MODELING AND FORECAST OF SOCIO-ECONOMIC PROCESSES

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Regional Aspects of Investment Processes: an Empirical Analysis of the Distribution of Capital Resources in the Far Eastern Federal District

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Abstract. The paper estimates the dynamic investment function on the basis of the flexible accelerator model according to the data for 2000–2016 for the Far Eastern Federal District and its constituent entities. In general, the dynamics of investment in the Far Eastern Federal District are significantly influenced by the change in expected demand with an average investment accelerator value of 1.78. Having assessed the partial adjustment parameter, we see that on average per year, investments cover 40% of the difference between the actual and desired capital stock in the Far East, and the parameter increases over time. This indicates that the gap between the desired and actual capital stock in the economy of the Far Eastern Federal District increased during the study period due to the growth in demand. This gap is larger for the resource-based regions like the Republic of Sakha (Yakutia) and the Sakhalin Oblast; it is due to a higher level of expected output driven by high external demand. The rise in the cost of capital as a factor in the demand for investment on average leads to a slowdown in investment dynamics in the region. Using the seemingly unrelated regressions model, we obtain the values of tightness and direction of interregional relations. We reveal that the increase in the inflow of investments into the Sakhalin Oblast has a negative impact on the investment dynamics in other regions of the Far Eastern Federal District; the highest competition for investment resources is observed in the Republic of Sakha (Yakutia) and Khabarovsk Krai. We conclude that the flexible accelerator model less efficiently describes the dynamics

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of investment processes in the regions of the Far Eastern Federal District with a high hydrocarbon rent; and, consequently, dynamic processes are determined mainly by exogenous factors in relation to the region. However, since the flexible accelerator model adequately characterizes the economy of the Far Eastern Federal District, the latter is able to support the endogenously reproducing economic growth without relying solely on external demand.

Key words: regional growth, investments in fixed capital, flexible accelerator model, Far East.

Introduction

Capital investment is one of the central objects of regional economic analysis. In most studies on the problems of regional growth and spatial convergence, investment flows are based on the well-known postulates of the neo-classical theory which states (see [1]) that: a) capital is completely mobile in space and is equally available at any point, b) the geographical differences in the price of a unit of capital good are due only to transport costs, c) capital is located where there is the highest return rate.

Much less attention is paid to dynamic characteristics of the regional economic system itself and the role they play in capital flows. Taking into account such dynamic properties, implying the presence of feedbacks and lag responses, helps model regional economic processes characterized by endogenous, self-reproducing growth. In particular, endogeneity is reflected through a dynamic investment function based on assumptions that the desired capital stock is a function of the expected level of output; expectations in turn are formed on the basis of the previous experience. At the same time, the pace of adaptation of the actual volume of private capital to the desired level is decisive. Contrary to the prevailing paradigm, this rate is not always proportional to the difference in return rates of capital prevailing in certain regions.

In the past decade, the Far East has been the object of close attention of federal authorities. When developing plans for the development of the Russian Far East by the highest political circles of the country, the main objective was defined – ensuring the region's accelerated development compared to the average Russian indicators up to 2025. This objective was not new. Despite the fact that in the modern Russian history the program of the Far East development was adopted in 1996, in fact, the state began to purposefully redistribute large-scale resources for the region's development only after 2007.

At the Eastern Forum on Economics – 2017, new priorities for the development of the Far East were identified – creating an economic and social environment that exceeds the average Russian indicators in its parameters. At the same time, barriers to attracting private investment to the region – underdeveloped infrastructure, high negative migration, tariff and tax barriers – were identified.

In Russian scientific publications, the regional investment aspect is mainly covered in works devoted to the processes of regional convergence. Among the works studying the factors in growth and convergence of the Russian regions (including investment standing out), we can note [2]; [3]; [4]. At the same time, there is lack of research into investment processes at the regional level, taking into account the endogenous nature of economic growth, feedbacks and lag dependences.

The study aims to identify the conditions that have a stimulating and disincentive effect on attracting private investment in the regions

of the Russian Far East through building and assessing the dynamic investment function based on the model of a flexible accelerator. The application of this function will help reveal empirically whether the export-oriented economy possesses the mechanisms of endogenous growth. The relevance of the chosen area is supported by the need to find ways to improve the effectiveness of the regional investment policy.

The article is structured as follows. Section 2 presents the analysis of investment processes in the Far Eastern Federal District (FEFD) for the period 2000–2016. Section 3 describes the basic investment model for further assessment. Section 4 discusses the selection of data and assessment methods. The results of analysis are presented in Section 5.

1. Retrospective analysis of investment performance in the Far Eastern Federal District

Since the beginning of the 21st century, the Russian Far East has experienced both periods of rapid investment inflow and their subsequent sharp reduction. In 2000–2011, the inflow of investment in the macroregion increased by almost 3.9 times. In fact, the growth rate during this period was one of the highest in the national economy. After 2011, there was a sharp decline in investment activity – in 2016, the volume of capital investment amounted to 64.2% of the 2011 level. The period of growth in investment activity was also characterized by an increase in government investment. In peak 2011 investment from the consolidated budget of the Russian Federation accounted for almost a quarter (23.5%) of total investment in the Far East. The growing state attention to the macro-region is evidenced by the fact that in that year the Far East accounted for more than 17% of all budget investment of the Russian Federation, while the contribution of the macro-region to the overall national product was only 5.6%. Large-scale public investment was mainly associated with constructing infrastructure in the framework of preparing for the APEC Summit in 2012 in Vladivostok.

The period of the investment boom is associated with the implementation of a number of other major investment projects in the Far East: preparation for the development of hydrocarbon deposits of the Sakhalin shelf and Yakutia, construction of the Eastern Siberia–Pacific oil pipeline, and the Sakhalin–Khabarovsk–Vladivostok gas pipeline. Building the infrastructure of Sakhalin projects was carried out at the expense of foreign (including offshore) investment, while the construction of the pipeline infrastructure was financed by large national companies with state participation. A sharp investment decline is due to the fact that the main construction projects in all of the above projects were completed by 2012[1].

The predominance of extractive and transport sectors in the structure of investment turned the Far East into a raw-material-based region by the end of the first decade of the 21st century. Mining is the only sector that has demonstrated an increase in investment until 2016. In that year, its share was 39.3% of the total investment in the Far East.

As for the investment performance in constituent entities of the Far Eastern Federal District, the situation differs dramatically depending on the profile of a certain constituent entity (*Tab. 1*). Thus, raw-material-oriented regions (Republic of Sakha (Yakutia), the Magadan and Sakhalin oblasts), investment during 2000–2016 had an upward trend. On the contrary, in the most structurally diversified Primorsky and Khabarovsk krais, the

[1] This is evidenced by the fact that investment reduction amounted to 65.8% in "Transport and communication" during 2011–2016.

Table 1. Growth rates of capital investment in constituent entities of the Far Eastern Federal District for 2000–2016, %

Constituent entity	2000–2016	2000–2011	2011–2016	Share in FEFD in 2016, %
Sakha (Yakutia) Republic	333.3	302.5	110.2	27.9
Kamchatka Krai	167.8	208.1	80.6	3.4
Primorsky Krai	221.3	849.5	26.0	12.5
Khabarovsk Krai	169.6	379.7	44.7	11.7
Amur Oblast	523.2	617.0	84.8	13
Magadan Oblast	300.2	242.4	123.9	3.9
Sakhalin Oblast	483.0	551.3	87.6	25.2
Jewish Autonomous Oblast	935.1	в 19.5 раз	47.9	1.3
Chukotka Autonomous Oblast	220.1	521.8	42.2	1.0

Sources: compiled from: *Russian regions. Socio-economic indicators. 2017: statistics book*. Rosstat. Moscow, 2017. Pp. 592–642; *Russian regions. Socio-economic indicators. 2010: statistics book*. Rosstat. Moscow, 2010. Pp. 932–956.

investment situation deteriorated significantly after 2011. In Primorsky Krai, the volume of capital investment in 2016 was only 26% to the level of 2011, in Khabarovsk krai – 44.7%. It should be noted that a significant share of investment in Primorsky Krai in 2011 was federal budget investment allocated to the region by non-economic criteria. Investment in the Amur Oblast – another region of the Far Eastern Federal District with a diversified economic structure – also decreased after 2011 but state investment in the construction of the Vostochny spaceport largely compensated for the decrease.

The characteristics of the investment performance of the Far East would not be complete without analyzing the ratio of investment and gross value added produced by the macro-region. The ratio is traditionally one of the most difficult in the analysis of the economic performance due to the variety of the cause-and-effect relations. It is known that investment demand is a component of aggregate demand, indicated by gross value added (GVA). At the same time, investment is a driver of supply, increasing (updating) the basic production capital. The overall GRP performance and capital investment of the Far Eastern Federal District is demonstrated in *Figure 1.*

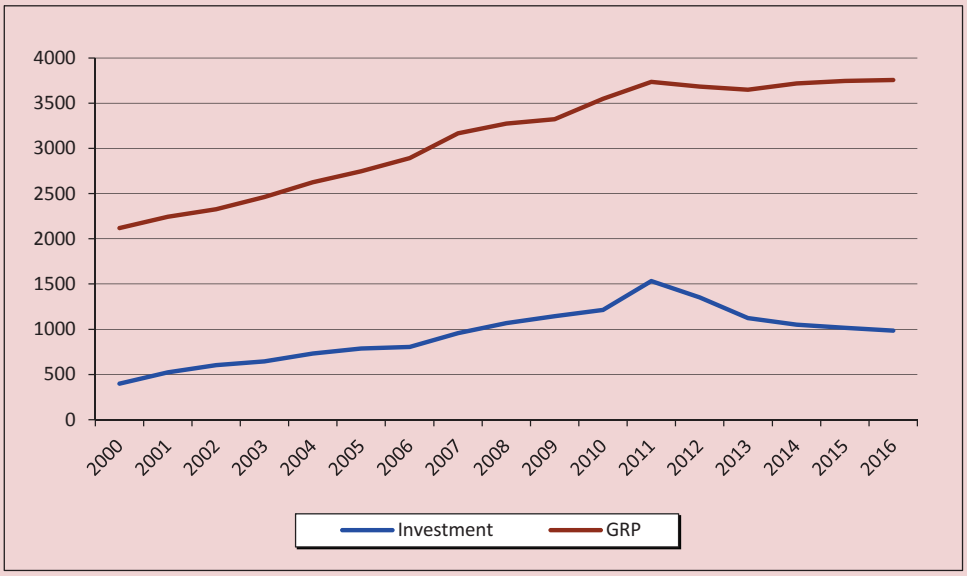
The figure suggests two conclusions. First, the increase in investment in year *t* is accompanied by an average smaller increase in GRP in the same year (this is well observed until 2010). Second, investment has certain inertia, i.e. a relatively long-term impact on GRP produced in the Far East. In other words, the increase (decrease) of investment at the time period *t* does not lead to a proportionate increase (decrease) in GRP in this, as well as several subsequent periods (*t*+1, *t*+2,...). Thus, a sharp decline in investment after 2011 led to stagnation of the economic growth rather than to its fall after investment.

The author of the article, together with A.V. Belousova in the study [5] calculated the multiplicative effect of investment (I_t) on GRP (Y_t) in the Far Eastern Federal District based on the model with a geometrically distributed lag:

$$Y_t = a_0 + b_0 I_t + b_0 l I_{t-1} + b_0 l^2 I_{t-2} + \\ + \cdots + b_0 l^i I_{t-i}, \quad (1)$$

where b_0 is a short-term multiplier, $0<l<1$. The authors revealed that the short-term investment multiplier is 0.45 rubles GRP per 1 investment ruble, while the long-term multiplier (the sum of all coefficients for variable *I* in equation 1) is 1.91 rubles GRP for the same investment ruble. In the first year of investment, only 18.2% of its long-term impact

Figure 1. GRP and capital investment in the Far Eastern Federal district, in 2016 prices, bln RUB



Sources: compiled by: *Russian regions. Socio-economic indicators, 2017: statistics book*. Rosstat. Moscow, 2017. Pp. 592–642; *Russian regions. Socio-economic indicators. 2010: statistics book*. Rosstat. Moscow, 2010. Pp. 932–956.

is realized (coefficient b_0 in equation 1). It is this "inertia" that explains the performance of the two macro-indicators after 2011 (investment cuts and subsequent stagnation of economic growth).

Since FEFD regions can be quite clearly divided into resource and diversified ones, it is expected that the response of their economies to investment will be different due to their different economic structure. Indeed, the calculations show that for a group of resource regions (Sakha (Yakutia) Republic, the Magadan and Sakhalin oblasts, the Chukotka Autonomous Oblast), the long-term multiplier is higher. At the same time, in the first year of investment in resource regions, only 14% of their long-term effect is realized, while in other regions of the Far East – 27%. This can be explained by the fact that investment in resource regions is mainly allocated to extractive infrastructures, while in regions with a diversified economic structure – to machinery and equipment. The latter traditionally have higher depreciation, but their effect on regional production affects faster than in the case of buildings. In addition, in the case of Primorsky Krai, there was another time-limited effect of state investment in infrastructure. In the short term, the latter lead to a surge in construction activity in the region, which fades after the project is completed[2]. Consequently, production of public goods also has a short-term effect on regional economic growth[3].

2. Investment and capital formation: theoretical aspect

The study of the performance of capital has a long history and is related mainly to two theoretical problems: 1) determination of the optimal amount of capital stock, i.e. the search for the function of demand for capital of profit-

[2] Over the period from 2011 to 2015, there was almost a twofold (47.6%) decline in GVA in "Constructions".

[3] For more detail on the structure and performance of capital investment in FEFD by sector see [5].

maximizing enterprises, and 2) the search for a mechanism for regulating capital stock, i.e. how the current capital stock adapts to the optimal or desired, level.

The theory of investment behavior of companies was developed in the second half of the twentieth century. One of the first fundamental works was the work by T. Haavelmo [6], which for the first time reflected the problems of specification of the function of demand for investment. Subsequently, this theoretical problem was solved by D. Jorgenson [7] who proposed the neoclassical demand function of the profit-maximizing company for investment. He also showed that a special case of the demand function is the flexible accelerator model. J. Tobin formulated the investment theory according to which the level of investment should depend on the ratio of the present value of fixed capital and the reconstructive value. The value of this ratio – ***q*** – gave the name of the Tobin theory of investment[4].

The theoretical platform on which the empirical model of this study is based lies in the model of a flexible accelerator. This model is convenient as it explicitly reflects the mechanism of adjustment of the value of fixed capital. According to the model, the driving force of capital formation is demand. Let the goal value of fixed capital K_t^* be proportional to the expected output level I_t^*:

$$K_t^* = vY_t^e \ . \qquad (2)$$

The actual level of capital, K_t, however, cannot instantly adapt to the level of the goal stock due to the inertia of adaptation costs. Thus, capital in the form of equipment requires time for planning, delivery, installation, and adjustment. Capital in the form of buildings requires even longer time periods for construction and commissioning. According to the flexible accelerator model, which is a special case of the model of adaptive expectations, capital in the current period can only be partially adjusted to the desired level:

$$K_t - K_{t-1} = (1-\lambda)(K_t^* - K_{t-1}), \qquad (3)$$

where λ is the parameter (pace) of partial adjustment. The left side of equation (3) is the net investment in year *t*. The level of actual investment is equal to the amount of net investment and the amount of retired assets:

$$I_t = K_t - K_{t-1} + \delta K_{t-1}, \qquad (4)$$

where δ is the depreciation rate.

The following investment function can be obtained from equations (2)–(4):

$$I_t = (1-\lambda)vY_t^e - (1-\lambda-\delta)K_{t-1}. \qquad (5)$$

Taking the first differences in equation (5) we obtain:

$$I_t - I_{t-1} = (1-\lambda)v\Delta Y_t^e - \\ - (1-\lambda-\delta)\Delta K_{t-1}. \qquad (6)$$

By expressing ΔK_{t-1} through equation (3), and $(1-\lambda-\delta)K_{t-2}$ through equation (5), we obtain a basic model of a flexible investment accelerator:

$$I_t = (1-\lambda)v\Delta Y_t^e + \\ + (1-\lambda)v\delta Y_{t-1}^e + \lambda I_{t-1}. \qquad (7)$$

Although this model reflects the relations between investment and expected output (demand), the cost of using capital is represented only by the depreciation parameter. It also does not address other important economic variables that affect investment behavior. From an empirical point of view, this model

[4] In domestic science there are fundamental studies in investment design and evaluation of the effectiveness of projects at different stages of development. See, for example [8].

is an advantage for regional studies as there is no need to use comparable time series of fixed assets, for which data on regional level are missing.

A significant contribution to the study of the impact of capital use costs on investment demand was made by D. Jorgenson made. He justified that these costs include not only depreciation δ, but also the interest rate on the borrowed funds used to purchase capital r_t and losses caused by changes in the prices of capital goods. As a result, the full opportunity costs of acquiring an additional unit of capital is the sum of these components $\delta + r_t + \Delta p_t^k / p_t^k$.

Model (7) can be extended by including factors affecting investment through the partial adaptation parameter (pace of adaptation) in it. After [9], [10], [11] and [12] let us take:

$$1 - \lambda = a_0 + \sum a_i X_i / (I_t^* - I_{t-1}), \quad (8)$$

where a_0 is the autonomous adaptation pace, X_i is the independent variable *i* that affects investment demand. An implicit assumption here is that the effects of these variables are manifested through a change in the adaptation pace. In other words, if a variable adversely affects investment demand, its effect will be reflected through reducing the adaptation pace to the desired level of capital. It follows from equation (4) that $I_t^* = K_t^* - (1 - \delta)K_{t-1}^*$. Then the modified model of the flexible accelerator will take the form:

$$I_t = a_0 v \Delta Y_t^e + a_0 v \delta Y_{t-1}^e + \\ + (1 - a_0) I_{t-1} + \sum a_i X_i. \quad (9)$$

In this form, the model is a more flexible tool since investment is a function not only of changes in the expected demand ΔY_t^e, but also of a number of other relevant variables. Coefficient *v* here acts as an investment accelerator.

3. Data and assessment methods

In this study, model (9) is assessed though statistical data for the period from 2000 to 2016 in the basic 2008 prices. Nine constituent entities of the Far Eastern Federal district were united into six regions: Sakha (Yakutia) Republic, Primorsky and Khabarovsk krais, the Sakhalin Oblast, North-Eastern region (part of Kamchatka Krai, the Magadan Oblast, and Chukotka Autonomous okrug), and South-Western region (the Amur Oblast and the Jewish Autonomous okrug). Joining the entities in the North-Eastern region was dictated by the general limited transport accessibility (lack of rail and road[5] communication with the rest of the regions), rather than by the structural features of their economies. Attributing the Jewish Autonomous oblast to the Amur Oblast is caused by the small-scale of the economy of the former against the background of the surrounding constituent entities. All initial data of the model are taken from the website of the Federal State Statistics Service.

Gross investment minus investment of budgets of all levels are taken as capital investment I_t. They can be called private investment, but to be correct, they are referred to as off-budget investment because in fact they include the funds of companies with state participation. The models of investment behavior in general and the model of flexible accelerator in particular are based on the prerequisite of profit maximization, which immediately excludes budget investment allocated mainly for infrastructure creation (public goods – as in the case of preparation for the 2012 APEC Summit) from consideration. Since the purpose of state-owned companies is ultimately to make profit (mainly pipeline infrastructure), it is incorrect to exclude them from consideration.

[5] Despite the Kolyma road connecting Magadan and Yakutsk, this factor was considered insignificant.

The expected demand is an unobservable variable. The studies use different approaches to its assessment. Thus, the model of adaptive expectations is used in [9]. In [10], the first-order autoregressive model AR (1) is used for this purpose. The original approach is proposed in [11], where the expected output is determined via a state-space model based on a combination of the consumption equation and the partial adjustment equation. Finally, in the works [12], [13], [14], [15] real output is used instead of expected demand. This study also applies this approach. Thus, the variables δY_{t-1}^{e} and ΔY_{t}^{e} are constructed based on the actual GRP values: GRP_{t-1}, and ΔGRP_{t} ($= GRP_{t} - GRP_{t-1}$), respectively.

The explanatory variables include the indicator of change in the price of capital goods in the previous period ($PRICE_{t-1}$) to assess the impact of the factor of investment appreciation in the regional and temporary breakdown. In the Jorgenson model, this factor is presented in the form of growth rates, whereas in this work, we construct an analogue of the average level of the price of a capital good unit. It was based on the cost of a fixed set of consumer goods in the base year as a percentage of the national average. This was done in order to reflect the level of prices in each region in relation to the average for the Russian Federation. Thus, for the base year 2008, this level was the minimum in the Amur Oblast (110) and the maximum in the Chukotka Autonomous okrug (200) (for FEFD as a whole – 130). Based on this, we calculated the values for the entire study period through the index of prices of capital goods. The index is calculated as a weighted average of the price index of construction and installation works and the price index of manufacturers of industrial products in the relevant regions, where the share of investment in buildings and structures and investment in machinery and equipment, respectively, served as weights.

As shown above, the costs of using capital include the bid rent, which in equilibrium equals the percentage. In the present study, this variable is not included in the number of explanatory variables for several reasons. First, theoretically, it should not differ for users of capital in different regions, which limits its use to one-dimensional time series models.

Second, it is difficult to use earnings per capital unit as a variable because of difficulties in obtaining reliable estimates of time series of capital assets at the regional level. Data on value of fixed assets by constituent entity are publicly available, but information on their performance in comparable prices is available only for the national economy as a whole. In research practice, the estimation of the capital value is based on the method of continuous inventory. However, this method requires data on capital investment over a long period of time (several decades), as well as assumptions about the function of physical depreciation of capital to calculate the depreciation rate δ. In this case, the value of fixed capital at time t can be calculated using formula (4).

Third, even if reliable estimates of returns per unit of capital are obtained for FEFD regions, the issue of correct interpretation of their impact still arises. In theory, an increase in r has a negative impact on investment performance, as it is treated as a rental rate. However, according to statistics, bank loans as sources of investment account for a small share in the Far East, while the share of own funds is high[6]. Therefore, it is impossible to accept the hypothesis about the negative influence of this variable on investment. In case of detecting statistically significant influence, it will be difficult to interpret the indicator. Due to these aspects, this indicator is not among the explanatory variables in this paper.

[6] Moreover, the structure of the "raised funds" statistics indicator includes funds of superior organizations.

The estimated regression equation for region *i* takes the following form:

$$I_{it} = c_0 + c_1 \Delta GRP_{it} + c_2 GRP_{it-1} + \\ + c_3 I_{it-1} + c_4 PRICE_{it-1} + e_{it}. \quad (10)$$

where c_0 – constant, $c_1 = a_0 v$, $c_2 = a_0 v \delta$, $c_3 = (1 - a_0)$, $c_4 = a_1$.

According to model (9), indices c_1 and c_2 are expected to be positive, c_3 is expected to be in the range (0,1). According to the hypothesis of the negative impact of increase in the price of capital goods on investment performance, it is expected that $c_4 < 0$.

It is expected that equation (10) for two types of objects – FEFD as a whole and its separate regions – will be estimated. The model for the Far Eastern Federal District is estimated by two types of data: 1) aggregated data for the district as a whole and 2) panel data for each constituent entity. The system of equations for each region (see below) is estimate through the second type of objects.

We should also focus on the methods of assessment. The least squares method (LSM) provides efficient unbiased estimates in the absence of autocorrelation of residuals (under the condition of the Gauss–Markov theorem). In the case of model (10), this condition is obviously not fulfilled since there is the lag dependent variable among the explanatory variables in the equation. To exclude first-order autocorrelation, we use the autoregression model AR (1), or the autoregressive distributed lag model (ARDL), evaluated through using nonlinear methods.

The estimation of FEFD as a whole based on one-dimensional time series was carried out using the ARDL model[7] (1,0). For the case of panel data of LSM with fixed or random effect is not suitable for the above reasons. In addition, there is the problem of endogeneity in models of this type (in this case, the relations between investment and growth rate of the economy). Therefore, the assessment was carried out through the generalized method of moments (GMM) which is devoid of these shortcomings. The two-step GMM is the variant of the method of instrumental variables, where the instruments are the explanatory variables with lags.

To estimate the parameters for each of the 6 regions, the method of seemingly unrelated regressions (SUR) proposed by A. Zeller [16] is applied. SUR is used to estimate the region-specific parameter vector based on a system of six equations AR (1) for each region. Zellner demonstrated that if there is a simultaneous correlation of residual terms of the system of equations, it is possible to obtain estimates of parameters β based on the generalized LSM, which are more effective than the estimates obtained on the basis of individual equations:

$$\hat{\beta} = (X' \Omega^{-1} X)^{-1} X' \Omega^{-1} Y,$$

where X is a block-diagonal matrix of explanatory variables modified according to AR(1)-process, Y is a vector of dependent variables, Ω is a covariance matrix of residues, each element of which is estimated from AR(1) models residuals for each individual equation.

In addition to obtaining more effective estimates, SUR helps track inter-regional relations that arise as a result of economic interactions between regions.

4. Discussion of empirical results

Table 2 presents the results of ARDL and GMM assessments for FEFD as a whole. The corresponding *t*-statistics are given in brackets. In the case of GMM there is no closest analogue of the R^2 determination coefficient, therefore the values of J-statistics are used, which can

[7] The values in brackets indicate that explanatory variables in the model are a dependent variable with lag 1 and the rest of independent variables without lags.

help roughly judge the quality of evaluation. High J-statistics values indicate that the model specification is incorrect (but do not indicate how it is specified incorrectly).

Despite the fact that for ARDL-evaluation the signs, under appropriate parameters, are consistent with the expected parameters, the quality of these estimates is low. We cannot claim that c_2 and c_4 estimates differ significantly from zero. A high value of R^2 should not be misleading as this is a fairly common case in models with lag dependent variable as a regressor. In contrast, panel data estimates demonstrated significant results, with expected signs and interval parameter values. This suggests that, according to GMM estimates, a number of parameters of the Far Eastern economic system can be estimated relatively reliably, which is impossible in case of the autoregression model.

The coefficient at I_{t-1} reflects the investment inertia. In other words, the increase in investment by 1 million rubles in the previous period leads to an increase in investment in the current period by 0.622 million rubles on average in FEFD. The coefficient c_1 at ΔGDP_t reflects investment increase as a result of changes in demand. Based on the obtained parameter estimates, the value of the investment accelerator $v = c_1/(1 - c_3) = 1.78$ can be calculated. In other words, a 1 ruble increase in demand leads to average additional investment of 1.78 rubles. The coefficient c_2 with a lag variable demand GDP_{t-1} helps calculate the value of average depreciation rate $\delta = 0.097$. Finally, change in the price of a unit of capital good also has a significant negative impact on investment performance. Thus, a price increase in the previous period by 1 ruble leads to a reduction in investment in the current period by an average of 47.5 rubles. Thus, the quality of estimates obtained for FEFD as a whole makes it possible to judge that the Far East possesses a mechanism for adjusting capital to aggregate market demand.

Based on the obtained estimates a_0, a_1, v, and δ, we can calculate the performance of the partial adjustment parameter from equation (8). Taking into account that

$$I_t^* = v(GDP_t - (1 - \delta)GDP_{t-1}),$$

the calculated values of the parameter $(1 - \lambda)$ are presented in *Figure 2*.

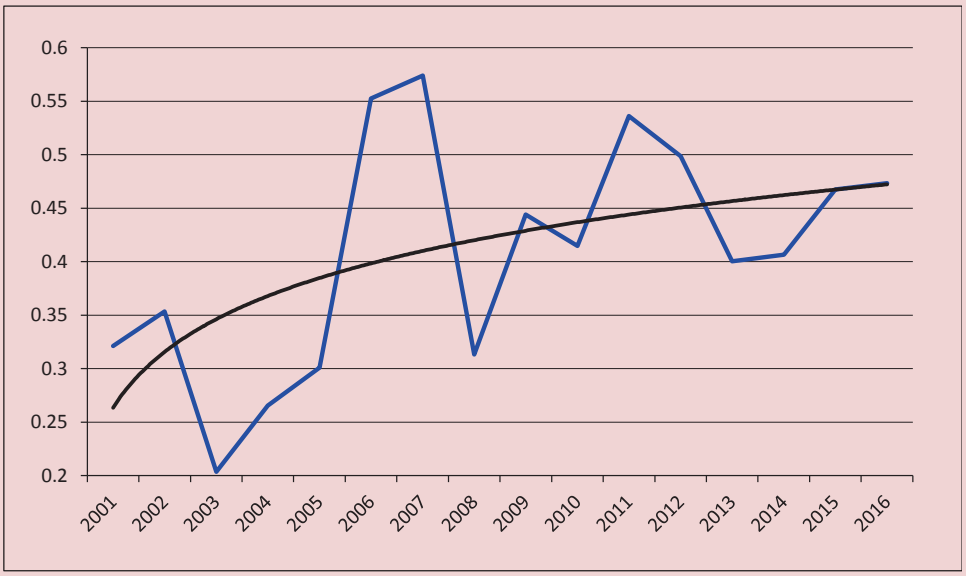
The figure demonstrates that this parameter is unstable in time but it is possible to identify its overall upward trend (black line). That is, over time the gap between the desired and actual capital stock in the FEFD economy

Table 2. The results of evaluation by FEFD

Independent variable	ARDL (1.0)	GMM
Constant	-453627	–
	(*-1.44*)	
ΔGDP_t	1.009*	0.673*
	(*2.44*)	(*13.1*)
GDP_{t-1}	0.607	0.172*
	(*1.38*)	(*6.49*)
I_{t-1}	0.584**	0.622*
	(*1.97*)	(*14.4*)
$PRICE_{t-1}$	-1940.7	-47.52*
	(*-1.27*)	(*-4.18*)
R^2	0.91	–
J-statistics (p-value)	–	3.643 (*0.602*)

* Significance at the 5% level.
** Significance at the 10% level.

Figure 2. Estimation of partial adjustment parameter values (1 - λ) for FEFD



increases, which leads to an increase in the pace of adaptation (on average, it is the higher, the further is the capital stock from the equilibrium level). The average value of the adjustment parameter for the entire period is 0.4, which means $K_t - K_{t-1} = 0{,}4(K_t^* - K_{t-1})$.

In other words, yearly investment covers the average of 40% of difference between the actual and desired capital stock.

The estimation results by separate region based on the SUR model are presented in *Table 3*.

All parameter estimates, as in the case for FEFD, have expected signs, but the quality of assessment for separate regions is generally worse than the GMM estimates, but better than the ARDL estimates for FEFD. In the case of the Western region, we have no reason to reject the null hypothesis that the coefficient for I_{t-1} is significantly different from zero or, in other words, that the autonomous pace of a_0 adaptation is different from 1. Estimates of a similar model without $Price_{t-1}$ variable

Table 3. Estimation results by SUR-model

Territory	Constant	ΔGDP_t	GDP_{t-1}	I_{t-1}	$PRICE_{t-1}$	R^2
Sakha (Yakutia) Republic	-420962* (*-4.02*)	1.993* (*3.45*)	2.446* (*4.13*)	0.317** (*1.81*)	-1779.5* (*-3.28*)	0.73
North-western region	-49137.2 (*-1.31*)	0.997* (*3.04*)	0.503 (*1.48*)	0.621* (*2.26*)	-61.48 (*-1.48*)	0.66
Primorsky Krai	-161932* (*-2.01*)	1.595* (*5.54*)	0.808** (*1.77*)	0.501* (*2.56*)	-432.6 (*-1.19*)	0.89
Khabarovsk Krai	-86254 (*-1.18*)	1.420* (*4.14*)	0.479 (*1.18*)	0.771* (*4.95*)	-182.2 (*-0.81*)	0.83
Western regions	-116475* (*-3.42*)	0.930* (*3.89*)	1.327* (*3.59*)	-0.037 (*-0.16*)	-70.8 (*-0.71*)	0.89
Sakhalin Oblast	61930* (*2.06*)	0.346 (*1.22*)	0.150 (*0.82*)	0.447* (*2.79*)	-209.1 (*-0.68*)	0.43

* 5%-level significance.
** 10%-level significance.

Таблица 4. Cross-correlation of SUR-model residuals

Territory	Sakha Rep.	Northeast	Primorsky	Khabarovsk	Western	Sakhalin
Sakha (Yakutia) Republic	1.000					
Northeastern region	0.362	1.000				
Primorsky Krai	0.624	0.108	1.000			
Khabarovsk Krai	0.644	0.305	0.723	1.000		
Western region	0.402	0.600	0.176	0.201	1.000	
Sakhalin Oblast	-0.780	-0.237	-0.323	-0.572	-0.069	1.000

somewhat made the situation better for the Western region ($c_3 = 0.16$), but even in this case it is impossible to guarantee that the true estimate is different from zero.

Regions with predominating investment in production with high resource rent (Sakha (Yakutia) Republic, the Sakhalin Oblast, the Northeastern region), have lowest R^2 values. This indicates that the investment processes performance in these regions may follow a model different from the flexible accelerator model. These are regions that, in terms of investment efficiency, are the leaders not only in the Far East, but also in Russia as a whole. On the other hand, the relatively high values of autonomous pace parameters of a_0 adaptation in the Sakha (Yakutia) Republic and the Sakhalin Oblast indicate a relatively big gap between the desired and the actual level of fixed capital, which, at high investment rates, also suggests a high resource rent.

However, estimation by SUR models have an additional advantage as it helps identify the closeness of interregional connections using the covariance matrix of the residual term. This matrix is presented in *Table 4*.

A positive correlation between the two regions implies that their economies are similar or interrelated. The negative correlation can be interpreted as the inflow of investment to one region due to the decrease (outflow) of investment in another region.

The table demonstrates that the Sakhalin Oblast has negative correlation coefficients with all other FEFD regions, which in the terms of the accelerator model can be interpreted as follows: capital inflow to the Sakhalin Oblast above the expected level is due to investment inflow in other regions below their expected level[8]. At the same time, the toughest competition for investment resources is observed with the Sakha (Yakutia) Republic where the level of investment in mining is also high, and Khabarovsk Krai.

Khabarovsk Krai has a fairly high level of interregional cooperation with all its closest neighbors, with the exception of the Amur Oblast and the Jewish Autonomous Oblast (Western region). In the case of the latter, an interesting phenomenon is their high level of interaction with the Northeastern regions of FEFD and weak – with highly diversified Khabarovsk and Primorsky krais. The expected closest interregional cooperation in FEFD is are recorded between the last two.

5. Conclusion

In this study, the investment function $I_t(i_{t-1}, Y^e)$ for FEFD and its separate regions is estimated based on the symbiosis of the Keynesian (flexible accelerator model) and the neoclassical (factors affecting the function of investment demand) approaches. It is revealed

[8] It is necessary to note that, according to Table 3, the flexible accelerator model poorly describes the investment performance of the Sakhalin Oblast ($R^2 = 0.43$). Obviously, the performance is determined by the demand for hydrocarbons. Therefore, according to the author, the result of Table 4 can be interpreted so that the increase in demand for natural resources inhibits endogenous investment mechanisms in the Far Eastern Federal district.

that the change in expected demand ΔY_t^e is a statistically significant factor determining the performance of extra-budgetary investment in the Far East. This conflicts with the common view that private investment performance in the region, as well as economic growth in general, is determined mainly by exports of hydrocarbons. Since the model includes feedbacks and lag dependences, it is confirmed that the economy of the Far East is potentially able to generate self-sustained endogenous growth. At the same time for some reasons (mainly statistical) the study of other factors affecting capital inflow was limited to assessment of the impact of prices of capital goods.

Adequately characterizing the investment performance of the entire District, the proposed model demonstrates only satisfactory behavior at the level of separate regions, especially those with a high share of mining. It should be noted that traditional models of regional growth as the main driving force of regional economic performance consider external demand, i.e. exogenous factor in relation to the region. Given the export nature of production of resource-producing regions, it is likely that endogenous dynamic processes are secondary there. Thus, the structure of the economy is an important indicator of which forces – endogenous or exogenous, or a combination of them – are the source of regional growth. Of course, the flexible accelerator model is a simplification of reality as it is based on the simple theory that technology is described by the production function with a constant ratio of output and capital. Constructing a modified model of investment performance, which would fully taking into account both endogenous and exogenous factors, as well as the specific features of the structure of the Far Eastern economy, is the purpose of further research.

Another important conclusion following from the previous one is that the economy of the Far Eastern Federal district, with the exception of certain territories specializing in mining, is able to support economic growth without relying solely on external demand. In other words, the latter is not an exclusive factor in economic performance throughout the region. Consequently, consumer and investment demand also determines the dynamic properties of the economy, which is important to take into account in applied research when forecasting investment performance in the Far Eastern Federal District.

It is important to find ways to take into account factors that are not reflected in this paper, for example, regional interest rate volatility[9]. It is necessary to analyze the impact of rate of return on unit of capital, which will require search and application of adequate methods of evaluation of regional capital assets. Of particular interest in this area are methods proposed by S. Alexiadis, D. Felsenstein [13], V.K. Gorbunov and A.G. L'vov [17] as they help estimate capital assets based on information on capital investment without building long time series of the latter.

As noted by M. Gertler [18], there is a number of conditions to obstructing capital mobility, for example, ratio of enterprises of different size located on a certain territory; shift of investment flows from regions with potentially high profit rates towards more traditional growth poles; "industrial inertia" linking investment to already created capacities and slowing capital mobility. The search for suitable regional indicators reflecting these differences is the area of further research.

[9] The impact of the short-term interest rate and other key macro-economic parameters on investment performance in the national economy is covered in [19].

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