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

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Abstract:

To determine a plausible instrument rule within the direct inflation targeting policy framework in Poland, I examine sensitivity of short-term market interest rates to inflation and real effective exchange rate. I use monthly data from January 1994 to March 2015 and employ Bai-Perron multiple breakpoint regression as well as a two-regime Markov switching process. The tests show pronounced sensitivity of interest rates to the exchange rate until 1998, i.e. during the exchange rate-based monetary policy that entailed instability and high probability of regime switching. Sensitivity to the expected inflation has become stronger since the inception of direct inflation targeting in 1999. The inflation targeting framework engendered remarkable stability of the examined relationship that effectively helped cushion potential contagion effects of the 2008-2010 global financial crisis. I suggest that Poland's monetary authorities continue pursuing a policy based on flexible, forward-looking inflation targeting that may take into consideration inflation expectations extracted from bond markets when feasible.

Keywords: direct inflation targeting; open economy instrument rules; real effective exchange rate; convergence to the euro; Bai-Perron multiple breakpoints; Markov switching process.

JEL classification: E42, E43, P24.

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I. Introduction

I examine sensitivity of short-term interest rates to changes in headline CPI-based inflation and real exchange rate in Poland, from the standpoint of the ability of the current direct inflation targeting (DIT) monetary policy to mitigate both the inflation and the exchange rate risks. I suggest modifications to the DIT regime as its operational framework evolves and domestic bond markets become increasingly integrated with the euro-area and global markets.

Sensitivity of short-term interest rates to both observed and anticipated changes in inflation and to the exchange rate has changed along with changes in the monetary policy framework in Poland. At the early stage of economic transformation it was necessary to adopt exchange rate-based monetary policy as financial markets and institutions were severely underdeveloped and not resilient, and nominal indexation propelled inflation to chronic levels (see for instance Fisher and Sahay, 2001). The exchange rate-based policy subdued nominal indexation and reduced inflation to sustainable levels by mid-1990s, albeit still exceeding the inflation in the US or in the euro area. The inflation differentials led to real currency appreciation and to the deepening current account deficit. It was therefore necessary to devise a sensible exit strategy from the currency peg toward inflation targeting (with a flexible exchange rate) that was reasonably expected to reinforce monetary autonomy and contribute to developing a resilient financial system (Jonas and Mishkin, 2005; Orlowski, 2008a).

To show the impact of transition from the currency peg to DIT, I conduct a series of tests showing high susceptibility of interest rates to the real effective exchange rate during the currency peg and well as during its gradual relaxation (from 1994 until 1997 in the applied sample period). Since the inception of DIT in 1999, interest rate changes have become responsive to the expected inflation, but not to variations in the exchange rate. I use monthly data for one-day (1D) and three month (3M) interbank offer rates, CPI-based year-on-year inflation rates and real effective exchange rate (REER) in Poland for the sample period starting in January 1994 and ending March 2015. The time-sensitive changes in interest rates as a function of expected inflation and REER are empirically tested with the stationary Bai-Perron multiple breakpoints (MBPs) regression and the two-regime Markov-switching process. The underlying hypothesis for the tested model is that the DIT strategy in Poland has helped achieve stability of inflation, exchange rates and interest rates, which in turn allowed cushioning potential contagion effects of the 2008-2010 global financial crisis.

To identify possible future venues of advancing the DIT strategy, I argue that the National Bank of Poland and, more generally, central banks in small open economies consider relying more on inflation and market risk signals absorbed from the leading sovereign bond markets, as their inflation-protected securities become more liquid. Information about both transitory and permanent changes in inflation risk premiums reflected in yields on sovereign bonds shall play a stronger role in the central banks' inflation forecasts in these countries. Thus far they have relied almost exclusively on survey-based inflation indexes.

Section II provides abbreviated discussion of central bank instrument rule in open economies, such as Poland. The underlying model of changes in short-term interbank rates as a function of changes in CPI-inflation and REER is proposed in Section III. It is tested with the Bai-Perron MBPs. The two-regime Markov switching process results of the same functional relationship are examined in Section IV. Section V summarizes the key findings and proposes DIT policy framework modifications.

II. Monetary Policy Instrument Rules under Open-Economy Direct Inflation Targeting

Monetary policy instrument rule that would guide DIT policies in open economies have been widely discussed in the literature initiated by the seminal paper by Ball (1999) and expanded in the number of studies (Clarida et al., 1998 and 2000; Svensson, 2000; Kuttner, 2004; Koenig, 2006; Fernandez and Nikolsko-Rzhevskyy, 2007; Orlowski, 2010; Égert, B., Kočenda, E., 2014). A general consensus is that DIT is a policy framework of "constrained discretion" as labelled in the landmark volume by Bernanke, et al. (1999). The constraint to the highly discretionary policy is imposed by the officially declared inflation target and the policy should be forward-looking in order to steer nominal indexation in the economy to a low inflation forecast. The forward-looking policy orientation requires guidance by appropriate instrument rule, which in an open-economy setting needs to pay attention to stability of the exchange rate.

For open economies it is generally agreed that the objective of reducing variability of the exchange rate, or in other terms, mitigating the exchange rate risk, ought to supplement the tasks of closing the inflation gap and the output gap (Svensson, 2000; Kuttner, 2004; Orlowski, 2010). Therefore, an open-economy instrument rule for DIT that is an extension of the baseline Taylor-type function can be specified as

$$\bar{r}_t = \hat{r}_t + \pi_t + \alpha_\pi \tilde{\pi}_t + \alpha_y \tilde{y}_t + \alpha_e \tilde{e}_t \qquad (1)$$

In this specification, $\bar{r}_t$ is the current short-term interest rate target, $\hat{r}_t$ is the neutral, long-term equilibrium (Wicksellian) interest rate, $\tilde{\pi}_t$ is the inflation gap, i.e. deviation from the current or the anticipated inflation from the inflation target, $\tilde{y}_t$ is the output gap – deviation between actual and potential output, and $\tilde{e}_t$ is a measure of exchange rate variability. The sum of α-weights should be equal to unity. A strict DIT policy would be based in the inflation gap weight equal to one and the remaining weights assigned a zero value.

Once fundamental price stability is achieved through a successful pursuit of a strict DIT strategy, the policy framework should evolve toward a more flexible DIT variant placing stronger weights in the output gap and the exchange rate stability parameters. Moreover, if an EU member country declares officially the euro adoption, it will have to enter the Exchange Rate Mechanism (ERM) II for a two-year period that will require adjusting its monetary policy to the predetermined stability of the domestic value of the euro. Then, the α_e parameter will have to be chosen at or near the unity, marginalizing weights on the inflation and the output gaps. The monetary policy framework will have to be switched again to the exchange rate based regime (Jonas and Mishkin, 2005; Orlowski, 2010).

In the meantime, policy-makers in the non-euro EU countries are facing a number of dilemmas related to a proper determination of the inflation gap and the exchange rate stability variables. The inflation gap can be generally specified as a deviation between the observed or predicted inflation and the inflation target at time t

$$\tilde{\pi}_t = \pi_{t+\tau} - \overline{\pi}_t \tag{2}$$

There is no uniform prescription for a specific determination of the inflation gap components Most of the prevalent inflation targeting policies are forward-looking, aimed at properly guiding domestic prices and indexation mechanisms, thus assuming the τ time displacement parameter to be positive. Therefore the $\pi_{t+\tau}$ inflation rate can represent the official central bank's inflation forecast or a forecast consensus of independent research centers and financial institutions. The inflation target $\overline{\pi}_t$ can be also determined in many different ways. At the early stage of DIT policies in emerging market economies in the 1990s, authorities in many countries have adopted year-end CPI-based inflation targets (Roger, 2009; Ebeke and Azangue, 2015). Furthermore, the inflation forecasts can be based on survey-based inflation indicators, such as CPI or personal consumption expenditures (PCE) measures, or on market-based inflation expectations. The latter are normally extracted from the spread between nominal yields on constant-maturity government bonds and the yields on inflation-indexed bonds of the same maturity[1]. The market-based, i.e. break-even inflation rates offer a number of particularly attractive advantages for DIT policies, as they: 1. are inferred from a very large number of bond market participants, 2. are frequently corrected on a daily basis, 3. accurately reflect agents' expectations, and 4. reveal anticipated inflation across a wide range of forecast horizons. However in practical terms, they are available only for large and resilient government security markets, such as those in the United States, the United Kingdom or the euro area, which have the deepest and the most liquid markets for both nominal and real bonds (Cunningham, 2010; Grothe and Meyler, 2015). In essence, application of market-based inflation measures is not plausible in the

[1] For a comprehensive review of pros and cons of survey-based and market-based inflation expectations and their usefulness for inflation targeting policies, see for instance Sack (2000), Gürkaynak, et al., (2007 and 2010), Cunningham (2010), Nautz and Strohsal (2015) and Grothe and Meyler (2015).

economies with non-existent or illiquid inflation-indexed bonds (Ang, et al., 2007). This includes most of the non-euro EU countries and emerging market economies.

For the countries pursuing convergence to a common currency system, particularly the candidates for adopting the euro, the domestic inflation target may be just adopted from the underlying currency-area forecast or target. This is consistent with the policy framework of *relative inflation forecast targeting* that I have proposed for the euro candidate countries (Orlowski, 2008b).

A range of policy choices pertains also to the exchange rate gap. If pass-through effects from the exchange rate through import prices on domestic inflation are significant, the α_e weight ought to be relatively high. Strong, unrestricted trade ties with the euro area are very likely to result in pronounced pass-through effects of external into domestic inflation mainly via import prices in Central European EU countries (Siklos, 2015; Cheikh and Louhichi, 2015; Potjagailo, 2016). In fact co-movements between the euro and the non-euro EU currencies exchange rates against the US dollar as a common denominator, have been very pronounced over the past two decades, amplified particularly during the recent financial crisis and the post-crisis period (Orlowski, 2016). Due to high susceptibility of domestic currencies to changes in the euro exchange rate, monetary policies of the euro-candidate countries ought to weight on the variability of the exchange rates of their national currencies against the euro.

In sum, parameterization of the α preference weights, i.e. the policy feedback coefficients is likely to evolve along with systemic changes that follow subsequent steps of integration with the EU and convergence to the euro. At the final stage of convergence to the euro, the weight on α_s will likely exceed the sum of $\alpha_\pi + \alpha_y$. In particular, this scenario will have to prevail upon the entry to the ERM2 mechanism, which needs to be maintained during a two-year period preceding the official adoption of the euro (Orlowski, 2010).

Association between short-term interest rates, the inflation gap and the exchange rate gap is particularly important for the non-euro EU countries that, based on the Union's accession agreements, are expected to join the euro at some point in the future. This is particularly relevant as their economies depend strongly on trade ties with the euro area, thus their national economies are prone to absorb inflation (or deflation) the euro-generated impulses and their currencies display pronounced co-movements with the euro in foreign exchange markets (Orlowski, 2016). Under such circumstances, their monetary policy instrument rules need to emphasize correlation between interest rate and both the inflation gap and the real exchange rate stability, while downplaying importance of the domestic output gap.

III. Interest Rate Responses to Expected Inflation and Real Exchange Rate in Poland

Following the premise of the essential interaction between short-term market interest rate and both the expected inflation and REER in an open, converging economy setting, I intend to analyze the path and the stability of this relationship in Poland over the past two decades. More specifically, I examine changeable sensitivity of interest rates to the path of expected inflation and the REER. The time frame covers the initial period of the exchange rate based monetary policy, starting from the fixed peg to the US dollar, through the peg to a currency basket, crawling devaluation regime and ending with the DIT strategy has been effective since the beginning of 1999.

The basic analytical model reflects changes in short-term interest rates as a function of changes in a one-month forwarded headline inflation and changes in (log of) the real effective exchange rate (REER). It is prescribed by

$$\Delta r_t = \alpha_0 + \alpha_1 \Delta \log \pi_{t+\tau} + \alpha_2 \Delta \log REER_t + \mu_t \qquad (3)$$

I test Eq.3 for Poland under two monetary policy regimes: the exchange rate targeting and DIT. The exchange rate targeting was initiated with the Economic Reform Program (the Balcerowicz Plan) in January 1990 and, after a gradual exit strategy, it became eventually replaced with DIT coupled with the flexible exchange rate. DIT policy rate has become effective since January 1999 (Orlowski, 2008a).

Specifically, the empirical tests of the base-line model examine the relationship between changes in the one-day (1D) and, separately the three-month (3M) Warsaw Interbank Offer Rate (WIBOR) as regressors specified by Δr_t, and changes in a one-moth forwarded year-on-year CPI inflation rate $\Delta \log \pi_t$, as well as changes in the log of REER as regressants. This relationship is tested with a Bai-Perron multiple breakpoints (MBPs) regression to allow for identifying discernible structural breaks in their time path. In order to identify a sharp distinction in the tested relationship between the exchange rate and the inflation targeting policy regimes, I allow a single structural break in the MBPs regression.

The Bai-Perron MBPs regression results of changes in 1D WIBOR as a function of inflation and REER are shown in Table 1. The estimation identifies a significant structural break in October 1997. The preceding phase covering the January 1994-September 1997 sub-period coincides with the exchange rate targeting policy regime. The second phase roughly corresponds with DIT policy. The estimation regression shows that 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. During the early phase, changes in interest rate are not significantly related to changes in inflation. The interplay between the examined variables is altered significantly in phase II. Under DIT policy, changes in 1D WIBOR are strongly and positively related to changes in inflation and unrelated to the real exchange rate.

….. insert Table 1 around here …..

The actual, fitted and residual series of 1D WIBOR are shown in Figure 1. The relationship prescribed by Eq. 3 was very unstable until the end of 2001, characterized by large variations in the residuals in different directions. Since the beginning of 2002, the regression has become very stable, well-confined within the +/- 2 standard deviation fluctuations band. The time-path of residuals shows also that this functional relationship was unscathed by the market turbulence triggered by the financial crisis of 2008-2010. Arguably, Figure 1 underscores a significant impact of DIT on stability and predictability of short-term interest rates, inflation and the real exchange rate in Poland.

….. insert Figure 1 around here …..

In order to validate the directional changes and stability patterns in the estimation of Eq. 3 obtained for 1D WIBOR, I test the same functional relationship for 3M WIBOR as well. I employ the same Bai-Perron MBPs regression allowing for a single structural break. The estimation results are shown in Table 2. The findings for 3M WIBOR series are similar to those for 1D WIBOR, although in this case the structural break takes place a bit later in December 1997. There is a strong, inverse relationship between changes in the interest rate and REER in phase I. The examined functional relationship changes its course in phase II showing a strong, positive association between 3M WIBOR and inflation and curbing significance of REER.

….. insert Table 2 around here …..

The corresponding distribution of actual, fitted and residual 3M WIBOR series is shown in Figure 2. The relationship is very unstable during the early period ending with the inception of DIT in 1999. Since then, it has been very stable, although there is a pronounced negative residual coinciding with the peak of the recent financial crisis in October 2008.

….. insert Figure 2 around here …..

In hindsight, the analyzed relationship patterns of short-term interest rates as a function of inflation and REER indicate high sensitivity of interest rates to the real exchange rate during the currency peg. Changes in short-term interest rates correspond with changes in inflation during the DIT strategy. Most importantly, our tests imply that the DIT strategy contributed to stability of interest rates, inflation expectations and the real exchange rate in Poland and have helped its financial system cushion contagion effects of the global financial crisis.

IV. Regime Switching Specification of Interest Rate Responses to Expected Inflation and Real Exchange Rate

For the purpose of validating the examined relationships between short term interest rates and both the expected inflation and the real exchange rate in the case of Poland, I further employ a two-regime Markov switching process. As a dependent variable, I use stationary monthly changes in, 1D and 3M WIBOR separately. The regressors (independent variables) are changes in a one-month forwarded CPI-based inflation rates and changes in REER. The data are obtained from the Federal Reserve Bank of St. Louis FRED and the National Bank of Poland statistics for the sample period between January 1994 and March 2015 (253 included observations).

The two-regime Markov switching process to simulate is specified below. The process in Regime 1, characterized by a positive relationship between the interest rate changes $\Delta r_{t|St=1}$ and the real effective exchange rate $\Delta \log(REER)_t$ is prescribed by

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

Regime 2 is characterized by an inverse relationship between changes in the interest rate and the REER. It is specified as

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

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

The transition probability matrix for switching the process between the two regimes at any given period is specified as:

$$P = \begin{bmatrix} p_{11} p_{21} \\ p_{12} p_{22} \end{bmatrix} \tag{6}$$

The results of the Markov switching process for Poland’s one-day WIBOR as a function of a one-month forwarded inflation rate and the REER are shown in Table 3. The estimation shows that regime I follows a moderately significant direct (positive) relationship between changes in 1D WIBOR and in REER. One may therefore argue that the higher short-term interest rate in coupled with real appreciation of the Polish Zloty (PLN) at this state. In addition, regime I indicates a moderately significant positive co-movement between the interest rate and (a one-month forwarded) inflation. Regime II displays very different characteristics whereas changes in 1D WIBOR correspond with the sharp, albeit not statistically significant real PLN depreciation and disinflation.

….. insert Table 3 around here …..

The corresponding constant transition probabilities and the expected monthly durations for the two regimes estimated in Table 3, i.e. for the one-day WIBOR series, are shown in Table 4. The obtained proportional probabilities of both regimes indicate that regime I dominates the entire Markov process. Probability of staying in regime I in any given period is 95.5% and switching from I to II is only 4.5%. Probability of the tested relationship's remaining in regime II on any given month is 15.8% and switching from II to I is significant at 84.1%. The expected duration of regime I is 22 months and regime II only 1 month. In sum, the relationship between changes in 1D WIBOR and changes in both inflation and REER is mainly prescribed by regime I for most of the observations, with the isolated episodes of following regime II.

….. insert Table 4 around here …..

These episodes of switching to regime II are shown in Figure 3 displaying the one-step ahead predicted regime probabilities for regimes I and II for the 1D WIBOR series. The obtained trajectory of regime switching probabilities indicates rather high instability of the examined process from 1994 through 2001, with three discernible switching incidents in 1995, 1998 and 2001. Since the beginning of 2002 the examined relationship has been remarkably stable, presumable doe to a stabilizing role of the increasingly credible DIT policy. There was only a minor, rather negligible and self-correcting switching problem in the fourth quarter of 2008, i.e. during the peak of the global financial crisis. Evidently, the Polish financial system has become more resilient, capable of mitigating contagion effects of external market risk. This resiliency can be at least partially attributed to the consistent, increasingly credible DIT strategy.

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A similar Markov switching process is estimated for three-month WIBOR series, with the same regressors, i.e. $\Delta\log(CPI)_{t+\tau}$ and $\Delta\log(REER)_t$. The regime characteristics are the same as above, i.e. regime I reflects a positive and regime II an inverse relationship between changes in the interest rate and in REER. Table 5 presents the results of the Markov switching process for the 3M WIBOR as a function of changes in the one-month forwarded inflation rate and REER. There is a positive association between 3M WIBOR and both the forwarded inflation and REER prescribed by regime I. This functional relationship is however moderately significant. Unlike in the 1D WIBOR case, the inverse relationship between 3M WIBOR and REER is very pronounced. There is also a strong positive association between 3M WIBOR and inflation in regime II.

….. insert Table 5 around here …..

The corresponding constant transition probabilities and the expected monthly durations for the two regimes estimated in Table 5, i.e. for the 3M WIBOR series, are shown in Table 6. As in the 1D WIBOR series case, regime I dominates the examined process, with the high (94.5%) probability of remaining in it on any given month and its average expected duration of 18 months.

….. insert Table 6 around here …..

The one-step ahead predicted regime probabilities for regimes I and II for the 3M WIBOR series are shown in Figure 4. The path of switching probability in the case of 3M WIBOR indicates high instability of the examined process from the beginning of 1994 until the end of 2001. The most discernible instability is shown in 1998, i.e. at the end of the exit strategy from the currency peg and before the official inception of DIT. There has been a remarkable stability of this process since 2002, with no apparent switching episodes, even at the peak of the global financial crisis.

….. insert Figure 4 around here …..

In sum, there are at least two key findings of the above empirical exercise. First, the results suggest that changes in interbank rates in Poland are highly sensitive to changes in the real effective exchange rate. This susceptibility is stronger than their sensitivity to changes in the headline inflation. For this reason, central bank reaction function within the DIT policy framework cannot ignore emphasizing stability of REER. Second, money market interest rates, or specifically interbank rates are positively correlated with changes in REER at times of low market risk, but they may become inversely related at times of financial distress. This suggests that stressful market conditions may trigger short-lived, temporary shocks in the exchange rate, very likely through pronounced speculative currency attacks. The volatility surges in the exchange rate were considerably stronger before the official adoption of DIT as of January 1999. The inflation targeting policy helped infuse considerable resiliency of exchange rates to external market conditions, as suggested by the absence of serious switching episodes in the examined Markov process, even during the peak of the recent financial crisis in the fourth quarter of 2008.

V. 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. I provide evidence that one-day and three-months interbank rates were closely correlated with the real effective exchange rate during exchange rate targeting in the 1990s. The same interbank rates have become strongly associated with the path of expected inflation since the inception of direct inflation targeting in January 1999. The empirical tests indicate that the DIT policy regime in Poland has been successful in terms of mitigating both the inflation and the exchange rate risks. The examined functional relationship has been remarkably stable since the DIT policy gained its credibility (within two years of its adoption).

It may useful for monetary policy reaction function under DIT strategy to focus on the relationship between the targeted short-term market interest rate and both the expected inflation and the REER. This specification is particularly relevant as Poland pursues monetary convergence to the euro as it is expected to adopt the euro at some point in the future. Such monetary policy focus is also underpinned by the increasing sensitivity of the PLN value to changes in the EUR values in USD and other major global currencies (Orlowski, 2016).

In long-term, I propose that DIT policies in Poland and in the non-euro EU member countries rely more on inflation trends and market risk signals from the leading sovereign bond markets. A proper extraction of inflation expectations from domestic and international government bond markets is conditional on increasing liquidity of inflation-protected securities. Monetary policy instrument rules in the countries converging to the euro may need to place stronger weights on stability of real effective exchange rates in order to ensure sustained economic growth. For the time being, DIT policies shall continue since they have proven to be successful in protecting domestic economies and financial systems from adverse shocks generated in the euro area and in the global financial markets. They are likely to safeguard economic and financial stability at the times of “secular stagnation” (Summers, 2016).

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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 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	

Notes and source as in Table 1.

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%.

Source: as in Table 1.

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

Source: as in Table 1.

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		

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

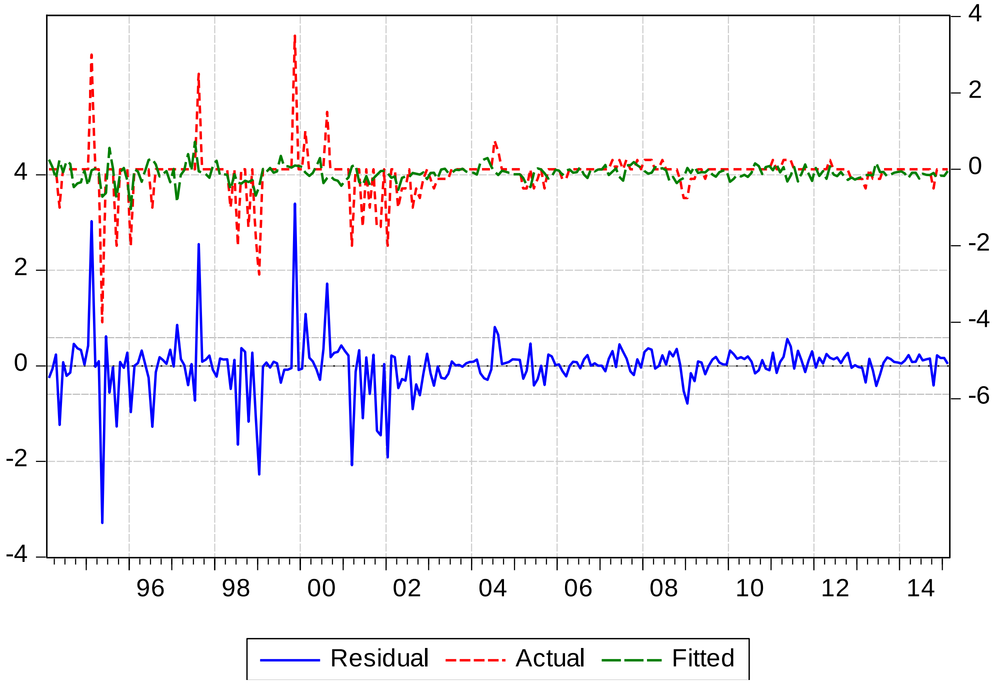
Source: as in Table 1.

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

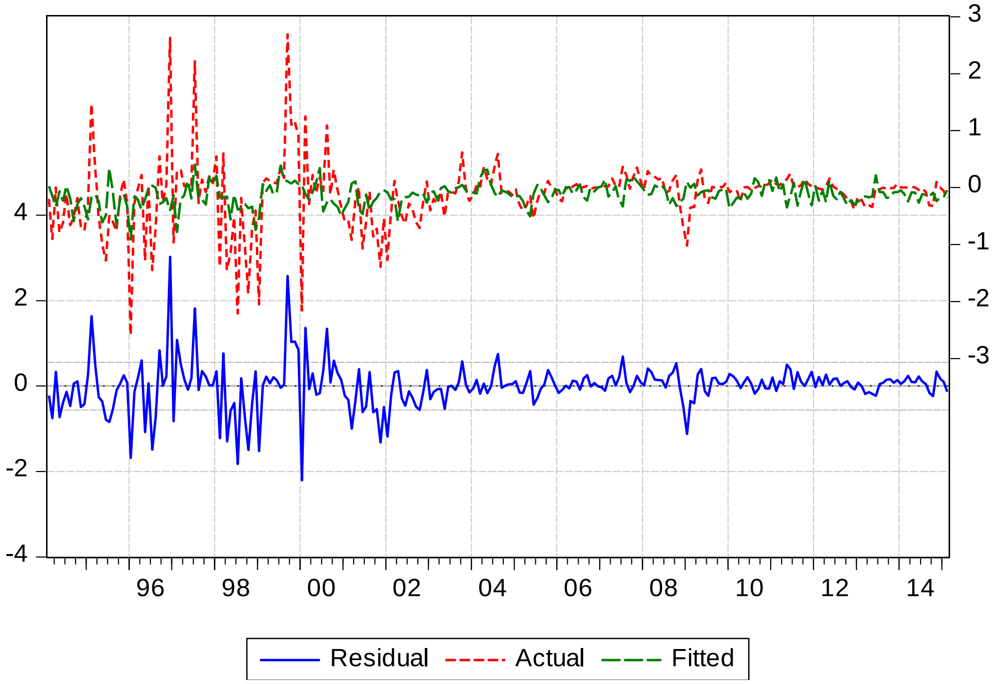
Source: as in Table 1.

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.



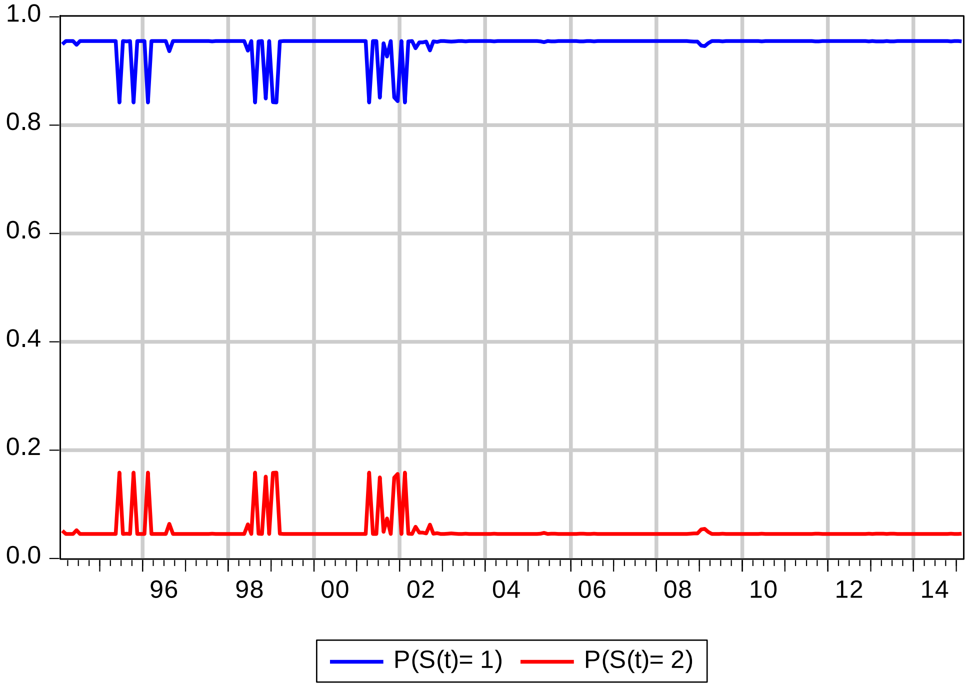
Source: as in Table 1.

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.



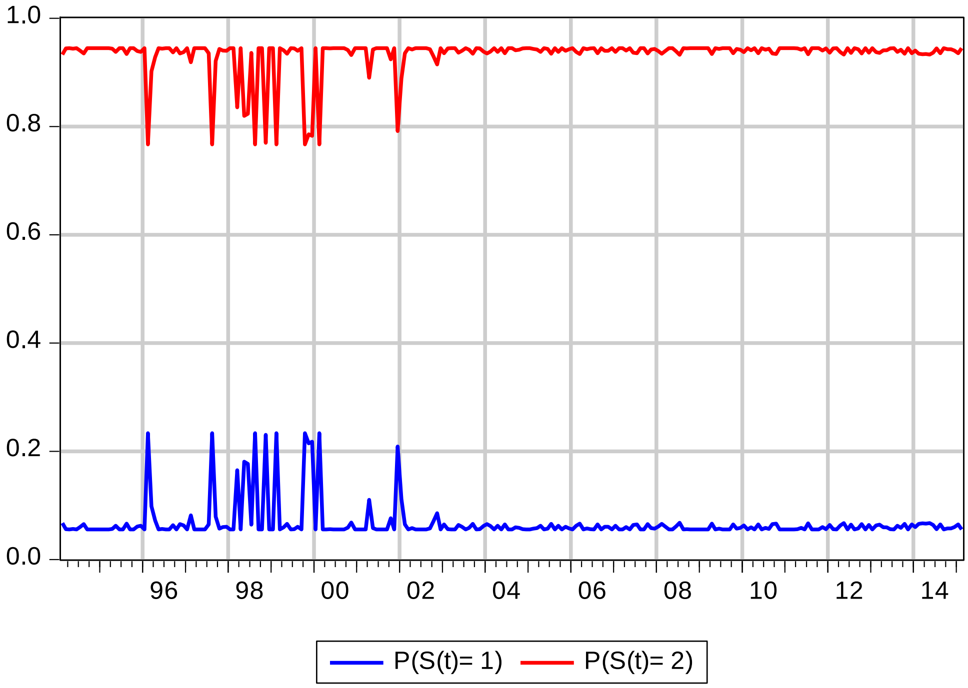
Source: as in Table 1.

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



Source: Author’s own estimation.

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



Source: Author's own estimation.