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## THE REACTION OF THE WIG STOCK MARKET INDEX TO CHANGES IN THE INTEREST RATES ON BANK DEPOSITS

Determination of the relationship between the money market and capital market is particularly important from the point of view of taking a decision on the location of investment capital. It may help to forecast future states. This study seeks to determine the relationship of the interest rate on deposits in zloty with the WIG stock index and the volume of turnover on the Warsaw Stock Exchange. Analysis of correlation and VAR models are used.

Analysis of long-term correlation indicates a negative relationship between the interest rate on deposits in banks and the value of the WIG stock-index. However, this may be spurious. The dependence between these variables may be more complex and should rather be seen as short term. It seems that in general the impact of an increase in interest rates on the value of the WIG index is negative in the short term, just as in the long term. In addition, in the short term these variables can move in the same direction.

The results obtained in the research are consistent with results obtained for other national markets. This applies in particular to the relatively weak, negative correlation described above.

**Keywords:** *interest rate on deposits, WIG index, correlation, causality*

### 1. Introduction

Analysis of the links between the capital market and the funds market are important both in terms of theory, it serves to verify the hypotheses posed for these markets, and from a practical point of view, it may be helpful to investors in making investment decisions. Determination of the strength and direction of the association between these

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markets may help predict future states. From an investor's standpoint, the most important element of the capital market is the stock market, but the most important elements of the money market are debt securities issued by the Treasury and bank deposits. These markets and the instruments available in them can be considered as complementary when talking about risk diversification and competitive when talking about separate investments. The existence of strong associations may limit the benefits of portfolio diversification.

The current rates in the money market have important implications for the behavior of all the participants in the financial markets. In the financial market as a whole, there is a wide range of interest rates, but from the perspective of an investor, the decision about where to invest his funds will depend crucially on the interest rate on Treasury debts and deposits in banks.

The relationship between share prices and interest rates may be very complex. The starting point for analysis may be a model for valuing shares based on an approach in which the price of a stock is equal to its present value adjusted according to the stream of dividends which are discounted according to some discount rate. This model indicates a direct, negative correlation between the price of shares and the interest rate, as indicated in previous research [2] and [7]. Changes in interest rates may lead to changes in the expected stream of dividends [3]. The negative impact of interest rates may be due to macroeconomic factors, such as rising capital costs, which reduces corporate investment, a decline in consumption in the economy or a shift in demand among investors between bond and stock markets [6], [8]. On the one hand, interest rates are results of economic activity, on the other hand, rates influence economic activity due to their impact on business investment and consumer spending over time [5].

Some empirical research points to the varied nature of the association between interest rates and share prices. The reaction may be varied depending on the time horizon. Long-term, interest rates may be negatively associated with share prices, since they are used as parameters in discounting future dividends. However, short-term, interest rates may be positively related to share prices, as they reflect the level of economic activity [4]. The financial market may react to signals of a future change in interest rates before they occur. Hence, an unexpected change in interest rates may have a greater impact on stock prices [1].

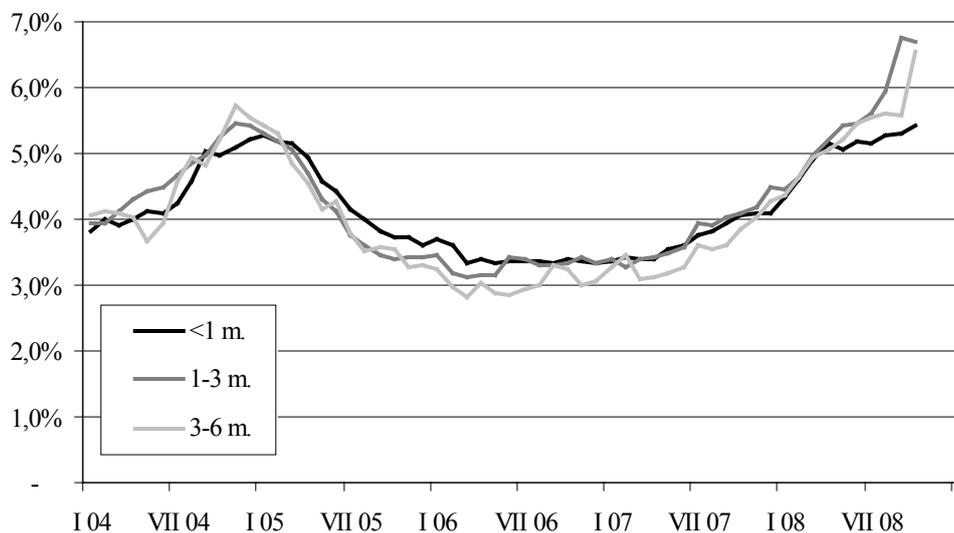
This study sought to determine the relationship between interest rates on deposits in zloty, the WIG stock market index and volume of turnover on the Stock Exchange in Warsaw. Given the existing empirical studies and theories, a negative relationship is expected between long-term rates and the WIG index, but in the case of short-term rates either a positive or negative relationship seems possible. From the perspective of risk diversification in investment portfolios, these associations should be weak.

## 2. Data to be analyzed

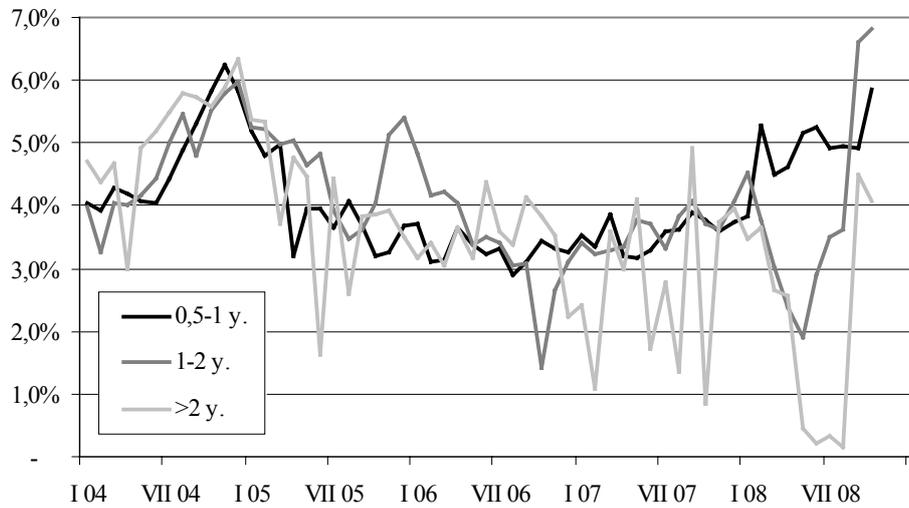
The study examined the average interest rate on bank deposits for the period January 2004–October 2008. Monthly data is given, presented as annual interest rates. This interest rate applies to newly established bank deposits in Polish zloty of households and non-commercial institutions serving households. The data come from the Polish National Bank. As of 2006 the sample consisted of 14 banks and from 2007 – 19. At the end of 2006, this sample covered 81% of non-financial sector deposits. Different interest rates applied to deposits held for the following six periods:

- up to 1 month,
- from 1 month to 3 months,
- from 3 months to 6 months,
- from 6 months to 1 year,
- from 1 year to 2 years,
- over 2 years.

As an indicator of the economic situation on the Polish stock market, we adopted the broadest WIG stock index and the volume of transactions of its component shares. We analyzed the series of quotations of this index and the series of the sales volume at the end of each month during the period January 2004–October 2008. The data were taken from the Stock Exchange in Warsaw.

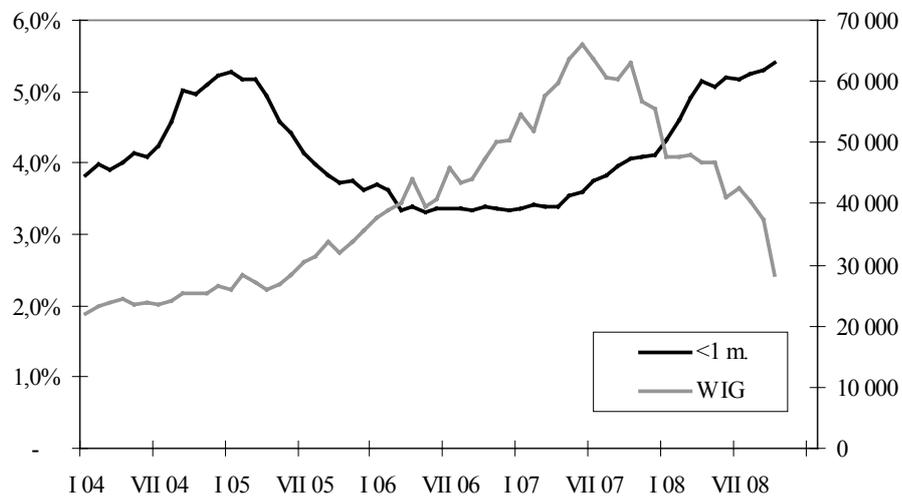


**Fig. 1.** The interest rate on short-term deposits.  
Source: Polish National Bank

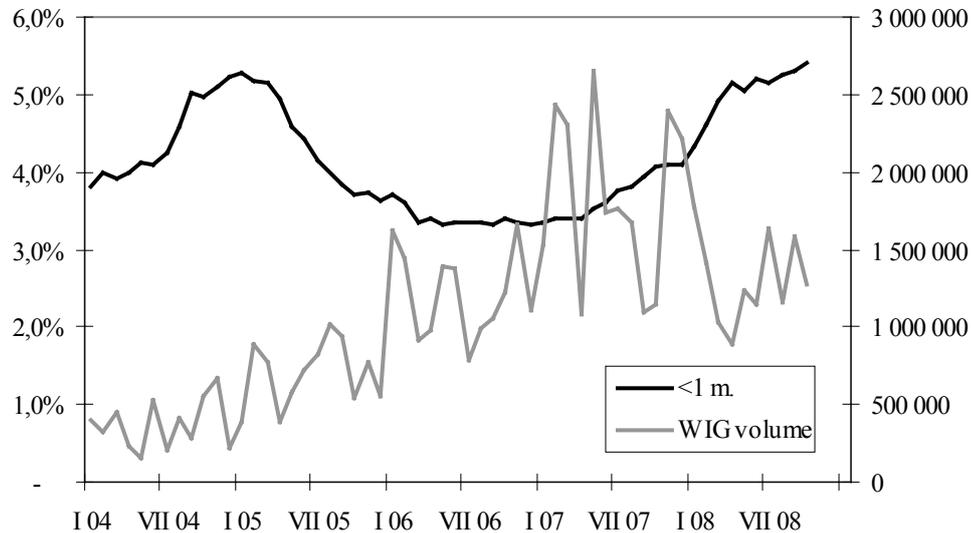


**Fig. 2.** The interest rate on medium- and long-term deposits.  
Source: Polish National Bank

We observe the following trends in the market interest rates on bank deposits over the period January 2004–October 2008 (figures 1 and 2): an initial phase of a relatively steady increase in interest rates during 2004, then a downward trend covering the period 2005–2006, followed by another phase of growth in rates in the period 2007–2008.



**Fig. 3.** The interest rate on short-term deposits (left axis) and the value of the WIG stock market index (right axis).  
Source: Polish National Bank, Stock Exchange in Warsaw



**Fig. 4.** The interest rate on short-term deposits (left axis) and the turnover on the WIG equity index (right axis).

Source: Polish National Bank, Stock Exchange in Warsaw

On the stock market during the period January 2004–October 2008, two phases can be distinguished (figures 3 and 4). An initial growth phase lasted from January 2004–June–July 2007 and a downward trend, lasting from the summit in the middle of 2007 until the end of the period examined.

**Table 1.** Numerical characteristics of the time series analyzed

description	<1 m.	1–3 m.	3–6 m.	0.5–1 y.	1–2 y.	>2 y.	WIG	WIG volume
min	3.32%	3.13%	2.81%	2.91%	1.41%	0.16%	21 947	152 796
max	5.41%	6.76%	6.55%	6.23%	6.83%	6.34%	66 078	2 650 955
distance	2.09%	3.63%	3.74%	3.32%	5.42%	6.18%	44 130	2 498 160
average	4.16%	4.23%	4.07%	4.07%	4.06%	3.55%	39 892	1 079 353
standard deviation	0.69%	0.91%	0.94%	0.83%	1.05%	1.49%	13 015	604 464
coefficient of variability	16.68%	21.59%	23.05%	20.42%	25.89%	41.91%	32.63%	56.00%

Source: our own calculations.

Table 1 shows the main characteristics of the time series analyzed. In the case of interest rates, we see quite a significant increase in diversity as the time horizon increases. The difference in the extreme values of interest rates on deposits of up to 1

month stood at 2.09 percentage points, whereas for the interest rate on deposits for a period exceeding 2 years this figure was 6.18 percentage points. For deposits with the shortest maturity period, the interest rate was not less than 3% in any month, whereas for long-term deposits the lowest value recorded was 0.16% and falls below 2% were quite common. The interest rates on fixed-term deposits averaged over the study period were similar and slightly exceeded 4% in all cases, except deposits with a maturity period of over 2 years, where the average rate amounted to only 3.55%. Quite significant differences are observed in the standard deviation and coefficient of variability of these interest rates – variability generally increases with the length of the deposit period.

The value of the WIG stock market index is characterized by a coefficient of variability of slightly above 30%. Turnover is characterized by a higher level of variability – well above 50%. Given the volatility of interest rates and the WIG stock market index, we can say that the volatility of interest rates on deposits is generally lower than the volatility of the value of the index, apart from the interest rate on deposits with the longest period to maturity.

### 3. Correlation analysis

Even a cursory observation of the time series illustrated in figures 3 and 4 suggests that the rates on bank deposits are related to both the value of the WIG stock market index and the volume of transactions on the stock exchange. Higher interest rates on deposits correspond to both lower values of the WIG stock index and lower volumes of sales on the stock market. Conversely, lower interest rates on deposits correspond to higher values of the WIG stock market index and higher volumes of sales on the stock exchange.

**Table 2.** Correlation between interest rates on deposits and the stock market index and turnover

Correlation	<1 m.	1–3 m.	3–6 m.	0.5–1 y.	1–2 y.	>2 y.
WIG	–0.4212	–0.3394	–0.4060	–0.4387	–0.5281	–0.5320
p-value	0.00	0.01	0.00	0.00	0.00	0.00
WIG volume	–0.2895	–0.1948	–0.2491	–0.3129	–0.3250	–0.4474
p-value	0.03	0.14	0.06	0.02	0.01	0.00

Source: our own calculations.

The interpretation of the time series graphs are confirmed by the full set of Pearson correlation coefficients (table 2). All of them take negative values. The values of the Pearson correlation coefficient between the interest rate on deposits and the WIG

stock market index are most statistically significant in the case of interest rates on deposits for between 1 year and 2 years and on deposits for over 2 years. These correlation coefficients were less than  $-0.5$ . Weaker correlations were observed for shorter period deposits, about  $-0.4$ .

The relationship of interest rates on deposits with the volume of sales on the stock market is weaker than with the value of the index. Two of the correlation coefficients are statistically insignificant at a significance level of 0.05.

These results confirm theory and previous research. In addition, it is worth noting that on a short time scale interest rates on deposits and the value of the stock index may move in the same direction. This happened in 2004. The WIG stock market index was relatively low in that year and this could explain such an observation. The time series are too short to ascertain this with any certainty.

#### 4. Stationarity and Cointegration

Autoregressive models referring to the concept of integration and cointegration give greater analytical capabilities than simple correlation analysis. Initial analysis includes the determination of the degree of integration of a time series. In this regard, one can use a number of statistical tests, such as the ADF test and the Phillips-Perron test. The results of the ADF test are presented in table 3. The results of the Phillips-Perron tests were similar.

**Table 3.** Tests of stationarity

Time series	I(0)		I(1)	
	ADF	p-value	ADF	p-value
<1 m.	0.4203	0.8008	-2.6900	0.0080
1-3 m.	1.0166	0.9167	-4.3822	0.0000
3-6 m.	1.3367	0.9528	-4.6329	0.0000
0.5-1 y.	0.3645	0.7865	-8.8841	0.0000
1-2 y.	0.1245	0.7180	-7.1564	0.0000
>2 y.	-0.8116	0.3600	-14.0385	0.0000
WIG	-0.0796	0.6519	-6.3426	0.0000
WIG volume	-0.3240	0.5642	-8.6033	0.0000

Source: our own calculations.

The results of the tests of stationarity clearly show that the time series of interest rates, of the values of the WIG index and of the sales volume are non-static, but their first differences are stationary, which means integration of the first degree. According to the concept of cointegration, there exists a long-term relationship between time

series of first order, since the residuals from the cointegration equations are stationary. The time series now analysed are the residuals from the regression equations:

$$y_t = a_1x_t + a_2t + c, \quad (1)$$

where:

$y_t$  – interest rate on deposits;

$x_t$  – value of the WIG stock market index or the volume of sales on the stock exchange (as appropriate);

$t$  – time;

$c$  – constant.

The research did not indicate the stationarity of residuals in any way and similar results were obtained for the series without deterministic trends. In practice, this means there is a need to create a model of a short term relationship. Such data requires a model relating changes in interest rates to changes in the stock index or changes in volume of sales, as appropriate.

A VAR model is a simple solution in this situation. A two-dimensional model is applied here:

$$x'_t = a_1 + a_{1,1}x'_{t-1} + \dots + a_{1,k}x'_{t-k} + b_{1,1}y'_{t-1} + \dots + b_{1,k}y'_{t-k}, \quad (2)$$

$$y'_t = a_2 + a_{2,1}x'_{t-1} + \dots + a_{2,k}x'_{t-k} + b_{2,1}y'_{t-1} + \dots + b_{2,k}y'_{t-k}, \quad (3)$$

where:

$y'_t$  – increase in the interest rate;

$x'_t$  – increase in the value of the WIG stock market index or increase in the volume of sales on the stock exchange, as appropriate.

Prior to the design and analysis of the VAR model, the Granger test of causality was performed in which the null hypothesis was:

$$H_0: b_{1,1} = \dots = b_{1,k} = 0, \quad (4)$$

which means that  $y'$  is not a cause of  $x'$  and  $y'$  can be eliminated from equation (2), since it does not significantly increase the prognostic value of this model.

**Table 4.** Granger test of causality

Rate	d(WIG)	
	Number of significant lags	p-value
d(1–3 m.)	3	0.0057
d(0.5–1 y.)	5	0.0537
d(1–2 y.)	8	0.0511

Source: our own calculations.

The results of the Granger test (table 4) indicate that it is possible to increase the accuracy of the forecasts of increases in the value of the WIG stock market index by intro-

ducing a model based on the three previous monthly changes in interest rates on deposits for a period of between 1 month and 3 months, (with a significance level of 5%). In the case of interest rates on deposits for a period between 6 months and 1 year, forecasts can be improved by using a model based on the five previous monthly changes (with a significance level of 10%). In the case of interest rates on deposits for a period between 1 year and 2 years, forecasts can be improved by using a model based on the eight previous monthly changes (with a significance level of 10%). Increases in the interest rates on deposits of other types do not significantly improve the accuracy of forecasts of growth in the WIG stock market index. None of the increases in interest rates on deposits improved the accuracy of forecasts of increases in volume significantly.

## 5. The impulse response function and decomposition of the variance in the forecast error

Taking into account the results of the tests of stationarity and the Granger test, three two-equation VAR models, described by equations (2) and (3), were constructed for increases in the value of the stock market index WIG and increases in the deposit rates highlighted in Table 4. This model can also be written in its initial form as:

$$Y_t = A_0 D_t + A_1 Y_{t-1} + A_2 Y_{t-2} + \dots + A_k Y_{t-k} + e_t, \quad (5)$$

where:

$Y_t = [Y_{1t}, Y_{2t}]'$  – the vector of observations of the current values of the variables,

$D_t$  – vector of the deterministic variables in the model,

$A_0$  – matrix of parameters associated with the deterministic variables,

$A_i$  – matrix of parameters associated with lagged values of the vector  $Y_t$ ,

$e_t = [e_{1t}, e_{2t}]$  – vector of stationary random perturbations.

In practice, more important than the interpretation of the parameters of such a model is the interpretation of the results given by tools related to these VAR models, such as the impulse response function and decomposition of the variance in the forecast error. Therefore, the initial model (5) was converted into its structural form:

$$B Y_t = \Gamma_0 D_t + \Gamma_1 Y_{t-1} + \Gamma_2 Y_{t-2} + \dots + \Gamma_k Y_{t-k} + \xi_t. \quad (6)$$

The following relations hold between the initial and the structural form:

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

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

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

The impulse response function enables assessment of the response of an individual variable to a unit change in the other variables included in the multivariate system. In order to interpret the impulse response function, the system is presented in the form of a moving average:

$$Y_t = \mu + \sum_{i=0}^{\infty} \theta_i \xi_{t-i}, \quad (7)$$

where  $\theta_i = \Phi_i B^{-1}$  and  $\xi_t$  is white noise with the appropriate covariance matrix. The elements of matrix  $\theta_i$  describe the system's response to unit perturbations. Element  $\theta_{jk,i}$  describes the reaction of the  $j$ -th variable to a unit perturbation in variable  $k$  occurring  $i$  periods earlier. In the  $i$  period forward update,  $\theta_{jk,i}$  describes the reaction of the  $j$ -th variable  $i$  periods after a current unit perturbation of variable  $k$ .

Model (7) enables predicting future states of the system. The  $n$  period ahead forecast is:

$$Y_{t+n} = \mu + \sum_{i=0}^{\infty} \theta_i \xi_{t+n-i}, \quad (8)$$

and the forecast error:

$$Y_{t+n} - E_t Y_{t+n} = \sum_{i=0}^{n-1} \theta_i \xi_{t+n-i}. \quad (9)$$

In the case analyzed we are dealing with a two-dimensional system. Using the notation  $Y_t = [Y1_t, Y2_t]$ , it is possible to decompose the variance of the forecast error for a variable based on future perturbations  $\xi_{Y1}$ ,  $\xi_{Y2}$ . For example, the decompositions of the variance of the error  $\sigma_{Y1}^2(n)$  based on future perturbations  $\xi_{Y1}$ ,  $\xi_{Y2}$  are as follows:

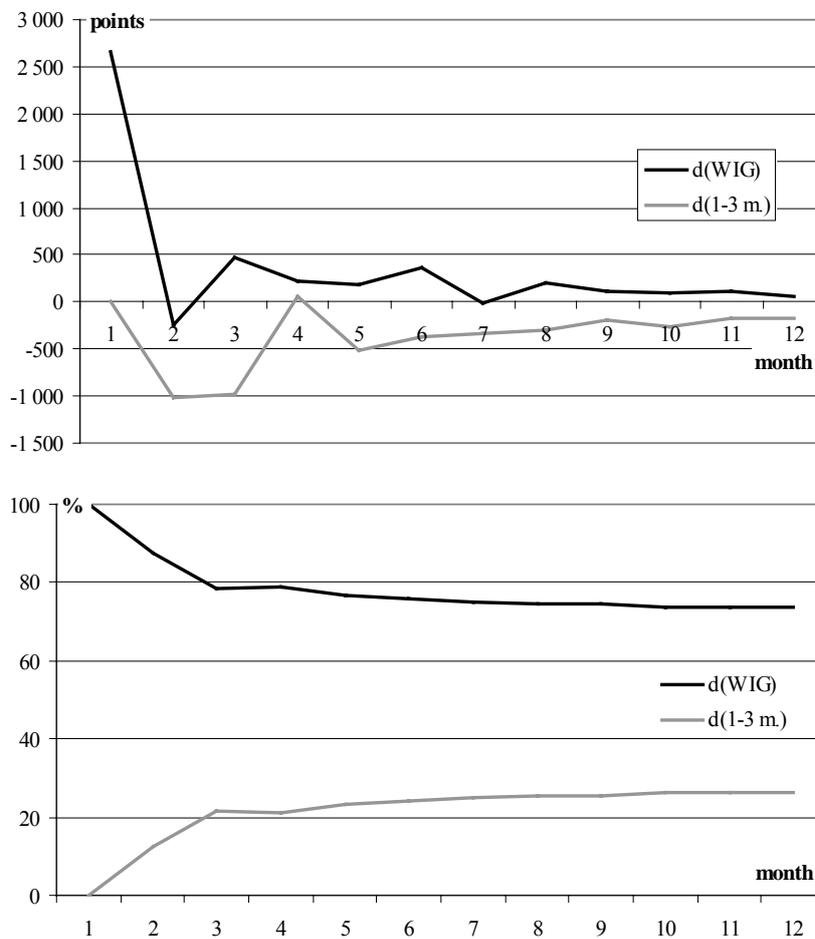
$$\frac{\sigma_{\xi Y1}^2 [\theta_{11}(0)^2 + \theta_{11}(1)^2 + \dots + \theta_{11}(n-1)^2]}{\sigma_{\xi Y1}^2(n)} \cdot \frac{\sigma_{\xi Y2}^2 [\theta_{12}(0)^2 + \theta_{12}(1)^2 + \dots + \theta_{12}(n-1)^2]}{\sigma_{\xi Y1}^2(n)}. \quad (10)$$

Variance decomposition describes the amount of the forecast error of a variable attributable to each of the variables included in the system.

The results given by the impulse response function and the decomposition of the variance of the forecast error are presented in figures 5, 6 and 7.

The first model to be analyzed is the (d(WIG); d(1–3m.)) model with three delays. The reaction of stock index gains to a perturbation in the WIG index of size equal to the standard deviation of changes in the WIG index is strong and occurs immediately after

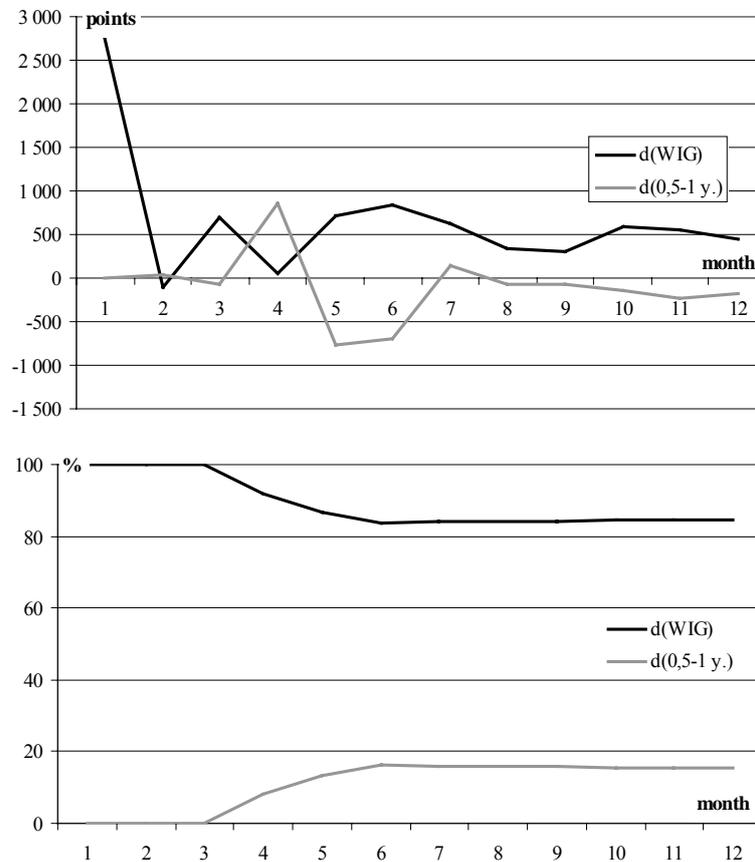
the occurrence of the pulse. This response is rapidly reduced (figure 5). By contrast, the response of the WIG stock index to a change in the interest rate on deposits with a period of between 1 month and 3 months equal to the standard deviation of such interest rate changes, does not occur until the second month after the occurrence of the pulse and is followed by a similar response in the third month, after which the response is reduced. This reaction is weaker than the reaction of the WIG index to changes in its own value, but is still relatively strong. The proportion of the variance in the forecast error for the WIG index attributable to changes in the short-term deposit rate increases from 0% in the first month to over 26% for forecast horizons of six or more months.



**Fig. 5.** (above) Impulse response function of WIG index gains for perturbations equal to one standard deviation of the changes in the variables considered in the model (d(WIG), d(1-3m.)). (below) Decomposition of the variance in the forecast error for gains in the WIG index.

Source: authors' own work

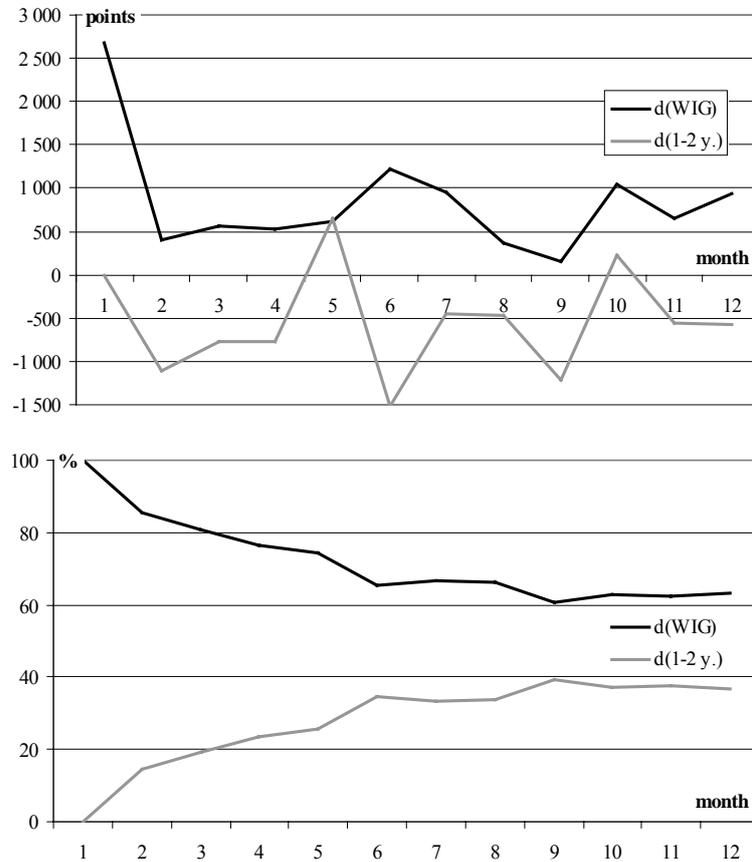
Another model is the  $(d(\text{WIG}), d(0.5-1y.))$  model with five delays. The reaction of the stock index to a change in the WIG index equal to the standard deviation of such changes is strong and occurs immediately after the occurrence of the pulse. This response is rapidly reduced (figure 6). By contrast, the response of the WIG stock index to a change in the interest rate on deposits with a period of between 6 months and 1 year equal to the standard deviation of such changes becomes significant only four months after the occurrence of such an impulse. This initial response is positive, but in the fifth and sixth months the response becomes negative, before becoming reduced. The proportion of the variance in the forecast error for the WIG index attributable to changes in the medium-term interest rate is approximately 0% for the first three months and then rises to about 15% for forecast horizons of at least six months.



**Fig. 6.** (above) Impulse response function of WIG index gains for perturbations equal to the standard deviation of the changes in the variables considered in the model  $(d(\text{WIG}), d(0.5-1y.))$ .  
(below) Decomposition of the variance in the forecast error for gains in the WIG index.

Source: author's own work

The third model is the  $(d(WIG), d(1-2y.))$  model with eight delays. The reaction of the stock index to a change in the WIG index equal to the standard deviation of such changes is strong and occurs immediately after the occurrence of the pulse. This response is rapidly reduced, but remained relatively high over the next 12 months (figure 7). By contrast, the response of the WIG stock index to a change in the interest rate on deposits with a period of between 1 and 2 years equal to the standard deviation of such changes follows in the second month after the occurrence of such an impulse. In the next few months, this response is somewhat variable, becoming positive in the fifth month. The proportion of the variance in the forecast error for the WIG index attributable to changes in the long-term interest rate increases from 0% in the first month to nearly 40% for forecast horizons of nine months or more.



**Fig. 7.** Impulse response function of WIG index for perturbations equal to one standard deviation of changes in the variables in the model  $(d(WIG), d(1-2y.))$  (below) Decomposition of the variance in the forecast error for gains in the WIG index.

Source: author's own work

## 6. Complete article

On certain issues, the results obtained in this article are consistent with the results obtained for other national markets. Principally, this concerns the direction of the relationship between the interest rate and the stock exchange index, which turns out to be negative and the weak strength of the association between these markets. This indicates the possibility of obtaining the benefit of risk diversification.

Preliminary analysis indicates a significant, negative correlation between interest rates on deposits in banks and the value of the WIG stock market index. This relationship is of moderate strength. However, more detailed studies indicate that the nature of this relationship is more complex. It may well be that any long-term correlation may be illusory, and only a short-term relationship exists. For the period analyzed, only the following interest rates on deposits are correlated with the value of the WIG stock market index: for a period of between 1 and 3 months, between 6 months and 1 year and between 1 and 2 years. The nature of these associations differ. Increases in the first of these interest rates affect the stock market purely negatively. The effect of increases in the second and third rates are mainly negative, but may also have a positive effect, as shown in figures 6 and 7. A change in the rate of these interest rates may be associated with a change in value of the WIG stock market index in the same direction a few months later. This fact has been previously noticed by Nasseh'ai Strauss [4] and is confirmed here.

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