

***Sensitivity of Interest Rates to Inflation and
Exchange Rate in Poland:
Implications for Direct Inflation Targeting***

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Motivation and Research Question

- Guiding notion: Monetary policy reaction function under Direct Inflation Targeting (DIT) strategy ought to focus on the relationship between the targeted short-term market interest rate and both the expected inflation and the real effective exchange rate (REER)
- Aim to show that changes in short-term market interest rates in Poland over the past two decades have been dependent on the prevalent monetary policy regime
- Examine sensitivity of short-term interest rates to changes in headline CPI-based inflation and REER in Poland, from the standpoint of the ability of DIT to mitigate both the inflation and the exchange rate risks
- Claim that one-day and three-months Warsaw interbank offer rates (WIBOR) were closely correlated with REER during exchange rate targeting in the 1990s; they have become strongly associated with the path of expected inflation since the inception of DIT in January 1999

Model, Data and Empirical Testing Methodology

- The analytical model is derived from monetary policy reaction function
- The model reflects changes in 1D and 3M WIBOR as functions of changes in (1M forwarded) CPI inflation and REER
- Monthly data obtained from FRB of St. Louis FRED and NBP database
- Sample period: January 1994 – March 2015
- Tests:
 - a) Bai-Perron multiple breakpoints regression
 - b) Two-regime Markov switching process

The Baseline Model

- Equation 3 in the paper:

$$\Delta r_t = \alpha_0 + \alpha_1 \Delta \log \pi_{t+\tau} + \alpha_2 \Delta \log REER_t + \mu_t$$

- Tested with Bai-Perron MBPs separately for 1D and 3M WIBOR series

Table 1: Bai-Perron multiple breakpoints (MBPs) estimation of changes in 1D WIBOR as a function of 1M forwarded CPI inflation and REER in Poland.

Regressors:	Estimated coefficients	Association with 1D WIBOR
Phase I: January 1994- September 1997 (breakpoint)		
Constant term	-0.007 (-0.05)	
Change in 1M forwarded CPI year-on-year inflation	4.826 (0.46)	Weak, positive
Change in log of REER	-24.260** (-2.40)	Strong, inverse
Phase II: October 1997- March 2015		
Constant term	-0.084** (-2.40)	
Change in 1M forwarded CPI year-on-year inflation	34.202*** (4.42)	Strong, positive
Change in log of REER	1.524 (1.00)	Weak, positive
Diagnostic statistics:		
F-statistics	5.875	
Log likelihood	-222.99	
AIC	1.810	
DW	1.954	

Notes: t-statistics are in parentheses; AIC = Akaike information criterion; DW = Durbin-Watson statistics; *** denotes significance at 1%, ** at 5% and * at 10%.

Source: author's own estimation based on FRB of St. Louis FRED and National Bank of Poland data.

Table 1 Results

- A significant structural break in October 1997; phase I corresponds with the policy of exchange rate targeting and phase II is dominated by DIT
- Changes in 1D WIBOR are inversely related to changes in REER under exchange rate targeting, suggesting that the real PLN depreciation corresponds with the higher interest rate
- Changes in interest rate are not significantly related to inflation in phase I
- Changes in 1D WIBOR are strongly and positively related to changes in inflation and unrelated to the real exchange rate in phase II

Figure 1: Actual, fitted and residual series from the Bai-Perron MBPs estimation of changes in 1D WIBOR as a function of 1M forwarded CPI inflation and REER in Poland.

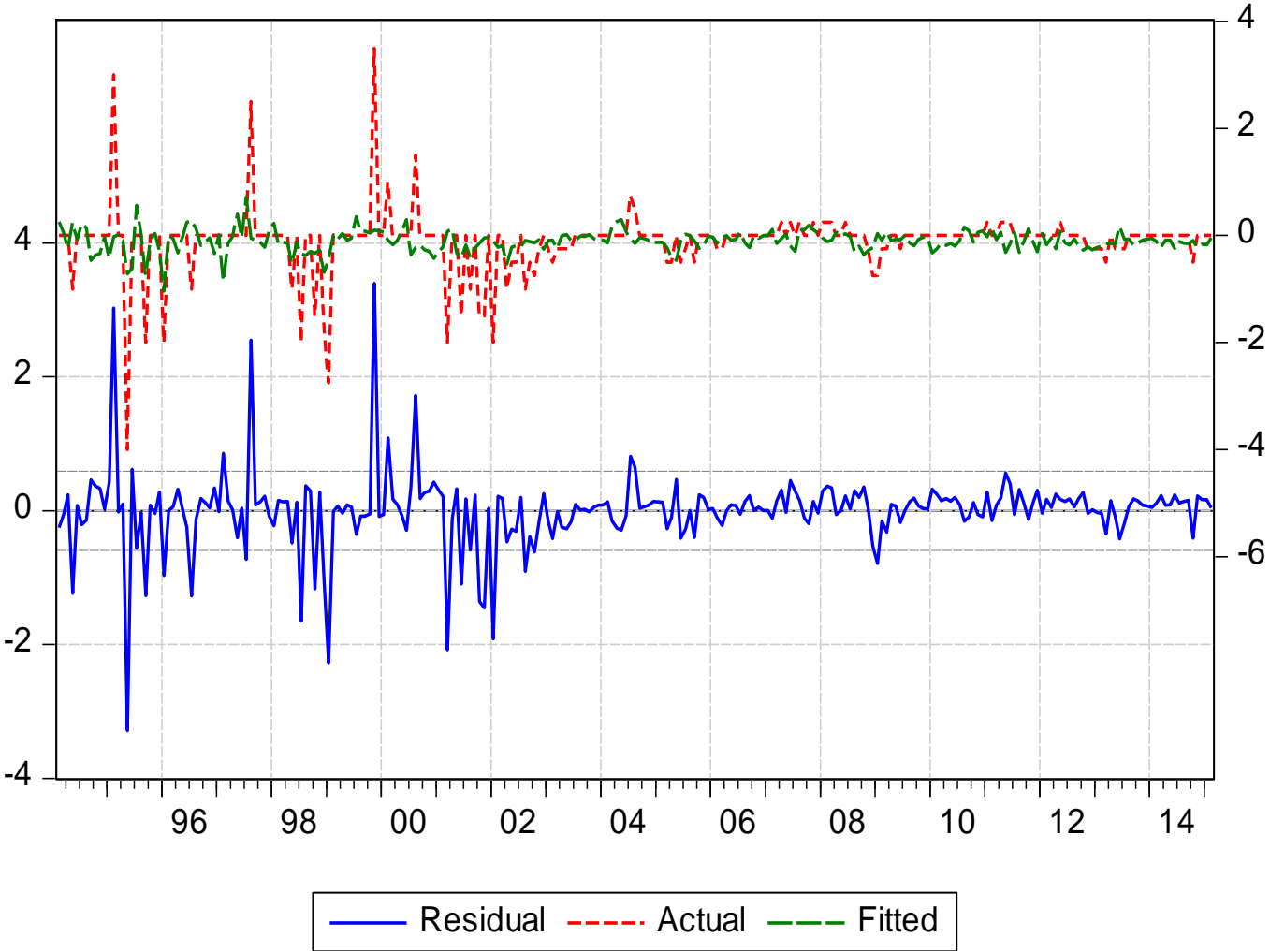


Figure 1 Results

- 1D WIBOR series very unstable until the end of 2001, with large variations in the residuals in different directions
- Since the beginning of 2002, the regression has been very stable, well-confined within the +/- 2 standard deviation fluctuations band
- The residuals show that this functional relationship was unscathed by the financial crisis of 2008-2010.
- In essence, Figure 1 underscores a significant impact of DIT on stability and predictability of short-term interest rates, inflation and REER in Poland

Table 2: Bai-Perron MBPs estimation of changes in 3M WIBOR as a function of 1M forwarded CPI inflation and REER in Poland.

Regressors:	Estimated coefficients	Association with 1D WIBOR
Phase I: January 1994- November 1997 (breakpoint)		
Constant term	-0.172** (-1.97)	
Change in 1M forwarded CPI year-on-year inflation	-1.309 (-0.21)	Weak, inverse
Change in log of REER	-18.422*** (-3.05)	Strong, inverse
Phase II: December 1997- March 2015		
Constant term	-0.084** (-2.13)	
Change in 1M forwarded CPI year-on-year inflation	38.034*** (4.38)	Strong, positive
Change in log of REER	0.656 (0.38)	Weak, positive
Diagnostic statistics:		
F-statistics	5.997	
Log likelihood	-208.77	
AIC	1.698	
DW	1.806	

Table 2 Results

- Results for 3M WIBOR are similar to those for 1D WIBOR series
- A significant structural break in December 1997, roughly matching a cutoff between exchange rate targeting and DIT policies
- Changes in 3M WIBOR are inversely related to changes in REER under exchange rate targeting, suggesting that the real PLN depreciation corresponds with the higher interest rate
- Changes in interest rate are not significantly related to inflation in phase I
- Changes in 3M WIBOR are strongly and positively related to changes in inflation and unrelated to the real exchange rate in phase II

Figure 2: Actual, fitted and residual series from the Bai-Perron MBPs estimation of changes in 3M WIBOR as a function of 1M forwarded CPI inflation and REER in Poland.

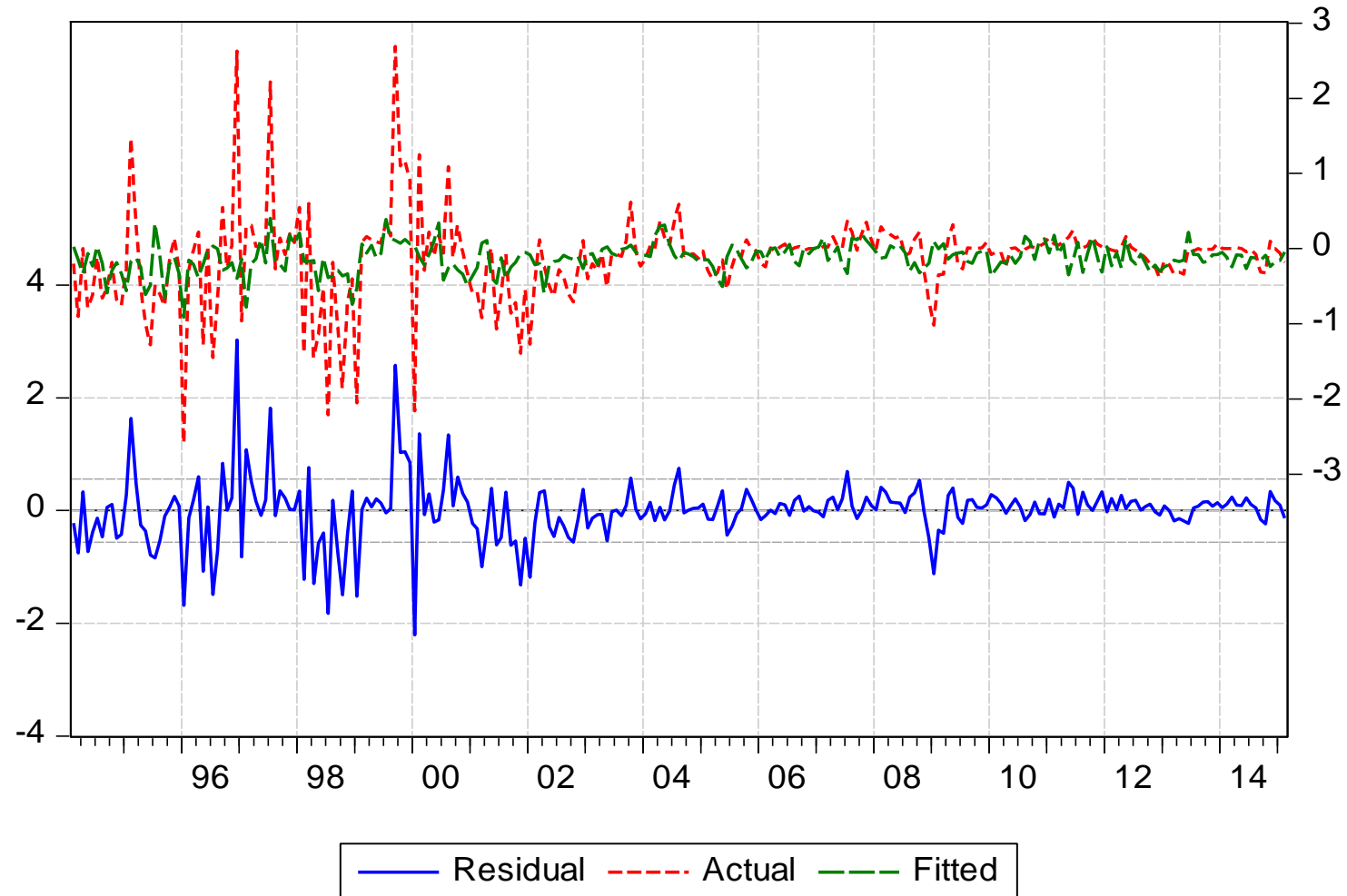


Figure 2 Results

- 3M WIBOR series very unstable until the end of 2000, with large variations in the residuals in different directions
- Since the beginning of 2001, the regression has been very stable, well-confined within the +/- 2 standard deviation fluctuations band
- There was a small, although discernible turbulence at the end of 2008 showing some contagion at the peak of the financial crisis
- Figure 2 reaffirms a significant impact of DIT on stability and predictability of short-term interest rates, inflation and REER in Poland

Two-Regime Markov Switching Model for 1D and 3M WIBOR Series

Regime 1, characterized by a positive relationship between the interest rate changes $\Delta r_{t|S_t=1}$ and the real effective exchange rate $\Delta \log(REER)_t$:

$$\Delta r_{t|S_t=1} = c_1 + \gamma_{11} \Delta \log(CPI)_{t+\tau} + \gamma_{12} \Delta \log(REER)_t + \varepsilon_{1t} \quad \varepsilon_{1t} \rightarrow N(0,1) \quad (4)$$

Regime 2 characterized by an inverse relationship between changes in the interest rate and the REER:

$$\Delta r_{t|S_t=2} = c_2 + \gamma_{21} \Delta \log(CPI)_{t+\tau} + \gamma_{22} \Delta \log(REER)_t + \varepsilon_{2t} \quad \varepsilon_{2t} \rightarrow N(0,1) \quad (5)$$

The τ -period forwarded inflation rate is reflected by $\Delta \log(CPI)_{t+\tau}$ in both regimes.

Table 3: Markov switching estimation of the one-day WIBOR as a function of (one-month forwarded) CPI-based inflation and REER. January 1994 – February 2015 sample period.

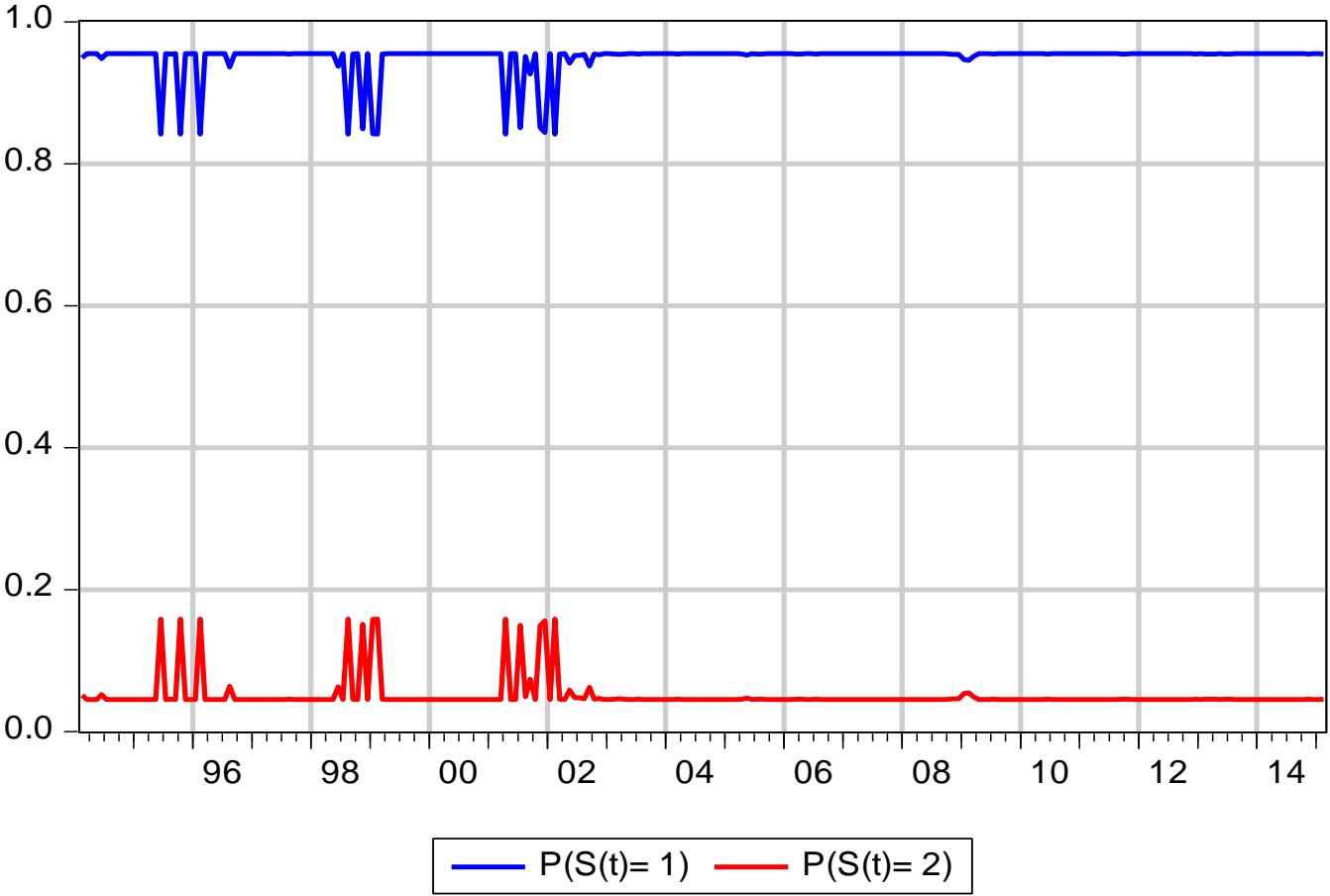
Regimes	Constant term	$\Delta\log(CPI)_{t+\tau}$	$\Delta\log(REER)_t$
I	-0.042 (-1.17)	6.530* (1.77)	2.594* (1.83)
II	-1.676*** (-3.67)	-19.525 (-0.89)	-12.640 (-0.57)
Log sigma (common)	-0.832*** (-17.62)		
Transition Matrix Parameters:			
P11-C	3.048*** (6.97)		
P21-C	1.670** (1.99)		
Durbin-Watson stat.	1.954		
Akaike Inf. Criterion	1.603		
Log Likelihood	-193.84		

Notes: z-statistics are in parentheses; *** denotes significance at 1%, ** at 5% and * at 10%.

Table 4: Constant transition probabilities and expected durations of Markov regimes I and II for 1D WIBOR series. *January 1994 – February 2015 sample period.*

Const. transition probability	Regime I	Regime II
Regime I	0.955	0.045
Regime II	0.841	0.158
Expected durations (months):	22.1	1.2

Figure 3: Markov switching estimation of 1D WIBOR: One step ahead predicted regime probabilities for regimes I and II.



Tables 3 and 4, and Figure 3 Results

- Regime I follows a moderately significant direct (positive) relationship between changes in 1D WIBOR and in REER
- Regime II shows inverse relationship between 1D WIBOR and REER
- Regime I dominates the Markov process, has much lower probability of switching to II and a longer duration
- The switching episodes prevailed until the first quarter of 2002
- No similar episodes are identified since 2002, the process has been very stable

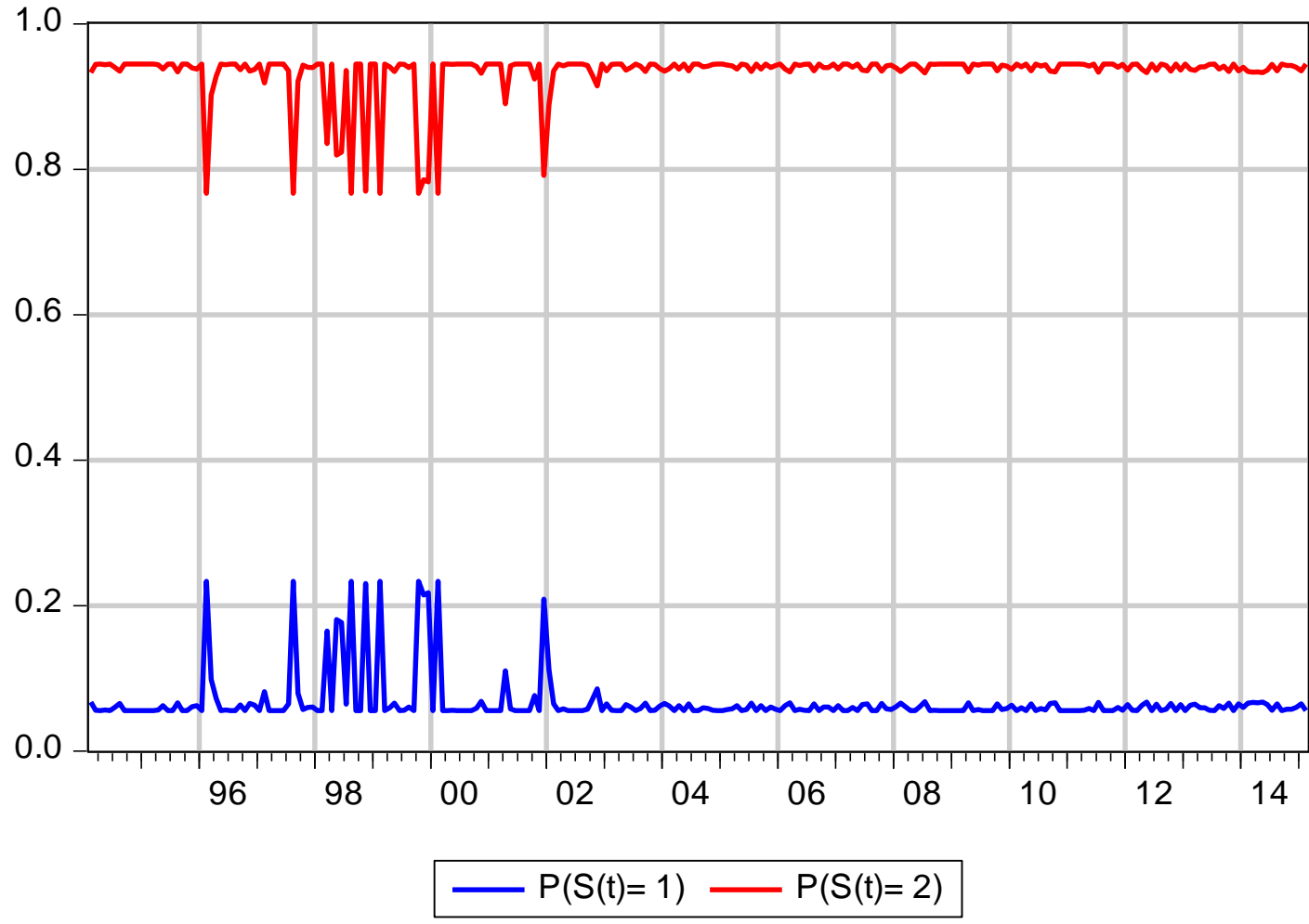
Table 5: Markov switching estimation of the three-month WIBOR as a function of (one-month forwarded) CPI-based inflation and REER. January 1994 – February 2015 sample period.

Regimes	Constant term	$\Delta \log(CPI)_{t+\tau}$	$\Delta \log(REER)_t$
I	-0.092*** (-3.04)	7.639* (1.84)	2.256* (1.66)
II	0.083 (0.58)	146.211*** (6.81)	-65.769*** (-9.48)
Log sigma (common)	-0.825*** (-16.94)		
Transition Matrix Parameters:			
P11-C	-2.839*** (-7.43)		
P21-C	-1.189 (-1.35)		
Durbin-Watson stat.	1.773		
Akaike Inf. Criterion	1.555		
Log Likelihood	-187.73		

Table 6: Constant transition probabilities and expected durations of Markov regimes I and II for 3M WIBOR series. *January 1994 – February 2015 sample period.*

Const. transition probability	Regime I	Regime II
Regime I	0.945	0.055
Regime II	0.766	0.233
Expected durations (months):	18.1	1.3

Figure 4: Markov switching estimation of 3M WIBOR: One step ahead predicted regime probabilities for regimes I and II.



Tables 5 and 6, and Figure 4 Results

- Regime I follows a moderately significant direct (positive) relationship between changes in 3M WIBOR and in both the expected inflation and REER
- Regime II shows 3M WIBOR inversely related to REER and positively to the forwarded inflation
- Regime I dominates the Markov process, has much lower probability of switching to II and a longer duration
- The switching episodes prevailed until the end of 2001
- No similar episodes are identified since 2002, the process has been very stable, unaffected by the global financial crisis

A Summary and Concluding Remarks

- Changes in short-term market interest rates in Poland over the past two decades have been dependent on the prevalent monetary policy regime
- 1D and 3M interbank rates were closely correlated with REER during exchange rate targeting in the 1990s
- The interbank rates have become strongly associated with the path of expected inflation since the inception of DIT
- DIT in Poland has been remarkably successful in mitigating both the inflation and the exchange rate risks
- In a long-term, flexible DIT in Poland and in other non-euro EU member countries may rely more on inflation trends and market risk signals from the leading sovereign bond markets
- However, a proper extraction of inflation expectations from domestic and international government bond markets will depend on increasing liquidity of inflation-protected securities