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Jens K. Perret

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On the importance of growth spillovers and regional clustering in the Russian Federation

Jens K. Perret*

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Abstract

Regions differ from each other not only in their economic structure but concerning the impact they have on their neighbors. In the present study interregional spillover activities are analyzed for the regions of the Russian Federation. Instead of knowledge spillovers, more general growth spillovers are accounted for. The time period observed in this study is 1994 to 2008, therefore a large part of the Russian transition period. Using the local Moran's I statistic as a measure of regional spillover activity reveals that only limited spillover activity is present. Additionally, to account for the range of these spillovers, an approach introduced by Bottazzi and Peri (2003) is implemented. It is shown that the spillovers' reach is very limited if present at all.

*European Institute for International Economic Relations at the University of Wuppertal

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1 Introduction

Regions of the Russian Federation are not homogeneous. While the same holds true for the European Union, the degree of heterogeneity in Russia reaches a different level and regional differences are more apparent.

Geographically, the Russian Federation consists of a broad range of differing regions; federal cities (Moscow and St. Petersburg) on the one hand and regions like the Republic of Sakha, which spans an area of around three quarter the size of the European Union. Economically the regions differ in the same way. With Moscow as the center of economic welfare in Russia, differences especially to Caucasian regions like the Republic of Ingushetia are enormous.

Due to the heterogenous structure of Russia concerning the size and layout of its regions, the sectoral distribution in the regions as well as the income levels, it stands to reason whether the theory concerning growth spillovers are mostly developed with a focus on European and Northern American regions[1] still holds for Russian regions or whether growth spillovers even exist across Russian regions. The following study takes a look at the development of the Russian regions and deduces the range of spillovers across them after describing to what extent spillovers are present and in what geographical areas they are most pronounced.

Using data for the years 1994 to 2007 the present study is the first approach to analyse the development of regional growth spillovers in a transition economy - especially in Russia - across a period that spans most of its transition period. For established market economies, studies have already been conducted especially for Canada, which reports a similar regional layout as the Russian Federation[2].

The following second section offers a basic description of the methodology applied. The third section contains a basic description of the growth process across the regions after which the range and importance of spillover effects is observed. Finally, the fourth section lists options for policy makers and the fifth concludes.

[1]See for example Jaffe, A.B.; Trajtenberg and Henderson (1993), Audretsch and Feldman (1996) or Audretsch (1998)

[2]See Bernstein (1996).

2 Methodology

2.1 Measuring Spatial Autocorrelation

Spillovers are a specific type of external effects - one region influencing another neighboring region - thereby closely related to effects of spatial autocorrelation. As such, they can be measured in the same fashion. In the course of this study the local Moran's I statistic[3] is used to check for regional spillovers.

As the interest in the present study is on spillovers generated by single regions. The local version of the Moran's I statistic is used, reporting whether a region is a growth enhancer (generating positive external effects) or a growth diminisher (generating negative external effects).

Central to the statistic is the matrix $W = (w_{i,j})_{i,j}$ of spatial weights. The matrix represents the distance between two regions. The matrix implemented in this analysis uses a weight matrix as introduced in Niebuhr (2000) where $w_{i,j}$ is calculated as follows:

$$w_{i,j} = exp\left(\frac{d_{i,j} \cdot ln(V)}{D_{MIN}}\right) \tag{1}$$

Parameter V $(0 < V < 1)$ gives the sensitivity of the weights. If a small V is used, the range of the neighborhood will enlarge and clusters are more likely to arise. The literature recommends a parameter of around $V = 0.5$[4] as this offers average levels of spillover activity to be reported. The variable D_{MIN} gives the average distance over all distances considered.

Furthermore, the matrix W needs to be row-normalized, so that the following restriction holds:

$$\sum_{j=1}^{N} w_{i,j} = 1 \qquad \forall i = 1, ..., N \tag{2}$$

Using the row-normalized matrix W, the local Moran's I statistic is given

[3]Moran (1950), Getis and Ord (1992) and Schulze (1993).

[4]See Niebuhr (2000).

as[5]:

$$I_i = \frac{N(x_i - \overline{x})}{\sum_{k=1}^{N}(x_k - \overline{x})^2} \sum_{j=1}^{N} w_{i,j} \cdot (x_j - \overline{x}) \tag{3}$$

Here N gives the number of spatial units, while x_i gives the value for region i and an overline signifies taking the mean[6]. Values of the statistic above / below the mean signify the presence of positive / negative autocorrelation and values close to the mean signify the absence of autocorrelation[7].

Additional more advanced approaches to measure spatial autocorrelation are given by Anselin (1988), Niebuhr (2001) or especially for the case when spatial heterogeneity is present as well (Karlström and Ceccato (2002)).

2.2 Measuring the Range of Spillovers

In this section the approach used by Bottazzi and Peri (2003) is modified to measure the extent of growth spillover effects across the Russian regions. In Bottazzi and Peri (2003) spillovers are considered to be generated via research and development activities and the following equation is estimated to measure their existence:

$$\begin{aligned} log(Patents^0_{j,t}) = &\beta_0 + \beta_1 \cdot log(RD^0_{j,t-1}) + \beta_2 \cdot log(RD^{30}_{j,t-1}) + \beta_3 \cdot log(RD^{75}_{j,t-1}) \\ &+ \beta_4 \cdot log(RD^{150}_{j,t-1}) + \beta_5 \cdot log(RD^{300}_{j,t-1}) \\ &+ \beta_6 \cdot log(RD^{500}_{j,t-1}) + \beta_7 \cdot log(RD^{1000}_{j,t-1}) + \mu \end{aligned} \tag{4}$$

Here $RD^x_{j,t}$ stands for the expenditures on research and development of region j in period t in a radius of x km around the center of region j - with zero signifying the expenditures of the region itself. Supposing, that Russia shows the same spillover dynamics as Western Europe and that results gained from studying European regions can be carried over to Russia, results from Bottazzi and Peri (2003), Döring (2004), Buccellato (2007), Varga (2000), Funke and Niebuhr (2000) and Anselin, L.; Varga and Acs (1997) suggest that the parameters β_2 to β_5 should be significant and positive.

[5]See Anselin (1988) and Schulze (1993). The Moran's I statistic is chosen over the Getis-Ord statistic as the Moran's I is more related to the spillover effects while the Getis-Ord statistic is more effective in detecting clustering activities as argued by Feldkircher (2006) and Carroll, M.C.; Reid and Smith (2008).

[6]Checking for growth spillovers, x_i is the regional GDP (GRP).

[7]For large N, the mean of the statistic converges to zero.

Though, the present study does not restrict itself to spillovers generated by research and development expenditures for two reasons. Expenditures on R&D are on the one hand a cumulative indicator of tacit and codified knowledge[8], but not all of the aspects of their transfers are represented by them[9]. For example knowledge generated by learning-by-doing processes is not considered. On the other hand, expenditures are no final measure, as there is no fixed relation between expenditures and knowledge.

Due to these restrictions in the following study R&D expenditures are substituted by real GRP. GRP represents the external facets of all knowledge generating processes in the regions, regardless of whether they are tacit or codified knowledge generating processes. The downside of observing GRP data is that GRP is also influenced by other aspects besides the knowledge generating processes. Even though, we assume that the GRP is generated via a standard Cobb-Douglas-type production function:

$$GRP = H \cdot K^{\alpha} \cdot L^{\beta} \tag{5}$$

Added to results from neoclassical growth theory it can be assumed that the main influences on GRP stem either from a change in the labor force, a change in capital stock or the knowledge stock. Furthermore, the model by Solow (1956) and Swan (1956) implies that the major influences for industrialized countries arise from the level of the stock of knowledge H. The labor force and the capital stock can only explain a small part of total GRP and correspondingly GRP per Capita as well. Therefore equation (3) is changed as follows.

$$\begin{aligned} log(grp^{0}_{j,t}) =& \beta_0 + \beta_1 \cdot log(grp^{0}_{j,t-1}) + \beta_2 \cdot log(grp^{30}_{j,t-1}) + \beta_3 \cdot log(grp^{75}_{j,t-1}) \\ &+ \beta_4 \cdot log(grp^{150}_{j,t-1}) + \beta_5 \cdot log(grp^{300}_{j,t-1}) \\ &+ \beta_6 \cdot log(grp^{500}_{j,t-1}) + \beta_7 \cdot log(grp^{1000}_{j,t-1}) + \mu \end{aligned} \tag{6}$$

Here $grp^{x}_{j,t}$ gives the cumulated GRP per Capita of region j in period t of a radius of x km around the center of region j. The distribution of distances is taken in accordance with Bottazzi and Peri (2003). The neighborhoods considered are: the region itself, a neighborhood of 30 km, 30 to 75 km, 75 to 150 km, 150 to 300 km, 300 to 500 km and finally 500 to 1000 km. In analogy to equation (3), the parameters β_2 to β_5 are assumed to be significantly

[8] See Jaffe, A.B.; Trajtenberg and Henderson (1993).

[9] Furthermore, Breschi and Lissoni (2001) argues that local spillovers are no pure knowledge spillovers.

positive as well, as this would imply a spillover radius of 300 km as is the case for the European Union and Northern America[10].

2.3 Data

The data used in the study stems from the Goskomstat database. The data on GRP is reported as nominal GRP but using regional price indices it is converted into real GRP. The data is available from 1994 to 2007 and therefore allows for an analysis of the pre-crisis transition process as well as the process of economic recovery starting in the early 2000s. To ensure data reliability, some constraints concerning the regions observed are necessary. Data for the okrugs of the krai Krasnoyarsk and the oblast Tyumen is only partially available. Therefore, the krai Krasnoyarsk and the oblast Tyumen are considered as single regions.

A problem given by the regional division implemented is the absolute difference in geographic size of the regions as the smallest region, the city of Moscow, only spans an area of 1,081 km^2, while the largest region, the Republic of Sakha, spans an area of 3,083,523 km^2. Nonetheless, the city of Moscow is the richest of the Russian regions - a problem insofar as regional size does not represent the regions' wealth. Another problem is the distance between two regions. Not only are the economic centers as well as the population unequally distributed but distances between the regions might be misleading; for example the capital of the republic of Sakha is near its southern border so that distances to southern regions might appear geographically less than to north eastern or north western regions. An alleviation to this is that it is to be assumed that most economic activity is concentrated in the area of the capital city.

3 Analysis of Growth Spillovers

The analysis of spillover processes is performed in two steps. At first, the local Moran's I statistic as introduced in section 2.1 is applied to regional GRP data for the periods 1994 to 2007 to characterize the process of regional interaction in the course of the Russian transition process. The results are strengthened in their significance by the second section where the approach for measuring the range of growth spillovers as introduced in section 2.2 is applied to the data.

[10]See Döring (2004), Bottazzi and Peri (2003), Varga (2000), Funke and Niebuhr (2000) and Anselin, L.; Varga and Acs (1997). They also in part motivate the setting of the distance intervals.

3.1 Indicators of Regional Clustering

To exemplify the development process the first four figures 1 to 4 give the absolute levels of the statistic for the years 1994, 1999, 2004 and 2007 and a parameter $V = 0.5$, while figures 5 to 8 give the change of the absolute levels. Figures 5 and 6 report the changes from 1994 to 1998 and figures 7 and 8 the changes from 1999 to 2007, thus capturing the development preceding and following the Russian crisis in 1998.

In figures 1 to 4 the regions colored in black are those regions that report a significantly positive local Moran's I statistic[11]. By contrast, the regions in gray are regions that report a significantly negative local Moran's I statistic. Finally, the white regions report regions with insignificant effects.

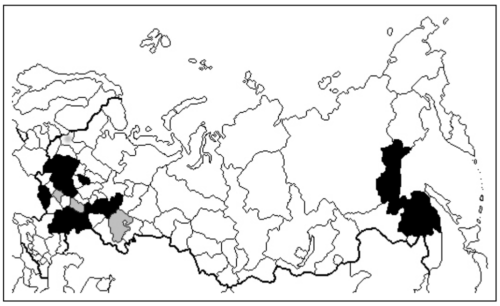

Figure 1: Moran's I - 1994

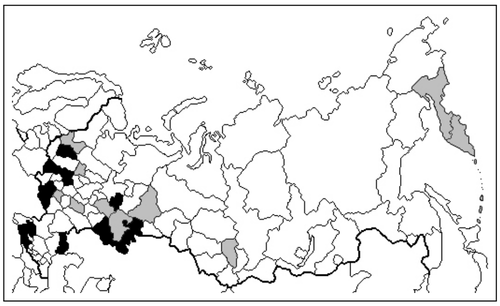

Figure 2: Moran's I - 1999

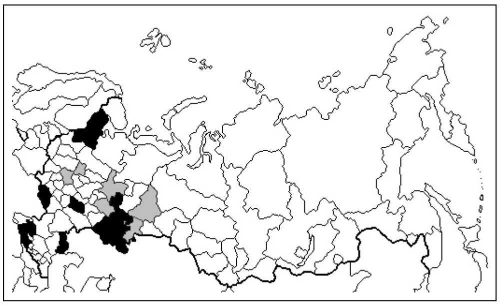

Figure 3: Moran's I - 2004

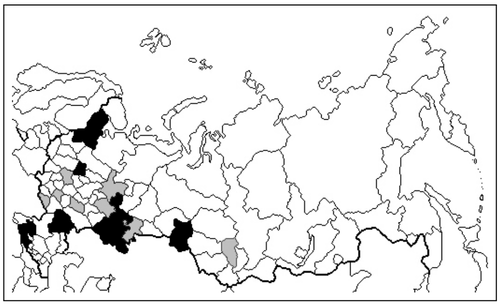

Figure 4: Moran's I - 2007

Comparing the figures above with results from Perret (2010), the role of the spatial weight matrix in the design of the landscape of spatial spillovers

[11]The statistical significance has been shown as follows. In a first step outliers regarding the their Moran's I value are omitted and using all remaining values the standard deviation is calculated. Assuming a normal distribution which is statistically incorrect, but (Tiefelsdorf, M.; Griffith and Boots (1999) and Tiefelsdorf (2002)) offer a solution that is sufficient for the present study, a t-test is performed on the significance of the calculated local Moran's I statistics.

and in the design of spatial autocorrelation effects in general is revealed. This necessitates the remark that the results discussed herein are only valid as far as the design of the weight matrix is appropriate. Though, it is assumed that a distance oriented approach in designing the weight matrix is preferable to a border based approach. As Russia, with heterogeneous region sizes and mostly long distances between two regions, a border based approach would imply a possible interaction of two regions whereas their distance from one another by far exceeds the distances spillovers usually travel (A maxmimum of 300 km for regions of the European Union[12]).

Before the findings can be discussed in detail it is necessary to mention that negative spillovers might as well signify regions that attracted industries from surrounding regions thereby being growth diminishers for their neighbors but growth enhancers for themselves. The same argument holds vice versa for positive spillovers.

Summing up the preceding figures, the growth enhancing regions are mostly in the Northern Caucasian (as is the case with Krasnodar, Volgograd and Astrakhan), in the area surrounding Moscow where members fluctuate quite rapidly over time and the area surrounding the Republic of Bashkortistan (as is the case with Udmurtia, Orenburg and Chelyabinsk). Growth diminishing clusters can also be found in the vicinity of Moscow and in the regions surrounding the Bashkortistan cluster.

Referring to the explanation above, it stands to reason that especially the regions in the vicinity of Moscow attracted industries from surrounding regions therefore reporting negative effects. The Caucasian regions might report positive spillovers as a sign of losing industries to surrounding regions.

The Moscow oblast, which has been a growth enhancing region in the first years, changed to a growth diminishing region in the later years. The reason for this development can be found in enterprises that relocate their production sites to the Moscow oblast or that found new firms in the oblast while investments in regions surrounding the Moscow oblast are not as interesting as those in the oblast and therefore diminish, which, taken together, generates the effect that the Moscow oblast has a negative effect on surrounding regions.

Aside from absolute levels, the following two figures illustrate the change in the statistics over two periods - 1994 to 1998 and 1999 to 2007. The figures are colored so that white regions are those that showed a positive statistic in the starting and ending periods (not necessarily statistically significant). The dark grey regions are those that reported negative statistics in both periods while the light grey regions report a change from positive to negative effects

[12]See Bottazzi and Peri (2003) and Döring (2004).

and the black regions report a change from negative to positive effects.

The light grey as well as black regions might face labor political problems as the possibilities of employment will change in these regions. With perfect labor mobility, no problems exist as the labor force would simply move to a different region. Even though, as is shown by Andrienko and Guriev (2004) and Berkowitz and DeJong (2003), labor mobility in Russia is rather low and therefore respective movement would not set in.

Consequently, for Russia, a presence of a large number of black or light grey regions would imply a worsening of the present distribution of labor force and labor supply. The figures show that in the first period a bigger number of these regions is present than in the later period. This might in part represent the development of economic decline in the years preceding the Russian crisis and the economic rise in the years after the crisis.

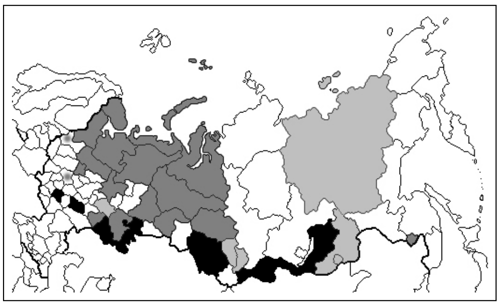

Figure 5: Moran's I Changes from 1994 to 1998

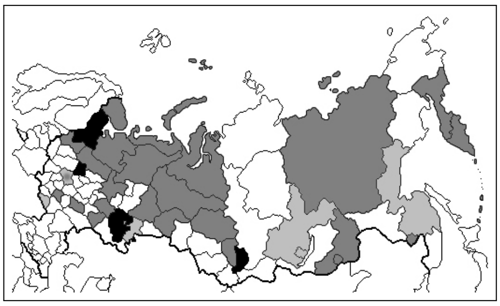

Figure 6: Moran's I Changes from 1999 to 2007

3.2 The Nature, Reach and Importance of Growth Spillovers

The preceding section presented a structure of interregional growth spillovers by pointing out regions that show a significant positive or negative influence on their neighbors. Even though, that analysis still lacks information on the extent of the influence. The figures in the preceding section showed that almost all spillovers are situated in the western part of Russia and are therefore mostly generated by smaller regions. Consequently, these regions are closer together and the supposition arises that in Russia, as well as in the European Union and Northern America, spillovers are regionally bounded and that the distance spillovers travel is bounded.

To test this hypothesis, the method applied by Bottazzi and Peri (2003) is implemented as described in section 2.2 and the results of the estimations are given in tables 1 to 4.

It was assumed that the period after the Russian crisis of 1998 is of special interest for current policy makers. Therefore, only the years 2002 to 2008 are considered as base years. This allows for lag structures of up to three years. The first three tables in the appendix report the results for estimations with a lag of one, two and three years respectively.

The figures show that regardless of the lag size and the starting year, almost no significant or consistent spillover activity can be detected. Though, in a few periods there is a slight trend of significant effects even if only on a very restricted level. This leads to three possible explanations.

- There is no significant spillover activity across the Russian regions.
- The model specification is not correct[13].
- There are spillovers present but in a manner only restricted to some sectors.

The following part of the study will take on the last two possibilities as hypotheses and provide insights on their validity, thereby proving the falsity of the first assumption.

In a first step, a panel estimation of the data above is performed to test for the model specification. The results are presented in table 4 in the appendix. While two estimations using a random effects as well as a fixed effects model have been carried out, it is the more reasonable choice to assume a fixed effects model. This setup would account for regional differences.

Even though, the results show, that even if the fixed effects model is applied, it only reports a low spillover activity in a radius of 30 km. Therefore, it is to be assumed that growth spillovers in the Russian Federation exist only on a very limited level at least considering the total economy and the lack of spillover activity is not due to some kind of model miss-specification. The consequence is to refuse the corresponding first two hypotheses.

The third hypothesis states that spillover activities are sectorally bounded. It is thereby related to the finding by Solanko (2003) that convergence is sector dependent. To account for this possibility, tables 5 to 9 in the appendix report estimation results for models only accounting for the sectors of most importance for the Russian economy. The selected sectors are: agriculture, mining and quarrying, manufacturing, financial intermediation and real estate, renting and business activities.

[13]As tests using a two-stage least square estimator with respective instrumental variable provide similar regression results (not part of this study), miss-specification of the model due to autocorrelation can be ruled out. Additional tests for heteroscedasticity are skipped as robust estimation coefficients have already been used.

In essence, the figures for the sectorally disaggregated estimations paint the same picture as those of the total economy. Except for the agricultural sector and the sector of real estate, renting and business activities, no sector shows significant spillover effects. Even the real estate sector only does so for recent years and agriculture is only significant if the results for the panel estimation are observed. Furthermore, the reach of spillovers in agriculture does not exceed the range of 150 km. The spillovers in real estate and business activities do not exceed the range of 30 km.

A possible explanation for the spillovers in real estate, renting and business activities might be found in the subsector of business activities. Especially in the larger cities, foremost in Moscow and St. Petersburg, enterprises are situated in the city but subsidiaries are found in the surrounding oblast or a nearby region. To keep a close connection between the firm and its subsidiary, the distance could not be too large, which might explain the existence as well as the short range of spillovers.

Consequently, the hypothesis of sectoral differences in growth spillover effects has to be partially accepted. Even though, the study shows that the effects are very limited. Therefore, it has to be assumed that for the general field of growth spillover across Russian regions there is only very limited proof. Therefore, arguing about Russian development trends and economic growth as well as possible policy options, a reference to a Kaldorian cumulative causation model[14] or to a growth pole model as introduced by Perroux[15] might be more fitting than to a spillover oriented one. A possible explanation for the low level of interregional spillovers might be found in a point argued by Eckey, H.-F.; Kosfeld and Türck (2005) and Berkowitz and DeJong (2003). It is necessary to differentiate between interregional and international activities and for the Russian regions it is shown that the international trade activities of the regions rise while the interregional trade diminishes. This especially means the regions develop mostly on their own and do not seem to follow a common goal nor are they influenced by each other in any profound manner.

4 Policy Issues and Conclusions

Almost no spillovers and therefore almost no regional interaction is present in the Russian Federation. This development trend does hinder positive development for Russia as a whole as all regions will develop on their own without a common goal. A problem that is also shown by the lack of absolute con-

[14]See Kaldor (1957).

[15]See Perroux (1948) and Perroux (1988).

vergence across the Russian regions (Buccellato (2007))[16]. While it has been argued that positive autocorrelation might as well signify positive spillover effects, it might as well signify diminishing economic welfare too. Nevertheless, even if autocorrelation effects are observed in general and not only the positive ones, their presence in the Russian Federation is rather limited.

Also before single policy options can be discussed it is necessary to differentiate between federal policy objectives and regional policy objectives. While federal policy should prepare the institutional background and the necessary infrastructure so that a common growth oriented policy can be implemented for the regions, it is necessary to evaluate their position in the interregional competition and take steps to alleviate region-specific problems or initiate growth-enhancing initiatives. Furthermore, the federal policy makers need to initiate more regional interaction, for example by supported cross-regional cluster or cooperation projects.

The first goal of federal policy should be to abolish barriers to knowledge and thereby growth spillovers[17] and secondly to pave the road for regions to be ready for absorbing the knowledge that might spill into them, as in investing in a better infrastructure and highly qualified human capital. Additionally, establishing a common development agenda which includes aspects of regional cooperation seems a reasonable starting point. An example of how such an agenda might be designed is to be found in one of the goals of the structural policy of the European Union - goal 3 of the European territorial cooperation. Methods implementable under this goal consist of a broad range of aspects, first and foremost those of the previous interregional or trade-oriented programs of the European Union. Nonetheless, the problem remains that policy makers can only change the environment in an economy but not the outcome directly, as argued in this context by Lall and Yilmaz (2000).

Referring to the figures in section 3, of particular interest are the black and the light grey regions, while for a single region's development outlook, the light grey regions should act as an example to other regions, especially if they could hold their status over a longer period of years. In contrast, for the black regions it is imperative to develop a program of structural policy. If on the contrary, a national policy is considered, it needs to focus on the light grey regions as to counter the trend of having a negative effect on neighboring regions.

After policies have been implemented to ensure the cooperation of regions

[16] Even though, in the context of regional convergence, the large distances between Russian regions play an important role as well.

[17] See Caniëls and Verspagen (2001).

with each other, policies need to be established to enable the regions to raise their level of spillover activity. While spillover activity is a broad expression, major necessities for high spillovers are a high labor mobility and an innovative firm structure. Both are aspects rather restricted or limited in the Russian Federation.

Additionally, the policy maker needs to keep in mind that to raise spillover activity, it is also necessary to raise the level of absorption potential of new innovations and new knowledge[18]. This includes the investment in higher levels of human capital[19].

Labor mobility is restricted by regulations concerning the movement to the federal cities of Moscow and St. Petersburg. Additionally, labor mobility is restricted by the poverty trap, where a large part of the populace is still trapped in[20]. To alleviate these problems, the Russian government needs to strengthen the labor markets in all regions and not the two federal cities alone. Thereby, not only raising the standard of living in these parts, but also lessening the wish to move to one of the major cities which in itself would make the regulation of labor mobility no longer critical.

The innovative firm structure is the second large problem of the Russian Federation as a large part of the capital stock is rather old and in need of reinvestments. Even though, few investments are actually done. Therefore, the Russian government needs to establish a system of investment incentives, while at the same time keeping track that the incentives do not get lost in a net of corruption. Only after establishing a necessary investment basis can the government go on to strengthen innovative activities such as the support of research and development activities or inter-firm and interregional cooperations.

Nevertheless, as almost all problems already listed by Vasiliev (1994) still exist in Russia today, the hope that actual change and even more so, significant spontaneous change will take place in Russia is rather slim.

The introductory question on the structure and the range of growth spillovers in the Russian Federation has to be answered in a very timid way. There are only very few spillover activities across Russia, almost all of which in the westernmost part. Additionally, those activities are not very strong and their reach is very limited. The only sectors where a significant level of spillover activity could be detected are the agricultural sector and the sector of real estate, renting and business activities.

Aside from the problem of missing spillover activities, possible points have

[18] Caniëls (2000) argues on the importance of absorption capacity and potential for knowledge of a region.

[19] On the importance of human capital formation see De La Fuente (2000).

[20] See Berkowitz and DeJong (2003).

been discussed where policy could start to establish a point of change.

Even though, the caveat of this study is that only growth spillovers have been analysed. While growth spillovers have advantages, as discussed in section 2, it might generate additional insights when accounting for knowledge spillovers as measured by research and development and patenting activities. Studying pure knowledge spillovers would provide the basis for painting a picture of the innovative structure of the Russian Federation and developing an according agenda for growth.

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Appendix

Variable	2008	2007	2006	2005	2004	2003	2002
$Constant$	-2679.489	-376.974	3069.378	-4604.358	-2903.520	2152.349	-354.388
	(0.004)	(0.802)	(0.065)	(0.010)	(0.014)	(0.004)	(0.544)
GRP_{t-1}	1.293	1.163	1.254	1.604	1.807	0.987	1.152
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GRP_{t-1}^{0-30}	-0.027	-0.145	0.049	-0.159	0.332	-0.221	0.096
	(0.619)	(0.151)	(0.749)	(0.165)	(0.072)	(0.102)	(0.254)
GRP_{t-1}^{30-75}	0.018	-0.006	0.165	-0.193	-0.044	0.020	0.047
	(0.335)	(0.850)	(0.003)	(0.002)	(0.521)	(0.611)	(0.249)
GRP_{t-1}^{75-150}	0.018	0.016	0.015	0.021	-0.099	0.014	-0.061
	(0.215)	(0.366)	(0.550)	(0.564)	(0.025)	(0.609)	(0.011)
$GRP_{t-1}^{150-300}$	0.001	0.003	0.006	0.004	0.012	-0.017	-0.001
	(0.835)	(0.568)	(0.323)	(0.551)	(0.322)	(0.020)	(0.915)
$GRP_{t-1}^{300-500}$	0.002	0.004	-0.016	0.008	0.030	-0.012	0.010
	(0.371)	(0.349)	(0.008)	(0.257)	(0.015)	(0.082)	(0.130)
$GRP_{t-1}^{500-1000}$	0.000	-0.003	-0.002	0.001	-0.001	-0.001	0.000
	(0.793)	(0.338)	(0.616)	(0.674)	(0.746)	(0.803)	(0.875)
R^2	0.995	0.982	0.974	0.972	0.964	0.947	0.982

Table 1: Estimation Results of Total Economy - Lag of 1 Year

Variable	2008	2007	2006	2005	2004	2003	2002
$Constant$	-2787.587	3789.495	-3027.001	-9306.363	575.372	1626.381	-1227.638
	(0.204)	(0.157)	(0.268)	(0.001)	(0.713)	(0.102)	(0.181)
GRP_{t-2}	1.496	1.442	2.024	2.893	1.816	1.152	1.789
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GRP_{t-2}^{0-30}	-0.230	-0.182	-0.149	0.262	-0.003	-0.139	0.058
	(0.198)	(0.538)	(0.450)	(0.461)	(0.992)	(0.305)	(0.759)
GRP_{t-2}^{30-75}	-0.041	0.178	-0.016	-0.399	-0.005	0.080	0.067
	(0.518)	(0.067)	(0.824)	(0.003)	(0.957)	(0.163)	(0.543)
GRP_{t-2}^{75-150}	0.039	0.034	0.050	-0.127	-0.068	-0.041	-0.093
	(0.261)	(0.306)	(0.358)	(0.162)	(0.322)	(0.284)	(0.171)
$GRP_{t-2}^{150-300}$	0.004	0.009	0.014	0.031	-0.019	-0.021	-0.006
	(0.582)	(0.297)	(0.179)	(0.245)	(0.185)	(0.014)	(0.750)
$GRP_{t-2}^{300-500}$	0.007	-0.014	-0.013	0.062	0.010	-0.003	0.033
	(0.220)	(0.074)	(0.180)	(0.016)	(0.458)	(0.705)	(0.036)
$GRP_{t-2}^{500-1000}$	-0.004	-0.005	-0.001	0.000	-0.003	-0.001	-0.016
	(0.419)	(0.381)	(0.827)	(0.966)	(0.580)	(0.737)	(0.009)
R^2	0.967	0.938	0.959	0.934	0.941	0.950	0.939

Table 2: Estimation Results of Total Economy - Lag of 2 Years

Variable	2008	2007	2006	2005	2004	2003	2002
$Constant$	3083.315	-3592.081	-10013.14	-4838.313	-23.821	555.131	-3551.302
	(0.456)	(0.219)	(0.002)	(0.008)	(0.992)	(0.543)	(0.014)
GRP_{t-3}	1.843	2.342	3.722	2.983	2.090	1.807	4.983
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GRP_{t-3}^{0-30}	-0.317	-0.445	0.494	-0.235	0.167	-0.247	1.529
	(0.495)	(0.223)	(0.166)	(0.522)	(0.593)	(0.353)	(0.023)
GRP_{t-3}^{30-75}	0.178	-0.028	-0.097	-0.332	0.088	0.105	-0.201
	(0.214)	(0.810)	(0.481)	(0.005)	(0.402)	(0.278)	(0.624)
GRP_{t-3}^{75-150}	0.063	0.084	-0.106	-0.052	-0.192	-0.056	-0.189
	(0.207)	(0.195)	(0.224)	(0.630)	(0.038)	(0.471)	(0.401)
$GRP_{t-3}^{150-300}$	0.013	0.022	0.050	-0.021	-0.024	-0.025	0.064
	(0.340)	(0.157)	(0.053)	(0.348)	(0.251)	(0.206)	(0.273)
$GRP_{t-3}^{300-500}$	-0.015	-0.007	0.043	0.031	0.029	0.074	0.035
	(0.141)	(0.522)	(0.049)	(0.127)	(0.175)	(0.215)	(0.405)
$GRP_{t-3}^{500-1000}$	-0.008	-0.006	-0.005	-0.003	-0.005	-0.018	-0.013
	(0.424)	(0.485)	(0.536)	(0.762)	(0.557)	(0.009)	(0.402)
R^2	0.912	0.933	0.956	0.954	0.924	0.920	0.899

Table 3: Estimation Results of Total Economy - Lag of 3 Years

Variable	Fixed Effects	Random Effects
$Constant$	2120.145	2989.079
	(0.000)	(0.000)
GRP_{t-1}	1.248	1.178
	(0.000)	(0.000)
GRP_{t-1}^{0-30}	-0.204	-0.134
	(0.004)	(0.645)
GRP_{t-1}^{30-75}	0.011	-0.003
	(0.705)	(0.978)
GRP_{t-1}^{75-150}	-0.003	0.018
	(0.847)	(0.597)
$GRP_{t-1}^{150-300}$	-0.001	0.003
	(0.797)	(0.714)
$GRP_{t-1}^{300-500}$	0.000	0.000
	(0.913)	(0.962)
$GRP_{t-1}^{500-1000}$	-0.003	-0.002
	(0.018)	(0.369)
Within R^2	0.953	0.953
Between R^2	0.997	0.997
Overall R^2	0.970	0.969

Table 4: Estimation Results of Total Economy - Panel Estimations

Variable	2008 (t-1)	2007 (t-1)	2006 (t-1)	2005 (t-1)	2008 (t-2)	2007 (t-2)	2006 (t-2)	Fixed Effects	Random Effects
$Constant$	-1539.309	-1444.375	1319.883	1776.051	-3016.038	-38.026	3134.806	2798.117	716.358
	(0.013)	(0.056)	(0.058)	(0.018)	(0.011)	(0.946)	(0.000)	(0.000)	(0.026)
GRP	1.106	1.305	1.056	0.764	1.431	1.438	0.816	0.506	1.007
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GRP^{0-30}	0.023	-0.024	-0.163	-0.015	-0.017	-0.215	-0.217	-0.217	-0.105
	(0.767)	(0.736)	(0.003)	(0.949)	(0.910)	(0.012)	(0.429)	(0.000)	(0.027)
GRP^{30-75}	-0.166	-0.089	0.041	-0.082	-0.292	-0.038	-0.045	-0.527	-0.095
	(0.007)	(0.199)	(0.139)	(0.302)	(0.027)	(0.696)	(0.641)	(0.008)	(0.037)
GRP^{75-150}	0.067	0.032	-0.001	-0.016	0.114	0.028	-0.017	0.203	0.036
	(0.071)	(0.193)	(0.947)	(0.585)	(0.048)	(0.486)	(0.709)	(0.016)	(0.062)
$GRP^{150-300}$	-0.004	0.013	-0.002	-0.001	0.004	0.011	0.001	0.029	0.000
	(0.751)	(0.389)	(0.849)	(0.945)	(0.985)	(0.541)	(0.971)	(0.389)	(0.965)
$GRP^{300-500}$	0.007	-0.003	0.005	-0.006	0.007	0.006	-0.004	0.003	0.000
	(0.336)	(0.680)	(0.373)	(0.580)	(0.605)	(0.627)	(0.776)	(0.869)	(0.950)
$GRP^{500-1000}$	0.000	0.004	-0.005	0.009	0.005	-0.003	0.004	0.007	0.001
	(0.991)	(0.173)	(0.005)	(0.141)	(0.308)	(0.515)	(0.523)	(0.380)	(0.611)
Within R^2								0.551	0.511
Between R^2								0.511	0.957
Overall R^2	0.892	0.867	0.880	0.667	0.760	0.820	0.593	0.520	0.810

Table 5: Estimation Results - Agriculture

Variable	2008 (t-1)	2007 (t-1)	2006 (t-1)	2005 (t-1)	2008 (t-2)	2007 (t-2)	2006 (t-2)	Fixed Effects	Random Effects
$Constant$	2599.381	5530.021	320.208	-2092.367	7650.702	6164.597	-1970.276	8766.897	2394.764
	(0.250)	(0.221)	(0.672)	(0.035)	(0.109)	(0.267)	(0.180)	(0.000)	(0.047)
GRP	0.960	1.124	1.102	-1.459	1.086	1.207	1.607	0.564	1.086
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
GRP^{0-30}	-2.732	-4.660	-0.087	4.335	-6.564	-3.916	3.800	-0.036	-2.093
	(0.266)	(0.214)	(0.859)	(0.047)	(0.102)	(0.273)	(0.195)	(0.900)	(0.055)
GRP^{30-75}	-29.566	7.597	-7.564	-11.528	-28.267	-9.579	-21.546	4.002	-15.720
	(0.116)	(0.750)	(0.681)	(0.520)	(0.287)	(0.798)	(0.425)	(0.800)	(0.241)
GRP^{75-150}	0.047	-0.055	-0.082	0.017	0.000	-0.146	-0.085	0.005	-0.018
	(0.379)	(0.639)	(0.034)	(0.784)	(0.999)	(0.387)	(0.398)	(0.964)	(0.681)
$GRP^{150-300}$	-0.008	-0.004	-0.004	0.004	-0.013	-0.011	-0.001	-0.002	-0.006
	(0.092)	(0.549)	(0.137)	(0.344)	(0.140)	(0.333)	(0.917)	(0.722)	(0.026)
$GRP^{300-500}$	-0.016	-0.004	-0.005	0.001	-0.200	-0.016	-0.007	0.006	-0.010
	(0.219)	(0.635)	(0.277)	(0.924)	(0.188)	(0.337)	(0.452)	(0.666)	(0.048)
$GRP^{500-1000}$	0.001	-0.021	0.006	0.018	-0.019	-0.015	0.029	-0.003	-0.003
	(0.944)	(0.243)	(0.267)	(0.038)	(0.307)	(0.490)	(0.017)	(0.823)	(0.607)
Within R^2								0.377	0.377
Between R^2								0.987	0.987
Overall R^2	0.974	0.856	0.994	0.987	0.845	0.810	0.979	0.925	0.926

Table 6: Estimation Results - Mining and Quarrying

Variable	2008 (t-1)	2007 (t-1)	2006 (t-1)	2005 (t-1)	2008 (t-2)	2007 (t-2)	2006 (t-2)	Fixed Effects	Random Effects
$Constant$	-3888.149	-815.630	-103.705	309.877	-4732.447	-900.485	305.354	3437.635	-491.07
	(0.003)	(0.429)	(0.874)	(0.787)	(0.010)	(0.476)	(0.848)	(0.022)	(0.344)
GRP	1.071	1.256	1.267	1.023	1.337	1.589	1.298	0.715	1.136
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GRP^{0-30}	0.266	0.041	0.056	-0.217	0.274	0.119	0.131	0.007	0.018
	(0.010)	(0.570)	(0.581)	(0.582)	(0.038)	(0.515)	(0.881)	(0.909)	(0.720)
GRP^{30-75}	-0.106	0.099	-0.011	-0.118	-0.039	0.080	-0.144	-0.253	-0.041
	(0.265)	(0.093)	(0.896)	(0.204)	(0.789)	(0.532)	(0.321)	(0.165)	(0.384)
GRP^{75-150}	-0.035	-0.057	0.003	-0.113	-0.099	-0.071	-0.141	-0.169	-0.053
	(0.411)	(0.140)	(0.890)	(0.012)	(0.157)	(0.241)	(0.010)	(0.087)	(0.02)
$GRP^{150-300}$	0.019	0.011	0.003	0.005	0.038	0.017	0.007	0.045	0.012
	(0.070)	(0.262)	(0.783)	(0.725)	(0.035)	(0.391)	(0.716)	(0.029)	(0.042)
$GRP^{300-500}$	0.009	0.019	0.009	0.013	0.031	0.038	0.026	0.026	0.012
	(0.284)	(0.114)	(0.130)	(0.246)	(0.140)	(0.045)	(0.127)	(0.125)	(0.032)
$GRP^{500-1000}$	0.006	-0.005	-0.005	0.008	0.002	-0.012	0.005	0.010	0.001
	(0.233)	(0.224)	(0.159)	(0.138)	(0.784)	(0.070)	(0.530)	(0.237)	(0.852)
Within R^2								0.700	0.677
Between R^2								0.931	0.989
Overall R^2	0.952	0.972	0.975	0.881	0.918	0.948	0.858	0.896	0.945

Table 7: Estimation Results - Manufacturing

Variable	2008 (t-1)	2007 (t-1)	2006 (t-1)	2005 (t-1)	2008 (t-2)	2007 (t-2)	2006 (t-2)	Fixed Effects	Random Effects
$Constant$	-24.262	-7.189	-33.905	-82.579	-32.658	-38.939	-123.452	366.090	-19.190
	(0.499)	(0.849)	(0.383)	(0.179)	(0.273)	(0.581)	(0.100)	(0.000)	(0.378)
GRP	0.986	1.001	1.132	1.205	0.991	1.131	1.366	0.332	1.059
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GRP^{0-30}	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
GRP^{30-75}	0.091	-0.065	0.128	0.175	0.044	-0.086	0.323	1.084	0.040
	(0.518)	(0.804)	(0.382)	(0.128)	(0.858)	(0.597)	(0.037)	(0.459)	(0.580)
GRP^{75-150}	0.020	-0.067	-0.080	0.091	-0.039	-0.099	0.040	-0.121	-0.009
	(0.480)	(0.473)	(0.141)	(0.022)	(0.632)	(0.175)	(0.362)	(0.230)	(0.737)
$GRP^{150-300}$	-0.002	0.007	0.004	-0.003	0.006	0.011	0.001	0.009	0.001
	(0.520)	(0.333)	(0.121)	(0.538)	(0.421)	(0.202)	(0.889)	(0.505)	(0.648)
$GRP^{300-500}$	0.001	-0.001	0.000	0.002	0.000	-0.001	0.000	0.008	0.000
	(0.841)	(0.787)	(0.994)	(0.542)	(0.896)	(0.759)	(0.917)	(0.535)	(0.904)
$GRP^{500-1000}$	0.000	0.004	0.003	0.004	0.003	0.007	0.007	0.006	0.001
	(0.863)	(0.170)	(0.350)	(0.504)	(0.217)	(0.171)	(0.298)	(0.321)	(0.441)
Within R^2								0.378	0.373
Between R^2								0.992	0.999
Overall R^2	0.994	0.994	0.995	0.980	0.996	0.984	0.978	0.978	0.985

Table 8: Estimation Results - Financial Intermediation

Variable	2008 (t-1)	2007 (t-1)	2006 (t-1)	2005 (t-1)	2008 (t-2)	2007 (t-2)	2006 (t-2)	Fixed Effects	Random Effects
$Constant$	-2819.976	-1599.487	751.896	-692.404	-4740.667	-501.747	-143.303	1310.256	-427.113
	(0.000)	(0.016)	(0.093)	(0.151)	(0.000)	(0.546)	(0.827)	(0.003)	(0.207)
GRP	1.225	1.458	1.241	1.389	1.782	1.810	1.731	1.064	1.285
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GRP^{0-30}	0.888	0.376	-0.367	-0.730	1.031	-0.049	-0.137	0.140	-0.135
	(0.000)	(0.006)	(0.010)	(0.124)	(0.000)	(0.858)	(0.826)	(0.251)	(0.188)
GRP^{30-75}	-0.567	-0.047	0.132	-0.016	-0.126	0.129	-0.132	-0.128	0.007
	(0.589)	(0.540)	(0.047)	(0.883)	(0.411)	(0.323)	(0.365)	(0.453)	(0.899)
GRP^{75-150}	0.053	0.006	0.017	-0.024	0.085	0.028	0.009	-0.090	0.003
	(0.144)	(0.870)	(0.712)	(0.751)	(0.213)	(0.662)	(0.929)	(0.159)	(0.903)
$GRP^{150-300}$	0.010	0.005	0.003	0.006	0.020	0.011	0.011	0.017	0.005
	(0.056)	(0.275)	(0.565)	(0.419)	(0.031)	(0.185)	(0.304)	(0.057)	(0.084)
$GRP^{300-500}$	0.005	0.006	-0.004	0.012	0.014	0.000	0.008	0.000	0.002
	(0.353)	(0.227)	(0.187)	(0.197)	(0.190)	(0.960)	(0.500)	(0.977)	(0.562)
$GRP^{500-1000}$	0.006	0.000	-0.001	-0.003	0.007	-0.001	-0.005	0.002	-0.001
	(0.178)	(0.986)	(0.782)	(0.583)	(0.343)	(0.855)	(0.503)	(0.763)	(0.705)
Within R^2								0.862	0.861
Between R^2								0.995	0.996
Overall R^2	0.984	0.989	0.990	0.966	0.971	0.980	0.964	0.975	0.976

Table 9: Estimation Results - Real Estate, renting and business activities