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Assessing hybrid monetary function reactions in transition economies

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Abstract. This paper specifies and estimates hybrid monetary policy reaction functions in five countries of the Eastern Europe (Bulgaria, Czech Republic, Hungary, Poland, and Romania) and four post-Soviet countries (Belarus, Russia, Kazakhstan, and Ukraine) during the transition period. The problem of choosing an effective monetary policy is essential and is of significant interest in developing economies. The assessed reactions made it possible to compare monetary policy goals in these countries and their changes due to the recent global financial and economic crisis. The calculations carried out by the generalized method of moments based on the quarterly data for 1998-2018 showed that in all the countries under consideration, price containment was the primary goal of monetary policy. Along with it, monetary authorities adhered to their alternative goals. Moreover, due to the financial and economic crisis, countries mainly began to less support economic growth and the accumulation of gold and foreign exchange reserves while increasing attention to stabilizing the exchange rate and the real effective exchange rate.

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1. INTRODUCTION

Monetary policy has been an important question in the center of long-lasting economic debates among many different economists. While John M. Keynes preferred it to improve the global demand and fight the Great Economic Depression in the 1930s (Keynes, 1936), Milton Friedman has found it effective only in the short term. See his hypothesis of adaptive expectations (Friedman, 1956). More radically, monetary policy does not appear to be effective in the short and long terms for Robert Lucas, given his hypothesis of rational expectations. Monetarist and neoclassical economists stipulate that monetary policy would only yield inflation tension with no significant effect on the real economy.

Policymakers have always tried to conduct an efficient and rigorous monetary policy to improve central bank actions' efficiency through effective economic cycle action. At least in the most developed economies, each central bank has publicly defined the purpose of its action and the conduct of its policy through an explicit rule. In particular, since Taylor's (1993) eminent paper, a well-known rule – called Taylor Rule has been developed and adopted by several central banks to conduct their monetary policy. This rule suggests that the central bank defines the short-term interest rate-setting in relation to the output gap, the inflation target, and the long-term interest rate. However, some structural breaks in the monetary policy conduct have taken place, for example, after the UK and New Zealand officially adopted the inflation targeting policy. Also, given the independent character of central banks, at least till the recent global financial crisis (2008-2009), central banks in developed countries (i.e., the Fed, the ECB), have tried to stay faithful to their policies even during the most turbulent times. Since the global financial crisis, several central banks, including the Fed, the ECB, and the Bank of England, have switched to unconventional monetary policy to better limit the crisis effect and stimulate their economies. In practice, monetary policy's conduct, at least until the recent global financial crisis, depended on the central bank and alternating between implicit and explicit inflation targeting. This was more transparent in developed countries due to the hybrid mandates of their central banks (Fed, BoE, ECB). In emerging economies, central banks have always conducted monetary policy to look beyond inflation and the stability of their exchange rates. Many studies have covered monetary policy conduct by policymakers in these regions (Fiolsa, 2001; Corbo, 2002; Mohanty & Klau, 2005; Jawadi et al., 2014).

In other countries, such as in Eastern Europe (EE) and the Commonwealth of Independent Countries (CIS), monetary policy has experienced different episodes. These economies have known mutations and shifts. During their transition process, the EE countries have created their first functioning financial systems, developed their banking systems, and started to implement a monetary policy process. The latter has evolved when these economies have switched from fixed to floating exchange rate regimes (Frömmel & Schobert, 2006). As for the CIS countries, the objective of price stability has always been a challenge. These economies experienced a hyperinflation episode in the first half of the 1990s because of the ruble area's dissolution. Straight after that, inflation went up to a two-digit level after introducing new currencies and adopting a stabilizing program. The monetary policy's conduct has also been affected by the financial crisis of 1998-1999 and more recently — by the recent global financial crisis (Dabrowski, 2013), pushing the post-Soviet central banks to follow hybrid monetary policies.

The following studies considered different issues related to monetary policy. Using correlation analysis of the Polish economy data, 2005-2017, Redo & Siemiatkowski (2019) showed that the National Bank's monetary policy affects companies' cost of working capital through changes in interest rates. Shkolnyk et al. (2019), based on the panel 2007-2017 data for Ukraine, Moldova, and Georgia, assessed the relationship between growth and employment, exports, the ratio of M1 to GDP, the Gini index, and other indicators. Using a nonlinear distributed lag autoregressive model for Indonesia data from 1970-2017, Sriana (2019) found that government spending, money supply, and exchange rate significantly affect inflation. Moreover, based on the Divisia aggregate for estimating the demand for money in Malaysia, Leong et al. (2019) used a nonlinear autoregressive method with a distributed lag and data from 1991-2018 to reveal the asymmetric effects of exchange rate changes.

The rest of the paper consists of four sections. Section 2 provides an overview of the literature on monetary policy rules in the EE and post-Soviet countries. Section 3 presents the specification monetary rule for transition economies. Section 4 briefly presents the data and the main empirical results. Section 5 concludes.

2. RELATED LITERATURE

We briefly comment on some of the general papers focusing on monetary policy rules. Papadamou et al. (2018), using the GMM method, investigated whether the Taylor rule has been applied in all to all members of the European Union. They concluded that no rule applies to all these countries. Based on the panel cointegration model and the data from 1999-2012, Arlt & Mandel (2014) showed that the past and present values of explanatory variables could explain the behavior of interest rates of Poland, Hungary, and Czech Republic central banks. Owusu (2020), using the GMM method on monthly data from 2003-2018, found that the European Central Bank's short-term interest rate affects the Swedish Central Bank's monetary policy.

On the other hand, there are only a few studies of monetary policy rules for post-Soviet countries. Hybrid policies are rarely studied for these countries. One study is that of Dabrowski (2013), where it is shown that hybrid policies failed to maintain price stability and provide an effective anti-inflation action. Furthermore, central banks' independence in these regimes does not seem to be the case. This yields a fundamental monetary policy challenge in this region.

For example, throughout 1999-2003, Vdovichenko & Voronina (2006) checked Russia's monetary policy. They showed that the central bank employs a discretionary policy towards the exchange rate rather than follow a policy of inflation targeting. Esanov et al. (2005) assert that, over the period 1993-2002, a simple Taylor rule fails to reproduce the Russian monetary policy. They recommend following the McCallum (1993) rule. According to Ghatak & Moore (2011), the failure of using interest rates in the EE and post-Soviet economies points to the superiority of the monetary base instrument. However, while the latter provides positive results during the transition period, the use of interest rates seems to achieve monetary policy goals over recent years. As far as Kazakhstan is concerned, Mukhamediyev (2007) showed that while the central bank has employed the monetary base instrument before 2000, its monetary policy switched to using the short-run interest rate over 2000-2006. Investigating the conduct of monetary policy in 12 countries in transition over the period 1992-2002, Drobyshevski et al. (2003) showed that central banks almost always take monetary actions that do not correspond to their declared purposes. El-Hodiri & Mukhamediyev (2014) also have reached the same conclusion for different economies in transition. In the same research line, Mohanty & Klau (2005) investigated monetary policy in 13 developing and transition economies in Asia, Latin America, Africa, and Eastern Europe, including Hungary, Poland, and the Czech Republic. The authors concluded that although most central banks have focused on fighting inflation, they

have changed their interest rates to protect exchange rates' parity. Thus, overall, no unanimous conclusion does result from these previous studies.

This paper assesses monetary policies in five countries of Eastern Europe (Bulgaria, Czech Republic, Hungary, Poland, Romania) and four principal post-Soviet countries (Belarus, Russia, Kazakhstan, Ukraine). Different known mutations and changes over the last decades of those economies have justified selecting this sample. Further, we develop and estimate different flexible and hybrid monetary rules for these economies to understand better the reaction in terms of their central banks' monetary functions. In particular, we check the hypothesis of hybrid monetary policies highlighted by several previous related studies and test whether monetary policy's conduct varies with the business cycle phase. Finally, we compare the monetary authorities' different actions and assess each policy rule's advantages and disadvantages.

3. THE MODEL OF MONETARY POLICY RULES FOR TRANSITION ECONOMIES

Each monetary authority always has direct objectives (i.e., inflation control) and indirect objectives (i.e., unemployment fighting, exchange rate control, and economic growth stimulation). Accordingly, the central bank always uses different instruments (i.e., interest rate, open market operation, etc.). To do this, the central bank often defines well-known monetary policy rules (Taylor Rule, McCullum Rule, etc.). Formally, Clarida et al. (1998) specified the monetary policy rule as follows:

$$i_t^* = \alpha + \beta[E_t(\pi_{t+n}|\Omega_t) - \pi^*] + \gamma[E_t(y_t|\Omega_t) - y_t^*] + \delta[E_t(z_t|\Omega_t) - z_t^*], \quad (1)$$

where: π_{t+n} denotes the inflation rate in the period $t+n$. π^* denotes the target value of the inflation rate. y_t is the real output and y_t^* represents its target value. Ω_t refers to the information set available for the central bank at the time *t*. E_t denotes the operator of expectations at the time t based on the information set Ω_t. z_t^* refers to the target value of alternative variable z_t. The term α denotes the desired value of the instrument i_t^*, provided the inflation, output and alternative target variable reached their desired levels. $\beta, \gamma,$ and δ are parameters to be estimated.

However, in practice, central banks do not prefer abrupt changes in interest rates, and the following partial correction mechanism is rather preferred:

$$i_t = (1-\rho)i_t^* + \rho i_{t-1} + \nu_t. \quad (2)$$

The parameter ρ determines the degree of inertia of the instrument i_t and thus the degree of smoothing of interest rate dynamics, while ν_t is a random disturbance. For illustration, the value of ρ for the developed countries such as the US, Germany, Japan, the UK, France, and Italy, is approximately equal to 0.95, indicating high inertia of the interest rate dynamics.

Let us substitute i_t^* from equation (1) into equation (2), we can specify the monetary policy rule as follows:

$$i_t = (1-\rho)\alpha + (1-\rho)\beta\pi_{t+n} + (1-\rho)\gamma y_t + (1-\rho)\delta z_t + \rho i_{t-1} + \eta_t, \quad (3)$$

where:

$$\eta_t = (1-\rho)[\beta(E_t(\pi_{t+n}|\Omega_t) - \pi_{t+n}) + \gamma(E_t(y_t|\Omega_t) - y_t) + \delta(E_t(z_t|\Omega_t) - z_t)] + \nu_t.$$

The model used in the paper is based on the Clarida et al. (1998) model but differs from it, which is explained by the features of the statistical data of the emerging economies of the post-Soviet countries and Eastern Europe. In equation (3) $i_t, \pi_{t+n}, y_t, z_t,$ and η_t are random variables. Let $\check{\imath}_t, \check{\pi}_{t+n},\ \check{y}_t,\ \check{z}_t,$ and $\check{\eta}_t$ are means of the corresponding random variables at period t. Besides, $\check{\eta}_t$ is assumed zero. Then by taking the mean of both sides of the equation (3), we get the equation:

$$\check{\imath}_t = (1-\rho)\alpha + (1-\rho)\beta\check{\pi}_{t+n} + (1-\rho)\gamma\check{y}_t + (1-\rho)\delta\check{z}_t + \rho\check{\imath}_{t-1}. \quad (4)$$

Subtracting (4) from (3), we get the following monetary rule:

$$\tilde{\imath}_t = (1-\rho)\beta\tilde{\pi}_{t+n} + (1-\rho)\gamma\tilde{y}_t + (1-\rho)\delta\tilde{z}_t + \rho\tilde{\imath}_{t-1} + \eta_t, \quad (5)$$

where: $\tilde{\imath}_t = i_t - \check{\imath}_t,\ \tilde{\pi}_t = \pi_t - \check{\pi}_t,\ \tilde{y}_t = y_t - \check{y}_t,\ \tilde{z}_t = z_t - \check{z}_t$. Thus, equation (5) is similar to the corresponding equation in Clarida et al. (1998). However, its derivation way is different. Specification (5) has the advantage of providing a flexible monetary rule. The monetary authority can act on the short-term interest to control inflation and GDP variations, and other macroeconomic variables (exchange rate, etc.) in reason of other economic drivers in the term z. Model (5), like Clarida et al. (1998), has a simple form. In contrast, the calculations showed that the t-statistics of the estimated coefficients in the model (5) do not take enormous values. Also, model (5) does not contain differences between the current and previous values of variables and random terms.

4. EMPIRICAL RESULTS

4.1 Data Description

We used the data obtained from the International Financial Statistics of the International Monetary Fund (IMF) and the Central Statistical Authorities of the nine countries included in this study. Inflation is measured on a CPI basis. The data is quarterly and covers the period: 1998q1 - 2018q4. A limitation of the study is the use of quarterly data due to the lack of monthly data for some countries' indicators under consideration.

We applied the Hodrick-Prescott filter to compute trend variables. We noted hereafter irh, inflh, lgdph, erh, reerh and resh deviations from trend values of the interest rate (lending rate, percent per annum), the rate of inflation, the logarithm of real GDP, the nominal exchange rate of the national currency versus the US dollar, the real effective exchange rate, and the gold and foreign reserves, respectively. Further, in the notation of these variable, we use the symbols be, bu, cz, hu, kz, pl, ro, ru, and ua to refer to the countries Belarus, Bulgaria, Czech Republic, Hungary, Kazakhstan, Poland, Romania, Russia, and Ukraine, respectively. For example, variable plerh denotes the deviation from the trend value of Poland's nominal exchange rate. Table 1 contains the results of the augmented Dickey-Fuller test for all these time series.

Table 1

Augmented Dickey-Fuller statistics for time series

Variable	Intervals		Variable	Intervals		Variable	Intervals	
	1998q1 – 2008q4	2009q1 – 2018q4		1998q1 – 2008q4	1998q1 – 2008q4		1998q1 – 2008q4	1998q1 – 2008q4
beirh	-2.78**	-3.67**	huirh	-2.30**	-4.72**	roirh	-1.98*	-3.23**
beinflh	-5.67**	-2.76**	huinflh	-1.32	-3.07**	roinflh	-2.30**	-2.15*
belgdph	-1.32	-2.22*	hulgdph	-0.74	-4.99**	rolgdph	-0.08	-5.79**
beerh	-0.57	-4.83**	huerh	-2.01*	-5.27**	roerh	-2.38*	-4.72**
bereerh	-2.54*	-4.30**	hureerh	-3.81**	-7.20**	roreerh	-2.07*	-3.38**
beresh	-5.90**	-3.01**	huresh	-2.54*	-1.64†	roresh	-2.26*	-4.13**
buirh	-5.32**	-2.38*	kzirh	-3.09**	-3.10**	ruirh	-3.01**	-3.18**
buinflh	-3.09**	-5.04**	kzinflh	-3.60**	-3.56**	ruinflh	-8.42**	-3.48**
bulgdph	-0.52	-4.50**	kzlgdph	-2.22*	-2.84*	rulgdph	-2.49*	-2.72**
buerh	-1.85†	-4.56**	kzerh	-1.97*	-3.62**	ruerh	-3.87**	-2.81**
bureerh	-2.94**	-2.99**	kzreerh	-3.06**	-5.78**	rureerh	-6.10**	-3.55**
buresh	-5.40**	-3.21**	kzresh	-3.75**	-2.33*	ruresh	-2.55*	-2.51*
czirh	-5.32**	-3.08**	plirh	-4.03**	-4.50**	uairh	-3.62**	-3.32**
czinflh	-1.99*	-5.13**	plinflh	-2.96**	-2.38*	uainflh	-2.43*	-3.78**
czlgdph	-2.06*	-5.80**	pllgdph	-2.17*	-5.50**	ualgdph	-2.18*	-4.64**
czerh	-2.10*	-5.11**	plerh	-2.67**	-5.08**	uaerh	-2.62**	-1.80†
czreerh	-4.19**	-3.80**	plreerh	-2.19*	-6.15**	uareerh	-3.53**	-3.21**
czresh	-2.30*	-2.97**	plresh	-6.07**	-3.21**	uaresh	-2.75**	-2.43*

Note ** – significance at a 1-percent level, * – significance at a 5-percent level, † - significance at a 10-percent level.
Source: own calculation

To detect further monetary policy changes over time, we assessed the rules of monetary policy at two intervals: the first one - from the first quarter of 1998 to the fourth quarter of 2008 and the second interval – from the first quarter of 2009 to the fourth quarter of 2018. This choice has the advantage of analyzing the conduct of monetary policy in economies in transition before and after the recent global financial crisis. In the data series evolution, the main point of interest is their stationarity. For the 108 data series in Table 1, the unit root hypothesis is not rejected at 5% significance level in 9 cases, 7 of them in the first interval, and 2 in the second interval. All of these cases are taken into account when evaluating the models in Tables 2-19.

4.2. Estimating Hybrid Monetary Rules

We used the generalized method of moments (GMM) to assess the monetary functions of responses in each country for each interval. Many researchers of monetary policy rules use this method, for example, Trung & Kiss (2020), Owusu (2020). When using it, GMM does not require information about the distribution of the error term. It is applicable for correlations between regressors and error terms and autocorrelation and heteroscedasticity (Greene, 2012). There are two main conditions for the applicability of GMM. The stationarity of variables and the absence of overidentifying constraints. As shown in Table 1, the first condition of the variables' stationarity is satisfied, except for several cases when evaluating the corresponding models. To check the second condition that there are no specification errors, we use J-

statistics (Hansen, 1982). To perform all calculations, we used the generalized method of moments with robust Newey-West estimates.

We used lags of dependent and independent variables as instrumental variables. Moreover, we chose the instrumental variables' composition to satisfy the condition for the absence of specification errors and to provide the number of instrumental variables used to be as small as possible. Our choice also provides that the error in equation (5) does not cover the previous period.

We report the main empirical results, including J-statistics in Tables 2-19. In each Table, in the first column, we specify the list of explanatory variables. The next column (a) shows the estimated coefficients of the base model without alternative target variables. Column (b) shows the estimated coefficients of the base model with an additionally included output variable. Finally, the last three columns (c) - (e) show the base model's estimated coefficients, including exchange rate variables, real effective exchange rate, and gold and foreign exchange reserves, respectively. Moreover, if in column (b) the output variable's coefficient is statistically significant and positive, then it is also included in these models.

Regarding the proxy of inflation expectation, we used in all cases ahead of one quarter. According to the model's specification, the coefficients for output variables and the exchange rate should be positive. The coefficients for the real effective exchange rate variables and gold and foreign exchange reserves should be negative. We use bold to show the columns in which all the estimated coefficients are statistically significant, and their signs correspond to the model's specification.

Next, we briefly analyze the calculation results and compare them with previous studies for all countries, excluding Belarus and Bulgaria, for which we could not find the relevant data.

Belarus

From Table 2, we note that for equation (a), the coefficient for the inflation variable is significant and positive. While the output gap's coefficient is statistically not significant when considering the first interval estimation (equation (b)). This suggests that the central bank policy in Belarus is inflation targeting. Furthermore, as one can see from equations (c), (d), and (e), the central bank in Belarus can adjust its interest rate. Therefore, its monetary reaction functions have only changed the real effective exchange rate and the gold and foreign exchange reserves. The fact that the hypothesis of a unit root (Table 1) is not rejected for variables belgdph and beerh does not affect these conclusions. This suggests that, before the recent global financial crisis (2008), the monetary policy in Belarus has aimed at fighting inflation while keeping a close eye on the variation of the real exchange rate and the foreign exchange reserves.

Table 2

Dependent variable beirh, Interval 1: 1999q1-2008q4

Equation	(a)	(b)	(c)	(d)	(e)
beirh (-1)	**0.972** (.00)**	0.984** (.00)	0.722** (.00)	**0.825** (.00)**	**0.998** (.00)**
beinflh (+1)	**0.082** (.00)**	0.085** (.00)	0.023** (.00)	**0.115** (.00)**	**0.073** (.00)**
belgdph		-0.245 (.79)			
beerh			-0.000 (.72)		
bereerh				**-0.132** (.00)**	
beresh					**-0.006* (.00))**
J-statistics	**6.26 (.94)**	6.25 (.90)	7.08 (.93)	**7.51 (.91)**	**8.00 (0.93)**

Note: ** – significance at a 1-percent level, * – significance at a 5-percent level, † - significance at a 10-percent level. The corresponding p-values are shown in parentheses.
Source: own calculation

It also appears that in the aftermath of the global financial crisis, the monetary policy remains more sensitive to changes in inflation than to the output. In column (c) of Table 3, all coefficients are statistically

significant, and the coefficient of the exchange rate is negative. Concerning the equation with alternative targets, the real effective exchange rate variable plays a significant role, suggesting that the monetary authorities also took into account changes in the real effective exchange rate and reacted in the right direction.

Table 3

Dependent variable beirh, Interval 2: 2009q1-2018q4

Equation	(a)	(b)	(c)	(d)	(e)
beirh (-1)	**0.636** (.00)**	0.714**(.00)	0.816** (.00)	**0.945** (.00)**	0.816** (.00)
beinflh (+1)	**0.063** (.00)**	0.012 (0.23)	0.086** (.00)	**0.037** (.00)**	0.097** (.00)
belgdph		*-22.72**(.00)*			
beerh			*-0.0002** (.00)*		
bereerh				**-0.192** (.00)**	
beresh					0.003 (.69)
J-statistics	**6.40 (.90)**	7.05 (0.90)	7.66 (.91)	**5.01 (.93)**	7.73 (.90)

Note: ** – significance at a 1-percent level, * – significance at a 5-percent level, † - significance at a 10-percent level. The corresponding p-values are shown in parentheses.
Source: own calculation

Overall, the country's monetary authorities in both intervals sought to stabilize inflation and the real effective exchange rate, which, according to the data, actually decreased in both intervals. The monetary policy did not help maintain economic growth and the national currency exchange rate. Although the interest rate reacted correctly to changes in the gold and foreign exchange reserves in the first interval, the monetary authorities did not pay much attention to this alternative goal in the second interval. Their decline replaced the growth of gold and foreign exchange reserves in the second interval.

Bulgaria

From Tables 4 and 5, as in Belarus, the Bulgarian central bank also aims to fight inflation rather pursing a policy that stimulates economic growth.

Table 4

Dependent variable buirh, Interval 1: 1999q1-2008q4

Equation	(a)	(b)	(c)	(d)	(e)
buirh (-1)	**0.803** (.00)**	0.788** (.00)	0.363** (.00)	-0.066 (.55)	1.802** (.00)
buinflh (+1)	**0.026* (.03)**	0.019 (.06)	0.001 (.98)	0.011 (.22)	-0.083 (.46)
bulgdph		-0.849 (.09)			
buerh			0.464† (.09)		
bureerh				0.097** (.00)	
buresh					-0.073† (.08))
J-statistics	**6.74 (.91)**	6.29 (.97)	7.55 (.91)	7.50 (.91)	3.10 (0.96)

Note: ** – significance at a 1-percent level, * – significance at a 5-percent level, † - significance at a 10-percent level. The corresponding p-values are shown in parentheses.
Source: own calculation

Table 5

Dependent variable buirh, Interval 2: 2009q1-2018q4

Equation	(a)	(b)	(c)	(d)	(e)
buirh (-1)	**0.617** (.00)**	0.899** (.00)	0.804**(.00)	1.119** (.00)	0.047 (.84)
buinflh (+1)	**0.047** (.01)**	0.025 (.17)	-0.009 (.17)	-0.135** (.00)	0.021** (.38)
bulgdph		0.097 (0.34)			
buerh			0.127 (.28)		
bureerh				-0.116 (.50)	
buresh					0.006* (.10))
J-statistics	**6.32 (.90)**	4.45 (.81)	8.36 (.91)	5.11 (.93)	7.57 (0.93)

Note: ** – significance at a 1-percent level, * – significance at a 5-percent level, † - significance at a 10-percent level. The corresponding p-values are shown in parentheses.
Source: own calculation

Further, while the coefficients of alternative exchange rate target variables, the real effective exchange rate, and gold and foreign exchange reserves, shown in columns (c) - (e), are not statistically significant for both intervals. Although the unit root hypothesis (Table 1) is not rejected for variables bulgdph and buerh in the first interval, this does not affect the conclusions. This suggests that monetary policy in Bulgaria does not look to be clearly defined. Indeed, in the second interval, the national currency weakened; GDP growth slowed.

Czech Republic

In table 6, we can note that over interval 1, the central bank was guided by expected inflation rates ahead of one quarter but did not take into account changes in output. The inflation variable's coefficient is positive, suggesting that changes in the interest rate have occurred in the right direction in response to changes in the inflation variable. The expected increase in the inflation rate contributed to a tightening of monetary policy, increasing the interest rate. In equations (c) and (d), the coefficients for variables of the nominal exchange rate and the real effective exchange rate are insignificant. Hence, their changes did not have a significant impact on the behavior of the interest rate. Simultaneously, in equation (e), the coefficient for the variable of gold and foreign exchange reserves is significant and negative, which corresponds to the model's specification. In the study (Popescu, 2014) for 1998-2012, the output gap coefficient is also positive, but it is significant, unlike the coefficient in Table 6. However, this study does not provide data on testing the stationarity of the series.

Table 6

Dependent variable czirh, Interval 1: 1999q1-2008q4

Equation	(a)	(b)	(c)	(d)	(e)
czirh (-1)	**0.893** (.00)**	0.891** (.00)	0.872** (.00)	0.845** (.00)	**0.924** (.00)**
czinflh (+1)	**0.043** (.00)**	0.041** (.00)	0.039** (.00)	0.037** (.00)	**0.041** (.00)**
czlgdph		0.037 (.83)			
czerh			-0.004 (.52)		
czreerh				0.001 (.95)	
czresh					**-0.009** (.00))**
J-statistics	**5.26 (.92)**	5.56 (.94)	6.06 (.91)	7.31 (.92)	**8.04 (0.92)**

Note: ** - significance at a 1-percent level, * - significance at a 5-percent level, † - significance at a 10-percent level. The corresponding p-values are shown in parentheses.
Source: own calculation

Table 7

Dependent variable czirh, Interval 2: 2009q1-2018q4

Equation	(a)	(b)	(c)	(d)	(e)
czirh (-1)	**0.901** (.00)**	0.759** (.00)	0.886** (.00)	0.914** (.00)	0.791** (.00)
czinflh (+1)	**0.010** (.00)**	0.011** (.00)	0.004 (.18)	-0.006* (.01)	0.011** (.00)
czlgdph		-0.021 (.69)			
czerh			-0.001 (.57)		
czreerh				-0.0004 (.69)	
czresh					-8.3E-05 (.50))
J-statistics	**4.66 (.95)**	7.50 (.91)	7.23 (.95)	4.75 (.96)	8.19 (0.92)

Note: ** - significance at a 1-percent level, * - significance at a 5-percent level, † - significance at a 10-percent level. The corresponding p-values are shown in parentheses.
Source: own calculation

Regarding the second interval, equation (b) with intermediate target inflation and release variables turned out to be insignificant, and equation (a) only with the inflation target was statistically significant (Table 7). The country's monetary authorities took into account inflation expectations but did not consider the changes in output. Equations (c) - (e) with additional alternative target variables are insignificant. Consequently, in the second interval, the interest rate did not react in the right direction to changes in the exchange rate, the real effective exchange rate, and the country's gold and currency reserves. Further, for both intervals, the country's monetary authorities pursued a policy of containing inflation and not aiming to support economic growth.

Hungary

From Table 8 (equations (a) and (b)), we note that, over the first interval, both inflation and output gap appear as significant drivers for the monetary policy. However, this conclusion is unreliable since the unit root hypothesis is not rejected for variables huinflh and hulgdph (Table 1). Further, the central bank seems not to adjust its interest rate to consider changes in the exchange rate, the real effective exchange rate, and its gold and currency reserves. Accordingly, in contrast to previous countries, it is unclear whether the Hungarian Central Bank was able with its mandate to combat price volatility and simultaneously accelerate economic growth in the first interval. In the results (Popescu, 2014) for 2001-2012, the output gap's coefficient is negative and significant. However, this may be a consequence of the nonstationarity of this variable.

Table 8

Dependent variable huirh, Interval 1: 1999q1-2008q4

Equation	(a)	(b)	(c)	(d)	(e)
huirh (-1)	**0.389** (.00)**	**0.885** (.00)**	0.992** (.00)	0.815** (.00)	0.773** (.00)
huinflh (+1)	**0.165** (.00)**	**0.115** (.00)**	0.169** (.00)	0.109** (.00)	-0.008 (.54)
hulgdph		**5.767** (.00)**	6.313** (.00)	10.53** (.00)	-10.58** (.00)
huerh			-0.003 (.51)		
hureerh				*0.037* (.02)*	
huresh					-0.001* (.01)
J-statistics	**6.05 (.91)**	**6.67 (.92)**	7.68 (.91)	6.63 (.92)	4.48 (.95)

Note: ** - significance at a 1-percent level, * - significance at a 5-percent level, † - significance at a 10-percent level. The corresponding p-values are shown in parentheses.
Source: own calculation

Table 9

Dependent variable huirh, Interval 2: 2009q1-2018q4

Equation	(a)	(b)	(c)	(d)	(e)
huirh (-1)	**0.805** (.00)**	0.799** (.00)	**0.851** (.00)**	**0.831** (.00)**	0.812** (.00)
huinflh (+1)	**0.222** (.00)**	0.214** (.00)	**0.155** (.00)**	**0.185** (.00)**	0.303** (.00)
hulgdph		*-1.814**(.00)*			
huerh			**0.006* (.02)**		
hureerh				**-0.113** (.00)**	
huresh					*0.305** (.00))*
J-statistics	**9.44 (.90)**	9.29 (.90)	**9.34 (.90)**	**8.42 (.91)**	6.95 (0.90)

Note: ** - significance at a 1-percent level, * - significance at a 5-percent level, † - significance at a 10-percent level. The corresponding p-values are shown in parentheses.
Source: own calculation

The results shown in Table 9 suggest that after the recent global financial crisis, monetary authorities have changed the interest rate in the right direction to contain inflation. Still, they do not react in the right direction to maintain economic growth (equations (a) and (b)). The coefficient at the exchange rate variable in equation (c) is positive, and the coefficient of the real effective exchange rate variable in equation (d) is negative. Hence, interest rate behavior changed to stabilize these exchange rates. However, the coefficient for gold and foreign exchange reserves' variable is positive, which does not correspond to the model specification. The unit root hypothesis is not rejected for variable huresh in the second interval (Table 1). Accordingly, the interest rate changes did not lead to the stabilization of gold and foreign exchange reserves.

Kazakhstan

Until the recent global financial crisis, the central bank appears to follow inflation targeting policy while also adjusting its rate to take into account further changes in the real effective exchange rate (Table 10, equations (a) and (d)). At the same time, fluctuations in the variables of output, nominal exchange rate, and gold and foreign exchange reserves do not affect interest rate behavior (equations ((b), (c), and (d)).

Table 10

Dependent variable kzirh, Interval 1: 1999q1-2008q4

Equation	(a)	(b)	(c)	(d)	(e)
kzirh (-1)	**0.712** (.00)**	0.742** (.00)	0.687** (.00)	**0.609** (.00)**	0.671** (.00)
kzinflh (+1)	**0.127** (.00)**	0.119** (.00)	0.124** (.00)	**0.141** (.00)**	0.132** (.00)
kzlgdph		-0.555 (.10)			
kzerh			-0.006 (.50)		
kzreerh				**-0.029** (.01)**	
kzresh					-0.007 (.36))
J-statistics	**7.62 (.91)**	7.85 (.90)	8.96 (.91)	**8.63 (.97)**	8.02 (0.92)

Note: ** - significance at a 1-percent level, * - significance at a 5-percent level, † - significance at a 10-percent level. The corresponding p-values are shown in parentheses.
Source: own calculation

Table 11

Dependent variable kzirh, Interval 2: 2009q1-2018q4

Equation	(a)	(b)	(c)	(d)	(e)
kzirh (-1)	**0.862** (.00)**	0.993** (.00)	**0.711** (.00)**	**0.617** (.00)**	0.927** (.00)
kzinflh (+1)	**0.217** (.00)**	0.248** (.00)	**0.110** (.00)**	**0.099** (.00)**	-0.039 (.27)
kzlgdph		-0.628 (0.61)			
kzerh			**0.024* (.00)**		
kzreerh				**-0.083** (.00)**	
kzresh					-0.026** (.00)
J-statistics	**4.84 (.90)**	5.94 (0.92)	**7.75 (.90)**	**7.61 (.91)**	8.24 (.91)

Note: ** - significance at a 1-percent level, * - significance at a 5-percent level, † - significance at a 10-percent level. The corresponding p-values are shown in parentheses.
Source: own calculation

Interestingly, the monetary authority has followed a similar rule in the aftermath of the recent global financial crisis. Indeed, the basic equation (a) with a variable of the expectation of inflation and the equation (d) with real effective exchange rates are statistically significant (Table 11). The interest rate changed in the right direction in response to fluctuations in the expected inflation rate ahead of one quarter. It did not react correctly to the current value of the variable of economic growth. In the second interval, the interest rate responded in the right direction to fluctuations in the nominal exchange rate (equation (c)).

Thus, during both intervals, the monetary authorities attached significant importance to curbing inflation, stabilizing the real effective exchange rate, and ignored support for economic growth and gold and foreign exchange reserves. Besides, in the second interval, one of the goals was to stabilize the nominal exchange rate, as there was a strong tendency to weaken the national currency. Drobyshevsky et al. (2003) undertook an attempt to assess Kazakhstan's rules based on data from 1993-2002. But it was unsuccessful. Mukhamediyev (2007) showed that for the period from 1995-1999, the monetary base, rather than the interest rate, was a more suitable monetary policy instrument.

Poland

As for Hungary, we found that over the first interval, the monetary policy in Poland fought inflation and boost economic growth simultaneously (Table 12, equations (a) and (b)). The conduct of monetary policy following the Taylor rule appears, however, more strict. The coefficients of alternative target variables of nominal and real effective exchange rates and gold and foreign exchange reserves are insignificant.

Table 12

Dependent variable plirh, Interval 1: 1999q1-2008q4

Equation	(a)	(b)	(c)	(d)	(e)
plirh (-1)	**0.837** (.00)**	**0.831** (.00)**	0.789** (.00)	0.781** (.00)	0.833** (.00)
plinflh (+1)	**0.405** (.00)**	**0.383** (.00)**	0.233** (.00)	0.456** (.00)	0.354** (.00)
pllgdph		**1.139** (.01)**	1.320* (.04)	-0.330 (.60)	0.112 (.87)
plerh			*-0.249 (.11)*		
plreerh				0.015 (.07)	
plresh					0.021** (.00)
J-statistics	**7.88 (0.90)**	**7.42 (.92)**	7.18 (.93)	7.19 (.93)	7.30 (.0.89)

Note: ** - significance at a 1-percent level, * - significance at a 5-percent level, † - significance at a 10-percent level. The corresponding p-values are shown in parentheses.
Source: own calculation

Table 13

Dependent variable plirh, Interval 2: 2009q1-2018q4

Equation	(a)	(b)	(c)	(d)	(e)
plirh (-1)	**0.817** (.00)**	860** (.00)	0.905** (.00)	0.862** (.00)	0.966** (.00)
plinflh (+1)	**0.109** (.00)**	*-0.049 (.13)*	0.025** (.00)	0.003 (.90)	0.216** (.00)
pllgdph		*-1.93** (.00)*			
plerh			*-0.981** (.00)*		
plreerh				*0.041** (.00)*	
plresh					-0.004 (.53)
J-statistics	**8.79 (.92)**	8.44 (.90)	9.15 (.95)	8.52 (.90)	5.99 (.92)

Note: ** - significance at a 1-percent level, * - significance at a 5-percent level, † - significance at a 10-percent level. The corresponding p-values are shown in parentheses.
Source: own calculation

Further, over the second interval, the central bank pursued a policy of targeting inflation but not stimulating growth (Table 13, equations (a), (b)). This conclusion is consistent with the finding in (Popescu, 2014). The coefficients for equations with alternative target variables of nominal and real effective exchange rates and gold and foreign exchange reserves are insignificant.

As a whole, this policy reacted in response to fluctuations in inflationary variables and economic growth in the right direction. According to the data, monetary policy quite successfully contributed to achieving two goals: the inflation rate almost always sat down. There was a steady increase in GDP over the entire interval from 2008 to 2018.

Romania

Tables 14 and 15 show that over both intervals, estimates in equations (a), (c), and (d) are statistically significant. The coefficients at inflation expectations, exchange rate variables, and real effective exchange rate have signs corresponding to the model specification. It is also true for the equation (e) in Table 15. Hence, the interest rate reacted to changes in these variables in the right direction. Note that in equation (b) in the first interval, the coefficient at variable rolgdph is negative, as in (Popescu, 2014). Still, the unit root hypothesis is not rejected for it (Table 1), and in the second interval, the coefficient at this variable is insignificant. Consequently, the interest rate reacted in the right direction to changes in all variables except the output variable in the first interval and excluding the output and foreign exchange reserves variables in the second interval.

Table 14

Dependent variable roirh, Interval 1: 1999q1-2008q4

Equation	(a)	(b)	**(c)**	(d)	(e)
roirh (-1)	**0.675** (.00)**	0.355** (.00)	**0.724** (.00)**	**0.745** (.00)**	**0.633** (.00)**
roinflh (+1)	**0.299** (.00)**	0.146** (.00)	**0.406** (.00)**	**0.470** (.00)**	**0.150** (.00)**
rolgdph		*-2.438* (.02)*			
roerh			**1.398** (.00)**		
roreerh				**-0.239** (.00)**	
roresh					**-0.078** (.00)**
J-statistics	**7.53 (.91)**	6.72 (.92)	**8.56 (.90)**	**7.29 (.94)**	**7.62 (.94)**

Note: ** - significance at a 1-percent level, * - significance at a 5-percent level, † - significance at a 10-percent level. The corresponding p-values are shown in parentheses.
Source: own calculation

Table 15

Dependent variable roirh, Interval 2: 2009q1-2018q4

Equation	(a)	(b)	(c)	(d)	(e)
roirh (-1)	**0.880** (.00)**	0.885** (.00)	**0.779** (.00)**	**0.890** (.00)**	0.745** (.00)
roinflh (+1)	**0.135** (.00)**	0.148** (.00)	**0.198** (.00)**	**0.148** (.00)**	-0.035 (.16)
rolgdph		0.289 (.19)			
roerh			**0.447** (.00)**		
roreerh				**-0.034* (.03)**	
roresh					-0.046** (.00)
J-statistics	**7.01 (.93)**	6.20 (.94)	**7.45 (.94)**	**7.61 (.94)**	7.94 (.93)

Note: ** - significance at a 1-percent level, * - significance at a 5-percent level, † - significance at a 10-percent level. The corresponding p-values are shown in parentheses.
Source: own calculation

Accordingly, it looks like in Romania, the monetary authorities took into account all the considered alternative goals and reacted in the right direction, especially in the second interval. The monetary policy pursued contained the weakening of the national currency, especially in the second interval, and excessive real effective exchange rate growth. Mera & Pop-Silaghi (2015) compared interest rates according to Taylor's rule and those set by the National Bank of Romania on data from 2003-2012 and showed similar trends.

Russia

From Table 16, we note that the monetary policy follows a rule that aims at fighting price instability and stabilizing the exchange rate over the first interval (equations (a) and (c), Table 16).

Table 16

Dependent variable ruirh, Interval 1: 1999q1-2008q4

Equation	(a)	(b)	(c)	(d)	(e)
ruirh (-1)	**0.533** (.00)**	0.615** (.00)	**0.503** (.00)**	0.932** (.00)	0.547** (.00)
ruinflh (+1)	**0.212** (.00)**	0.139** (.00)	**0.159** (.00)**	0.041* (.02)	0.211** (.00)
rulgdph		-0.104 (.89)			
ruerh			**0.158* (.02)**		
rureerh				0.069 (.23)	
ruresh					*0.017* (.02))*
J-statistics	**8.71 (.92)**	8.71 (.72)	**7.72 (.90)**	6.87 (.91)	7.44 (0.92)

Note: ** - significance at a 1-percent level, * - significance at a 5-percent level, † - significance at a 10-percent level. The corresponding p-values are shown in parentheses.
Source: own calculation

Table 17

Dependent variable ruirh, Interval 2: 2009q1-2018q4

Equation	(a)	(b)	(c)	(d)	(e)
ruirh (-1)	**0.803** (.00)**	0.796** (.00)	0.898** (.00)	0.801** (.00)	**0.543** (.00)**
ruinflh (+1)	**0.170** (.00)**	0.169** (.00)	0.226** (.00)	0.159** (.00)	**0.140** (.00)**
rulgdph		*-0.452 (.31)*			
ruerh			*-0.015 (.35)*		
rureerh				-0.001 (.82)	
ruresh					**-0.102** (.00)**
J-statistics	**8.55 (.93)**	8.54 (.90)	7.63 (.91)	8.43 (.91)	**6.83 (.91)**

Note: ** - significance at a 1-percent level, * - significance at a 5-percent level, † - significance at a 10-percent level. The corresponding p-values are shown in parentheses.
Source: own calculation

For the second interval, the main equation (a) is statistically significant. However, in equation (b), the output variable's coefficient is also insignificant (Table 17). Consequently, the interest rate changed in the opposite direction, which was required to support business activity. The coefficients in equations (c) and (d) show that fluctuations in the nominal and real effective exchange rates did not significantly affect interest rate changes. An equation (e) is significant, and the coefficient for the variable gold and foreign exchange reserves in the equation is negative, which corresponds to the model's specification. The estimates of the coefficients at the output gap and at the exchange rate variable are consistent with the results (Salmanov, 2018).

In both periods, the country's monetary authorities aimed to contain inflation, did not react to support economic growth, and stabilized the real effective exchange rate. The monetary policy's supporting exchange rate stabilization in the first interval switched to supporting the accumulation of gold and foreign exchange reserves in the second interval. Accordingly, the data show that GDP growth slowed down in the second interval, and the national currency quickly depreciated.

Ukraine

As for Poland and Hungary, the central bank acts to contain inflation and boost economic growth over the first interval, but its action supports the nominal exchange rate (Table 18).

Table 18

Dependent variable uairh, Interval 1: 1999q1-2008q4

Equation	(a)	(b)	(c)	(d)	(e)
uairh (-1)	**0.759** (.00)**	**0.994** (.00)**	**0.792** (.00)**	0.685** (.00)	0.711** (.00)
uainflh (+1)	**0.092** (.00)**	**0.110** (.00)**	**0.118** (.00)**	-0.003** (.77)	0.121** (.00)
ualgdph		**3.160** (.00)**	**2.722** (.00)**	-0.779** (.92)	-0.737 (.12)
uaerh			**1.121** (.00)**		
uareerh				0.001* (.02)	
uaresh					-0.019* (.02)
J-statistics	**8.13 (0.92)**	**6.71 (.92)**	**7.72 (.90)**	6.79 (.94)	6.74 (.91)

Note: ** - significance at a 1-percent level, * - significance at a 5-percent level, † - significance at a 10-percent level. The corresponding p-values are shown in parentheses.
Source: own calculation

Table 19

Dependent variable uairh, Interval 2: 2009q1-2018q4

Equation	**(a)**	(b)	(c)	(d)	(e)
uairh (-1)	**0.287** (.00)**	0.599** (.00)	**0.181** (.00)**	0.485** (.00)	0.781** (.00)
uainflh (+1)	**0.084** (.00)**	0.044** (.00)	**0.042** (.00)**	0.083** (.00)	-0.011 (.53)
ualgdph		*-2.506* (.01)*			
uaerh			**0.266** (.00)**		
uareerh				*0.172** (.00)*	
uaresh					-0.009(.51))
J-statistics	**7.78 (.90)**	9.63 (.92)	**9.09 (.94)**	7.36 (.92)	7.60 (0.91)

Note: ** - significance at a 1-percent level, * - significance at a 5-percent level, † - significance at a 10-percent level. The corresponding p-values are shown in parentheses.
Source: own calculation

For the second subsample, the central bank continued to change the interest rate in response to price level fluctuations in the right direction. Still, it no longer takes into account changes in output (Table 19).

This conclusion is consistent with Kozmenko et al. (2014), who analyzed the Taylor rule on quarterly data from 2004-2013 and found that the output gap did not significantly affect the National Bank of Ukraine's interest rates. The unit root hypothesis is not rejected for the exchange rate variable uaerh (Table 1). Thus, we can conclude that the monetary policy's main goal was to support price stability because of the country's political events in the second interval.

5. CONCLUSION

In Eastern Europe and post-Soviet countries, monetary authorities directly or indirectly adhered to specific rules based on interest rates as an instrument of monetary policy. In this study, monetary policy rules' evolution reflects each country's changing priorities after the recent financial and economic crisis. We performed an analysis of actual goals using quarterly data for two intervals: the first from 1998 to 2008 and the second from 2009 to 2018 in nine transition economies of Eastern Europe and post-Soviet countries. In practice, the research results provide a basis for identifying the actual goals, the achievement of which, along with price stabilization, has been supported by monetary policy in each country.

The calculations showed that monetary authorities in all the countries under consideration contained price growth as their priority goal throughout the entire interval. Moreover, the monetary authorities of the countries chose alternative goals differently in each interval. The purpose of monetary policy was to support economic growth in Hungary, Poland, and Ukraine only in the first interval. In all other cases, the interest rate reacted in the wrong direction, or its effect was insignificant.

Interest rate behavior contributed to stabilizing Russia's exchange rate in the first interval, in Hungary and Kazakhstan in the second interval, and Romania and Ukraine at both intervals. Moreover, in Belarus and Poland, on the contrary, interest rate reactions did not contribute to the stabilization of the exchange rate in both the first and second intervals.

The monetary authorities of Belarus, Kazakhstan, and Romania generated interest rate responses to fluctuations in the real effective exchange rate in the direction of its stabilization at both intervals. Wrong interest rate responses in Hungary in the first interval have changed to correct responses in the second interval, which helps stabilize the real effective exchange rate. On the other hand, in Ukraine, the interest rate responses have destabilized the second interval's real effective exchange rate.

The accumulation of gold and foreign exchange reserves was one of the alternative monetary policy objectives in Belarus, the Czech Republic, and Romania in the first interval and Russia in the second interval. Note that the interest rate dynamics did not correspond to Hungary's goal in the second interval and Russia in the first interval.

Thus, in all the countries under consideration, price stabilization was the primary goal of their monetary policy. In each of the two intervals, monetary authorities followed their own alternative goals. Moreover, countries changed their priorities from the first interval to the second interval due to the financial and economic crisis. Overall, they began to less support economic growth and the accumulation of foreign exchange reserves while strengthening attention to stabilizing the exchange rate and the real effective exchange rate. Further research may include more EE and CIS countries and other approaches, such as cointegration analysis and dynamic stochastic general equilibrium models.

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