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USING OF THE VAR MODEL IN ANALYSIS OF INTEREST RATES RELATIONSHIP IN POLAND¹

Abstract. In this research it is examined the relationship between daily, monthly, yearly and 5-yearly interest rates in Poland. VAR model was used in analyze, the impulse response function and variance decomposition. These results indicate that there is influence of long-term interest rates on short-term rates. Such a relationship indicates the presence of feedback, an enhanced response rates.

Key words: interest rates, causality, VAR model.

I. INTRODUCTION

Relationship between short-term and long-term interest rates are not important only from the point of view the analysis of financial markets, but also from the point of view of Campbell and Shiller (1987), Mankiw (1986), Sellon (2004) macroeconomic policy. These relationships are most often explained by using the expectations hypothesis. In line with its long-term rate is an average of current and expected of future short-term Evans and Levis (1994), Mankiw (1986) interest rates. The results of empirical analysis give the divergent assessment of compliance between expectations hypothesis and the actual behavior of Campbell and Shiller (1987), Lange (2005), Mankiw (1986), Quiros-Romero and Sosvilla-Rivero (1997) interest rates.

VAR model was used in this research and procedures associated with this model for the characterization of the relationships between interest rates for different time horizons. Direction of relationships and their distribution in time was one of the research aim.

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II. THE TEST METHOD

The research used daily quotations of interest rates in Poland established on the basis of yield to maturity instruments for 1-day (ON), monthly (M1), yearly (Y1) and for 5-years (Y5). The data of years 2001-2006 was taken from the National Bank of Poland.

The construction of autoregression model preceded by unit root, cointegration and Granger causality tests. The basic VAR model has Enders (2004) form:

$$Y_t = A_0 D_t + A_1 Y_{t-1} + A_2 Y_{t-2} + \dots + A_k Y_{t-k} + e_t, \quad (1)$$

where:

$Y_t = [Y_{1t}, Y_{2t}, \dots, Y_{nt}]'$ – vector observation on the current values of n variables

D_t – vector of deterministic variables

A_0 – matrix of parameters of no stochastic variables

A_i – matrices of parameters of the delayed variable vector Y_t

$e_t = [e_{1t}, e_{2t}, \dots, e_{nt}]$ – vector of stationary random disturbances.

The analysis was carried out using the impulse response function and variance decomposition of the forecast error. The basic VAR model was converted to the structural form:

$$BY_t = \Gamma_0 D_t + \Gamma_1 Y_{t-1} + \Gamma_2 Y_{t-2} + \dots + \Gamma_k Y_{t-k} + \xi_t \quad (2)$$

Between the basic and structural form occurred following compounds:

$$A_0 = B^{-1} \Gamma_0;$$

$$A_i = B^{-1} \Gamma_i; \quad .$$

$$e_t = B^{-1} \xi_t.$$

In this way, it becomes possible the definition of the impulse response function and the variance decomposition. Impulse response function allows to assess the response of single variable to another unit change variable, the variables included in the multi-dimensional system. To make the interpretation on the impulse response function is to provide the necessary system in the form of representation of the average mobile:

$$Y_t = \mu + \sum_{i=0}^{\infty} \theta_i \xi_{t-i} \quad (3)$$

where $\theta_i = \Phi_i B^{-1}$, and ξ_t is a white noise of the diagonal matrix of variance and covariance. Elements of θ_i matrix system responded to separate disorder. $\theta_{jk,i}$ element describes the reaction of the j -variable to separate disorder of k -variable which occurred i periods previously. Update of i periods makes that $\theta_{jk,i}$ describes the reaction of the j -variable in that i period forward to the current disorder unit k -variable. Model (3) makes it possible to forecast the future state system. The variables in period $t+n$ is:

$$Y_{t+n} = \mu + \sum_{i=0}^{\infty} \theta_i \xi_{t+n-i} \quad (4)$$

and the error forecast:

$$Y_{t+n} - E_t Y_{t+n} = \sum_{i=0}^{n-1} \theta_i \xi_{t+n-i} \quad (5)$$

In its analysis, we have to deal with the four-dimensions system. Using the mark $Y_t = [Y5_t, Y1_t, M1_t, ON_t]$ it is possible to forecast error variance decomposition of variables because of the subsequent disorder $\xi_{Y5}, \xi_{Y1}, \xi_{M1}, \xi_{ON}$.

III. RESULTS

The first step of analyze was degree of integration between the various testing variables. Carried out the test of ADF. It was found that all the variables was integrated into the zero degree, that they are stationary at their levels. As a result, in the next analysis used the VAR model with endogenous variable on their levels.

Analysis of the relationships between interest rates started from the Granger causality test (Table 1). The results show indicate that the causal relationship is dominated by the targeted long-term interest rates for short-term interest rates. Behind except relationship ON-M1, in all other cases there was no evidence that the rates for a shorter period were the cause in terms of Granger the long term rates, but in each case were the presence of causal relationships aimed in the opposite direction.

Table 1. The results of the Granger causality test

Variables	Variables tested as a cause			
	ON	M1	Y1	Y5
ON		100,2440 (0,0000)	51,4890 (0,0000)	26,3742 (0,0000)
M1	22,9750 (0,0000)		14,3711 (0,0000)	12,7195 (0,0000)
Y1	1,3168 (0,2683)	1,1719 (0,3101)		21,7123 (0,0000)
Y5	0,9028 (0,4057)	1,1156 (0,3280)	2,4842 (0,08327)	

Source: Own calculations.

For a more accurate description of the relationships between interest rates the VAR model was constructed. By the Schwarz criterion adopted three delays in this model. Model parameters are summarized in Table 2. It should be noted that the system of equations VAR model is consistent with tests of causality: Y5, Y1, M1, ON. Obtained results confirm that long-term interest rates impacted to short-term interest rates, at a much lower impact targets in the opposite direction. In the system delayed the 5-years interest rates does not have a significant impact only on 1-day interest rates. The 1-day rates have had an impact only on monthly interest rates.

Correlation between the VAR model rests were low or very low, it accepted that order of equations was good. Possible the order change of equations has no consequently in the values of impulse response function and the forecast error variance decomposition. Therefore maintained in these studies order equations from VAR model.

Figure 1 shows the response of the VAR model equations on the impulses of the interest rates on the size of one standard deviation. Time horizon is scheduled to one year. Generally interest rates most responsive to changes in their own values, but in some cases, these impulses are quickly stifled, and more pulses are maintained with other interest rates. In particular, impulses are quickly stifled by the short-term interest rates.

The next stage of analysis related to the VAR model was forecast error variance decomposition, who was carried out for the annual time horizon. The obtained results indicate the essential differences between the forecasts for each interest rates. Overall, the forecast error variance in the rates for the period had delayed the largest share of the value of their own. Participation in the case of 5-years rates decreased very slowly, and in the case of rates for the shortest period decreased significantly faster. This reaction was particularly marked for monthly rates.

Table 2. The VAR model for interest rates

Parameters of the model	Y5	Y1	M1	ON
Y5(-1)	1.0856 [42.2902]	0.2745 [6.0349]	0.1801 [3.9637]	0.4148 [1.9062]
Y5(-2)	-0.1358 [-3.6528]	-0.1149 [-1.7451]	-0.2425 [-3.6859]	-0.0644 [-0.2042]
Y5(-3)	0.0380 [1.4978]	-0.1348 [-2.9970]	0.0549 [1.2224]	-0.3283 [-1.5256]
Y1(-1)	0.0255 [1.7900]	0.5526 [21.8758]	0.0418 [1.6574]	-0.2672 [-2.2109]
Y1(-2)	0.0066 [0.4111]	0.1951 [6.8833]	0.0591 [2.0886]	0.1260 [0.9292]
Y1(-3)	-0.0142 [-1.0239]	0.2203 [8.9491]	-0.0536 [-2.1801]	0.0211 [0.1791]
M1(-1)	-0.0293 [-1.9909]	-0.0131 [-0.5040]	0.6443 [24.7675]	0.6625 [5.3165]
M1(-2)	-0.0071 [-0.4143]	0.0541 [1.7850]	0.2020 [6.6713]	-0.3600 [-2.4819]
M1(-3)	0.0283 [1.9912]	-0.0363 [-1.4394]	0.0997 [3.9628]	0.1242 [1.0305]
ON(-1)	-0.0030 [-0.9814]	0.0029 [0.5387]	0.0439 [8.1304]	0.6666 [25.7841]
ON(-2)	0.0026 [0.7191]	0.0085 [1.3310]	-0.0157 [-2.4611]	0.0949 [3.0980]
ON(-3)	-0.0007 [-0.2199]	-0.0068 [-1.2461]	-0.0141 [-2.5951]	-0.0890 [-3.4241]
stala	0.0210 [2.3175]	-0.0251 [-1.5638]	0.0019 [0.1173]	-0.0861 [-1.123]
R ²	0.9990	0.9985	0.9988	0.9762
Test F	129910.10	83715.91	110838.10	5280.11
Mean dependent	7.19	7.38	7.69	7.56
S.D. dependent	2.61	3.72	4.27	4.52

Source: Own calculations.

From these results it can be said that the independence of interest rates with a long maturity is higher than rates for a shorter period of time. Influence on interest rates on the maturity are all past observations of these interest rates, followed by the rate of similar maturity, and with significantly lower rates of different maturity. In the research are presented the results of system $Y_t = [Y5_t, Y1_t, M1_t, ON_t]$, but these proposals remain in force for systems of a different order equations.

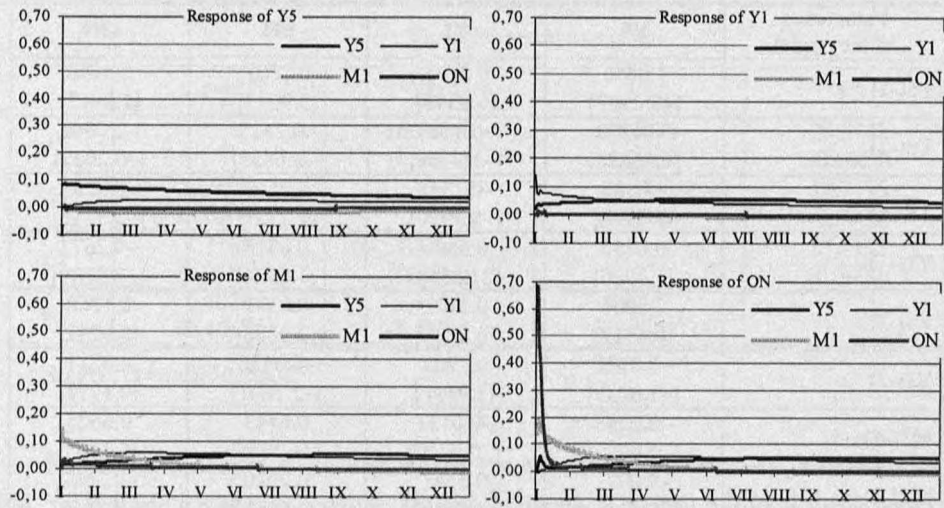


Figure 1. The values of the impulse response functions.

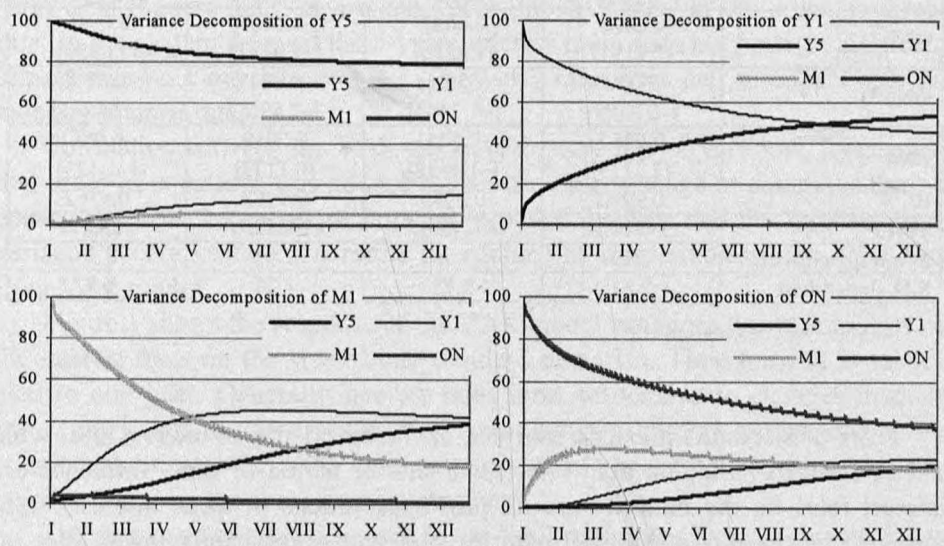


Figure 2. The forecast error variance decomposition.

IV. COMPLETION

The research confirms a lot usefulness of VAR models in the analysis of the time structure of interest rates. The results obtained indicate a strong link between interest rates for different time, this convinces for more expectations hypothesis than theory of segmented markets. However, the prevailing direction of the impact, directed from the long-term to short-term interest rates indicates that the expectations hypothesis does not fully explain the nature of the relationships between the rates for different period of time. One of possible explaining such relationships are stronger long-term interest rates sensitivity to changes in the factors relevant to the level of interest rates. As more sensitive long-term rates may react more strongly to these changes, and this reaction give an impulse for triggering a response short-rates.

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WYKORZYSTANIE MODELU VAR W ANALIZIE POWIĄZAŃ STÓP PRO-CENTOWYCH W POLSCE

W opracowaniu analizowano powiązania pomiędzy dziennymi, miesięcznymi, rocznymi i pięcioletnimi stopami procentowymi w Polsce. W analizie wykorzystano modele VAR, funkcje odpowiedzi na impuls oraz dekompozycję wariancji. Uzyskane wyniki wskazują, że dominuje oddziaływanie stóp długookresowych na stopy krótkookresowe. Taki charakter powiązań wskazuje na występowanie zwrotnej, wzmocnionej reakcji stóp procentowych.