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The drivers of regional
growth in Russia: A baseline
model with applications

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DRIVERS OF REGIONAL GROWTH IN RUSSIA: A BASELINE MODEL WITH APPLICATION

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By Olivier Durand-Lasserve and Hansjörg Blöchliger

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Abstract / Résumé**DRIVERS OF REGIONAL GROWTH IN RUSSIA: A BASELINE MODEL WITH APPLICATION**

Russia is a federation of more than 80 regions spanning across a huge territory. Natural resource endowment, inherited industrial specialization, remoteness and climate conditions contribute to large regional disparities. This paper presents an empirical framework model for assessing determinants of regional growth in Russia between 2004 and 2015 with an extension to include sub-national fiscal policies. Baseline results show convergence rates of regional GDP per capita in line with the 2% “iron law of convergence” between countries. Capital investment, and public investment in particular, is a stronger driver of regional growth than in most OECD countries. Natural-resource rich regions are growing faster, and oil price shocks have little economic impact in these regions, pointing at Russia’s centralized tax and transfer system. Subnational current government expenditure is associated with lower growth and slower regional convergence, suggesting low sub-national spending efficiency. There is also weak evidence that sub-national investment yields higher returns than federal government investment. Transfers have mixed effects depending on their nature. Budget equalization grants tend to slow regional growth as they reduce incentives to improve spending efficiency. On the other hand earmarked matching grants tend to spur growth and convergence as they direct resources towards more productive spending.

JEL Classification: H72, O47, P25, R12, R50

Key words: Regional convergence, empirical growth model, public investment, fiscal federalism.

Déterminants de la croissance régionale en Russie : modèle de base et applications

La Russie est une fédération de plus de 80 régions, qui s’étendent sur un immense territoire. Les richesses en ressources naturelles, les spécialisations industrielles préexistantes, l’isolement et les conditions climatiques, contribuent à de larges disparités régionales. Ce papier présente un cadre de modélisation empirique pour évaluer les déterminants de la croissance régionale en Russie entre 2004 et 2015, avec une extension qui inclue des politiques fiscales infra-nationales. Les résultats du modèle de base montrent un taux de convergence des PIB régionaux en ligne avec les 2% de la « loi de fer de la convergence » entre pays. L’investissement, en particulier l’investissement public, est un moteur de croissance plus important que dans la plupart des pays de l’OCDE. Les régions riches en ressources naturelles croissent plus vite et elle sont peu influencées par les chocs de prix du pétrole du fait du système centralisé d’impôt et de transferts. Les dépenses courantes des gouvernements infra-nationaux sont associées à une croissance plus faible et à une convergence plus lente, suggérant une efficacité faible des dépenses de ces gouvernements. Des indices suggèrent par ailleurs que les investissements des gouvernements régionaux sont plus efficaces que ceux du gouvernement fédéral. Les transferts ont des effets différents selon leur nature. Les subventions de péréquation budgétaire tendent à ralentir la croissance régionale en réduisant les incitations à améliorer l’efficacité des dépenses. Tandis que les subventions de contreparties affectées tendent à stimuler la croissance car elles dirigent les ressources vers des dépenses plus productives.

Classification JEL H27, O47, P25, R12, R50

Mots clés : convergence régionale, modèle empirique de croissance, investissement public, fédéralisme fiscal

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Drivers of regional growth in Russia: a baseline model with application

By Olivier Durand-Lasserve and Hansjörg Blöchliger¹

Introduction

1. Differences in regional GDP per capita and labour productivity are larger within Russia than in most OECD and non-member emerging economies. They are driven by geographical concentration of extractive industries, strong agglomeration economies, insufficient infrastructure and structural specialisation. Moreover, regional inequality goes along with high income inequality and large pockets of poverty, generating social and ethnic tensions. However, little is known about the extent to which Russian regions converge and, in particular, to what extent such convergence is driven by policies at the national and regional level. To understand which policies can help reduce regional income gaps without undermining growth, it is important to know the regional growth determinants.

2. This paper presents a growth model to analyse the main determinants of regional growth in Russia and is organised as follows. Section two surveys the state and evolution of regional disparities in Russia, with a special view on the geographical distribution of economic wealth. Section three applies a baseline empirical error-correction model to analyse the role of the key drivers of regional growth such as investment, education, various total factor productivity components and short-term shocks for the period 2004-15. Section four extends the basic model to include variables for regional fiscal policy and intergovernmental transfers. Section five concludes and proposes further extensions of the modelling framework.

3. The results can be summarised as follows:

- Russian regions converge at a rate of around 2%, in line with the “iron law of convergence” found in a majority of cross-country studies. Hence the conditional factors holding back convergence between Russian regions seem to be as considerable as if these regions were independent countries.

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- Regions with natural resources and large urban areas grow faster than other regions. Investment has a stronger effect on growth than in most other countries, suggesting a dearth of capital and technology in Russian regions. Education has become a more significant driver of growth between 2004 and 2015, suggesting a growing importance of skill-intensive industries in Russia. Sectoral specialisation is a drag on growth, except for the extractive industries.
 - Oil price fluctuations have little effect on oil producer regions, suggesting that Russia's tax and transfer system largely absorbs asymmetric commodity price shocks. However, financial crises affected disproportionately regions with a large financial sector.
 - A larger regional government sector is associated with lower growth and does not reduce differences in regional GDP per capita, suggesting that sub-national government resources are spent inefficiently.
 - The rate of return for *total* public investment (regional plus federal) is higher than for private investment, pointing at some public infrastructure needs.
 - There is weak evidence that investment financed by subnational government has a larger return than federal investment, suggesting that regional and local authorities may better target growth-enhancing opportunities. This also implies that rebalancing regional government expenditure towards less current and more capital spending would help accelerate growth.
 - Equalisation transfers from the federal government are associated with less growth. They seem to encourage inefficient spending and reduce subnational government's incentives to increase the tax base. Yet matching earmarked grants - called *subsidies* - are associated with higher growth, albeit weakly.
4. The results suggest that public investment into both physical and human capital rather than equalisation grants should be privileged as the key instrument to foster regional growth and convergence. Matching earmarked transfers can finance these investments while raising sub-national governments' incentives to develop their economies.

1. Level and evolution of regional disparities in Russia

1.1. Regional disparities are driven by differences in labour productivity

5. Economic disparities among Russia's regions are large. Russia ranks second in a sample of OECD and emerging market economies in terms of variation of regional GDP, close to Indonesia, Mexico or Chile and way above Canada or the United States (Figure 1.1)². Moreover, disparities in regional household income are similarly large, pointing at little inter-regional redistribution. The metropolitan areas of Moscow and Saint-Petersburg as well as some natural resource-rich regions in the North and East generate the highest incomes, while some European and South Russian as well as Southern Siberian regions belong to the country's poorest (Figure 1.2). A gap also persists between Moscow and the surrounding areas, while some iron and steel-focused regions of the South-West show relatively high per capita GDP.

Figure 1.1. Regional GDP and income disparities are large in Russia

Coefficients of variation of per capita region GDP real disposable income, 2012

Note: Calculation based on TL2 regions; coefficients of variation are weighted by population.

Source: OECD Regional Statistics database (OECD, 2017^[1]) and Rosstat (2018^[2]) and authors' calculations.

² Regional disparity indicators are a statistical artefact to some extent. They are measured as the population-weighted coefficient of variation of GDP per capita or household income, which is sensitive to the size and number of administrative units in a country. Russia has the largest number of "statistical regions" among the countries considered, exacerbating differences as measured by the coefficient of variation. Moreover, some Russian regions — in particular in the Arctic part of the country — have very small populations.

Figure 1.2. GDP per capita is higher in metropolitan areas and resource-rich regions

Per capita GDP and per capita value added of the extraction sector, 2015

Figure 1.3. Differences in labour productivity are driving disparities

Note: Calculation based on TL2 regions; coefficients of variation are weighted by population. Labour productivity is regional GDP per worker; employment rate is employment as percent of labour force (15-year-old and over); activity rate is the labour force as percent of total population.

Source: OECD Regional Statistics database (OECD, 2017^[1]), Rosstat (2018^[2]) and authors' calculations

7. The productivity gap between the two leading and the remaining urban areas is particularly striking (Figure 1.4). Productivity in Moscow is 75% and in Saint Petersburg 30% above the country average, while all other urban areas are below, with Ekaterinburg being the only exception, and some areas lagging far behind (IUE, 2017^[5]). Overall, productivity appears to be concentrated in a few large metropolitan areas, suggesting strong agglomeration economies and/or weak knowledge transmission among urban areas, while rent-seeking could also inflate GDP values. Congestion, upward wage pressure, rising real estate prices and other centrifugal forces seem not yet strong enough to drive activities out of Moscow and St. Petersburg and to neighbouring regions or other urban areas, as happens in other countries (Henkel, Seidel and Südekum, 2018^[6]).

8. The geography of natural resources is another key for explaining the productivity and per capita GDP divide. Extraction, which accounts for around 10% of Russia's GDP³ and around 75% of exports⁴ in 2015, is concentrated in remote regions with low population density, insufficient infrastructure and a generally hostile climate. Seven regions, making up less than 3% of the Russian population, produce 75% of oil and 90% of natural gas as well as most precious minerals (Rosstat, 2008^[7]). Employment and activity in these regions are above the Russian average. The productivity of jobs, wages, GDP and income per capita are higher than in the large urban areas, although measuring GDP in this type of region is fraught with difficulties (Box 2.1).

³ See : www.gks.ru/free_doc/new_site/vvp/vvp-god/tab10.htm

⁴ See: www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/fttrade/#

Figure 1.4. Productivity differs widely across urban areas and along the urban-rural divide

Note: 1 For OECD countries, OECD statistics for functional urban areas are used. For Russian metropolitan areas, by lack of OECD data, we use data from the Institute of Urban Economics (IUE, 2017^[5]) which are only available for urban areas of 900 000 inhabitants or more. 2. 2012 for France, Germany, Italy, Japan, Poland, Spain; 2015 for Russia. Rural regions are those where more than 40% of the population is rural, according to the urban-rural definition of Rosstat. Extraction regions are those where extraction contributed more than 30% to regional GDP on average between 2006 and 2015. Regions of energy extraction are those where fossil fuels represented more than 50% of total extraction.

Source: data on OECD countries are taken from OECD (2017^[8]), and Gal and Egeland (2018^[9]), productivity in Russian urban areas is calculated based on the GDP of urban areas estimated by IUE (2017^[5]).

Figure 1.5. Extraction is highly productive but concentrated in sparsely populated areas

Note: See notes of figure 2.4. Regions “with metropole” are those whose largest city has more than 1 million inhabitants within its administrative territory. Hence we not refer here to the notion of functional urban area.

Source: Rosstat (2018^[2]) and authors’ calculations.

9. Finally, the urban-rural divide might also explain interregional productivity disparities. The productivity of rural regions is 40% lower than the country’s average,

partly due to low productivity in agriculture⁵. (Figure 1.5, Panel B). The rural picture is more diverse, however. In some agricultural regions, particularly in the South-West of Russia, good soil, and closeness to consumer markets allow for high productivity and per capita regional GDPs are closer to the national average. Others, particularly in Southern Siberia, have few competitive advantages both in agriculture and industry. They lack the infrastructure to gain access to Russia's European part, while trade barriers limit the potential to export to Asian neighbours.

1.2. The drivers of productivity: a simple cross-sectional analysis

10. As shown above, economic geography plays an important role in explaining regional GDP patterns in Russia. Yet leaving it there would be too fatalist. Factors such as education, infrastructure, innovation, the institutional environment or the integration into global value chains may also affect regional GDP, and these factors are amenable to policy. To better understand the influence of policy, we link regional GDP levels to physical and human capital as well as to a set of variables influencing multi-factor productivity in two simple cross-sectional regressions, one for 2005 and the other for 2015.

11. The results suggest that policy can explain differences in economic activity in Russia, at least partly (Table 1.1). Both physical and human capital are positively associated with productivity. The results suggest a value share of physical capital close to 50%, which is higher than the 30 to 40% in most OECD countries but in line with other studies for Russia (International Labour Organization, 2015_[10]). This high value share suggests that investment is particularly important for lifting regional GDP. Education plays a significant positive role in 2015 but not in 2005, suggesting that diversification of the Russian economy towards skill-based manufacturing and services has increased the marginal productivity of human capital over the last ten to fifteen years.

⁵ A rural region is where more than 40% of the total regional population lives in a rural area (as defined by Rosstat).

Table 1.1. Education, innovation, FDI and access to credit contribute to higher GDPDependent variable: logarithm of nominal regional GDP per worker ($\log(YN/EMPL)$) - 2005 and 2015

	Year = 2015			Year =2005	
<u>Physical and Human capital</u>					
Log(K/EMPL)	0.710*** (0.046)	0.540*** (0.062)	0.545*** (0.060)	0.539*** (0.062)	0.543*** (0.086)
Log(EDUC)	0.561 (0.338)	0.608* (0.305)	0.498* (0.292)	0.641** (0.307)	0.498 (0.436)
<u>TFP components</u>					
Agriculture (share of GDP) ²		0.154 (0.425)	0.409 (0.411)	0.054 (0.440)	-2.876*** (0.630)
Extraction (share of GDP) ²		1.008*** (0.231)	0.940*** (0.218)	0.952*** (0.239)	0.812*** (0.281)
Manufacturing (share of GDP) ²		0.652*** (0.233)	0.347 (0.249)	0.555** (0.256)	0.291 (0.277)
Credit to GDP ratio (Credit/Y) ²		0.032*** (0.009)	0.024** (0.009)	0.031*** (0.009)	0.025** (0.012)
FDI to GRP ratio ²			0.676** (0.335)		
Innovation Index			0.565** (0.221)		
Log(Criminal risk)				-0.025 (0.024)	
Constant	-2.515 (2.122)	-1.823 (1.983)	-1.299 (1.878)	-1.885 (1.983)	-1.369 (2.956)
Observations	77	77	77	77	77
R2	0.832	0.879	0.896	0.880	0.835
Adjusted R2	0.828	0.868	0.884	0.868	0.821

Note: *p<0.1; **p<0.05; ***p<0.01. The cities of Moscow and Saint-Petersburg are excluded from the sample. For descriptions of *EDUC*, credit to regional GDP ratio and FDI to GDP ratio, see Table 2.1. 2: For these variables coefficient corresponds to a % increase of GDP per worker associated with the ration increase by one percentage point. For instance, a 1 percentage point increase of the regional FDI to GDP ratio – from, say 10 to 11% – is associated with a 0.68% increase of the level of per worker GDP. *Source*: Authors' calculations. GDP, capital stock, education, sectoral value added, credit and FDI are drawn from Rosstat (2018_[2]). The innovation index is the index of innovation development calculated by AIRR (2017_[11]) which is based mostly on 2015 data. The criminal risk index is a ranking published by the Magazine Ekspert (2017_[12]), it corresponds to year 2016.

12. Foreign direct investment, innovation and access to finance are positively associated with productivity. FDI is an indicator for regional integration into global value chains (GVA), technology diffusion and productivity improvements⁶. Innovative activities in the regions, as measured by the innovation index of the Association of Innovative Regions of Russia (AIRR, 2017_[11]), have also a significant and positive impact on regional GDP. Access to finance improves the allocation of capital to the most productive sector. There are no regional indicators reflecting institutional quality, the business climate or

⁶ Other GVA indicators, in particular the regional trade turnover to GDP ratio would have been more relevant, but regional trade data are not reliable.

regional governance. The only governance indicator available at the regional level is the criminal risk, which is however not significant. Since the relationship between GDP, innovation and FDI may be subject to endogeneity, results have to be interpreted with care.

13. Differences *within* industrial sectors play a larger role for regional GDP differences than differences *between* sectors (Figure 1.6). In other words, in productive regions, *all* sectors are more productive, while the industrial composition has little impact on productivity except for resource-rich regions. As such, productivity is bound by regional characteristics rather than by sectors, suggesting insufficient inter-regional capital and labour mobility. The poor diffusion of productivity gains across regional borders reduces the potential for convergence. As such, policies to improve diffusion from high to low productivity regions like education and infrastructure would probably better contribute to fostering regional convergence than sector-specific policies.

Figure 1.6. Specialisation contributes little to regional productivity

Decomposition of labour productivity into between and within-sector effects¹, (Russia average = 1), 2015

Note: 1. The between-sector effect is the productivity that would pertain if regional sectoral productivities were equal to the national sectoral average. The within-sector effect is the productivity that would pertain if the sectoral structure was the same in all regions. The sectoral breakdown used for the calculations are: agriculture, extraction, manufacturing, construction, utilities, trade, hotels and restaurants, transport, housing services, education, health, communal services and “other”.

Source: Rosstat (2018^[2]), authors’ calculations.

Box 1.1. Measuring regional productivity and price levels in Russia

The Russian Federal Statistics service (Rosstat) publishes regional GDP, employment and various other data for the *subjects* of the Russian federation. The subjects are administrative units, for which the term “region” is used in this paper. They are relatively small - average population of 1.7 million - compared with the European Union nomenclature of statistical territorial units (NUTS2). Rosstat defines regional GDP as the sum of value added, an approach consistent with the OECD regional data base, making productivity comparison straightforward. A recent publication (IUE, 2017^[5]) assesses the productivity of the 15 largest Russian agglomerations, but these units neither correspond to the subjects nor to functional urban areas as defined by the OECD (2017), making international comparisons awkward.

Measuring regional GDP for regions with very low population or population density is also challenging as regional prices may vary considerably. Low density is usually associated with higher prices because of diseconomies of scale and scope and higher infrastructure costs. Moreover, in regions with low density GDP evaluation is influenced by methodological choices to assess the value added of the government sector, for instance a more costly provision of public services. Difference of regional price levels may hence artificially exacerbate differences in regional productivity.

However, using the regional vital minimum income – the relative price of a basic basket of goods and services published by Rosstat – to adjust for inter-spatial price differences has little or no effect on the large regional GDP disparities (Figure 2.7). For this reason, and for simplicity, we will henceforth use regional GDP without price correction, except when controlling for the cost of providing public services and of the needs of regional governments in part 4.

Figure 1.7. Adjusting for regional prices has little influence on per capita regional GDP distribution

Note: Each pair of point is a region. The average price level for Russia is equal to 1

Source: Gal and Egeland (2018^[9]), Rosstat (2018^[2]), OECD (2017^[8]), IUE (2017^[5])

1.3. Regions are converging

14. In Russia, as in the majority of emerging market economies, GDP growth between 2004 and 2012 was associated with a reduction in regional inequality (Figure 1.8). Regional convergence was faster in Russia than in all other countries except China, although a major reason for the considerable reduction in regional disparities in Russia was their high initial level. In a global perspective, the relationship between growth and regional disparity reduction is rather weak.

Figure 1.8. In emerging economies, GDP growth helped reduce regional inequality

Source: (OECD, 2017^[1]), Rosstat (2018^[2]) and authors' calculations.

15. Regional disparities in Russia have been declining since the 1998 crisis (Figure 1.9) suggesting sigma convergence (Box 1.2). Convergence continued through 2009, when the lead of Moscow and other large cities melted in the wake of the financial crisis. In the following years, anti-crisis measures of the federal government, especially a surge of fiscal transfers from resource-rich regions to the rest of the country, further helped reduce regional inequality. Convergence was fast: by some measures regional inequality more than halved since the turn of the millennium. The activity rate, employment rate and labour productivity also converged as labour and capital mobility strengthened (Figure A C.1). However, as many convergence-fostering measures were abandoned after 2014 when the country entered again into recession, convergence slowed down. The annex provides a detailed analysis of regional growth over the successive boom and recession episodes between 2004 and 2015 (Table A2).

Figure 1.9. Russian regions are converging

Note: Coefficients of variation are weighted for the regional population

Source: Rosstat (2018_[2]) and authors' calculation

16. Convergence is faster within groups of regions with similar characteristics; for instance regions with a large city, or resource-rich regions (Figure 1.10). Differing convergence between groups of regions suggests that they are in a process of conditional beta convergence: they converge, but to their own long-term GDP potential which depends on their characteristics (Box 1.1). The speed of convergence tends to decrease when a region gets closer to the frontier. As such, rural regions, which tend to have a lower initial GDP per capita, tend to grow faster. Moreover, some resource-rich regions, whose extraction sector developed only in the 2000s, grew very fast over the past ten years.

Figure 1.10. Per capita regional GDP convergence is faster within each region group

Note: See notes of Figure 1.4 and Figure 1.5 for the definition of the region groups. The GDP per capita are normalized to 1 which is the national average, hence a value above (below) zero on the horizontal axis means the GDP per capita is above (below) the national average. The vertical axis represents the difference between average growth rate in the region and the national average growth rate between 2000 and 2015.

Source: Rosstat (2018_[2]) and authors' calculation

Box 1.2. Measuring regional convergence

Measuring regional convergence is less straightforward than it seems. There are several definitions of “convergence”, and no single measure can capture all aspects of GDP and income evolution over time. The most commonly used convergence measures are *Beta-convergence* and *Sigma-convergence*.

Beta-convergence. Beta-convergence refers to the relationship between initial GDP levels and growth rates of a set of regions as shown by the “beta-coefficient”. Beta-convergence describes a process where poor regions grow faster than rich ones and are therefore catching up. Beta-convergence is measured by estimating a growth function of the following form:

$$\Delta \ln(y_{it}) = \alpha + \beta \ln(y_{i,t-1}) + \gamma Z_{it} + u_{it}$$

where y_{it} are respectively the level and the growth rate of GDP per head in region i at time t ; Z_{it} includes all other factors affecting the growth rate; and u_{it} is the error term. Regions are converging if the beta coefficient is significant and negative. Convergence is unconditional if all other variables are insignificant, which means that income across jurisdictions converges towards the same level. It is conditional otherwise and income differences will prevail in the long term, as expected by the neoclassical growth model (Barro and Sala-i-Martin, 1990^[13]). Conditional beta convergence also means that regions with similar characteristics tend to converge among each other but that GDP growth rates and levels differ across groups of similar regions, as shown in Figure 2.10.

Sigma convergence. Sigma-convergence refers to a reduction of disparities – or differences in GDP per capita – among regions over time. The most common measure for assessing sigma convergence is the coefficient of variation or the Gini coefficient, *i.e.* the standard deviation of regional GDP per capita divided by the national GDP per capita, and is estimated in the following way:

$$COV_{i,t} = \alpha + \beta Z_{i,t} + u_{i,t}$$

where COV is the coefficient of variation of regional GDP per capita, and Z_{it} includes the same factors as those affecting regional growth above. Disparities are decreasing if δ is negative, positive otherwise. Beta-convergence is necessary but not sufficient for sigma-convergence since regions may converge over time but still remain apart because of asymmetric shocks, or one region may actually grow so fast that it overtakes other regions, thereby increasing disparity. Sigma-convergence is more intuitive since it measures directly how equal or unequal jurisdictions become over time, rather than measuring the growth process.

Both measures are useful for measuring convergence of Russian regions. Sigma convergence portrays in a nutshell the evolution of regional disparities over time. Conditional beta-convergence allows assessing the role of region-specific characteristics in the convergence process as predicted by the neoclassical growth theory. This is important as Russian regions are very heterogeneous in terms of resource wealth, climate, population, initial development, specialisation and many others.

Source: Blöchliger *et al.* (2016^[14])

2. A baseline model for assessing regional convergence in Russia

2.1. A short literature review

17. The majority of studies assessing regional convergence in Russia focus on geographical factors, on the location of extraction activities and the weight of Moscow. These studies produced several interesting but often contradictory results, depending on the methods and the time horizon⁷. Benini and Czyzewski (2007^[15]) show GDP per capita divergence over the period 1990-2004. They use cross-sectional regressions to identify three major drivers: the positive agglomeration effect in Moscow, the concentration of wealth in resource-rich regions, and the decline of Siberia and the Far East caused by population outflows. Kholodilin et al (2012^[16]) find convergence of regional GDP per capita well below 1% between 1998 and 2006⁸. They point at increasing spatial polarisation where spatial clusters of wealthy regions converge at around 3%. Lehmann and Silvagni (2013^[17]) use panel data and non-parametric methods, concluding that there is no GDP or income per capita convergence over the period 1995-2010. Akhmedjonov et al (2013^[18]) use unit root tests and find divergence for Russian regional GDP per capita between 2000 and 2008. Di Bella *et al.* (2017^[19]) use unit root tests and find no convergence of real per capita income even within Russian Federal Districts except for the Far East. Ledyeva and Linden (2008^[20]) use panel data analysis and find conditional convergence for the period 1996-2005, stressing the contribution of investment and exports to growth. Akhmedjonov et al (2013^[18]), also with panel data, finds conditional beta convergence. However, aside from the stock of physical capital, they find no variable that influences regional growth.

18. Other studies are dedicated to traditional drivers of regional convergence such as interregional migration, investment and foreign direct investment (FDI). Guriev and Vakulenko (2015^[21]) use panel data and non-parametric techniques to show that by the mid-2005 labour mobility started to contribute to reducing interregional unemployment, wage and poverty gaps. Before that period, poverty traps persisted as people from poor regions could not afford moving to wealthier regions. Weakly developed housing markets and, to less extent, administrative restrictions seem to hamper labour mobility (White, 2007^[22]). Ledyeva (2009^[23]) uses spatial-autoregressive panel regressions to show that the presence of big cities and ports, and the proximity to European markets contributed to attract FDI. The paper also shows that the effects of FDI spill over to neighbouring regions. Iwasaki and Sukanuma (2014^[24]) stress the role of FDI in improving regional R&D potential after 2003, creating growth-enhancing synergies.

19. Some papers highlight the role of structural or macroeconomic policies, although without much empirical evidence. Goliashev and Grigoriev (2014^[25]) assert that the economic crisis of 2009 and the years of low growth helped reduce regional GDP disparities, because the financial and economic centres were affected disproportionately.

⁷ Only recent studies on convergence are quoted here. For a more complete overview, the reader may refer to Glushenko (2012^[61]) and to the appendix of Guriev and Vakulenko (2012^[26]) with an exhaustive list of publications on convergence.

⁸ Studies on beta convergence often compare their results with a convergence rate of 2% — referred to as the “Iron law of convergence” (Barro, 2015^[41]) — which emerges with surprising regularity in most cross-regional or cross-country studies.

They insist on the role of equalising intergovernmental transfers in that period, such as expenditure cuts in wealthy regions to finance support measures in poorer regions. However, their analysis remains rather descriptive and the conclusions are at odds with , for instance, Guriev and Vakulenko (2012^[26]) who stress that interregional fiscal redistribution never played a crucial role in reducing inequality.

20. Other studies look for empirical evidence for the influence of policy on growth. An early example is Berkowitz and Dejong (2003^[27]) who find that in 1993-1997 economic growth was based on price liberalisation and large-scale privatisations. However, Ahrend (2005^[28]) who examines the period 1990-1998 finds no significant effect of price liberalisation and large-scale privatisations on income, regional GDP and industrial activity growth. Instead, natural resources, location, human capital and initial industrial specialisation inherited from the Soviet era determine regional performance. Still, small-scale privatisation and a region's commitment to reform helped foster growth. The same author found also found (Ahrend, 2012^[29]) that the determinants of performance may be different in times of decline – as during the 1998 crisis – and in times of growth.

21. Regional fiscal policy and its contribution to regional stability and growth attract some attention. For Kwon and Spilimbergo (2009^[30]), pro-cyclical regional fiscal policy and inadequate transfer policy exacerbated the regional impact of income shocks between 1992 and 2003. In addition, Eller *et al* (2016^[31]) found discretionary policies to be responsible for increasing output volatility during the period 2000-2009. Intergovernmental arrangements seem to shape the fiscal responses of regions to external shocks. For instance, Alexeev and Chernyavskiy (2014^[32]) attribute the comparatively better growth performance of oil producing regions to the fact that the centralisation of oil-related taxes makes those regions almost immune to the variation of oil prices.

22. Intergovernmental budget arrangements also influence growth. In an early assessment covering 1994-2002, Dobryshevsky *et al.* (2005^[33]) find a negative relationship between transfers from the federal to the regional level and economic growth. Yushkov (2015^[34]) stresses that the decentralisation of spending from the regional to the municipal level is associated with lower growth. A large part of municipal spending expenditures is covered by intergovernmental grants, reducing incentives for improving spending efficiency. Yushkov points at the beneficial role of transfers from the federal to the regional level but mentions that these transfers helped mainly to stabilise macroeconomic conditions in the regions during the 2008-09 crisis, particularly in the North Caucasus, rather than support potential growth. Finally, Di Bella *et al.*, (2017^[19]) underline that transfers from the federal to the regional level contribute to reducing interregional disparities in physical and human capital, but do not help income per capita to converge, and do not foster incentives for subnational debt sustainability.

2.2. The model

23. The empirical approach to assess convergence between Russian regions builds on the neo-classical growth theory. In a human capital augmented Solow model, in the steady state, the logarithm of GDP per capita depends linearly on the logarithm of the stock of human capital and on the logarithm of the investment rate (Mankiw, Romer and Weil, 1992^[35]). This long-term relationship is embedded in a convergence growth equation where the potential *growth rate* of GDP per capita depends on the past potential GDP per capita *level*, production factors and a set of structural variables influencing growth. The convergence growth equation is embedded in an error-correction model (ECM).

24. The baseline model specification is largely drawn from the cross country model of Fournier and Johansson (2016_[36]) and Blöchliger and Akgun (2018_[37]) and based on the following equation.:

$$\Delta \ln(Y_{i,t}/POP_{i,t}) = \alpha_0 - \phi [\ln(Y_{i,t-1}/POP_{i,t-1}) - \alpha_1 \ln(EDUC_{i,t-1}) - \alpha_2 \ln(INVR_{i,t-1})] + b_1 \Delta \ln(POP_t) + b_2 ENERGY_{i,t-1} \cdot \Delta \ln(POIL_t) + b_3 INDUS_{i,t-1} \cdot \Delta \ln(WGDP_t) + b_4 CREDIT_{i,t-1} \cdot \Delta INTR_t + v_t + \varepsilon_{i,t} \quad (1)$$

25. where i indicates the region, t is time, Y is real regional GDP, POP is the working-age population, here approximated by population aged from 15 to 64. $EDUC$ is the average years of education of the working-age population. The parameter ϕ is the convergence rate⁹. $INVR$ is the cyclically-adjusted total investment rate of the regional economy. The estimation period is 2005-2015, and 75 Russian regions are examined¹⁰.

26. Asymmetric shocks can play a crucial role for regional convergence in large countries, as exemplified by Canada where shocks seem to slow down convergence across provinces considerably (Minns and Rosés, 2018_[38]). To account for their impact on regional convergence, several shocks hitting the Russian economy such as commodity price shocks, financial shocks and global shocks are inserted into the model. The commodity price shock is approximated by multiplying the share of fuel extraction activities in GDP at $t-1$ ($ENERGY$) with the variations of oil price ($POIL$)¹¹. The global business cycle shock is captured by interacting the share of industry in GDP ($INDUS$) at $t-1$ with the growth of world GDP ($WGDP$). Finally, the financial shock is represented by multiplying the credit to GDP ratio ($CREDIT$) by the variation of short-term interest rate ($INTR$). Time fixed effects are used in all the regressions. They capture the shocks that affect the entire Russian economy.

27. The model is estimated using OLS without region fixed effects¹² and with System Generalized Moment Estimation (GMM) (Blundell and Bond, 1998_[39]). The model has a lagged dependent variable (Y/POP) and a small time dimension, where OLS with fixed effects would be subject to a bias several times higher than the parameter (Nickell, 1981_[40]). Typically, for GDP series where persistence in level is high, the convergence rates obtained are misleadingly high (Barro, 2015_[41]). Estimation without fixed effects lead to an omitted

⁹ In this estimation the error-correction dynamics reflects two conceptually different effects: (i) the speed of convergence towards a steady state and (ii) shorter-term adjustment that brings GDP back to the transition path. In that respect, the model differs from Fournier and Johansson (2016_[36]) where the dependent variable is potential GDP without cyclical fluctuations and hence where ϕ reflects long term convergence only.

¹⁰ Moscow and Saint Petersburg, which have the status of federal cities and are not comparable with other regions, are excluded from the regression. We also exclude Chechnya, Ingushetia, Kalmykia for data availability and quality reasons. We finally remove the Nenets and the Chukotka AOs which are two very low-populated resource-rich Antarctic regions, and which we regard as outliers. The Tyumen regions, the Khanty Mansiisky AO and the Yamalo-Nenetski AO, which are often aggregated in statistical data, are taken as 3 different regions.

¹¹ Similar variables were also used in Kwon and Spilimbergo (2009_[30]) for the period 1992-2003. However, they multiplied the share of industry by the real exchange rate, in order to reflect losses of competitiveness of the Russian Industry.

¹² In the remainder of the paper we use terminology ‘OLS’ for OLS without fixed effects and LSDV (Least-square with dummy variables) for OLS with region fixed effects.

variable bias that we try to offset by adding time invariant regional characteristics. System GMM is an efficient way to reduce the dynamic panel bias. Note that in our econometric specification we use all the available lags of the lagged dependent variable Y/POP as GMM instruments¹³.

2.3. Data for the baseline model

28. Most data originate from Rosstat and are described in Table 2.1. When possible the regional block sections of the Rosstat (2018^[2]) online central database which provides some harmonized regional times series. Since important series were not available through this database, the dataset is completed using several statistical yearbooks published on the Rosstat website¹⁴.

¹³ Panel data regressions are done with the ‘plm’ R package (Croissant and Millo, 2008^[70])

¹⁴ We used editions 2005 (Rosstat, 2005^[64]) to 2016 (Rosstat, 2016^[54]) available on http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/publications/catalog/doc_11_38623506156

Table 2.1. Variables used in the baseline model

	Name	Description / remarks	Source
Time-varying indicators (used in all regressions)			
Y	Real regional GDP	In real 2010 RUB; calculated based on the index of real regional GDP, taking 2010 as the base year	Rosstat (2018 _[2])
POP	Population aged between 15 and 64	Regional population data collected in the OECD regional statistical database.	Rosstat (2018 _[2])
INVRAT	Cyclically-adjusted investment rate	Computed as the residual of the regression of real investment to the output gap. The output gap is calculated by filtering real regional GDP using the Method of Hamilton (2017 _[42]). In line with his suggestion for annual data, we take $h=2$ and $d=3$.	Rosstat Regional Yearbooks 2005 to 2016, Rosstat (2018 _[2]), authors' calculations
EDUC	Average years of education of the labour force	Calculated using the breakdown of working population and unemployed population in five education attainment groups	Rosstat Regional Yearbooks 2005 to 2016, Rosstat (2018 _[2]), authors' calculations
ENERGY	Share of fuel extraction	Calculated as the share of all extraction activities in regional GDP multiplied by the share of energy in extraction.	Rosstat (2016 _[43] ; 2018 _[2])
POIL	Oil price	Annual average Brent oil price, in USD per barrel	OECD (2017 _[44])
INDUS	Share of industry	Share of manufacturing (excluding extraction and utilities) in regional GDP	Rosstat (2016 _[43] ; 2018 _[2])
WGPD	World GDP	World GDP in volume, at market exchange rate	OECD (2017 _[44])
CREDIT	Loan to GRP ratio	Covers both corporate and retail loans in roubles and foreign currency. The latter were converted from USD to RUB using the average annual exchange rate of OECD (2017 _[44]). Data were adjusted to make the time series consistent following the 2010 change in Rosstats' definition of credit ¹	Rosstat Regional Yearbooks 2005 to 2016, Rosstat (2018 _[2]), authors' calculations, FRBS (2017 _[45]), OECD (2017 _[44])
INTR	Nominal interest rate	Russia's Central bank key policy rate	OECD (2017 _[44])
Time-Invariant indicators (used in OLS only)			
AGRIC	Average share of agriculture in GDP	Average share of agriculture in GDP between 2005 and 2015	Rosstat (2018 _[2])
EXTRACT	Average share of extraction in GDP	Average share of extraction (including fuel and non-fuel minerals) in regional GDP between 2005 and 2015	Rosstat (2018 _[2])
FDI to GRP ratio	Foreign direct investment as % GDP	Average share of FDI to regional GDP ratio between 2005 and 2013. FDI was converted from USD to RUB using the average annual exchange rate of OECD (2017 _[44]).	Rosstat Regional Yearbooks 2005 to 2016, Rosstat (2018 _[2]), authors' calculations
REGPRICE	Regional price level	Relative price of the basic consumption basket defined by Rosstat, normalised so that Russia's average is equal to 1	Rosstat (2018 _[2])

Note: 1 The definition of credit used in Rosstat regional indicators changed in 2010, to include individual businesses. To build regional credit to GDP series: (i) we assume that credit to individual businesses evolved as household and corporate credit and (ii) we computed aggregate credit for Russia between 2004 and 2014 using data from FRBS (2017_[45]) and from the Central Bank. The dataset is available from the authors upon request.

29. Rosstat does not provide cyclically-adjusted regional GDP and investment. To calculate cyclically-adjusted GDP the filter proposed by Hamilton (2017_[42]) is used. With this method, the output gap is the residual of the regression of real GDP at time t on GDP at time $t-2$ and $t-3$. The cyclically-adjusted investment rate is computed as the residual of the regression of real investment to this output gap.

2.4. Results of the baseline model

30. The baseline regressions cover the production function with physical and human capital and a number of controls, using both OLS and system GMM (Table 3.2). The convergence terms range from 2.1% to 2.7% which is roughly in line with the 2% from the

“iron law of convergence” (Barro, 2015^[41]) and the results of Fournier and Johansson (2016^[36]) on a panel of OECD countries. The slow convergence process points at limited catch-up: the barriers hampering the diffusion of productivity improvements across Russian regions seem to be as considerable as if these regions were independent countries. The convergence parameters are lower than in studies with comparable models and time coverage¹⁵.

31. Investment has, as expected, a positive and significant impact on regional GDP growth. An increase of the investment-to-GDP rate by 1% is associated with an increase of almost 2% of GDP per capita. This is in the upper bound of the results of (Fournier and Johansson, 2016^[36]), suggesting a higher return to investment in Russian regions than in OECD countries. The effect of education is significant in the GMM regression only, suggesting that some control variables capture the role of better education for growth.

32. Some Russia-specific results are worth mentioning. Resource-rich regions are not exposed to oil-price shocks, pointing at the centralised nature of the Russian federation, whose tax and transfer system seems to absorb the growth effects of these shocks (Alexeev and Chernyavskiy, 2014^[32]). However, regions relying on manufacturing are affected by the global business cycle. Finally, higher regional debt is associated with lower growth, even if the city of Moscow, which was severely hit during the 2009 and 2015-2016 financial crises, is not included in the regression. Foreign direct investment has no positive and significant impact on growth, probably owing to the high correlation with overall investment and the share of extraction in the economy. Low density or remoteness, which are approximated by the regional price level, have no significant influence on growth.

¹⁵ For instance Yushkov (2015^[34]) and Akhmedjonov et al (2013^[18]) find convergence rates around 10%. However, they use OLS estimations with individual fixed effects over small samples and their results are very likely to suffer from dynamic panel bias. Using the LSDV estimation we also get a high convergence coefficient (18%), almost ten times higher than in the other estimations, illustrating this bias. Moreover Akhmedjonov et al (2013^[18]) use the capital stock as regressor, which is awkward because the quality of regional capital stock data is rather poor.

Table 2.2. Estimation of the baseline regional growth model

Dependent variable: growth of regional GDP per capita

	LSDV (1)	OLS (2)	OLS (3)	GMM (4)	GMM (5)
$\ln(Y_{i,t-1}/POP_{i,t-1})$	-0.178*** (0.024)	-0.021** (0.01)	-0.021* (0.01)	-0.026** (0.012)	-0.027** (0.012)
$\ln(EDUC_{i,t-1})$	-0.025 (0.062)	0.015 (0.022)	0.016 (0.022)	0.076* (0.039)	0.077* (0.038)
$\ln(INVRAT_{i,t-1})$	0.009 (0.007)	0.018*** (0.006)	0.018*** (0.006)	0.025*** (0.007)	0.025*** (0.007)
$\Delta \ln(EDUC_{i,t})$	-0.019 (0.046)	-0.001 (0.036)	-0.001 (0.036)	0.044 (0.042)	0.046 (0.042)
$\Delta \ln(POP_{i,t})$	-1.432*** (0.514)	-0.424 (0.277)	-0.437 (0.275)	-0.380 (0.286)	-0.387 (0.286)
$ENERGY_{i,t-1}$ * $\Delta \ln(POIL_t)$	0.0002 (0.001)	-0.0003 (0.0005)	-0.0003 (0.0005)	-0.00001 (0.001)	-0.00001 (0.001)
$INDUS_{i,-1t}$ * $\Delta \ln(WGDP_t)$	0.019** (0.009)	0.017*** (0.006)	0.017*** (0.006)	0.009** (0.004)	0.008** (0.004)
$CREDIT_{i,t-1}$ * $\Delta \ln(INTR_t)$	-0.0001 (0.0001)		-0.0001** (0.0001)		-0.0002* (0.0001)
AGRIC		0.105 (0.065)	0.107 (0.065)		
EXTRACT		0.052** (0.024)	0.052** (0.024)		
REGPRICE		0.026 (0.016)	0.025 (0.016)		
FDI to GDP ratio		0.050 (0.034)	0.050 (0.034)		
Constant		0.036 (0.133)	0.032 (0.132)		
Observations	825	825	825	825	825
R²	0.604	0.535	0.536		
Adjusted R²	0.554	0.523	0.523		
F Statistic or Sargan test	62.029*** (df = 18; 732)	43.965*** (df = 21; 803)	42.48*** (df = 22; 802)	chisq(70) = 59.601 (p.value=0.807)	chisq(71) = 59.854 (p.value=0.824)

Note: *p<0.1; **p<0.05; ***p<0.01. Coefficients α_1 to α_3 of equation (1) can be obtained by dividing the coefficient of the long term dynamics above by minus the convergence rate (the coefficient of $\ln(Y_{i,t-1}/POP_{i,t-1})$). Year fixed effects are included in all the regressions. The standard errors are clustered by regions to adjust for heteroscedasticity. Source: authors' calculations

3. Extension: the role of intergovernmental fiscal frameworks

3.1. Intergovernmental fiscal frameworks in Russia

33. Russian regions have wide spending responsibilities, accounting for around 40% of total government expenditures, 15% of regional GDP on average and over 25% of GDP in 12 regions (Figure 3.1). Since tax and spending autonomy are low, Russian fiscal federalism is nevertheless regarded as centralized (Blöchliger and Kantorowicz, 2015^[46]), and the federal government strongly shapes regional fiscal policy using different types of transfers (see Box 3.1). The poorest regions are those with the largest share of sub-national spending in regional GDP and often those where low population density increases the cost of public good provision. Hence it is crucial to understand how subnational government spending, federal transfers and federal investment are related to regional growth.

Figure 3.1. Size of SNG spending and revenue

Note: In Panel A: plain lines are shares of SNG spending (revenue) in total government spending (revenue). Panel A does not include extra-budgetary territorial funds (EBTF). Panel B includes EBTF. In addition, in Panel B, the Russia's average is calculated by dividing the sum of SNG spending by the sum of regional GDPs. The sum of regional GDPs does not include some of the government services, such as defence, that are not assigned to a particular region. Hence it cannot be equal to the GDP drawn from national accounts which is used in the calculations of Panel A.

Source: Federal Treasury (2017^[47]), Rosstat, Federation, authors' calculations.

Box 3.1. Subnational budgets and fiscal federalism in Russia

Russia has three tiers of subnational governments (SNGs). The subject of the Russian Federation is the highest sub-national tier. Subjects are further divided into “first-tier municipalities” – big cities or rural districts – and into “second-tier municipalities” which are municipal districts, small towns or villages.

SNGs are responsible for primary education, part of health and social protection, local and regional roads, district heating and water supply. Funding comes from exclusive local taxes, shared taxes, own non-tax revenue and transfers from higher level of government. Two shared taxes – the personal income tax (PIT) and corporate income tax (CIT) – represented more than 50% of subnational revenue in 2016. The PIT is shared between subjects and municipalities. The tax rate is set by the federal government. The CIT is shared between the regional and the federal level, whereby the regional government can vary the rate between 13.5% and 17%. Federal rules limit SNG’s capacity to run deficits.

Transfers received from the federal level represented more than 15% of SNG revenues in 2016. This is lower than the OECD average (around 35%), which can be explained by the relatively high regional share in federal taxes. There are three types of transfers.

“Dotations” are non-earmarked – non-matching grants. They consist mainly of “equalisation grants” attributed to SNGs to reduce differences in tax revenues and public service cost. They also include “balancing grants” that are attributed in a discretionary manner to regions that did not receive adequate resources through equalisation grants.

“Subsidies” are earmarked matching grants from the Federal level. They reflect federal policy priorities, for instance in industrial policy, education, or for nationwide social policy programs.

“Subventions” are earmarked non-matching grants. They finance federal obligations or policies delegated to subnational levels. For example, they financed access to housing programs and increases in social benefits during the 2009 crisis Yushkov *et al.* (2017^[48]).

Figure 3.2. Subnational budget: structure of spending and financing

As % of total subnational expenditures/revenues, 2016

Note: Excluding extra-budget territorial funds. Source: World Bank (2017^[49])

34. Regions have limited tax authority (see Box 3.1) and the regional budget stance is largely determined by federal transfers. Transfers from the Federal Government represent

around 15% of consolidated regional budgets on average (see Box 1.1), but this share varies significantly (Figure 3.3). Some regions depend almost entirely on transfers because of their low tax basis. On the opposite side, some regions, traditionally resource-rich or with large cities, do not benefit from the transfer system. Moreover, a rising share of public investment is financed by the federal government (Figure 3.4).

Figure 3.3. Some regions rely strongly on federal transfers

Share of federal transfers in subnational budgets (left axis) and regional GDP (right axis), 2015

Source: Federal Treasury (2017^[47]), Rosstat (2018^[2]).

Figure 3.4. Federal government increased its share in regional public investment

Share of federal and subnational governments' investment in regional public investment, 2015

Note: Average over the 75 regions included in the model. The average is not weighted by GDP. For descriptive statistics about assignment of investment by private, federal and subnational origin, see Annex E.

Source: Rosstat (2018^[2]), Rosstat Regional Yearbooks 2005 to 2015, Federal Treasury (2017^[47]) and authors' calculations.

3.2. Questions to be addressed in the model extension

35. The baseline model of section 3 is extended to assess the role of the intergovernmental fiscal framework for regional *growth* and whether this framework helped reduce regional *disparities* over time. Altogether four questions will be addressed:

- *Sub-national spending and growth*: Sub-national public spending - current plus capital - may have both positive and negative impacts on regional growth in Russia. Public spending may contribute to improving infrastructure and public services and boost potential growth if directed toward “productive government spending” (Barro, 1990_[50]). On the other hand, public resources may be spent inefficiently and generate a large non-tradeable sector where low competitive pressure limits productivity gains (Di Bella, Dynnikova and Grigoli, 2017_[19]).
- *Public investment and growth*: The investment part of public spending is usually seen as conducive to growth (Fournier and Johansson, 2016_[36]). In the specific context of Russia where the public capital stock is low, returns on public investment may be even higher than in OECD countries (OECD, 2013_[4]). In some cases however public investment may crowd out private investment yielding higher returns, which could be detrimental to growth.
- *Sub-national public investment and growth*: The extent to which investment should be decentralised to lower government levels is part of an old debate, especially in federal countries (Blöchliger and Akgun, 2018_[37]). Decentralization may improve allocative efficiency, as sub-national governments know best where investment brings the highest returns. On the other hand and since investment tends to generate externalities across regional borders, sub-national governments might underinvest if not supported by the federal government (Zodrow and Mieszkowski, 1986_[51]).
- *Transfers and growth*: The role of federal transfers for growth depends much on design. Transfers may stimulate growth if they foster sub-national productive spending such as on education or infrastructure. Yet some transfers – in particular equalisation – could reduce sub-national governments’ efforts to develop their economic base and to increase own fiscal revenues, thereby slowing growth (Blöchliger et al., 2007_[52]). A large transfer system could also yield an oversized public sector (Hines and Thaler, 1995_[53]).

36. The additional variables used in the model extension are described in Table 3.1 and descriptive statistics are provided in Table E.1. The cyclically-adjusted sub-national spending (*SPENDING*) ratio measures the size of the sum of regional government’s current plus capital public spending relative to regional GDP. For studying the role of public investment, we use cyclically-adjusted public investment (*INVRAT_PUB*), which includes all investment financed by the federal (*INVRAT_FED*) and regional (*INVRAT_SNG*) budget. Lastly, the private part of investment (*INVRATE_PRIV*) is computed by subtracting public investment from total investment.

37. To assess the role of transfers, we use the cyclically adjusted rate of transfers in SNG revenue (*TRANSF_REV*). Then we use two subcategories of transfer. We compute the share of *dotations* (*DOTAT_REV*) which include balancing and equalisation grants; and the share of *subsidies* (*SUBS_REV*) which include earmarked matching grants (see Box 1.1).

Table 3.1. Variables used in the fiscal policy extension

	Name	Description / remarks	Source
SPENDING	SNG spending to GDP ratio	SNG spending to GDP ratio, cyclically adjusted ¹	Rosstat (2018 _[2]), Federal Treasury (2017 _[47])
INVRAT_PRIV	Total gross private investment rate	Private investment to GDP ratio, cyclically adjusted ¹ . Private investment is investment not financed by public budgets ² .	Rosstat Regional Yearbooks 2005 to 2016, Rosstat (2018 _[2]), authors' calculations
INVRAT_PUB	Total gross public investment rate	Public investment to GDP ratio, cyclically adjusted ¹ . Public investment is investment financed by federal or SNG budget ²	Rosstat Regional Yearbooks 2005 to 2016, Rosstat (2018 _[2]), authors' calculations
INVRAT_FED	Federal government gross investment rate	Public investment from the federal government to GDP ratio, cyclically adjusted ¹ . Public investment from the federal government is the investment financed by the federal budget ² .	Rosstat Regional Yearbooks 2005 to 2016, Rosstat (2018 _[2]), authors' calculations
INVRAT_SNG	Subnational government gross investment rate	SNG investment to GDP ratio, cyclically adjusted ¹ . SNG investment is investment financed by SNG budgets ² .	Rosstat Regional Yearbooks 2005 to 2016, Rosstat (2018 _[2]), authors' calculations
TRANSF_REV	Share of transfers in SNG revenue	Total transfers received from the federal government as share of total SNG revenue, cyclically adjusted ¹	Rosstat (2018 _[2]), Federal Treasury (2017 _[47])
DOTAT_REV	Share of <i>dotations</i> in SNG revenue	Non-Earmarked non matching grant (equalization and balancing grants) as share of total SNG. The ratio is cyclically adjusted ¹ .	Rosstat (2018 _[2]), Federal Treasury (2017 _[47])
SUBS_REV	Share of subsidies in SNG revenue	Earmarked matching grants as share of total SNG revenue. The ratio is cyclically adjusted ¹ .	Rosstat (2018 _[2]), Federal Treasury (2017 _[47])

Note: 1 The cyclically-adjusted ratio is the residual of the regression of the ratio on the output gap (see explanation in paragraph 29).

2: see the definition used in Rosstat (2016_[54]), Table 23.6. The dataset is available from the authors upon request.

38. Data on consolidated subnational budgets are published online by the Federal Treasury of the Russian Federation (2017_[47]) for the years 2004 to 2015¹⁶. We extract the size of SNG spending and revenue and the structure of financing. For the role of investment, we use data published in Rosstat's yearbooks on the structure of regional investment by source of financing such as the share of investment financed by own revenue, federal and SNG budgets, to create time series on the private, public, federal and sub-national investment rates.

3.3. Effect of sub-national spending and public investment on growth

39. The empirical results with the additional variables inserted suggest that the design of intergovernmental frameworks matters for growth of Russian regions (Table 3.2). Columns 1-5 present different findings of the OLS estimations and columns 6 to 9 present the GMM estimations. Reverse causality cannot be fully excluded in our results, as, for instance, public spending may be pro-cyclical. However, using lagged variables and filtering time series may have helped to reduce the problem of reverse causality.

¹⁶ The budget categories changed from one year to other in the Federal Treasury (2017_[47]) releases. We had to reconcile the budget categories to compute consistent time series for the period 2004-2015. The reconciliation procedure is available upon request.

3.3.1. A larger sub-national government sector is associated with lower growth while more investment could boost growth

40. Large regional governments seem to be quite negative for regional growth. Increasing the spending-to-GDP share by 1 percentage point is associated with a reduction of the potential growth rate by around 3% to 4% (Table 4.3). This is in line with other cross country empirical studies suggesting that a large government sector is negative for long-term growth (Bergh and Henrekson, 2011^[55]; Fall and Fournier, 2015^[56]). The detrimental effect of large government seems to originate in poor efficiency rather than higher spending needs: if the regional price index, which reflects regional fiscal needs, is removed (column 5), government spending becomes insignificant. As such, higher public service cost, especially in remote areas, is not detrimental to regional growth (most regional spending is covered by federal transfers, Table E.2).

41. Public investment is positively associated with growth (columns 3 and 8). This is again in line with findings for OECD countries (Fournier, 2016^[57]). Splitting public investment into the federal and regional part provides rather similar coefficients, suggesting that the share of each government level in total public investment is roughly adequate in Russia. As such the Russian case is different from the average OECD country where public investment appears too decentralised and where a lack of coordination of investment projects across jurisdictional borders might generate negative externalities (Blöchliger and Akgun, 2018^[37]). Moreover, public investment was higher in the poorer regions of Russia, contributing to GDP per capita convergence (Table E.2).

Table 3.2. Effect of regional governments' spending and public investment on growth

Dependent variable: growth of regional GDP per capita

	OLS (1)	OLS (2)	OLS (3)	OLS (4)	OLS (5)	GMM (6)	GMM (7)	GMM (8)	GMM (9)
$\ln(Y_{i,t-1}/POP_{i,t-1})$	-0.021** (0.01)	-0.032*** (0.011)	-0.032*** (0.011)	-0.028** (0.011)	-0.017* (0.009)	-0.026** (0.012)	-0.028** (0.011)	-0.016 (0.011)	-0.012 (0.011)
$\ln(EDUC_{i,t-1})$	0.015 (0.022)	0.013 (0.022)	-0.007 (0.023)	-0.008 (0.023)	0.036 (0.023)	0.076* (0.039)	0.064** (0.032)	0.034 (0.034)	0.030 (0.028)
$\ln(INVRATE_{i,t-1})$	0.018*** (0.006)	0.019*** (0.006)			0.020*** (0.006)	0.025*** (0.007)	0.025*** (0.007)		
$\ln(SPENDING_{i,t-1})$		-0.017** (0.007)	-0.019*** (0.007)	-0.017** (0.008)	-0.009 (0.008)		-0.021** (0.010)	-0.013* (0.008)	-0.011** (0.007)
$\ln(INVRAT_PRIV_{i,t-1})$			0.014*** (0.005)	0.014*** (0.005)				0.015*** (0.005)	0.014*** (0.005)
$\ln(INVRAT_PUB_{i,t-1})$			0.007* (0.004)					0.007* (0.004)	
$\ln(INVRAT_FED_{i,t-1})$				0.003* (0.002)					0.003 (0.003)
$\ln(INVRAT_SNG_{i,t-1})$				0.003 (0.003)					0.004 (0.003)
$\Delta \ln(EDUC_{i,t})$	-0.001 (0.036)	0.003 (0.036)	0.002 (0.036)	0.002 (0.037)	0.016 (0.037)	0.044 (0.042)	0.042 (0.042)	0.018 (0.042)	0.014 (0.039)
$\Delta \ln(POP_{i,t})$	-0.424 (0.277)	-0.413 (0.253)	-0.450* (0.258)	-0.399 (0.257)	-0.567** (0.262)	-0.380 (0.286)	-0.490** (0.247)	-0.475* (0.254)	-0.431* (0.238)
$ENERGY_{i,t-1}$ * $\Delta \ln(POIL_{i,t})$	-0.0003 (0.0005)	-0.0003 (0.001)	-0.0004 (0.0005)	-0.0004 (0.001)	-0.0004 (0.001)	-0.00001 (0.001)	-0.0003 (0.001)	-0.0004 (0.001)	-0.0005 (0.001)
$INDUS_{i,t-1}$ * $\Delta \ln(WGDP_{i,t})$	0.017*** (0.006)	0.014*** (0.005)	0.015*** (0.005)	0.015*** (0.005)	0.010** (0.004)	0.009** (0.004)	0.003 (0.004)	0.004 (0.004)	0.005 (0.004)
AGRIC	0.105 (0.065)	0.108* (0.061)	0.109* (0.059)	0.117** (0.058)	0.087 (0.058)				
EXTRACT	0.052** (0.024)	0.053** (0.022)	0.060*** (0.023)	0.057** (0.022)	0.030 (0.022)				
FDI to GRP ratio	0.050 (0.034)	0.063** (0.025)	0.061** (0.026)	0.058** (0.024)	0.057 (0.037)				
REGPRICE	0.026 (0.016)	0.045*** (0.017)	0.046*** (0.016)	0.044*** (0.016)					
Constant	0.036 (0.133)	0.067 (0.131)	0.124 (0.142)	0.101 (0.146)	-0.104 (0.137)				
Observations	825	825	825	825	825	825	825	825	825
R ²	0.535	0.540	0.542	0.539	0.534				
Adjusted R ²	0.523	0.527	0.529	0.525	0.522				
F Statistic or Sargan test	43.965*** (df = 21; 803)	42.722*** (df = 22; 802)	41.053*** (df = 23; 798)	38.569*** (df = 24; 792)	43.804*** (df = 21; 803)	chisq(70) = 59.601 (p.v=0.807)	chisq(71) = 64.773 (p.v=0.687)	chisq(72) = 66.40 (p.v=0.663)	: chisq(73) = 67.560 (p.v=0.657)

Note: The standard errors are clustered by regions to adjust for heteroscedasticity.

Source: see Table 3.1

3.3.2. Public investment multipliers are large

42. To assess the consequences of reallocating revenue and spending we present the results in the form of *multipliers*. They reflect the impact of an increase of 1 percentage

point of the spending and investment-to-GDP ratio on GDP per capita in the short and long term¹⁷.

43. Public investment is key to boost growth in Russian regions (Table 4.3). Marginal productivity is larger for public than for private investment, probably owing to the small size of regional public capital stocks and years of underinvestment. Also, the federal government investment multiplier is below the public investment multiplier, suggesting that federal government investment yields lower returns than sub-national investment. The multiplier for regional government spending is very negative. Increasing regional government spending by an amount equivalent to 1% of regional GDP would reduce the GDP growth rate by around 0.1 percentage point or 3% to 4%.

Table 3.3. Investment and regional government spending multipliers

Short term and long term effects of an increase equivalent to 1% of GDP

	Short-term multiplier (OLS)	Short-term multiplier (GMM)	Long-term multiplier (OLS)	Long-term multiplier (GMM)
SNG expenditure	-0.09%	-0.11%	-2.89%	-4.08%
Total investment	0.07%	0.10%	3.43%	3.85%
Private investment	0.07%	0.08%	2.26%	4.84%
Public investment	0.12%	0.12%	3.88%	7.77%
Federal government investment	0.08%	-	2.76%	-

Note: Multipliers show the short-term and long-term effect on regional GDP of increasing the policy variable by the equivalent of 1% of regional GDP. For instance, in the OLS specification, increasing private investment by the equivalent of 1% of GDP will increase GDP by 0.07% on the short run and by 2.26% on the long run. “-“ when not significant.

Source: see Table 3.1; authors’ calculations.

3.3.3. Regional spending widens regional disparities, while public investment reduces them

44. To assess whether public spending contributed to increase or to reduce inequality across regions over the model’s time horizon, we use the correlations between public spending rates, public investment rates and initial regional GDPs per capita (see Table E.2). Positive or negative correlations will tell us whether those policies that reduce or enhance growth – total public spending and public investment respectively – have been more used in initially richer or in poorer regions.

45. Spending at the regional level contributed to widen the gap between rich and poor regions. The poorer regions are those that have higher regional spending to GRP ratios: spending ratio and regional GDP per capita are negatively correlated. Therefore they are those that suffer most from having a big government. However, regional spending may have also helped the interregional convergence of households’ income and their stabilisation during recessionary periods.

¹⁷ Multipliers are used because the regression coefficients of investment and fiscal variables are not easy to compare. Coefficients measure the effect of a one percent change of the spending or revenue category rather than in relation to GDP. A higher coefficient may then simply reflect the fact that the category was larger. Note also that the multipliers reflect the supply-side effects of policies, i.e. the impact on potential GDP.

46. Public investment was more used in poorer regions and contributed to GDP per capita convergence. However, we see that SNG investments were not necessarily higher in poorer regions. Therefore they seem to have contributed less to the reduction of interregional disparities.

3.4. Effect of fiscal transfers on growth

47. There is little evidence that federal transfers have an impact on regional growth (Table 3.4). The coefficients associated with total transfers are small and insignificant in both the OLS (column 2) and the GMM regressions (column 6). This compares with contradictory results in the literature: Yushkov (2015^[34]) finds a growth-enhancing effect of transfers. But he suspects the result reveals short term effects of a transfer increase during the 2008-2009 crises rather than improved potential growth. Such effects are netted out in our model, which nets out the impacts of policies on potential growth. Alexeev and Blöchliger (2018^[58]) find that transfers have an overall growth-reducing effect.

48. The effects vary by type of transfer. Dotations have a negative influence on growth due to their propensity to encourage SNG spending, which has in turn detrimental effects on regional growth. They seem to reduce spending efficiency in Russian regions, resulting in overall spending growth. While earmarked matching transfers (subsidies) are designed to mobilise sub-national spending with a high return, findings suggest that they have a small positive impact on growth, but this effect is not confirmed by the GMM regressions.

Table 3.4. Effect of federal transfers on growth

Dependent variable: growth of regional GDP per capita

	OLS (1)	OLS (2)	OLS (3)	OLS (4)	OLS (5)	GMM (5)	GMM (6)	GMM (7)	GMM (8)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\ln(Y_{i,t-1}/POP_{i,t-1})$	-0.021** (0.010)	-0.032*** (0.012)	-0.035*** (0.011)	-0.031** (0.011)	-0.032*** (0.011)	-0.026** (0.012)	-0.021* (0.012)	-0.034*** (0.012)	-0.016 (0.011)
$\ln(EDUC_{t-1})$	0.015 (0.022)	0.012 (0.022)	0.012 (0.022)	0.010 (0.022)	0.014 (0.022)	0.076* (0.039)	0.047 (0.034)	0.078** (0.037)	0.040 (0.030)
$\ln(INV_{t-1})$	0.018*** (0.006)	0.019*** (0.006)	0.018*** (0.006)	0.017*** (0.006)	0.017*** (0.006)	0.025*** (0.007)	0.023*** (0.006)	0.026*** (0.007)	0.020*** (0.006)
$\ln(SPENDING_{t-1})$		-0.018* (0.010)	-0.014 (0.010)	-0.019*** (0.007)			-0.019** (0.009)	-0.021** (0.009)	-0.015* (0.009)
TRANSF_REV _{t-1}		0.001 (0.022)					0.010 (0.028)		
DOTAT_REV _{t-1}			-0.020 (0.023)		-0.038** (0.037)			-0.018 (0.026)	
SUBS_REV _{t-1}				0.065* (0.037)					0.067 (0.049)
$\Delta \ln(EDUC_{i,t})$	-0.001 (0.036)	-0.001 (0.037)	-0.002 (0.037)	-0.002 (0.036)	-0.005 (0.036)	0.044 (0.042)	0.025 (0.043)	0.050 (0.046)	0.019 (0.041)
$\Delta \ln(POP_{i,t})$	-0.424 (0.277)	-0.407 (0.250)	-0.367 (0.256)	-0.373 (0.249)	-0.338 (0.282)	-0.380 (0.286)	-0.477* (0.244)	-0.488* (0.277)	-0.461* (0.230)
$ENERGY_{i,t-1} * \Delta \ln(POIL_t)$	-0.0003 (0.0005)	-0.0003 (0.001)	-0.0004 (0.001)	-0.0004 (0.001)	-0.0004 (0.001)	-0.00001 (0.001)	-0.0004 (0.001)	-0.0003 (0.001)	-0.0004 (0.001)
$INDUS_{i,t-1} * \Delta \ln(WGDP_t)$	0.017*** (0.006)	0.014*** (0.005)	0.014** (0.005)	0.014*** (0.005)	0.014*** (0.006)	0.009** (0.004)	0.005 (0.004)	0.001 (0.005)	0.005 (0.004)
AGRIC	0.105 (0.065)	0.106 (0.066)	0.119* (0.067)	0.081 (0.055)	0.129** (0.066)				
EXTRACT	0.052** (0.024)	0.052** (0.023)	0.058** (0.023)	0.050** (0.022)	0.063** (0.025)				
FDI to GRP ratio	0.050 (0.034)	0.062** (0.027)	0.062** (0.027)	0.063*** (0.023)	0.054* (0.030)				
REGPRICE	0.026 (0.016)	0.044*** (0.017)	0.051*** (0.018)	0.046*** (0.016)	0.046*** (0.019)				
Constant	0.036 (0.133)	0.070 (0.133)	0.088 (0.136)	0.071 (0.132)	0.085 (0.137)				
Observations	825	820	820	820	820	825	820	820	820
R ²	0.535	0.540	0.541	0.542	0.539				
Adjusted R ²	0.523	0.527	0.528	0.529	0.526				
F Statistic or Sargan test	43.965*** (df = 21; 803)	40.709*** (df = 23; 796)	40.821*** (df = 23; 796)	41.034*** (df = 23; 796)	42.364*** (df = 22; 797)	chisq(70) = 59.601 (p.v=0.807)	chisq(72) = 71.11894 (p-value = 0.50721)	chisq(72) = 70.89517 (p-value = 0.51471)	chisq(72) = 66.39643 (p-value = 0.66411)

Note: The standard errors are clustered by regions to adjust for heteroscedasticity.

Source: see Table 3.1; authors' calculations

4. Conclusion and possible extensions

49. We developed a convergence growth equation for studying Russian regional growth. Our baseline results show a convergence rate of per capita GRP roughly in line with the 2% “iron law” generally found in cross country studies. We find that regions which depend on fuel extraction are not particularly affected by variations of oil price. But specialisation in industry; and to a lesser extent dependence on credit; are factors of vulnerability to international business cycles and interest rates hikes.

50. Model extensions give results on the effect of fiscal policies on regional per capita GRP growth and convergence. We find that higher subnational government spending is associated with lower growth and reduced convergence. However, higher spending may also compensate for higher cost of public good procurement due to regional circumstances, and in this case they have much less detrimental effects on growth. Public investment has a very strong growth-enhancing effect. The multiplier is greater than for private investment and tends to accelerate regional convergence.

51. The paper also puts forward insights on the effects of intergovernmental fiscal frameworks. There is some weak evidence that regional government investment yields higher returns than federal government investment. However, equalisation and balancing grants (*dotations*) appear to increase overall subnational government spending and slow down growth and regional convergence, probably as a result of poor spending efficiency and adverse development incentives at the regional level. We also find weak evidence that earmarked matching grants have beneficial impacts on growth and convergence.

52. There is a potential trade-off between efficiency and regional inequality within regions. Dotations, even if they appear inefficient, are always necessary to redistribute wealth within the country, reducing interregional household incomes, inequality and physical and human capital gaps. Including income inequality in the modelling framework would add an important dimension of the debate, given the high level of household income inequality in Russia.

53. The modelling framework might be augmented to complement the regional growth model with two types of modules. The first one would represent the influence of policies on average regional household incomes. The other one would link policies with intraregional income dispersions measured for instance by the Gini coefficient. The models could also be extended to studying more in details the contribution of various types of expenditure of regional growth and the importance of the structure of spending. Results could serve to fuel the debate of regional budget reforms. Last, one could add some structural policy variables to the model, in particular on regional innovation activity. Their contribution to total factor productivity is difficult to establish so far, but more indicators are becoming available.

References

- Ahrend, R. (2012), “Understanding Russian regions' economic performance during periods of decline and growth-An extreme bound analysis approach”, *Economic Systems*, [29]
<http://dx.doi.org/10.1016/j.ecosys.2011.10.002>.

- Ahrend, R. (2005), “Speed of reform, initial conditions or political orientation? Explaining Russian regions' economic performance”, *Post-Communist Economies*, <http://dx.doi.org/10.1080/14631370500204198>. [28]
- AIRR (2017), *Ranking 2017 of Russian Innovative Regions*. [11]
- Akgun, O., B. Cournède and J. Fournier (2017), “The effects of the tax mix on inequality and growth”, *OECD Economics Department Working Papers*, No. 1447, OECD Publishing, Paris, <http://dx.doi.org/10.1787/c57eaa14-en>. [62]
- Akhmedjonov, A., M. Lau and B. Izgi (2013), “New evidence of regional income divergence in post-reform Russia”, *Applied Economics*, <http://dx.doi.org/10.1080/00036846.2012.665600>. [18]
- Alexeev, M. and H. Blöchliger (2018), “Fiscal Federalism in Russia and its Asian Regions”, in *Fiscal decentralisation in Asian countries*, OECD Publishing, Paris. [58]
- Alexeev, M. and A. Chernyavskiy (2014), “Natural resources and economic growth in Russia's regions”, *Higher School of Economic Working Paper WP BRP 55/EC/2014*. [32]
- Barro, R. (2015), “Convergence and modernisation”, *Economic Journal*, <http://dx.doi.org/10.1111/econj.12247>. [41]
- Barro, R. (1990), “Government Spending in a Simple Model of Endogenous Growth”, *Journal of Political Economy*, Vol. 98/5, pp. 103-125, <https://doi.org/10.1086/261726>. [50]
- Barro, R. et al. (2012), “NBER WORKING PAPER SERIES CONVERGENCE AND MODERNIZATION REVISITED”, <http://www.nber.org/papers/w18295>. [60]
- Barro, R. and X. Sala-i-Martin (1990), “Economic growth and convergence accross the united states”, *NBER Working Paper*, Vol. 3419. [13]
- Benini, R. and A. Czyzewski (2007), “Regional disparities and economic growth in Russia: New growth patterns and catching up”, *Economic Change and Restructuring*, <http://dx.doi.org/10.1007/s10644-007-9026-0>. [15]
- Bergh, A. and M. Henrekson (2011), “Government size and growth: a survey and interpretation of the evidence”, *Journal of Economic Surveys*, Vol. 25/5, pp. 872-897, <http://dx.doi.org/10.1111/j.1467-6419.2011.00697.x>. [55]
- Berkowitz, D. and D. DeJong (2003), “Policy reform and growth in post-Soviet Russia”, *European Economic Review*, [http://dx.doi.org/10.1016/S0014-2921\(02\)00186-1](http://dx.doi.org/10.1016/S0014-2921(02)00186-1). [27]
- Blöchliger, H. and A. Akgun (2018), “Fiscal decentralisation and economic growth”, in *Decentralisation and inclusive growth*, OECD Publishing, Paris. [37]
- Blöchliger, H., D. Bartolini and S. Stossberg (2016), “Does Fiscal Decentralisation Foster Regional Convergence?”, *OECD Economic Policy Paper*, No. 17, OECD, <https://doi.org/10.1787/5jlr3c1vcqmr-en>. [14]
- Blöchliger, H. and J. Kantorowicz (2015), “Fiscal constitutions: An empirical assessment”, *OECD Economics Department Working Papers*, No. 1248, OECD Publishing, Paris, <http://dx.doi.org/10.1787/5jrxjctrxp8r-en>. [46]
- Blöchliger, H. et al. (2007), “Fiscal Equalisation in OECD Countries”, *OECD Working Papers on Fiscal Federalism*, No. 4, OECD Publishing, Paris, <http://dx.doi.org/10.1787/5k97b11n2gxx-en>. [52]
- Blundell, R. and S. Bond (1998), “Initial conditions and moment restrictions in dynamic panel data models”, *Journal of Econometrics*, [http://dx.doi.org/10.1016/S0304-4076\(98\)00009-8](http://dx.doi.org/10.1016/S0304-4076(98)00009-8). [39]

- Croissant, Y. and G. Millo (2008), “Panel Data Econometrics in R: The plm Package”, *Journal of Statistical Software*, Vol. 27/2, <http://dx.doi.org/10.18637/jss.v027.i02>. [70]
- Di Bella, G., O. Dynnikova and F. Grigoli (2017), “Fiscal Federalism and Regional Performance”, *IMF Working Paper*, No. WP/17/265, IMF. [19]
- Drobyshevsky, S. et al. (2005), *Factors of Economic Growth in Russia's Regions*, SSRN Electronic Journal, <http://dx.doi.org/10.2139/ssrn.2170309>. [33]
- Ekspert (2017), *Ekspert ranking of regional Risks*. [12]
- Eller, M., J. Fidrmuc and Z. Fungáčová (2016), “Fiscal Policy and Regional Output Volatility: Evidence from Russia”, *Regional Studies*, <http://dx.doi.org/10.1080/00343404.2015.1064884>. [31]
- Fall, F. and J. Fournier (2015), “Macroeconomic uncertainties, prudent debt targets and fiscal rules”, *OECD Economics Department Working Papers*, No. 1230, OECD Publishing, Paris, <http://dx.doi.org/10.1787/5jrxv0bf2vmx-en>. [56]
- Federal Reserve Bank of St. Louis (2017), *Use of Financial Services, Assets: Outstanding Loans at Commercial Banks for Russian Federation, National Currency, Annual, Not Seasonally Adjusted [RUSFCSODCXDC]*, 2017, <https://fred.stlouisfed.org> (accessed on 05 November 2017). [45]
- Federal Treasury of the Russian Federation (2017), “Consolidated Budgets of subjects of the Russian Federation and extra budget territorial governmental funds”, , <http://www.roskazna.ru/ispolnenie-byudzheto/konsolidirovannye-byudzhety-subektov/> (accessed on 2018). [47]
- Fournier, J. (2016), “The Positive Effect of Public Investment on Potential Growth”, *OECD Economics Department Working Papers*, No. 1347, OECD Publishing, Paris, <http://dx.doi.org/10.1787/15e400d4-en>. [57]
- Fournier, J. and Å. Johansson (2016), “The Effect of the Size and the Mix of Public Spending on Growth and Inequality”, *OECD Economics Department Working Papers*, No. 1344, OECD Publishing, Paris, <http://dx.doi.org/10.1787/f99f6b36-en>. [36]
- Gal, P. and J. Egeland (2018), *Reducing regional disparities in productivity in the United Kingdom*, Organisation for Economic Co-operation and Development, <http://www.oecd-ilibrary.org/content/workingpaper/54293958-en>. [9]
- Gluschenko, K. (2012), “Methodologies of Analyzing Inter-Regional Income Inequality and Their Applications to Russia”, No. 66824, MPRA, <https://mpra.ub.uni-muenchen.de/66824/>. [61]
- Goliashev, A. and L. Grigoriev (2014), *Types of Russian Regions, Stability and Changes in Years 2003-2013 (in Russian)*, Analytical Center under the Government of the Russian Federation. [25]
- Guriev, S. and E. Vakulenko (2015), “Breaking out of poverty traps: Internal migration and interregional convergence in Russia”, *Journal of Comparative Economics*, <http://dx.doi.org/10.1016/j.jce.2015.02.002>. [21]
- Guriev, S. and E. Vakulenko (2012), “Convergence between Russian Regions”, *CEFIR Working Paper*, No. 180, CEFIR, Moscow. [26]
- Hamilton, J. (2017), “Why you should never use the hodrick-prescott filter”, No. 23429, National Bureau of Economic Research, <http://www.nber.org/papers/w23429>. [42]

- Henkel, M., T. Seidel and J. Südekum (2018), “Fiscal Transfers in the Spatial Economy”, No. CEPR 12875, Center for Economic Policy Research, http://www.cepr.org/active/publications/discussion_papers/dp.php?dpno=12875. [6]
- Hines, J. and R. Thaler (1995), “The Flypaper Effect”, *Journal of Economic Perspectives*, Vol. 9/4, pp. 217-226, <http://dx.doi.org/DOI: 10.1257/jep.9.4.217>. [53]
- International Labour Organization (2015), *Global Wage Report 22014/2015*, International Labour Office, Geneva. [10]
- IUE (2017), *Economics of Russian Cities and Russian Agglomerations: do urban assets play a role in Urban Development*, http://www.urbaneconomics.ru/sites/default/files/ekonomika_rossiyskih_gorodov_i_gorodskih_aglomeracij_vypusk_1_iyul_2017.pdf. [5]
- Iwasaki, I. and K. Suganuma (2014), “Foreign Direct Investment and Regional Economic Growth in Russia: An Econometric Assessment”, *RRC Working Paper Series*, No. 44, RRC. [24]
- Kholodilin, K., A. Oshchepkov and B. Siliverstovs (2012), “The Russian Regional Convergence Process”, *Eastern European Economics*, <http://dx.doi.org/10.2753/EEE0012-8775500301>. [16]
- Kwon, G. and A. Spilimbergo (2009), “Regional volatility in emerging countries: The case of Russia”, *Economics of Transition*, <http://dx.doi.org/10.1111/j.1468-0351.2009.00342.x>. [30]
- Ledyaeva, S. (2009), “Spatial Econometric Analysis of Foreign Direct Investment Determinants in Russian Regions”, *The World Economy*, Vol. 32/4, pp. 643-666, <http://dx.doi.org/10.1111/j.1467-9701.2008.01145.x>. [23]
- Ledyaeva, S. and M. Linden (2008), “Determinants of Economic Growth: Empirical Evidence from Russian Regions”, *European Journal of Comparative Economics*, Vol. 1/5, pp. 87-105, <http://eaces.liuc.it/18242979200801/182429792008050105.pdf>. [20]
- Lehmann, H. and M. Silvagni (2013), “Is There Convergence of Russia's Regions?: Exploring the Empirical Evidence: 1995–2010”, *OECD Economics Department Working Papers*, No. 1083, OECD Publishing, Paris, <http://dx.doi.org/10.1787/5k422105ht33-en>. [17]
- Mankiw, G., D. Romer and D. Weil (1992), “A Contribution to the Empirics of Economic Growth”, *The Quarterly Journal of Economics*, Vol. 107/2, pp. 407-437, <https://doi.org/10.2307/2118477>. [35]
- Minns, C. and J. Rosés (2018), “Power to the Periphery? the Failure of Regional Convergence in Canada, 1890-2006”, No. Discussion Paper No.DP12803, Center for Economic Policy Research, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3149472. [38]
- Nickell, S. (1981), “Biases in Dynamic Models with Fixed Effects”, *Source: Econometrica*, Vol. 49/6, pp. 1417-1426, <http://www.jstor.org/stable/1911408>. [40]
- OECD (2017), *Metropolitan Areas - OECD regional statistics (database)*. [8]
- OECD (2017), *OECD Economic Outlook 102 Database*, <https://stats.oecd.org/index.aspx?DataSetCode=EO>. [44]
- OECD (2017), *OECD Economic Surveys: Mexico 2017*, OECD Publishing, Paris, http://dx.doi.org/10.1787/eco_surveys-mex-2017-en. [3]
- OECD (2017), “Regional Economics”, *OECD Regional Economics Database*. [1]
- OECD (2013), *OECD Economic Surveys: Russian Federation 2013*, OECD Publishing, Paris, http://dx.doi.org/10.1787/eco_surveys-rus-2013-en. [4]

- Rosstat (2018), *Rosstat Central Database*, <http://www.gks.ru/dbscripts/cbsd/#1> (accessed on February 2018). [2]
- Rosstat (2016), *Regions of Russia, Main Socio Economic Indicators of Cities*, Rosstat. [59]
- Rosstat (2016), *Regions of Russia: Socioeconomic Indicators 2016 Edition*, Federal Statistics Service, Moscow, http://www.gks.ru/bgd/regl/B16_14p/Main.htm. [43]
- Rosstat (2016), *Regions of Russia: Socioeconomic Indicators 2016 Edition*, Federal Statistical Service of the Russian Federation, Moscow. [54]
- Rosstat (ed.) (2015), *Regions of Russia: Socioeconomic Indicators 2015 Edition*. [67]
- Rosstat (ed.) (2014), *Regions of Russia: Socioeconomic Indicators 2014 Edition*. [66]
- Rosstat (ed.) (2012), *Regions of Russia: Socioeconomic Indicators 2012 Edition*. [65]
- Rosstat (2010), *Regions of Russia: Socioeconomic Indicators 2010 Edition*, Federal Statistical Service of the Russian Federation, Moscow. [69]
- Rosstat (ed.) (2008), *Regions of Russia: Socioeconomic Indicators 2008 Edition*. [7]
- Rosstat (2006), *Regions of Russia: Socioeconomic Indicators 2006 Edition*, Federal Statistical Service of the Russian Federation. [68]
- Rosstat (ed.) (2005), *Regions of Russia: Socioeconomic Indicators 2005 Edition*. [64]
- White, A. (2007), “Internal Migration Trends in Soviet and Post-Soviet European Russia”, *Europe-Asia Studies*, Vol. 59/6, pp. 884-911, <https://doi.org/10.1080/09668130701489105>. [22]
- World Bank (2017), *Russia Economic Report No 37: from recession to recovery*, World Bank, <http://documents.worldbank.org/curated/en/782451497437509084/pdf/116237-WP-P161778-PUBLIC-RERengforweb.pdf>. [49]
- Yushkov, A. (2015), “Fiscal decentralization and regional economic growth: Theory, empirics, and the Russian experience”, *Russian Journal of Economics*, <http://dx.doi.org/10.1016/j.ruje.2016.02.004>. [34]
- Yushkov, A., N. Oding and L. Savulkin (2017), “The trajectories of donor regions in Russia”, *Voprossi Ekonomiki* 9, pp. 63-82, <https://elibrary.ru/item.asp?id=29982262>. [63]
- Yushkov, A., L. Savulkin and N. Oding (2017), “Intergovernmental relations in Russia: still a pendulum?”, *Public Administration Issues Public Administration Issues, Special Issue*, pp. 38-59, <http://dx.doi.org/10.17323/1999-5431-2017-0-5-38-59>. [48]
- Zodrow, G. and P. Mieszkowski (1986), “Pigou, Tiebout, property taxation, and the underprovision of local public goods”, *Journal of Urban Economics*, Vol. 19/3, pp. 356-370, [https://doi.org/10.1016/0094-1190\(86\)90048-3](https://doi.org/10.1016/0094-1190(86)90048-3). [51]

Annex A. Size of regions used in cross-country comparisons

Table A.1. Number and size of OECD TL2 regions in various countries

	Average surface area -Square km2)	Average population size (2012), thousands	Number of OECD TL2 regions
AUS	962919	2841	8
AUT	9157	934	9
BEL	10109	3698	3
BGR	18155	1221	6
BRA	315231	7383	27
CAN	699501	2673	13
CHE	5714	1136	7
CHL	49350	1163	15
CHN	307872	43580	31
COL	34599	1412	33
CZE	9654	1313	8
DEU	22321	5020	16
ESP	26408	2464	19
FIN	60779	1080	5
FRA	24340	2511	26
HUN	13290	1419	7
IND	95951	37400	33
ITA	14053	2828	21
JPN	37353	12752	10
MEX	61227	3658	32
NLD	2810	1394	12
NOR	43464	712	7
NZL	22079	367	12
PER	53551	1256	24
ROU	28771	2512	8
RUS	229373	1793	81
USA	179645	6159	51

Source: OECD regional database (OECD, 2017^[1])

Annex B. GRP disparities: influence of distance, density and city sizes

54. Regional GDP per capita disparities are associated with spatial characteristics. There is a U-shaped relationship between GDP per capita and population density as denoted by the significance and the sign of density (negative) and square density (positive) coefficients in Table B.1. A possible explanation is that higher density fosters positive agglomeration effects, while low density regions are in general those where abundant natural resources contribute to a higher GDP per capita. The regions with intermediate density have none of these advantages. A U-shape relationship is also found for distance to Moscow: regions very close or very far from Moscow tend to have higher GDP per capita, although this reflects mostly the fact that Moscow and the far North East periphery are wealthy relative to the rest of the country. Regions on the Western borders tend to be wealthier than the others, thanks to greater proximity to foreign markets. Lastly, the existence of a large urban area in a region has no significantly positive influence on regional GDP per capita. But this absence of positive relationship may also reflect that the regional level of analysis does not provide sufficient spatial granularity to isolate effects at the city-level.

Table B.1. U-Shape relationship between density and GDP per capita*Dependent variable:* GRP per inhabitant aged between 15 and 64

	GRP per capita in 2015	GRP per capita in 2004
Manufacturing in GDP	0.017*** (0.004)	0.012*** (0.004)
Agriculture in GDP	0.003 (0.006)	-0.019** (0.008)
Extraction in GDP	0.028*** (0.002)	0.026*** (0.003)
Total population	0.059* (0.033)	0.017 (0.037)
Population density	-0.819*** (0.273)	-1.166*** (0.326)
(Population density)2	0.508*** (0.184)	0.805*** (0.243)
Distance to Moscow	-0.111*** (0.042)	-0.082* (0.045)
(Distance to Moscow)2	0.014*** (0.004)	0.012*** (0.004)
log(Schooling)	1.342*** (0.393)	0.519 (0.510)
Metropole > 1 Million (dummy)	0.060 (0.091)	0.062 (0.103)
Border with Europe (dummy)	0.160** (0.075)	0.039 (0.081)
Constant	-3.812 (2.647)	1.813 (3.391)
Observations	76	76
R2	0.854	0.837
Adjusted R2	0.829	0.809
Residual Std. Error (df = 64)	0.213	0.240
F Statistic (df = 11; 64)	34.009***	29.812***

Note: * p<0.1; ** p<0.05; *** p<0.01. *EDUC* is the average years of education of the labour force (see Table 2.1) Moscow and Saint-Petersburg are excluded from the sample.

55. Using city-level wage data from Rosstat (2016_[59]), we see that there is a positive correlation between the city size and average wage for the group of cities of more than one million inhabitants, but this is largely due to Moscow and Saint Petersburg where wages are particularly high. When taking all the cities of more than 100 000 inhabitants, we see that both population size and the fact that city is specialisations in extraction or not play a key role. The highest wages - above Moscow and Saint-Petersburg levels - are found in cities with much less than 1 million inhabitants which are specialized in extraction or related activities. For the group of cities with population between 100 000 and 1 million inhabitants and which are not specialised in extraction, we see a positive correlation between population size and real wage suggesting positive agglomeration effects.

Figure B.1. Population size and specialisation of extraction explain wage disparities across cities

Note: Statistics for municipalities. We include cities of more than 100 000 inhabitants except Moscow and Saint Petersburg that are beyond the right bound of the horizontal axis. Real wages are adjusted for regional price differences

Source: Rosstat (2016^[59]; 2018^[2])

Annex C. Beta convergence for productivity, employment and participation

Figure A C.1 There is unconditional beta convergence for labour productivity, employment and participation rate

Source: Rosstat (2018^[2]) and authors' calculations

Annex D. Cross-sectional growth regressions

Table D.1 Cross-sectional growth regressions, 2004-2015

Dependent variable: GRP per inhabitant aged between 15 and 64

	2004-2015	2004-2007	2008-2009	2010-2013	2014-2015
Initial (GRP/POP1564) ¹	-0.014** (0.006)	-0.037*** (0.012)	-0.02 (0.015)	0.003 (0.008)	0.005 (0.011)
Extraction	0.0004** (0.0002)	0.001*** (0.0004)	0.001 (0.001)	-0.00004 (0.0003)	-0.0001 (0.0004)
Agriculture	0.001** (0.0004)	-0.0001 (0.001)	0.001 (0.001)	0.001* (0.001)	0.002*** (0.001)
Iron and Steel	-0.002 (0.022)	0.057 (0.039)	-0.125** (0.049)	-0.014 (0.027)	0.047 (0.039)
Machine Building	-0.015 (0.045)	0.078 (0.083)	-0.357*** (0.103)	0.147** (0.058)	-0.084 (0.081)
Agrofood	0.092 (0.063)	0.097 (0.111)	0.366** (0.142)	-0.019 (0.08)	-0.016 (0.115)
Largest city population ¹	0.003 (0.002)	0.009** (0.004)	-0.0005 (0.005)	0.003 (0.003)	-0.002 (0.004)
Far-East ²	0.013** (0.006)	0.028*** (0.011)	0.024* (0.013)	-0.002 (0.007)	0.013 (0.01)
North-Caucasus ²	-0.01 (0.007)	-0.004 (0.013)	0.008 (0.016)	-0.011 (0.009)	-0.028** (0.013)
South ²	-0.0002 (0.006)	0.009 (0.012)	-0.005 (0.015)	0.008 (0.008)	-0.01 (0.011)
Constant	0.076** (0.034)	0.198*** (0.07)	0.102 (0.087)	-0.006 (0.046)	-0.011 (0.063)
Observations	75	75	75	75	75
Adjusted R ²	0.211	0.184	0.358	0.161	0.111
F Statistic (df = 10; 65)	2.980***	2.663***	5.122***	2.423**	1.926*

Note: * p<0.1; ** p<0.05; *** p<0.01; 1: in logarithm, 2: dummy variable.

Source: Authors' calculations based on Rosstat

Annex E. Descriptive statistics of the panel data model's variables

Table E.1. Univariate statistics of the model's variables

	N	Mean	St. dev	Min	Max
Time-varying indicators					
$\Delta \ln(Y_{i,t-1}/POP_{i,t-1})$	825	0.04	0.05	-0.22	0.25
$Y_{i,t-1}/POP_{i,t-1}$	825	322.19	289.14	91.90	2,191.07
EDUC _{i,t-1}	825	839.64	63.29	675.61	1,131.17
INVRAT _{i,t-1}	825	0.27	0.27	0.10	0.91
$\Delta \ln(EDUC_{i,t})$	825	0.004	0.03	-0.13	0.14
$\Delta \ln(POP_{i,t})$	825	-0.01	0.01	-0.03	0.03
ENERGY _{i,t-1} * $\Delta \ln(POIL_t)$	825	0.40	4.27	-31.59	27.63
INDUS _{i,t-1} * $\Delta \ln(WGDP_t)$	825	0.71	0.54	-0.30	3.07
CREDIT _{i,t-1} * $\Delta \ln(INTR_t)$	825	0.40	10.18	-268.82	35.67
SPENDING	825	0.21	0.08	0.08	0.68
INVRAT_PRIV	825	0.21	0.08	-0.01	0.9
INVRAT_PUB	825	0.06	0.04	0.01	0.3
INVRAT_FED	825	0.04	0.03	-0.004	0.2
INVRAT_SNG	825	0.02	0.02	0.003	0.13
TRANSF_REV	820	0.30	0.17	-0.10	0.87
DOTAT_REV	820	0.14	0.14	-0.05	0.67
SUBS_REV	820	0.08	0.05	-0.01	0.36
Time invariant indicators					
AGRIC	75	8.35	4.94	0.16	21.81
EXTRACT	75	8.31	13.82	0	66.92
FDI	75	0.02	0.06	0	0.39
REGPRICE	75	0.99	0.18	0.81	1.77
AGRIC	75	8.35	4.94	0.16	21.81

Note: The statistics are not weighted

Source: see Table 2.1 and Table 3.1; authors' calculations.

Table E.2. Correlation matrix of the model's variables

	$\Delta \ln Y$	Y/POP	INVRAT	EDUC	SPE NDIN G	INVRAT_ PRIV	INVRAT_ T_PUB	INVRAT_ FED	INVRAT_ T_SNG	TRANS F_REV	DOTAT _REV	SUB S_R EV
$\Delta \ln Y$	1.00	-0.06	-0.03	-0.02	-0.07	-0.01	-0.04	-0.04	0.00	-0.01	0.05	-0.13
Y/POP	-0.06	1.00	0.23	0.49	-0.31	0.38	-0.25	-0.27	-0.08	-0.42	-0.32	-0.30
INVRAT	-0.03	0.23	1.00	0.09	0.09	0.87	0.35	0.32	0.22	0.08	0.00	0.24
EDUC	-0.02	0.49	0.09	1.00	-0.03	0.09	0.01	0.01	0.00	-0.05	0.03	-0.12
SPENDIN G	-0.07	-0.31	0.09	-0.03	1.00	-0.26	0.66	0.57	0.53	0.76	0.76	0.33
INVRAT_ PRIV	-0.01	0.38	0.87	0.09	-0.26	1.00	-0.17	-0.16	-0.11	-0.28	-0.34	0.00
INVRAT_ PUB	-0.04	-0.25	0.35	0.01	0.66	-0.17	1.00	0.93	0.65	0.70	0.63	0.47
INVRAT_ FED	-0.04	-0.27	0.32	0.01	0.57	-0.16	0.93	1.00	0.33	0.66	0.58	0.46
INVRAT_ SNG	0.00	-0.08	0.22	0.00	0.53	-0.11	0.65	0.33	1.00	0.45	0.46	0.27
TRANSF_ REV	-0.01	-0.42	0.08	-0.05	0.76	-0.28	0.70	0.66	0.45	1.00	0.93	0.55
DOTAT_R EV	0.05	-0.32	0.00	0.03	0.76	-0.34	0.63	0.58	0.46	0.93	1.00	0.25
SUBS_RE V	-0.13	-0.30	0.24	-0.12	0.33	0.00	0.47	0.46	0.27	0.55	0.25	1.00

Note: The coefficients of correlation are not weighted.

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