

## **Comparative analysis and forecast of dynamics of main macroeconomic indicators of households economic activities of Poland and Ukraine**

**JEL classification:** C20, C53, E27

**Keywords:** household, households economic activities system, macroeconometric model, impulse response, forecast

**Słowa kluczowe:** gospodarstwo domowe, system działalności ekonomicznej gospodarstw domowych, model makroekonometryczny, impulsowe reakcje, prognoz

**Abstract:** The aim of the paper is to study the structure of households economic activities system in Poland and Ukraine as well as dynamics of interdependencies between the main indicators of their functioning. In order to investigate the dynamics of the main indicators of households economic activities systems in both countries, two VAR-models were developed for Poland and Ukraine respectively. Impulse responses of the main indicators of households economic activities systems of Poland and Ukraine were tested, two types of forecasts of household consumption expenditures in both countries were made with the help of developed VAR-models. High quality forecast power of developed models proves their possible usefulness for forecasting the main indicators of households economic activities system.

### **Analiza porównawcza i prognoza dynamiki głównych wskaźników ekonomicznych działalności gospodarstw domowych w Polsce i na Ukrainie**

**Abstrakt:** Celem pracy jest badanie struktury systemu działalności gospodarczej gospodarstw domowych w Polsce i na Ukrainie oraz dynamiki relacji pomiędzy kluczowymi wskaźnikami ich działalności. W celu badania dynamiki głównych wskaźników systemu ekonomicznej działalności gospodarstw domowych w obu krajach zostały zbudowane dwa modele VAR — odpowiednio dla Polski i Ukrainy. Zbadano reakcje na impulsy głównych wskaźników systemu aktywności ekonomicznej gospodarstw domowych w Polsce i na Ukrainie. Dwa rodzaje prognoz wskaźnika wydatków konsumpcyj-

cyjnych gospodarstw domowych w obu krajach zostały opracowane za pomocą rozbudowanych modeli VAR. Wysoka jakość prognozowania zbudowanych modeli potwierdza możliwość ich zastosowania do przewidywania głównych wskaźników systemu aktywności ekonomicznej gospodarstw domowych.

## Introduction

The household sector of economy plays an important role in shaping the macroeconomic situation of any given country. Households are the foundation of a nation and an important factor in improving the demographic processes. It is therefore particularly important to understand development trends of households at the macroeconomic level.

The object of the research is the household system of Poland and Ukraine.

The main purpose of the research is a comparison of household systems of Poland and Ukraine and the analysis of the main indicators of households economic activity in these countries.

A modern approach to the research of households began with works of an American scientist G. Becker, in particular with his work "A theory of the allocation of time,"<sup>1</sup> and was named "New Home Economics." The idea of an influence of the head of the family's individual decisions on all household members, proposed by G. Becker, was strongly criticized, in particular alternative approaches to decision-making by all members of a household were considered in the research of an American economist P.A. Chiappori.<sup>2</sup>

In this paper households' economic activities are considered at the level of macroeconomics. According to this, the main indicators that characterize households economic activities were highlighted: household consumption expenditures gross domestic savings, domestic credits to private sector, consumer price index and gross national income.

## Methodology

The research of economic activities of households in Poland and Ukraine was conducted using econometric vector-autoregressive modeling (VAR-modeling).

In its generalized form the simplest bivariate VAR-model of k-th order can be represented as follows:

$$y_{1t} = \beta_{10} + \beta_{11}y_{1,t-1} + \dots + \beta_{1k}y_{1,t-k} + \alpha_{11}y_{2,t-1} + \dots + \alpha_{1k}y_{2,t-k} + \varepsilon_{1t}$$

$$y_{2t} = \beta_{20} + \beta_{21}y_{2,t-1} + \dots + \beta_{2k}y_{2,t-k} + \alpha_{21}y_{1,t-1} + \dots + \alpha_{2k}y_{1,t-k} + \varepsilon_{2t}$$

<sup>1</sup> G.S. Becker, A theory of the allocation of time, *The Economic Journal* 1965, no 299, pp. 493–517.

<sup>2</sup> P.A. Chiappori, Rational household labor supply, *Econometrica* 1988, no 56(1), pp. 63–90.

where  $y_{it}$ ,  $i = 1, 2$  endogenous variables of the model;  $\alpha_{it}$ ,  $\beta_{it}$ ,  $i = 1, 2$ ;  $\tau = 1, k$  — unknown parameters near lagged values of endogenous variables;  $\beta_{i0}$ ,  $i = 1, 2$  — intercepts of equations;  $t$  — time periods;  $\tau = 1, k$  — value of lag;  $\varepsilon_{it}$ ,  $i = 1, 2$  — residuals.

VAR-models have already been used in studying the problems related to the activities of households. For example, Italian scientists Alessandro Cigno, Luca Casolaro and Furio Camillo Rosati in their work<sup>3</sup> performed an analysis of the impact of social security on household decisions regarding savings and fertility in Germany. They confirmed the hypothesis that the better level of social security from the government encourages households to a lower fertility level.

Romanian researchers Gheorghe Ruxanda and Andreea Muraru in their paper “Household money demand in Romania. Evidence from cointegrated VAR”<sup>4</sup> investigated the household money demand. With cointegrated VAR-model, scientists examined the factors that influence households money holdings in Romania.

## Results

Variables that are used in the research on households economic activities in Poland and Ukraine are given in Table 1.

Table 1. Variables of the models

No	Variable	Designation of variable
1	Household consumption expenditures, USD	HC
2	Consumer price index (2005 = 100), %	CPI
3	Domestic credit to private sector, % GDP	CREDIT
4	Gross national income, USD	GNI
5	Gross domestic savings, USD	GDS

Statistical data from the database of the World Bank<sup>5</sup> for a period of 1991 to 2012 was used to develop VAR-models that reflect the relationships between these variables in the economies of Poland and Ukraine. Estimation of parameters of the models was made with the use of Eviews 7.1.<sup>6</sup>

According to the testing of this data lag length of variables in each model should be two.

VAR-model of the second order, which describes the relationships between the main indicators of households economic activities in Poland, has the following form:

<sup>3</sup> A. Cigno, L. Casolaro, F. Rosati, The role of social security in household decisions: Var estimates of saving and fertility behaviour in Germany, *CESifo Working Paper Series* 394, CESifo Group, Munich 2000.

<sup>4</sup> G. Ruxanda, A. Muraru, Household money demand in Romania. Evidence from cointegrated VAR, *Technological and Economic Development of Economy* 2011, no 17(2), pp. 382–396.

<sup>5</sup> www.worldbank.org.

<sup>6</sup> Quantitative Micro Software LLC, *EViews 5 User's Guide*, Irvine 2004, p. 990.

$$y_{1t} = 88551651514,3 - 2,2413y_{1,t-1} - 7615138567,7y_{2,t-1} + 8090099370,73y_{2,t-2} - 7212729315,01y_{3,t-1} + 5352368601,8y_{3,t-2} + 4,1863y_{4,t-1} - 3,2594y_{4,t-2} + 1,2339y_{5,t-1} + 2,1561y_{5,t-2}$$

$$y_{2t} = 8,6922 - 1,324E - 10y_{1,t-1} + 5,771E - 10y_{1,t-2} - 1,2968y_{2,t-1} - 0,3741y_{2,t-2} + 0,49597y_{3,t-1} - 0,2872y_{3,t-2} + 1,7171E - 10y_{4,t-1} + 2,9611E - 10y_{4,t-2} + 1,7934E - 11y_{5,t-1} - 4,1731E - 10y_{5,t-2},$$

$$y_{3t} = 14,2846 - 5,2219E - 10y_{1,t-1} - 5,0657E - 10y_{1,t-2} - 1,0752y_{2,t-1} + 1,1561y_{2,t-2} - 0,1527y_{3,t-1} + 0,5697y_{3,t-2} + 3,9796E - 10y_{4,t-1} - 7,1433E - 11y_{4,t-2} + 2,9327E - 10y_{5,t-1} + 3,2176E - 10y_{5,t-2},$$

$$y_{4t} = 46102304089,7 + 0,4007y_{1,t-1} + 0,687994y_{1,t-2} - 2720408545,05y_{2,t-1} + 2701096113,31y_{2,t-2} - 2826774727,41y_{3,t-1} + 1507816064,1y_{3,t-2} + 2,2075y_{4,t-1} + 0,5988y_{4,t-2} + 1,4903y_{5,t-1} + 2,6549y_{5,t-2},$$

$$y_{5t} = 160805107787 - 3,0723y_{1,t-1} - 2,8265y_{1,t-2} - 12285459405,6y_{2,t-1} + 12892413226,9y_{2,t-2} - 11752895309,8y_{3,t-1} + 7942328836,42y_{3,t-2} + 7,3707y_{4,t-1} - 4,0903y_{4,t-2} + 1,4903y_{5,t-1} + 2,6549y_{5,t-2}$$

VAR-model of the second order, which reflects the interdependencies between the main indicators of households economic activities in Ukraine, is written in the following way:

$$y_{1t} = -582339691,489 + 1,3268y_{1,t-1} - 0,3727y_{1,t-2} + 127139593,089y_{2,t-1} + 62426845,99y_{2,t-2} - 254999047,637y_{3,t-1} + 428400799,054y_{3,t-2} - 0,5617y_{4,t-1} + 1,6554y_{4,t-2} - 0,0156y_{5,t-1} - 0,4185y_{5,t-2}$$

$$y_{2t} = 30,8747 + 5,9215E - 10y_{1,t-1} + 7,00112E - 10y_{1,t-2} + 0,942y_{2,t-1} - 0,5364y_{2,t-2} + 1,2684y_{3,t-1} + 0,3085y_{3,t-2} + 4,0329E - 10y_{4,t-1} - 7,1518E - 10y_{4,t-2} - 5,4877E - 10y_{5,t-1} - 3,4206E - 10y_{5,t-2},$$

$$y_{3t} = 9,5239 + 5,9295E - 10y_{1,t-1} - 1,1047E - 10y_{1,t-2} - 0,0619y_{2,t-1} - 0,0658y_{2,t-2} + 1,2778y_{3,t-1} - 0,0744y_{3,t-2} + 8,8318E - 10y_{4,t-1} - 1,1625E - 9y_{4,t-2} - 3,0516E - 11y_{5,t-1} + 3,2855E - 10y_{5,t-2},$$

$$y_{4t} = 17336578607,8 + 0,7978y_{1,t-1} - 0,7109y_{1,t-2} - 189135661,224y_{2,t-1} - 18162156,6316y_{2,t-2} + 558715008,654y_{3,t-1} + 187706897,754y_{3,t-2} + 0,9221y_{4,t-1} - 3,400006y_{4,t-2} - 0,3333y_{5,t-1} + 0,0944y_{5,t-2},$$

$$y_{5t} = 36117451038,8 + 3,9102y_{1,t-1} - 1,4176y_{1,t-2} - 19030147,0081y_{2,t-1} - 503118695,269y_{2,t-2} + 1388393013,48y_{3,t-1} + 639626408,494y_{3,t-2} + 1,7645y_{4,t-1} - 0,2659y_{4,t-2} - 1,2271y_{5,t-1} - 0,2141y_{5,t-2}.$$

In both models  $y_{1,t-\tau}$  is value of household consumption expenditures,  $y_{2,t-\tau}$  is value of consumer price index,  $y_{3,t-\tau}$  is value of domestic credits to private sector,

$y_{4,t-\tau}$  is value of gross domestic savings,  $y_{5,t-\tau}$  is value of gross national income,  $\tau = 0, 1, 2$  — lag length.

The impulse responses of the three main factors: household consumption expenditures, domestic credits to private sector, gross domestic savings, to shock impulses in all variables within nine subsequent periods were investigated to compare the systems of households economic activities of Poland and Ukraine.

Impulse responses trace out the responsiveness of the dependent variables in the VAR to shocks in each of the variables. For each variable from each equation separately, a unit shock is applied to the error, and the effects upon the VAR system over time are noted.<sup>7</sup>

The results of testing impulse response of household consumption expenditures of Poland and Ukraine to shocks in all other variables during nine periods are shown in Figures 1 and 2, respectively.

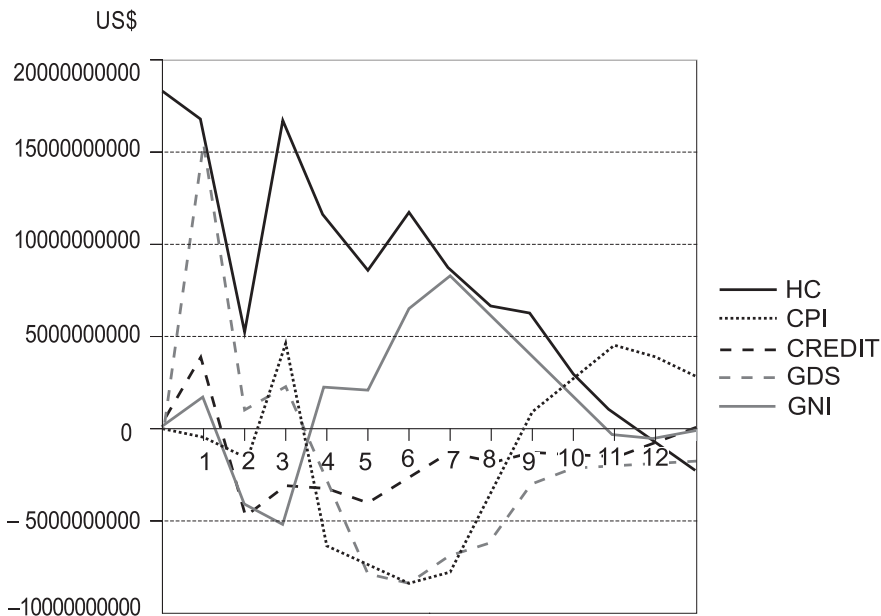


Figure 1. Impulse response of household consumption expenditures of Poland to model variables shocks

Source: author's calculations in Eviews.

While comparing impulse responses of household consumption expenditures in Poland and Ukraine, we can draw a conclusion that the value of impact of all

<sup>7</sup> C. Brooks, *Introductory Econometrics for Finance*, 2nd ed., New York 2008, p. 299.

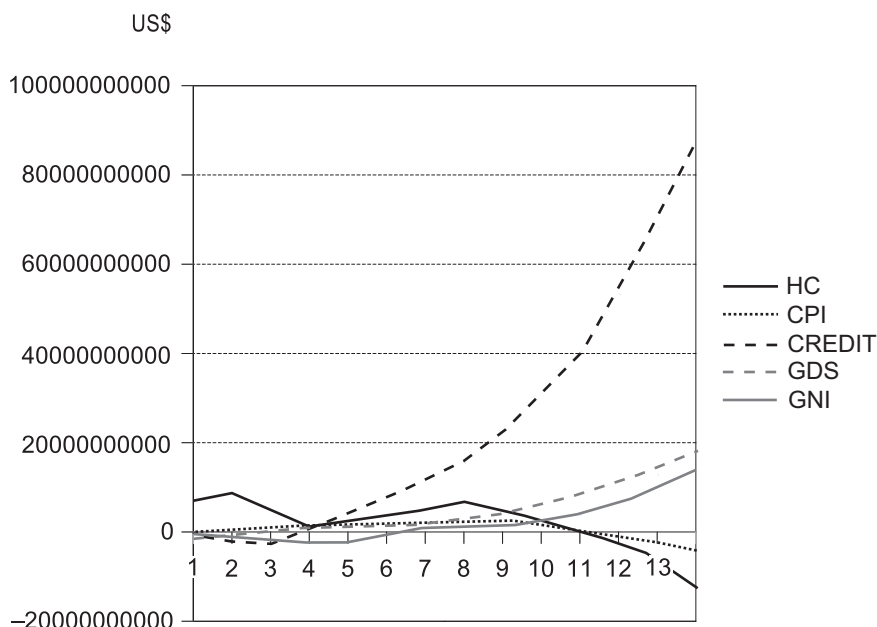


Figure 2. Impulse response of household consumption expenditures of Ukraine to model variables shocks

Source: author's calculations in Eviews.

shocks in this indicator in Poland is much bigger than in Ukraine, but it decreases and approaches zero over time. The biggest influence on household consumption expenditures in Ukraine during the first three periods have the lagged values of this indicator, in the following periods this influence weakens, but is still significant. Starting from the fourth period, the biggest influence on household consumption expenditures in Ukraine has the value of domestic credits to private sector.

The results of testing impulse response of domestic credits to private sector of Poland and Ukraine to shocks in all other variables during nine periods are shown in Figures 3 and 4, respectively.

A characteristic feature of impulse responses of domestic credit to private sector of Poland to shocks is that this indicator is characterized by large fluctuations compared to impulse responses of the corresponding indicator of Ukraine. In the system of households economic activities of Ukraine, starting from the fourth period of time, the influence of domestic credits to private sector lagged values shocks in this indicator begins to increase sharply, therefore the influence of lagged values of this indicator is destabilizing.

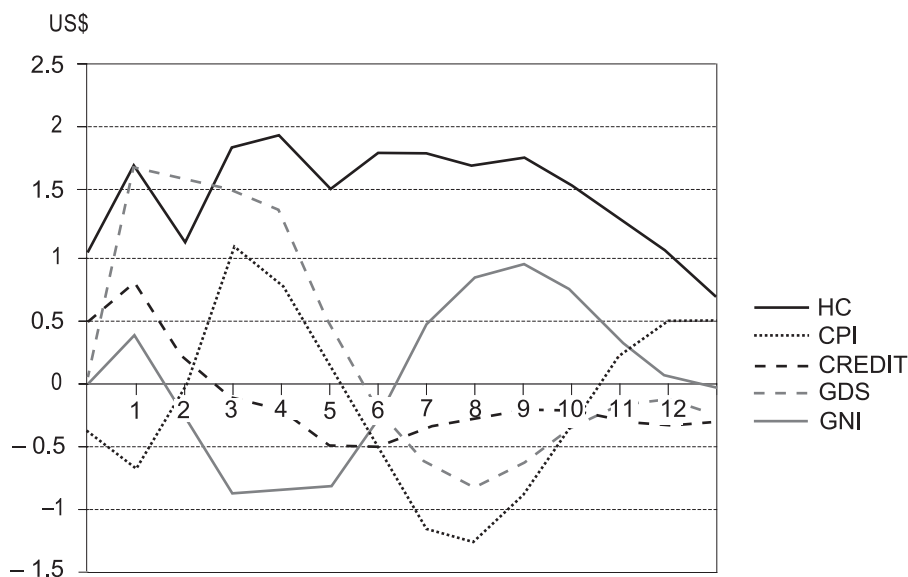


Figure 3. Impulse response of domestic credit to private sector of Poland to model variables shocks

Source: author's calculations in Eviews.

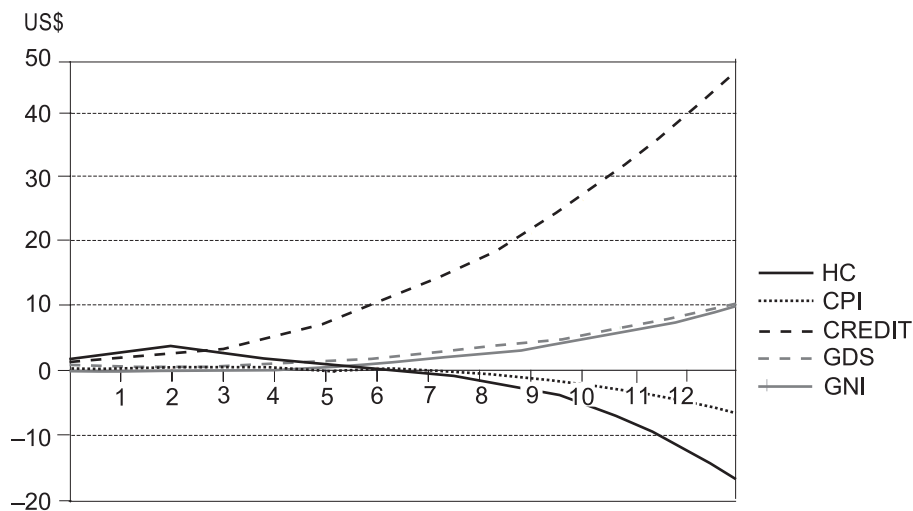


Figure 4. Impulse response of domestic credit to private sector of Ukraine to model variables shocks

Source: author's calculations in Eviews.

The results of testing impulse response of gross domestic savings of Poland and Ukraine to shocks in all other variables during nine periods are shown in Figures 5 and 6.

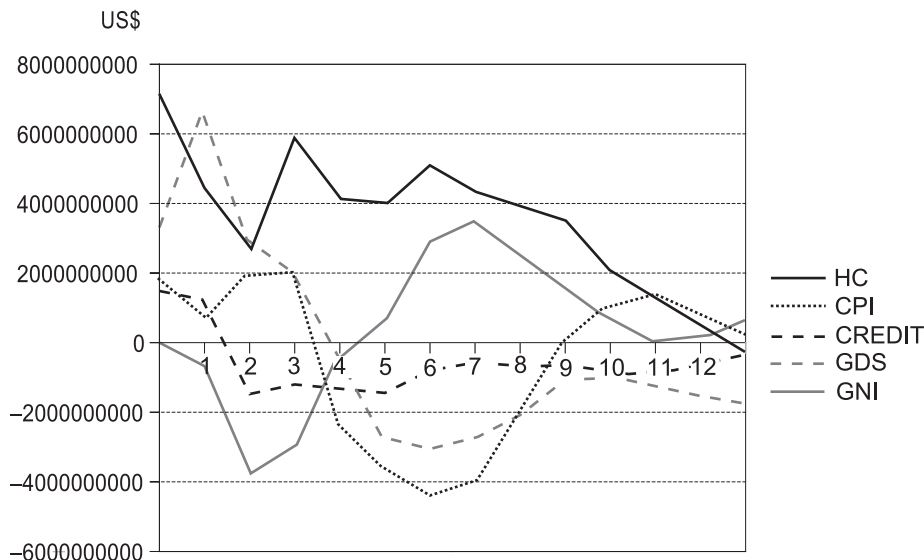


Figure 5. Impulse response of gross domestic savings of Poland to model variables shocks

Source: author's calculations in Eviews.

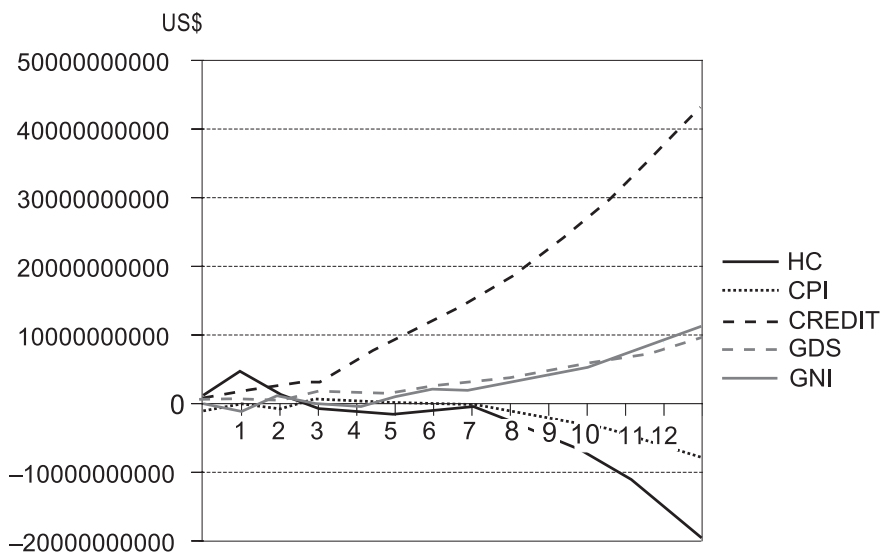


Figure 6. Impulse response of gross domestic savings of Ukraine to model variables shocks

Source: author's calculations in Eviews.



Reactions of gross domestic savings of Poland and Ukraine to shock impulses in other indicators are also vary considerable. During the first three time periods the influence of impulses on gross domestic savings in Poland is greater than in Ukraine, moreover, relatively large influence of each shock impulse is typical for this indicator in Poland. The influence of household consumption expenditures is clearly seen to be significant in the system of households economic activities in Ukraine during the first three time periods, then it approaches zero and the influence of other factors, especially domestic credit to private sector, begins to grow.

Summing up the impulse response of main indicators of households economic activities system in Poland and Ukraine to shocks in all other indicators of this system we should note that the functioning of households in Poland is more stable than in Ukraine: deviations of shock impulses influence remained within the limits of certain values and showed a tendency to decrease.

The stability of households economic activities system in Poland and the instability of this system in Ukraine are also confirmed by inverse roots of autoregressive characteristic polynomial constructed on the basis of the VAR-models (Figures 7 and 8).

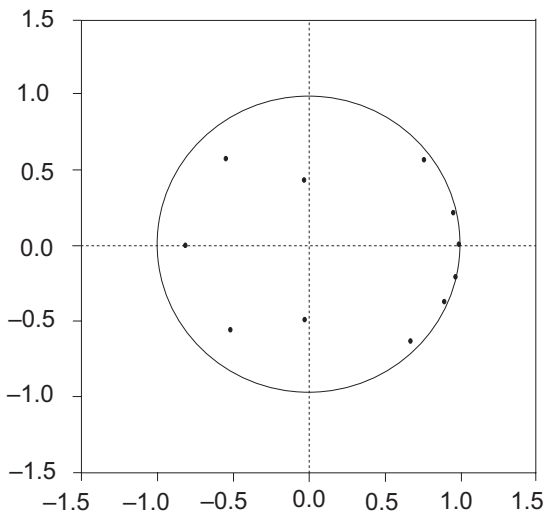


Figure 7. Inverse roots of autoregressive characteristic polynomial constructed on the basis of the VAR-model of households of Poland

Source: author's calculations in Eviews.

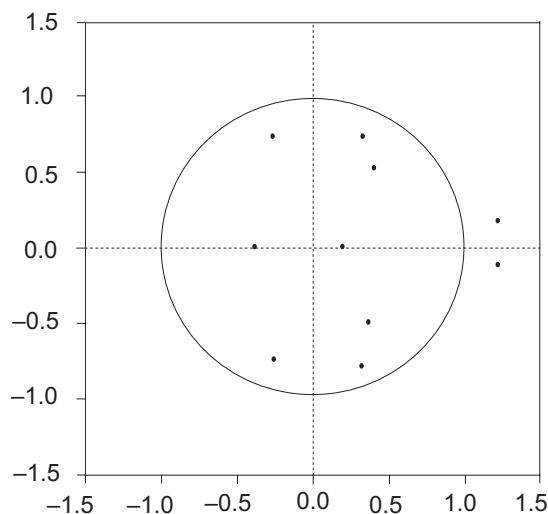


Figure 8. Inverse roots of autoregressive characteristic polynomial constructed on the basis of the VAR-model of households of Ukraine

Source: author's calculations in Eviews.

The inverse roots of autoregressive characteristic polynomial constructed on the basis of the VAR-model of households of Poland are inside the circle (all their modulus values are less than one), which indicates the stability of households economic activities system in Poland. For Ukraine two roots are outside the circle indicating the instability of the system.

The dynamics of households economic activities system indicators of Poland and Ukraine was forecasted with the help of the proposed econometric models, in particular two types of forecasts of household consumption expenditures indicator dynamics in Poland and Ukraine were made in time interval from 1994 to 2012 and compared with the actual data (Figures 9 and 10). In the first case the actual data on the values of indicators of households economic activities in Poland and Ukraine for the years 1992 and 1993 was used to make a forecast until 2012 annually based only on this data, i.e. to obtain the forecast of each following period the data received with the help of developed models was used. In the second case the forecasts of values of indicators of households' economic activities in Poland and Ukraine for the years 1994–2012 were made as follows: based on the actual data for the years 1992 and 1993 the forecast for 1994 was obtained, based on the actual data for the years 1993 and 1994 the forecast for 1995 was obtained and so on.

Based on these graphs we can draw a conclusion about the high quality of forecast power of developed models. Besides, particularly accurate forecasts were

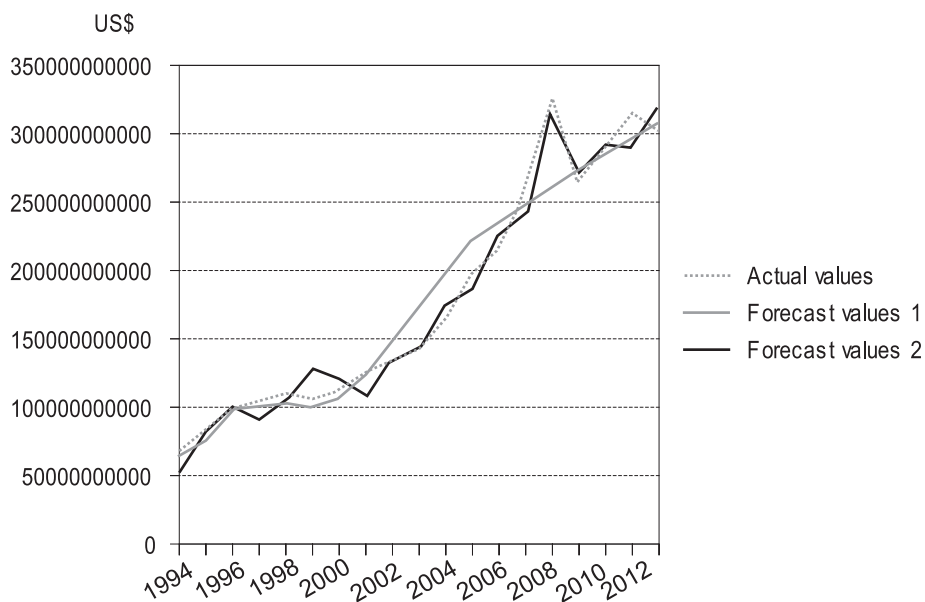


Figure 9. Forecasts of household consumption expenditures dynamics in Poland

Source: author's calculations in Eviews.



Figure 10. Forecasts of household consumption expenditures dynamics in Ukraine

Source: author's calculations in Eviews.

made with the help of a model developed for the system of household economic activities of Poland.

## Conclusions

The practical application of the proposed models lies in the possibility to use them in forecasting the dynamics of the main indicators of households economic activities of Poland and Ukraine: household consumption expenditures, gross domestic savings, domestic credit to private sector. Models can also be used as tools to research inflationary processes in the household sector of economies of the two countries.

Forecasting the dynamics of the main indicators of households economic activities in the country allows us to predict both positive and negative tendencies in this sector, thanks to which it is possible to use the methods of economic and regulatory influence on the activity of household system.

Improvements to the proposed models can be made by including additional variables that represent governmental instruments of influence on the economy.

The results of the research showed significant differences in households economic activities systems of the two neighboring countries — Poland and Ukraine: households economic activities system of Ukraine appeared to be unstable, the opposite conclusion was drawn with regard to the households system of Poland.

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## Comparative analysis and forecast of dynamics of main macroeconomic indicators of households economic activities of Poland and Ukraine

### Summary

The purpose of the paper is to compare and analyze the differences in households economic activities systems in Poland and Ukraine and also to forecast the dynamics of the main indicators of households economic activities in both countries. The author has developed two VAR-models of

households economic activities systems of Poland and Ukraine. The impulse response of the main indicators of households economic activities systems in both countries to shocks in all variables of models was investigated. Inverse roots of autoregressive characteristic polynomials constructed on the basis of the VAR-models were analyzed. The dynamics of household consumption expenditures was forecasted to show the quality of forecast power of developed models.