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Implementing Monetary Policy in Hungary Under Flexible Inflation Targeting*

István Ábel – Pierre L. Siklos

Stabilising properties have always been an important aspect of monetary policy implementation, albeit with due recognition of the economic environment. We develop a simple theoretical model to evaluate the main elements in the choice of policy strategy aimed at inflation control. While the analytical framework is useful to assess different monetary policy frameworks, our focus is the flexible inflation targeting framework that provides a role for exchange rate fluctuations. Empirical evidence, relying on Taylor rules, suggests that monetary policy has been practiced with considerable flexibility in Hungary and has contributed to business cycle stabilisation.

Journal of Economic Literature (JEL) codes: E31, E32, E52, E58, E61

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1. Introduction

This paper examines the relationship between economic policy, particularly monetary policy, and the business cycle in Hungary which is an emerging economy that also happens to be a member of the European Union. This topic continues to interest researchers and there are no signs of a let-up of interest among academics and policy-making circles, especially considering events over the past two decades. Moreover, the series of crises, both economic and geopolitical, has once again attracted the attention of analysts interested in how central banks conduct monetary policy under difficult conditions. Indeed, some observers have questioned not only whether central banks have lost their autonomy, but whether autonomy remains a desirable institutional feature in the manner it was designed several decades ago. *Friedman* (*1962*), for example, pushed back against modern notions of central bank independence by noting how monetary authorities can use crisis

* The papers in this issue contain the views of the authors which are not necessarily the same as the official views of the Magyar Nemzeti Bank.

István Ábel: Budapest Business University, Professor. Email: abel.istvan@uni-bge.hu
Pierre L. Siklos: Wilfrid Laurier University, Professor; Balsillie School of International Affairs; Professor. Email: psiklos@wlu.ca

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conditions to their advantage, implying that central banking is less technical and more political (see also *Wachtel and Blejer 2020*).

Friedman's forerunners in Chicago, especially *Henry C. Simons* (*1934*, *1936*, *1948*) and *Lloyd Mints* (*1945*, *1950*), long ago highlighted the need for a central bank to have a clearly defined mandate. More precisely, the monetary authority should be limited to achieving price stability alone.[1] The Chicago tradition also expressed the hope that this strategy would ensure that monetary policy would not be used for political purposes, that is, as a device to inflate the economy before elections. As a result, there is a well-developed intellectual connection between the concepts of price stability, central bank autonomy and the continuing preference for a monetary policy strategy that focuses on inflation performance.

Even if price stability is the optimal goal, there remains the question of what kind of monetary policy strategy is required to deliver price stability? Several decades ago, *Friedman* (*1948*) still entertained the possibility that it was somehow desirable for monetary policy to stabilise the business cycle and limit inflation. But over ten years later, he rejected this view (*Friedman 1960*), concluding that such an outcome is not feasible. Indeed, he arrived at the now often repeated conclusion that monetary policy acts with long and variable lags. The lag is relatively long (up to two years or longer). An even bigger problem is that the time span of the lag is variable and unpredictable. Empirical evidence appears to support this result (e.g. see *Havranek and Rusnak 2013*).[2] Eventually, the macroeconomic costs arising from a discretionary monetary policy were formalised in the seminal work of *Kydland and Prescott* (*1977*).

Since shortly after the end of the pandemic of 2020, renewed concerns over inflation risks emerged owing to continuing loose monetary policies, the fiscal response to the pandemic and demographic factors, to name just three factors (inter alia, see *Goodhart and Pradhan 2020*; *Bordo and Levy 2020*; *Gopinath 2021*; *Sternberg 2021*).

Goodfriend and King (*1997*) argued that the pessimism expressed by Friedman regarding inflation targeting was exaggerated. The periods highlighted by Friedman were not ones when price stability was the monetary policy strategy in place. The introduction of unconventional monetary policies (UMP) renewed attention to the

[1] Price stability should be understood here to mean inflation control. Whether there are biases in the measurement of inflation or relative price adjustments that temporarily show up in headline price level data price stability has come to mean low and stable inflation not necessarily zero inflation. A separate strand of the literature has explored the desirability of price level targeting (e.g. see *Bernanke 2017*). A discussion of this type of policy strategy is beyond the scope of this paper.

[2] Several factors explain this conclusion. It takes time to gather data, but it also takes time for decision-makers to understand the implications of these data and formulate a response, not to mention ensuring that the data forming the basis of their decisions are trustworthy (internal delay). This is reflected in the potential for monetary policy mistakes in failing to account for revisions to real time data (e.g. *Croushore 2011*, *Orphanides 2001*).

economic consequences of central banks' balance sheets and, by implication, the behaviour of monetary aggregates. Nevertheless, there continue to be discussions about the relationship between interest rates, inflation and economic slack that is addressed by the Taylor rule. Indeed, the continued popularity and usefulness of this policy rule is explained by how well it encapsulates how nominal and real economic forces influence the way central banks set the stance of monetary policy.

Emerging market economies (EMEs) are also affected by these issues because resilience to macroeconomic shocks in these economies is in question and institutions are believed to be weaker, despite significant progress over the past two decades (*Bordo and Siklos 2021*). These questions also continue to be relevant in the case of Hungary. Interestingly, while the idea that inflation and output gaps alone are sufficient to explain how central banks set the stance of monetary policy, the role of exchange rate fluctuations has been displaced as inflation targeting is seen as synonymous with a fully floating exchange rate.

Central banks in emerging markets continue to insist that best practices in monetary policy adopted from the experience of more advanced economies, including the application of inflation targeting, should remain in place. However, central banks in these countries also continue to publicly advocate for the need to balance inflation control and other traditional means of ensuring monetary discipline, such as limiting exchange rate fluctuations via verbal or other forms of intervention (e.g. *Feldkircher at.al. 2021*; *Hofman et. al. 2020*; *Nagy Mohácsi et al. 2024; Pourroy 2012*).

The principal aim of this paper is to assess, in light of exchange rate developments, how monetary policy contributed to business cycle stabilisation in Hungary. Practical considerations suggest that exchange rates play a more important stabilisation role in Hungary than given credit by the existing literature. Indeed, a form we refer to as flexible inflation targeting is practiced, which may help explain the success of the Hungarian central bank in its effort to stabilising business cycle fluctuations. This form of flexible inflation targeting manifests in a more explicit concern for exchange rate movements than in the inflation targeting regimes of central banks in larger and more advanced economies and is an under-appreciated element of the policy strategy adopted in Hungary (see also *Nordstrom et al. 2009*).

The remainder of the paper is organised as follows. *Section 2* outlines a simple model to allow a focus on the key points of debate about what is meant by best practice in the design of monetary policy. In the interests of simplicity, our model ignores dynamics only because conclusions about the role of the exchange rate are not altered by formulating a more complex model. However, our approach provides an explicit role for the exchange rate, a variable which is left out in comparable analyses.[3]

In providing evidence, we offer a few stylised facts about the evolution of inflation and the output gap and the real exchange rate in Hungary, via an ex-post factual assessment of the aggregate macroeconomic experience. Hungary's experience illustrates the negative correlation between inflation and output gaps when central banks indicate a concern over exchange rate movements.

We then supplement the stylised facts with estimates of Taylor rules to further illustrate the notion of a flexible inflation targeting policy. This device has been adopted by many authors (e.g. *Hofmann and Bogdanova 2012*). Moreover, there is some consensus about the usefulness of Taylor type policy rules as a window through which monetary policy actions can be interpreted and understood. This approach allows us to show how the Magyar Nemzeti Bank (the central bank of Hungary, MNB) lowered policy rates more than would have been recommended by a Taylor rule prescription that leaves out exchange rate considerations. We also suggest that future research include the application of other methodologies (e.g. structural models, DSGE models).

The paper ends with a summary, and we also point out a few lessons for monetary policy design applicable to other EMEs.

2. A simple theoretical framework for monetary policy analysis[4]

One frequently used approach to the implications of monetary policy actions considers the role and functions of available policy instruments. Policy management can then be understood through rules that incorporate the impact of various instruments. The widely used Taylor rule (*Taylor 1993*; *McCallum and Nelson 2005*) is an obvious example. Of course, some have raised questions about this strategy (*Svensson 2005*).

In the following, we summarise the transmission of monetary policy via a simple theoretical model. The model has many well-known features found in most monetary policy models. However, our version aims to highlight interactions between the key macroeconomic variables used to interpret the conduct of monetary policy in countries such as Hungary. The model is used to solve for the monetary policy instrument which then responds to an assumed structure of the economy. As demonstrated below, even in this model, the Taylor rule remains an

[3] Clearly, UMP created challenges for all central banks. However, this type of policy can be accommodated within the same flexible inflation targeting policy framework. Also, the role of the exchange rate is unaffected by UMP.

[4] The material below draws heavily on *Ábel and Siklos* (*2023*).

important ingredient to interpret monetary policy decisions. Dynamics are left out both for simplicity and because the principal conclusions would be left unchanged by resorting to a more complex model.

The works of *Walsh* (*2002*), used in *Bofinger et al.* (*2006*) and *Bofinger and Mayer* (*2006*), inspire the discussion below. A similar approach is presented in *Carlin and Soskice* (*2014*) and is called the 3-equation model of macroeconomic policy used to analyse economic stabilisation (*Carlin and Soskice 2014: pp. 80–115*). Our framework can also be extended, as in *Ostry et al.* (*2012*), to take account of a role for the exchange rate in an open economy and this is the feature incorporated below. Of course, a role for the exchange rate as a policy instrument in EMEs has also been incorporated in other works (e.g. *Siklos and Ábel 2002*).

Assume that inflation is described as follows:

$$\pi = \pi^e + ax - ve + \varepsilon_1, \tag{1}$$

where, π is the rate of inflation, π^e are inflation expectations, and x is the output gap. The exchange rate, e, is such that an exchange rate appreciation (a positive value) reduces inflation. The v parameter captures pass-through effects from exchange rate changes to inflation. All other neglected factors (i.e. supply shocks) are relegated to the residual term ε_1. The output gap is defined as:

$$x = \frac{y - y^n}{y^n}, \tag{2}$$

where y^n represents potential output. Equation (1) is a model of inflation where inflation expectations change one for one with inflation. Inflation, also responds positively to any overheating of the economy as reflected in a positive output gap. Equation (1) is nothing more than a Phillips curve (PC) where the impact of exchange rates is included. In theory, equation (1) permits the derivation of sound economic policies aimed at curbing inflation expectations (fixing the anchor) while seeking to balance observed economic activity against potential. This implies an explicit objective function of the following form:

$$(\pi - \pi^T)^2 + dx^2 + he^2 \longrightarrow min \tag{3}$$

Equation (3) reflects the objective, captured by the arrow to the right, that it is desirable to minimise loss by focusing on deviations from an inflation target, π^T. The form of equation (3) is easy to criticise, but the contents reflect the main concerns frequently expressed by policymakers in their speeches and other public communications. The quadratic form, captured by the squaring of the variables, significantly penalises larger deviations from zero in the inflation target or output gaps relative to smaller ones. Since a deflationary slump is rare in most EMEs, it is useful to think of equation (3) as reflecting the challenge of minimising the overshooting of inflation, which is a much more frequent occurrence. The parameter *d* lets the policymaker choose whether to place relatively more emphasis on the output gap than on inflation, or vice-versa. The last term in equation (3) captures the desire for exchange rate stability.[5]

When considering the implications of this model, we use equation (1) of the Phillips curve as a restriction in the Lagrangian function of the conditional minimisation written as follows:

$$L = (\pi - \pi^T)^2 + dx^2 + he^2 + \lambda(\pi - \pi^e - ax + ve - \varepsilon_1) \longrightarrow min \tag{4}$$

The optimum first order conditions for minimisation of the loss function, *L*, are obtained by using expressions for *x* and *π* to obtain:

$$\lambda = \frac{2d}{a}x \tag{5}$$

$$\lambda = -2(\pi - \pi^T) \tag{6}$$

The conditions in equations (5) and (6) imply the following requirement for policy implementation, namely:

$$\pi - \pi^T = -\frac{d}{a}x \tag{7}$$

Equation (7) captures the relationship that requires the monetary authority to formally meet the inflation target, as shown by *Svensson* (*2005: p. 618*). The result is also consistent with the expression in *McCallum and Nelson* (*2005: p. 603*) who focus on instrument rules instead of targeting rules.[6]

A positive output gap is normally associated with higher inflation, and thus the monetary rule described by equation (7), which predicts a negative correlation between the inflation gap and the output gap, deserves further discussion. The monetary rule described above defines the required central bank response under inflation targeting and leads to an inverse relationship between the output gap and

[5] We kept some ambiguity about the exact representation of exchange rate in the model. Interpreting the exchange rate variable *e* as a nominal exchange rate makes the interpretation of the simple model more straightforward. We could just as well use the real exchange rate here: This would not make any difference in the derivation of the model as the exchange rate is not optimised and is not considered as a policy variable. The specification can also reflect the gap between actual and equilibrium exchange rates, but we did not want to add additional ambiguity by specifying how the equilibrium exchange rate is determined. A further complication considering the exchange is its endogeneity. Changes in the monetary policy variables may generate changes in the exchange rate. We do not want to go into the complexities of how exchange rates are determined so we omitted these considerations also. From equation (7), however, we observe that this term has no major consequences for the simplified model, which focuses on the basics of inflation targeting regardless of how the exchange rate variable is specified or interpreted. The challenges associated with estimating the equilibrium exchange rate are well known.

[6] The third term in equation (3) captures the policymaker's aim for exchange rate stability. See also *Ábel and Siklos* (*2023*) for issues related to the concept of an equilibrium exchange rate which is outside the scope of this paper.

the inflation gap, stating that the central bank must reduce output (or aggregate demand) below its potential level so that inflation declines.

We now require some expressions to capture changes in the central bank's nominal policy rate to derive the central bank's reaction function.[7] Again, we start with equation (1). Next, an expression to explain the determinants of aggregate demand in the economy is necessary, which is also influenced by interest rate developments and provides the channel through which monetary policy is transmitted to the rest of the economy.[8] Therefore, we introduce an IS curve to capture the investment-saving relationship. The traditional IS curve describes how a change in real interest rates affects demand, via investment spending, which then influences the output gap. Therefore, we write:

$$x = b - c(i - \pi^e) + \varepsilon_2, \tag{8}$$

where *i* denotes the nominal interest rate. The negative correlation between real interest rate and the output gap is a typical feature of the IS curve. The term ε_2 is a residual that captures demand shocks.

A monetary rule, such as equation (7), describes the link between a central bank's policy instrument (*i*), inflation (π) and the output gap (*x*) function. Taylor's rule (*Taylor 1993*) posits a similar relationship between an inflation gap, an output gap and the central bank's policy rate. Since both inflation and the output gap are endogenous variables in the model, this leads to various ways of expressing the central bank's reaction function (e.g. see *Svensson and Woodford 2005*).

If we substitute equation (1) into the monetary rule (MR) of equation (7), this yields the following expression for the output gap:

$$x = \frac{a}{a^2+d}(\pi^T - \pi^e) + \frac{a}{a^2+d}ve - \frac{a}{a^2+d}\varepsilon_1 \tag{9}$$

Substituting *x* into equation (9) and using the IS curve expression from equation (8) leads to the following solution for the nominal interest rate, here the central bank's instrument of monetary policy:

$$i = \frac{b}{c} + \pi^e + \frac{a}{c(a^2+d)}(\pi^e - \pi^T) - \frac{va}{c(a^2+d)}e + \frac{1}{c}\varepsilon_2 + \frac{a}{c(a^2+d)}\varepsilon_1 \tag{10}$$

A central bank reaction function of the form (10) expresses the notion that when expected inflation exceeds the inflation target the policy rate is raised. It is also important for the effectiveness of monetary policy that the real interest rate ($i - \pi^e$)

[7] Most central banks, at least until the financial crisis of 2008–2009 used an interest rate as an instrument to tighten or loosen policy. This strategy has not changed, although many central banks also rely on other instruments to complement the policy rate. Indeed, the pandemic encouraged the spread of UMP beyond advanced economies. See, for example, *Fratto et al.* (*2021*).

[8] That is, changes in interest rates affect inflation and output developments through changes in aggregate demand.

increases in line with the increase in the nominal interest rate (i.e. the so-called Taylor principle). Note also that the exchange rate plays a role by appreciating in response to the higher domestic real interest rate. Finally, positive shocks to the output gap also lead to a monetary policy tightening. Hence, equation (10) retains the ingredients of the standard Taylor rule but adds a response from exchange rate fluctuations.

The theoretical construct above provides some background to explain the evolution of inflation, exchange rates and monetary policy in Hungary. In doing so, of course, many issues are abstracted from. Our focus is whether monetary policy in Hungary has been successful in stabilising economic outcomes consistent with the objective of price stability in the form of an inflation target. As argued in the introduction, the lags in effect in monetary policy make it difficult to precisely assign the timing of a central bank's responses to various shocks.[9] Hence, dynamics are difficult to specify. We now turn to some empirical evidence.

3. Empirical evidence

Inflation targeting was introduced in Hungary in 2001.[10] We begin with a few stylised facts to assess the relationship between inflation, exchange rates and the output gap, considering the theoretical relationships derived above before concluding with supplementary evidence relying on Taylor rules.

3.1. Stylised fact I: Inflation, inflation targets and the real exchange rate

Figure 1 depicts the evolution of observed CPI inflation (solid line), inflation targets and the inflation reference values used to determine inflation performance according to the Maastricht Treaty requirements.[11] The Maastricht reference inflation rate is the rate of inflation of the European Union member countries with the three lowest inflation rates, plus 1.5 per cent.[12] Since at least the Eurozone Sovereign Debt Crisis (ESDC), the date of euro adoption has been pushed back indefinitely in Hungary. Indeed, there are no announced plans to join the euro in a specific time.

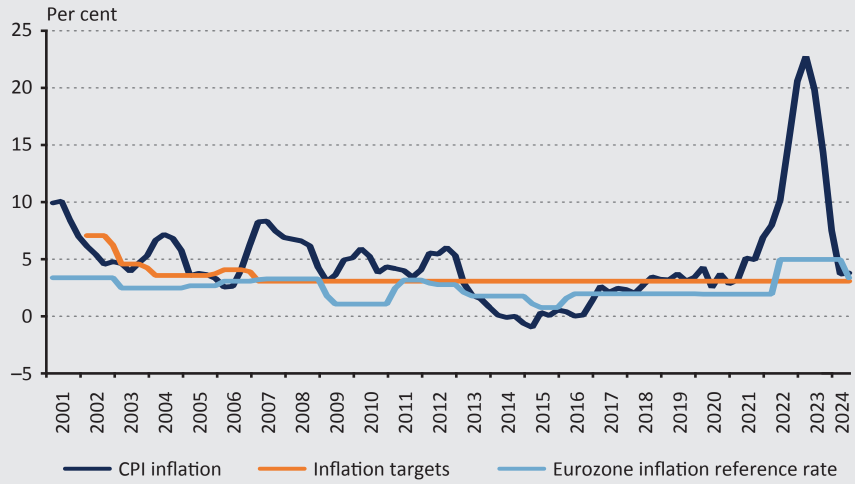
[9] Of course, the model's implications will rest partly on how expectations are determined. While this is true, it does not change the policymaker's problem of reacting to gaps between observed and expected values. How expectations are determined is outside the scope of this paper.

[10] The appendix in *Siklos* (*2017*), and *Bordo and Siklos* (*2021*) contain the dating and details about inflation targeting regimes around the world.

[11] The EU Commission and the ECB regularly update the reference inflation value for Eurozone entry via convergence reports, generally every two years. Convergence involves several quantifiable criteria. The academic profession has tended to focus on inflation performance. Experience suggests that judgment is also involved in deciding the timing of admission into the euro area [e.g. see *Mody* (*2018*), and *Brunnermeier et. al.* (*2016*)]. See https://ec.europa.eu/info/business-economy-euro/euro-area/enlargement-euro-area/convergence-reports_en.

[12] See http://europa.eu.int/comm/enlargement/negotiations/chapters/chap11.

Figure 1
Inflation and inflation targets in Hungary, 2001Q1–2024Q2



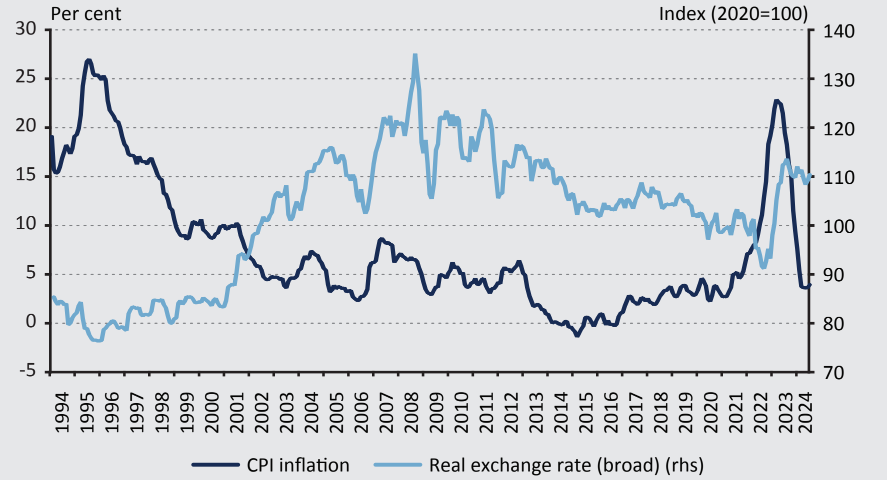
Sources: Magyar Nemzeti Bank (inflation target), Bank for International Settlements (CPI inflation), and ESTAT (https://ec.europa.eu/eurostat/cros/category/acronyms/estat_en) for convergence reference inflation rates (EUR_CONV). Convergence reports are published approximately every two years. The figure assumes that the reference inflation rate remains unchanged between reports. Data are in per cent and are quarterly.

Figure 1 reveals several interesting features in the data. The euro reference rate is more often than not lower than observed inflation. Moreover, inflation largely was on a downward trend between 2001 and 2016. The trend has been interrupted three times. The first occasion was in 2003–2004, just before Hungary entered the EU, and then again in 2007–2008 as the Global Financial Crisis (GFC) spread beyond the US economy and, finally, the noticeable surge in inflation that accompanied the COVID pandemic. Examining the inflation targets, these have mostly proved to be too optimistic relative to outturns, at least until the ESDC. It is only toward the end of the sample, but before the global pandemic, that actual inflation and the inflation targets overlap for a time. It is also worth noting that the euro area reference inflation rate varies far more often than does the MNB's inflation target.[13]

[13] *Golinelli and Rovelli* (*2005*) show progress toward convergence to the EU reference inflation rate in the period of their study (quarterly for the 1991Q1–2001Q1 period). *Siklos* (*2010*) also reports progress towards convergence for the period 1995Q1–2007Q4.

Figure 2 plots observed CPI inflation (left hand scale) against the CPI-based real exchange rate measured on the right hand scale. Data are monthly. The pre-GFC period is marked by real exchange rate appreciation which is then reversed after the financial crisis. There is, once again, a sharp appreciation in the aftermath of the pandemic. Relative to the early days of inflation targeting, the real exchange rate at the end of the sample has appreciated while inflation has generally varied around the domestically set inflation targets (see also *Figure 1*), that is, until the COVID crisis.

Figure 2
Inflation (HICP) in Hungary and the real exchange rate, 1994–2024



Note: The real exchange rate (REER) is CPI-based and is based on 42 trading partners (broad version). Data are in per cent. The unconditional contemporaneous correlations in the table below are for the series plotted above. p-values are in parenthesis. Data are monthly.

2000M1–2007M6 (pre-crisis)	*2000M1–2024M05 (full)*
–0.57 (0.00)	*–0.38 (0.00)*

Sources: Bank for International Settlements

The (unconditional) relationship between inflation and the real exchange rate is often negative, as predicted by equation (1).[14] That said, the results can be sensitive to the sample in question (results not shown), likely due to the impact of the three

[14] For a detailed description of the inflation targeting framework and maintaining the exchange rate system in Hungary and the neighbouring countries, see *Ciżkowicz-Pękała et al.* (*2019*).

great crises during the sample considered. The table in the note to *Figure 2* provides estimates of the correlation between the two series plotted in *Figure 2* for the pre-GFC as well as the entire sample. Both estimates are negative and statistically significant. Hungary's exchange rate was managed until 2008.[15] The data give the distinct impression, in the early part of the sample, that the convergence of inflation to the European benchmark was largely made possible by the strengthening of the domestic currency, the forint. Other than a brief surge around the time of the GFC, when real exchange rate behaviour is largely consistent with the model outlined in this paper, inflation remained stable, that is, until the COVID pandemic.

Although we would expect a negative relationship between inflation and the real exchange rate, it is important to keep in mind that this also assumes that pass-through effects [the coefficient v in equation (1)] are constant. As *Mihaljek and Klau* (*2008*) and *Jašová et al.* (*2016*) have reported, however, pass-through effects have declined in most emerging markets. It is interesting to note that the effects are asymmetric with pass-through changes different for appreciations than for depreciations.

Policy toward the exchange rate in Hungary, broadly speaking, reflects an active concern about how these threaten achieving domestic inflation objectives. It is fair to say that, prior to the ESDC, real appreciations dampened inflationary pressures. Thereafter, the effect was reversed somewhat in large part because of the offsetting effects of the loosening of monetary policy stance. We return to this aspect of stabilisation policies below.

3.2. Stylised fact II: The output-inflation gaps relationship

It is well-known that there is no consensus on how to best estimate the output gap. As a result, many filters have been proposed to estimate trend or potential output. The most popular and best-known filters include the Hodrick-Prescott (H-P), band pass (*Christiano and Fitzgerald 1999*), and Hamilton (*Hamilton 2018*) filters. Often, due to the non-stationarity of levels of (log) real GDP, first differences (i.e. annualised growth rates) are also often used as a proxy for cyclical output variations. Central banks, typically, blend various techniques to estimate the output gap or rely on some aggregate production function (see, for example, *Roeger et al.* (*2019*) for the European case). *Blondeau et al.* (*2021*) is the latest addition of estimates of the output gap in the EU. *Drehmann and Yetman* (*2020*) proved a recent evaluation of various univariate filters and *Hamilton and Leff* (*2020*) revisit some of their results.

[15] In Hungary, a crawling peg exchange rate system with a fluctuation band of +/– 2.5 per cent guided monetary policy between 1995 and 2001. The band of exchange rate fluctuations was widened to +/– 15 per cent in 2001 and was maintained after the introduction of the inflation targeting system. Maintaining a dual target (inflation target and exchange rate band) created a potential conflict, but the main concern about losing competitiveness because of exchange rate appreciation kept the system in place until 25 February 2008, when a floating regime was introduced.

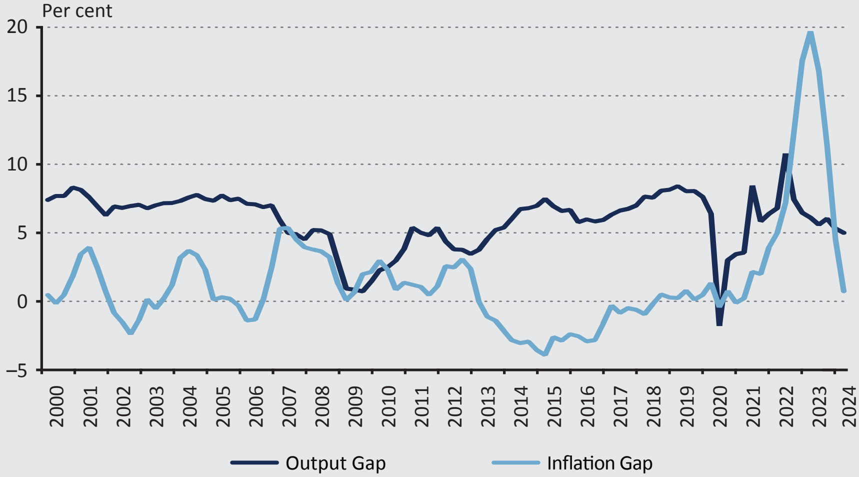
We consider what happens when we arithmetically average the Hamilton, H-P and band pass filters, together with the growth rate of real GDP.

The results of monetary policy actions may show up with long and variable lags. Therefore, while theory requires that the output and inflation gaps move in opposite directions, i.e. that the two processes are negatively correlated as seen from equation (7), the relationship is not expected to be contemporaneous. Indeed, the strength of the relationship is a function of the policymakers' aversion to the inflation and output gaps.[16] As stressed earlier, the relationship in equation (7) is expressed without time subscripts. In practice, of course, it is likely that the lags in policy referred to above also operate and this will also impact the Taylor-type rule that describes how the policy rate is set according to equation (10).

Figure 3 displays the evolution of inflation and output gaps in Hungary for the period from 2000 through early 2024. The main features of the data suggest a negative correlation between the two, albeit with a lag consistent with the observations made in the introduction about lags in monetary policy. The table in the note to *Figure 3* confirms this prediction. If, as is typically observed, prices are more flexible than output changes, combined with the desire to keep inflation near the central bank's inflation target as the means to ensure that output is also near potential, we would expect changes in contemporaneous inflation gaps to be reflected in future output gap changes. This is, in fact, what is observed in Hungary. A rise in the current inflation gap translates into a decline in the output gap several quarters into the future for the full sample (2000–2024), and the negative correlation remains even if we exclude the COVID and post-pandemic periods. Of course, the cross-correlations shown are unconditional. Hence, monetary policy alone may not have generated this outcome. Accordingly, we turn to additional evidence relying on varieties of Taylor rules.

[16] For example, in Norway, a small open economy like Hungary albeit resource rich, the Norges Bank relies on six criteria to generate an appropriate future interest rate path. The second criterion stipulates that "the inflation gap and the output gap should be in reasonable proportion to each other until they close. The inflation gap and the output gap should normally not be positive or negative at the same time further ahead." (*Kloster – Solberg-Johansen 2006: p. 119*). This approach is one that is generally followed in most inflation targeting central banks.

Figure 3
Inflation gap and output gaps in Hungary, 2000–2024



Note: Quarterly data are expressed in per cent. The inflation gap is calculated as the difference between the annualised CPI inflation less the inflation target (see Figure 1). The output gap estimation is explained in the main body of the paper and is the average of four filters applied to the logarithm of real GDP. The table below shows the peak negative unconditional cross-correlations between current inflation gap, labelled t in parenthesis, and the lagged (t-#) or lead (t+#) output gap for the full sample and the crisis sample (2010–2019).

Peak Negative Cross-Correlations

Samples	
2000Q1–2024Q1	*2010Q1–2019Q4*
–0.20 (t,t+10)*	*–0.23* (t,t+10)*

** indicates that the correlations are statistically significant at least at the 10 per cent level.*

Source: See Figure 1.

3.3. More formal evidence: Taylor rule estimates

We now extend the analysis by examining the claims in this paper through the lens of monetary policy instrument rules. It is important to note that, by the end of the sample, unlike the ECB and central banks in advanced economies, the MNB did not engage in QE-style policies to the same degree as in advanced economies (see *CGFS 2023*), nor did it reach the effective lower bounds (viz. negative interest rates), although it did come close.[17] This makes it easier to rely on conventional style policy rules to investigate the time-varying policy stances of the MNB.

[17] Policy rates did briefly come close to, but did not reach zero during the height of the pandemic (i.e. 2020Q4 and 2021Q1). However, like many other emerging markets, the MNB tightened policy earlier and faster than all advanced economies. See, for example, *Evdokimova et al.* (*2023*) and *Nagy Mohácsi et al.* (*2024*).

Mackiewicz-Łyziak (*2016*) report regime switches from active to passive monetary policy practices in Hungary and other central European countries. A passive regime is characterised by strong smoothing of the interest rate (*Mackiewicz-Łyziak 2016: p. 133*). Such persistence in interest rates to expected inflation or output gaps may be justified by uncertainty and concerns about the perceptions of the public and the market's confidence in the central bank. Interest rate persistence is a well-known and widely documented phenomenon. Monetary policies in countries such as Hungary suggest significant interest rate smoothing (e.g. see also *Mackiewicz-Łyziak 2016*, and see below).[18]

However, owing in part to disagreement about estimates from policy rules, the existing literature relies on simpler versions of the reaction function than the one derived in equation (10), especially the omission of exchange rate effects.

There is, of course, a vast body of literature dealing with estimated and calibrated versions of the Taylor rule. *Orphanides* (*2003*) and *Kahn* (*2012*) provide good overviews. Despite the simplicity of the rule, challenges exist when interpreting the stance of monetary policy using this approach. Two stand out especially. First, there continues to be considerable uncertainty surrounding the measurement of the output gap as previously noted. A similar problem applies to estimates of the real exchange rate gap. In recent years, policy rules must also deal with the decline in the neutral real interest rate, that is, the so-called *r**.[19] There is some evidence that it has also declined in some emerging markets (e.g. Brazil and Mexico, see *Perrelli and Roache 2014*; and *Carrillo et al. 2018*). The extant literature dealing with EMEs also considers whether estimated Taylor rules have been subject to structural breaks (e.g. *Galimberti and Moura 2013*; *Yilmazkuday 2008*), or are subject to non-linearities (e.g. *Klose 2019*), though usually not simultaneously with recognition of a changing *r**.

We rely on estimated rules based on Taylor's original formulation (*Taylor 1993*). However, as noted above, we also estimate versions with a time-varying neutral real rate.[20]

[18] In exceptional circumstances, such as a perceived speculative attack or the global financial crisis, monetary policies tend to switch in favour of an active regime where the interest rate reaction to expected inflation or output gap is stronger (*Mackiewicz-Łyziak 2016: p. 134*). Debate over the stochastic properties of nominal interest rates, and central bank policy rates in particular, has abated since the GFC. Evidence is generally favourable to the interest rate smoothing phenomenon. Inter alia, see *Romero-Ávila* (*2007*), and *Coibion and Gorodnichenko* (*2012*).

[19] While there is a consensus that the neutral real rate has declined over the past decade or more, there is also a great deal of uncertainty around point estimates as well as the precise source(s) of the decline.

[20] Estimates are based on a so-called state space model where $R_t = R_t^* + u_t$ and $R_t^* = R_{t-1}^* + v_t$ is latent (i.e. unobserved) which follows a random walk (i.e. only the immediate past value helps forecast its future value). The observed interest rate, *R*, fluctuates around R^*. Since the Kalman filter estimates are volatile, we apply an H-P filter (smoothing parameter of 100,000) and use these estimates of *r** to generate the estimates in the table in the note to *Figure 2*.

Next, since we argue that the exchange rate plays a separate role in setting the stance of monetary policy, we extend the original Taylor rules described above by adding a real exchange rate gap. Parallel to the output gap, this gap is estimated as the arithmetic mean of gaps estimated with the four filters previously described. For the real exchange rate there is no consensus about the expected size of the coefficient, but empirical evidence suggests that the coefficient is smaller than ones obtained for either the inflation or output gaps (e.g. see *Engel and West 2006*).

The inflation target π^* is proxied either by the stated inflation target or the inflation criterion of the EU Commission in their convergence reports. The output gap is constructed from real GDP data, we also consider using the mean of a variety of filters (viz. one-sided H-P, Hamilton, and real GDP growth rate) in addition to the estimates obtained from the central bank. Finally, there are cases where expected inflation is proxied by a one-year inflation forecast, while the output gap is replaced by an estimate of a one-year forecast of real GDP growth relying on the forecasts from the World Economic Outlook.[21]

Theory suggests that a positive inflation gap (viz. inflation above the target) accompanies a positive output gap (i.e. observed output is above potential), while a positive real exchange rate gap signals exchange rate appreciation that exceeds the equilibrium proxy and would serve to dampen both the inflation and output gaps in the future. This suggests then that the central bank actively contributed to business cycle stabilisation thanks to the implementation of a flexible form of inflation targeting. The so-called Taylor principle (e.g. see *Taylor 1999*) suggests that the steady state coefficient on inflation should be at least one to indicate that a positive shock to the inflation gap is met by a larger than proportional rise in the policy rate. The basic inertial version of the Taylor rule, if it is written as an estimated regression, is:

$$R_t = r^* + \pi_t^* + \beta_0(\pi_t - \pi_t^*) + \beta_1 \tilde{y}_t + \rho R_{t-1} + \varepsilon_t \tag{11}$$

where R_t is the policy rate, r^* is the neutral real interest rate, which may be time-varying (i.e. written as r_t^*), π^* is the inflation target. For Hungary, the inflation target is shown in *Figure 1*. The remaining variables are π_t, the observed CPI inflation rate, so that $(\pi_t - \pi_t^*)$ is the inflation gap, while $\tilde{y}_t$ is the output gap. In *Taylor's* (*1993*) original calibrated specification β_0, β_1 are both set to 0.5. *Taylor* (*1999*) and *Yellen* (*2012*) raise the calibrated value of β_1 to 2, partly in recognition of the US Federal Reserve's dual mandate.

[21] These are semi-annual forecasts. We assume that the forecasts remain constant over two quarters, although converting the semi-annual forecasts to quarterly forecasts using the Chow-Lin method has no impact on the conclusions.

Returning to equation (11), at least one other extension can be considered. In view of the major crises that have impacted Hungary during the sample examined in our study, the possibility of structural breaks in the relationship would change the estimated coefficients in (11). While events can dictate the choice of break points, a preferred strategy is to let the data speak for itself. Accordingly, we write

$$R'_t = \delta_0 D_{t\leq\kappa} + \delta_1 D_{t>\kappa} + \nu_t \tag{12}$$

where $D_{t\leq\kappa}$ and $D_{t>\kappa}$ are dummy variables such that a break takes place at time κ with the estimation of the break date based on Bai and Perron's structural break test (see *Bai and Perron 1993*). While, for simplicity, equation (12) assumes a single break, we actually consider the possibility that more than two structural breaks are possible over the 2000–2024 period. Estimates of equation (12) are referred to as conditional Taylor rules as estimates are conditioned on the possibility of structural breaks.

Finally, since the claim of this paper is that the flexible form of inflation targeting practiced by the MNB requires sensitivity to exchange rate developments, we also estimate versions of equation (11), assuming either constant or time-varying neutral rates, with the addition of a real exchange rate gap. The extended model is thus written

$$R_t = r^* + \pi^* + \beta'_0(\pi_t - \pi^*_t) + \beta'_1\tilde{y}_t + \beta'_2\widetilde{reer}_t + \rho R_{t-1} + \varepsilon_t, \tag{13}$$

where $\widetilde{reer}_t$ is the real exchange rate gap. Equation (13) is referred to as an extended policy rule.

Estimation results are provided in *Table 1* in the *Appendix*. Two sets of estimates are presented, depending on whether the neutral real rate is time-varying (first four columns) or not (last four columns). While there are a few differences depending on whether the neutral real interest rate is time-varying, there is at least one striking result that consistently emerge across all varieties of estimated Taylor rules. First, in line with the central hypothesis of this paper, the MNB has shown significant sensitivity to the real exchange rate gap. Indeed, the size of the steady state response is often at least as large as that of the steady state output gap effect on the policy rate. Therefore, appreciation of the exchange has allowed the central bank to reduce the policy rate. This is in line with the simple model developed in this paper.

There are a couple of other important findings that emerge from the results shown in *Table 1*. First, the MNB has largely followed the Taylor principle, since the steady state estimates shown for the inflation gap are greater than one regardless of the estimated form of the Taylor rule. Next, the MNB has also shown that it is responsive to the output gap in the manner predicted by theory. In several cases, the size of the steady state coefficient is comparable to some of the calibrated Taylor rules used to illustrate the conduct of monetary policy in advanced economies. Finally, we also note that three structural breaks are always found and these take place around Hungary's entry into the EU, the GFC, or the COVID 19 pandemic. Once estimates are conditioned on these breaks, our proposition on the role of the exchange rate in the conduct of monetary policy in Hungary is still supported. Moreover, the steady state responses of the three gaps are largely unchanged, although reliable estimates hold for a slightly smaller sample.[22]

3. Summary and conclusions

The implementation of monetary policy is occasionally discussed from the traditional theoretical framework of macroeconomics. The central bank's policy autonomy gives the outside observer the misconception that monetary policy, especially in the form of inflation targeting, can be independent of any kind of real economic considerations. This misunderstanding also reinforces the view among some analysts that inflation targeting translates into ignoring other macroeconomic factors when the stance of monetary policy is set. In the case of small open economies, among EMEs this attitude is often interpreted as assuming that output and inflation gaps are sufficient in dictating the stance of monetary policy.

Our study begins with a simple theoretical model of monetary policy to establish a conceptual framework. The model links real economic activity, inflation and the exchange rate. We then consider the implications of the model for Hungary. Empirically, we show that real exchange rate developments play an important role in how the stance of monetary policy is set by the MNB, in addition to the traditional inflation and output gap variables.

Exchange rate fluctuations do not entirely succeed in protecting the domestic economy from foreign shocks. Most notably, how monetary policy is set by the ECB will also impact Hungary. This is not surprising. While Hungary is someday expected to adopt the euro, the time horizon for euro adoption has lengthened considerably. It is no longer a priority for Hungary and, indeed, for its neighbours, the Czech Republic and Poland.

The results of this paper argue in favour of the view that business cycle stabilisation is enhanced by involving exchange rate considerations which are not foreign to a flexible implementation of the inflation targeting approach. The conduct of monetary policy in Hungary highlights the recognition that monetary policy

[22] We only present conditional estimates for samples between the two major structural breaks, in part because the number of observations around these breaks is small. Hence, estimates for these often very short samples are unreliable.

autonomy is not constrained by incorporating exchange rate considerations in a framework where inflation control is the central bank's objective.

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Appendix

Table 1
Varieties of Taylor rule estimates

Variable	Standard	Conditional	Extended	Conditional Extended	Standard	Conditional	Extended	Conditional Extended
Full samples	2000Q1–2024Q1	2004Q2–2021Q4	2000Q1–2024Q1	2009Q1–2024Q1	2000Q1–2024Q1	2002Q1–2021Q4	2001Q1–2024Q1	2009Q1–2024Q1
Break samples	NA	2004Q2–21Q4	NA	2009Q1–24Q1	NA	2009Q1–24Q1	NA	2009Q1–24Q1
Constant	NA	NA	NA	NA	–0.09 (0.32)	0.09 (0.32)	–0.74 (0.37)**	–0.48 (0.18)***
π_t^{gap}	1.01(0.12)***	1.06 (0.31)***	1.18 (0.17)***	1.17 (0.12)***	1.16 (0.25)***	1.19 (0.36)***	2.47 (1.28)*	1.43 (0.20)***
y_t^{gap}	0.58(0.08)***	0.39 (0.10)***	0.55 (0.09)***	0.34 (0.07)***	0.81 (0.44)*	0.23 (0.61)	2.70 (1.96)	0.78 (0.22)***
$reer_t^{gap}$	NA	NA	–0.37 (0.16)**	–0.57 (0.16)***	NA	NA	–1.65 (1.21)	0.86 (0.02)***
R_{t-1}	0.80(0.04)***	0.89 (0.05)***	0.82 (0.02)***	0.80 (0.04)***	0.89 (0.03)***	0.92 (0.03)***	0.95 (0.02)	–0.95 (0.22)***
r_t^*	0.19(0.06)**	0.06 (0.05)	0.17 (0.06)***	0.07 (0.06)***	NA	NA	NA	NA
Adj. R^2	0.95	0.96	0.95	0.97	0.95	0.96	0.95	0.98
Observations	97	71	97	61	89	71	89	61
Break dates	NA	2004Q2 2022Q1	NA	2005Q2 2009Q1	NA	2004Q2 2022Q1	NA	2004Q1 2009Q1

*Note:*** means statistically significant at the 1% (** - 5%;* - 10%) level of significance. Standard errors in parenthesis. Quarterly data for the samples shown. Variable definitions are given in the text. Table 1 provides two sets of estimates depending on whether the neutral real interest rate is constant or not. The first four columns represent the estimates using the constant neutral real interest rate. In this case the extended Taylor rule is of the forward-looking variety; otherwise, the policy rule is viewed as being backward-looking. Standard is the conventional Taylor rule as written in the main body of the text. Conditional is the Taylor rule shown conditional on the estimation of up to 2 structural breaks. Extended is the standard Taylor rule augmented by the real exchange rate gap. The gap is the mean of four filters applied to the logarithm of real GDP (see also Figure 3 and the main body of the text). Newey-West standard errors in parenthesis. Trim was 10 per cent except for the conditional extended Taylor rule with time-varying neutral real interest rate (trim = 15%). The null of L+1 versus L breaks is used to test, at the 5 per cent level, for the presence of at most 2 structural breaks. For the three gap variables the steady state estimates and standard errors are shown. The steady state is found by applying the expression $z_t = \beta/(1–\rho)$ where z_t is the steady state estimate for one of the three gap variables, β is the estimated coefficient on a gap variable [see equations (11) and (13)], and ρ is the estimated interest rate smoothing parameter.*