Evaluating inflation forecast models for Poland: Openness matters, money does not (but its cost does)

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Evaluating inflation forecast models for Poland: Openness matters, money does not (but its cost does)

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Abstract

Countries in which inflation targeting has been adopted require high quality inflation forecasts. The Polish National Bank adopted a variant of implicit inflation targeting and therefore the ability to forecast inflation is critically important to policy makers. Since the domestic price formation process is still evolving, medium term inflation forecasting is often difficult. Using quarterly data from 1995-2007, we estimate and evaluate three types of models for inflation forecasting: (1) output gap models, (2) models involving money, and (3) models which bring the foreign sector into the price formation process. We find that openness is significant in the price formation process and inflation targeting is associated with lower inflation. Traditional measures of forecast accuracy indicate that the simple price gap version of the P* model and the money demand model perform best of this group for medium term forecasting.

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1. Introduction

Inflation forecast targeting has widely been adopted as an effective monetary policy regime to lower and stabilize inflation[1]. Inflation targeting monetary policy includes several elements: a public announcement of medium term numerical targets for inflation, the institutional commitment to price stability as the primary goal for monetary policy, increased transparency and increased accountability[2]. To ensure central bank credibility utilization of an explicit inflation target as a policy anchor requires accurate inflation forecasts. Inflation forecasts take into consideration a wide spectrum of information related to past economic conditions and expected future economic developments[3] and hence are essential for policy deliberations.

We examine several inflation forecasting models applied to Poland, a transition economy that has recently adopted inflation targeting. Among the many specific studies that have examined the accuracy of alternative inflation forecast models, Stockton and Glassman (1987) and Lee (1999) are noteworthy. Analyzing U.S data, Stockton and Glassman reported the forecast performances of three types of models: a rational expectations model with instantaneous market clearing, the monetarist model and a Phillips curve-NAIRU model, and concluded that the Phillips curve-NAIRU model performs better than the alternative inflation forecasting models. In a similar vein, Lee (1999) evaluated the inflation forecast performance of P* models relative to other competing models also for the U.S. and found that a money demand model and the

[1] IMF (2005).
[2] Mishkin (1999, 2000) provides an excellent discussion.
[3] See Batini and Haldene (1999), Svensson (1997), Giannoni and Woodford (2002), for further details.

Phillips curve NAIRU model provide more accurate forecasts than the P* model, especially over longer horizons. Here we build upon the empirical literature and examine models which include the foreign sector in domestic price formation process. For Poland, we employ quarterly data from 1995-2007 to estimate and evaluate three types of models: 1) models based upon "gaps," the basic price gap version of the P* model, the explicit version of P*, and a Phillips curve-NAIRU model, 2) models involving money, a monetarist model and a model based upon money demand, and 3) models incorporating the foreign sector, one including a measure of openness and one a measure of exchange rate effects. The objective is two fold: (1) to assess (via traditional measures of forecast accuracy) the relative performance of popular inflation forecast models when applied to Poland; and (2) to compare the popular inflation forecast models with newer models incorporating external factors which may influence domestic price formation.

Poland provides an excellent case for the analysis of inflation forecast models for three reasons. First, Poland is a relatively successful transition economy; therefore results obtained using Polish data may illuminate the forecast performances of different groups of inflation models for other transition economies. Second, as Poland adopted full fledged inflation targeting as a monetary policy in 1998, it would be interesting to know if the policy regime change effects the relative forecast accuracy of alternative inflation models. Third, Poland's relative openness and desire to enter the euro zone suggests that knowledge of whether openness effects domestic price formation would be useful for policymakers.

The next section briefly describes monetary policy regimes employed by the National Bank of Poland (NBP) from the early 1990's to present. Section 3 elaborates several forecasting models to be evaluated and empirical results are discussed in Section 4. Section 5 presents the forecast results and section 6 summarizes and concludes. The appendix provides information on data sources. The results suggest that in terms of forecast accuracy the basic price gap version of the P* model and the money demand model are preferred, but the models including foreign sector information also add significant information to the price formation process.

2. Monetary regimes in Poland (1990-2005)

Monetary policy of Poland in the 1990s evolved through three rather distinct regimes. In 1990, the collapse of the centrally planned economy brought about a hyperinflation. The NBP adopted a fixed exchange rate regime to provide a highly visible nominal anchor. This initial phase of stabilization lasted roughly from 1990 to 1994 bringing an economic recovery and lowering inflation from 249.3% in 1990 to 29.5% by 1994.

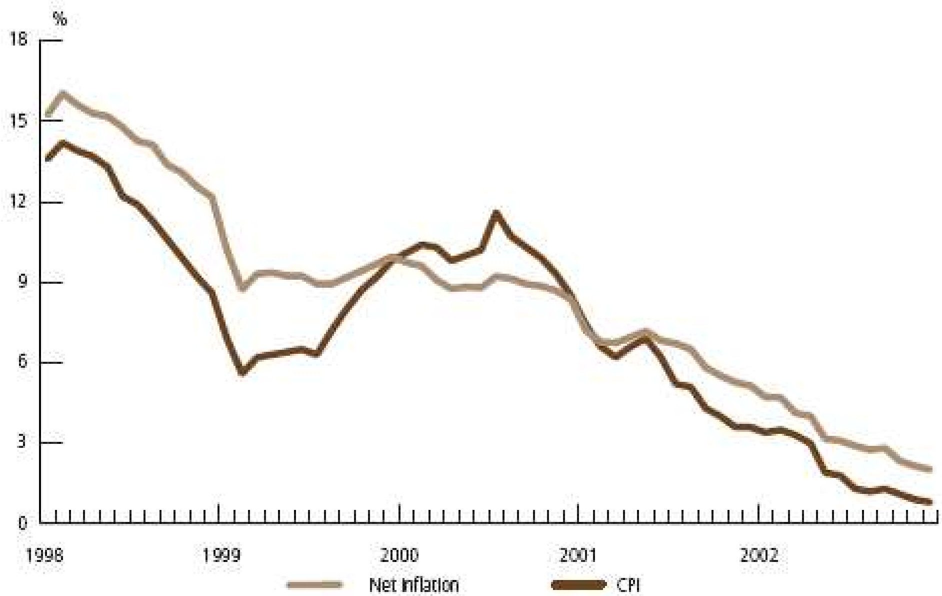
The initial success in stabilizing the economy coupled with rigidities of the fixed exchange rate policy led to a more eclectic policy by 1995. The strategy focused on multiple objectives. It attempted to meet inflation goals and maintain financial stability, but also focused on the current account balance. In order to achieve the objectives, NBP attempted to employ different instruments for different objectives. Exchange rate policy was directed to prevent worsening of the current account. Short term interest rates were used to limit demand pressure and influence the yield curve. On occasion, a monetary aggregate, M2, was targeted. When these instruments appeared to be ineffective in curbing inflation other instruments, like reserve requirements on commercial bank deposits were increased. In 1997 Parliament approved legislation for greater independence of the National Bank of Poland and a ten member monetary policy committee was created. This decision facilitated the implementation of full fledged monetary targeting. (Christoffersen et al, 2001).

This 'eclectic approach' to monetary policy during the late 1990s resulted in lowering the high level of inflation, 21.6 % in 1995, to 13% by the second quarter of 1998. Several important structural changes were undertaken as well. Current and capital accounts were liberalized the banking sector was essentially privatized and continued to develop as an effective legal and institutional framework for a sound banking system was created. Such structural changes then allowed the NBP to introduce a more focused monetary policy. Though Poland experienced a steady decline in inflation in this period, the rate of disinflation was slow compared to some other transition countries[4]. In addition, despite the managed float the current account balance steadily deteriorated. The 'eclectic' monetary policy, with a multiplicity of objectives and multiple instruments, often led to ineffective communications with the markets and lessened the accountability of the NBK. As a result, the newly established monetary policy council decided to implement full fledged inflation targeting in September 1998. The Council adopted a short term (one year) and medium term (3 year) inflation goal, to reduce inflation to less than 4% by 2003, which was indeed achieved. The Council also decided to focus on the consumer price index (CPI) rather than the "core inflation index", because the CPI was the most common and understandable measure of the price level in the mind of the public.

A floating exchange rate regime was introduced in April 2000 re-focusing the NBPs commitment to a single objective: attaining price stability via inflation targeting. Since then the central bank intervened in the foreign exchange market mainly to ensure the stability required as a criteria for convergence towards the euro zone. In addition, the NBP began regular publication of quarterly inflation reports that further enhanced the accountability and transparency of their policy strategy. As Figure 1 indicates, the policy was successful in bringing down inflation as CPI growth fell from roughly 14% in 1998 to 0.7% in 2003.

[4] Czech Repulic, Hungary, Slovenia, Slovak Republic

Figure 1: CPI and Net Inflation 1998-2003



Source: http://www.nbp.pl/en/publikacje/o_polityce_pienieznej/strategy_beyond_2003.pdf

The framework for monetary strategy beyond 2003 is based on objectives associated with joining the European Union (Poland joined the European Union on May 2004), the completion of the disinflation process and the approaching membership in the Euro zone. The monetary policy council targeted an inflation rate of 2.5% ±1% for 2003 and thereafter, which was also achieved. Currently inflation meets Maastricht inflation criteria. However for the smooth transition to the Euro zone the NBP must relax its strict direct inflation targeting strategy of monetary policy (inflation targeting is the sole objective) and devise a new strategy to provide a more congenial framework for monetary convergence. Since the Maastricht criteria also require exchange rate stability along with the low inflation rate, it is likely that greater weight must be assigned to exchange rate stability. This suggests models of inflation that reflect international conditions may be useful.

3. Model specifications

Because the economic structure for the typical transition economy has been unstable it is unclear how best to model the inflationary process. Thus, at this point our analysis is partly exploratory in nature. In this section we briefly describe seven models from the literature. The first two sets of models focus on domestic sources of inflationary pressures, either the output gap or money; while the third set of models add external factors which may influence price behavior.

3.1. The Basic P* Model

Hallman, et al. (1989, 1991) developed a model for forecasting inflation in the US based on the quantity theory of money, the P* model. It is simply derived from the equation of exchange: $P_t Y_t = M_t V_t$, where P_t is the price level during period t, Y_t is real output, M_t is the amount of money in circulation during the period and V_t is the velocity of money. Letting V_t*, Y_t* be the equilibrium levels of V_t and Y_t, then in equilibrium the equation of exchange may be written as: $P_t * Y_t * = M_t V_t *$.

Taking logarithms and subtracting the actual from the equilibrium equation gives

$$\mathrm{p}_t^* - \mathrm{p}_t = (v_t^* - v_t) + (y_t - y_t^*) \quad (1)$$

where small letters indicate logarithms of the variables. The price gap, the difference between actual inflation and long run expected inflation is a function of the velocity gap and the real output gap respectively. The long run potential price, output and velocity of money are estimated via the Hodrick-Prescott filter.

The basic inflation forecasting model is then specified as an error correction model:

$$\Delta p_t = \alpha_0 + \sum_{j=1}^{4} (\alpha_{1j}\Delta p_{t-i}) + \alpha_2(p_{t-1}^{*} - p_{t-1}) \qquad \text{(basic price gap model)} \qquad (2)$$

where Δ is the difference operator. Here the general price level will tend to rise if its lagged value is below p^*_{t-1}, and fall if it is above p^*_{t-1}. Lags up to four periods capture inertia and seasonal patterns.

Substituting the expression for the price gap from equation (1) gives the explicit version of the P* model:

$$\Delta p_t = \gamma_0 + \sum_{j=1}^{4} (\gamma_{1j}\Delta p_{t-i}) + \gamma_2(v_{t-1}^{*} - v_{t-1}) + \gamma_3(y_{t-1} - y^*_{t-1}) \qquad \text{(explicit price gap model)} \qquad (3)$$

Here inflation adjusts simultaneously to disequilibrium in both the goods market and the money market.

3.2. The expectations augmented Phillips curve –NAIRU model

This model is derived from separate wage and price equations (Gordon, 1982). If demand causes output to exceed potential output, factor input prices are bid up resulting in inflationary pressure. On the contrary, if actual output is below potential output, there are disinflationary pressures. The reduced form version of this model specifies inflation as a function of its lagged values, a real output gap and current nominal income growth.

With all variables as defined above, the forecasting equation is

$$\Delta p_t = \delta_0 + \sum_{j=1}^{4} (\delta_{1j}\Delta p_{t-i}) + \delta_2(y_{t-1} - y_{t-1}^{*}) + \delta_3(\Delta y_{t-1}' - \Delta y_{t-1}^{*}) \qquad \text{(PC-NAIRU model)} \ (4)$$

3.3. Traditional monetarist model

The traditional monetarist model specifies the past growth rate in the money supply as the main determinant of long run aggregate inflation (Carlson (1980), Hafer (1983)). Inflation is therefore a function of current and past measures of money growth. The inflation forecasting model is specified as:

$$\Delta p_t = \beta_0 + \sum_{j=1}^{4} [(\beta_{1j}\Delta p_{t-i}) + (\beta_2\Delta m_{t-i})] \qquad \text{(monetarist model)} \qquad (5)$$

Again, lagged inflation captures inertia and Δm_{t-i} is lagged money growth. Empirical estimates from the monetarist model vary with the choice of monetary aggregates. Mehra (1988), Stockton and Glassman (1987) and Reichenstein and Elliot (1987) suggest that the forecasting performance of this model is poor regardless of the choice of monetary aggregate.

3.4. The money demand model

Here we adopt a model based on Reichenstein and Elliott (1987) and Tallman (1995). The forecasting equation includes a monetary aggregate and the interest rate, the opportunity cost of money. The intuition underlying the forecasting equation is that if money supply growth is the same as the rate of growth of money demand (captured by interest rate and output fluctuations) inflation will remain stable. If money growth exceeds the growth in money demand, then the excess money growth results in inflation.

The forecasting equation is:

$$\Delta p_t = ø_0 + \sum_{j=1}^{4} (ø_{1j}.\Delta p_{t-i}) + \sum_{j=1}^{4} (ø_{2j}.\ \Delta m_{t-i}) + ø_3.\ \Delta y_{t-i} + ø_4.\ \Delta r_{t-1} \qquad \text{(money demand model)} \ (6)$$

Lagged inflation is added again to capture inertia and seasonality and r is an appropriate interest rate (here money market rate).

3.5. An augmented Phillips curve model with trade openness

Allard (2007) constructed an augmented Phillips curve and incorporated 'trade openness' to determine if globalization affects the relationship between output and inflation. Trade openness (T) is defined as the ratio of imports to GDP. Allard's specification is

$$\Delta p_t = \alpha \Delta p_{t-1} + \beta (1 + \gamma T_{t-1}) (y_{t-1} - y_{t-1}^{*}) + \varepsilon_{it} \qquad \text{(trade-openness model)} \qquad (7)$$

This specification allows globalization, defined narrowly as trade openness, to influence the trade off between inflation and domestic economic conditions.

3.6. Models with exchange rate pass through

Edwards (2006) examines exchange rate pass through in the context of inflation targeting and investigates the relationship between exchange rate changes and inflation for a panel of countries, some of which had adopted inflation targeting. The model he examines is specified as:

$$\Delta p_t = \gamma_0 + \alpha \sum_{j=1}^{4} \Delta p_{t-1} + \beta_1 \Delta e_t + \beta_2 p^* + \beta_3 (\Delta e_t * dit) + \beta_4 \sum_{j=1}^{4} (\Delta p_{t-1}^{f} dit) \qquad (8)$$

Where DIT is a dummy variable that takes the value of one at the time IT is adopted, and zero otherwise, p is the log of the CPI, e is the log of the exchange rate and p^f is the log of an index of foreign prices.

4. Empirical results

Each of the inflation models is estimated with quarterly data from 1995q1 to 2007q4. First we performed the Phillips-Perron unit root test on the key variables. As shown in Table 1, for all variables except the price gap the null hypothesis of a unit root is rejected at the 1% and 5% level, indicating stationarity for those variables. For the price gap, a unit root is rejected at the 5% level.

Table 1: (Unit root test) Phillips -Perron Statistics (1995Q1-2007Q4)

	With trend	Without trend
dcpi	-3.41 *	-5.06 **
p-gap	-2.96 *	-2.93*
v-gap	-6.64**	-6.54 **
rgdp-gap	-11.81 **	-12.25**
dm2	-5.06**	-7.59**
dmmr	-5.07**	-5.04**

** indicates rejection of the null hypothesis at 1% and * indicates rejection at the 5% level.

Table 2: Estimates of Inflation Forecast Models (p-values in parentheses)

	1	2	3	4	5	6	7
	Basic gap model n=47 after adj.	Explicit gaps model n=47 after adj.	Phillips curve Nairu model n=47 after adj.	Traditional monetarist model n=47 after adj.	Demand for real money balances n=47 after adj.	Trade Openness n=47 after adj.	Exchange Rate pass through n=47 after adj.
Intercept	0.0013	0.0043	0.0044	0.0009	0.0020	-0.0006	-0.0024
	(0.6318)	(0.1894)	(0.1687)	(0.8952)	(0.5146)	(0.8374)	(0.4931)
Δp_{t-1}	0.4764	0.3862	0.3853	0.4167	0.2245	0.3260	0.2439
	(0.0055)	(0.0515)	(0.0505)	(0.0512)	(0.2436)	(0.0055)	(0.0853)
Δp_{t-2}	-0.2436	-0.2482	-0.2482	-0.2152	-0.0877		0.0119
	(0.1361)	(0.2432)	(0.2499)	(0.3078)	(0.6584)		(0.9387)
Δp_{t-3}	0.2346	0.1682	0.2012	0.0835	0.1524		0.1455
	(0.1066)	(0.3717)	(0.2921)	(0.6595)	(0.4620)		(0.2638)
Δp_{t-4}	0.3897	0.4083	0.3671	0.3551	0.4253	0.5111	0.5354
	(0.0040)	(0.0103)	(0.0233)	(0.0407)	(0.0081)	(0.0000)	(0.0001)
$p_{t-1}^* - p_{t-1}$	0.3105						
	(0.0019)						
$v_{t-1}^* - v_{t-1}$		0.0284					
		(0.5940)					
$y_{t-1}^* - y_{t-1}$		0.0531	0.0662			0.2923	
		(0.3798)	(0.2797)			(0.0714)	
$\Delta y_{t-1}' - \Delta y_{t-1}^*$			-0.0290				
			(0.4252)				
Δm_{t-1}				0.1364	0.1489		
				(0.1028)	(0. 0560)		
Δm_{t-2}				0.0154	0.0510		
				(0.8634)	(0.5165)		
Δm_{t-3}				-0.1053	-0.1083		
				(0.1894)	(0.1375)		
Δm_{t-4}				0.0638	0.1246		
				(0.4520)	(0.1182)		
Δy_{t-1}					0.0219		
					(0.4461)		
Δr_{t-1}					0.0025		
					(0.0091)		
$(y_{t-1}^* - y_{t-1})*T_{t-1}$						-0.5512	
						(0.1005)	
Δe_t							0.2604
							(0.0541)
Δe_t*DIT							-0.2401
							(0.0993)
Δp_t*							0.2536
							(0.5390)
Adj. R^2	0.7766	0.6856	0.6896	0.6988	0.7721	0.7047	0.6981
F (p-value)	0.000	0.001	0.001	0.001	0.000	0.000	0.000
DW	1.76	1.75	1.72	1.72	1.88	1.66	1.33
LM test statistic	1.63	2.33	2.29	2.13	0.227	1.16	0.475
	(0.21)	(0.11)	(0.12)	(0.14)	(0.79)	(0.32)	(0.62)
AIC	-6.77	-6.41	-6.43	-6.42	-6.68	-6.59	-6.51
BIC	-6.34	-5.94	-5.96	-5.82	-6.04	-6.38	-6.16

The regression results are summarized in Table 2. In each specification the adjusted R^2 is reasonably high. For the basic price gap model (Specification 1) most of the individual coefficient estimates are significant. The Durbin Watson statistic (DW) is 1.76 $>D_{U\,(39,\,6)}$ and we do not reject the null hypothesis of no serial correlation. The LM test for higher order serial correlation does not reject the null hypothesis of no serial correlation as well. In the money demand model (Specification 5) the adjusted R^2 is again relatively high and inflation lagged four periods, money lagged one period and interest rates lagged one period are statistically significant. The LM test for serial correlation indicates no higher order serial correlation. In the explicit gap model (Specification 2), the Phillips Curve – NAIRU model (Specification 3), and the traditional monetarist model (Specification 4) the coefficient estimates of critical variables are not statistically significant.

The augmented Phillips curve model with trade openness (Specification 6) and the exchange rate pass through model (Specification 7) have reasonably high adjusted R^2. In specification 6 the estimated coefficient that measures the effect of globalization ($(y_{t-1}^* - y_{t-1})*T_{t-1}$) is statistically significant and negative confirming the results of Allard (2007). Also the LM test for higher order serial correlation indicates there is none. For the model with exchange rate pass through the estimated coefficient for Δe (an increase is a nominal depreciation) has a positive sign and is statistically significant. The estimated coefficient of (Δe_t*DIT) is negative and statistically significant, indicating that in Poland inflation has significantly declined in the post-IT period. Further, the LM test for serial correlation implies the absence of serial correlation. These two models clearly indicate that the openness of the Polish economy plays an important role in the domestic inflation process. Further, inflation targeting has made a significant impact on domestic inflation.

5. Forecast results:

We examine the in-sample forecast performance using three criteria: root mean square error (RMSE), mean absolute error (MAE) and the Theil inequality coefficient (TIC). The first two statistics are scale dependent (upon the endogenous variable) while TIC is scale invariant. All three have a range of zero to one with zero indicating a perfect fit. As judged by both RMSE and MAE and the TIC the best in-sample forecast performance is obtained with the price gap version of the P* model.

5.1. In-sample forecasts

We construct a dynamic forecast for the period 1995Q1:2005Q4 using the estimated specifications. Dynamic forecasts calculate multi-step forecasts starting from the first period (1995Q1) of the forecast sample. In addition we compared the in sample forecast results with a benchmark random walk model. The ratio of RMSE of each model to that of the random walk model is presented in Table 3 which summarizes the results for all models.

Table3: Summary of measures of in- sample forecast accuracy

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
RMSE	0.0055*	0.0076	0.0074	0.0073	0.0062	0.0075	0.0072
MAE	0.0042*	0.0058	0.0056	0.0054	0.0048	0.0054	0.0054
RMSE / RMSERW	0.3777	0.4222	0.4111	0.4051	0.3666	0.4166	0.4000
TIC	0.1371 *	0.2044	0.1994	0.1919	0.1641	0.2013	0.1964

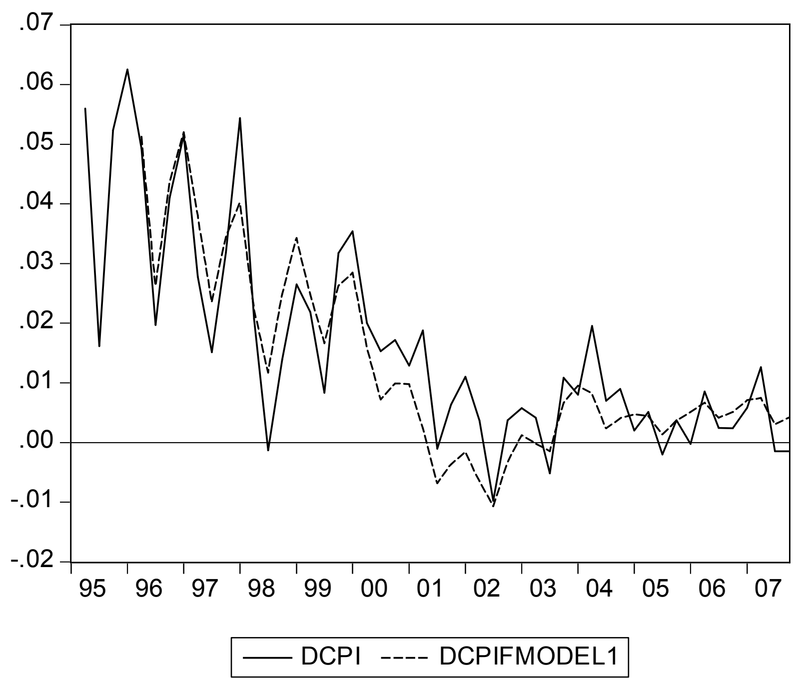
* indicates the lowest values for the particular criterion.

From these results we conclude that Specification 1, the basic price gap version of the p* model, the very simplest model, performs best of this group in terms of in-sample forecast accuracy.

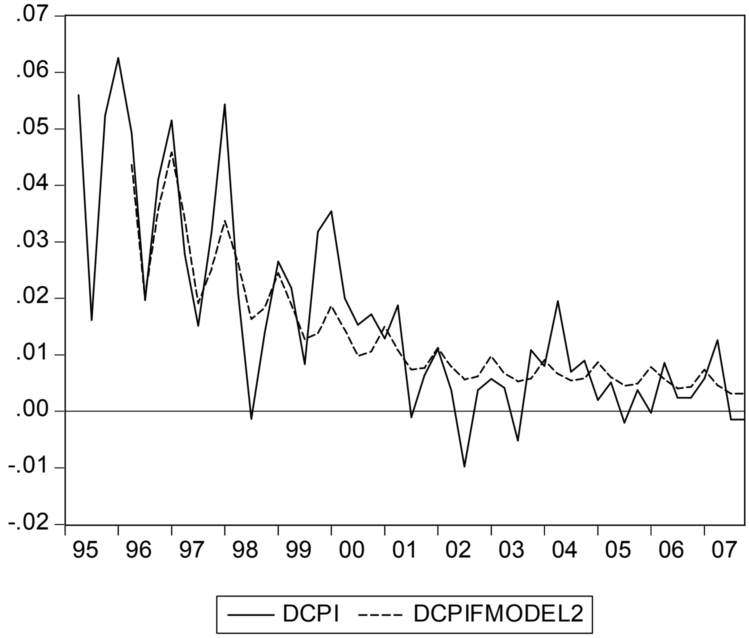
The in-sample forecasts are presented in Figures 2-8. The solid line is the actual inflation rate while the dashed line is the forecasted inflation rate.

Figures 2-8: In-sample forecasts

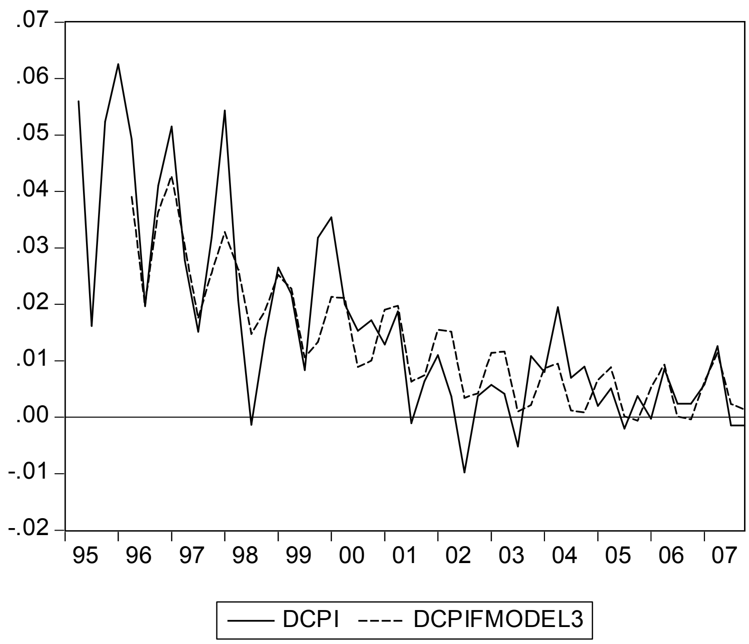
Model 1: Price Gap version of the P* Model



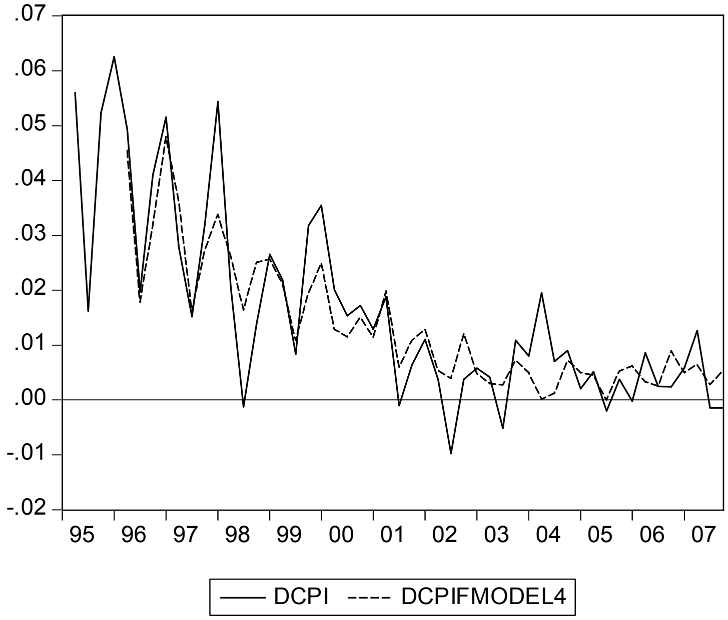
Model 2: Explicit Gap version of the P* Model



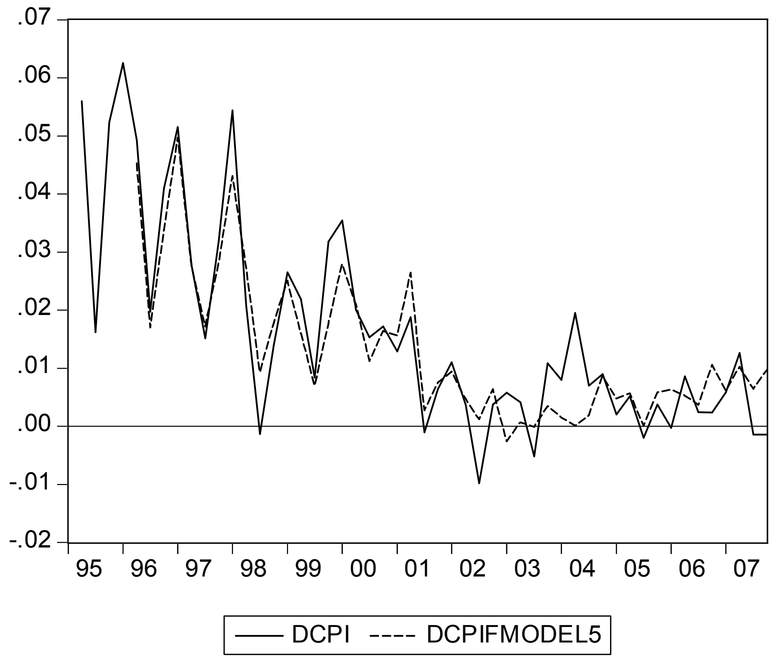
Model 3: Phillips Curve- NAIRU Model



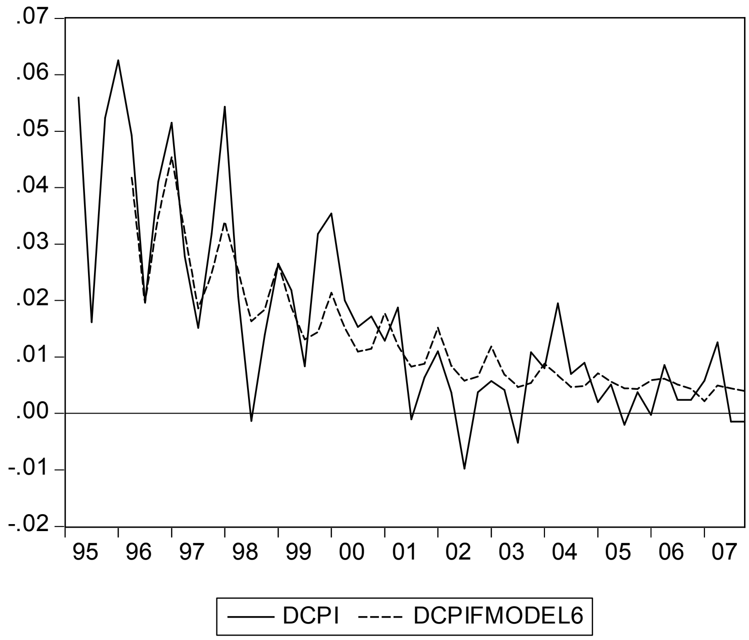
Model 4: Monetarist Model



Model 5: Money Demand Model



Model 6: Augmented Phillips curve model with trade openness



Model 7: Model with Exchange Rate pass through

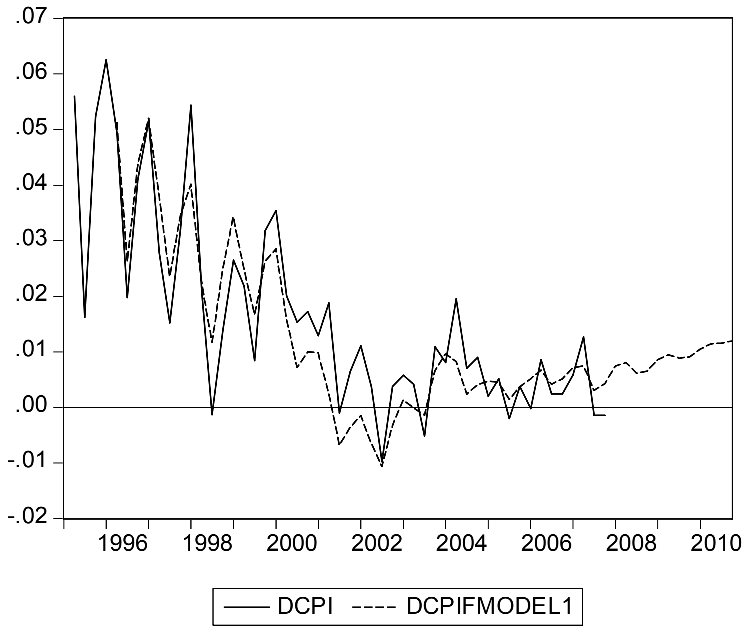
5.2. Out of Sample forecasts

Now let us consider out of sample forecasts for the four best models in terms of in-sample forecast accuracy namely, for the basic price gap P* model, the monetarist model, the money demand model and the inflation model with exchange rate pass through. The out of sample forecasting procedure requires forecasted values of exogenous variables, which are slightly different for each model. For the price gap model we construct the out of sample values for the price gap. For the monetarist model and the money demand model we construct the out of sample values for money growth, the interest rate and growth in real GDP. Likewise for the model with exchange rate pass through we constructed future values of the exchange rate and extended the values for the dummy variable, DIT, up to 2010q4. We assume that the log of exogenous variables across the models roughly follows a linear trend with deviations from that trend in a cyclical pattern. The cyclical component is determined by a simple model in which we regress the exogenous variable against a constant and a time trend, with an AR (4) error

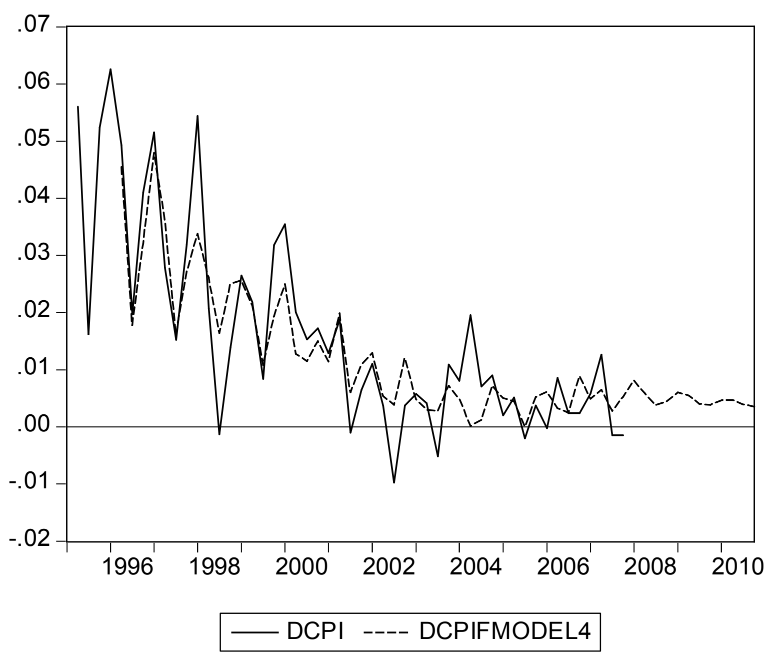
The out of sample forecast graphs are presented in Figures 9-12. The solid line represents the actual rate of inflation and the dashed line the forecasted rate of inflation. Model 1, the basic price gap model forecasts inflation around 1% and rising slightly while the other models forecast inflation to be fluctuating just under 1%. Of course, deviations from the assumed paths for the exogenous variables would alter these forecasts, and many alternative scenarios could be constructed.

Figures 9-12.

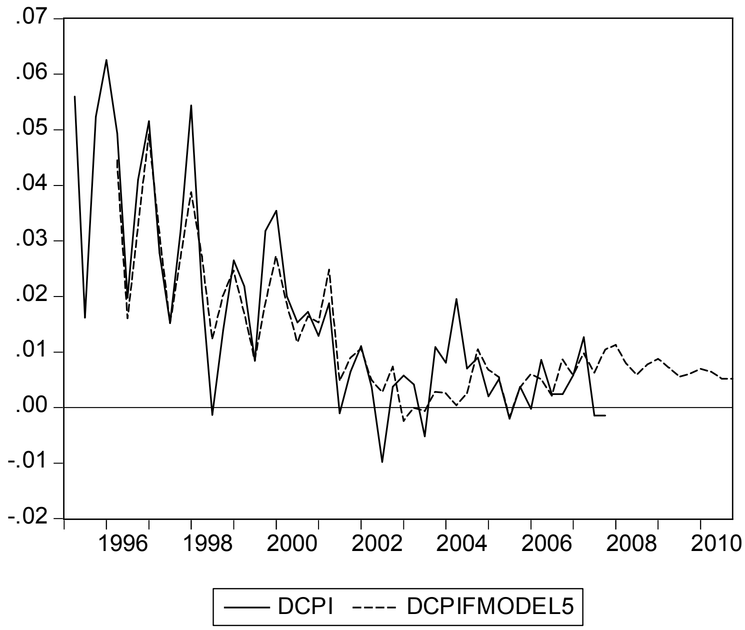
Model 1: Price Gap version of the P* Model



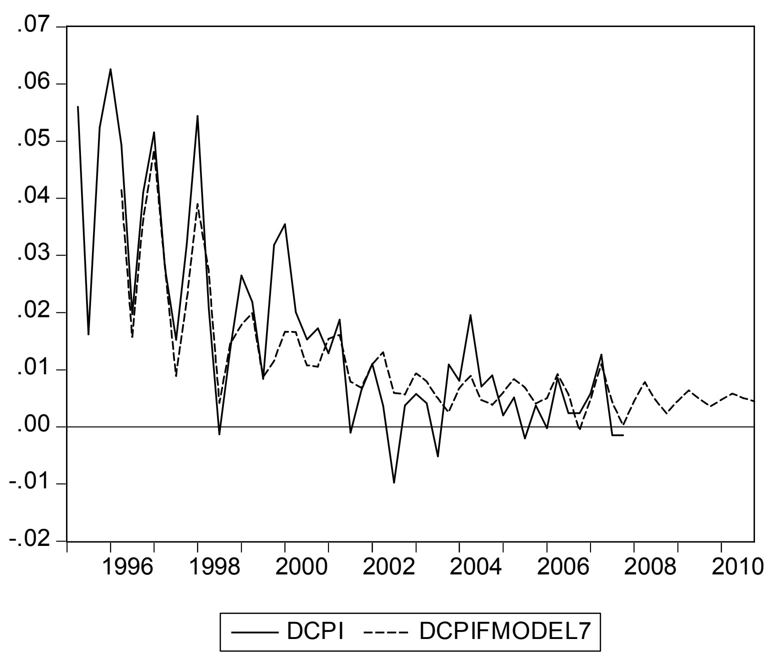
Model 4: Monetarist Model



Model 5: Money Demand Model



Model 7: Model with Exchange Rate pass through



6. Conclusions

We evaluate the forecast performance of alternative inflation models. Several important features of price formation in Poland are revealed. First, rapid adjustment of inflation rates to the change in money growth does not generally appear to occur. Instead, the money demand model indicates that interest rates and output movements do impact inflation. For forecasting purposes the simple, most parsimonious model, the price gap version of the P* model and the money demand model provide the best forecasts. Because inflation was more volatile in the early part of the sample, the models likely would improve as more data become available allowing the earlier observations to be dropped. Further, it appears that the relative openness of the economy is important. Foreign shocks, either through trade flows or exchange rate pass through, do matter in determining domestic inflation. Policy makers should be keenly aware of the role of the foreign sector in domestic price determination as full integration into the Euro zone proceeds.

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Appendix: Data Sources

Data are from International Financial Statistics (IFS) of the IMF. The following variables are employed.

M2: M2 comprises M1 and time, savings, and foreign currency deposits of the private sector, public non financial enterprises, and non bank financial institutions with the Bank of Poland and commercial banks.
Source: IFS CD-ROM

Interest Rates:
Money market rate: Weighted average rate on outstanding one-month deposits in the inter bank market. Beginning January 1992, weighted average rate on outstanding deposits of one month or less in the inter bank market.
Treasury bill rate: Weighted average yield on 13-week Treasury bills sold at auctions.
Source: IFS CD-ROM

Consumer Price Index: The index covers 1800 goods and services from 307 districts. Since 1990, the weight system has been based on a household budget survey. The weights are revised every year.
Source: IFS CD-ROM

National Accounts:

Real GDP: Beginning in 1990, data are sourced from the Eurostat database. Eurostat introduced chain-linked GDP volume measures to both annual and quarterly data.

Chain-linked GDP volume measures are expressed in the prices of the previous year and re-referenced to 1995.

Source: IFS CD-ROM

Trade openness: defined as the ratio of the imports to GDP. The value for GDP and imports are taken from IFS CD database.

Source: IFS CD-ROM