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Econometric Analysis of the Mortgage Loans Dependence on Per Capita Income

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Abstract

The article makes the econometric modeling of the size of the mortgage loan in order to identify the most important prognostic factors. The leading role of mortgage lending in the domestic banking services market is emphasized. Using Excel, Gretl software the authors are trying to prove the predominant influence of household income on the dynamics of the mortgage market. The article presents the methodical approach to measuring the dependence of mortgage loans on per-capita income. The results of empirical evaluations have confirmed their practical feasibility in the management of the credit portfolio.

Keywords: mortgage lending, per capita income, least square method, nonlinear regression, heteroscedasticity

1. Introduction

Currently, when there is instability of exchange rates, households are actively investing in real estate, the prices have always been increasing for it, and given the decline in national currency, it is advantageous for borrowers to capture their costs for the mortgage (Diaz-Serrano & Raya, 2014; Lou & Yin, 2014). For banks, the mortgage is a highly profitable product with a low degree of risk, so they continue to increase the share of mortgage loans in their portfolios (Ferreira, Spahr, & Irina, 2013; Grydaki & Bezemer, 2013). Therefore, it is possible to emphasize that mortgage lending in Russia is an important component of both the banking system and the economy as a whole. The state support of mortgage lending contributes to this, which, through the economic effects of increased consumption and increased demand leads to economic growth (Abel & Bernanke, 2010; Jordi, 2008; Steinbuks & Elliehausen, 2014). Even with unemployment and low income, employed population prefers to invest in property (Gabriel & Rosenthal, 2013; Gyourko & Tracy, 2014). In this regard, we have studied the dependence of the average size of mortgage credits on per-capita income of the population in the Russian Federation and the Volga Federal district in particular. Thus, the growing role of mortgage lending for the development of the national economy certainly testifies to the relevance of this article.

2. Methods

The study uses time series data from official site of the Central Bank of the Russian Federation and the Federal service of state statistics (Official website of the Federal service of state statistics; Official website of the Central Bank of the Russian Federation): the sample of 51 monthly observations for the period from the 1st quarter 2010 to the 1st quarter 2014 on the average amount of mortgage and average per capita money income in the Russian Federation as a whole, as well as the sample of 48 monthly observations for the period from 2010 to 2013 on the average amount of mortgage lending and average per capita money income in the Volga Federal district. Average loan size per month in rubles (Y) and average per capita income (X) were used as variables. In the study, we used the classical least square method and the weighted least squares method using the Gretl 1.9.91 software.

3. Results

The time series is significantly different from the simple sample data so that the analysis takes into account the correlation of measurements over time, and not just statistical diversity and statistical characteristics of the sample. When analyzing time series there can be two main objectives: characterization of the series nature (distinguishing deterministic and random components, their parameters estimation) and the use of the estimates received for forecasting (Hamilton, 1994). Based on time series, OLS-regression estimates (Wooldridge, 2013) of the average mortgage size per month depending on per capita income were obtained for the Russian Federation as a whole, and they are presented in Figure 1.

```
Model 1: OLS, using observations 2010:01-2014:03 (T = 51)
Dependent variable: Y

             coefficient   std. error    t-ratio    p-value
  ---------------------------------------------------------
  const      929884        91052.6       10.21     9.97e-014 ***
  X              22.2732       4.02262    5.537    1.20e-06  ***

Mean dependent var    1423448   S.D. dependent var   167353.0
Sum squared resid    8.61e+11   S.E. of regression   132587.8
R-squared            0.384871   Adjusted R-squared   0.372317
F(1, 49)             30.65811   P-value(F)           1.20e-06
Log-likelihood      -672.8907   Akaike criterion     1349.781
Schwarz criterion    1353.645   Hannan-Quinn         1351.258
rho                  0.516088   Durbin-Watson        0.945220

White's test for heteroskedasticity -
  Null hypothesis: heteroskedasticity not present
  Test statistic: LM = 2.35188
  with p-value = P(Chi-square(2) > 2.35188) = 0.308529

Breusch-Pagan test for heteroskedasticity -
  Null hypothesis: heteroskedasticity not present
  Test statistic: LM = 1.77146
  with p-value = P(Chi-square(1) > 1.77146) = 0.183201

Breusch-Pagan test for heteroskedasticity (robust variant) -
  Null hypothesis: heteroskedasticity not present
  Test statistic: LM = 2.1737
  with p-value = P(Chi-square(1) > 2.1737) = 0.140388
```

Figure 1. OLS-estimates of model of average mortgage lending in the Russian Federation as a whole

It is obvious that the linear regression model can be represented as: Y=929884+22.2732*X+ ε. Tests by White, Breusch-Pagan and robust version by Breusch-Pagan allow us to accept the null hypothesis of no heteroskedasticity in the residual of the regression. Each of the regression parameters and the overall model are statistically significant. Taking into account that the model explains 38% of the variation of the average mortgage size of, to improve the accuracy of the model we will apply a non-linear regression (Table 1), which shows that the most accurate is the power model.

Table 1. The simulation results of the average mortgage size in the Russian Federation

Model type	Specification model	Standard error of the model
Linear	Y=929884+22.2732*X+ε	132587,8
Power	$Y=26664.81*X^{0.3976}*\varepsilon$	0,09
Exponential	$Y=1039390*e^{0.000014*X}*\varepsilon$	134979,4
Semi-log	Y=-4150170+558128* lnX + ε	127232,5

The Volga Federal district is a most densely populated and prosperous federal districts in the Central Russia. Therefore, it is of interest to study mortgage lending in the district in comparison with the Russian Federation as a whole. OLS-regression estimates of the average mortgage size per month depending on per capita income in the Volga Federal district are presented in Figure 2.

As it can be seen from Figure 2, the linear regression model Y=557450+25.6732*X+ ε is statistically significant. The model explains 48% of the variation of the average mortgage size, and the standard error of the model is 104244.9 rubles (10 % of the mean value of the dependent variable). The test by White does not confirm heteroscedasticity in the regression residuals when p value=0.130 (p>0.05). In the test by Breusch-Pagan at the p=0.023 (p<0.05) heteroscedasticity was detected. A robust version of the test by Breusch-Pagan did not find the heteroscedasticity at the p=0.0604 (p>0.05).

To improve the quality of the model we will perform correction for heteroscedasticity of regression residuals using the weighted least squares method (Figure 3).

As can be seen from Figure 3, the tests by White, Breusch-Pagan and robust version by Breusch-Pagan allow us to accept the null hypothesis of no heteroskedasticity in the residuals of the regression. As the linear regression model: Y=556801 +25.6922*X+ ε, and its parameters are statistically significant. The model explains 58% of the variation of the average mortgage size, and the standard error of the model is 5.411 rubles (9% of the mean value of the dependent variable). Before correction the standard errors were m_a=74047.2; m_b=3.8947 (Figure 2), after correction they are: m_a=70417.2; m_b=4.0138 (Figure 3). The standard error decreased only for the coefficient a.

The results of the correction for heteroscedasticity of regression residuals using built-in Gretl tools are presented in Figure 4.

The linear regression model Y= 550802+26.0134*X+ ε and its parameters are statistically significant. The model explains 48% of the variation of the average mortgage size, and the standard error of the model is 1.76 ruble. Before correction the standard errors were m_a=74047.2; m_b=3.8947 (Figure 2). After correction they are: m_a=71540.6; m_b=3.9639 (Figure 4). The standard error decreased only for the coefficient a.

As it can be seen from Figure 5, the linear regression model Y=549542+26.098*X+ ε and its parameters are statistically significant. The model explains 48% of the variation of the average size of the mortgage, and the standard error of the model is 743.347 ruble. The standard error for the free coefficient decreased: ma=72467.4; mb=3.9715. Simulation results are evaluated in Table 2.

```
Model 1: OLS, using observations 2010:01-2013:12 (T = 48)
Dependent variable: Y

             coefficient   std. error    t-ratio   p-value
  ---------------------------------------------------------
  const      557450        74047.2        7.528    1.48e-09 ***
  X              25.6732       3.89473    6.592    3.74e-08 ***

Mean dependent var    1035369   S.D. dependent var   143813.5
Sum squared resid     5.00e+11  S.E. of regression   104244.9
R-squared             0.485755  Adjusted R-squared   0.474576
F(1, 46)              43.45155  P-value(F)           3.74e-08
Log-likelihood       -621.7035  Akaike criterion     1247.407
Schwarz criterion     1251.149  Hannan-Quinn         1248.821
rho                   0.431720  Durbin-Watson        1.134550

White's test for heteroskedasticity -
  Null hypothesis: heteroskedasticity not present
  Test statistic: LM = 4.07405
  with p-value = P(Chi-square(2) > 4.07405) = 0.130416

Breusch-Pagan test for heteroskedasticity -
  Null hypothesis: heteroskedasticity not present
  Test statistic: LM = 5.15788
  with p-value = P(Chi-square(1) > 5.15788) = 0.0231412

Breusch-Pagan test for heteroskedasticity (robust variant) -
  Null hypothesis: heteroskedasticity not present
  Test statistic: LM = 3.52485
  with p-value = P(Chi-square(1) > 3.52485) = 0.0604551
```

Figure 2. OLS-regression estimates of the average mortgage size per month depending on per capita income in the Volga Federal district

```
Model 2: OLS, using observations 2010:01-2013:12 (T = 48)
Dependent variable: YX

             coefficient   std. error    t-ratio    p-value
  ----------------------------------------------------------
  const          25.6922       4.01381    6.401    7.24e-08  ***
  XI         556801        70417.2        7.907    4.05e-010 ***

Mean dependent var    56.82337  S.D. dependent var   8.222460
Sum squared resid     1346.903  S.E. of regression   5.411146
R-squared             0.576128  Adjusted R-squared   0.566913
F(1, 46)              62.52327  P-value(F)           4.05e-10
Log-likelihood       -148.1337  Akaike criterion     300.2675
Schwarz criterion     304.0099  Hannan-Quinn         301.6817
rho                   0.429008  Durbin-Watson        1.136313

White's test for heteroskedasticity -
  Null hypothesis: heteroskedasticity not present
  Test statistic: LM = 0.236146
  with p-value = P(Chi-square(2) > 0.236146) = 0.888631

Breusch-Pagan test for heteroskedasticity -
  Null hypothesis: heteroskedasticity not present
  Test statistic: LM = 0.0684801
  with p-value = P(Chi-square(1) > 0.0684801) = 0.793563

Breusch-Pagan test for heteroskedasticity (robust variant) -
  Null hypothesis: heteroskedasticity not present
  Test statistic: LM = 0.0582831
  with p-value = P(Chi-square(1) > 0.0582831) = 0.80923
```

Figure 3. The model estimates of the average mortgage lending in the Volga Federal district obtained by the method of weighted least squares manually

```
Model 3: Heteroskedasticity-corrected, using observations 2010:01-2013:12
(T = 48)
Dependent variable: Y

             coefficient   std. error    t-ratio    p-value
  ----------------------------------------------------------
  const      550802        71540.6        7.699    8.24e-010 ***
  X              26.0134       3.96394    6.563    4.14e-08  ***

Statistics based on the weighted data:

Sum squared resid    142.5515   S.E. of regression   1.760382
R-squared            0.483533   Adjusted R-squared   0.472306
F(1, 46)             43.06670   P-value(F)           4.14e-08
Log-likelihood      -94.23311   Akaike criterion     192.4662
Schwarz criterion    196.2086   Hannan-Quinn         193.8805
rho                  0.418554   Durbin-Watson        1.160417

Statistics based on the original data:

Mean dependent var    1035369   S.D. dependent var   143813.5
Sum squared resid    5.00e+11   S.E. of regression   104254.0
```

Figure 4. The model estimates of the average mortgage lending in the Volga Federal district received by means of Gretl

```
Model 4: WLS, using observations 2010:01-2013:12 (T = 48)
Dependent variable: Y
Variable used as weight: XI

             coefficient   std. error    t-ratio   p-value
  ---------------------------------------------------------
  const      549542        72467.4        7.583    1.22e-09 ***
  X              26.0980       3.97149    6.571    4.01e-08 ***

Statistics based on the weighted data:

Sum squared resid    25417980   S.E. of regression   743.3470
R-squared            0.484204   Adjusted R-squared   0.472991
F(1, 46)             43.18253   P-value(F)           4.01e-08
Log-likelihood      -384.4234   Akaike criterion     772.8469
Schwarz criterion    776.5893   Hannan-Quinn         774.2611
rho                  0.415296   Durbin-Watson        1.166853

Statistics based on the original data:

Mean dependent var    1035369   S.D. dependent var   143813.5
Sum squared resid    5.00e+11   S.E. of regression   104258.4
```

Figure 5. Model estimates of the average mortgage lending in the Volga Federal district, obtained by the method of weighted least squares of Gretl tools

According to the simulation results, with the increase of average money income per capita by 1 ruble, the average mortgage size for residents of the Russian Federation increased by 22.273 ruble, and for those of the Volga Federal district the increase is 25.763 rubles. Correction for heteroscedasticity helped to adjust the estimate of the regression coefficient to 26.013 rubles. Heteroscedasticity corrected model enabled to significantly reduce the sum of standard errors for the model in general and for the coefficients a and b.

Table 2. Simulation results of the average mortgage size in the Volga Federal district

Equation type	Equation form	Standard error of the coefficient a	Standard error of the coefficient b	Standard error of the model
Linear regression equation	Y=557450+25.7632X+ε	74047.2	3.89473	104244.9
Weighted OLS (manually)	Y=556801+25.6922X+ε	70417.2	4.01381	5.4111
Heteroskedasticity corrected	Y= 550802+26.0134X+ε	71540.6	3.96394	1.760382
Weighted OLS (Gretl)	Y=549542+26.098X+ε	72467.4	3.97149	743.347

4. Conclusions

The performed econometric analysis of the dependence of the average mortgage size for a month on cash income per capita in the Russian Federation showed that the regression residuals are homoscedastic, which indicates the relative stability of mortgage lending dynamics.

During the research it was decided to construct a model of the average mortgage size for the Volga Federal district. Based on the analysis, we can draw the following practice-oriented conclusions:

1. The average amount of mortgage is growing with the growth of incomes more progressively. Direct correlation of mortgage lending with the growth in real income is seen, i.e., the faster household incomes are growing, the more opportunities there are to make savings to service the mortgage loan. This leads to the growth of the mortgage volume.

2. It is evident that one of the main factors in the development of the mortgage market in the Russian Federation is the growth of household income as a source of savings which is spent for housing purchase. With exchange rates instability, investing in real estate is more profitable than having deposits in banks.

Thus, the study confirmed the direct correlation between the growth of mortgage lending and wage growth. This model can be used for calculating future amounts of mortgage loans, forecasting growth or absence of demand in the mortgage market.

References

Abel, A., & Bernanke, B. (2010). *Macroeconomics* (5th ed., p. 764). Addison Wesley.

Diaz-Serrano, L., & Raya, J. M. (2014). Mortgages, immigrants and discrimination: An analysis of the interest rates in Spain. *Regional Science and Urban Economics*, (45), 22-32.

Ferreira, F. A. F., Spahr, R. W., & Irina, F. M. D. (2013). Gavancha, Amali Çipi. Readjusting trade-offs among criteria in internal ratings of credit-scoring: an empirical essay of risk analysis in mortgage loans. *Journal of Business Economics and Management, 14*(4), 715-740.

Gabriel, S. A., & Rosenthal, S. S. (2013). Urbanization, agglomeration economies, and access to mortgage credit. *Regional Science and Urban Economics*, (43), 42-50.

Grydaki, M., & Bezemer, D. (2013). The role of credit in the Great Moderation: A multivariate GARCH approach. *Journal of Banking & Finance,* (37), 4615-4626.

Gyourko, J., & Tracy, J. (2014). Reconciling theory and empirics on the role of unemployment in mortgage default. *Journal of Urban Economics,* (80), 87-96.

Hamilton, J. D. (1994). *Time Series Analysis* (1st ed., p. 820). Princeton University Press.

Jordi, G. (2008). *Monetary policy, inflation, and the business cycle: an introduction to the New Keynesian framework* (p. 203). Princeton University Press.

Lou, W., & Yin, X. (2014). The impact of the global financial crisis on mortgage pricing and credit supply. *Journal of International Financial Markets, Institutions & Money,* (29), 336-363

Official website of the Central Bank of the Russian Federation. Retrieved from http://www.cbr.ru/statistics/?Prtid=ipoteka

Official website of the Federal service of state statistics. Retrieved from http://www.gks.ru/free_doc/new_site/population/urov/urov_11sub09-13.xls

Steinbuks, J., & Elliehausen, G. (2014). The Economic Effects of Legal Restrictions on High-Cost Mortgages. *The Journal of Real Estate Finance and Economics, 49*, 47-72.

Wooldridge, J. (2013). *Introductory Econometrics. A modern approach* (5th ed., p. 909). J. Wooldridge. Michigan State University: South-Western Cengage Learning.