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REACTION OF THE INTEREST RATES IN POLAND TO THE INTEREST RATES CHANGES IN THE USA AND EURO ZONE[1]

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Abstract: Behavior of interest rates is of key importance for understanding the functioning of an open economy. The simplest models usually assume equal interest rates in individual countries, while the international arbitrage serves as a mechanism of their equalization. In our study an attempt has been made to determine whether and to what extend the interest rates in the Polish market are linked to the USA and the euro zone exchange rates. The analyses have been carried out for rates of different maturity terms, using the integration and co-integration concept.The analyses indicate that differences between the Polish interest rates, and those in the USA and the euro zone have strongly diminished. Cointegration analyses show the existence of a long-term linkages between the domestic and foreign interest rates, in particular with those in the euro zone. The nature of co-integrating relationships was different in the period 2001-2004 as compared with that after 2004, when we see a stronger impact of the euro zone rates than those of the USA. It may be assumed that the Polish accession to the EU had certain influence in the change of the above mentioned relationships.

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Key words: interest rates, world markets, cointegration analysis, Error Correction Model (ECM)

INTRODUCTION

Behavior of interest rates is of vital importance for understanding the functioning of an open economy and its significance in pursuing of macroeconomic policy must not be underestimated. Usually in the simplest models the real interest rates in individual countries are assumed equal with their level equalized by the mechanism of international arbitrage2. In accordance with the rule of unsecured interest parity the domestic interest rate for the same term of maturity should differ by the anticipated rate of foreign exchange modification and a specific for a given country risk premium3.

Analyses made for the periods of 60's and 70's indicated a significant differentiation of interest rates4. In the last 30 years however an alignment of interest rates has been observed at least in the countries with the developed financial markets5. Nevertheless it's still rather difficult to talk about full markets' integration. Many are the reasons of such incomplete integration to mention only not fully coordinated macroeconomic policy in individual countries, still existing restrictions in transfer of capital in some countries or the so called „home bias".

Many analyses have been focused on interest rate linkages in individual countries and most of them are based on the integration and cointegration methods. Their findings however do not present an unambiguous result. Some works confirm the existence of cointegration among markets6, while other do not show a full integration of interest rates between countries7. In case of some countries the

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existence of cointegration has been found while in the case of some a hypothesis of such relationship has been rejected.

In our study an attempt has been made to determine whether and to what extend the interest rates in the Polish market are linked to those in the USA and in the Euro zone. We have also been interested in identification of long- and short term relationships. Analyses have been made for the interest rates with different maturities using the concept of integration and cointegration.

METHODOLOGY

The very straightforward methods of analyzing relations between interest rates are based on calculations of correlation coefficients. They are technically the simplest, but due to certain characteristics of time series (non-stationarity, heteroscedacity) they may yield results of little reliability. More analytical possibilities are provided by auto regression models referring to the concepts of integration and cointegration and in our study the latter have been used. Our analyses encompassed the following stages:

- analysis of the integration degree of individual variables (interest rates time series). To this end the ADF test has been used while the selection of lags number in testing has been determined on the basis of the Akaike information criterion;
- analysis of cointegration. It has been carried out by construction of a cointegration vector between the level of interest rates in Poland and those in the USA and the euro zone and also by testing the stationarity of residuals from cointegrating regression;
- analysis of transmission based on the autoregression model. A specific shape of the model depended on results obtained in the first two stages. In the case when stationarity of exchange rates has been established, an autoregression model based on variables on their levels should be applied; while for the stationary variables in degree one (stationary first differences of variables) and mutually cointegrated we use the autoregressive model based on first differences of variable with the error correction mechanism, as shown below:

$$\Delta y_t = c + \sum_{i=1}^{k-1} \theta_i \Delta y_{t-i} + \sum_{i=0}^{k-1} \gamma_i \Delta x_{t-i} + \alpha ECM_{t-1} + \varepsilon_t \qquad (1)$$

where:
ECM_{t-1} - residuals of cointegration equation.

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In the case of change in the non-integrated variables it would seem more appropriate to use the autoregression model overriding the error correction mechanism.

Source material for our analyses has been based on data on the interest rates level calculated for 1-year, 1-month and 1-week treasury bonds in the period 2001-2009. Data on interest rates level were obtained from the National Bank of Poland. In our analyses of integration, cointegration and transmission we used data on the weekly interest rates quotes.

TRENDS IN THE INTEREST RATE CHANGES IN THE MARKETS UNDER STUDY

Difficulties in modeling relationships between the Polish interest rates and those in the USA and the euro zone may be a result of not only the levels of interest rates, but also of different statistical properties of these series (table 1). In the beginning of the period under examination the Polish interest rates were at the higher level than those in the USA and in the euro zone. It is only since 2005 when there has been a significant drop in the Polish interest rates that we can talk about the interest rates alignment.

The interest rates time series in Poland are marked by the highest variability (standard deviation about 4%), while in the USA it has been significantly lower (standard deviation about 1.5%) and the lowest in the euro zone (standard deviation below 1%). All the interest rates time series are marked by the right bias asymmetry i.e. in general the low interest rates prevail and the average level of interest rates is significantly higher than that for the most often observed, however the magnitude of this phenomenon varies. For the Polish interest rates the asymmetry coefficient was about 1.5, while for the USA and the euro zone the asymmetry level is weaker. Besides, the time series in Poland display a very strong kurtosis while for the USA and the euro zone this measure is very weak.

Table 1. Descriptive characteristics of the interest rates time series

Interest rate	Mean	Std.deviation	Skewness	Kurtosis
POLAND 1Y	7.24	3.71	1.55	1.33
USA 1Y	3.28	1.52	0.14	-1.48
EURO 1Y	3.06	0.81	0.39	-1.26
POLAND 1M	7.51	4.27	1.50	1.04
USA 1M	2.96	1.61	0.37	-1.42
EURO 1M	2.91	0.85	0.75	-0.50
POLAND 1W	7.55	4.38	1.49	0.95
USA 1W	2.94	1.62	0.39	-1.40
EURO 1W	2.90	0.86	0.79	-0.41

Source: own studies

ANALYSIS OF THE INTEREST RATES RELATIONSHIPS

Different statistical properties of the interest rates time series produce different results of the interest rates stationarity tests in Poland, the USA and the euro zone (table 2). As evidenced by the tests, the interest rates time series in Poland are marked by stationarity. Non-stationarity has only been shown by the ADF test with the 1-week constant. Besides, due to the close to zero values of the ADF statistics, the test for first differences of interest rates has also been made and statistical values turned out to be much lower. The results indicate stationarity of the first increments of interest rates. In the case of the USA and the euro zone interest rates non-stationarity of the observation series has been found, as well as stationarity of the first differences which means the 1 degree integration of variables.

Table 2. Stationarity tests of the interest rates time series

Interest rate	ADF without constant				ADF with constant			
	I(0)		I(1)		I(0)		I(1)	
	ADF	p	ADF	p	ADF	p	ADF	p
POLAND 1Y	-3.8730	0.0001	-20.9989	0.0000	-3.2835	0.0164	-21.5309	0.0000
USA 1R	-0.5397	0.4827	-17.9385	0.0000	-0.9577	0.7688	-17.9112	0.0000
EURO 1R	-0.2467	0.5968	-15.6917	0.0000	-0.9541	0.7700	-15.6674	0.0000
POLSKA 1M	-4.3811	0.0000	-21.8390	0.0000	-3.4191	0.0110	-22.5688	0.0000
USA 1M	-0.5016	0.4985	-12.5497	0.0000	-0.7555	0.8296	-12.5302	0.0000
EURO 1M	-0.8154	0.3622	-12.6076	0.0000	-1.4297	0.5680	-12.6005	0.0000
POLSKA 1T	-3.5396	0.0004	-23.3005	0.0000	-2.5845	0.0972	-23.7656	0.0000
USA 1T	-0.6676	0.4274	-22.7245	0.0000	-0.8695	0.7971	-22.6930	0.0000
EURO 1T	-0.9204	0.3171	-21.2561	0.0000	-1.5689	0.4974	-21.2393	0.0000

Explanations: I(0) - level stationarity testing. I(1) - first increments stationarity testing, ADF - empirical value of test, p - significance level of test.
Source: own studies

Results of stationarity tests may indicate a lack of long-term linkages between national and foreign interest rates. However, attention must be drawn to a different nature of the interest rates changes in Poland in the years 2001-2004 and 2005-2009, as expressed by taking an account of a zero-one variable in the cointegrating equation (table 3). All the parameters of determined cointegrating equations have proven to be of statistical significance and also provide a very good explanation of the interest rates shaping in Poland - determination coefficients are formed at the level close to 0.9.

The obtained results show the existence of cointegration between the Polish and foreign markets. One exception to the above is a linkage of 1-year interest rates in Poland with the USA interest rates where the cointegrating equation residuals turn out to be non-stationary. In other cases, the hypothesis about nonstationarity of the cointegrating equation residuals may be rejected in favor of the residuals stationarity at the significance level below 0.1.

Table 3. Cointegration tests

Independent variable	Model					ADF without constant		ADF with constant	
	a1	a2	a3	c	R2	ADF	p	ADF	p
Dependent variable: POLAND 1YEAR									
USA 1YEAR	0.3705	0.2619	-0.0058	2.3150	0.9226	-1.2172	0.2050	-1.2072	0.6723
EURO 1YEAR	0.7141	0.5132	-0.0056	1.7590	0.9221	-3.0407	0.0024	-3.0363	0.0326
Dependent variable: POLAND 1MONTH									
USA 1MONTH	0.3247	0.2266	-0.0062	2.5027	0.9515	-1.7976	0.0688	-1.7888	0.3858
EURO 1MONTH	0.6927	0.4200	-0.0054	1.8527	0.9320	-2.6692	0.0076	-2.6652	0.0812
Dependent variable: POLAND 1WEEK									
USA 1WEEK	0.3287	0.2052	-0.0061	2.5089	0.9501	-2.2605	0.0232	-2.2510	0.1889
EURO 1WEEK	0.7148	0.3975	-0.0053	1.8272	0.9298	-2.6411	0.0082	-2.6370	0.0866

Explanations: parameters of the cointegrating equation are denoted in accordance with formula 1.
Source: own studies

Taking into account the previously obtained results for describing linkages between the national and foreign interest rates we used here the model with an error correction mechanism. In table 4 we present detailed characteristics for individual categories of interest rates. In the models presented below the following parameters remained:

- parameters of explanatory variables for statistically significant,
- parameters of explanatory variables with the significance level not meaningly divergent from 0.1,
- parameters of current independent variable increments and parameters of residuals from cointegrating equation irrespective of their significance.

At the aforesaid conditions, it will be possible to determine the reaction of the interest rates in Poland to the current changes of interest rates in the USA and the euro zone, as well as the process of coming to a long-term equilibrium.

The model of interest rates linkages shows that changes in the 1 Y Polish interest rates are significantly influenced by changes in the level of current interest rates in the USA and the euro zone. Impact of the euro interest rates is stronger

than that of the USA. It appears that the increase of the USA interest rate by 1% generates an average increase of the Polish interest rate by 0.1275%, while the same interest rate increase in the euro zone generates an average increase of the interest rate in Poland by 0.2270%.

Table 5. Interest rates transmission models

Independent variable	c	d(yt-1)	d(yt-2)	d(yt-3)	d(yt-4)	d(yt-5)	d(xt)	d(xt-1)	d(xt-2)	d(xt-3)	d(xt-4)	d(xt-5)	ECMt-1	R2	DW
Dependent variable: d(POLAND 1Y)															
d(USA 1Y)	-0.0033	-0.1684	0.0958	0.1155	0.1308		0.1275						-0.0244	0.1172	2.0123
	0.0267	0.0019	0.0775	0.0331	0.0138		0.0001						0.0419		
d(EURO 1Y)	-0.0033	-0.1780	0.0877	0.1051	0.1471		0.2270						-0.0206	0.1084	2.0120
	0.0268	0.0012	0.1094	0.0538	0.0058		0.0004						0.0886		
Dependent variable: d(POLAND 1M)															
d(USA 1M)	-0.0057	-0.2415	-0.1160		0.0947		0.0982	-0.1011		0.2092			-0.0201	0.1235	1.9981
	0.0002	0.0000	0.0356		0.0727		0.1026	0.0903		0.0002			0.1535		
d(EURO 1M)	-0.0056	-0.2236	-0.1464		0.0917		0.2044	-0.2930	0.2020			0.2555	-0.0332	0.1427	2.0000
	0.0002	0.0000	0.0067		0.0829		0.0512	0.0081	0.0541			0.0094	0.0040		
Dependent variable: d(POLAND 1W)															
d(USA 1W)	-0.0086	-0.4719	-0.4328				0.2309						-0.0664	0.3222	1.9946
	0.0033	0.0000	0.0000				0.0006						0.0227		
d(EURO 1W)	-0.0084	-0.4633	-0.4002				0.1393	-0.1690		0.2226			-0.0719	0.3222	2.0156
	0.0041	0.0000	0.0000				0.1983	0.1195		0.0391			0.0023		

Explanations: the first figure in a box denotes the value of model's parameters, while the next a significance of this parameter. Source: own calculations

Behavior of the 1-month interest rates is quite similar. Here also, the strongest influence on the short term interest rate fluctuations is exerted by the euro zone interest rates rather than by those in the USA. 1 per cent increase of the USA interest rate results in an average of 0.0982 per cent increase in the Polish interest rate, while a similar increase in the euro zone brings about in Poland an increase by 0.2044 per cent.

A reverse relationship has been observed with regard to the 1-Week interest rates. In this case, the impact of the USA interest rates on the short-term changes of interest rates in Poland is stronger that of the euro zone interest rates 1 per cent increase of the USA interest rate results in an average of 0.2309 per cent increase in the Polish interest rate, while a similar increase in the euro zone generates in Poland an increase by 0.1393 per cent.

The process of attaining the long-term equilibrium between the interest rates in Poland and those in the USA and the euro zone is a slow one, as evidenced by very low values of the ECM parameters. The slowest rate is observed for the 1 year and 1 month interest rates and only slightly stronger for the 1 week rates of interest.

CONCLUDING REMARKS

Our studies indicate a strong decrease in the differences between the Polish interest rates and the interest rates in the USA and the euro zone. Thus, the trend observed earlier in other open economies is noticeable now also in Poland.

Cointegration analyses show the existence of long-term linkages between the domestic and foreign interest rates in particular with those of the euro zone. The nature of cointegrating relations was different in the period 2001-2004, as compared with the years after 2004. It may be thus assumed that such a change in linkages was influenced by the Polish accession to the EU.

The transmission models show an increase of the Polish interest rates as a reaction to the interest rates growth abroad, although such a response has not been strong. Also, the very process of reaching the long-term equilibrium between the Polish and foreign interest rates has been slow. In the light of the above it would seem advisable to extend the interest rates quote interval from one week to one month.

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