

Demidova, Olga; Bukina, Tatiana; Sverchkova, Natalia

## Conference Paper

# Dependence of spatial effects on the level of regional aggregation, weights matrix, and estimation method

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# **Dependence of spatial effects on the level of regional aggregation, weights matrix, and estimation method**

Bukina T.V.<sup>1</sup>, Demidova O.A.<sup>2</sup>, Sverchkova N.V.<sup>3</sup>

## **Extended abstract**

Researchers have repeatedly noted that the results in spatial-econometric studies depend significantly on the level of regional aggregation (Turner et al., 1989; Bonfiglio A. et al., 2014; Arbia, Petrarca, 2013, Jacobs-Crisioni et al., 2014; Kang et al., 2014, Baltagi, Li, 2014). Currently, hierarchical models can contribute a lot to the studies of spatial effects since they take into account nested structure of regions (Dong, Harris, 2014). In addition, some studies say that econometric results also depend on the choice of the weighting matrix  $W$  and the estimation method used (Elhorst, Vega, 2013; Kukenova, 2008). In different studies Monte-Carlo method with specially generated data is used to justify the selection of models or estimation method and to test the goodness-of-fit criteria (Kukenova, 2008, Piras, 2012). But there are not so many studies that use real data to compare the results obtained from estimating different types of models, weights matrix and methods. In this work we try to fill this gap by using different levels of regional aggregation, various weights matrices, and different models for economic growth in the Russian regions.

Based on the previous results of other practitioners, we are testing three main hypotheses in our own study:

H1: The estimation results of spatial-econometric models depend on the level of regional aggregation.

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<sup>1</sup> Associate Professor, National Research University Higher School of Economics, Perm, Russia, bukinyat@mail.ru

<sup>2</sup> Associate Professor, National Research University Higher School of Economics, Moscow, Russia, demidova@hse.ru

<sup>3</sup> Student, National Research University Higher School of Economics, Moscow, Russia, and Humboldt University, Berlin, Germany, n.v.sverchkova@gmail.com

H2: The estimation results of spatial-econometric models depend on the choice of the method of estimation.

H3: The estimation results of spatial-econometric models depend on the choice of the weights matrix.

To test these hypotheses we started with the estimation of spatial autoregression model with a time lag. However, we are planning to extend the choice of estimated models later.

In these models we use the GRP growth in analyzing spatial units (federal regions, economic regions or federal districts) in a certain year (in %) as a dependent variable, because growth models are the most commonly used types of models so that we could draw on the experience of other researchers in the selection of functional form and explanatory variables (Dall'Erba & Le Gallo, 2008; Seya et al., 2012; Basile, 2008; Fingleton & Lopez-Bazo, 2006; Lall & Shalizi, 2003; Lopez-Bazo et al., 2004; Fischer & LeSage, 2008, 2014 etc.). In the future we are planning to estimate models with different levels of regional aggregation and various weighting matrices for other variables.

In this paper data for 75 Russian regions within the period between 2005 and 2011 years are used to test the spatial effects occurring between them. The data for the other 8 regions are not included in the study for the following reasons: 1) there were changes in the administrative-territorial structure of Russia, 2) official information for some years is absent for some regions, such as Chechnya.

We could not use the earlier data, as before 2005 structure of gross value added was classified differently. More recent data on these indicators are also not yet available. We also include two levels of data aggregation: we aggregate data into 12 economic regions and into 8 federal districts to explore the interaction effects.

Taking into account the papers of the authors listed above we have chosen the following independent variables: the ratio of urban population to the total population (in %); the ratio of total population to the total area (separately for Moscow and St. Petersburg, and separately for the other regions, the number of

people / km<sup>2</sup>); GRP per capita (thousand rubles / person); the ratio of the investment volume in fixed assets to GRP; the share of agriculture, mining, manufacturing and financial services in the gross value added (in %); the ratio of gratuitous transfers to the total revenues of the consolidated budgets (in %); the share of total exports and total imports in GRP (in %); the ratio of people with higher education to the total population (in %); the number of patents granted per 10,000 population (units / 10 ths. people); the real growth in the economic region or federal district, which the certain region belongs to (in%). The description of all variables is given in Appendix 2.

In our research we have used three levels of aggregation: 1) most commonly used regional level (75 observation in each year) – analog of NUTS 3 level for Russia, 2) federal districts level (8 observation in each year) - analog of NUTS 2 level for Russia in the administrative context, 3) 12 enlarge economic regions - analog of NUTS 2 level for Russia in the economic context.

As we mentioned before, we use SAR with spatial lag as our basic model:

To test our first hypothesis we estimated models:

$$Y_{it} = \alpha_i^1 + \theta_1 Y_{it-1} + \rho_1 (WY)_{it} + (X\beta_1)_{it} + d_t^1 + \varepsilon_{it}^1 \quad (1)$$

$$Y_{ft} = \alpha_f^2 + \theta_2 Y_{ft-1} + \rho_2 (WY)_{ft} + (X\beta_2)_{ft} + d_t^2 + \varepsilon_{ft}^2 \quad (2)$$

$$Y_{et} = \alpha_e^3 + \theta_3 Y_{et-1} + \rho_3 (WY)_{et} + (X\beta_3)_{et} + d_t^3 + \varepsilon_{et}^3 \quad (3)$$

Where  $i = 1, \dots, 75$  - number of region,  $f = 1, \dots, 8$  - number of federal district,  $e = 1, \dots, 12$  - number of enlarge economic region,

Y - GRP growth in corresponding spatial units, X – matrix of explanatory variables,  $\alpha$  - fixed effects, d – time effects,  $\varepsilon$  - disturbances,  $\theta, \rho, \beta$  - estimated parameters (for simplicity we omitted all indexes).

To include the hierarchical structure of Russian regions (each federal district includes several regions, the same situation with enlarge economic regions) we added the average growth rate in corresponding federal district (or enlarge economic region) to model (1):

$$Y_{ift} = \alpha_i^4 + \theta_4 Y_{it-1} + \rho_4 (WY)_{it} + (X\beta_4)_{it} + \gamma \bar{Y}_{ft} + d_t^4 + \varepsilon_{it}^4 \quad (4)$$

$$Y_{iet} = \alpha_i^5 + \theta_5 Y_{it-1} + \rho_5 (WY)_{it} + (X\beta_5)_{it} + \phi \bar{Y}_{et} + d_i^5 + \varepsilon_{it}^5 \quad (5)$$

To test our second hypothesis we compared the results of ML, difference GMM and system GMM as estimation methods.

To test our third hypothesis we used three types of weights matrices: the binary contiguity ones (WC75, WC8, WC12), matrices of boundaries lengths (WB75, WB8, WB12), and matrix of inverse distance between the capitals of the regions by road (WID75).

The results of estimation are provided in the tables A1-A4 in Appendix 3.

According to the results obtained from estimated models we get the empirical support for the first hypothesis. The estimations of spatial autoregressive coefficient were positively significant for 75 regions and for the federal districts (Tables A1 and A2). The results for enlarged economic regions were unstable (Table A3). In models with hierarchical structure spatial autoregressive coefficients were insignificant for 75 regions (Table A4). However, coefficients of average growth in federal district or enlarge economic regions were highly significant.

Our second and third hypotheses also received empirical confirmation. We just discussed the difference in spatial effects. Concerning the results of estimation for explanatory variables' coefficients, we can note that the results for different methods of estimation and various weights matrices were the similar (in some cases with distinctions in the significance of coefficients) for the majority of cases. Some opposite estimates were obtained only in the case of federal districts and enlarged economic regions and can be easily explained by small number of observation (which entails a small number degrees of freedom in estimated models, matrices singularity etc.).

Thus, obtained results provided by the data on Russian regions largely confirm the findings of the articles cited above (Elhorst, 2013), (Kukenova, 2008), (Piras, 2012), and other studies related to the importance of choosing the right level of aggregation, model specification and estimation method when working

with spatial data. However, all of estimated models show the stable positive spatial effect at any level of aggregation, any specification and estimation method used.

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## **Appendix 1.**

### **List of Russian regions**

Number	Name	Federal District	Enlarge Economic Region
1	Belgorod region	Central	Central Black Earth
2	Bryansk region	Central	Central
3	Vladimir region	Central	Central
4	Voronezh region	Central	Central Black Earth
5	Ivanovo region	Central	Central
6	Kaluga region	Central	Central
7	Kostroma region	Central	Central

8	Kursk region	Central	Central Black Earth
9	Lipetsk region	Central	Central Black Earth
10	Moscow region	Central	Central
11	Orel region	Central	Central
12	Ryazan region	Central	Central
13	Smolensk region	Central	Central
14	Tambov region	Central	Central Black Earth
15	Tver region	Central	Central
16	Tula region	Central	Central
17	Yaroslavl region	Central	Central
18	Moscow	Central	Central
19	Republic of Karelia	Northwestern	Northern
20	Republic of Komi	Northwestern	Northern
21	Arkhangelsk region	Northwestern	Northern
22	Vologda region	Northwestern	Northern
23	Kaliningrad region	Northwestern	Kaliningrad
24	Leningrad region	Northwestern	Northwestern
25	Murmansk region	Northwestern	Northern
26	Novgorod region	Northwestern	Northwestern
27	Pskov region	Northwestern	Northwestern
28	Saint-Petersburg	Northwestern	Northwestern
29	Republic of Adygea	Southern	North Caucasus
30	Republic of Kabardino-Balkaria	Southern	Volga
31	Republic of Kalmykia	Southern	North Caucasus



32	Republic of Karachaevo-Cherkessia	Southern	Volga
33	Republic of Northern Osetia – Alania	Southern	Volga
34	Krasnodar Territory	Southern	North Caucasus
35	Stavropol Territory	North Caucasian	North Caucasus
36	Astrakhan region	North Caucasian	North Caucasus
37	Volgograd region	North Caucasian	North Caucasus
38	Rostov region	North Caucasian	North Caucasus
39	Republic of Bashkortostan	Volga	Urals
40	Republic of Marii El	Volga	Volga-Vyatka
41	Republic of Mordovia	Volga	Volga-Vyatka
42	Republic of Tatarstan	Volga	Volga
43	Republic of Udmurtia	Volga	Urals
44	Republic of Chuvashia	Volga	Volga-Vyatka
45	Perm territory	Volga	Urals
46	Kirov region	Volga	Volga-Vyatka
47	Nizhny Novgorod region	Volga	Volga-Vyatka
48	Orenburg region	Volga	Urals
49	Penza region	Volga	Volga
50	Samara region	Volga	Volga
51	Saratov region	Volga	Volga
52	Ulyanovsk region	Volga	Volga

	Eastern regions		
53	Kurgan region	Ural	Urals
54	Sverdlovsk region	Ural	Urals
55	Tumen region	Ural	West Siberian
56	Chelyabinsk region	Ural	Urals
57	Republic of Altay	Siberian	West Siberian
58	Republic of Buryatia	Siberian	East Siberian
59	Republic of Tyva	Siberian	East Siberian
60	Republic of Khakassia	Siberian	East Siberian
61	Altay Territory	Siberian	West Siberian
62	Krasnoyarsk Territory	Siberian	East Siberian
63	Irkutsk region	Siberian	East Siberian
64	Kemerovo region	Siberian	West Siberian
65	Novosibirsk region	Siberian	West Siberian
66	Omsk region	Siberian	West Siberian
67	Tomsk region	Siberian	West Siberian
68	Republic of Sakha (Yakutia)	Far Eastern	Far Eastern
69	Kamchatka territory	Far Eastern	Far Eastern
70	Primorsky Territory	Far Eastern	Far Eastern
71	Khabarovsk Territory	Far Eastern	Far Eastern
72	Amur region	Far Eastern	Far Eastern
73	Magadan region	Far Eastern	Far Eastern
74	Sakhalin region	Far Eastern	Far Eastern
75	Jewish autonomous area	Far Eastern	Far Eastern

## Appendix 2. List of variables

Variable	Acronym	Definition	Values
Share of urban population	urb_s	The ratio of urban population to total population	%
The population density	density	Ratio of total population to total land area	number of people / km <sup>2</sup>
The population density in Moscow and St. Petersburg	densitycap		
The population density in other regions of Russia	densitynocap		
GRP per capita in prices of basis year	rgrp_per_c	Ratio of to the GRP population	thousand rubles / person
Investment in fixed assets in the GRP	inv	The ratio of investment in fixed assets to GRP	
Structure of gross value added by production approach	agr min man fin	The share of agriculture, mining, manufacturing and financial services in gross value added	%
Share of transfers in the general consolidated budget revenues	tr_s	Ratio of gratuitous transfers to the general consolidated budget revenues	%
Export and import openness of region	exp_s imp_s	Percentage of total exports and total imports in GRP	%
Education of population	educ	Percentage of people with higher education diploma in the total population	%

Innovative activity of region	pat_per_c	The number of patents granted per 10,000 people	items / 10 thousand people
Average growth in neighboring regions	Ec_dist_growth/ fed_dist_growth	Growth in real GRP in the economic area in which the entity is located  Growth in real GRP in the federal district in which the entity is located	%

### Appendix 3.

#### Results of estimation for models with different level of data aggregation

Table A1. Regional level

Method of estimation	ML			Dif. GMM			System GMM		
	WC75	WB75	WID75	WC75	WB75	WID75	WC75	WB75	WID75
Weights matrix									
Variables									
Time lag	- 0.253** *	- 0.256** *	- 0.245** *	- 0.0589*	-0.0535	- 0.0701*	- 0.0536*	-0.0520	-0.0516
	(0.0416)	(0.0418)	(0.0418)	(0.0346)	(0.0350)	(0.0375)	(0.0319)	(0.0328)	(0.0334)
Spatial lag	0.183** *	0.146** *	0.384** *	0.191** *	0.146** *	0.764** *	0.203** *	0.147** *	0.0224
	(0.0548)	(0.0509)	-0.1306	(0.0571)	(0.0467)	(0.110)	(0.0547)	(0.0471)	(0.159)
urb_s	-0.511	-0.487	-0.420	-1.019	-1.056	-0.826	- 0.978** *	- 0.982** *	- 0.987** *
	(0.516)	(0.518)	(0.517)	(0.642)	(0.650)	(0.633)	(0.261)	(0.257)	(0.253)
rgrp_per_c	0.0712* *	0.0709* *	0.0678* *	0.301** *	0.291** *	0.311** *	0.316** *	0.312** *	0.320** *
	(0.0290)	(0.0291)	(0.0291)	(0.0514)	(0.0505)	(0.0506)	(0.0371)	(0.0371)	(0.0361)
inv_sh	0.206** *	0.206** *	0.204** *	0.123	0.120	0.0989	0.172**	0.168**	0.155**

	(0.0565)	(0.0568)	(0.0568)	(0.0826)	(0.0827)	(0.0851)	(0.0751)	(0.0750)	(0.0736)
agr	-0.118	-0.0932	-0.0726	0.316	0.356	0.316	0.367	0.384	0.399
	(0.252)	(0.252)	(0.252)	(0.348)	(0.341)	(0.335)	(0.349)	(0.341)	(0.341)
min	0.591** *	0.589** *	0.563** *	0.687** *	0.719** *	0.581** *	0.765** *	0.780** *	0.744** *
	(0.160)	(0.161)	(0.161)	(0.190)	(0.190)	(0.192)	(0.168)	(0.169)	(0.168)
man	0.562** *	0.569** *	0.556** *	1.137** *	1.147** *	1.084** *	1.085** *	1.085** *	1.111** *
	(0.138)	(0.139)	(0.139)	(0.212)	(0.214)	(0.213)	(0.208)	(0.210)	(0.204)
fin	1.036	0.923	0.820	0.989	1.110	0.300	0.0972	0.127	0.124
	(1.327)	(1.332)	(1.332)	(1.520)	(1.493)	(1.410)	(1.301)	(1.289)	(1.171)
tr_sh	0.100	0.101	0.120	- 0.00216	- 0.00677	- 0.00638	0.0500	0.0394	0.0497
	(0.0786)	(0.0790)	(0.0791)	(0.0774)	(0.0759)	(0.0717)	(0.0644)	(0.0649)	(0.0638)
exp_s	- 0.00961	-0.0114	-0.0143	0.0201	0.0178	0.0277	- 0.00750	- 0.00898	0.00952
	(0.0330)	(0.0331)	(0.0331)	(0.0310)	(0.0313)	(0.0306)	(0.0282)	(0.0284)	(0.0305)
imp_s	0.0436	0.0415	0.0408	0.0272	0.0293	0.00357	0.0496	0.0516	0.0399
	(0.0469)	(0.0470)	(0.0471)	(0.0329)	(0.0326)	(0.0319)	(0.0335)	(0.0331)	(0.0338)
educ_s	1.577	1.728	1.605	-0.947	-0.639	-2.347	2.042	2.391	2.736
	(2.673)	(2.682)	(2.687)	(2.874)	(2.941)	(2.785)	(2.594)	(2.635)	(2.678)
pat_per_c	-1.108*	-1.092*	-0.985*	- 1.010** *	- 1.009** *	- 0.982** *	- 0.860**	- 0.857**	- 0.887**
	(0.596)	(0.598)	(0.598)	(0.379)	(0.365)	(0.327)	(0.374)	(0.363)	(0.371)
density									
densitycap	- 0.00469	- 0.00515	- 0.00556	0.0192* *	0.0185* *	0.0127*	-0.0105	-0.0112	-0.0118
	(0.0097 6)	(0.0098 0)	(0.0098 1)	(0.0080 9)	(0.0078 0)	(0.0075 0)	(0.0089 1)	(0.0091 8)	(0.0094 1)
densitynocap	-1.116	-1.105	-1.062	- 4.493** *	- 4.502** *	- 4.284** *	0.201	0.189	0.216

	(0.988)	(0.992)	(0.993)	(0.529)	(0.539)	(0.465)	(0.257)	(0.256)	(0.253)
y2006	1.785	-0.417	-1.729	5.830** *	5.974** *	3.309** *	6.203** *	6.396** *	6.510** *
	(1.896)	(1.843)	(3.308)	(0.918)	(0.906)	(1.081)	(0.803)	(0.790)	(0.800)
y2007	-1.423	- 3.776**	-4.164						
	(1.645)	(1.604)	(2.785)						
y2008	- 7.169** *	- 9.621** *	- 9.332** *	- 4.936** *	- 4.956** *	- 2.947** *	- 5.165** *	- 5.293** *	- 5.943** *
	(1.440)	(1.403)	(2.359)	(0.903)	(0.905)	(0.845)	(0.863)	(0.861)	(0.913)
y2009	-18.03	-21.08	-16.92	- 11.01** *	- 11.88** *	0.692	- 10.83** *	- 11.91** *	- 14.41** *
	(0)	(0)	(0)	(1.685)	(1.725)	(2.371)	(1.715)	(1.736)	(3.302)
y2010	- 11.16** *	- 13.66** *	- 12.87** *	- 4.950** *	- 4.789** *	-2.106	- 4.545** *	- 4.599** *	- 4.686** *
	(1.486)	(1.462)	(2.289)	(1.682)	(1.717)	(1.760)	(1.568)	(1.579)	(1.603)
y2011	- 4.959** *	- 7.231** *	- 7.932** *	- 4.180** *	- 3.896** *	- 4.531** *	- 4.046** *	- 3.882** *	- 3.473**
	(1.577)	(1.519)	(2.859)	(1.451)	(1.465)	(1.495)	(1.306)	(1.295)	(1.463)
Const				231.5** *	239.0** *	157.6** *	92.72** *	99.16** *	110.1** *
				(45.37)	(46.77)	(48.56)	(21.03)	(19.96)	(24.39)
Observations	450	450	450	375	375	375	450	450	450

**Table A2. Federal districts level**

Method of estimation	ML		Dif.GMM		System GMM	
	WC8	WB8	WC8	WB8	WC8	WB8
Variables						
Time lag	-0.292*** (0.0936)	-0.297*** (0.0942)	-0.149** (0.0711)	-0.151** (0.0707)	-0.0773 (0.0710)	-0.0708 (0.0715)

Spatial lag	0.310**	0.279**	0.395***	0.370***	0.880***	0.868***
	(0.124)	(0.119)	(0.125)	(0.120)	(0.0663)	(0.0680)
urb_s	-7.076**	-6.766**	1.630***	1.692***	0.906***	0.938***
	(2.842)	(2.862)	(0.595)	(0.587)	(0.298)	(0.296)
rgrp_per_c	0.0830	0.0823	0.332***	0.340***	0.541***	0.561***
	(0.0583)	(0.0588)	(0.0647)	(0.0637)	(0.162)	(0.159)
inv_sh	-0.985***	-0.983***	-2.689***	-2.759***	-2.393***	-2.374***
	(0.208)	(0.210)	(0.770)	(0.832)	(0.530)	(0.539)
agr	-0.294	-0.179				
	(0.767)	(0.762)				
min	0.857**	0.885**			-4.508***	-4.739***
	(0.376)	(0.378)			(1.325)	(1.295)
man	0.845**	0.893**				
	(0.387)	(0.389)				
fin	-2.134	-1.723				
	(3.111)	(3.114)				
tr_sh	0.325**	0.303*	-0.435**	-0.479**	0.321**	0.249*
	(0.155)	(0.157)	(0.196)	(0.193)	(0.138)	(0.148)
exp_s	0.112	0.107	-0.741**	-0.798*	-0.0342	-0.0401
	(0.172)	(0.173)	(0.373)	(0.416)	(0.163)	(0.162)
imp_s	-0.185	-0.181	2.155**	2.298**		
	(0.220)	(0.222)	(0.995)	(1.080)		
educ_s	-8.404	-9.056				
	(8.526)	(8.595)				
pat_per_c	-17.51***	-17.38***				
	(3.148)	(3.171)				
density	6.169*	6.389*				

	(3.483)	(3.536)				
densitycap						
densitynocap						
y2006	1.169	1.242				
	(4.289)	(0)				
y2007	3.252	3.392*				
	(3.565)	(1.759)				
y2008	3.158	3.274				
	(2.842)	(2.677)				
y2009	-3.241	-3.625				
	(0)	(4.309)				
y2010	-0.342	-0.328				
	(3.006)	(3.780)				
y2011	5.720*	5.871				
	(3.320)	(3.642)				
Const						
Observations	48	48	40	40	48	48

**Table A3. Economic regions level**

Method of estimation	ML		Dif.GMM		System GMM	
	WC12	WB12	WC12	WB12	WC12	WB12
Weighted matrix						
Variables						
Time lag	-0.321***	-0.323***	0.631	0.426***	0.00671	-0.0260



	(0.0981)	(0.0986)	(0.574)	(0.117)	(0.187)	(0.181)
Spatial lag	0.137	0.103	0.724**	0.109	0.912***	0.800***
	(0.0975)	(0.0903)	(0.342)	(0.0837)	(0.192)	(0.188)
urb_s	4.349*	4.185*	2.201**	0.174	-0.451	-0.398
	(2.237)	(2.241)	(0.874)	(1.251)	(0.339)	(0.340)
rgrp_per_c	0.160**	0.167**	0.154	0.137	0.734**	0.775**
	(0.0746)	(0.0749)	(0.165)	(0.181)	(0.297)	(0.308)
inv_sh	-0.0468	-0.0373	-	0.651	-	-
	(0.183)	(0.184)	(0.627)	(1.528)	(0.953)	(0.988)
agr	2.096***	2.117***	-14.87		8.620	8.528
	(0.804)	(0.809)	(9.716)		(6.398)	(6.507)
min	1.236***	1.223***	-2.082	4.131**	0	0
	(0.334)	(0.337)	(3.488)	(1.618)	(0)	(0)
man	1.288***	1.275***	-1.443	0.811	0.494	1.080
	(0.303)	(0.305)	(1.571)	(0.640)	(1.540)	(1.624)
fin	4.783	4.721				
	(3.455)	(3.476)				
tr_sh	-0.0278	-0.0156	-0.566**	0.0285	1.034**	1.037**
	(0.177)	(0.178)	(0.241)	(0.248)	(0.516)	(0.523)
exp_s	0.0882	0.0870	0.0914	0.883*	-	-
	(0.109)	(0.110)	(0.756)	(0.479)	(0.137)	(0.135)
imp_s	0.216***	0.208***	-0.185	0.293***	1.434***	1.469***
	(0.0801)	(0.0798)	(0.247)	(0.0848)	(0.336)	(0.346)
educ_s	0.532	0.607				
	(7.488)	(7.532)				
pat_per_c	-4.652	-4.742				

	(3.547)	(3.567)				
density	-4.574*	-4.651*			-0.849*	-0.866*
	(2.757)	(2.771)			(0.498)	(0.490)
densitycap						
densitynocap						
y2006	10.58	10.99		14.75		
	(0)	(0)		(10.26)		
y2007	8.614***	8.850***	-0.223	15.43***		
	(1.831)	(1.828)	(6.162)	(4.320)		
y2008	2.380	2.416				
	(2.625)	(2.598)				
y2009	-4.985	-5.652				
	(4.306)	(4.133)				
y2010	-0.0688	-0.00821				
	(3.913)	(3.910)				
y2011	2.576	2.820			-15.36**	-14.74*
	(3.472)	(3.486)			(7.286)	(7.677)
Const						
Observations	72	72	60	60	72	72

**Table A4. Results of estimation for models with hierarchical structure**

Method of estimation	Dif.GMM					
	WC75	WB75	WID75	WC75	WB75	WID75
Weighted matrix						
Time lag	-	-	-	-	-	-

	0.0935***	0.0913***	0.0961***	0.0711**	0.0671**	0.0718**
	(0.0335)	(0.0336)	(0.0343)	(0.0337)	(0.0339)	(0.0346)
Spatial lag	-0.0344	-0.0578	-0.0185	0.0372	-0.00542	0.167
	(0.0534)	(0.0472)	(0.185)	(0.0511)	(0.0451)	(0.199)
Average growth in corresponding Economic Region	0.462***	0.471***	0.452***			
	(0.0725)	(0.0656)	(0.0812)			
Average growth in corresponding Federal District				0.384***	0.412***	0.363***
				(0.0803)	(0.0771)	(0.0958)
urb_s	-1.021	-1.046	-1.016	-0.930	-0.918	-0.853
	(0.671)	(0.671)	(0.652)	(0.680)	(0.677)	(0.661)
rgrp_per_c	0.264***	0.263***	0.268***	0.289***	0.287***	0.290***
	(0.0529)	(0.0531)	(0.0532)	(0.0549)	(0.0551)	(0.0542)
inv_sh	0.0944	0.0881	0.0875	0.109	0.101	0.102
	(0.0740)	(0.0745)	(0.0742)	(0.0711)	(0.0711)	(0.0733)
agr	0.358	0.342	0.379	0.332	0.309	0.352
	(0.319)	(0.316)	(0.324)	(0.309)	(0.304)	(0.310)
min	0.654***	0.629***	0.653***	0.696***	0.679***	0.677***
	(0.177)	(0.179)	(0.177)	(0.180)	(0.180)	(0.182)
man	0.923***	0.923***	0.897***	0.929***	0.924***	0.923***
	(0.200)	(0.194)	(0.201)	(0.207)	(0.205)	(0.210)
fin	0.843	0.787	0.908	0.484	0.394	0.393
	(1.569)	(1.550)	(1.543)	(1.674)	(1.648)	(1.626)
tr_sh	0.0144	0.0120	0.00571	-0.00324	-0.0113	-0.00771
	(0.0676)	(0.0675)	(0.0667)	(0.0712)	(0.0717)	(0.0712)
exp_s	0.0290	0.0310	0.0263	0.0165	0.0173	0.0150
	(0.0244)	(0.0236)	(0.0246)	(0.0299)	(0.0294)	(0.0306)
imp_s	0.0275	0.0249	0.0301	0.0309	0.0298	0.0253
	(0.0325)	(0.0330)	(0.0329)	(0.0337)	(0.0336)	(0.0341)
educ_s	-3.355	-3.253	-3.110	-2.835	-2.709	-2.760

	(2.495)	(2.545)	(2.521)	(2.603)	(2.670)	(2.677)
pat_per_c	-0.909***	-0.911***	-0.915***	1.005***	1.019***	1.001***
	(0.303)	(0.306)	(0.302)	(0.310)	(0.305)	(0.310)
densitycap	0.00970*	0.00885*	0.0103*	0.00894	0.00785	0.00821
	(0.00545)	(0.00519)	(0.00539)	(0.00820)	(0.00795)	(0.00809)
densitynocap	-3.450***	-3.410***	-3.359***	3.774***	3.702***	3.731***
	(0.613)	(0.607)	(0.618)	(0.586)	(0.589)	(0.586)
y2006	4.654***	4.688***	4.612***	9.812***	9.952***	7.162**
	(0.957)	(0.959)	(1.047)	(2.291)	(2.359)	(3.632)
y2008	-3.308***	-3.272***	-3.232***	4.761**	4.847**	2.593
	(0.964)	(0.967)	(0.972)	(2.021)	(2.074)	(3.020)
y2009	-4.798**	-4.946**	-4.642	1.236	1.344	-0.504
	(1.987)	(2.007)	(3.111)	(1.632)	(1.690)	(2.709)
y2010	-3.787**	-3.674**	-3.724**	1.414	1.695	-0.156
	(1.619)	(1.621)	(1.649)	(1.772)	(1.840)	(2.697)
y2011	-3.281**	-3.122**	-3.317**	1.045	1.329	-1.149
	(1.344)	(1.360)	(1.410)	(2.068)	(2.141)	(3.379)
Constant	191.5***	193.9***	189.2***	189.0***	188.5***	173.6***
	(49.86)	(49.84)	(49.88)	(51.93)	(51.96)	(51.35)
Observations	375	375	375	375	375	375

Method of estimation	System GMM					
	WC75	WB75	WID75	WC75	WB75	WID75
Weighted matrix						
Time lag	- 0.0835***	- 0.0806***	- 0.0880***	-0.0583*	-0.0542*	-0.0552*
	(0.0304)	(0.0305)	(0.0313)	(0.0304)	(0.0307)	(0.0308)
Spatial lag	-0.0622	-0.0828*	-0.234	0.0214	-0.0295	-0.201
	(0.0507)	(0.0464)	(0.152)	(0.0518)	(0.0460)	(0.166)
Average growth in corresponding Economic Region	0.491***	0.498***	0.502***			

	(0.0668)	(0.0597)	(0.0670)			
Average growth in corresponding Federal District				0.403***	0.434***	0.457***
				(0.0794)	(0.0766)	(0.0761)
urb_s	-0.875***	-0.892***	-0.857***	-	-	-
	(0.233)	(0.230)	(0.238)	0.947***	0.978***	0.876***
				(0.246)	(0.245)	(0.252)
rgrp_per_c	0.279***	0.277***	0.283***	0.298***	0.294***	0.291***
	(0.0391)	(0.0386)	(0.0379)	(0.0392)	(0.0387)	(0.0371)
inv_sh	0.132*	0.121*	0.110	0.148**	0.138**	0.127*
	(0.0703)	(0.0713)	(0.0710)	(0.0659)	(0.0663)	(0.0677)
agr	0.432	0.394	0.472	0.308	0.269	0.403
	(0.312)	(0.308)	(0.314)	(0.300)	(0.294)	(0.306)
min	0.675***	0.634***	0.658***	0.748***	0.724***	0.761***
	(0.158)	(0.157)	(0.151)	(0.155)	(0.154)	(0.149)
man	0.942***	0.939***	0.931***	0.893***	0.898***	0.906***
	(0.194)	(0.188)	(0.195)	(0.195)	(0.193)	(0.196)
fin	0.389	0.386	0.533	0.138	0.148	0.268
	(1.558)	(1.547)	(1.544)	(1.653)	(1.646)	(1.618)
tr_sh	0.0504	0.0460	0.0384	0.0426	0.0353	0.0314
	(0.0617)	(0.0624)	(0.0606)	(0.0643)	(0.0658)	(0.0646)
exp_s	0.0164	0.0189	0.0224	-0.0112	-0.00910	-0.00876
	(0.0231)	(0.0221)	(0.0240)	(0.0273)	(0.0269)	(0.0271)
imp_s	0.0374	0.0349	0.0358	0.0512	0.0496	0.0450
	(0.0334)	(0.0339)	(0.0329)	(0.0328)	(0.0327)	(0.0331)
educ_s	-1.061	-1.044	-0.654	0.295	0.359	1.121
	(2.409)	(2.452)	(2.377)	(2.399)	(2.461)	(2.428)
pat_per_c	-0.780**	-0.787**	-0.819***	-	-	-
	(0.309)	(0.315)	(0.308)	0.917***	0.930***	0.938***
				(0.306)	(0.304)	(0.308)
densitycap	-0.00182	-0.000955	-0.00376	-0.0119	-0.0112	-0.0125

	(0.0104)	(0.0105)	(0.0100)	(0.0103)	(0.0104)	(0.00982)
densitynocap	0.0206	-0.0199	0.133	0.286	0.248	0.342
	(0.274)	(0.273)	(0.281)	(0.256)	(0.255)	(0.262)
y2006	5.153***	5.161***	5.421***	10.80***	11.08***	14.08***
	(0.875)	(0.880)	(0.875)	(2.106)	(2.145)	(3.368)
y2008	-3.365***	-3.315***	-3.714***	1.376	1.592	4.079
	(0.886)	(0.883)	(0.931)	(1.634)	(1.679)	(2.677)
y2009	-4.701**	-4.924***	-7.729***			
	(1.900)	(1.895)	(2.996)			
y2010	-3.224**	-3.168**	-3.552**	1.809	2.139	4.705*
	(1.496)	(1.484)	(1.553)	(1.675)	(1.727)	(2.773)
y2011	-3.013**	-2.852**	-2.428*	1.248	1.655	5.015
	(1.204)	(1.215)	(1.319)	(1.902)	(1.967)	(3.484)
Constant	77.95***	82.69***	91.49***	68.43***	74.06***	75.19***
	(20.25)	(20.00)	(23.43)	(20.20)	(20.15)	(20.84)
Observations	450	450	450	450	450	450