939 are taken from Chauncy D. Harris (1970).

Small satellite cities within 20 km radius around Moscow, St. Petersburg, Ekaterinburg, Novosibirsk, and Nizhnii Novgorod were dropped from the sample as separate observations and added up to construct the population of the metropolitan areas.

GULAG camps

The main source of data for GULAG prisons and labor camps, is a publication by the *Memorial* society (Smirnov (1998)). It documents geographical location, gives estimates of the number of prisoners in different years and the type of production activity for every camp. There are 474 camps on the territory of the Soviet Union.

I use the geographical coordinates to match population centers inside Russian

Federation (cities, towns, villages, settlements) to GULAG camps inside a 20 km, 50 km and 100 km radius. For each population center I also calculate the distance to the closest GULAG camp. I also categorize the camps according to the verbal description of their specialization. Four main camp categories are construction, industrial production, mining (resource extraction), and agriculture and forestry (mainly logging operation). I split construction activities into construction of industrial establishments in primary sector, other industrial construction, construction of housing, and construction of infrastructure.

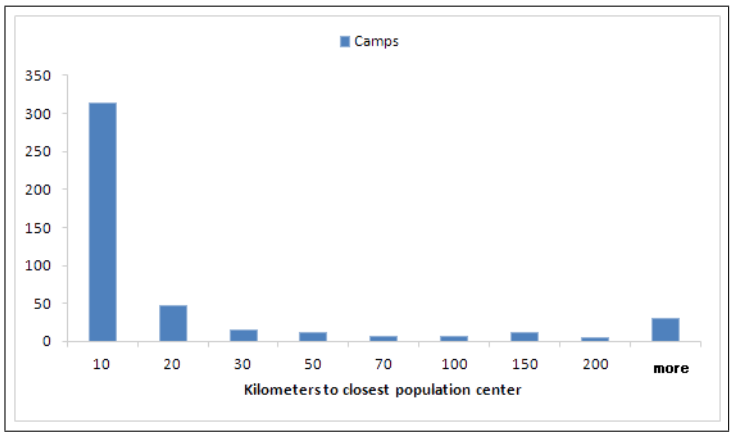


Figure 1: Number of GULAG labor camp sites by the distance to the nearest population center.

Figure 1 shows the distribution of camps with respect to the distance to the closest population center. The overwhelming majority of camps operated near populated areas, only few of them were located in remote territories. Camps were more often located near larger cities (Figure 2). But remote camps and camps near small settlements were bigger by capacity (number of prisoners) – see Figure 3.

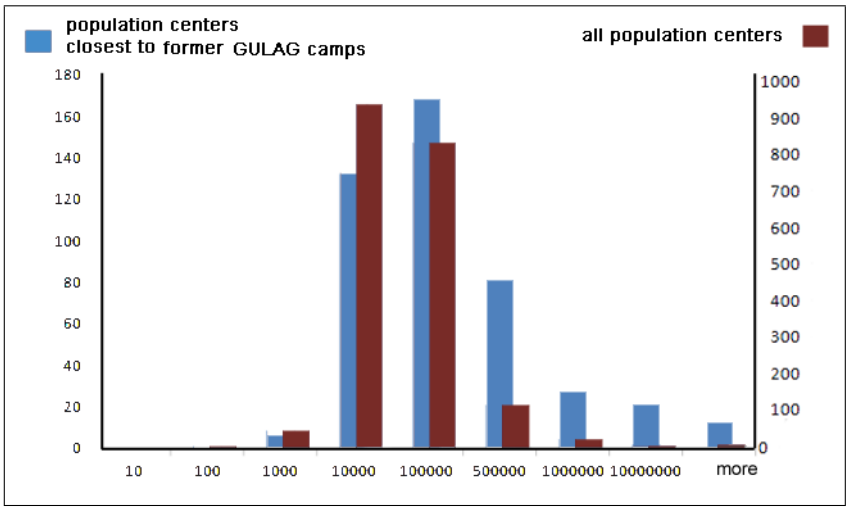


Figure 2: Size of population centers nearest to GULAG labor camp sites and all population centers in the sample.

WWII

WWII affected economic geography of the Soviet Union dramatically. Rough estimates point to as high as 20%-25% loss of population and up to 90% loss of productive capacity in Ukraine and Belarus. CITE Similar human losses could be presumed for the western parts of RSFSR that were also occupied by Nazi Germany. Unfortunately, detailed data on low level of geographical aggregation on any kind of war disruption in the USSR does not exist in public domain. It is not possible to infer human losses from census data, since first after-war population census took place in 1959, 14 years after the war. Neither data on destruction of infrastructure and capital nor information on restoration efforts by city or region were ever avaiable in public domain. Therefore, only limited number of indicators of WWII disruption could be constructed for the cities that suffered.

Another source of wartime differences in city growth was evacuation. Soviet gov-

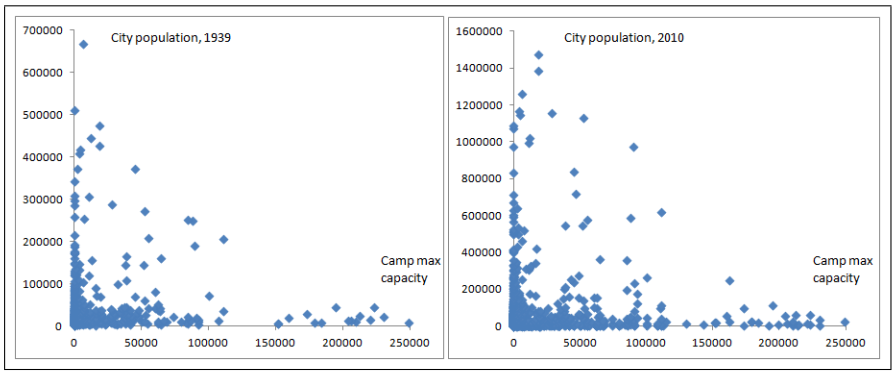


Figure 3: City size and total max capacity of GULAG camps in 50 km radius.

ernment[2] evacuated not only production lines from the western territories, but also people, priority given to the skilled industrial workers and engineers. A significant shift in regional industrial structure resulted. According to USSR Ministry of Defence. Institute of Military History (1985) 2593 enterprizes (1523 of them classified as "large") were moved to the Urals, Volga region, Central Asia, Kazakhstan and Siberia. Many of the evacuated plants either never moved back, or continued to operate at the both new and old cites after the war. This was a major shock to regional population shares with (possibly) long-lasting consequences.

Location of front lines

I construct three dummy variables on city location to single out population centers that suffered from the war. First is an indicator that a city was at some point in the WWII history occupied by the Germans. Second indicator includes all occupied cities and cities in the near vicinity of the front lines (30 km). This way, we include cities that might be never formally lost by the Soviet Army, but that could be severely

[2]Central Committee of the Union Communist Party (bolshevik) and the Soviet of People's Commissars of the USSR, "On the order of evacuation and relocation of the people and valuable resources", June 27, 1941.

damaged by the bombings and artillery fire. Third indicator includes all occupied cities and all cities inside 200 km from the front lines. This range should cover the majority of the massive bombing targets.

Evacuation of enterprizes

Source of data on evacuations is the "Factories, Research and Design Establishments of the Soviet Defence Industry" database maintained by the University of Warwick.[3] Practically all functioning enterprizes in the USSR produced defence-related products in 1941-1946, and therefore are included in the database. For each city I record the number of establishments evacuated in 1941-1942 from the city, establishments evacuated to the city, and establishments returned from evacuation in 1942-1948. Unfortunately, it is not possible to get a estimate on the size of evacuated enterprizes, since data on employment, capital, or production volume are not available. Thus, only enterprize count variables and indicator variables for each city are constructed.

Mobility restrictions in the USSR

Gang & Stuart (1999) studied the effect of migration restrictions on the growth of the Soviet cities. Following their classification, I construct dummy variables for two types of restrictions: total and expansion restrictions. Total restrictions supposedly presented a stronger barrier to the city growth, as they were meant to prohibit all in-migration except for the cases of family reunion. Expansion restrictions set targets for new labor from the outside of the city that can be attracted by resident enterprizes, and supposedly presented a weaker barrier for city growth. I break the cities under the total restrictions into two groups: those restricted since 1939 and since 1959.

[3]Online at http://www2.warwick.ac.uk/fac/soc/economics/staff/academic/harrison/vpk/.

4 Results

Data exploration: history of city growth

The first step is to explore the general trends in city growth geography in Russia from 1897 to 2002 by a series of linear growth regressions with the explanatory variables capturing geography and prior history of city development. Geographical controls are a quadratic form of latitude and longitude. I also include prior growth, prior size of cities and spatial lags of population. Administrative status of the settlement should also be a factor, however over such a long run and with many administrative changes and reforms during the history of the Soviet Union, it is likely endogenous to population growth. I include the status of *oblast* center only, since Soviet *oblast* centers used to be either province centers (*gubernskii gorod*) or a sizable city of economic significance even in Imperial Russia.

The estimates are presented in table 1. The estimated effect of geographical location is presented on Figures 9 and 10 in appendix A. Several robust empirical regularities are evident. During the first half of the century smaller cities had a growth advantage, while in the second half this effect disappeared. Spatial lags become significant in the late USSR: in 1979-89 isolated cities grew faster. The shape of latitude-longitude quadratic form replicates well-known historical waves of migration in Russia and USSR: spatial expansion to the east up until the mid XXth century, and the return migration to the south-western parts of the country that started in 1970s-1980s and intensified during the first years after transition. Interestingly enough, growth of cities is highly persistent, but only starting from 1939. In fact, city growth from 1926 to 1939 on is orthogonal to that of 1897-1926. This is an expected result, since heavy influence on spatial patterns of development by the Soviet planning system takes off precisely in the beginning of 1930s. Oblast center dummy is

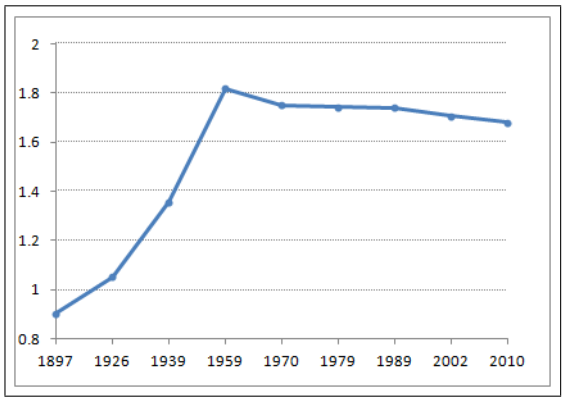
highly significant, which is consistent both with ongoing process of urbanization and concentration of population in large cities, and with the oblast centers being favored by the central planning system.

The spatial patterns of city growth evidently reverse in 1959. The period of 1939-1959 is characterized by faster growth of the middle-part of the country (Volga region, Urals and Western Siberia). From 1959 to 1979 we see quite the opposite: Far East and westernmost regions grow faster *ceteris paribus*. Apparently, the reversal of Stalinist policies began practically immediately, at least, as the data allows to observe, in 1960s.

Stalin's industrialization, WWII and GULAG

Figures 4 - 6 summarize the dynamics of population growth in three groups of cities that were affected by WWII and Stalinist policies relative to control group. Of course, 1)these graphs just show correlations - cities were specially chosen as homes for GULAG and evacuation recipients. Control group and treatment groups are different inherently. Second - these three simple variables do not describe the impact of the war and policies adequately enough. But we do not have more info.

It is clear from the graphs that dynamics of city growth has a clear structural break at 1959 - which is the first census after Stalin's death. There is difference in the dynamics of population geography in Stalin's time and after Stalin. Periods prior to WWII (1926-1939) and including wartime (1939-1959) look very similar - as if there is no structural break due to the war. Cities that received evacuation were growing faster than the average even prior to the war. Same is true for the cities that were not occupied. This illustrates the general eastward bias of Soviet industrialization in the 1930s. WWII just reinforced and accelerated the trends that existed prior to the war. The main driver of this eastward shift was military strategy: to move the industrial



Graph shows the ratio of population of average city that was occupied in WWII to the population of the average city that was not occupied.

Figure 4: Difference in city sizes by WWII occupation status.

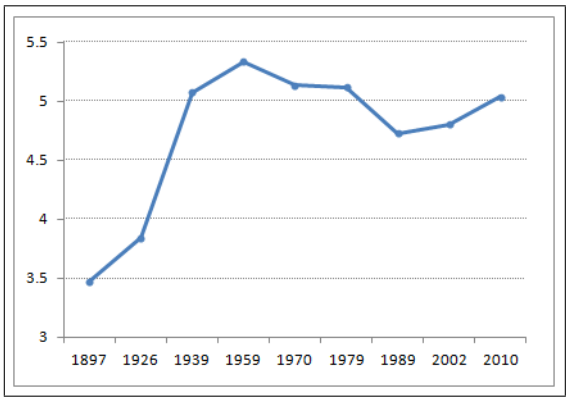
capacity away from the western borders, and to create a powerful industrial base in the Urals region. (See, for example, Harrison (1990).)

For the rest of the paper I try to control for heterogeneity in city characteristics. First - using individual effects in panel estimations. Second - with matching estimations.

Panel estimations

In this section I estimate a series of panel models on city growth data, employing a differences-in-differences methodology. I compare an average trajectory of city growth in treatment group (where treatment group is a subset of Russian cities that are affected by WWII, evacuation, or GULAG) with control group (other cities), controlling for the unobserved heterogeneity by individual effects. An empirical specification is:

$$g_{it} = \alpha_t + \beta Treatment + \sum_s \gamma_s (Treatment \times Period_s) + \epsilon_{it}, \qquad (1)$$

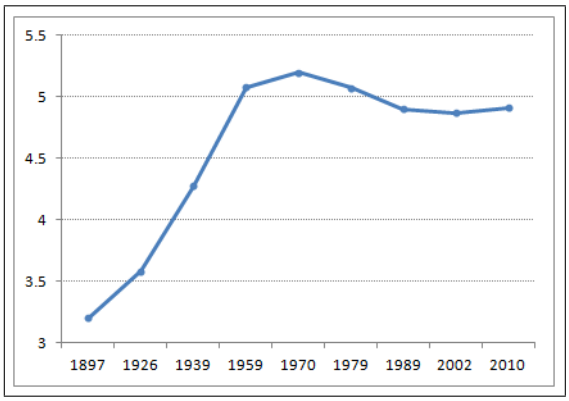


Graph shows the ratio of population of average city that had a GULAG camp in 20 km vicinity to the population of the average city that did not have a GULAG camp in 20 km.

Figure 5: Difference in city sizes with and without GULAG camps nearby.

where $g_{it} = \ln Pop_{it} - \ln Pop_{i,t-1}$; $Treatment$ - indicator whether city i was affected by GULAG, WWII fighting or evacuations; $Period_s$ - time periods indicator; α_t - period-specific intercept, ϵ_{it} - random error. Error structure may include individual (city-level) or regional (oblast-level) random effects. To trace the changes in city growth patterns I include the set of time-treatment interaction terms for all periods (with 1897-1926 as omitted benchmark).

Results are presented in tables 2 - 4. Table 2 summarizes the results for WWII occupation and being close to the front lines. As expected, time period that includes war years (1939-1959) admits a negative coefficient for treatment: cities that were affected by the war grow slower. From 1959 to the 1980s a slow recovery in the growth rates of the western cities is observed. But the biggest decline in the growth rate of the cities that would be later occupied by the Nazi Germany comes in the pre-war period of 1926-1939. It is not the war itself that is responsible for the divergence between the growth trajectories of eastern and western cities. The shift of population from the west to the east intensified in the late 1920s-1930s, during pre-war industrialization period.



Graph shows the ratio of population of average city that received evacuated plants to the population of the average city that were not occupied in WWII, but did not receive evacuated plants.

Figure 6: Difference in city sizes by evacuation status.

Table 3 shows the estimation results for the wartime evacuation of industrial enterprizes. For the cities that received evacuated factories (columns (1)-(4)) treatment variable has a positive and significant coefficient. But the time period that includes the war years (1939-1959) is not significantly different from the benchmark. Cities that received evacuated enterprizes were inherently attractive and grew faster than average. Yet on average, evacuation itself had little or no influence on their growth (column (1)).

In columns (2) and (3) he sample is split by city size. Large cities do not gain from evacuation. Medium cities grow faster in 1939-1959, and somewhat slower after that (but the difference is not statistically significant). Finally, in column (4) specification includes not just a binary evacuation indicator, but also a number of evacuated enterprizes per capita. Outliers with high number of plants per capita (10 % of all cities that received evacuation) were dropped from the sample. Number of plants does make a difference in city growth, cities that received more enterprizes grew faster in 1939-1959.

Column (5) traces the growth trajectory of the cities that sent plants into evacuation. Again, pre-war growth of such cities is higher than the average, while growth in 1940s-1950s is indistinguishable from the average. The interpretation is as follows. First, westernmost regions of the USSR were occupied in the first weeks after the beginning of German invasion, there was no time for evacuation of industry. Most of evacuated enterprizes came from the regions further to the east – and these areas were relatively more favored in the pre-war shift of industry in the 1930s. Second, most important enterprizes received investment prior to the war, and were the first to evacuate. Cities that hosted such enterprizes were growing faster before the war, and were restored as soon as possible after the war. On the contrary, cities where evacuated enterprizes did not return after the war, were not among fast-growing prior to the war, and lost population after the war (column (6)).

Finally, table 4 shows the panel estimations where treatment variable is whether there is a GULAG camp near the city. In sum, having a GULAG camp nearby increases city growth by much more than being spared in war or receiving evacuated plants. The implied trajectories of city growth are plotted on figure 7.

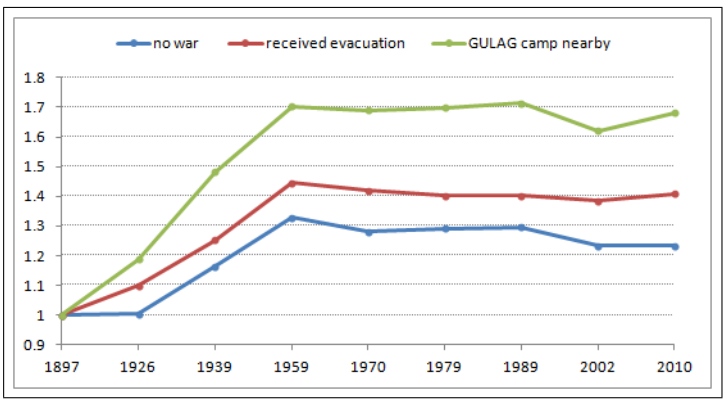


Figure 7: City size index, treatment group vs. control group, as implied by panel estimations with city effects.

Comparing the trajectories on figure 7 still does not allow to satisfactory dis-

tinguish and compare the effects of various factors. Both regional industrial policy priorities (as proxied for by GULAG) and exogenous factors (such as impact of the WWII) work at the same time and in similar directions: pushing people and economic activity in the USSR to the east. Given that the effects of all these policies could be long-lasting, it is possible that individual effects do not properly control for heterogeneity: cities that received evacuations may have GULAG camps as well. It is likely that decisions by the Soviet authorities on where to locate industry or invest in infrastructure drove both GULAG camp construction and evacuations, and these decisions correlated with the distance from the western border, and therefore, with being close to or behind the WWII front lines. I now turn to matching estimations that allow to control for these factors more specifically.

Matching estimations

In this section I employ matching technique to estimate treatment effects for all three groups of factors: location relative to WWII front, industry evacuation, and GULAG. For each treated city one or several matches from the control group are found. Matching cities have to be as similar as possible to the treated city, the similarity is defined over the set of chosen characteristics. Then, the differences between treatment group and matching control group are analyzed to estimate the the effect of treatment. Matching (as opposed to parametric regression analysis) allows a researcher to be agnostic about specific functional form of the relationship between city growth and these characteristics.

In all regressions, I match cities exactly on *oblast* center status. That is, *oblast* centers are compared with other *oblast* centers, and ordinary cities – with other ordinary cities. *Oblast* centers may be more attractive than an average city because of their administrative functions.

Cities are also matched on latitude, longitude, initial population level, and the rate of growth in preceding time period. That is, the algorithm looks for the closest matches in this four-dimensional space of matching characteristics (standardized by the sample variance), where metric is given by the euclidian distance (for details, see Abadie, Drukker, Herr & Imbens (2001)).

Finally, for each treatment cities are matched exactly on other treatments. For example, the growth of cities on the both sides of WWII front lines is compared for the same evacuation status (whether enterprizes were evacuated from the city or to the city) and controlling for having a GULAG camp nearby. Same way, cities that received evacuated plants are compared with cities also unaffected by WWII fighting, and with the same GULAG status (presence or absence of a camp in the vicinity).

Tables 5, 6, and 7 (column (1)) present the results. For the WWII treatments the effect is negative in 1939-1959 (as expected), but by 1970 the recovery is complete. There is no evidence that being occupied has any long-term effects on city growth beyond approximately 25 years after the war end. This is in line with the results by Davis & Weinstein (2002), who found similarly complete recovery from wartime destruction for the Japanese cities.

For evacuation status (table 6) positive effects are observed for the cities that received evacuation, but the effect is also short-lived. By 1970 there is no statistically significant difference. Cities, where industrial establishments did not after the war, grew slower than the average, but the difference is not statistically significant.

Positive and long-lasting effects for the cities that sent plants into evacuation (column (3)) are due to the differences in industrial policies toward the westernmost regions of the USSR vs central Russia. When I do not match by longitude, this effect disappears (column (4)). Westernmost regions were considered (since late 1920s) vulnerable in the case of war – indeed they were. So investment into these regions

was restricted practically through all the history of the Soviet Union. So, western cities did not have too many important industrial establishments, they were taken by the Nazis in the first months after the invasion, and there was limited means for rapid evacuation. On the other hand, cities in central Russia had more time to evacuate, were favored for important investments even prior to the war, and continued to grow faster after the war.

In contrast, presence of a GULAG camp has a long-lasting and positive impact on city growth (table 7, column (1)). The difference between treatment and control group becomes indistinguishable only in 1989! In columns (2)-(5) I estimate treatment effects for different types of GULAG camps. Camps that specialized in agriculture or forestry (most of these were logging operations, where prisoners worked) had the shortest impact. This is not surprising, since the main purpose of such camps was to provide slave labor in harsh climatic conditions. Prisoners were used to extract valuable resource (timber), not to create infrastructure for future settlement by "free" population.

Camps that were specialized in industrial production (either primary industries or other manufacturing) were in many ways creating this coveted "eastern industrial base" of the Soviet Union. It turns out, their impact lasted longer. In case of manufacturing (column (3)), data shows no reversal of population levels not only long after Stalin's death, but also 20 years after the break up of the Soviet Union! Camps where prisoners worked in construction also affected city growth up until the end of the USSR.

GULAG labor was used on a variety of construction projects. Table 8 presents estimated treatment effects for the different types of construction in GULAG. In consistency with table 7, construction of industrial objects and housing lead to permanent population increase. Construction of infrastructure (this includes major transporta-

tion projects: Baikal-Amur railroad, White sea - Baltic canal) lead to local population growth in short run, but in time this growth is reversed.

5 Conclusion

It is well understood that GULAG (as a tool of regional policy) brought significant changes to the spatial economy of the Soviet Union. It's impact was not only strong, but also long lasting. It worked on interregional and on intra-regional scale. GULAG was as a tool of reallocation of productive resources toward the remote regions of the Soviet East. Presence of a camp is a good indicator that a city was favored as a location of investment projects, controlling for the geographical location.

The effect of GULAG is much stronger than estimated effects of the WWII or wartime industry reallocation. WWII is an example of exogenous impact. Evacuation was designed by the Soviet authorities, but it was done under the pressure of Nazi invasion and, obviously, served the purpose of maximizing Soviet industrial potential in wartime. GULAG was a part of Soviet location policy, it served long-term goals. Redding et al. (2007) note that even if multiple equilibria in industrial location are potentially possible, to switch equilibria the shock to industrial location has to be strong and (even more important) agents should perceive the change as permanent. Soviet location policy is a perfect example of such a significant change.

GULAG camps were heterogeneous. Some of locations were oriented exclusively on resource extraction, were not planned as permanent settlements and quickly withered after Stalin's death. Others were used to build basic industrial and public infrastructure, supply labor for industrial facilities - a part of long-term regional planning strategies. Such locations continue to attract population even after GULAG system (and prison labor in general) stopped functioning as a source of slave labor.

The long-term effect was found for GULAG camps that specialized in industry, industrial construction, and construction of housing. What are the mechanisms behind this? Did Stalin's-era investments in capital and infrastructure make the cities attractive? Is there a difference between cities with GULAG camps, and cities without them in local industrial structure? In sectoral diversity? Industrial concentration? Is there a difference in human capital? We leave these questions for further research.

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A Additional figures and tables

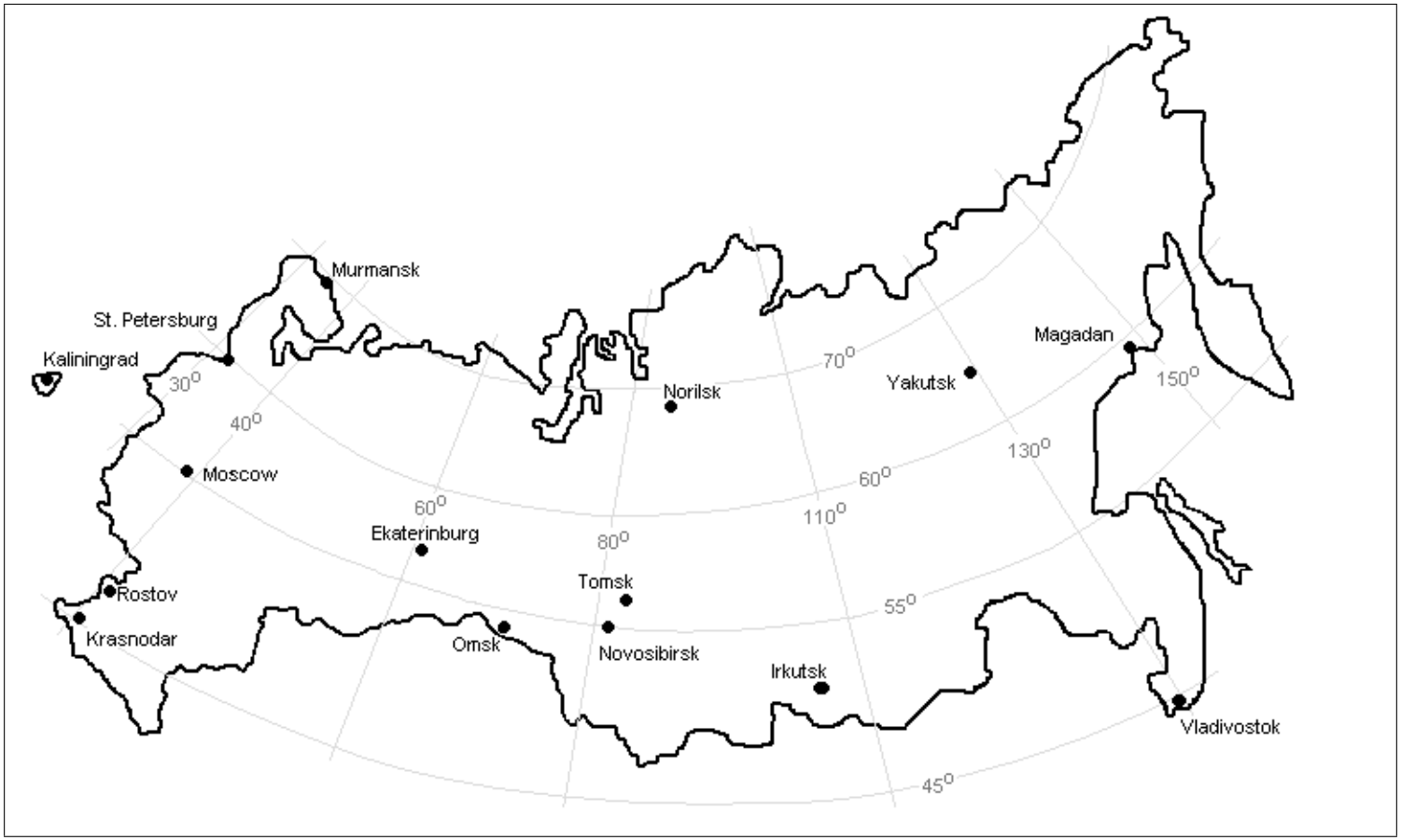

Figure 8: Several major cities in Russian Federation, geographical location.

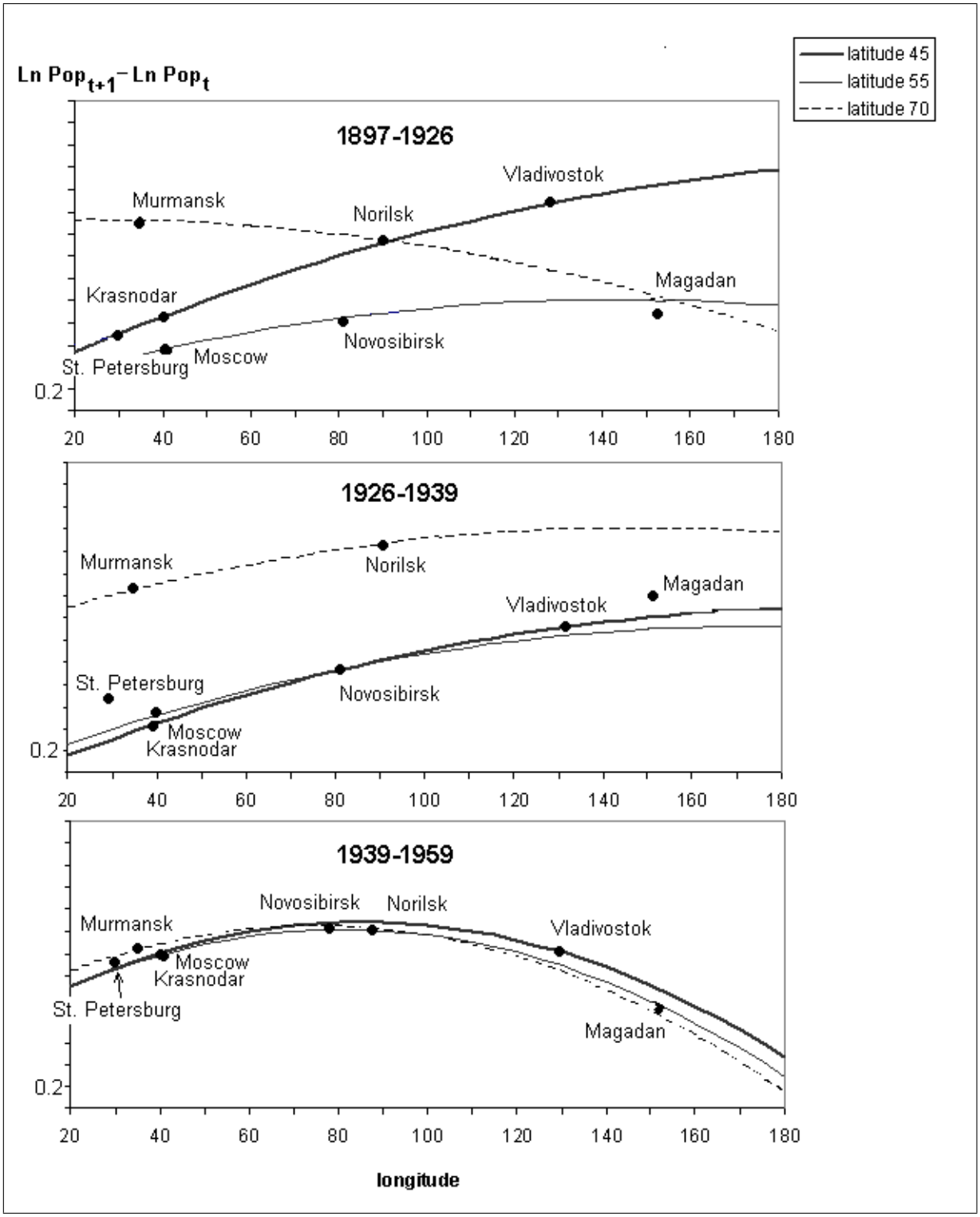

Figure 9: Urban population growth as a function of geographical location, 1897-1959.

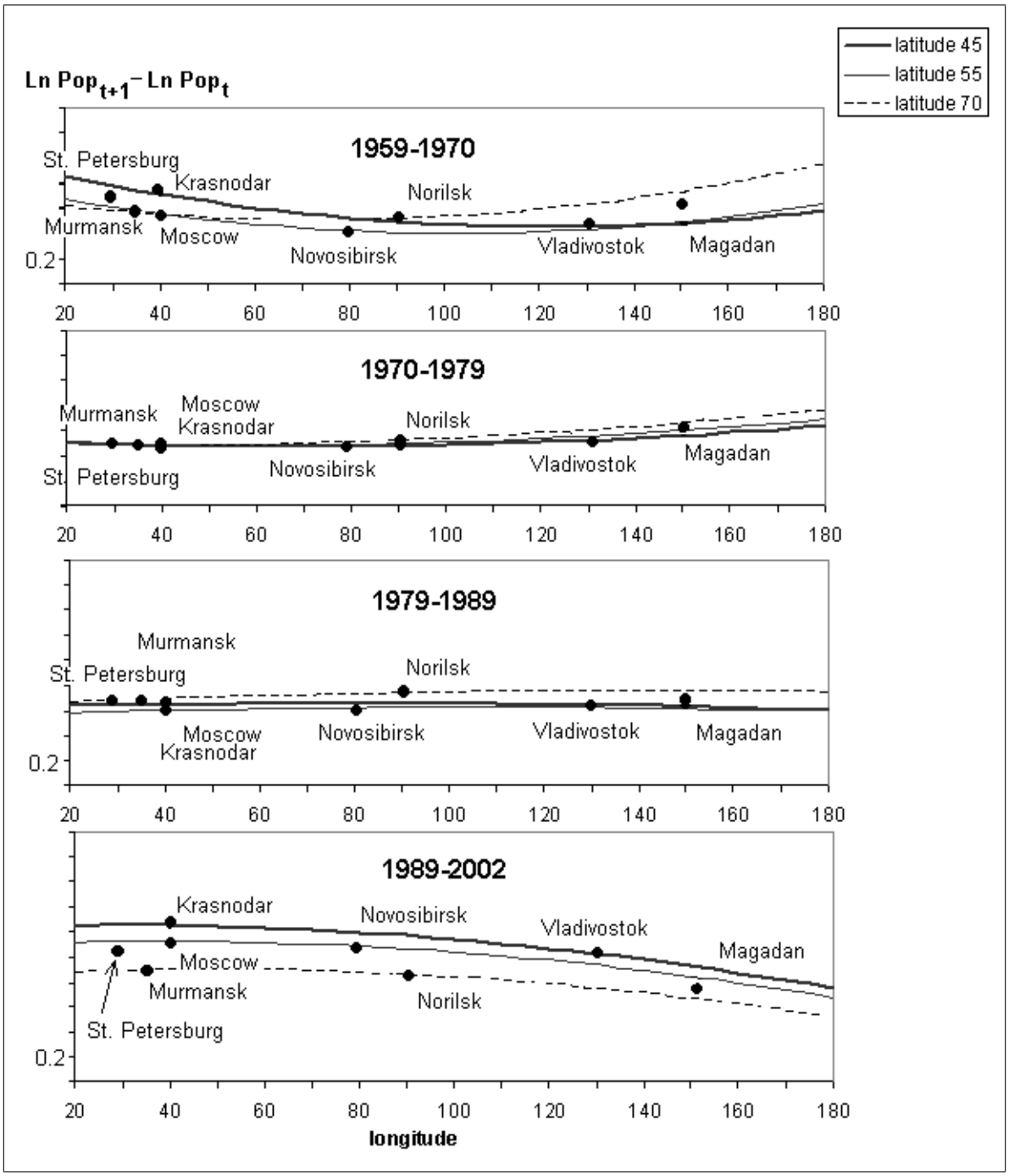

Figure 10: Urban population growth as a function of geographical location, 1959-2002.

Dependent variable is Ln(Population$_t$)-Ln(Population$_{t-1}$)

Date$_t$ - Date$_{t-1}$	1926 - 1897 (1)	1939 - 1926 (2)	1959 - 1939 (3)	1970 - 1959 (4)	1979 - 1970 (5)	1989 - 1979 (6)	2002 - 1989 (7)
Ln population$_{t-1}$	-.18	-.16	-.11	-.015	-.018	-.006	-.012
	(.064)	(.050)	(.035)	(0.11)	(.016)	(.007)	(.010)
Ln urban population$_{t-1}$ inside 20 km radius	.075	.031	.044	-.019	-.010	-.017	.010
	(.061)	(.047)	(.029)	(.01)	(.009)	(.006)	(.008)
Ln urban population$_{t-1}$ inside 100 km radius	.027	.060	.00	-.008	-.005	.002	.001
	(.019)	(.021)	(.011)	(.007)	(.008)	(.003)	(.004)
Growth$_{t-1}$		.097	.14	.089	.26	.32	.19
		(.070)	(.027)	(.023)	(.032)	(.028)	.027)
Oblast center dummy	.43	.50	.29	.25	.13	.07	.043
	(.068)	(.088)	(.051)	(.028)	(.031)	(.021)	(.021)
Geography controls	yes	yes	yes	yes	yes	yes	yes
N of obs	500	459	624	756	902	946	955
R^2	0.19	0.25	0.20	0.18	0.25	0.35	0.31

Robust SE in parentheses

Table 1: History of city growth in Russia and USSR, XXth century

Treatment	occupied in WWII			30 km to front	200 km to front
Indep. variable	(1)	(2)	(3)	(4)	(5)
Treatment	-0.017	-0.017	-0.070**	-0.105**	-0.080
	(0.018)	(0.029)	(0.020)	(0.046)	(0.050)
Treatment ×					
1926-1939	**-0.230****	**-0.230****		**-0.150****	**-0.226****
	(0.051)	(0.089)		(0.064)	(0.067)
1939-1959	-0.163**	-0.164**	-0.117**	-0.082	-0.168**
	(0.033)	(0.049)	(0.032)	(0.053)	(0.057)
1959-1970	0.111**	0.111**	0.158**	0.147**	0.120**
	(0.021)	(0.031)	(0.023)	(0.052)	(0.057)
1970-1979	0.047**	0.047*	0.094**	0.092*	0.056
	(0.018)	(0.027)	(0.021)	(0.048)	(0.053)
1979-1989	0.032*	0.033	0.080**	0.097**	0.058
	(0.017)	(0.026)	(0.019)	(0.047)	(0.051)
1989-2002	0.053**	0.053*	0.100**	0.150**	0.116**
	(0.017)	(0.027)	(0.021)	(0.046)	(0.051)
2002-2010	0.015	0.015	0.063**	0.101**	-0.077
	(0.016)	(0.026)	(0.018)	(0.045)	(0.050)
Year effects	yes	yes	yes	yes	yes
Years	1987-2010	1987-2010	1987-2010	1987-2010	1987-2010
Number of obs	5636	5636	5636	5636	5636
Errors clustered on	city	region	city	city	city
Number of clusters	763	87	763	763	763
R-sq overall	0.35	0.35	0.34	0.30	0.31

Robust SE in parentheses, ** - significant at 95% level, * - at 10% level

Table 2: The effect of WWII on city growth, panel estimations.

Treatment	plants evacuated to city				plants evacuated from city	plants did not return
Indep. variable	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	0.137**	0.163	0.014	0.122	0.126*	0.153**
	(0.051)	(0.114)	(0.059)	(0.081)	(0.068)	(0.078)
Treatment ×						
1926-1939	0.092	-0.002	0.134	0.143	0.189*	0.063
	(0.075)	(0.194)	(0.084)	(0.168)	(0.111)	(0.106)
1939-1959	0.070	0.121	0.133*	-0.129	-0.067	-0.191**
	(0.059)	(0.129)	(0.070)	(0.086)	(0.081)	(0.094)
1959-1970	-0.159**	-0.183*	-0.059	-0.152*	-0.095	-0.125
	(0.059)	(0.113)	(0.063)	(0.082)	(0.074)	(0.087)
1970-1979	-0.152**	-0.294**	-0.045	-0.159*	-0.116	-0.144*
	(0.052)	(0.143)	(0.061)	(0.085)	(0.070)	(0.081)
1979-1989	-0.137**	-0.177	-0.028	-0.146*	-0.143**	-0.151*
	(0.052)	(0.113)	(0.062)	(0.082)	(0.070)	(0.079)
1989-2002	-0.147**	-0.177	-0.050	-0.142*	-0.139*	-0.173**
	(0.051)	((0.117)	(0.061)	(0.083)	(0.071)	(0.086)
2002-2010	-0.121**	-0.177	-0.019	-0.099**	-0.088	-0.102
	(0.050)	(0.113)	(0.060)	(0.082)	(0.067)	(0.079)
Evacuated plants per 10000 people				-0.001		
				(0.081)		
Evacuated plants per 10000 people ×						
1926-1939				-0.104		
				(0.101)		
1939-1959				0.138**		
				(0.067)		
1959-1970				0.054		
				(0.062)		
1970-1979				0.032		
				(0.063)		
1979-1989				0.028		
				(0.063)		
1989-2002				0.025		
				(0.061)		
2002-2010				0.001		
				(0.064)		
Year effects	yes	yes	yes	yes	yes	yes
Years	1987-2010	1987-2010	1987-2010	1987-2010	1987-2010	1987-2010
Observations	all,	large, no war	medium, no war	no outliers, no war	all occupied	all occupied
Number of obs	5636	437	2394	3072	2433	2433
Errors clustered on	city	city	city	city	city	city
Number of clusters	763	83	388	417	328	328
R-sq overall	0.35	0.55	0.34	0.42	0.26	0.25

Robust SE in parentheses, ** - significant at 95% level, * - at 10% level

Table 3: Wartime evacuations and city growth, panel estimations.

Treatment Indep. variable	GULAG camp in 50 km (1)	GULAG camp in 20 km (2)
Treatment	0.154**	0.255**
	(0.051)	(0.064)
Treatment ×		
1926-1939	0.170**	0.145*
	(0.070)	(0.089)
1939-1959	0.031	-0.053
	(0.059)	(0.075)
1959-1970	-0.195**	-0.265**
	(0.052)	(0.065)
1970-1979	-0.148**	-0.250**
	(0.052)	(0.065)
1979-1989	-0.167**	-0.246**
	(0.051)	(0.064)
1989-2002	-0.204**	-0.308**
	(0.051)	(0.064)
2002-2010	-0.121**	-0.219**
	(0.050)	(0.063)
Year effects	yes	yes
Years	1987-2010	1987-2010
Number of obs	5636	5636
Errors clustered on	city	city
Number of clusters	763	763
R-sq overall	0.36	0.36

Robust SE in parentheses, ** - significant at 95% level, * - at 10% level

Table 4: GULAG camps and city growth, panel estimations.

Dependent variable is $LnPop_t - LnPop_{t-1}$

Treatment variable	(1) Occupied	(2) 30 km to front	(3) 200 km to front	# of obs
Time period				
1939-1959	-0.076**	-0.085**	-0.097**	624
	(0.029)	(0.034)	(0.030)	
1939-1970	-0.022	-0.013	-0.039	625
	(0.035)	(0.039)	(0.042)	
1939-1979	0.022	0.027	-0.030	625
	(0.041)	(0.043)	(0.051)	
1939-1989	0.010	0.008	-0.032	629
	(0.046)	(0.047)	(0.058)	
1939-2002	0.055	0.003	0.021	629
	(0.048)	(0.053)	(0.066)	
1939-2010	0.049	0.013	0.015	627
	(0.049)	(0.056)	(0.073)	
% of obs treated	32	43	59	
% of exact matches	84	86	85	
Matching variables	latitude, population 1939, growth 1926-1939,	latitude, population 1939, growth 1926-1939,	latitude, population 1939, growth 1926-1939,	
exact matching on	oblast center status, factory evacuation (to, from), GULAG in 50 km.	oblast center status, factory evacuation (to, from), GULAG in 50 km.	oblast center status, factory evacuation (to, from), GULAG in 50 km.	

Number of matches - 3, estimators are bias-adjusted for non-exact matching. Standard errors are heteroskedasticity- robust, ** denotes significance at 95% level, * - at 90% level.

Table 5: WWII and city growth, matching estimations.

Dependent variable is $LnPop_t - LnPop_{t-1}$

Treatment variable	(1) factories evacuated to	(2) factories evacuated to	(3) factories evacuated from	(4) factories evacuated from	(5) factories did not return	# of obs
Time period						
1939-1959	0.089**	0.083**	0.325**	-0.003	-0.050	624
	(0.037)	(0.037)	(0.041)	(0.064)	(0.071)	
1939-1970	0.060	0.060	0.275**	0.038	-0.034	625
	(0.041)	(0.040)	(0.058)	(0.086)	(0.076)	
1939-1979	0.038	0.044	0.237**	0.037	-0.055	625
	(0.047)	(0.045)	(0.069)	(0.095)	(0.088)	
1939-1989	0.059	0.060	0.382**	0.041	-0.015	629
	(0.058)	(0.056)	(0.083)	(0.114)	(0.107)	
1939-2002	0.043	0.045	0.288**	0.019	-0.053	629
	(0.070)	(0.068)	(0.078)	(0.111)	(0.102)	
1939-2010	0.028	0.030	0.232**	0.021	-0.060	627
	(0.062)	(0.060)	(0.087)	(0.101)	(0.097)	
% of obs treated	25	25	16	16	8	
% of exact matches	99	96	97	32	21	
Matching variables	latitude, longitude, population 1939, growth 1926-1939,	latitude, longitude, population 1939, growth 1926-1939,	latitude, longitude, population 1939, growth 1926-1939,	latitude, population 1939, growth 1926-1939,	latitude, population 1939, growth 1926-1939,	
exact matching on	oblast center status, war front in 200 km, GULAG in 50 km.	oblast center status, war front in 200 km, GULAG in 50 km, Urals, Siberia.	oblast center status, war front in 200 km, GULAG in 50 km.	oblast center status, war front in 200 km, GULAG in 50 km, longitude.	oblast center status, war front in 200 km, GULAG in 50 km, longitude.	

Number of matches - 3, estimators are bias-adjusted for non-exact matching. Standard errors are heteroskedasticity- robust, ** denotes significance at 95% level, * - at 90% level.

Table 6: Wartime factory evacuations and city growth, matching estimations.

Dependent variable is $LnPop_t - LnPop_{t-1}$

	GULAG camp in 50 km					
Treatment variable	(1) all camps	(2) resource extraction	(3) industry	(4) agriculture and forestry	(5) construction	# of obs
Time period						
1926-1939	0.160**	0.126*	0.223**	0.134**	0.097**	459
	(0.81)	(0.076)	(0.061)	(0.057)	(0.048)	
1939-1959	0.233**	0.218**	0.161**	0.060	0.090**	458
	(0.047)	(0.053)	(0.033)	(0.048)	(0.031)	
1926-1959	0.307**	0.323**	0.381**	0.190**	0.185**	458
	(0.080)	(0.094)	(0.074)	(0.085)	(0.062)	
1926-1970	0.394**	0.281**	0.382**	0.162*	0.202**	461
	(0.092)	(0.085)	(0.087)	(0.085)	(0.073)	
1926-1979	0.334**	0.323**	0.410**	0.196	0.227**	461
	(0.101)	(0.092)	(0.097)	(0.089)	(0.084)	
1926-1989	0.130	0.212	0.364**	-0.052	0.104	500
	(0.107)	(0.146)	(0.104)	(0.113)	(0.089)	
1926-2002	0.178	0.179	0.351**	-0.062	0.104	500
	(0.114)	(0.150)	(0.108)	(0.119)	(0.091)	
1926-2010	0.183	0.254	0.350**	0.053	0.205**	484
	(0.120)	(0.170)	(0.110)	(0.147)	(0.093)	
% of obs treated	46	18	24	13	34	
% of exact matches	88	91	95	93	97	
Matching variables	latitude, longitude population 1926, growth 1897-1926,	latitude, longitude population 1926, growth 1897-1926,	latitude, longitude population 1926, growth 1897-1926,	latitude, longitude population 1926, growth 1897-1926,	latitude, longitude population 1926, growth 1897-1926,	
exact matching on	oblast center status, factory evacuation (to, from), war front in 30 km	oblast center status, factory evacuation (to, from), war front in 30 km	oblast center status, factory evacuation (to, from), war front in 30 km	oblast center status, factory evacuation (to, from), war front in 30 km	oblast center status, factory evacuation (to, from), war front in 30 km	

Number of matches - 3, estimators are bias-adjusted for non-exact matching. Standard errors are heteroskedasticity- robust, ** denotes significance at 95% level, * - at 90% level.

Table 7: GULAG and city growth, matching estimations.

Dependent variable is $LnPop_t - LnPop_{t-1}$

	GULAG camp in 50 km				
Treatment variable	(1) industrial construction (primary)	(2) industrial construction (manufacturing)	(3) housing construction	(4) infrastructure construction	# of obs
Time period					
1926-1939	0.206**	0.097*	0.160**	0.105**	459
	(0.062)	(0.056)	(0.067)	(0.049)	
1939-1959	0.248**	0.141**	0.146**	0.082**	458
	(0.065)	(0.036)	(0.041)	(0.031)	
1926-1959	0.460**	0.236**	0.302**	0.184**	458
	(0.093)	(0.072)	(0.086)	(0.063)	
1926-1970	0.400**	0.224*	0.288**	0.210**	461
	(0.094)	(0.078)	(0.093)	(0.076)	
1926-1979	0.415**	0.250**	0.314**	0.241**	461
	(0.109)	(0.085)	(0.100)	(0.086)	
1926-1989	0.435**	0.120	0.332**	0.103	500
	(0.109)	(0.092)	(0.103)	(0.094)	
1926-2002	0.434**	0.120	0.333**	0.099	500
	(0.117)	(0.096)	(0.107)	(0.096)	
1926-2010	0.479**	0.212**	0.408**	0.195*	484
	(0.120)	(0.107)	(0.116)	(0.101)	
% of obs treated	11	17	21	31	
% of exact matches	91	95	94	97	
Matching variables	latitude, longitude population 1926, growth 1897-1926,	latitude, longitude population 1926, growth 1897-1926,	latitude, longitude population 1926, growth 1897-1926,	latitude, longitude population 1926, growth 1897-1926,	
exact matching on	oblast center status, factory evacuation (to, from), war front in 30 km	oblast center status, factory evacuation (to, from), war front in 30 km	oblast center status, factory evacuation (to, from), war front in 30 km	oblast center status, factory evacuation (to, from), war front in 30 km	

Number of matches - 3, estimators are bias-adjusted for non-exact matching. Standard errors are heteroskedasticity- robust, ** denotes significance at 95% level, * - at 90% level.

Table 8: Construction by GULAG prisoners and city growth, matching estimations.