Keskustelualoitteita #40
Joensuun yliopisto, Taloustieteiden laitos

Determinants of Investment Distribution Across Russian Regions: A Bayesian Averaging of Classical Estimates (BACE) Method Application

Svetlana Ledyaeva
Anna Mishura

ISBN 952-458-863-3
ISSN 1795-7885
no 40

Determinants of Investment Distribution Across Russian Regions: A Bayesian Averaging of Classical Estimates (*BACE*) Method Application*

SEPTEMBER 2006

Svetlana Ledyaeva** and Anna Mishura***

Abstract

The paper studies the determinants of regional distribution of aggregate regional investment into physical capital per capita in Russia for years 1999-2003. BACE method is used in analysis. The method is a general robustness-checking method. The explanatory variables include net profits, savings, foreign firms' production shares, government expenditures and different indicators of regional investment climate. The BACE approach constructs estimates of regression coefficients as a weighted average of OLS estimates for every possible combination of included variables. For each included variable the posterior probability of non-zero coefficient is calculated. The posterior inclusion probability is a measure of the weighted average goodness of fit of models including a particular variable relative to models not including the variable. The estimation results show that the only factor that is strongly and robustly related to investment distribution across Russian regions is the net profits.

Keywords: investments, Russian regions, BACE method

---

*The paper was prepared under the project of Saint-Petersburg European University "Development in Advanced Teaching of Economics (DATE)" in Applied Macroeconomics (financed by HESP, OSI, Budapest, INTAS).

** University of Joensuu, Finland. E-mail: ledyaeva@joyx.joensuu.fi
*** Novosibirsk State University, Russia. E-mail: mav76@mail.ru

Acknowledgements. We would like to thank professor Wojtek Charemza for the idea of using BACE method in the analysis and for the very helpful comments on its application. We also wish to thank Daniela Hristova and anonymous panel of experts and resource persons of European University in Saint Petersburg for the very helpful comments on earlier drafts and Olga Varlamova for kindly submitting us an electronic version of Russia's Regions Yearbook.

I. Introduction

During the last 15 years – the transition period – aggregate investment into Russian economy was rather modest if to compare with other transition countries. In the year of 2003 gross capital formation per capita in Russia was equal to 449 euro and it is 1,8 times less than in Poland, 3,5 times less than in Hungary and 4,6 times less than in Czech Republic. Even Romania has a higher level of the indicator in 2003 (IFS CD-ROM (IMF, August, 2005)).

Besides the small amounts of aggregate investment in Russia, their regional structure seems to be inconsistent and ineffective in the context of more or less equal regional development. One of the ways to analyze the unequal distribution of aggregate investment across Russian regions is to use the well-known Herfindal - Hirshman Index calculated as follows:

$$I_{HH} = \sum_{j=1}^{k} \left(\frac{I_j}{I} \cdot 100\right)^2, \qquad (1)$$

where k = 89 (the quantity of Russian regions), I_j – the amount of aggregate investment into physical capital in a region j, I – the amount of total aggregate investment into physical capital in Russia (Valiullin and Shakirova, 2004). The maximum value of this Index is 10 000 (if all investment goes into 1 region) and the minimum is 112 (if investment is evenly distributed amongst all the Russian regions). The time path of the Index for Russian regions for the period of 1990-2003 is represented in Diagram 1.

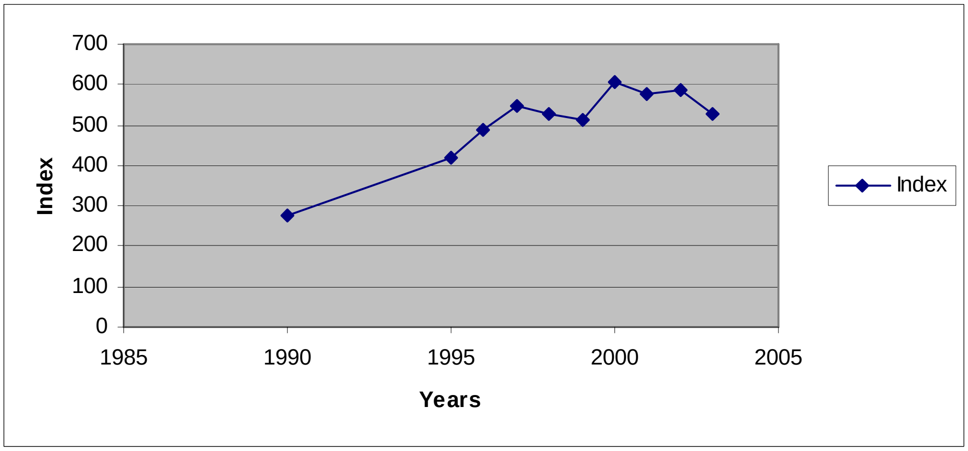

Diagram 1. Dynamics of the Index of Inequality of Investment Distribution across Russian regions

We conclude that the inequality of investment distribution across Russian regions is rather high. In the years of 2000 – 2003 the Index is 5 – 6 times higher then its minimum value of perfectly even distribution. The Index has increased twice from 1990 to 2000. In recent years there is some tendency of the Index's declining, but still this tendency is not evident. For comparison we have calculated the Index for 13 countries of European Union (namely, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, and Sweden) on the basis of Gross Capital Formation Indicator from the IFS CD-ROM for the year of 2003. It equals to 1500 and it is only 2 times higher its minimum value of perfectly even distribution (769).

The question arises what is the cause for such a high inequality in regional distribution of aggregate investment in Russian economy? One of the most possible answers is that some regions have exclusive advantages of investment climate. Thus the aim of our study is to find out which factors determine the distribution of aggregate investment across Russian regions.

Here we should stress the importance of the discussed topic. According to the economic theory and empirical evidence investment is considered to be one of the most important sources of economic growth. Thus its small amount and unequal distribution within a country will lead in long run to problems of low living standards and unfair (uneven) distribution of gross national income.

In modern economic literature the empirical studies of investment climate is usually based on the analysis of factors that stimulate investment growth in a country or its territory and on the accession of risks' level of investment. Recently a number of methods specifically designed of regional investment climate's analysis in Russia have been developed. The following methods can be mentioned here: 1) Method of "expert" journal; 2) method of the committee of production forces` (COPF) analysis of the Russian Federation Ministry of Economic Development (Grishina et al, 2004); 3) Klimova's method (Deryabina, 2003); 4) Finikov's method (Finikov et al, 1999). All these methods are similar in nature as they just offer different classifications of the factors of regional investment climate and differ mostly in classification's criterion of the factors and their relative importance.

Several empirical studies on the discussed topic have already developed. Valiullin and Shakirova (2004) used two econometric methods (Panel data fixed effects model (FEM) and simple correlation matrix) and found no evidence that the indicators of investment risk and investment potential are important for investment distribution across Russian regions. Next Valiullin and Shakirova used same methods for assessing the relationship between regional investment and its potential prosper sources (profits, depreciation, and private savings). Their results showed the high degree of influence of these variables on investment dynamics.

Kolomak (2000) evaluated the role of regional investment legislations (she paid particular attention to tax preferences in regions) in investments dynamics in Russian regions in the period of 1992-1998. She estimated a system of multiple simultaneous equations using fixed effects model for panel data with instrumental variables technique. Kolomak`s results are the following: 1) presence of regional investment law is an important and significant factor of regional investment, 2) regions in which fuel, oil and chemistry, forest and metallurgy's industries are highly developed, attract more investments, and 3) the level of infrastructure development (transport infrastructure, science potential, the level of pay services per capita) is positively related to the regional investments dynamics.

In his paper on reforms and economic performance in Russian regions Popov (2001) also investigated the factors of investment dynamics. Using OLS cross-sectional regressions he found that over 50 % of the regional variation in investment change in 1990-1997 can be explained by resource stock and capital city advantages in addition to three indicators of the institutional strength – share of small enterprises in total employment, risk index and the level of shadow income.

In the context of our research the empirical study of Broadman and Recanatini (2004) is also relevant. They used as a dependent variable different variants of net FDI inflow into Russian regions. The set of explanatory variables consisted of different indicators (mostly taken from Goskomstat), which characterize economic development, infrastructure, policy framework, institutional development, geography, and social stability in Russian regions. By using panel data for the period of 1995-2000 and appropriate econometric methods they found that market size, infrastructure development, policy environment and agglomeration effects appear to explain much of the observed variation of FDI flows across Russia` s regions.

In all mentioned studies authors choose several factors from a large amount of other potential factors underlined in different investment theories and investment climate analysis's methods. However, the many questions arise. Why they choose some factors but leave out some others? Are some factors more important than others? What factors are robust to different model specifications and which of them just occasionally turn out to be significant? The objective of this paper is not to test a specific investment theory or investment climate's method. Our target is to analyze empirically what are the truly influential and robust factors in terms of their effect on investment flows across the Russian regions. The analysis is conducted with the novel BACE method (Bayesian Averaging of Classical Estimates) suggested by Dopelhoffer et al. (2000, 2004). The method is a generalization of other model-averaging and robustness-checking methods. It uses cross-sectional data and tries to determine the variables that are robustly related to the dependent variable. To the best of our knowledge this method has not yet been applied to the analysis of determinants of aggregate investment although there are some attempts to use other robustness-checking methods in the similar analysis (see, e.g., Moosa, Cardak, 2009).

The reminder of the paper is constructed in the following way. Section 2 specifies the method we use in empirical analysis. Section 3 describes the variables used in the study and data sources. Section 4 discusses the results and section 5 concludes the paper.

II. BACE method

2.1. Basic idea of BACE method

The usual OLS regression method consists of estimation of model like

$$Y = a + b_1 \cdot x_1 + b_2 \cdot x_2 + ... b_n \cdot x_n + e, \qquad (2)$$

where Y is dependent variable (here per capita investment), $\boldsymbol{x}$ is the vector of explanatory variables, $\boldsymbol{b}$ is the vector of parameters and $\boldsymbol{e}$ is the vector of model errors. Typically theories are not explicit enough or consistent about what ***x*** variables belong to"true" model. We do not know exactly what variables we should use. The multiplicity of possible regressors and models is the major difficulty. Usually the simple rule is "try and error" rule with different variables which are thought to be potentially important determinants of investment. However, the well-known data-mining problem arises. It means that different combinations of included variables lead to different results.

Several methods are suggested to deal with the problem. They assume running many possible regressions and then analyzing and averaging results. We use a novel approach, Bayesian Averaging of Classical Estimates (BACE) which was suggested by Doppelhofer et al (2000, 2004). This method is a robustness-checking method. Also it is easy to understand and easy to use.

The task of any Bayesian analysis is to build a model between parameters (***b***) and observables (*Y*,***x***), and than calculate the probability distribution of parameters conditional on the data, Prob(***b***/*Y*). In a pure Bayesian analysis specification of the prior distribution of relevant parameters conditional on each possible model should be made. But as Doppelhofer et al (2000, p.7) argue: "…when the number of possible regressors is K, the number of possible linear models is 2^K so with K large, fully specifying priors is infeasible. Thus, authors implementing the fully Bayesian approach have used priors which are essentially arbitrary. This makes the ultimate estimates dependent on arbitrary chosen prior parameters in a manner which is extremely difficult to interpret." Further Doppelhofer et al (2000, p.8) argue that "…the weighting method can be derived as a limiting case of a standard Bayesian analysis as the prior information becomes "dominated" by the data. BACE combines the averaging of estimates across models, which is a Bayesian concept, with Classical OLS estimation which comes from the assumption of diffuse priors."

In contrast to a standard Bayesian approach, BACE requires the specification of only one prior hyper-parameter, the expected model size $\bar{k}$. The weights applied to different models in BACE are proportional to the logarithm of the likelihood function corrected for degrees of freedom analogous to the Schwarz model selection criterion. The estimates can be calculated using only repeated applications of OLS. The further advantage of the BACE method is that it considers models of all sizes and no variables are held “fixed” and therefore “untested”.

2.2. Statistical basics of the method

The BACE approach constructs estimates of regression coefficients as a weighted average of OLS estimates for every possible combination of included variables. A posterior mean of an estimate is defined to be the expectation of its posterior distribution:

$$E(b/y)=\sum_{j=1}^{2^K}\Pr(M_j/y)\hat{b} \qquad (3)$$

where b = regression coefficient, the vector y is the observed data, K = number of regressors, $\hat{b}$ = the OLS estimate for b belonging to regressor set that defines model M_j. $\Pr(M_j/y)$ is posterior probability of the model M_j conditional on the observed data. M_j defines the region of the parameters space of a particular model (e.g. $M_1: b_1=0, b_2\neq 0$ versus $M_2: b_1\neq 0, b_2=0$).

In order to get the posterior model probabilities for each individual regression (i.e. model) Doppelhofer et al (2000, 2004) simply normalize the weight of a given model by the sum of the weights of all possible models, i.e. with K possible regressors, in the following way:

$$\Pr(M_j/y)=\frac{\Pr(M_j)T^{-k_j/2}SSE_j^{-T/2}}{\sum_{i=1}^{2^k}\Pr(M_i)T^{-k_i/2}SSE_i^{-T/2}} \qquad (4)$$

where SSE_i is the OLS sum of squared errors under model *i*, k_i is the number of included regressors in model M_i, *T* is the sample size, $\Pr(M_i)$ is the prior probability of model *i*.

Model prior probabilities are specified by choosing a prior mean model size, $\bar{k}$ with each variable having a prior probability $\bar{k}/K$ of being included, independent of the inclusion of any other variables. Thus $\bar{k}/K$ is prior inclusion probability, which is equal for each variable. Then Doppelhofer et al. (2000, 2004) determine the prior probability of the model M_j as:

$$\Pr(M_j) = \left[\prod_{i=1}^{K} M_{ji}\frac{\bar{k}}{K}\right]\cdot\left[\prod_{i=1}^{K}(1-M_{ji})(1-\frac{\bar{k}}{K})\right] = \left(\frac{\bar{k}}{K}\right)^{k_j}\cdot\left(1-\frac{\bar{k}}{K}\right)^{1-k_j}, \qquad (5)$$

where k_j is the number of included variables in model j and M_{ji} is the i'th element of the M_j vector. The second equality in (5) holds only in the case of equal prior inclusion probabilities for each variable, but the first equality is easily adapted to the case in which the prior inclusion probabilities may differ across variables.

Thus user can specify average prior model size and, therefore, prior inclusion probability. The posterior variance of b is given by:

$$Var(b/y) = \sum_{j=1}^{2^K}\Pr(M_j/y)Var(b/y,M_j) + \sum_{j=1}^{2^K}\Pr(M_j/y)\left\{\hat{b}_j - \sum_{j=1}^{2^K}\Pr(M_j/y)\hat{b}_j\right\}^2. \qquad (6)$$

The algorithm calculates for each included variable the posterior probability that a particular variable has a non-zero coefficient, which is called posterior inclusion probability. It is the sum of the posterior probabilities (weights) of all of the regressions that including a particular variable. Thus, computationally, the posterior inclusion probability is a measure of the weighted average goodness of fit of models including a particular variable, relative to models not including the variable. This measure is a meaningful summary of the importance of a variable.

We can analyze different variables according to whether the data increases or decreases their inclusion probability relative to the prior probability. If posterior inclusion probability is close to 1 than this variable is strongly and robustly related to dependent variable. If posterior inclusion probability is larger than prior inclusion probability then this variable is robustly related to dependent variable.

Also some other characteristics of particular variables are calculated (see the tables of results below). Posterior mean is weighted average of OLS estimates for all regressions, including regressions in which the variable does not appear and thus has a coefficient of zero. Posterior standard deviation averages both standard errors of each regression as well as dispersion of estimates across models. They both may be interpreted as usual OLS estimates.

Posterior mean conditional on inclusion and conditional posterior standard deviation are weighted average of OLS estimates for regressions in which a variable actually occurs. Thus conditional posterior mean is equal to the posterior mean divided by the posterior inclusion probability. The conditional mean and variance are also of interest. From a Bayesian point of view they have interpretation of the posterior mean and variance for a researcher who has a prior inclusion probability equal to 1 for a particular variable. For example, if posterior inclusion probability is less then prior inclusion probability but posterior mean and standard deviation conditional on inclusion suggest that, if included, variable is significant than such variable is marginally related to dependent variable. This means that if we strongly believe that this variable is important we may assume it as significant.

The sign certain probability is another measure of significance of a variable. This is the posterior probability of same sign of coefficient as the posterior mean of the coefficient, conditional on the variable's inclusion. It lies between 0.5 and 1. If it is close to 1 than we can reinforce our conclusion that this variable is robust.

"Fraction of regressions with *Abs(t)>2*" reports the unweighted fraction of regressions in which the variable is classically significant at 95% level. This calculated partly for sake of comparison with usual OLS method.

Another interesting statistic is the posterior mean model size. It is weighed average model size. It may be compared with prior mean model size and show if data favor smaller or large model. The method faces the problem that computations should be made for 2^K regressions. This is an infeasible large number even though each term only requires the computation of an OLS regression. Several stochastic algorithms have been proposed for dealing with this issue, including the Markov-Chain Monte-Carlo Model Composition technique (Madigan and York, 1995), SSVS (George and McCulloch, 1993) and the Gibb's sampler-based method of Geweke (1994). These algorithms all moves randomly through the different models as a Markov chain approach and use results from the theory of Markov chain Monte Carlo's to derive theoretical convergence results. In contrast Doppelhofer et al. (2000, 2004) take a simpler approach that matches the form of the prior distribution. They select models to evaluate by randomly including each variable with independent sampling probability $\Pr_s(b)$. The sampling is based on the so-called stratified sampler (for details, see Doppelhofer et al, 2000).

III. Data and variables description

The data sources in our research are Russia's Regions Yearbook (2004) published on the yearly basis by Goskomstat (Russian Statistical Agency) and investment ratings of Russian regions issued by "Expert" journal. These ratings are being made on the basis of Russian statistics, Russian state and regional legislation's analysis, official opinions of business, state and regional authorities' representatives and other experts in the corresponding spheres.

The basic dependent variable employed in our model is the investment into physical capital per capita in each region as average for the years of 1999-2003, as calculated by Goskomstat. Almost all explanatory variables have been also calculated as average for the period of 1999-2003 as we are interested in this post-crisis period of economic growth in Russian economy. The quantity of observations is 78 Russian regions[1]. The main purpose of averaging the data over 5 years is to smooth up the possible business cycle movements of the dependent and explanatory variables.

---

[1] Actually there are 89 regions in Russia. We exclude from the analysis the autonomous territories, which are included in other regions (thus including them we could face the problem of double counting), namely, Neneckij, Komi-Permyatckij, Hanty-Mansijskij, Yamalo-Neneckij, Dolgano-Neneckij, Evenkijskij, Ust-Ordynskij and Aginskij Buryatskij and Koryakskij autonomous territories; two problematic regions, namely, Chechnya and Ingushetiya; and unique territory, Chukotka.

Based on the existing investment theories and regional investment climate analysis's methods, we introduce factors (explanatory variables), which are likely to influence the distribution of aggregate investment flows into physical capital across Russian regions. The factors, their indicators and theoretical and empirical studies, which, among the others, emphasize their importance, are summarized in Table 1.

Table 1. Factors of investment distribution across Russian regions involved in the study

Factor (the expected influence: "+" – positive, "-" – negative, "?"– unpredictable)	**Indicator in the empirical study**	**Theories and empirical studies which among the others, emphasized the factor's importance for investment**	**Variable as they appear in calculation tables**
1	**2**	**3**	**4**
Profit (+)	Net aggregate financial result (net profit) in a particular Russian region, mil. dollars on 1000 of people, av.1999-2993	Kalecki model (1943) (see note 1 in Appendix) Valiullin and Shakirova (2004)	Financial result
1	**2**	**3**	**4**
Savings (+)	Deposits attracted by credit organization in mil. dollars by 1000 people, 2003	Kalecki model (1943); Valiullin and Shakirova (2004)	Deposits
Foreign investors` activity (?) – see note 2)	Share of production of foreign firms (firms with foreign capital), %, as average for the period of 1999-2003	Markusen and Venables (1999) (see note 2)	FIA
Government expenditures (?) – see note 5)	Expenditures of regional budget, mil. Dollars, av. 1999-2003	Ndikumana (2000)	Budget_exp
Regional investment climate variables			
Investment risk variables			
Legislation risk (-)	Legislation risk, av. 2003	"Expert" journal's method; Grishina I. et al (2004); Finikov et al (1999) (ecological risk)	Legislation risk
Political risk (-)	Political risk, av. 2003		Political risk
Economical risk (-)	Economical risk, av. 2003		Economical risk
Financial risk (-)	Financial risk, av. 2003		Financial risk
Social risk (-)	Social risk, av. 2003		Social risk
Criminal risk (-)	Criminal risk, av. 2003		Criminal risk
Ecological risk (-)	Ecological risk, av. 2003		Ecological risk
Investment potential variables			
Telecommunication infrastructure (+)	Quantity of telephones on 1000 people, av. 1999-2003	Finikov et al (1999), Kolomak (2000)	Telephones
Transport infrastructure (+)	Integrated coefficient (see note 3) of two indicators: 1) share of car roads with solid covering in the total length of car roads, %, and 2) length of railway roads in km on 10000	Finikov et al (1999), Kolomak (2000)	Transport

	square km of region's territory; both indicators were taken as average for the period of 1999-2003		
Technological potential (+)	Costs on technological innovations in mil. dollars on 1000 people, av. 1999-2003	Expert journal method, Finikov et al (1999), Kolomak (2000)	Technology
1	**2**	**3**	**4**
Human capital development (+)	The share of people that have University education (high education + average professional education + basic professional education), %, 2003	Finikov et al (1999), Kolomak (2000)	Human_capital
Climate (-)	Dummy variable for climate, 1 if the average t in January is lower than –15 degrees and zero if it is not	Our proposition is that regions with milder climate attract more investments then regions with severe climate, as the latter might create inconveniences in conducting business activities	Climate
General infrastructure development (+)	Agglomeration effect measured by the ration of GRP to region's territory (see note 4)	Finikov et al (1999)	Agglomeration
Small business infrastructure's and regional legislation's development (+)	Share of employed people in small enterprises in the economic active population, %, av. 1999-2003	Finikov et al (1999)	Small business

IV. Results [2]

4.1. Baseline estimation

The estimation results for the baseline estimation with a prior model size, $\bar{k}$, of five regressors, are represented in table 2. The prior model size is chosen on the notion that previous empirical studies of investment function were mostly based on inclusion of relatively small number of explanatory variables (see also information in Introduction). Most existing investment theories also do not indicate many factors in explaining investment dynamics. Moreover our estimation results favor small model size (see below).

Column (1) reports the posterior inclusion probability of a variable in the investment regression. Columns (2) and (3) show the posterior mean and standard deviation of the distributions of the regressors` estimates. Columns (4) and (5) report the conditional posterior mean and standard deviation, which is conditional on being included in the model. The “sign certainty probability” is contained in column (6). Finally, column (7) contains the (unweighted) fraction of regressions in which a coefficient is significantly different from zero in the classical sense of having t-statistic with an absolute value greater than two.

Table 2. BACE method results: baseline estimation. The dependent variable is aggregate investment into physical capital per capita as average of period 1999-2003: Baseline estimation with $\bar{k} = 5$.

Variable	Posterior Inclusion Probability	Posterior Mean	Posterior Standard Deviation	Posterior Mean Conditional On Inclusion	Conditional Posterior Standard Deviation	“Sign Certainty Probability”	Fraction of Regressions With Abs (t)>2
	1	2	3	4	5	6	7
Profits	1.000	0.094	0.011	0.094	0.011	1.000	1.000
Social risk	0.307	0.071	0.122	0.230	0.108	0.973	0.401
Criminal risk	0.300	0.060	0.105	0.199	0.095	0.973	0.456
Transport	0.225	-0.026	0.057	-0.117	0.061	0.956	0.385
Agglomeration	0.258	0.000	0.000	-0.001	0.000	0.966	0.357
Political risk	0.168	0.024	0.064	0.144	0.085	0.943	0.041
Small enterprises	0.118	-0.030	0.104	-0.255	0.188	0.903	0.233
Education	0.095	0.095	0.381	0.998	0.793	0.886	0.048
Budget exp.	0.095	0.000	0.000	0.000	0.000	0.862	0.311
Telephones	0.094	0.047	0.196	0.499	0.431	0.866	0.097
Ecological risk	0.044	0.001	0.021	-0.015	0.097	0.560	0.018
Climate	0.059	0.005	0.046	0.078	0.175	0.678	0.070
Foreign capital	0.057	-0.020	0.155	-0.349	0.552	0.734	0.000
Technology	0.047	0.001	0.018	0.031	0.075	0.654	0.087
	posterior mean model size =3.1711969						
	raw average model size = 3.4728525						
	sess= 2.6454156e-044						
	maxchng = 4.3910985e-006						
	maxchngpp = 3.102766.90E-04						
	nvar= 18.0000						
	nobs= 77.0000						

---

[2] All the definitions and technical explanations are cited from the original paper of Doppelhofer et al (2000, p.21-26).

In Table 2 the variables are sorted in descending order of their posterior inclusion probabilities. We can divide the variables according to whether the data increases or decreases our inclusion probability relative to the prior probability: for the baseline estimation the prior inclusion probability is 5/18=0.278. There are three variables, profits, social and criminal risks, for which the data strengthens our belief that the variable belongs to the regression. The remaining 15 variables have little or no support for inclusion: seeing the data further reduces our already modest initial assessment of their inclusion probability.

The results indicate that profits variable is highly supported by the data (with positive sign) and is also conditionally well estimated. According to Doppelhofer et al (2000, 2004) this variable is called robust. As for the social and criminal risks, their posterior inclusion probabilities are higher then prior inclusion probabilities but still they are rather modest. Besides the fact, that they appear with the signs opposite to the expected and their standard deviations are too large, does not enable us to make reliable inferences concerning their relevance to investment dynamics.

The "sign certainty probability" in column (6) is another measure of the significance of the variables. For each individual regression the posterior density is equal to the classical sampling distribution of the coefficient. In classical terms, a coefficient would be 5% significant in a two-sided test if 97.5% of the probability in the sampling distribution was on the same side of zero as the coefficient estimate. So for example, if it just happened that a coefficient was exactly 5% significant in every single regression its sign certainty probability would be 97.5%. Applying a 0.975 cutoff to this quantity identifies the set of 3 variables, i.e. profits, social and criminal risks.

The final column in Table 2 reports the (unweighted) fraction of regressions in which the variable is classically significant at the 95% level. This is calculated partly for sake of comparison with extreme bounds analysis results. Note that for all but one (profits) of the variables, many individual regressions can be found in which they are not significant.

The last reported statistics of a particular interest is the posterior mean model size. For this baseline estimation the prior model size is 5. But the data appear to favor somewhat smaller models: the posterior mean model size is 3.17.

Thus we have only one variable (net profits) that is strongly and robustly related to investment per capita. Its inclusion probability is maximal (=1). The posterior mean coefficient is 0.094 with a standard deviation of 0.011. So this is very precisely estimated. Due to the high inclusion probability the posterior mean is very close to the posterior mean conditional on inclusion. The sign certainty probability in column (6) shows that the probability mass of the density to the left of zero equals one which means that almost all of the continuous density lies above zero. The fraction of regressions in which the coefficient for profits has t-statistics greater than two in absolute value is 100%, so that an extreme bounds test very easily labels the variable is robust. The results indicate that all the other variables, which are included into estimation, do not exhibit any evident relationship with the dependent variable.

In general from the results we can draw the following conclusions:

1) Profit is the main attracting force of aggregate investment in Russia.

2) As there is a strong correlation between profits and fuel and electricity export in Russia (the correlation coefficient for per capita values is 0.79), it may be suggested that investment in Russia is mostly resource-export oriented investment.

3) Savings variable is not significant, which may indicate that finance market in Russia is underdeveloped and does not play any important role in promoting investment and, therefore, economic growth in Russian economy.

4) As the share of production of foreign firms' variable is not significant, we conclude that foreign investment in Russia also does not exhibit any role in investment distribution across Russia. This fact may be due to the very low amount of foreign investment in Russian economy.

5) According to our results government expenditures also do not affect investment distribution across Russian regions. One of the possible explanations is that government expenditures` effects on investment dynamics appear after a time lag.

6) The insignificance of the factors, which characterize regional investment climate, such as investment risks, transport and telecommunication infrastructure, general business infrastructure, human capital development, technological potential, can be due to the fact that in average the investment climate is rather unfavorable in Russia and thus the relative differences between Russian regions do not play any significant role in investment decision into Russian economy

7) The variables of social and criminal risks have some significance but the appear with the positive sign contradicting the theory and our expectations.

Table 3. BACE method results. The dependent variable is aggregate investment into physical capital per capita as average for the period of 1999-2003: with $\bar{k} = 7$.

Variable	Posterior Inclusion Probability	Posterior Mean	Posterior Standard Deviation	Posterior Mean Conditional On Inclusion	Conditional Posterior Standard Deviation	"Sign Certainty Probability"	Fraction of Regressions With Abs (t)>2
	1	2	3	4	5	6	7
Profits	1.000	0.096	0.011	0.096	0.011	1.000	1.000
Criminal risk	0.387	0.075	0.112	0.194	0.096	0.968	0.426
Social risk	0.350	0.079	0.128	0.226	0.117	0.962	0.344
Agglomeration	0.297	0.000	0.000	-0.001	0.000	0.953	0.298
Transport	0.241	-0.026	0.056	-0.107	0.067	0.929	0.320
Political risk	0.241	0.034	0.074	0.142	0.086	0.940	0.045
Telephones	0.170	0.095	0.275	0.560	0.429	0.893	0.095
Small enterprises	0.163	-0.041	0.121	-0.248	0.197	0.887	0.205
Budget exp.	0.131	0.000	0.000	0.000	0.000	0.834	0.285
Education	0.153	0.156	0.482	1.020	0.796	0.889	0.029
Deposits	0.127	-0.018	0.067	-0.140	0.135	0.844	0.193
Legislation risk	0.126	-0.011	0.042	-0.088	0.084	0.845	0.000
Financial risk	0.126	0.017	0.065	0.131	0.135	0.830	0.249
Foreign capital	0.089	-0.031	0.194	-0.346	0.558	0.729	0.000
Climate	0.087	0.004	0.054	0.048	0.179	0.613	0.053
Economic risk	0.081	-0.005	0.045	-0.067	0.145	0.672	0.188
Technology	0.075	0.002	0.022	0.030	0.076	0.649	0.056
Ecological risk	0.070	-0.001	0.026	-0.015	0.098	0.559	0.013
	posterior mean model size = 3.9153495						
	raw average model size = 4.1851710						
	sess= 5.9374946e-043						
	maxchng = 1.0537034e-005						
	maxchngpp = 7.561226.00E-04						
	nvar= 18.0000						
	nobs= 77.0000			Note: Prior inclusion probability equals to 0.389			

Table 4. BACE method results. The dependent variable is aggregate investment into physical capital per capita as average for the period of 1999-2003: with $\bar{k} = 9$.

Explanatory variables	Posterior inclusion probability	Posterior mean	Posterior standard deviation	Posterior mean conditional on inclusion	Conditional posterior standard deviation	"Sign certainty probability"	Fraction of regressions with Abs (t)>2
Financial result	1.000	0.097	0.012	0.097	0.012	1.000	1.000
Criminal risk	0.473	0.090	0.116	0.191	0.097	0.964	0.401
Social risk	0.398	0.089	0.135	0.223	0.125	0.951	0.299
Agglomeration	0.340	0.000	0.000	-0.001	0.000	0.938	0.246
Political risk	0.322	0.045	0.082	0.139	0.086	0.935	0.048
Telephones	0.277	0.169	0.354	0.612	0.428	0.912	0.108
Transport	0.257	-0.024	0.055	-0.095	0.072	0.891	0.253
Small business	0.221	-0.054	0.140	-0.244	0.205	0.874	0.176
Education	0.222	0.228	0.571	1.028	0.802	0.888	0.017
Legislation risk	0.189	-0.017	0.051	-0.091	0.084	0.849	0.000
Savings	0.177	-0.024	0.078	-0.136	0.139	0.830	0.167
Financial risk	0.172	0.021	0.074	0.125	0.139	0.812	0.203
Budget_exp	0.172	0.000	0.000	0.000	0.000	0.802	0.247
FIA	0.134	-0.048	0.240	-0.354	0.566	0.729	0.000
Climate	0.124	0.003	0.064	0.024	0.181	0.560	0.037
Economic risk	0.122	-0.008	0.055	-0.070	0.144	0.679	0.153
Technology	0.113	0.003	0.027	0.028	0.076	0.641	0.036
Ecological risk	0.107	-0.001	0.033	-0.014	0.099	0.556	0.008
	posterior mean model size 4.819						
	raw average model size 5. 140						
	sess= 1.1513202e-0	41					
	maxchng = 5.558047	9.00E-06					
	maxchngpp = 4.0497	1.52E-03					
	loops= 263000	1					
	elapsed time =	805.59					
	secs/regs = 0.00	30630787					
	nvar= 18.0000	0					
	nobs= 77.0000	0	Note: Prior inclusion probability equals to 0.5				

4.2. Robustness of Results

In our baseline estimation we have concentrated on the results derived for a prior model size $\bar{k} = 5$. While we feel that this is a reasonable expected model size, it is still arbitrary. So we explore the effects of the prior on our conclusion. Table 3 and 4 report the posterior inclusion probabilities and conditional posterior means, respectively, for $\bar{k}$ equal 7 and 9.

Here we conclude that in general the results do not show much sensitivity to the choice of prior model size. The profit variable is highly significant in both estimations and they do not differ much. As for the variables of social and criminal risks, in the models with prior inclusion probability equals to 0.5 ($\bar{k} = 9$), their posterior inclusion probabilities are lower than prior inclusion probability.

V. Conclusion

In transition period in Russia regional investment distribution was rather uneven. As investment can be considered one of the most important factors of economic growth, an uneven investment distribution across Russian regions can lead to uneven economic development and, therefore, cause social problems. Obviously this topic has become rather important for Russia and several studies devoted to it have been developed in recent years. In these studies researchers usually use standard econometric techniques to find some evidence on the factors of regional investment distribution in Russia. As a rule, authors take several factors that they consider to be important for investment distribution across Russian regions and test them. But still the question arises why the authors choose some factors and not the others as there are a considerably large number of factors stemming from different theories and investment climate schemes.

In this paper we made an attempt to find some solution for this problem. In order to do this we used the BACE method. The method allowed us to include into estimation 18 explanatory variables, which theoretically can explain investment distribution across Russia. We used cross-sectional data on 74 Russian regions as average for the period of 1998-2003. Our main result is that only one factor among the considered is robustly related to regional distribution of investment in Russia. This factor is aggregate profit in a particular Russian region. Such a result can be explained by the fact that in general investment climate in Russia is very unfavorable and only high profits attract investors. High profits in Russia are concentrated in resources` export oriented industries and investment mostly flows into these industries.

Appendix 1

Notes:

1) Kalecki (1943) focuses on the role of profits and savings to investment financing decisions and he argues that the rate of investment is increasing in gross corporate savings, decreasing in the rate of change in capital stock and increasing in the rate of change in profits (Baddeley, 2003).

2) Markusen and Venables (1999) developed a model that determine the effects of inward FDI (multinational firms entry) on the industry's development with monopolistic competition: 1) competition effect in the product and factor markets tends to reduce profits of local firms and forces them out of the market and 2) linkage effects to supplier industries that reduce input costs and raise profits (encouraging of entry of new domestic firms). Thus foreign firms` activities may have both positive and negative impact on domestic investment. If the negative competition effect prevails then foreign firms will crowd out domestic investment. The opposite situation happens when the linkage effects dominate. Barrios, Görg, and Strobl (2005) built a simple model on above framework in which coexistence of domestic firms and foreign multinationals is possible. According to this model the u-curve represents the potential effect of FDI on the number of local firms in the host country.

3) The integrated index was calculated using the following formula:

$$Int\_index_i = \frac{1}{m}\sum_{j=1}^{m}\left[100*\left(\frac{F_{j,i}}{\overline{F_j}}\right)\right],$$

where Int_index_i is the integrated index for transport infrastructure, $\overline{F_j}$ is the sample mean of the indicator (in our case the mean value for Russian regions involved in the study), m is the number of indicators included in the computation of the index (in our case m=2) (adopted from Ndikumana , 2000).

4) Agglomeration effect here serves as a proxy of general level of regional infrastructure development as the ratio of GDP to the territory is expected to be higher in regions with many big cities (so the concentration of production is higher). Big cities usually have relatively good business infrastructure (car roads, financial institutions, trade network, etc).

5) Government policies affect domestic investment through various channels. Government consumption spending may crowd out domestic investment by raising interest rates, by reducing the pool of funds in the markets, and by increasing distortionary taxation on investment activities. It is also possible, however, for government spending to "crowd in" domestic investment through the accelerator effect. The net effect is theoretically unpredictable. It can only be determined empirically. .

Table A.1. Correlation matrix of the depended and explanatory variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Dependent var 1	1.00	0.79	0.42	0.09	0.01	-0.43	-0.39	-0.15	0.18	0.22	0.18	0.13	0.27	-0.12	0.30	0.26	0.21	0.11	0.59
Financial result 2	0.79	1.00	0.65	0.16	-0.14	-0.57	-0.64	-0.41	0.01	0.30	0.40	0.27	0.37	0.09	0.36	0.27	0.12	0.36	0.84
Savings 3	0.42	0.65	1.00	0.12	-0.14	-0.40	-0.58	-0.52	-0.03	0.23	0.71	0.36	0.56	0.26	0.32	0.41	0.04	0.55	0.80
Legislation risk 4	0.09	0.16	0.12	1.00	0.07	0.14	0.04	0.17	-0.13	0.18	0.02	-0.17	0.03	-0.11	0.14	0.10	0.24	0.04	0.16
Political risk 5	0.01	-0.14	-0.14	0.07	1.00	0.14	0.11	0.09	0.19	0.01	0.07	-0.10	-0.09	0.04	-0.02	0.13	0.14	-0.08	-0.14
Economic risk 6	-0.43	-0.57	-0.40	0.14	0.14	1.00	0.67	0.57	0.09	-0.27	-0.38	-0.47	-0.45	-0.27	-0.34	-0.33	0.13	-0.36	-0.53
Financial risk 7	-0.39	-0.64	-0.58	0.04	0.11	0.67	1.00	0.75	0.14	-0.38	-0.68	-0.52	-0.60	-0.46	-0.41	-0.38	0.15	-0.47	-0.63
Social risk 8	-0.15	-0.41	-0.52	0.17	0.09	0.57	0.75	1.00	0.26	-0.15	-0.66	-0.53	-0.61	-0.66	-0.28	-0.33	0.44	-0.60	-0.53
Criminal risk 9	0.18	0.01	-0.03	-0.13	0.19	0.09	0.14	0.26	1.00	-0.08	-0.08	-0.06	-0.22	-0.38	0.04	-0.01	0.49	-0.10	0.00
Ecological risk 10	0.22	0.30	0.23	0.18	0.01	-0.27	-0.38	-0.15	-0.08	1.00	0.12	0.37	0.16	0.12	0.35	0.20	0.19	0.03	0.17
Small business 11	0.18	0.40	0.71	0.02	0.07	-0.38	-0.68	-0.66	-0.08	0.12	1.00	0.42	0.60	0.45	0.17	0.40	-0.10	0.54	0.64
FIA 12	0.13	0.27	0.36	-0.17	-0.10	-0.47	-0.52	-0.53	-0.06	0.37	0.42	1.00	0.47	0.36	0.27	0.30	-0.07	0.23	0.24
Telephones 13	0.27	0.37	0.56	0.03	-0.09	-0.45	-0.60	-0.61	-0.22	0.16	0.60	0.47	1.00	0.33	0.33	0.44	-0.26	0.39	0.47
Transport 14	-0.12	0.09	0.26	-0.11	0.04	-0.27	-0.46	-0.66	-0.38	0.12	0.45	0.36	0.33	1.00	0.04	0.18	-0.61	0.63	0.29
Technology 15	0.30	0.36	0.32	0.14	-0.02	-0.34	-0.41	-0.28	0.04	0.35	0.17	0.27	0.33	0.04	1.00	0.24	0.11	0.15	0.34
Education 16	0.26	0.27	0.41	0.10	0.13	-0.33	-0.38	-0.33	-0.01	0.20	0.40	0.30	0.44	0.18	0.24	1.00	0.06	0.26	0.35
Climate 17	0.21	0.12	0.04	0.24	0.14	0.13	0.15	0.44	0.49	0.19	-0.10	-0.07	-0.26	-0.61	0.11	0.06	1.00	-0.21	0.02
Agglomeration 18	0.11	0.36	0.55	0.04	-0.08	-0.36	-0.47	-0.60	-0.10	0.03	0.54	0.23	0.39	0.63	0.15	0.26	-0.21	1.00	0.66
Budget_exp 19	0.59	0.84	0.80	0.16	-0.14	-0.53	-0.63	-0.53	0.00	0.17	0.64	0.24	0.47	0.29	0.34	0.35	0.02	0.66	1.00

References

Barrios S., Görg H. and Strobl E., 2005. Foreign direct investment, competition industrial development in the host country, European Economic Review**,** Vol. 49, 1761 - 1784

Broadman H. and Recanatini F, 2004. Where does all the foreign direct investment go in Russia? Draft paper.

Deryabina Ya., 2003. Comparative analysis of the approaches to investment attractiveness and investment activity's evaluations in Russian regions, Investment in Russia 8, 9-20

Doppelhofer G., Miller R. and Sala-I-Martin X., 2000. Determinants of long-term growth: A Bayesian Averaging of Classical estimates (BACE), NBER (NBER WP-7750).

____________, 2004. Determinants of long-term growth: A Bayesian Averaging of Classical estimates (BACE), American Economic Review, Vol. 94, 813 – 835.

Duesenberry J., 1958. Business cycles and economic growth, New York, McGrow – Hill.

Finikov A., Arbuzov A., Tihomirov V. and Trofimov V., 1999. Regional aspects of favorable investment climate formation, http://www.invest-in.ru/ruslibrary/oecd_regions_rus.pdf

George E. and McCulloch R., 1993. Variable Selection via Gibbs sampling, Journal of the American Statistical Association, Vol. 88, 881-889.

Geweke J., 1994. Bayesian comparison of econometric models, WP-532, Federal Reserve Bank of Minneapolis.

Grishina I., Shahnazarov L. and I. Rojzman, 2004. Complex evaluation of investment attractiveness and investment activity in Russian regions: methodical aspect, Investment in Russia 4.

Hall R. and Jorgenson D., 1967. Tax policy and investment behavior, American economic Review, Vol. 57, 391 – 414.

IFS CD-ROM (IMF, August 2005).

Kalecki M., 1943. The determinants of Investment, In Studies in Economic Dynamics, London: Allen and Unwin.

Kolomak E., 2000. Sub federal tax preferences and their influence on investment's attraction, Russian program of Economic Research, Science report, 2/07.

Madigan D. and York J., 1995. Bayesian Graphical Models for Discrete Data, International Statistical Review, Vol. 89, 215-232.

Markusen J. and Venables A.,1999. Foreign direct investment as a catalyst for industrial development, European Economic Review**,** Vol. 43, 335-356.

Moosa I., Cardak B., 2005. The determinants of foreign direct investment: an extreme bounds analysis, Journal of Multinational financial management, Vol. 16, 199-211.

Ndikumana L., 2000. Financial Determinants of Domestic Investment in Sub-Saharan Africa: Evidence from Panel Data, World Development, Vol. 28, 381-400.

Popov V., 2001. Reform Strategies and Economic Performance of Russia's Regions, World Development, Vol. 29, 865-886.

Valiullin X. and Shakirova E., 2004. Heterogeneity of investment space in Russia: regional aspect, Forecasting problems.