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SOCIAL PROBLEMS

Models for Predicting Prices in the Moscow Residential Real Estate Market

V. A. Salnikov and O. M. Mikheeva*

Institute of Economic Forecasting, Russian Academy of Sciences, Moscow, 117418 Russia

**e-mail: omikheeva@forecast.ru*

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Abstract—The paper presents the results of modeling the pricing mechanism in the residential real estate market (by using Moscow as an example). The key factors that influence the monthly and annual dynamics of real estate prices are revealed; their quantitative impact is assessed using regression analysis methods. The close dependence of the real estate price on the change in the US dollar-ruble exchange rate in a monthly model with a distributed lag is revealed. In the annual model, the best explanatory force is possessed by factors such as the dynamics of the Urals oil prices and the change in the average cost of basic materials, parts, and structures purchased by construction companies in the current year. The study also proposes a new indicator, which, is believed by the authors to approximate the change in the propensity to save in high-income groups of the population.

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The level of prices in the residential real estate market is one of the most important indicators of the socioeconomic development of a particular region and the country as a whole. The market reacts impetuously to changes in the external economic situation and economic situation within the country. Identifying the factors that determine the dynamics of prices in the residential real estate market and building a model for forecasting prices are important in making managerial decisions for the public authorities and the actions of real estate market participants.

The Moscow residential real estate market was selected for analysis and modeling. The Moscow housing market is the most developed in Russia. Moscow accounts for 22.6% of the country's housing stock in value terms [1, 2]. Moscow is ranked fourth in the world in terms of the average cost per square meter of a 120-meter apartment in the city center [3].

Prices for residential real estate in Moscow have grown intensively, having increased by a factor of five from the middle of 2002 to the end of 2008. A significant drop occurred in 2009, when the price of 1 sqm fell by one third, from 170000 to 115000 rubles. After the economic crisis, prices for residential real estate resumed growth, reaching 200000 rubles/sqm. However, with the onset of a new economic downturn, housing prices have started to decline again since 2015. From 2002 to 2016[1], the cost of housing increased by a factor of five, while the consumer price index increased by a factor of 3.5 for the same period. Thus, despite the sharp ups and downs, the price continued to rise. It should be noted that prices for residential real estate in US dollars have been more volatile. Thus, in 2008 the cost of housing reached very high values (6000 US dollars/sqm), exceeding the level of 2002 by a factor of 5.8. As a result of the economic crisis in 2008–2009, the price fell by one third and returned to growth only at the end of 2009; meanwhile, the price of 1 sqm did not reach the precrisis level (6000 US dollars, observed in mid-2008). In 2014–2015, due to the devaluation of the ruble, housing prices denominated in US dollars more than halved. By the end of 2015, the cost of 1 sqm of residential real estate (in US dollars) had risen by a factor of only 2.2 from December 2002. Let us analyze the factors that can explain the sharp price fluctuations.

Review of Literature. In the publications of recent years that are associated with the analysis of the real estate market, there are two main areas of the real estate price modeling: (1) studies of the price level depending on the characteristics of real estate objects (the number of floors, structural elements, etc.); (2) studies of the dynamics of prices depending on economic factors. In the world practice, the topic of modeling the real estate price has been worked out quite deeply in both areas. Since in this article we study the dependence of the price on economic factors, attention will be paid to a review of the literature in this field.

[1] The article uses the data for the first half of 2016.

The results of research on the dependence of the price and demand for real estate on economic factors are presented in the works of foreign authors. In [4], econometric models for the US residential real estate market that reflect the impact of several factors on the price were constructed. The positive dependence of the price on the indicators such as permanent income and loan-to-value ratio was noted. The negative impact on the price was demonstrated by the following indicators: the per capita housing stocks and the the real user cost of housing (a combination of variables: the real after-tax interest rate of borrowing, the depreciation rate, the property tax rate, and the expected real rate of capital appreciation).

The paper [5] presents, a cointegration analysis of the impact of household incomes, mortgage rates, and construction costs on the price for residential real estate in the United States, both for the country and the cities. A linear dependence was only found for the city of Cleveland. A nonlinear relationship was revealed for the USA and its six large cities (Chicago, Dallas, Philadelphia, Richmond, Seattle, and St. Louis). For Boston, Los Angeles, and New York, there was no cointegration.

The working paper [6] analyzes, the data on the former Soviet Union countries (Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Latvia, Lithuania, Moldova, Russia, Tajikistan, Ukraine, and Estonia). The authors explain the change in the price for residential real estate in the long-term by the dynamics of the following factors: real GDP, remittances, and foreign inflows (mostly in the form of bank borrowing from abroad). Meanwhile, the degree of exposure the price to factors varies across the countries. For example, the inflow of foreign capital plays a significant role in the Baltic countries, Kazakhstan, Ukraine, and Russia, whereas remittances are a more important factor for the remaining countries. For all countries, real GDP has a significant impact on the housing price.

In [7], a model of residential real estate prices was constructed for 17 countries depending on five endogenous variables: the GDP growth rate, the rate of inflation in consumer prices, the real short-term interest rate, the growth rate in inflation-adjusted bank credit, and the difference in yield between a long-maturity government bond and the short rate. The main conclusion of the study is that inflation explains more than half of the total change in housing prices on a five-year horizon, and in the short-term outlook, the influence of this factor is even greater.

In [8], based on the study of the determinants of house prices in 19 OECD countries and eight transition economies of Central and Eastern Europe, the influence of the factors such as per capita GDP, real interest rates, housing credit[2], real wages, population, and labor market indicators (unemployment rate, labor force share) is determined. The study revealed the following information:

—Under decreasing real interest rates, the price for residential real estate in Central and Eastern Europe grows twice as fast as in the OECD countries;

—With an increase in the indicator of housing credit, the price response in the OECD countries is approximately twice as high as in the countries of Central and Eastern Europe.

The dissertation study [9] revealed the dependence of housing prices in Russia on three factors: average per capita monetary income, the number of people employed, and the number of commissioned residential buildings. Meanwhile, the influence of factors such as the number of mortgage loans extended to individuals and investments in housing construction turned out to be insignificant.

The works of Russian authors pay considerable attention to studying the effect of the physical characteristics of real estate on its value. However, in our opinion, the topic of modeling the price for residential real estate depending on economic factors has not been sufficiently developed: we managed to find only a few works, in which this topic is revealed. An illustrative analysis of the dynamics of oil prices, exchange rates, and the cost of residential real estate for Moscow and Moscow oblast is given in [10], but without constructing a model. The work [11] contains a model that describes the dependence of the price of 1 sqm of residential real estate in rubles in Russia on the dynamics of the euro, but the time period ends with the data for 2011.

There are two main approaches to the analysis of data: (1) discrete-time state space model [12–14]; (2) correlation regression analysis [14, 15]. In the second approach, there are several areas for studying the dynamics of prices for residential real estate. For example, the change in oil prices is often directly correlated with the dynamics of the cost of housing [16–18]. There are studies on the relationship between the ruble price for residential real estate and the dynamics of exchange rates [10, 11].

In this paper, the dependence of the price for residential real estate objects on macroeconomic factors is also considered based on the correlation regression analysis using the least squares method (LSM). We have built four models that allow us to understand the monthly and yearly pricing mechanism in the residential real estate market.

The Monthly Model. In the monthly model, the dynamics of the average monthly price for residential

[2] It is measured by changes in the ratio of private sector credit to GDP in OECD countries, and by the ratio of housing credit to GDP in transition economies.

Table 1. Results from estimating regression parameters*

Explaining variable	Coefficient	
ln(exchange rate index in the period t)	0.568***	0.576***
	(0.042)	(0.042)
ln(exchange rate index in the period t – 1)	–0.402***	–0.393***
	(0.043)	(0.042)
Constant	0.003*	–
	(0.002)	

* Detailed results from assessing each model are available through link in [20]. Here and below in Tables 2–4 *, **, *** indicate significance at the 10, 5, and 1% levels, respectively. Standard errors are given in brackets.

real estate from January 2010 to June 2016 was analyzed. The influence of many factors that explain the price change was assessed based on it. The result of structuring the assessed factors of pricing in the real estate market by groups is presented below.

Macroeconomic factors	Urals oil price, rubles and USD
	Average monthly US dollar-ruble exchange rate
	Consumer price index
Indicators of real estate market	Number of commissioned residential buildings in city of Moscow
	Number of registered transfers of rights based on purchase and sale (exchange) of housing in Moscow
	Number of registered mortgage transactions in Moscow
Indicators of housing lending	Volume of mortgage housing loans issued in Moscow, rubles
	Weighted average mortgage rate (in nominal* and in real terms)
	Weighted average deposit rate**
Indicators of income level of population in region	Average accrued wages in city of Moscow, rubles
	Per capita monetary incomes in city of Moscow, rubles

* Methodology for calculating average mortgage rate of Central Bank of Russian Federation [19]. ** Deposits of up to 1 year, excluding demand deposits and Sberbank deposits.

In the works of foreign authors, the price for residential real estate depends mainly on the income level of the population and the economic state of the region under study, but in our calculations such factors proved to be insignificant. The change in the price for residential real estate (in ruble terms) is most accurately described by the dynamics of the US dollar/ruble exchange rate (Table 1, Fig. 1)[3]. The model has the following form:

$$\ln Pr_{t(\text{rub.})} = \beta_0 + \beta_1 \ln(I\$_t) + \beta_2 \ln(I\$_{t-1}),$$

where $\ln Pr_t$ is the index of prices for residential real estate (the ratio of the price for residential real estate in rubles in the current month to the previous one); $I\$_t$ is the exchange rate index (the ratio of the US dollar/ruble exchange in the current month to the previous one).

Thus, the regression equation is given by

$$\overline{Pr_{t(\text{rub.})}} = 1.003 I\$_t^{0.568} I\$_{t-1}^{-0.402}.$$

Consequently, in recent years, the average monthly housing price is most accurately modeled depending on the dynamics of the US dollar-ruble exchange rate (and not by the oil price[4]): the same factor acts with different signs, and the sum of elasticities is 0.169. In accordance with the results of the regression equation, the appreciation of the currency leads to an instantaneous jump in ruble prices; however, as early as the next month, under otherwise equal conditions, prices decline, cancelling approximately 2/3 of the rise. Thus, as the exchange rate index in the current period increases by 1%, the price of 1 sqm of residential real estate grows by 0.568 thousand rubles. Since the elasticity depending on the exchange rate index in the previous period is negative, its growth by 1% leads to a decrease in the price by 0.402 thousand rubles. Therefore, the cumulative elasticity of the change in real estate prices depending on the exchange rate is 0.166. Under otherwise equal conditions, the value of the constant indicates a monthly increase in the cost of housing by 0.003 thousand rubles.

This situation, in which the depreciation (appreciation) of the domestic currency leads to an increase

[3] Figures 1–3 were made using the calculations of the Center for Macroeconomic Analysis and Short-Term Forecasting based on the data [21, 22].

[4] Of course, the oil price affects the cost of residential real estate, but only indirectly, through the exchange rate; i.e., the change in the oil price determines the dynamics of the exchange rate, and the exchange rate determines the price for residential real estate.

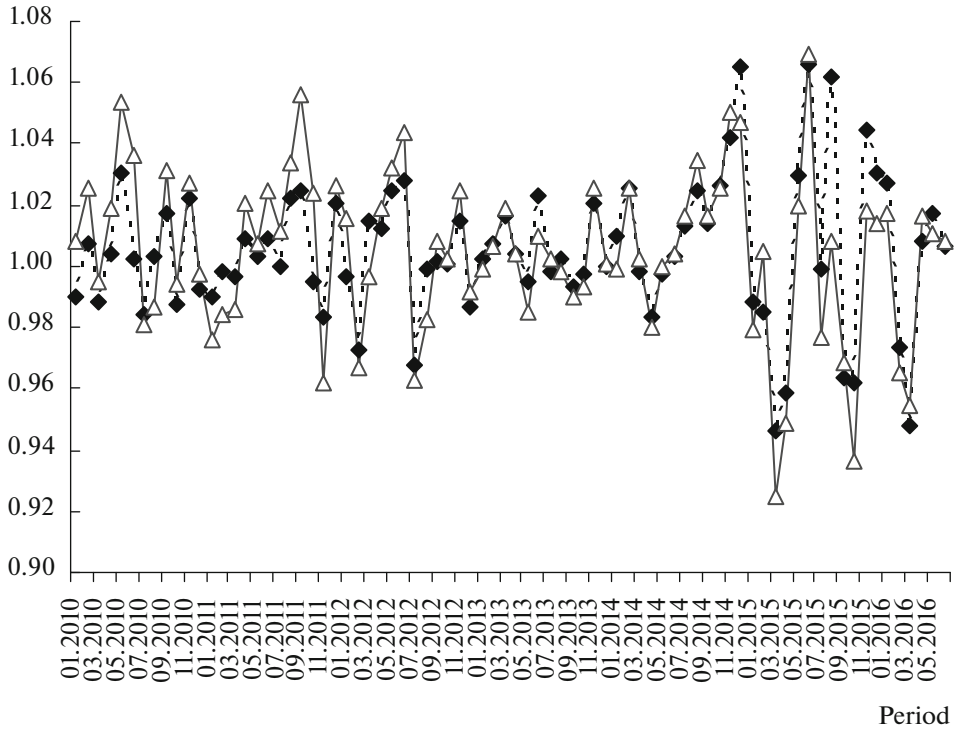

Fig. 1. Actual (–△–) and model (–◆–) values of price for residential real estate in monthly model.

(fall) in prices for residential real estate, indicates that some sellers fix prices for apartments in US dollars (or quickly index them depending on the change in the US dollar-ruble exchange rate). However, from mid-2015 to early 2016, the model describes the price dynamics less accurately (Fig. 2), which probably indicates a correction of the behavior model by the real estate market players due to the ruble devaluation wave. Thus, in some months there is a significant deviation of the model value from the actual one (in particular, in December 2014, March, July–August, and October–November 2015). This is due to the fact that in the conditions of high volatility of the ruble many developers tried to delink ruble prices from US dollar ones.

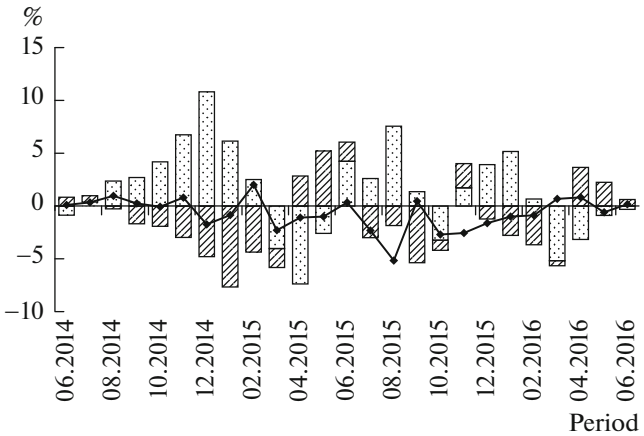

Fig. 2. Model of dependence of price for residential real estate on exchange rate index in monthly model (factorization): ▨ $I\$_{t-1}$; ⬚ $I\$_t$; –◆– difference between actual and model values.

Moreover, developers often reduced prices (despite the weakening of the ruble) in order to maintain demand for housing in the unfavorable economic situation. In the conditions of the decline in prices that began in mid-2014, the reluctance of real estate sellers in the secondary market (especially housing purchased during a boom in investment) to lower prices to the market level resulted in buyers switching to the primary real estate market.

The Annual Models. When constructing the annual models that reflect the existence of a relationship with the price, the following factors were tested and structured.

Macroeconomic factors	Urals oil price, USD and ruble
	Average annual US dollar-ruble exchange rate
	Consumer price index
	Average prices for basic materials, parts, and structures purchased by construction organizations*, rubles
Indicators of real estate market	Number of commissioned residential buildings in city of Moscow

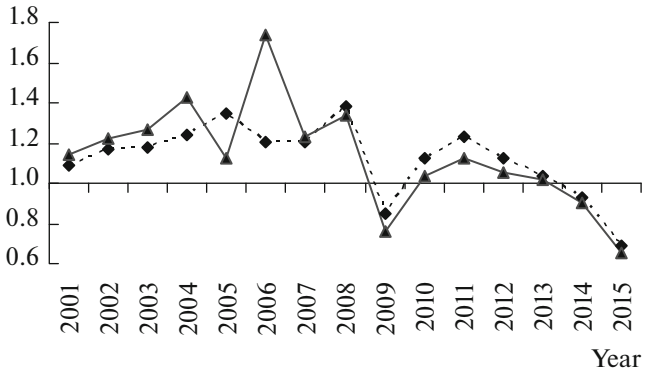

Fig. 3. Actual (–▲–) and model (–◆–) price for residential real estate (in dollar terms) in annual model.

Indicators of housing lending	Volume of mortgage housing loans issued in city Moscow, rubles
	Weighted average mortgage rate (in nominal and real terms)
	Weighted average deposit rate**
Indicators of income level of population	Average accrued wages in city of Moscow, rubles
	Per capita monetary income in Moscow, rubles
	Incomes from entrepreneurial activity in Russia, rubles
	Other cash incomes in Russia, rubles
	Ratio of changes in household savings, rubles, to dynamics of oil prices, rubles
	Expenses for non-food products in Russia, rubles
	Volume of funds on ruble accounts and deposits in Russia, rubles
	Volume of funds on deposits in foreign currency in Russia, rubles
	Profit (income) of enterprises and organizations, rubles

* This indicator includes the following set of goods: concrete ready for pouring (ready-mixed concrete), large wall blocks (including blocks of cellar walls) made of heavy cement concrete, ceramic firebrick, other built-up steel structures, paints, internal reinforced concrete wall panels, external reinforced concrete wall panels, other natural sands, ordinary lumber not included in other groups, other materials, cement, road metal. ** Deposits of up to 1 year, excluding demand deposits and Sberbank deposits.

The first variant of the annual model explains the dynamics of the average annual price for residential real estate in dollar terms from 2002 to 2015[5]. According to the estimates, the model showed a fairly close dependence of the price for residential real estate on the average annual price of Urals oil (in US dollar terms) and average prices for basic materials, parts, and structures purchased by construction organizations (in ruble terms) (Table 2, Fig. 3). Thus, the model has the following form:

$$\ln Pr_{t(\text{doll.})} = \beta_0 + \beta_1 \ln (Ioil_t) + \beta_2 \ln (Istr_{te}),$$

where $\ln Pr_{t(\text{doll.})}$ is the index of prices for residential real estate (the ratio of the price for residential real estate in US dollars in the current month to the previous one); $Ioil_t$ is the Urals oil price index (the ratio of the Urals oil price in dollar terms in the current year to the previous one); $Istr_{te}$ is the price index for basic materials, parts, and structures purchased by construction organizations (the ratio of the price of purchased building products in ruble terms in the current year to the previous one) with a distributed lag[6]:

$$\ln (Istr_{te}) = 0.6 \ln (Istr_t) + 0.4 \ln (Istr_{t-1}).$$

Despite the fact that the constant is insignificant, its inclusion in the model is necessary to avoid a significant shift in the coefficient for the second factor. The model with the constant is the best in comparing statistics (corrected R^2, the Akaike and Schwartz criterion). Thus, the regression equation in the annual model is given by

$$\overline{Pr_{t(\text{doll.})}} = -1.058 Ioil_t^{0.551} Istr_{te}^{0.664}.$$

As can be seen in Fig. 3, the relationship between the price of oil and the price of residential real estate is not as significant as expected: the elasticity is 0.540. Meanwhile, the model does not properly describe the price change in the market in 2005–2006, because during this time period, other factors had a significant effect. Thus, despite the rapid rate of growth in the cost of oil in 2005, the housing price grew quite weakly. In the first half of 2005, the residential real estate market experienced stagnation, which continued from mid-2004. The decrease in demand for housing was caused by banking instability[7], as a result

[5] Data for 2006 were excluded from the calculations, since we interpreted them as an upsurge due to the atypical situation in the Moscow housing market. In 2006, there was a record rise in the cost of residential real estate: the average cost of 1 sqm increased from 2300 US dollars in December 2005 to 4200 US dollars in December 2006; i.e., it almost doubled. The increase in prices heated up, as first, the rush of investment demand that was caused by the rapid rise in apartment prices and the entry into force of law 214-FL on shared construction, which toughened construction norms, and, second, the limited volumes of housing construction (despite the increased commissioning in housing, the supply volume was reduced, since an increasing proportion of the constructed housing was allocated for social needs: the number of new apartments that fell into free sale was 20–50% smaller in comparison with the previous years).

[6] Using the Granger test, it was confirmed that it was prices for building materials that affected the price for residential real estate, and not vice versa (see [20]).

[7] It is classified in economics as a crisis of confidence in the banking system that occurred in 2004.

Table 2. Results from estimating regression parameters

Explaining variable	Coefficient	
ln(Urals oil price in period *t*)	0.540***	0.551***
	(0.081)	(0.086)
ln(price index for basic materials, parts, and structures purchased by construction organizations in the period *t*)	0.980***	0.664***
	(0.255)	(0.173)
Constant	–0.058	–

Table 3. Results from estimating regression parameters (first model of real estate prices in ruble terms)

Explaining variable	Coefficient	
ln(exchange rate index in period $t-1$)	0.811**	0.810***
	(0.305)	(0.255)
ln(price index for basic materials, parts, and structures purchased by construction organizations in period *t*)	1.043***	1.041***
	(0.227)	(0.132)
Constant	–0.0003	–
	(0.032)	

of which buyers expected a decline in the cost of real estate. The price growth resumed from the second half of 2005, when it became obvious to market participants that the banking crisis had been overcome and there were no reasons to reduce the cost of housing. In 2006, the record growth in residential real estate prices was caused by several factors: first, the effect of deferred demand since 2005; second, the increased investment demand due to a steady increase in prices for natural resources (the revenues of export-commodity companies and, accordingly, bonus payments to personnel increased). Thus, the relationship between the cost of oil and real estate prices does exist, but it is not as unambiguous as it seems at first glance.

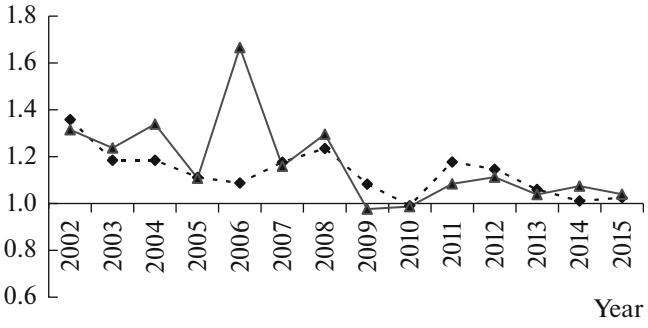

Fig. 4. Actual (–▲–) and model (–◆–) price for residential real estate in annual model (first model of real estate prices in rubles).

It is important to note that the factors that characterize the income level of the population (the average accrued wages, income from entrepreneurial activity, and per capita monetary incomes), which seemingly could influence the real estate price, have proved to be insignificant. Perhaps this is due to the high level of the shadow component in incomes that is not taken into account in the official statistics, which, consequently, can distort real changes in incomes. It should also be considered that the dynamics of not all incomes affect the demand for real estate (for example, an indicator such as monetary cash incomes includes social payments from the state). Ultimately, it is the fluctuation in oil prices that most accurately reflects the change in the consumer and investment demand for real estate denominated in US dollars, since it seems to accurately approximate the income dynamics in the upper decile of the population with the highest incomes (which forms the bulk of the demand for real estate).

When constructing the annual model in ruble terms, several dependences were revealed. In the first case, the explanatory variables were the exchange rate index and the price index for basic materials, parts, and structures, which are purchased by construction organizations (Table 3, Fig. 4). In the second case,

Table 4. Results from estimating regression parameters (second model of real estate prices in ruble terms)

Explaining variable	Coefficient	
ln(index of savings dynamics to oil dynamics in period $t-1$)	0.220** (0.090)	0.230** (0.076)
ln(price index for basic materials, parts, and structures purchased by construction organizations in period t)	0.802*** (0.199)	0.835*** (0.130)
Constant	0.007 (0.032)	–

these were the index of savings dynamics with respect to oil dynamics and the price index for basic materials, parts, and structures purchased by construction organizations (Table 4, Fig. 5). The first model is given below:

$$\ln \mathrm{Pr}_{t(\mathrm{rub.})} = \beta_1 \ln (I\$_{(t-1)e}) + \beta_2 \ln (Istr_{te}),$$

where $I\$_{(t-1)e}$ is the exchange rate index (the ratio of the average annual US dollar-ruble exchange rate in the last year to the previous one).

In this case,

$$\ln (I\$_{(t-1)e}) = 0.2 \ln (I\$_{t-1}) + 0.8 \ln (I\$_{t-2});$$
$$\ln (Istr_{te}) = 0.6 \ln (Istr_t) + 0.4 \ln (Istr_{t-1}).$$

Thus, the regression equation of the first annual model is given by

$$\overline{\mathrm{Pr}_{t(\mathrm{rub.})}} = I\$_{(t-1)e}^{0.810} Istr_{te}^{1.041}.$$

The second model is given by

$$\ln \mathrm{Pr}_{t(\mathrm{rub.})} = \beta_1 \ln (I(\mathrm{S}aiv/Oil)_{t-1}) + \beta_2 \ln (Istr_{te}),$$

where $I(Saiv/oil)_{t-1}$ is the index of savings dynamics with respect to oil dynamics (the ratio of the dynamics of the total savings of the population in the last year to the previous one, which is divided by the ratio of oil price dynamics in rubles in the last year to the previous one). This indicator is believed by us to reflect the change in the propensity to save, primarily in the high-income population groups, which form the demand for residential real estate[8].

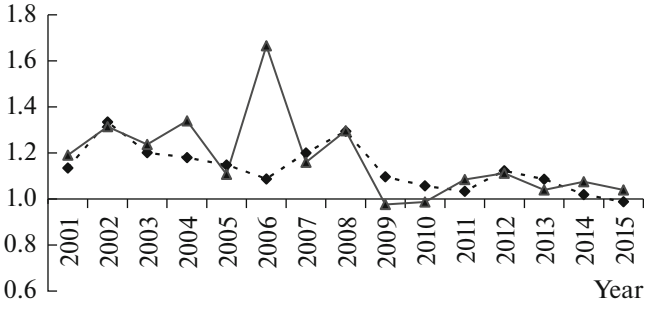

Fig. 5. Actual (–▲–) and model (–◆–) prices for residential real estate in annual model (second model of real estate prices in rubles).

$$\ln (Istr_{te}) = 0.6 \ln (Istr_t) + 0.4 \ln (Istr_{t-1}).$$

Thus, the regression equation of the second annual model appears as follows:

$$\overline{\mathrm{Pr}_{t(\mathrm{rub.})}} = I(\mathrm{S}aiv/Oil)_{t-1}^{0.230} Istr_{te}^{0.835}.$$

In both models, a significant contribution to determining the cost of 1 sqm of real estate in ruble terms is made by the oil price dynamics: in the first model, it occurs indirectly through the exchange rate, and in the second one, it takes place in relation to the savings dynamics. The variable "price index for basic materials, parts, and structures purchased by construction organizations" turned out to be significant for both models.

* * *

Consequently, the paper presents the monthly model and three annual models that explain the behavior of real estate prices in the long term. When analyzing the dynamics of the price for residential real estate (in rubles) by months, its significant dependence on a change in the US dollar-ruble exchange rate was revealed: the same factor acts with different signs in the current and previous month. The result shows that so far some real estate sellers nominate the prices of their properties in US dollars.

When considering the annual dynamics of the cost of 1 sqm of residential real estate (in US dollar terms), it was found to be dependent on fluctuations in the US dollar price of oil. In the annual models of prices for residential real estate in ruble terms, the determining factor in the first case was the dynamics of the exchange rate, and in the second case, the decisive factor was the change in the propensity to save. The oil

[8] It is known that the overwhelming part of the population's savings in the Russian economy is formed by high-income population groups. Meanwhile, the dynamics of the real disposable incomes of the population most accurately reflect the change for low-income groups [23]. As a result, a direct correlation of savings and incomes gives a biased estimate. At the same time, it seems that in the period under review, the dynamics of prices in world markets (and, in particular, oil prices) could serve as an approximator of the dynamics of the population's incomes, since at that time they were the main driver of income growth in the economy as a whole and in high-income groups in particular.

price dynamics are the main, but not the only, dependence for these factors, because other factors also have an effect: for example, the change in prices for export goods with a large share in Russia's trade balance, the balance of payments, the inflation rate, and the use of foreign currency in international calculations. In all the annual models, the dynamics of the cost of building materials are a significant factor. Apparently, this factor closely approximates the change in the economic situation in the construction sector, which affects the cost of real estate.

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REFERENCES

1. The Federal Service of State Statistics. http://www.gks.ru/.
2. Territorial Body of the Federal State Statistics Service in the City of Moscow. http://moscow.gks.ru/.
3. Global Property Guide. http://www.globalpropertyguide.com/Europe/square-meter-prices.
4. J. V. Duca, J. Muellbauer, and A. Murphy, "Shifting credit standards and the boom and bust in U.S. house prices," SERC Discuss. Pap., No. 76 (2011).
5. J. Zhou, "Testing for cointegration between house prices and economic fundamentals," Real Estate Econ. **38** (4), 599–632 (2010).
6. V. Stepanyan, T. Poghosyan, and A. Bibolov, "House price determinants in selected countries of the former Soviet Union," in *IMF Working Paper* (2010).
7. K. Tsatsaronis and H. Zhu, "What drives housing price dynamics: Cross-country evidence," BIS Q. Rev., March, 65–78 (2004).
8. B. Égert and D. Mihaljek, "Determinants of house prices in Central and Eastern Europe," Compar. Econ. Stud. **49**, 367–388 (2007).
9. A. S. Orekhova, Extended Abstract of Candidate's Dissertation in Economics (2012).
10. T. N. Kisel and Ya. I. Palastrova, "Analysis of the main trends in prices in the real estate market of Moscow in the period of economic instability," Ekon. Predpr., No. 2, 847–851 (2016).
11. L. M. Mingazova, "On one approach to modeling the value dynamics of the real estate market," Sovrem. Tendentsii Ekon. Upr.: Nov. Vzglyad, No. **17**, 111–115 (2012).
12. G. M. Sternik and S. G. Sternik, "Mass estimation of real estate on the basis of discrete space-parametrical modeling of the market (on an example of townhouses of the western sector of near Moscow suburbs)," Otsenochnaya Deyat., No. 2, 22–27 (2010).
13. G. M. Sternik, "Pricing in the Russian housing market," Imushchestv. Otnosheniya Ross. Fed., No. 5, 67–83 (2010).
14. S. V. Gribovskii, M. A. Fedotova, G. M. Sternik, and D. B. Zhitkov, "Economic and mathematical models of real estate evaluation," Fin. Kredit, No. **3**, 24–43 (2005).
15. I. N. Anisimova, N. P. Barinov, and S. V. Gribovskii, "On the requirements for the number of comparable objects in the valuation of real estate by a comparative approach," Vopr. Otsenki, No. **1**, 2–7 (2003).
16. N. I. Kornilov, "Influence of oil prices on the value of residential property," Ross. Predpr. **16** (10), 1483–1494 (2015).
17. T. A. Cherkashina, T. V. Khaustova, and N. B. Firsova, "Analysis of the influence of general economic indicators on the regional real estate market," Izv. Yugo-Zap. Gos. Univ., No. 1, 34–45 (2015).
18. V. V. Ivanitskii, "Increase of housing affordability on the basis of state compensation of prices for energy resources," Ekon. Reg., No. 4, 123–131 (2015).
19. https://www.cbr.ru/regions/CredDepozit/Metodology/Print.asp?file=Cred.htm.
20. www.forecast.ru/Outgoing/PP201801Appx.pdf.
21. Indicators of the real estate market. http://www.irn.ru.
22. Central Bank of the Russian Federation. http://www.cbr.ru.
23. V. N. Ivanov and A. V. Suvorov, "Incomes and consumption of the Russian population during the crisis and alternatives to the government policies in this sphere," Stud. Russ. Econ. Dev. **20**, 569 (2009).

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