ARGUMENTA OECONOMICA
No 1(4) · 1997
PL ISSN 1233-5835

*Maria Piotrowska**

EVALUATION OF INTEREST RATE STRATEGY

The paper presents a model and modelling research results which evaluate the behaviour of the Central Bank and money market in Poland. It tries to answer two main questions:
– did the money market meet the requirements of the Central Bank interest rate strategy,
– why did the NBP decide to change its strategy of monetary policy.
The model was based on cointegration method and error-correction models. The tables contain the numerical results of research conducted.

1. INTRODUCTION

The interest rate strategy of monetary policy, caried out by the central bank, covers following elements (Kokoszczyński et al. 1996; Osiński 1995; Sławiński et al. 1995, and Henning et al. 1988):
– tools – first of all open market operations,
– operating target – the short-term interest rates,
– initial target indicator – the long-term interest rates,
– ultimate goals – the economic growth and the price stabilisation.

The interest rate strategy will be efficient if:
– the central bank is able to control the operating target using open market operations (Burger 1971),
– there are stable relationships between the short-term and long-term interest rates,
– the long-term interest rates have the anticipated influence on the ultimate goals.

When the central banks establish an operating target for their day-to-day open market operations, they accept either money market interest rates or bank reserves. Principal criterion of choice is the possibility to control the operating target on a near-term basis. The National Bank of Poland (NBP) was not in such a comfortable situation when in 1993 it begun its interventions in the interbank money market. Daily data on bank reserves have not been available until August 1994. Therefore one of the shortest money market interest rate, called repo rate, was becoming the operating target. Considering the paper form of T-bills NBP was forced to set the interest rate of one day

* Department of Economics, Wrocław University of Economics.

transactions in the T/N market as the repo rate. Its level was determined periodically on base of monetary and credit conditions as well as interest rate differentials between the Polish market and abroad. The Assumption was that the repo rate was to perform a function of the lowest interest rate in the money market. NBP tried to influence the other ones through open market operations.

In February 1996 the NBP formally changed the operating target. What was the cause of this change and what was the efficiency of interest rate strategy? The paper tries to find the answer.

DATA

The following variables were included in the research:

a) NBP interventions were described by:
   - repo rate;
   - open market operations balance, million zł;

b) Interbank money market rates, called WIBORs (Warsaw Interbank Offered Rates):
   - interest rates of 1-day loans: O/N, T/N, S/N;
   - interest rates of 1 and 2-week loans: W1, W2;
   - interest rates of 1-, 2-, 3-month loans: M1, M2, M3;

c) T-bills market (Treasury bills market):
   - interest rates of 8-, 13-, 26-, 39-, 52-week T-bills: i8, i13, i26, i39, i52;
   - share of demand for r-week T-bill in the total demand ($r = 8, 13, 26, 39, 52$): p8, p13, p26, p39, p52;
   - ratios of offers (for n-week T-bill) accepted by the Ministry of Finance to demand for r-week T-bill: op8, op13, op26, op39, op52;

d) Exchange rate:
   - PLN/USD: k.

e) Credit market:
   - average interest rate for a loan with the lowest-risk: ik.

Data concerning the variables are the weekly data for the period from 3.10.1994 to 31.01.1996. The beginning of the period was determined by the introduction date of a system of the monthly average for required reserves. The new system radically improved the interbank money market. The end of the period is the date of change in the operating target.

2. METHODOLOGY

The first step of the analysis was to investigate the existence of the long-term relations between the variables. I have applied the cointegration method

suggested by Johansen and Juselius – maximum likelihood in an error--correction model (MLECM). The method of MLECM estimates β by maximum likelihood in the ECM:

$$\Delta X_t = \Pi X_{t-k} + \Gamma_1 \Delta X_{t-1} + \ldots + \Gamma_{k-1} \Delta X_{t-k+1} + a + \xi_1;\ t =$$

$$= 1 \ldots T,\ \xi_t \approx \text{i.i.d. } N_\xi(O, \Sigma),$$

where the following hypothesis is assumed: $H_1(r)$: $\Pi = \alpha\beta'$.

The hypothesis $H_1(r)$ implies that under certain conditions (see Johansen 1986) the process ΔX_t is stationary, X_t is nonstationary, but also that $\beta' X_t$ is stationary. Thus we can interpret the relations $\beta' X_t$ as the stationary relations among nonstationary variables, i.e., as cointegrating relations (see Johansen and Juselius 1990).

Two objections have been raised against Johansen's method:

– the number of lags (k) in the ECM is unknown,

– $\{\xi_t\}$ may be non-Gaussian.

Johansen and Juselius (1990) suggest to start the empirical analysis from the misspecification tests (normality test and LM test), which should help making the decision whether the lag length is enough. Johansen's procedure is to analyse whether there exist stationary linear relations between the levels of the variables, and if this is the case, whether the unrestricted result is consistent with the hypothetical long-run relations. The expectations hypothesis, for example, requires that the cointegrating vector was 1. Johansen and Juselius suggested some tests for linear structural hypotheses on the cointegrating vectors. The hypotheses are formulated in terms of the cointegrating relations β, since these describe the long-run relations in which most economic structural hypotheses are formulated. These hypotheses are structural in the sense that they do not depend on any normalisation of the parameter β. One of these hypotheses, H_5, is formulated by asking whether the cointegrating relation is stationary by itself, i.e., without involving the other variables of the system.

I was encouraged to apply Johansen's procedure by investigation of results given in Gonzalo's paper (1994). Gonzalo examined the asymptotic distribution of the estimators resulting from five methods, and showed that Johansen's procedure had clearly better properties than the other when $\{\xi_t\}$ were non-Gaussian or when the dynamics were unknown and we over-parametrized by including additional lags in the ECM. At the end of the paper I have investigated the short-term dynamics of the T-bill interest rates using simultaneous equations model.

Table 1

Test for Integration

Symbol of variable	Regression $\Delta y_t = a_0 + a_1 T + \gamma y_{t-1} + \sum_{i=1}^{p} a_i \Delta y_{t-i} + u_t$			Order of integration
	Number of lags p^*	$H_0: \gamma = 0$		
		Statistic ADF		
		without trend	with trend	
i8	4	−2.535 (−2.8907)	−3.369 (−3.4645)	I(1)
i13	6	−1.412 (−2.8976)	−3.434 (−3.4659)	I(1)
i26	3	−1.094 (−2.8963)	−3.063 (−3.4639)	I(1)
i39	3	−1.574 (−2.8963)	−3.442 (−3.4639)	I(1)
i59	3	−1.774 (−2.8963)	−3.409 (−3.4649)	I(1)
p8	7	−2.141 (−2.8981)	−1.884 (−3.4666)	I(1)
p13	3	−2.386 (−2.8963)	−2.722 (−3.4639)	I(1)
p26	2	−2.264 (−2.8959)	−2.988 (−3.4632)	I(1)
p39	4	−2.331 (−2.8967)	−3.301 (−3.4645)	I(1)
p52	6	−1.047 (−2.8976)	−3.203 (−3.4659)	I(1)
op8	6	−2.195 (−2.8976)	−2.512 (−3.4659)	I(1)
op13	6	−3.820 (−2.8976)	−3.798 (−3.4659)	I(0)
op26	6	−5.764 (−2.8981)	−5.727 (−3.4666)	I(0)
op39	12	−3.539 (−2.9012)	−3.501 (−3.4713)	I(0)
op52	8	−2.866 (−2.8991)	−2.852 (−3.4681)	I(1)
K	1	−0.302 (−2.8955)	−1.729 (−3.4626)	I(1)
O/N	2	−1.937 (−2.8959)	−3.028 (−3.4632)	I(1)
T/N	1	−0.418 (−2.8955)	−2.274 (−3.4626)	I(1)
S/N	1	−0.659 (−2.8955)	−2.303 (−3.4626)	I(1)
W1	1	−0.369 (−2.8955)	−2.123 (−3.4626)	I(1)
W2	2	−0.998 (−2.8959)	−3.079 (−3.4632)	I(1)
M1	1	−0.093 (−2.8955)	−1.948 (−3.4626)	I(1)
M2	1	−0.015 (−2.8955)	−2.127 (−3.4626)	I(1)
M3	1	−0.254 (−2.8955)	−2.496 (−3.4626)	I(1)
O	5	−2.481 (−2.8972)	−2.692 (−3.4652)	I(1)

* The general LM test for autocorrelation was used to check whether the value of p was large enough to ensure that u_t is white noise. In brackets there are 95% critical values given in MacKinnon (1990).

3. EMPIRICAL RESULTS

I have applied the cointegration analysis to test the hypothesis on the existence of stable, long-term relationship between: open market operations – shorter money market interest rates – longer interest rates, (see Figure 1).

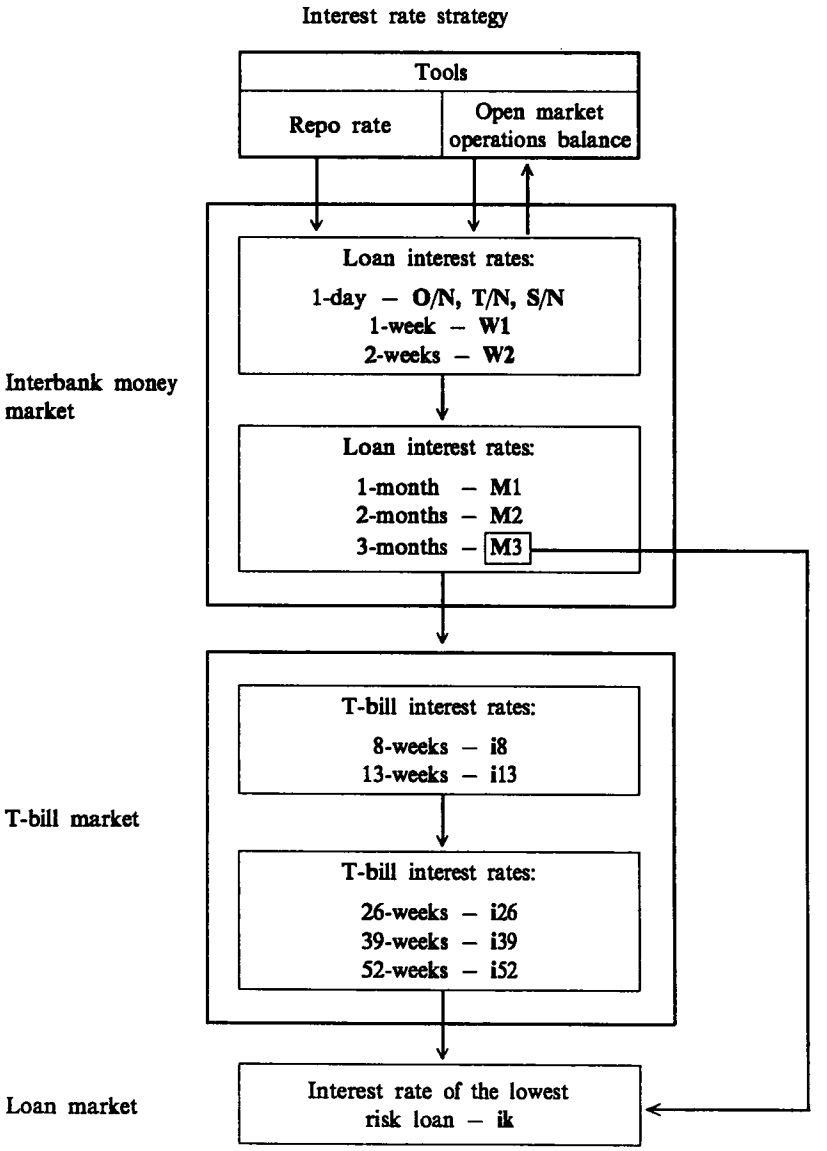

Fig. 1. Scheme of relationships between tools, operating target
Source: own research.

Table 2

Long-term relations in the interbank money market

Variables	Results of misspecification tests for choosen number of lags			Number of cointegration vectors r	H_5: Cointegrating vector is of the form [1; −1] Yes/No	Variables are cointegrated d Yes/No
	Choosen number of lags VAR = m	Normal distribution of residuals Yes/No	Lack of autocorrelation Yes/No			
1	2	3	4	5	6	7
O, O/N	VAR = 3	No	Yes	1	H_5: [1; −1] Yes	Yes
O, T/N	VAR = 3	No	Yes	1	H_5: [1; −1] Yes	Yes
O, S/N	VAR = 3	No	Yes	1	H_5: [1; −1] Yes	Yes
O, W1	VAR = 3	No	Yes	1	H_5: [1; −1] Yes	Yes
O, W2	VAR = 3	No	Yes	1	H_5: [1; −1] Yes	Yes
O, M1	VAR = 3	No	Yes	1	H_5: [1; −1] Yes	Yes
O, M2	VAR = 3	No	Yes	1	H_5: [1; −1] Yes	Yes
O, M3	VAR = 3	No	Yes	1	H_5: [1; −1] Yes	Yes
O, all WIBORSs	VAR = 3	—	—	$\lambda_{max}\, r = 1$, trace $r = 4$	H_5: [1; 1; 1; 1; 1; 1; 1; 1; 1] No	Yes
O/N, repo	VAR = 7	No	Yes	1	H_5: [1; −1] Yes	Yes
T/N, repo	VAR = 7	No	Yes	0	—	No
S/N, repo	VAR = 7	No	Yes	0	—	No
W1, repo	VAR = 7	No	Yes	0	—	No
W2, repo	VAR = 7	No	Yes	0	—	No
M1, repo	VAR = 7	No	Yes	0	—	No
M2, repo	VAR = 7	No	Yes	0	—	No
M3, repo	VAR = 7	No	Yes	0	—	No

continuation Table 2

1	2	3	4	5	6	7
i8 – repo	VAR = 3	No	Yes	1	H_5: [1; −1] Yes	Yes
p8 – repo	VAR = 3	1/2 Yes[1]	Yes	1	H_5: [1; −1] Yes	Yes
M3, W2						
M1, W2, W1	VAR = 6			4	H_5: [1; −1; −1; −1; −1; −1; −1; −1] No	
S/N, T/N, O/N						
S/N, T/N, O/N	VAR = 7	No	Yes	1	H_5: [1; −1; −1] No	Yes
					H_5: [1; −1; 0] No	
					H_5: [1; 0; −1] No	
					H_5: [0; −1; −1] No	
W2, W1	VAR = 3	No	Yes	1	H_5: [1; −1] No	Yes
M3, M2, M1	VAR = 6	No	Yes	1	H_5: [1; −1; −1] No	Yes
					H_5: [1; −1; 0] No	
					H_5: [1; 0; −1] No	
					H_5: [0; −1; −1] No	
ik, i52	for all k	–	–	0	–	No
ik, i	for all k	–	–	0	–	No
ik, pop	for all k	–	–	0	–	No
ik, M3	VAR = 8	No	Yes	1	H_5: [1; −1] No	Yes

[1] Symbol 1/2 Yes means that the residuals of only the equation from two ones in error-correction model were not serial correlated.
Source: own research.

The results were as follows:

1. There were cointegrating relations between all the WIBORs and the open market operations balance (see Table 2). In each case the cointegrating vector was of a form [1, −1]. This means that change in the open market operations balance was fully reflected in change of each WIBOR. Then in the long run the size of open market operations balance correctly responsed to changes in the interbank interest rates. Did the feed-back exist? Did the levels of WIBORs adjust to changes in open market operations balance in long run? Estimation of error-correction models (Table 3) pointed out only the one-way relationship. There were not the long-term tendency changes in WIBORs to adjust to changes in the open market operation balance. Then the results showed the important drawback of the interest rate strategy.

2. The analysis of relations between the repo rate and each WIBOR showed that there was only the one, long-term relationship between the repo rate and O/N rate (see Table 2). Introducing the repo rate has made O/N rate much more stable.

3. The stable relationships between interest rates in the interbank money market would help in carring out the interest rate strategy. The results of cointegrating tests confirmed the existence of the long-term relations between WIBORs (see Table 2).

4. The interest rate strategy required changes in short rates to be transmitted to the other segments of the money market. Were there the stationary relations between WIBORs and the T-bill interest rates? The cointegrating analysis gave the positive answer, showing many long-term relations between the rates of these two markets (see Table 4). The obtained results pointed out the existence of the transmission mechanism of the interest rate changes from the interbank money market to the T-bill market. These changes were transmitted mainly by one and two week WIBORs.

5. The stable relationships between the T-bill market and the credit market should be the next element in the transmission mechanism of the interest rate changes. The cointegrating analysis did not confirm the hypothesis on the existence of this element. The test results pointed out no cointegrating relates between the interest rate of the lowest risk loan and the interest rate of 52-week bill (see Table 2).

6. However, the results of the cointegration analysis confirmed the existence of the long-term relation between the interest rate of the lowest risk loan and the 3-month WIBOR, M3, (see Table 2).

In general, the empirical results of the analysis carried analysis showed that there were many stable, long-term relationships between the tools and target of the interest rate strategy. Most of the requirements of this strategy were met. However, NBP made the decision to give the interest rate strategy up and

Table 3

Long-term relationships between T – bill interest rates (i...) and money market interest rates (O/N, T/N, S/N, W1, W2, M1, M2, M3) and open market operations balance (O)

Variables	Results of misspecification tests for choosen number of lags			Number of cointegration vectors r	H_5: Cointegrating vector is of the form [1; −1] Yes/No	Variables bare cointegrated Yes/No
	Choosen number of lags VAR = m	Normal distribution of residuals Yes/No	Lack of autocorrelation Yes/No			
i 8 – all WIBORs	VAR = 5	–	–	λ_{max} $r = 4$ trace $r = 6$	No	Yes
i 8 – O/N, T/N,	VAR = 8	No	Yes	$r = 1$	No	Yes
S/N	VAR = 4	No	Yes	$r = 1$	No	Yes
i 8 – W1, W2	VAR = 6	No	1/2 Yes	$r = 1$	–	No
i 8 – M1, M2, M3						
i 13 – all WISORs	VAR = 5	–	–	$r = 5$	No	Yes
i 13 – O/N, T/N,	VAR = 8	No	Yes	$r = 2$	No	Yes
S/N, T/N,	VAR = 3	No	Yes	$r = 2$	[1; −1; −1] No	Yes
i 13 – W1, W2	VAR = 6	No	1/2 Yes	$r = 1$	No	Yes
i 13 – M1, M2, M3						
i 26 – all WIBORs	VAR = 4	–	–	λ_{max} $r = 4$ trace $r = 5$	No	Yes
i 26 – O/N, T/N,	VAR = 8	No	Yes	$r = 1$	No	Yes
S/N, T/N,	VAR = 8	No	Yes	$r = 0$	–	Yes
i 26 – W1, W2	VAR = 6	No	1/2 Yes	$r = 1$	No	Yes
i 26 – M1, M2, M3						
i 39 – all WIBORs	VAR = 8	–	–	λ_{max} $r = 4$ trace $r = 6$	No	Yes
i 39 – O/N, T/N,	VAR = 7	No	Yes	$r = 3$	No	Yes
S/N	VAR = 4	No	Yes	$r = 2$	No	Yes
i 39 – W1, W2	VAR = 6	No	1/2 Yes	$r = 1$	No	Yes
i 39 – M1, M2, M3						
i 52 – all WIBORs	VAR = 5	–	–	λ_{max} $r = 5$ trace $r = 6$	No	Yes
i 52 – O/N, T/N,	VAR = 8	No	Yes	$r = 1$	No	Yes
S/N	VAR = 4	No	Yes	$r = 2$	[1; 0; −1] Yes	Yes
i 52 – W1, W2	VAR = 4	No	Yes	$r = 1$	No	Yes
i 52 – W1	VAR = 4	No	Yes	$r = 1$	[1; −1] Yes	Yes
i 52 – M2	VAR = 6	No	1/2 Yes	$r = 1$	No	No
i 52 – M1, M2, M3						
each i... – O	each m	–	–	$r = 0$	–	No

Source: own research.

Table 4

Estimation of error-correction models (OLS method)

	Dependent variable									
	Δ ON	Δ O	Δ TN	Δ O	Δ SN	Δ O	Δ W1	Δ O	Δ W2	Δ O
eOON (−1)	−0.00017 (−0.8691)	−0.7989 (−7.0607)								
eOTN (−1)			0.000034 (0.5235)	−0.9113 (−8.0825)						
eOSN (−1)					−0.00013 (−2.2363)	−0.9247 (−8.56651)				
eOW((−1)							−0.000128 (−2.4556)	−0.9513 (−8.4513)		
eOW2 (−1)									−0.00044 (−2.5024)	−0.9234 (−8.5410)
ΔO	−0.000467 (−3.3208)				−0.000129 (−2.9588)		−0.000074 (−1.9396)		−0.00023 (−0.7013)	
ΔON		−178.29 (−2.4956)								
ΔON (−1)	−0.5863 (−5.4179)									
ΔON (−2)	−0.323 (−2.6508)									
ΔON (−3)	−0.2069 (−1.9450)									
ΔTN (−1)			−0.3021 (−2.7939)							
ΔSN						−759.26 (−2.9588)				

continuation Table 4

	Dependent variable									
	Δ ON	Δ O	Δ TN	Δ O	Δ SN	Δ O	Δ W1	Δ O	Δ W2	Δ O
ΔW1								−605.62 (−1.9386)		
ΔW2										−225.34 (−2.9664)
ΔW2 (−1)									−0.6136 (−5.3110)	
ΔW2 (−2)									−0.3704 (−3.0641)	
ΔW2 (−3)									0.1884 (−1.6909)	
a	0.1978 (0.5889)	1214.4 (5.674)	−0.207 (−0.9025)	3012.3 (7.6068)	0.4377 (1.9389)	3342.7 (8.053)	0.4436 (2.0966)	3720.0 (8.0651)	1.0738 (2.0580)	25.786 (7.8301)
R^2	0.399	0.483	0.101	0.446	0.099	0.501	0.072	0.473	0.346	0.499
Functional form test $\chi^2(1)$	5.216	1.726	5.473	1.74	1.59	1.07	0.75	0.91	19.94	0.454
Normality test $\chi^2(2)$	277.89	54.65	105.11	19.29	62.79	25.06	75.41	27.86	4795.8	13.31
LM (12)	15.125	13.68	4.26	15.36	9.19	8.22	11.41	11.72	22.08	15.15
ARCH (12)	47.576	8.41	7.33	10.06	10.06	9.51	7.44	10.68	1.16	7.56

Notes: t – ratios are in parentheses.

eOON – residuals of cointegration relations between open market operations balance and 1-day WIBOR O/N
eOZN – residuals of cointegration relations between open market operations balance and 1-day WIBOR T/N
eOSN – residuals of cointegration relations between open market operations balance and 1-day WIBOR S/N
eOW1 – residuals of cointegration relations between open market operations balance and 1-week WIBOR W1
eOW2 – residuals of cointegration relations between open market operations balance and 1-week WIBOR W2

Source: own research.

Table 5

Estimation of simultaneous equations model of the interbank money market interest rates (WIBORs) – 2 SLS method

x \ y	Δ O/N	Δ T/N	Δ S/N	Δ W1	Δ W2	Δ M1	Δ M2	Δ M3
Δ M3 (0)	−2.1962 (−10.8214)	0.7423 (3.9269)	−0.6383 (7.7883)	0.2074 (7.7883)	−1.0518 (−2.4844)		0.7695 (22.4241)	
Δ M3 (−1)							0.431 (−4.9192)	
Δ M3 (−2)								−0.3977 (−4.9192)
Δ M2 (0)		−0.8259 (−2.7156)	0.8900 (3.8478)		2.9741 (5.2221)	1.0070 (27.5188)		1.3221 (27.1433)
Δ M2 (−2)								0.6213 (4.5444)
Δ M2 (−4)			−0.0899 (−1.8348)					
Δ M2 (−6)		−0.2074 (−3.1654)						0.0953 (3.1587)
Δ M1 (0)	1.5874 (5.0729)	−0.2695 (−1.7489)					0.1401 (3.3928)	
Δ M1 (−1)							−0.022 (−1.6912)	
Δ M1 (−2)								−0.1941 (−3.0841)
Δ W2 (−1)					−3.3862 (−5.5454)			
Δ W2 (−2)					−0.2263 (−3.7202)			

continuation Table 5

x \ y	Δ O/N	Δ T/N	Δ S/N	Δ W1	Δ W2	Δ M1	Δ M2	Δ M3
Δ W1 (0)			0.3434 (3.6645)					
Δ W1 (−1)				−0.5579 (−6.6967)	0.8579 (2.1456)			
Δ W1 (−2)				−0.2049 (−3.8965)				
Δ S/N (0)		0.3561 (2.9120)		0.1935 (2.2171)				
Δ S/N (−5)				0.2280 (4.1383)	4.9541 (7.4666)			
Δ S/N (−6)					−1.0298 (−3.9808)			
Δ T/N (0)	0.8275 (5.0526)		0.3052 (6.8609					0.1823 (4.5687)
Δ T/N (−1)						0..1426 (5.9051)		
Δ T/N (−2)			0.1149 (3.8252)					
Δ T/N (−5)					−2.2676 (−7.7841)			
Δ O/N (0)		0.1075 (3.6598)				0.1169 (12.2467)		−0.0671 (−6.3072)
Δ O/N (−1)			0.0545 (3.6255)					
Δ O/N (−2)			0.0444 (3.2711)					

continuation Table 5

x \ y	Δ O/N	Δ T/N	Δ S/N	Δ W1	Δ W2	Δ M1	Δ M2	Δ M3
Δ O/N (−3)						−0.0302 (−3.668)		
Δ O/N (−4)		−0.0352 (3.0453)				−0.045 (−5.4562)	−0.0462 (−3.4564)	
Δ O/N (−5)		(3.0453)	0.052 (−2.3156)	−0.0240				
Δ O/N (−9)	0.1488 (3.2764)							
eONREPO (−1)	−0.3889 (−4.9962)							
Δ repo (0)		1.2735 (10.7501)		0.4010 (4.1583)			0.1180 (3.7038)	−0.3831 (−5.8082)
Δ repo (−1)					−0.6679 (−1.8811)			
Δ O (−1)		0.0000455 (2.6318)						
Δ O (−2)					−0.000212 (−3.3965)			
Δ i 8 (−2)						−0.00591 (−3.3501)		
Δ i 8 (−3)						−0.00245 (−2.1870)		
Δ i 8 (−6)	0.0488 (5.5915)							
Δ i 13 (−4)				−0.0252 (−3.7512)				

continuation Table 5

x \ y	Δ O/N	Δ T/N	Δ S/N	Δ W1	Δ W2	Δ M1	Δ M2	Δ M3
Δ i 26 (−6)		0.02398 (3.9351)						
Δ i 52 (0)		−0.36004 (−3.9254)						
Δ i 52 (−1)			−0.1285 (−1.8714)	0.3293 (3.3436)				
Δ i 52 (−3)				−0.2183 (−3.7615)				
Δ op 8 (−1)						−0.0011 (−3.0090)		
op 13 (−3)		−0.00274 (−2.0467)		0.00329 (3.5359)				
op 13 (−6)				0.00631 (6.7995)				
op 26 (−2)				0.00083 (2.6823)				
op 26 (−3)						0.00082 (3.5826)		
op 26 (−4)							−0.0059 (−4.4591)	
op 52 (0)		0.00485 (4.1924)						
op 52 (−1)	−0.006 (−1.9879)	0.00477 (3.8348)						
Δ p 13 (0)		−0.0146 (−2.8704)						

continuation Table 5

x \ y	Δ O/N	Δ T/N	Δ S/N	Δ W1	Δ W2	Δ M1	Δ M2	Δ M3
Δp 26 (0)								
Δ p 52 (0)		−0.00414 (−2.0632)						
Δ k (−1)	6.3596 (2.8121)				10.0632 (3.3175)			−1.0539 (−2.4132)
Δ k (−2)					−9.9674 (−2.8613)			
stała	−0.5366 (−5.2222)	−0.0279 (−0.9715)	−0.0186 (−0.8472)	−0.0354 (−1.8236)	0.1248 (1.5221)	0.0382 (2.5372)	−0.0059 (−0.5711)	0.0340 (2.2272)
R^2	0.9328	0.9321	0.8481	0.9278	0.9345	0.9452	0.9814	0.9815
RSS	14.0358	1.3139	1.750	0.6354	14.1262	0.5098	0.2428	0.4818
Test Sargana χ^2 (32)	25.08	29.99	31.40	24.37	30.058	22.67	33.95	39.51
Test RESET (Ramsey'a) χ^2 (1)	3.5153	3.8694	3.9539	0.1264	1.7376	0.0593	1.6625	0.0182
Normality test χ^2 (2)	1.5056	1.1626	3.2026	1.1044	0.9304	0.8885	1.7498	1.1395
ARCH χ^2 (1)	0.0549	0.8445	0.3664	0.0809	2.4029	0.1353	0.2240	0.5734

Notes: t − ratios are in parentheses.
Source: own research.

accept the money supply one. The short-term disturbances could be the causes of this change.

In the short run the interest rates in the interbank money market can strongly react to the disturbances and shocks arising outside this market. Two factors destabilizing WIBORs should be taken into account: goals of managing the domestic public debt and the situation in the currency market. The Ministry of Finance has tried to lower the T-bill interest rates, because the interest costs of the domestic public debt were too high, while the central bank was forced to maintain interest rates because of too high inflation. Such a situation has generated conflicts between these institutions and disturbed them to meet their goals. For two years the Polish T-bill market has lived through the waves of speculative demand, connected with expectations of Polish currency appreciation. The exchange rate was becoming the important factor influencing not only the T-bill market but also, via open market operations, the interbank money market.

It was necessery to include in the research both the long-term and short-term relationships. Then last step of the analysis carried out was to estimate the simultaneous equations model which described the dynamics of the interbank money market interest rates. The estimated model showed the strong influence of T-bill market and the exchange rate on WIBORs (see Table 5).

The transmission mechanism of the monetary policy has suffered from the disturbances generated by the T-bill market and the currency market. The central bank had a basis to give the interest rate strategy up, but the new strategy (i.e. the money supply strategy) has its own problems:

- difficulties in controlling the bank reserves in the short run,
- feedbacks between the monetary base and the money multiplier,
- measures of money supply,
- income money velocity – its stabilisation and anticipation – what is the benefit of this strategy?

There is an opinion that stabilizing money supply is a better target than stabilizing interest rates in a situation of high inflation. Then the money supply strategy should be more suitable for the fight against inflation.

4. CONCLUSIONS

Stabilizing by NBP the shortest interest rates (WIBORs for 1 till 14 days) by means of open market operations was not fully succesful. The research results showed that the trend of interest rate levels was similar to the REPO rate one but it also proved the trend to be unstable. The deviations from the trend lasted a few months. They suggested the limited efficiency of the

open market operations. The stable and long-run relations between the strategy tools (open market operations) and their operating target (stabilizing of the shortest WIBORs) did not exist to a sufficient extent. Nevertheless the interest rate strategy had some chances for success because there were stable relations between the short and long-term rates of the money market, and also the long-term influence of the money market rates on loan rates. The weakest point of the interest rate strategy was stabilizing of the shortest WIBORs by means of open market operations. The reason for that was not the bad estimation of the open market operation balance. The cointegration tests showed that the changes on the open market operation balance were fully explained by the changes of interbank interest rates. The problem was that the relationship was a one-way relation and the opposite one did not exist so in the long run the changes of WIBORs did not adjust to the changes of balance. Simultaneous equations models results proved that the influence of the open market operation balance on WIBORs existed only in the short run and affected only two of the WIBORs. Such a weak impact of the open market operation balance on changes of WIBORs could not sufficiently compensate the destabilizing influence of the T-bill market. When the decisions of the Ministry of Finance and the Central Bank on the desired levels of interest rates did not match, the stablizing of the shortest WIBORs on the required by NBP level was not sufficiently strong.

The changes of exchange rates were the second strongest destablizing factor for the interbank money market interest rates. The simultaneous equation model results pointed out that they are a shockingly strong disturbance for two of the interest rates: 1-day (i.e. O/N) and 2 weeks.

Concluding, the research proved that every part of the interest rate strategy was strongly affected by the disturbances from the T-bill market and currency market. The limited effectiveness of interest rate stabilization was one of the causes which made the NBP to change the strategy in February 1996.

REFERENCES

Burger, A. E. (1971): *The Implementation Problem of Monetary Policy, Federal Reserve Bank of St. Louis*, "Review", March, pp. 20-30.

Gonzalo, J. (1994): *Five Alternative Methods of Estimating Long-run Equilibrium Relations*, "Journal of Econometrics" vol. 60, pp. 203-233.

Henning, Ch. N., Pigott, W., Scott, R. H. (1988): *Financial Market and the Economy*. Prentice Hall, New Jersey.

Jarque, C. M., Bera, A. K. (1980): *Efficient Tests for Normality, Homoscedasticity and Serial Independence of Regression Residuals*, "Economic Letters" no. 6, pp. 255-259.

Johansen, S. (1988): *Statistical Analysis of Cointegration Vectors*, "Journal of Economic Dynamics and Control" vol. 12, pp. 231-235.

Johansen, S. (1989): *Likelihood Based Inference on Cointegration: Theory and Applications.* Lecture Notes Institute of Mathematical Statistics, University of Copenhagen.

Johansen, S. (1991): *Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models*, "Econometrica" vol. 59, pp. 1551-1580.

Johansen, S., Juselius, K. (1990): *Maximum Likelihood Estimation and Inference on Cointegration — with Applications to the Demand for Money*, "Oxford Bulletin of Economics and Statistics" vol. 52, pp. 169-210.

Johansen, S., Juselius, K. (1992): *Testing Structural Hypotheses in a Multivariate Cointegration Analysis of the PPP and the UIP for UK*, "Journal of Econometrics" vol. 53, pp. 211-244.

MacKinnon, J. G. (1990): *Critical Values for Cointegration Tests.* UC San Diego Discussion Paper, pp. 90-94.

Kokoszczyński, R., Stopyra, J. (1996): *Dylematy wyborów celów pośrednich i operacyjnych w polityce pieniężnej Narodowego Banku Polskiego* [*Dilemmas on Choosing the Intermediated and Operating Targets in the Polish National Bank*], "Bank i Kredyt" no. 6, pp. 36-49.

Osiński, J. (1996): *Operacje otwartego rynku NBP* [*The NBP Open Market Operations*], "Bank i Kredyt" no. 6, pp. 37-48.

Sławiński, A., Osiński, J. (1995): *Operacje otwartego rynku Banku Centralnego* [*The Central Bank Open Market Operations*]. Fundacja Edukacji i Badań Naukowych, Warszawa.