Identifying central bank's preferences: the case of Poland[*]

Michal Brzozowski

Department of Economics, Warsaw University, Dluga 44/50, 00-241 Warszawa
brzozowski@wne.uw.edu.pl

Abstract:

We seek to test the hypothesis that the weight on output gap variability in the central bank's loss function is equal to zero in Poland. To that end we derive monetary policy reaction function from the central bank's optimization problem. We find that the weights assigned to target variables were not constant over the period 1995-2003. The weight attached to inflation stabilization objective in the central bank's loss function in Poland was equal to the weight assigned to output gap stabilization in the period 1995-1999 and the latter goal has been disregarded since 2000.

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1. Introduction

In political debates and academic discussions the National Bank of Poland (NBP) is very often blamed for conducting an excessively restrictive monetary policy. The criticism became especially fierce when the Polish economy has been undergoing a slowdown following a period of high output growth. An average in 1995-2000 real GDP growth rate was equal to 5,5 percent and it dropped to 1 percent in 2001 and 1,4 percent in 2002. The economic slowdown coincides with the adoption of inflation targeting regime and a rapid fall

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in CPI inflation rate from about 10 percent in 2000 to 5,5 percent in 2001, 1,9 percent in 2002 and 0,8 percent in 2003. This development justifies the hypothesis that the weight on output gap variability in the central bank's loss function is equal to zero in Poland. The aim of this paper is to test this hypothesis and identify the parameters of the loss function of the NBP by means of econometric analysis of the monetary policy reaction function.

To assess the importance of non-zero weight assigned to output in the central bank's loss function it is useful to consider a situation in which an adverse supply shock hits the economy and spurs the inflation rate. When output is included in the monetary policy objective function a monetary tightening in response to a rise in inflation is lessened by concerns to avoid a decline in output. By contrast, under a strict inflation targeting regime, a more restrictive monetary policy is conducted that allows to avoid higher inflation at the cost of deep recession. Thus a central bank which has price stability as its sole objective is likely to respond to inflationary pressures in a way which is not optimal from the social point of view. The likely divergence of social and central bank's preferences is a rationale for the empirical analysis of the NBP policy rule.

There are very few attempts in the literature to recover the preferences parameters of the central bank from estimated monetary policy rules, Lippi and Swank (1998) and Favero and Rovelli (1999) being noticeable exceptions. In the former paper the central bank is assumed to control the growth rate of nominal output which is equivalent to a model in which the policy maker imperfectly controls money growth. As a result the interest rate is not included in the objective function and the model does not provide a good characterization of monetary policy conduct in Poland.

In the paper by Favero and Rovelli (1999) the first order conditions are derived from a central bank's optimization problem and analyzed with structural model of the US economy. The small structural model used by the authors is a VAR system with no theoretical foundations. In this paper the optimal interest rate behavior is derived by solving the intertemporal optimization problem of the central bank and estimated with the use of GMM methodology. The parameters characterizing the structure of the economy are obtained from the estimation of the New Keynesian Phillips curve which is based on the individual firm price-setting decision.

The rest of the paper is structured as follows. Section 2 gives an overview of monetary policy in Poland in the 1990s. Section 3 is devoted to the exposition of theoretical model. The empirical results are presented in section 4. Finally, section 5 concludes.

2. Monetary policy in Poland in 1990s

From 1990 the NBP has followed a clear anti-inflationary policy. The actual instruments used, however, have evolved during this period. At the beginning of transition period a fixed zloty rate of exchange to the dollar - a “nominal anchor” - was introduced to stabilise the dynamics of inflation. At the early stage of money market development the monetary policy tools such as reserve requirements, central bank’s interest rates and open market operations proved to be ineffective in restricting the growth of the credit supply and in 1990 the Governor of the NBP introduced the administrative measure of credit ceilings.

At the end of 1992 the administrative measure of credit ceilings were no longer necessary and during 1993 they were phased out. The NBP switched to relying entirely on the use of interest rate policy to control money supply. The open market operations became the main tool to control the interest rates and the money supply since the beginning of 1993. The managed exchange rate regime was sustained to limit inflationary expectations but the zloty was occasionally devaluated and the rate of crawl was reduced.

Over the period 1994-1996 the monetary policy was challenged by the necessity to reconcile two opposite aims: the maintenance of a falling trend in inflation and the accumulation of a sufficiently high level of foreign exchange reserves. The latter objective was imposed by the necessity to resume the debt service after a finalisation of the agreement with the London Club and avoid excessive current account disequilibrium. Although in 1995 a surplus of the current account had been observed, a rapid economic growth and a pressure on zloty to appreciate predicted an imminent reversal of this trend. In order to weaken the pace of increase in the stock of foreign exchange reserves, which constituted the main source of the money supply increase, the foreign exchange policy was modified: the crawling band system replaced the crawling peg. The fixing rate was allowed to fluctuate within ±7 percent around central parity which rate of crawl was reduced. In 1997 the NBP reduced its degree of foreign currency intervention, which was hoped to curb capital inflows.

In 1997 the establishment of the Monetary Policy Council was followed by the formulation of a medium-term strategy based on direct inflation targeting. The policy of using money supply growth as the official intermediate monetary policy target was abandoned because the correlation between the monetary aggregate and inflation was becoming increasingly less stable and predictable. This was primarily a consequence of a rising money demand due to the development of financial markets and the progress made in macroeconomic stabilisation. In addition, the policy was abandoned because the central bank control of the money supply was impeded by the exchange rate management.

However the exchange rate controls have not been removed until 2000 and thus the absence of other nominal anchors which is one of the five pillars, enumerated in Mishkin and Schmidt-Hebbel (2001), on which a full-fledged inflation targeting is based was not in force. In 1998 the rate of crawl was reduced three times and in September it was as low as 0,5% per month. In 1999 further reduction brought the level of crawl to 0,3% per month. In 1998 the band within which the fixing rate was fluctuating was widened to ±10% in February and to ±12,5% in October. In 1999 the authorities took preparatory steps to adopt the policy of floating exchange rate – in March the band was widened to 15% and in 2000 it was abandoned and the latter year can be considered as a starting point for the adoption of a pure inflation targeting framework in Poland.

3. Specification of a monetary policy reaction function

In this section we specify a monetary policy reaction function in Poland. The NBP has had an important degree of autonomy over its monetary policy even at the early stage of transition process when the fixed exchange rate regime was accompanied by capital controls. The starting point is the observation that a short-term interest rate has been since 1993 the main operating instrument of monetary policy in Poland. It is therefore natural to assess the NBP policy in the context of optimal interest rule.

3.1 Macroeconomic framework for monetary policy

The idea that monetary policy should follow a rule in order to avoid time inconsistency and inflation bias problem is attributed to Kydland and Prescott (1977) and Barro and Gordon (1983). A procedure under which at each date central bank evaluates current economic situation and its possible future development and derives the optimal current action in the light of this analysis is inappropriate if agents' expectations are forward-looking. In a system in which people's expectations about future policy impinge upon the effects of current monetary policy action, the central bank should commit to an explicit rule that determines its conduct at any point in time.

Most of the literature uses a narrow interpretation of policy rule as an instrument rule. According to this interpretation, a monetary policy rule is defined as a description of how the instruments of policy, mainly interest rates, change in response to economic variables[1]. The most prominent example of such a rule in recent years has been the rule form proposed by Taylor (1993) which describes the reaction of nominal interest rate in time *t*, i_t, to deviations of inflation π_t from its target π^* and to the output gap

$$i_t = \alpha_1 + \alpha_2 \left(\pi_t - \pi^*\right) + \alpha_3 x_t \tag{1}$$

where $x_t = y_t - y_t^p$ stands for the output gap, y_t is (log) output, y_t^p denotes (log) potential output and α_1, α_2, α_3 are positive parameters. To account for interest rate smoothing, the lagged value of interest rate was included in the set of independent variables in Eq. (1). As Clarida et al. (1998) demonstrated, the actual policy conduct in the largest economies (US, Japan and Germany) could be rather well described by a Taylor rule at least after 1979.

Despite the fact that Eq. (1) does not seem to be in contrast with the way monetary policy operates in practice the idea of central bank commitment to a simple instrument rule has been subject to criticism[2]. First, the objective of monetary policy reform in Poland and many other countries was to define the price stability as the major concern of central banks. As Svensson (2003) notes there has been commitment to objectives rather than to simple instrument rules. Second, the instrument setting is not in reality as mechanical as a simple rule suggests and central banks in their decision-making process collect and analyze larger amount of information than just data on inflation and output. Third, simple rules used in practice describe the necessary adjustment of interest rate in terms of the desired evolution of target variables rather than the change of instrument rate itself.

On the other hand, Eq. (1) can be regarded as an optimal feedback policy for the interest rate and does not imply the central bank's commitment to a specific interest rule. Eq. (1) is thus consistent with a solution to the policy problem of choosing a time path for the instrument to engineer time paths of the target variables that maximize the objective function. In this paper we assume that the behavior of interest rate reflects the central bank's commitment to objectives and formulae like Taylor rule are considered as a monetary policy reaction function. In fact the NBP has never committed to an instrument rule.

To make sense of monetary policy non-neutrality in the short run we refer to a dynamic general equilibrium model with temporary nominal wage and price rigidities. In the New Keynesian framework, used in this paper, the aggregate behavioral equations are derived from optimizations by households and firms. A distinctive feature of this approach is that

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[1] See, for example, Taylor (1999)

[2] See Svensson (2003) for a critical assessment.

current economic behavior depends on the expectations of the future course of monetary policy, as well as on current policy. Since the detailed derivations of the model aggregate relationship are readily available in the literature[3], we directly introduce the structural equations of the model, which consist of the aggregate supply relation together with the intertemporal IS equation.

The demand or IS curve relates the output gap to the real interest rate and is obtained by log-linearizing the consumption Euler equation.

$$x_t = E_t x_{t+1} - \sigma E_t \left(i_t - \pi_{t+1}\right) \tag{2}$$

where E_t denotes expectations conditional on the information set available at time *t* and the parameter $\sigma > 0$. The intertemporal IS curve (2) differs from the traditional IS curve mainly because current output depends on expected future output as well as the real interest rate. Higher expected future output raises current output, as Clarida et al. (1999) point out, because individuals prefer to smooth consumption and expectation of higher output and the resulting rise in consumption next period induce them to raise consumption today. The negative impact of the real interest rate on output, in turn, is explained by intertemporal substitution of consumption and in the present formulation of the IS curve there is no mention of investment spending.

One obvious limitation of Eq. 2 is that other variables besides expected output gap and the real interest rate may affect aggregate demand. In empirical open economy extensions of the New Keynesian model[4], the exchange rate appears as an additional variable in the IS curve. A depreciation of the real exchange rate lowers the relative price of domestic goods, boosts exports and therefore has a positive impact on aggregate demand. The forward looking IS curve in a small open economy takes the form

$$x_t = E_t x_{t+1} - \sigma E_t \left(i_t - \pi_{t+1}\right) - \delta q_t \tag{3}$$

where q_t denotes the real exchange rate (a higher q_t means appreciation) and the parameter $\delta > 0$.

In a small open economy changes in the interest rate have, along with the impact on consumers' behaviour, an effect on the aggregate demand through the exchange rate channel.

$$q_t = \theta E_t \left(i_t - \pi_{t+1}\right) \tag{4}$$

where the parameter $\theta > 0$.

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[3] For the derivation of demand or IS curve see, for example, Woodford (2003, ch. 2) and for the New Keynesian Phillips and its empirical relevance – Gali and Gertler (1999).

[4] Ball (1999) and Svensson (2000) are among prominent examples.

Eq. (4) posits the link between the interest rate and the exchange rate and captures the idea that a rise in the real interest rate makes domestic assets more attractive, leading to an appreciation. Although its simplistic form equation like (5) was employed, for example, by Ball (1999).

The AS or the New Keynesian Phillips curve is the second structural equation of the model

$$\pi_t = \kappa x_t + \beta E_t \pi_{t+1} \tag{5}$$

where $0 < \beta < 1$ is a discount factor. The Phillips curve (4) can be derived from staggered nominal price setting behavior of optimizing firms with an assumption of Calvo pricing. As with the standard Phillips curve the relationship between inflation and output gap is positive. A key difference with the traditional expectations-augmented Phillips curve is that expected future inflation $E_t \pi_{t+1}$ enters Eq. (5) instead of expected current inflation $E_{t-1} \pi_t$. Since firms adjust nominal price on the basis of the expectations of future marginal costs, inflation rate depends on current and expected economic conditions and is independent of its own lagged values.

The extension of the analysis of the Phillips curve to small open economy has not led to a consensus on whether real exchange rate should enter Eq. (5). In his derivation of a backward-looking Phillips curve Ball (1999) argues that foreign firms desire constant real prices in their home currencies and they adjust their prices to changes in the real exchange rate. As a result, aggregate inflation, which is a weighted average of domestic and import inflation is a function of the change in the real exchange rate. Batini and Haldane (1999) also include the real exchange rate in the reduced-form Phillips curve derived in their model. However, the presence of the real exchange rate in inflation equation is not a consequence of optimizing behavior of firms but is due to the assumption, captured in the IS curve, that output depends negatively on the real exchange rate. On the other hand, Clarida et al. (2001) present a small open-economy model in which the AS curve has the same general form as in the closed economy and the effect of the exchange rate on output and inflation is captured in the parameters of the policy rule. We will follow that approach in this paper and adopt the AS curve equation in the form of Eq. (5) but we assume, as was mentioned before, that the real exchange rate enters the IS equation.

In order to close the model we need to specify the instrument of monetary policy. As was mentioned before, the nominal interest rate has been employed by the NBP to control the time paths of target variables over the period under investigation. Therefore it is not necessary to establish a money market equilibrium condition. Thus Eq. (3), (4) and (5) fully describe a macroeconomic environment in which the central bank decides on optimal policy.

3.2 Central bank's preferences and optimal policy

The objective of monetary policy is to minimize the expected value of a loss function of a form

$$W = E_t\left[\sum_{t=0}^{\infty}\beta^t L_t\right] \tag{6}$$

where the loss each period is given by

$$L_t = \frac{1}{2}\left[(\pi_t - \pi^*)^2 + \lambda_x(x_t - x^*)^2 + \lambda_i(i_t - i^*)^2 + \lambda_q(q_t - q^*)^2\right] \tag{7}$$

where π^*, i^*, q^* stand for the target level of the respective variables and coefficients λ_x, λ_i, λ_q>0 denote the weight assigned by the central bank to the deviation of a variable from the target[5]. For ease of exposition the weight on inflation is normalized to 1.

While the first and the second term on the RHS of Eq. (7) are standard components of the central banks' loss function, the presence of the remaining terms needs to be motivated. The term in interest rate reflects the interest rate stabilization objective[6]. On the one hand, the zero nominal interest rates means that it cannot be reduced in response of deflationary shock. On the other hand, high nominal interest rates always imply distortions. Furthermore, if the magnitude of distortions associated with positive nominal interest is a convex function of the interest rate, then its lower variance will reduce the average size of these distortions. Finally, the term in real exchange rate is added in (7) to account for the NBP intention, mentioned before, to achieve current account surplus and accumulate a high level of foreign exchange reserves.

The central bank's problem is to choose π_t, x_t, i_t and q_t to minimize (6) and (7) subject to Eq. (3) – (5). Using the law of iterated expectations, the Lagrangian for this problem can be written in the form

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[5] Woodford (2003, ch. 6) offers a welfare-based justification for quadratic objective function.

[6] See Woodford (1999)

$$\begin{aligned} L = E_t \sum_{t=0}^{\infty} \beta^t & \left\{ \frac{1}{2}\left[(\pi_t - \pi^*)^2 + \lambda_x (x_t - x^*)^2 + \lambda_i (i_t - i^*)^2 + \lambda_q (q_t - q^*)^2 \right] \right. \\ & + \varphi_{1t}\left[x_t - x_{t+1} + \sigma\left(i_t - \pi_{t+1}\right) + \delta q_t \right] \\ & + \varphi_{2t}\left[\pi_t - \kappa x_t - \beta \pi_{t+1} \right] \\ & \left. + \varphi_{3t}\left[q_t - \theta\left(i_t - \pi_{t+1}\right) \right] \right\} \end{aligned} \tag{8}$$

The optimal plan must satisfy the first order conditions for each date $t \geq 1$

$$\pi_t - \pi^* - \beta^{-1}\sigma\varphi_{1,t-1} + \varphi_{2t} - \varphi_{2,t-1} + \beta^{-1}\theta\varphi_{3,t-1} = 0 \tag{9}$$

$$\lambda_x\left(x_t - x^*\right) + \varphi_{1t} - \beta^{-1}\varphi_{1,t-1} - \kappa\varphi_{2t} = 0 \tag{10}$$

$$\lambda_i\left(i_t - i^*\right) + \sigma\varphi_{1t} - \theta\varphi_{3t} = 0 \tag{11}$$

$$\lambda_q\left(q_t - q^*\right) + \delta\varphi_{1t} + \varphi_{3t} = 0 \tag{12}$$

The same conditions must also hold at date $t = 0$, where however the stipulation is imposed that

$$\varphi_{1,-1} = \varphi_{2,-1} = \varphi_{3,-1} = 0 \tag{13}$$

as there is in fact no constraint associated with fulfillment of period-minus-one relations (3) – (5).

It is possible to eliminate the three Lagrange multipliers, employing (11) and (12) to solve for φ_{1t} and φ_{3t} and using this solution to eliminate φ_{1t} from (10) which can be then used to infer the value of φ_{2t}. Then substituting the expressions for the three Lagrange multipliers into (9) one obtains a linear relation among the endogenous variables π_t, x_t, x_{t-1}, i_t, i_{t-1}, i_{t-2}, q_t, q_{t-1} and q_{t-2} that must hold in any period $t \geq 2$. Because the relation in question involves a non-zero coefficient on i_t, it can be expressed as an implicit instrument rule of the form

$$i_t = -A\left(\pi^* + \frac{\lambda_i}{\beta} i^*\right) + \left(1 + A\frac{\lambda_i}{\beta}\right) i_{t-1} + \frac{1}{\beta}\Delta i_{t-1} + A\pi_t + A\frac{\lambda_x}{\kappa}\Delta x_t - B\Delta q_t + B\frac{1}{\beta}\Delta q_{t-1} \tag{14}$$

where

$$A = \frac{\kappa\left(\delta\theta + \sigma\right)}{\lambda_i} > 0 \tag{15}$$

$$B = \frac{\theta\lambda_q}{\lambda_i} > 0 \tag{16}$$

As was mentioned before we do not require that the central bank commit to the rule derived above. Eq. (14) describes optimal reaction of the central bank, in terms of the interest rate time-path, to the changes in inflation rate, output gap and real exchange rate. It may be instructive, however, to note that Eq. (14) has important similarities to the Taylor rule (1) with which it shares the recommendation that the interest rate should be raised in response to the rise in inflation or the output gap. Nonetheless, the optimal reaction function (14) involves history dependence, omitted from the Taylor rule. The history dependence is due to non-zero coefficients on the lagged interest rate, lagged increase in the interest rate, lagged output gap and lagged real exchange rate. The form of the optimal rule (14) parallels that proposed by Woodford (2003, ch. 8), the main difference being that the importance of the real exchange rate in the pattern of monetary policy in Poland has been acknowledged.

The coefficients of the interest rate rule are depending on the parameters describing central bank preferences and on those determining the structure of the economy. More specifically, the value of λ_x cannot be directly worked out from the estimated coefficients of Eq. (14). Consequently, it is necessary to estimate the Phillips curve equation in order to find the value of parameter κ. The methodology and the result of empirical analysis are presented in the next section.

4. Empirical analysis of central bank's preferences

In this section we test the hypothesis that the inflation stabilization objective outweighs the output objective in the NBP loss function. To that end we estimate the monetary policy reaction function.

4.1 Specification and the estimation technique

Following the discussion of the previous section, we assume that the monetary policy reaction function can be described by:

$$i_t = \rho_0 + \rho_1 i_{t-1} + \rho_2 \Delta i_{t-1} + \rho_3 \pi_t + \rho_4 \Delta x_t + \rho_5 \Delta q_t + \rho_6 \Delta q_{t-1} + \varepsilon_t \qquad (17)$$

where ε_t is the error term.

Since we normalized the weight assigned to inflation stabilization to one, the relative importance of the output gap stabilization in the central bank's loss function will be given by λ_x. The theoretical underpinnings of Eq. (17) outlined above reveal that the value of λ_x is given by

$$\lambda_x = \frac{\kappa\rho_4}{\rho_3} \tag{18}$$

where κ is a coefficient on the output gap in the Phillips curve. The starting point is therefore the estimation of Eq. (5).

The estimation of the forward-looking Phillips curve is not straightforward, since the set of independent variables includes the term in expected inflation. A measure of inflationary expectations of individuals in Poland can be obtained by applying Carlson and Parkin (1975) method to qualitative surveys. However, the survey focuses on inflationary expectations over next 12 months and we use quarterly data for the output gap. Since inflationary expectations over next quarter cannot be deduced from the expected CPI change year to year, we employ the generalized method of moments (GMM) to estimate Eq. (5).

Using ex-post data will deliver unbiased estimators of the parameters of Eq. (5) if the forecast errors have a zero mean. To find a set of parameters which will guarantee average zero forecast errors, the GMM technique uses the information contained in a vector of variables $\mathbf{z}_t$ known at time *t* and orthogonal to the inflation surprise in period *t*+1. The orthogonality condition that forms the basis for estimating Eq. (5) via GMM is given by

$$E_t\left[\pi_t - \kappa x_t - \beta\pi_{t+1} \middle| \mathbf{z}_t\right] = 0 \tag{19}$$

We use quarterly data for Poland over the period 1995:1-2003:2 from IMF *International Financial Statistics*. All data except interest rates and the real effective exchange rate are seasonally adjusted. The interest rate is measured in percent at an annual rate. As a measure of the output gap we use the percentage deviation of the real GDP from the potential GDP, calculated using the Hodrick-Prescott filter with a smoothing parameter of 1600. The current inflation π_t is represented by the percentage change in the CPI[7]. The set of instruments comprises the constant, the lags 1-5 of the output gap and lags of the CPI and PPI inflation rate[8]. We test the robustness of the results to the number of lags of the inflation rates included in the instruments. The money market interest rate is assumed to reflect best the NBP policy stance even in the period when the reserve money was the operating target.

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[7] The CPI and PPI inflation rates are defined, respectively, as $\pi_t \equiv \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} \cdot 100$ and

$$\pi_t^{PPI} = \frac{PPI_{t-j} - PPI_{t-j-1}}{PPI_{t-j-1}} \cdot 100$$

[8] The quarterly time series for the real GDP is not available prior to 1995 and an extensive use of its lagged values as instruments would further reduce the number of observations which even so is limited.

We applied the Augmented Dickey-Fuller (ADF) test of unit root for all involved time-series. The results reported in the Appendix suggest that both measures of inflation, the output gap and the interest rate are all $I(0)$. The real effective exchange rate series is not stationary. The ADF test carried out for the first difference of the real exchange rate suggests that the hypothesis of a unit root can be rejected.

4.2 Results

The results of estimation of Eq. (5) are presented in Table 1. In the first row we specify the number of lagged values of CPI and PPI inflation included in the instruments list. We report the coefficient estimates with t-statistics in parentheses. We also report the adjusted coefficient of determination (R^2 adj.), the Durbin-Watson statistic (DW) and the J-statistic of the overidentifying restrictions with p-values.

TABLE 1 GMM estimates of the New Keynesian Phillips curve, 1996:2-2003:1

Dependent variable: π_t

Instruments: constant, $\sum_{k=1}^{5} x_{t-k}$, $\sum_{j=1}^{n} \pi_{t-j}$, $\sum_{j=1}^{n} \pi_{t-j}^{PPI}$

Instruments	n=5	n=6	n=7	n=8	n=9	n=10
x_t	.36*** (3.71)	.32*** (3.53)	.31*** (3.66)	.29*** (4.45)	.25*** (4.05)	.23*** (4.34)
$E_t\pi_{t+1}$	1.01*** (18.56)	1.00*** (19.71)	.97*** (20.71)	.95*** (21.67)	.98*** (24.68)	.96*** (35.09)
R^2 adj.	.6	.6	.6	.6	.6	.6
DW	2.15	2.18	2.15	2.12	2.19	2.17
J-test (p-value)	10.83 (0.63)	12.12 (0.67)	14.1 (0.66)	16.89 (0.6)	19.95 (0.52)	24.88 (0.36)

T-statistics in parentheses (based on heteroskedasticity robust White errors) except for the J-test where the p-values to reject the hypothesis that over-identifying restrictions hold are reported.

****Statistically significant at 99% confidence level*

All coefficients are associated with the expected sign. In all specifications parameters κ and β are statistically significant at the 99% confidence level. The set of instruments seems to be appropriate since it is not possible to reject the hypothesis that all the over-identifying restrictions are satisfied. The goodness of fit is satisfactory with about 60 percent of variability in the inflation rate explained by the regression.

The key result is of course the magnitude of the parameter κ. The estimated slope of the Phillips curve ranges from 0.23 to 0.36 and we decide to pick the value of 0.3 to be substituted in Eq. (18) in what follows. It is also noteworthy that the estimates of the discount factor β are quite sensible and it appears that the New Keynesian Phillips curve provides a reasonable description of inflation in Poland.

With the estimated value of $\kappa = 0.3$ at hand we proceed to estimate the monetary policy reaction function (17). The results of estimates of Eq (17) are presented in Table 2 with t-statistics in parentheses, Durbin-Watson (DW), the adjusted coefficient of determination (R^2 adj.) and F-statistic to test the hypothesis that all coefficients are equal to zero.

The results of the baseline regression suggest that Eq. (17) does not provide an adequate description of the NBP reaction function. Although i_{t-1} and Δi_{t-1} are statistically significant and are associated with expected sign, the coefficients on remaining variables are not statistically different from zero. This disappointing result may be due to the evolution of the monetary policy objectives and strategy in Poland. In other words, the weights assigned by the NBP to various objectives in Eq. (7) may be unstable. The overview of monetary policy in Poland in section 2 points towards the conclusion that the goal of inflation stabilization has been emphasized in the recent years after the adoption of direct inflation targeting strategy.

TABLE 2 OLS estimates of the reaction function, 1995:2-2003:2
Dependent variable: money market interest rate i_t

Variable	Baseline regression	Regression with dummy	Regression with no real exchange rate terms
constant	.9	.75	.99
	(.61)	(.54)	(.77)
i_{t-1}	$.88^{***}$	$.88^{***}$	$.86^{***}$
	(7.71)	(8.16)	(8.67)
Δi_{t-1}	$.28^{**}$	$.36^{**}$	$.33^{**}$
	(2.31)	(2.67)	(2.7)
π_t	.34	.4	$.43^{*}$
	(1.25)	(1.63)	(1.73)
Δx_t	.41	-.84	-.84
	(.8)	(-1.12)	(-1.19)
$D \cdot \Delta x_t$	…	1.5^{*}	1.46^{**}
	…	(1.76)	(2.18)
Δq_t	.08	-.005	…
	(1.44)	(-.08)	…
Δq_{t-1}	-.04	-.05	…
	(-.57)	(-.74)	…
R^2 adj.	.93	.93	.93
DW	2.14	2.23	2.14
F-statistic	72.91	64.36	94.16

T-statistics in parantheses. *D* – dummy variable which takes on value 0 over the period 2000:1-2003:2 and 1 otherwise.

*Statistically significant at 90% confidence level

**Statistically significant at 95% confidence level

***Statistically significant at 99% confidence level

To test the hypothesis of instability of regression coefficients we enrich the set of independent variables with a dummy variable. The dummy variable *D* takes on value 0 over the period 2000:1-2003:2, corresponding to the fully-fledged inflation targeting in Poland, and 1 otherwise. We multiply *D* by Δx_t to estimate the coefficient associated with this variable under the assumption that weight the NBP assigned to inflation stabilization differs in two sub-periods. We experimented with various samples splits, i.e. with various lengths of the periods in which the dummies take one value 1 but only the most statistically significant results are presented.

The results of estimation of the unrestricted[9] regression with dummy corroborate the hypothesis that the weights assigned by the NBP to target variables in the objective function have been shifted between 1995 and 2003. In particular, the coefficient on $D \cdot \Delta x_t$ is statistically significant at the 90% confidence level and is associated with the positive sign. Thus, the output gap stabilization objective seems to shape the NBP policy over the period 1995-1999 and to be neglected afterwards. The analysis of results in Table 2 does not allow, however, to conclude that the NBP objective function has been inter alia over the real exchange rate in the period 1995-2003. The coefficients on both Δq_t and Δq_{t-1} are not statistically different from zero and the first lag of the first difference of the real exchange rate enters with the negative sign. One possible explanation of this result is that the sample includes only the brief period of strict exchange rate control imposed by the NBP.

Provided that the coefficients on Δq_t and Δq_{t-1} are not statistically significant, we estimate the following version of Eq. (17) with a dummy:

$$i_t = \rho_0 + \rho_1 i_{t-1} + \rho_3 \pi_t + \rho_4 \Delta x_t + \rho_5 (D \cdot \Delta x_t) + \varepsilon_t \qquad (20)$$

i.e. we impose the restriction that the real exchange rate does not enter the objective function of the NBP. It can be shown that equation (14) remains valid in this case[10].

It stems from the last column of Table 2 that the supposition that the output objective has lost its importance since 2000 is robust to the inclusion of the real effective exchange rate in the set of independent variables. The estimated monetary policy reaction function uncovers that interest rate is raised by about 40 basis points in response to a one percentage point increase in the inflation rate. A one percent increase in output above the natural level induces the NBP to raise the money market interest rate by about 150 basis points. The estimates of ρ_3 are lower and of ρ_4 higher than the estimate of the corresponding coefficients obtained by Clarida et al. (1998) but they are plausible. The results presented in the last column of Table 2 support the conclusions drawn from the estimation of the unrestricted version of Eq. (17) with dummy. Overall, the results of this exercise reinforce the hypothesis that the inflation stabilization was the ultimate goal of the NBP policy since the adoption of flexible exchange rate regime and pure inflation targeting strategy in 2000. We may therefore proceed to the calculation of the value of λ_x

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[9] Unrestricted regression with dummy is run on the independent variables form the baseline regression and on the product of output gap and the dummy variable.

[10] See Woodford (2003)

To evaluate the weight assigned to the output objective we choose, on the basis of the regression results reported in Table 2, the value of ρ_4 to be equal to 1.46 and the value of ρ_3 to be equal to 0.43. Together with the value of $\kappa = 0.3$ the results of estimation of the policy reaction function in Poland suggest that the value of λ_x in the period 1995-1999 is equal to 1.02 and zero afterwards. In other words, the weight attached to inflation stabilization objective in the NBP loss function was equal to the weight assigned to output gap stabilization in the period 1995-1999 and the latter goal has been disregarded since 2000.

5. Conclusions

This paper analyzes the NBP preferences for stabilization of output gap, inflation, interest rate and real exchange rate in the period 1995-2003. The evidence presented shows that the weights assigned to the target variables were not constant and have evolved with the changing pattern of monetary policy strategy in Poland. The stabilization of inflation has had an important role in the determination of short-term interest rate by the Polish central bank over the whole period under investigation. Before the adoption of direct inflation targeting and fully flexible exchange rate regime the NBP monetary policy has been in addition guided by the output gap stabilization considerations. The weight attached to inflation stabilization objective in the NBP loss function was equal to the weight assigned to output gap stabilization in the period 1995-1999. A definite confirmation of the NBP concern to secure the desired time-path of the real exchange rate has not been found in the data.

The estimation of the New Keynesian Phillips curve for Poland is a by-product of the main analysis conducted in this paper. We find that the forward-looking specification of the Phillips curve fits the data reasonably well. The slope of the curve, i.e. the coefficient on the output gap in inflation equation is equal to 0.3.

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Appendix

Table A Unit root tests (ADF without a constant)

Variable	Number of lags	t-statistics (p-values)
π_t	4	-2.1 (0.03)
π_t^{PPI}	10	-2.03 (0.04)
x_t	3	-2.53 (0.01)
i_t	7	-2.43 (0.01)
q_t	2	0.48 (0.82)
Δq_t	2	-2.89 (0.004)