The Price of Oil as a Pricing Factor of the Residential Real Estate at the Regional Market

N A Yarushkina[1], E G Matyugina[2,3], E V Vaganova[2]
[1]Tomsk State University of Architecture and Building, Tomsk, Russia
[2]National Research Tomsk State University, Tomsk, Russia
[3]Tomsk State University of Control Systems and Radioelectronics, Tomsk, Russia

E-mail: emk512542@mail.ru

Abstract. The article is to study the influence of oil price variation on the parameters of the residential real estate market, which is a significant factor of the development of the country's living standards. The analysis of oil price variation as one of the key figures determining price variation of goods and services in Russia, covers the period of the 2008 crisis and the post-crisis period of 2011-2017 (on a quarterly basis). The price variation of living space per square meter in the primary and secondary housing markets in remote federal districts (Central, Siberian, Far Eastern) has been analyzed. That allowed to identify the specifics of the process investigated in far-flung territories with significantly different indicators of economic development. As an assessment tool of the impact of structural changes in the Russian economy on price variation a statistical Chow-test, showing the presence of structural instability during the crisis, has been used. Based on the data, modeling of the interconnection between the oil price variation and a housing square meter price variation has been carried out in the period of 2011-2017. The official data of the Federal State Statistics Service of the Russian Federation have been used.

1. Introduction

The predominant focus of national industries on the use of traditional energy sources contributes to the formation of the dependence of production efficiency on energy prices. Ultimately, this determines the indicators of the country's socio-economic development and the level of the population's well-being. The formulation of the welfare assessment problem was described in the works of the classics (A. Smith, D. Ricardo, K. Marx, J. S. Mill, A. Pigou, V. Nordhaus, E. Clark, and others). Detalization of the welfare components (economic, social, environmental, etc.) was presented in the studies of Russian scientists VN. Bobkov, T.I. Zaslavskaya, N. Volgin, V.S. Bochko, ON Antipin, E.V. Zhuravskaya, L.A. Rodionov et al. [1, 3-5, 14, 15]. This article focuses on the availability of goods. This makes it possible to identify the groups of the population according to the criteria of income and housing security, access to education and medical care; and also to establish the connection between welfare and the level of socioeconomic inequality, etc. [2, 5, 6, 9, 10].

The importance of the criterion of "housing security" in assessing welfare confirms its involvement in the category of basic services [17]. The level of availability of this category is determined by the ratio of effective demand and the cost per square meter of housing and depends on the state of the national economy, the development of financing mechanisms, the level of incomes of the population and other factors. The impact of oil price fluctuations on the housing market was considered earlier [7, 11,

13, 19], but the reasonableness of the findings in the current economic situation is not sufficient. That is why the study of the dynamics of the relationship between oil prices and the square meter of housing in the primary and secondary real estate market is of scientific interest. For comparison, representatives of the federal districts of the Russian Federation with a significant geographical spread such as Tula Region (Central Federal District), Tomsk Region (Siberian Federal District), and Primorsky Krai (Far Eastern Federal District) have been selected. The choice is not random. It allows to confirm or reject the hypothesis about the difference in price dynamics trends in different territories [12]. The dynamics of the cost of 1 square meter of living space in the primary market is shown in Figures 1 and 2.
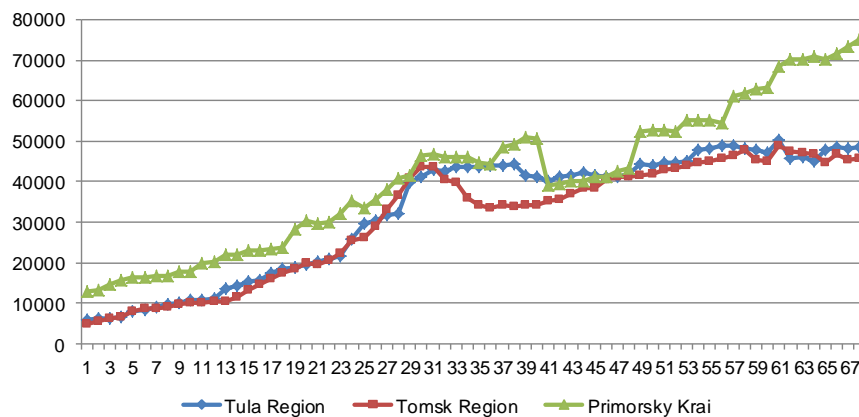

Figure 1. The dynamics of the cost of 1 square meter of living space in the primary market in 2001-2017, quarterly, in rubles.
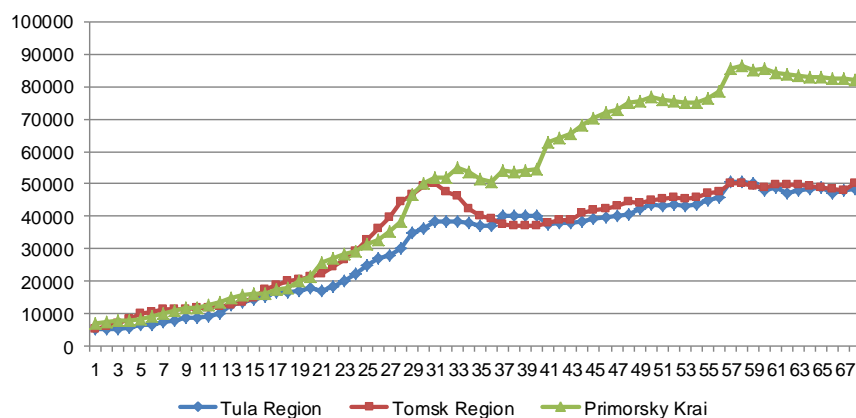

Figure 2. The dynamics of the cost of 1 square meter of living space in the primary market in 2001-2017, quarterly, in rubles.

Absolute price leader in the primary market is the Primorski Krai, which has acquired this status in the secondary market. For all regions, the price dynamics of 1 square meter of housing is almost identical in the primary and secondary markets: continuous growth until 2007, the decline in 2008 and subsequent growth (slightly less intensive than the first segment). The presence of a "splash" indicates a high sensitivity of prices to the markers of the financial crisis. A return to the previously formed trend actualizes the task of assessing the impact of structural changes on price dynamics. To study the structural changes in the series, the statistical test of G. Chow [18, 20] is to be applied. It allows develop a hypothesis about the structural stability of the trend of time series of the average cost of 1 square meter of living space. After calculating the basic characteristics, the residual sum of squares on

the piecewise-linear model C_{ost}^{kl} is calculated as the sum C_{ost}^{1} and C_{ost}^{2}, and corresponding number of degrees of freedom $n - k_1 - k_2$. The reduction of the residual dispersion upon transition from the trend equation over the entire time interval to the piecewise linear model is defined as the difference of the residual sums of the squares of the deviations. The actual value of Fisher's F-criterion for variances per degree of freedom of variation is compared with the tabular (Fisher distribution tables) for significance level α and a certain number of degrees of freedom

$$F_{fakt} = \frac{\Delta C_{ost} : k_1 + k_2 - k_3}{C_{ost}^{kl} : n - k_1 - k_2} \qquad (1)$$

The required calculations for each area and types of markets are given in Tables 1, 2.

Table 1. Calculation of indicators for the test G. Chow (primary market).

Equation №	The form of equation	Number of observations	Residual sum of squares	Number parameters in equation	Number of degrees of freedom residual variances
		Piecewise-linear model			
(1)	$y^{(1)} = a_1 + b_1 \cdot t$	n_1	C_{ost}^1	k_1	$n_1 - k_1$
(2)	$y^{(2)} = a_2 + b_2 \cdot t$	n_2	C_{ost}^2	k_2	$n_2 - k_2$
		The trend equation for the whole set			
(3)	$y^{(3)} = a_3 + b_3 \cdot t$	n	C_{ost}^3	k_3	$n - k_3 = $ $= n_1 + n_2 - k_3$
		Tula region			
(1)	$y^{(1)} = 3485,5 + 803,7 \cdot t$	24	22590070	2	22
(2)	$y^{(2)} = 40892,0 + 310,9 \cdot t$	28	73567950	2	26
(3)	$y^{(3)} = 3090,0 + 1041,6 \cdot t$	52	1432870630	2	50
		Tomsk region			
(1)	$y^{(1)} = 3485,5 + 803,7 \cdot t$	24	47061454	2	22
(2)	$y^{(2)} = 40892,0 + 310,9 \cdot t$	28	81232071	2	26
(3)	$y^{(3)} = 3090,0 + 1041,6 \cdot t$	52	1081600670	2	50
		Primorsky Krai			
(1)	$y^{(1)} = 10743,0 + 881,1 \cdot t$	24	49860836	2	22
(2)	$y^{(2)} = 35373,0 + 1446,3 \cdot t$	28	118105925	2	26
(3)	$y^{(3)} = 5817,5 + 1304,3 \cdot t$	52	167966761	2	50

According to the calculations (Table 1) for the primary housing market, the actual values of Fisher's (F) are as follows:

1)   Tula region $F_{fakt} = 333,6$;

2)   Tomsk region $F_{fakt} = 178,3$;

3)   Primorsky Krai $F_{fakt} = 35,5$.

Table 2. Calculation of indicators for the test G. Chow (secondary market).

Equation №	The form of equation	Number of observations	Residual sum of squares	Number parameters in equation	Number of degrees of freedom residual variances
		Tula region			
(1)	$y^{(1)} = 2558,9 + 747,0 \cdot t$	24	21892349	2	22
(2)	$y^{(2)} = 37611,0 + 473,0 \cdot t$	28	93778953	2	26
(3)	$y^{(3)} = 775,4 + 1081,5 \cdot t$	52	1177292025	2	50
		Tomsk region			
(1)	$y^{(1)} = 3594,0 + 902,2 \cdot t$	24	59703086	2	22
(2)	$y^{(2)} = 39829,0 + 424,6 \cdot t$	28	63562726	2	26
(3)	$y^{(3)} = 3869,9 + 1047,4 \cdot t$	52	1050994957	2	50
		Primorsky Krai			
(1)	$y^{(1)} = 3457,5 + 947,4 \cdot t$	24	74273303	2	22
(2)	$y^{(2)} = 66573,0 + 749,0 \cdot t$	28	262243217	2	26
(3)	$y^{(3)} = -4037,2 + 1992,2 \cdot t$	52	5796075172	2	50

The actual values of Fisher's (F) are as follows:

1)   Tula region $F_{\text{fakt}} = 220,3$;

2)   Tomsk region $F_{\text{fakt}} = 180,6$;

3)   Primorsky Krai $F_{\text{fakt}} = 389,4$.

All actual Fisher's values (F) are considerably higher than the tabulated value equal to 5.08 for the significance level of 0.01 and the number of degrees of freedom equal to 2 and 48, respectively. This allows to reject a hypothesis about the structural stability of the series under consideration and recognize the impact of structural changes on the dynamics of the cost of 1 square meter in both the primary and secondary markets. At the same time, the lowest value F corresponds to the cost of 1 square meter of housing in the primary market of Primorsky Krai, and characterizes the changes in the structure of the series as not significant compared to other series (Figure 3).

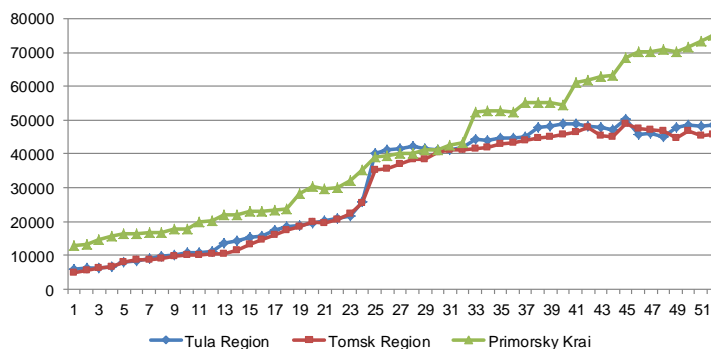In the secondary market, on the contrary, the largest increase in value falls on 2007-2010 (Figure 4).

Figure 3. Dynamics of the cost of 1 square meter of living space in the primary housing market for the period 2001-2017 on a quarterly basis (except for the period of the structure change in 2007-2010), in rubles.

Figure 4. Dynamics of the cost of 1 square meter of living space in the primary housing market for the period 2001-2017 on a quarterly basis (except for the period of the structure change in 2007-2010), in rubles.
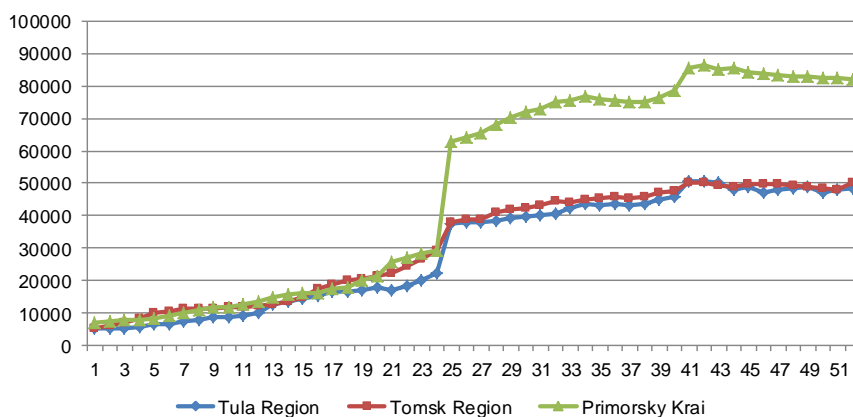
The actual value of Fisher (F), equal to 136.1, allows to conclude that there are structural changes in a number of oil prices during the crisis (Table 3, Figure 5)

Table 3. Calculation of indicators for the test G. Chow

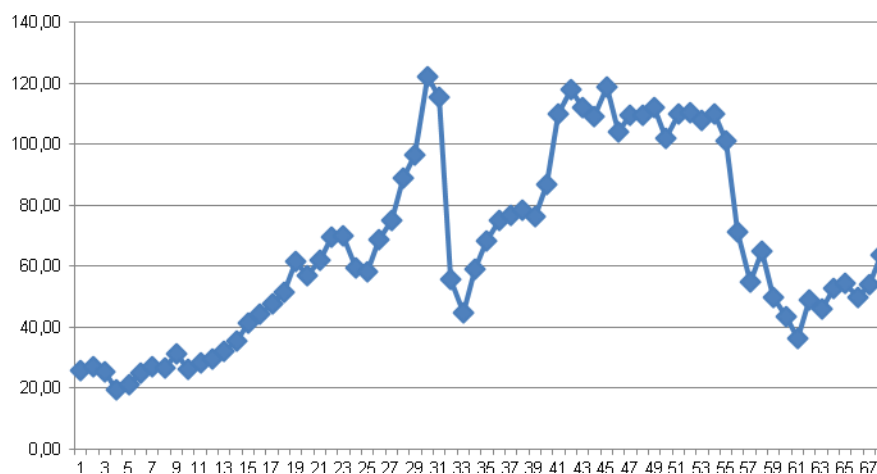| Equation №	The form of equation	Number of observations	Residual sum of squares	Number parameters in equation	Number of degrees of freedom residual variances
(1)	$y^{(1)} = 12,7 + 2,1 \cdot t$	24	906	2	22
(2)	$y^{(2)} = 129,1 - 3,1 \cdot t$	28	5631	2	26
(3)	$y^{(3)} = 37,1 + 0,98 \cdot t$	52	43602	2	50

Figure 5. Dynamics of the cost of 1 barrel of Brent crude for the period 2001-2017 quarterly, in US dollars [8, 16].

Investigation of the relationship between the cost of 1 square meter of housing (a result characteristic) and 1 barrel of Brent oil (a factor characteristic) made it possible to obtain the results presented in Table 4.

Table 4. Indicators of the interconnection of series.

Region	The regression equation	The value of the Durbin-Watson criterion	Correlation coefficient
Primary housing market			
Tula region	$\tilde{y}_x = 51797 - 76,62 \cdot x$	0,568	- 0,75
Tomsk region	$\tilde{y}_x = 51972 - 102,55 \cdot x$	0,427	- 0,80
Primorsky Krai	$\tilde{y}_x = 86107 - 356,44 \cdot x$	0,516	- 0,87
Secondary housing market			
Tula region	$\tilde{y}_x = 55166 - 128,11 \cdot x$	0,618	- 0,88
Tomsk region	$\tilde{y}_x = 54939 - 107,23 \cdot x$	0,376	- 0,83
Primorsky Krai	$\tilde{y}_x = 94344 - 202,53 \cdot x$	0,371	- 0,87

Table 4 shows that all the values of the Durbin-Watson criterion for significance level 0.10 exceed its critical value equal to 0.322. This gives grounds for rejecting a hypothesis about the absence of cointegration of the investigated series in the regions under consideration. Coefficients of correlation exceeding 0.7 indicate a close reverse linear relationship between the cost of 1 barrel of Brent oil and 1 square. m of living space.

Thus, as a result of the study, the presence of cointegration of the investigated series on geographically dispersed territories has been established. This creates the prerequisites for further in-depth study of the allocated relationship with the positioning of an additional set of factors.

2. References

[1]   Belyaeva L A 2009 Level and quality of life Problems of measurement and interpretation *Sociologicheskie issledovaniya* **1** 33-42
[2]   Bobkov V N 2009 The methodological approach of the All-Russian Center for Living Standards to the study and assessment of the quality and standard of living of the population *Vestnik VGU. Ser.:Ekonomika i upravlenie* **2** 26–36
[3]   Bobkov V N, Kolmakov I B 2017 Identification of social structure and inequality of distribution of money incomes of the population *Ekonomika regiona* **13**(4) 971–984
[4]   Bobkov V N, Odintsova E V 2012 The social structure of Russian society by the criteria of income and housing provision *Uroven' zhizni naseleniya regionov Rossii* **1** 20–28
[5]   Bochko V S 2013 The vitality of the territory: the content and ways of strengthening *Ekonomika regiona* **3** 26–37
[6]   Zhukovskaya I F 2012 Income and the provision of housing for the population as factors in raising living standards *Imushchestvennye otnosheniya v Rossijskoj Federacii* **9** 15–31
[7]   Ivanitskii N N 2015 Increase of housing affordability on the basis of state compensation of energy prices *Ekonomika regiona* **4** 123-131
[8]   Kal'kulyator: spravochnyj portal *Dinamika ceny nefti Brent za 2017 god* https://www,calc,ru/dinamika-Brent,html?date=2017, last accessed 2018/04/07.
[9]   2007 Quality and standard of living of the population in the new Russia (1991-2005) M: *VCUZH* 162–177

[10] Klimonova A N 2016 The welfare of the population as a target for the activities of the state: the essence, elements, welfare factors *Social'no-ehkonomicheskie yavleniya I processy* **11**(12). 60–67

[11] Kornilov N I 2015 The impact of oil prices on the value of residential property *Rossijskoe pred-prinimatel'stvo* **10** 1483-1494

[12] Oficial'nye statisticheskie pokazateli https://fedstat.ru/indicator/31452 last accessed 2018/04/02

[13] Puzina N V 2011 Features of pricing in the housing market: the example of the Omsk region Author's abstract. Dis ... cand. Econ. Science *Omsk: Omskij gos. Un-t im*

[14] Rodionova L A 2015 Statistical analysis and modeling of the dynamics of life satisfaction in Russia: the age aspect *Voprosy statistiki* **8** 37-46

[15] Rodionova L A 2012 Methodological aspects of measuring and modeling the level of happiness *Ekonomika. Upravlenie. Pravo***1** 25-30

[16] The price of Brent crude oil https://worldtable.info/ yekonomika/ cena-na-neft- marki-brent-tablica-s-1986-po-20.html, last accessed 2018/04/12

[17] Chuvakova S V 2010 Analysis of the economic well-being of the population in modern Russia *Nacional'nye interesy: prioritety i bezopasnost'* **35** (92) 16-21

[18] 2002 Econometrics M.: *Finansy i statistika* 344

[19] Yasnitskii L N, Yasnitskii V L 2016 Methods of creating a comprehensive economic-mathematical model for mass valuation of real estate objects on the example of the apartment market of the city of Perm *Vestnik Permskogo universiteta. Ser. «Ekonomika» Perm University Herald. Economy* **2**(29)54–69

[20] Chow Gregory C 1960 Tests of equality between sets of coefficients in two linear regressions *Econometrica* vol 28 **3** 591-605