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Macroeconomic Risks and Monetary Policy in Central European Countries: Parallels in the Czech Republic, Hungary, and Poland

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Abstract: Changes in interest rates, inflation, and exchange rates are the main components of macroeconomic risks (financial risks) in projects evaluation. However, the conduct of monetary policy as well as its impact on the economic environment is seldom considered as an important component of macroeconomic risks. In this paper, we offer a simple framework to analyze the conduct of monetary policy. We examine the stabilizing properties of monetary policy, its impact, and the parallels in the monetary policy approaches taken in the Czech Republic, Hungary, and Poland until the pandemic. We provide a simple theoretical background to motivate the main elements of the debate and the choice of policy strategy. We then rationalize the adoption of a form of flexible inflation targeting (FIT). It is characterized by an explicit concern over exchange rates. The empirical evidence, consisting of calibrated and extended Taylor rules, together with local projections estimates, suggests that monetary policy has been practiced with considerable flexibility by all three central banks and has contributed to business cycle stabilization in the region. Most notably, the exchange rate plays an important role in the conduct of monetary policy.

Keywords: monetary policy; interest rate; macroeconomic stabilization; exchange rate

JEL Classification: E31; E32; E52; E58; E61

1. Introduction

Macroeconomic risks do not relate directly to firms' finances or to projects but are important determinants of the economic environment in which firms take financial decisions. Macro financial risks, including changes in interest rates, inflation, and exchange rates, need to be analyzed and handled in the same way as the specific commercial risks influencing firms' finances (Yescombe 2014, p. 257).

Macroeconomic risks may have an impact not just on daily business decisions, but on capital structures as well. Cook and Tang (2010) confirmed that firms change their capital structure mostly during good macroeconomic conditions. Homapour et al. (2022) noted that leverage influences decisions on capital structure, and firms tend to be highly leveraged during business cycle downturns. As expansionary monetary policy eases access to credit, we may expect that monetary policy affects firm leverage. Their regression analysis confirmed that concerning macroeconomic conditions, the stock market performance, the credit supply, and the business cycle had the most significant impact on the financing decisions of UK firms. They concluded that "macroeconomic conditions have a significant impact during the financial crisis and that firms' capital structure is highly sensitive to the macroeconomic conditions. Therefore, it is essential that the government mitigate the impact of the financial crises by deploying and implementing timely policies. . ." (Homapour et al. (2022)).

Liosi (2023) examined the sources of economic uncertainty in the eurozone markets and emphasized that "[m]onetary policy has a significant impact on both financial variables of risk aversion and uncertainty, which may in turn have effect on the business cycle" (Liosi 2023, p. 4).

In this paper we focus on the impact of monetary policy on the business cycle in the Czech Republic, Hungary, and Poland. The relationship between monetary policy and the business cycle has been the focus of research for decades, and there are no signs of a let-up of interest in academic and policy making circles. This is due, in no small part, to the Global Financial Crisis (GFC) of 2008–2009, the subsequent Eurozone Sovereign Debt Crisis (ESDC), and the ongoing global pandemic that began in 2020. All these events have once again drawn attention to how central banks conduct monetary policy in crisis conditions, including whether they have effectively lost their independence. Friedman (1962), for example, pushed back against modern notions of central bank independence by noting how monetary authorities can use crisis conditions to their advantage, implying that central banking is less technical and more political. More recently, Tooze (2020) revived this idea in a fashion. Moreover, since the GFC, the more traditional view of monetary policy as operating exclusively via policy rates has changed as central banks, first in advanced economies and, once the pandemic erupted, in emerging market economies, have resorted to balance sheet operations to provide additional monetary easing. In so doing, central banks have argued that the series of recent crises led them to become more flexible and adaptable to changing circumstances (e.g., see Bernanke 2015).

Friedman's forerunners in Chicago, especially Henry C. Simons (1934, 1936, 1948) and Lloyd Mints (1945, 1950), previously concluded that a central bank should have a clearly defined mandate to conduct monetary policy. More precisely, the monetary authority should be limited to achieving price stability only.[1] They also expressed the hope that this strategy would ensure that monetary policy would not be used for political purposes, that is, as an inflationary device to stimulate the economy before elections. Hence, there is a well-developed intellectual connection between the twin concepts of price stability, central bank autonomy, and the continuing preference for monetary policy strategies that target inflation performance.

Even if price stability is the correct goal, a question posed long ago remains germane to this day: what kind of monetary policy strategy is required to deliver price stability? Friedman (1948), early in his career, still entertained the possibility that it was somehow feasible for monetary policy to counter the economic cycle, stabilize prices, and the business cycle. But ten years later, he rejected this view (Friedman 1960), concluding that such an outcome is not feasible. Indeed, he arrived at the famous conclusion that monetary policy acts with long and variable lags. The lag is relatively long (up to two years or longer). Perhaps more importantly, an even bigger problem is that the length of the lag is variable and unpredictable, and empirical evidence appears to vindicate this view (e.g., see Havranek and Rusnak 2013).[2] Eventually, the macroeconomic consequences stemming from discretionary monetary policy were formally developed in the seminal work of Kydland and Prescott (1977).

As this is written, there are renewed concerns over inflation risks owing to the fiscal response to the pandemic, demographic factors, as well as the series of real economic shocks such as the strains in global supply chains and the war in Ukraine (inter alia, see Goodhart and Pradhan 2020; Bordo and Levy 2020; Gopinath 2021; Sternberg 2021; and Broadbent 2022). Previously, Friedman and Schwartz's (1963) seminal analysis of US monetary policy contains several examples that led the central bank (the Fed) to fan the flames of unfavorable movements in the business cycle.

Goodfriend and King (1997) argued that the pessimism expressed by Friedman regarding inflation targeting was exaggerated. They pointed out that the periods highlighted by Friedman were not ones when price stability was the principal objective of monetary policy. Quantitative easing (QE), and other forms of unconventional monetary policy (UMP), may have led to a significant change in our understanding and interpretation of these issues but their emergence does not appear so far to have undermined the desirability of the inflation targeting monetary policy framework. While UMPs have once again focused attention on the economic consequences of central banks' balance sheets and, by implication, the

behaviors of monetary aggregates, discussions remain firmly anchored around the connection between interest rates, inflation, and economic slack that are linked to each other via the eponymous Taylor rule. Indeed, the continued popularity and usefulness of this reaction function is that it encapsulates how nominal and real economic forces influence how central banks set the stance of monetary policy.

Important questions about the conduct of monetary policy are also being raised in emerging market economies where resilience to macroeconomic shocks is in question and institutions are believed to be weaker despite significant progress made over the past two decades (Bordo and Siklos 2021). These questions also have resonance in Central Europe where, nominally, economies are tied to the fortunes of the rest of Europe but have not yet joined the euro area and are unlikely to do so in the foreseeable future. Curiously, while the notion that inflation and output gaps alone are adequate in explaining how central banks, even in emerging markets, set the stance of monetary policy, the role of exchange rate fluctuations is largely downplayed as inflation targeting is seen as synonymous with a fully floating exchange rate. This, in spite of the fact that academics have argued for some time that "...policy makers ignore open-economy influences at their peril" (Clarida 2009, p. 139).

Central banks in the region, notably the Czech Republic, Hungary, and Poland, continue to insist that best practices in monetary policy adopted from the experience of more advanced economies, most notably the practice of inflation targeting, should remain in place. However, these same institutions also continue to publicly advocate the need to balance inflation control and other traditional means of ensuring monetary discipline, namely limiting exchange rate fluctuations via verbal or other forms of intervention (e.g., Hofman et al. 2020). The principal aim of this paper is to suggest that exchange rates play a more important stabilization role in the three Central and Eastern European economies than the existing literature gives them credit. Hence, the flexible inflation targeting (FIT) regime is practiced in Central and Eastern Europe, evincing a concern for exchange rate movements, and this strategy helps explain the success of the three central banks considered in aiming to stabilize business cycle fluctuations. The form of FIT in question translates into a more explicit concern for exchange rate movements than in inflation targeting central banks in larger and more advanced economies and is an under-appreciated element of the policy strategy adopted in the three economies investigated in this paper.

The rest of the paper is organized as follows. In the following section, we outline the main conclusions of a simple standard model as a reminder of the key points of debate about what constitutes best practice in the design of monetary policy. The approach ignores dynamics only because conclusions about the role of the exchange rate are not altered by formulating a more complex model, but it does provide an explicit role for the exchange rate as a variable typically left out in comparable analyses.[3]

For evidence, we first rely on stylized facts about the evolution of inflation, the output gap, and the real exchange rate in the Czech Republic, Hungary, and Poland via an ex-post factual assessment of the aggregate macroeconomic experience in these three countries. We also highlight the negative correlation between inflation and output gaps when central banks evince a concern over exchange rate movements.

Next, we supplement the stylized facts with estimates from varieties of calibrated Taylor rules to provide additional support for our interpretation of FIT. This device is adopted not only because it has been followed in several other studies (e.g., Hofmann and Bogdanova 2012), but also because there is some consensus about its usefulness and applicability as a window through which monetary policy actions can be interpreted and understood. This approach also allows us to illustrate how, at times, the three central banks considered lowered policy rates more than would have been recommended by the conventional Taylor rule prescription, or vice versa. It is worth bearing in mind, however, that the requisite models remain rather unsettled in both academic and policy circles. Finally, drawing upon Han and Wei (2018), we report estimates of policy reaction functions and VARs based on local projections (Jordà 2005), which provides further support for our hypothesis.

The paper ends with a summary, some lessons for monetary policy design applicable for emerging market economies, and future research directions.

2. A Simple Theoretical Framework: Framing the Issues

An understanding of the workings of monetary policy can be approached from several points of view. One frequently used approach considers the role and functions of monetary policy instruments. Policy management can then be framed by rules applied to these instruments. Arguably, the best known of these is the Taylor rule (Taylor 1993; McCallum and Nelson 2005). Needless to say, some have raised doubts about this approach (Svensson 2005).

The transmission of monetary policy, as described in the most simple theoretical models, has many well-known features for students of monetary policy but our interest is focused on the stabilizing role of monetary policy. Our aim is to highlight interactions between the key macroeconomic variables used to interpret the conduct of monetary policy in the countries that we focus on. Monetary policy instruments respond to the hypothesized structure of the economy. This broad framework can accommodate more types of monetary policy practices, regardless of the economic policy or the existing policy framework. Furthermore, even in this broad approach, the Taylor rule remains useful as one ingredient to interpret monetary policy performance. In our simple approach, dynamics are avoided in the interests both of simplicity as well as because the principal conclusions would be unchanged by a resort to a more fully developed model.

Our approach is inspired by illustrative examples developed by Walsh (2002), and also used in Bofinger et al. (2006), and Bofinger and Mayer (2006). A similar approach is discussed in Carlin and Soskice (2014) as the three-equation model of macroeconomic policy, concerning the workhorse of modern monetary macroeconomics (Carlin and Soskice 2014, pp. 80–115). Of course, this framework can be extended, as in Ball (1999) and Ostry et al. (2012), to take account of a role for the exchange rate in an open economy, and this is precisely the feature that we incorporate in the next section below. Others have also highlighted the role of exchange rates in emerging market economies as a policy instrument (e.g., Siklos and Ábel 2002).

Using these considerations in a simple standard approach yields the following requirement for the conduct of policy, namely

$$\pi - \pi^T = -\frac{d}{a}x \tag{1}$$

where, π is the rate of inflation, π^T is the inflation target, x is the output gap, d is the parameter in the central bank loss function linked to the output gap, and a is the parameter linked to the output gap in the Phillips curve.

Equation (1) captures the relationship that requires the monetary authority to formally meet the inflation target, as shown by Svensson (2005, p. 618), and is also consistent with the expression in McCallum and Nelson (2005, p. 603), who focus on instrument rules instead of targeting rules.[4] Svensson (2002) uses a more sophisticated approach with time lags and forward-looking and backward-looking elements and explicitly includes other considerations for monetary policy practices including applying hybrid rules as an extension of the Taylor rule. Svensson (2002), using a similar formulation for the central bank loss function as in the standard simple model, derived the marginal rate of substitution between inflation and output gaps in a similar vein as reflected in Equation (1).

A positive output gap is normally associated with higher inflation, so the monetary policy rule described by Equation (1), which prescribes a negative correlation between the inflation gap and the output gap, deserves some further explanation. This monetary rule requires the central bank's response under inflation targeting and creates an inverse relationship between the output gap and the inflation gap because the central bank must reduce output (or aggregate demand) below its potential level to reduce inflation.

In order to derive the central bank's reaction function, we look at the central bank's policy rate (a nominal magnitude).[5] To this end, we need an expression to explain the

determinants of aggregate demand in the economy, which is also influenced by interest rate developments and provides the means for the transmission mechanism of monetary policy to operate.[6] This is accomplished by introducing the IS curve, which captures the investment-saving relationship. The traditional IS curve describes how a change in real interest rates affects demand (via investment spending), which is eventually transmitted to the output gap already included in our model. Therefore, we write

$$x = b - c(i - \pi^e) + \varepsilon_2 \qquad (2)$$

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.[7]

A monetary rule, such as Equation (1), describes the link between a central bank's policy instrument (i), inflation (π), and the output gap (x) function. The eponymous Taylor rule (Taylor 1993) posits a similar relationship between an inflation gap, an output gap, and the central bank's policy rate, which represents the instrument of monetary policy. Since both inflation and the output gap are endogenous variables in the model, this leads to various ways of writing down the central bank's reaction function (e.g., see Svensson and Woodford 2004).

We take the standard simple inflation dynamics described by the following simple form of the Phillips curve:

$$\pi = \pi^e + ax - ve + \varepsilon_1 \qquad (3)$$

where, π is the rate of inflation, π^e are inflation expectations, and x is the output gap. The exchange rate, e, is defined in such a way 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.

Substituting Equation (3) into the monetary policy rule (MR) of Equation (1) yields the following relationship for the output gap:

$$x = \frac{a}{a^2 + d}(\pi^T - \pi^e) + \frac{a}{a^2 + d}ve - \frac{a}{a^2 + d}\varepsilon_1 \qquad (4)$$

Now, substituting x of Equation (4) into the IS curve of Equation (2) leads to the following solution for the nominal interest rate; here, the central bank's instrument of monetary policy:

$$i = \frac{b}{c} + \pi^e + \frac{a}{c(a^2 + d)}(\pi^e - \pi^T) - \frac{va}{c(a^2 + d)}e + \frac{1}{c}\varepsilon_2 + \frac{a}{c(a^2 + d)}\varepsilon_1 \qquad (5)$$

A central bank reaction function of the form (5) expresses the notion that, if expected inflation exceeds the inflation target, the central bank raises the policy rate. It is also important for the effectiveness of monetary policy that the forward-looking real interest rate ($i - \pi^e$) increases in parallel with the increase in the nominal interest rate. This is the so-called Taylor principle. Equally important is that the exchange rate also plays a role by appreciating since real returns are now higher, other things being equal. Finally, positive shocks to the output gap also generate a tightening of stance of monetary policy. Hence, Equation (5) retains the ingredients of the standard Taylor rule but adds a response from exchange rate fluctuations. Clarida (2001) accomplishes much the same result using the widely employed Clarida et al. (1999, 2000) framework using the Taylor rule alone as a starting point.

The theoretical outline described above, we think, provides some context to help us explain the evolution of inflation, exchange rates, and monetary policy for the Czech Republic, Hungary, and Poland. Of course, a rather broad characterization of the policy framework of the kind discussed above also means that many issues are abstracted from. Our focus is whether monetary policy, in the countries considered below, has been successful in stabilizing economic outcomes consistent with the theoretically expected goal of price stability. We also

need a reminder that a time dimension has been dropped in the model developed above. This is deliberate. 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.[8] This will become clearer when we turn to the data below. In the meantime, we first consider some relevant institutional consideration before turning to the empirical evidence.

3. UMPs, Liquidity, and Exchange Rates in Emerging Market Economies

The operational framework and the decision-making aspect of monetary policy are worth a closer look on their own, although many questions are outside the scope of this paper. The model of the previous section leaves unanswered the issue of how UMP, introduced in advanced economies during the GFC, fits since, de facto, this means that central banks operate with multiple instruments. The issue was germane in advanced economies only after 2008. However, since the onset of the COVID-19 crisis, emerging market economies have also introduced some UMPs while retaining space to change policy interest rates as a function of the same factors as in the pre-crisis period (e.g., see Cantú et al. 2021).

The operational framework covers the measures used and the operational characteristics of keeping the central bank instruments on target. To prevent the drastic fall in economic activity following both the GFC and COVID-19 crisis, central banks in advanced economies quickly lowered their policy interest rates. Moreover, several advanced economies implemented various types of UMPs. Many of these have been referred to as quantitative easing or QE (Borio and Zabai 2016). QE aims to change the size and/or composition of the balance sheet of the central bank.[9] While, in some advanced countries, policy rates hit the ZLB or even negative interest rates, in most emerging market countries, including the Czech Republic, Hungary, and Poland, interest rate reductions were slower and policy rates remained positive, despite being low by historical standards.

UMPs can take several forms. However, in emerging markets, central banks normally faced excess liquidity caused by capital inflows even before the GFC, and QE in these economies led to different forms of interventions. Their typical approach can perhaps best be characterized as credit easing (CE). This refers to a change in the composition of the central bank's assets. The aim is to improve liquidity conditions in one or more segments of the financial system, but it need not lead to a change in the size of the central banks' balance sheets (i.e., asset purchases may be sterilized by the sale of other types of assets, like central bank bonds). By the time of the COVID-19 crisis, which triggered QE in emerging markets in the form of government paper purchases to help financing the pandemic-related expenditures of the state, the balance sheets of these central banks also increased significantly. Emerging market central banks formerly focused on improving credit conditions by using a third type of balance sheet policy by creating incentives for the recipients of funds from central bank operations, namely commercial banks, to increase lending (Borio and Zabai 2016).

While QE has been used in advanced economies as a tool to lower the cost of funding once conventional tools were exhausted, in emerging markets, the objectives of such measures were to improve liquidity and keep markets functioning. The amounts associated with emerging market QE programs has, so far, remained limited in size relative to GDP. QE in the Czech Republic, Hungary, and Poland began in April 2020 as a response to the COVID-19 crisis (Arslan et al. 2020). Arslan et al. (2020) note that government bond purchase programs of the type announced are intended to restore liquidity in the local bond market, thereby lowering the cost of borrowing for the rest of the economy. This is particularly relevant for economies in which foreign investors hold a significant share of the local currency sovereign debt.

It is an open question whether UMP in emerging market economies represents a change in the policy framework. The monetary policy framework refers to a country's financial arrangements and the commitments or constraints placed on interventions the central bank is permitted to undertake. As Grossmann-Wirth (2019, p. 337–38) notes, UMPs imply ad hoc changes to central banks' operational frameworks, regarding the setting of

short-term market interest rates. This policy shift involves large increases in excess liquidity on the liability side of central bank balance sheets, but this development is not seen as threatening the existing monetary policy framework so far, since there is no direct link between an increase in reserves and broader money aggregates or real variables (beyond the expected effect of non-conventional measures and the decrease in market interest rates).

The stated policy framework remains flexible inflation targeting, and central bank independence continues to represent a key component of the legislation guiding the actions of the central banks. The exchange rate system and the openness of the country to international financial flows are also critical components of this framework. In Pourroy's (2012) characterization, Hungary (after 2008) and Poland belong to the free floaters, while the Czech Republic (after 2013) has a managed or dirty float exchange rate system (or a hybrid inflation targeting regime, in which exchange rate concerns played a prominent role). Ilzetzki et al. (2019) consider all three countries to have adopted some form of a crawling peg or to be engaged in managed floating since 2000. On the other hand, relying on IMF data, Galimberti and Moura (2013) report that all three countries, at least until 2011, had independently floating exchange rate regimes. Keeping exchange rates as an integral part of the basic model helps to retain focus on the importance of external shocks as a factor in the stabilization properties of policies. The observed discrepancy in the inflation and output gaps can reflect the fact that while monetary policy stabilization is an internal matter, external shocks can also be an important source of fluctuations that alter the outcome of monetary stabilization. Maćkowiak (2006) shows that external shocks accounted for about 20–50 percent of the short-run variance in aggregate price level in the Czech Republic, Hungary, and Poland between 1992 and 2004 (Maćkowiak 2006, p. 524). Clearly then, there is scope to support the notion, explicit in Equation (1), that the exchange rate is part of these central banks' loss functions.[10]

4. Empirical Evidence

Inflation targeting was introduced in the Czech Republic and Poland in 1998 and in Hungary in 2000.[11] We first begin with a few stylized facts in the following two sections to assess the relationship between inflation, exchange rates, and the output gap in light of the theoretical relationships derived above before concluding with supplementary econometric evidence relying on Taylor rules and vector autoregressions.[12]

4.1. Stylized Facts I: Inflation, Inflation Targets, and the Real Exchange Rate

Figure 1 depicts side by side the evolution of observed CPI inflation (solid line), inflation targets, as well as the inflation reference values used to determine inflation performance according to the Maastricht Treaty requirements in the Czech Republic, Hungary, and Poland.[13] The Maastricht reference inflation rate is the rate of inflation among the European Union member countries with the three lowest inflation rates, plus 1.5%.[14] Presumably, this criterion ought to influence a candidate economy's monetary policy strategy since, in principle, all three countries are committed to eventually joining the euro area. However, since the Eurozone Sovereign Debt Crisis (ESDC), the date of euro adoption has been pushed back indefinitely in the three countries considered in this study (CZE, HUN, and POL).

Figure 1 reveals several interesting features in the data. The Maastricht inflation reference rate (noted by "euro reference rate" in Figure 1) is, more frequently than not, lower than observed inflation in all three countries. Moreover, inflation has largely been on a downward trend since 1999 in the three countries considered. The trend has been interrupted twice, first in 2003–2004, just before these countries entered the EU, and then again in 2007–2008, as the GFC spread beyond the US economy. Next, examining the individual inflation targets in the three countries considered, these have mostly proved to be too optimistic relative to out-turns, at least until the ESDC. It is only toward the end of the sample (2019–2020) that observed inflation and inflation targets begin to overlap. Finally, it is also worth noting the greater volatility in the euro area referencing inflation rate compared with the largely unchanging individual inflation targets that each one of the three central banks are expected to aim for.[15]
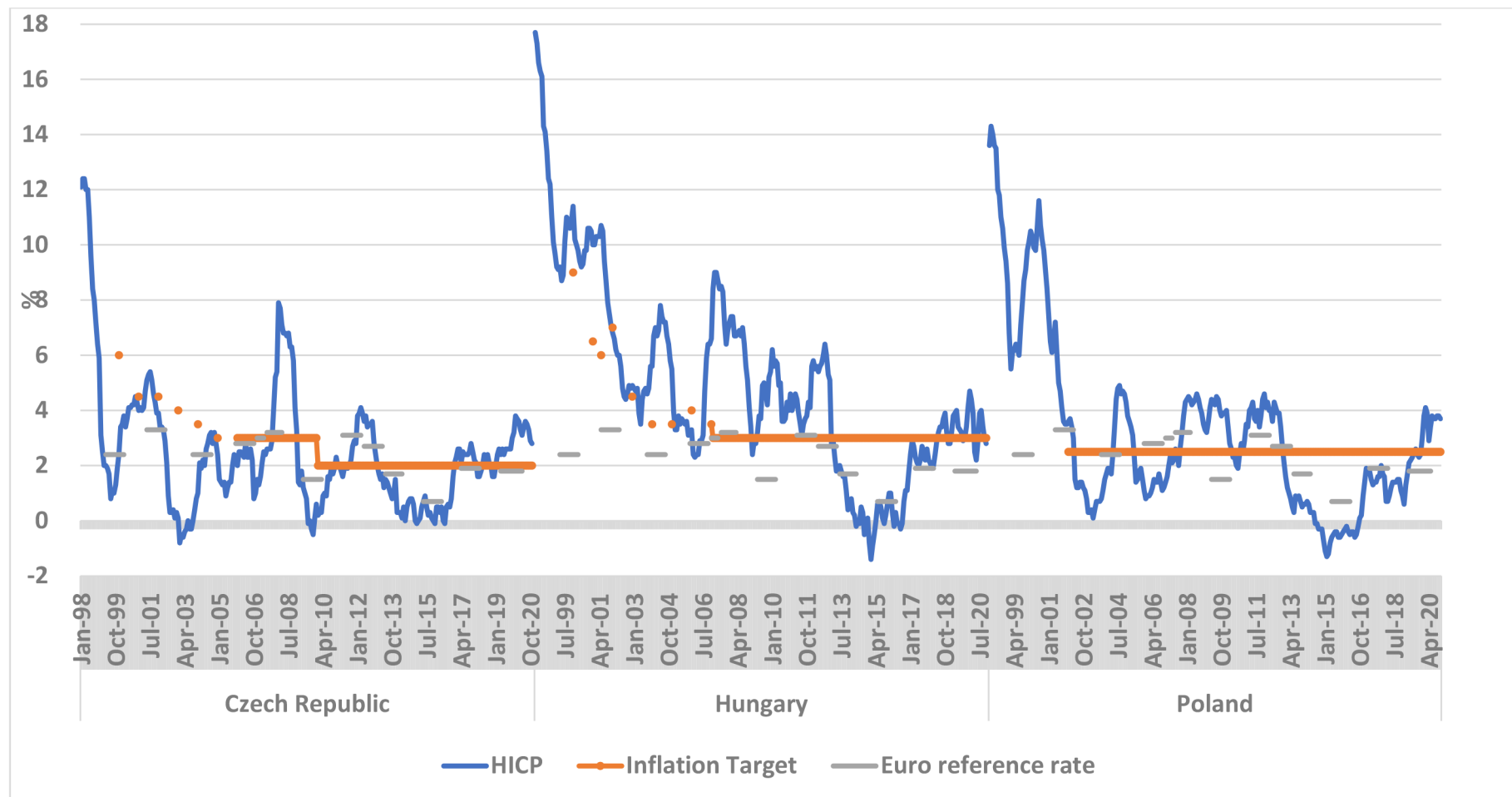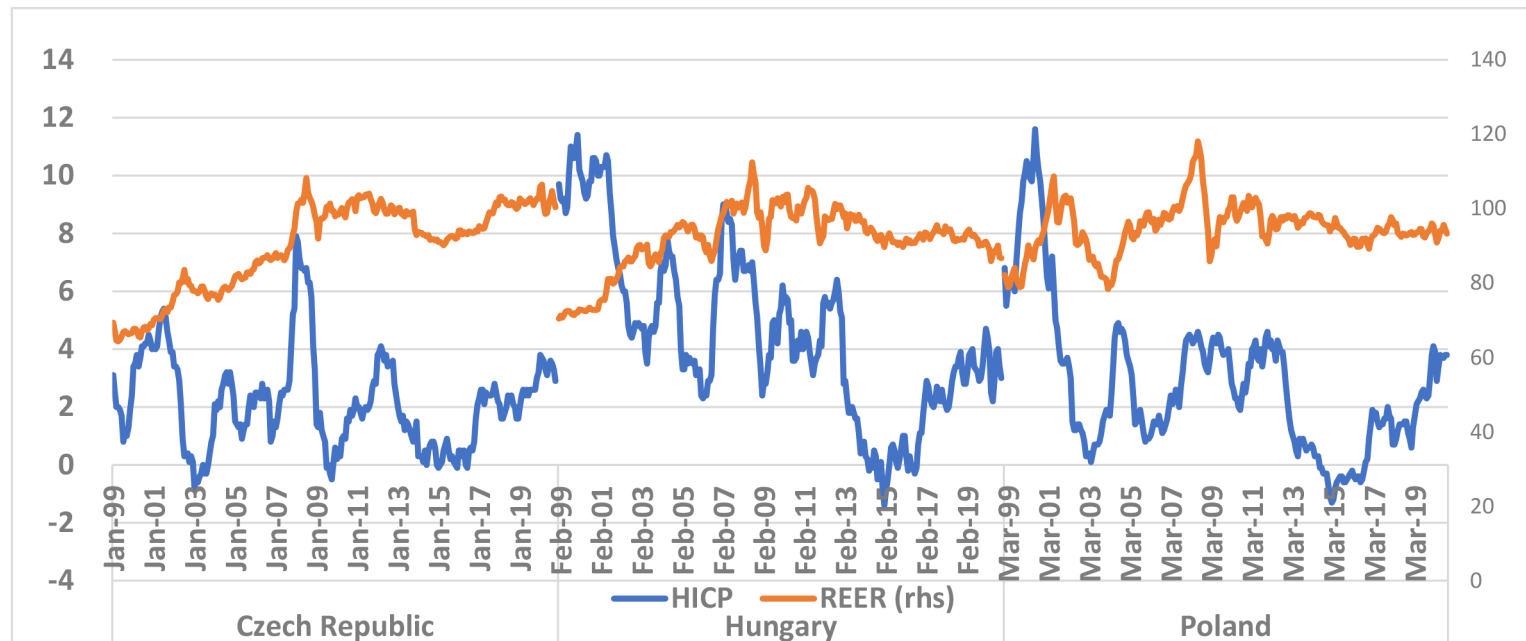
Figure 1. Inflation and inflation targets in the Czech Republic, Hungary, and Poland, and the Maastricht (area) reference inflation rate: 1999–2020. Sources: Individual central banks (ČNB, MNB, NBP, and the ECB), ESTAT (https://ec.europa.eu/eurostat/cros/category/acronyms/estat_en) accessed on 10 January 2023, and Bordo and Siklos (2021). Inflation is the Harmonized Index of Consumer Prices (HICPs). Data are in percent and are monthly.

Figure 2 plots, again side by side, observed CPI inflation (left-hand scale) against the change in CPI-based real exchange rate measured on the right-hand scale. Data are monthly. Although there are some common features in the behavior of the real exchange rate, there are also some differences that reflect, in part, idiosyncratic behavior in how the flexible inflation targeting regime is managed in each one of the three countries under investigation. For example, in the case of the Czech Republic, there is a general trend toward real exchange rate appreciation though interrupted at times (see below). In Hungary's case, the pre-GFC period is marked by real exchange rate appreciation, which is then reversed after the financial crisis. Poland's experience is marked by volatile real exchange rate movements pre-GFC and then followed by relative stability. In all three countries, however, the real exchange rate at the end of the sample appreciated relative to the early days of inflation targeting while inflation generally varied around the domestically set inflation targets (also see Figure 1).

The relationship between inflation and the change in real exchange rate is often negative, as predicted by Equation (3).[16] That said, the results are, unsurprisingly given the period under investigation, sensitive to the sample in question. The table below Figure 2 provides a few results. In Poland, the exchange rate floated and intervention was limited to when there were crisis conditions. In Hungary, the exchange rate was managed until 2008.[17] The data give the distinct impression in the early part of the sample (also see Figure 1) that Hungary's convergence of inflation to the European benchmark is largely made possible by the strengthening of the domestic currency, namely the forint. Poland's inflation record somewhat resembles Hungary's with a drop in average levels of inflation by the mid-2000s. Other than a brief surge around the time of the GFC, when real exchange rate behavior is largely consistent with the model outlined in this paper, inflation remained stable although both the Czech Republic and Poland have flirted with very brief bouts of deflation.

Although we would expect a negative relationship between inflation and the change in real exchange rate, it is important to keep in mind that this also assumes that pass-through effects (the coefficient v in Equation (3)) are constant. As Mihaljek and Klau (2008) and Jašová et al. (2016) 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. Also noteworthy is that, beginning in November 2013, the Czech National Bank (CNB) began to intervene in foreign exchange markets to effectively put a ceiling on the appreciation of the currency. The CNB originally intended to use the asymmetric exchange rate commitment until the risks of below the target inflation were significantly reduced at around mid-2015. The effect on the change in real exchange rate is visible from Figure 2 during this period. As a result, a negative correlation between the two series is more apparent in the years prior to the ESDC than after. The CNB expected that the weakening of the Czech koruna would raise the inflation close to the 2% target within about one year and they would avoid deflation. But, the asymmetric exchange rate commitment in the Czech Republic was maintained until April 2017 (Ciżkowicz-Pękała et al. 2019, p. 136).

Clearly, policies toward the exchange rate in all three countries, broadly speaking, appear to reflect an active concern about how these threaten attaining 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 stabilization policies below.

| Country	1999M1–2007M6 (pre-crisis)	1999M1–2020M10 (full)
CZE	−0.39(0.00)	0.01(0.86)
HUN	−0.67(0.00)	−0.38(0.00)
POL	−0.17(0.09)	−0.02(0.76)

Figure 2. Inflation (HICP) in the Czech Republic, Hungary, and Poland and the change in real exchange rate, 1999–2020. Sources: Individual central banks (ČNB, MNB, and NBP), and IMF International Financial Statistics. The change in real exchange rate (REER) is CPI-based and is based on 42 trading partners. Data are in percent. Also, see Figure 1. The unconditional contemporaneous correlations in the table below are for the series plotted above.

4.2. Stylized Facts II: The Output–Inflation Gaps' Relationship

We rely on central bank output gap estimates, as indicated in the sources given in the figures below. Nevertheless, we also used alternative output gap estimates when investigating the evolution of the stance of monetary policy in the three countries considered in this study. 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, and Hamilton (Hamilton 2018) filters. Often, due to the non-stationarity of levels of (log) real GDP, first differences 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. The study by Blondeau et al. (2021) is the latest addition of estimates of the output gap in the EU. Drehmann and Yetman (2020) provide a recent evaluation and critique of various univariate filters, and Hamilton and Leff (2020) revisit some of their results. We also consider what happens when we average the Hamilton, H–P, and growth rate filters. Due to the loss of observations for the version of the band pass filter used, we drop this proxy.

Monetary policy that produces changes in inflation and the business cycle are meant to be stabilizing according to the model outlined in Section 2. However, monetary policy lags can be long and variable. Therefore, while the theory of economic stabilization requires that the output gap and inflation gap move in opposite directions, i.e., that the two processes are negatively correlated as seen from Equation (1), the relationship is not expected to be a contemporaneous one. Moreover, the strength of the relationship is a function of the policy makers' aversion to the inflation and output gaps.[18] Readers will have noted that the relationship in Equation (1) 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 (5). Indeed, the vast literature spawned by the appealing feature of instrument rules generally links expectations of the inflation and output gaps to the current interest rate. When such data are not available, practitioners often allow for a lagged response. To some extent, the issue of lags is also partly a function of the sampling frequency used in empirical work. Inflation and inflation expectations are generally available at the monthly frequency while output data are normally only available at the quarterly frequency. Moreover, unless the inflation target is explicit (and credible), it is not observable. Potential output, of course, is another variable that is unobserved. Even the EU's reference values are published only occasionally and so are sometimes not observed for years. Additionally, the Maastricht requirements are backward-looking in nature and, as noted above, far more volatile than domestically set central bank inflation targets.

Figure 3 shows the evolution of inflation and output gaps for the Czech Republic, Hungary, and Poland over the period from 1999 to 2020.[19] The main features of the data suggest a tendency to observe a negative correlation between the two in all three countries, albeit with a lag consistent with the observations about long and variable lags in monetary policy. More precisely, a consistently negative and significant relationship between the current inflation gap and future output gap is found. If, as is typically observed, prices are more flexible than output changes, combined with the desire to keep inflation near the stated target so 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 we observe for all three countries. The table below the figure provides some results. A rise in the current inflation gap translates into a decline in the output gap several quarters into the future for the full sample (1999–2019). Of course, the cross-correlations shown are unconditional. Hence, monetary policy alone may not have generated this outcome. We turn to additional evidence relying on various instrument rules.
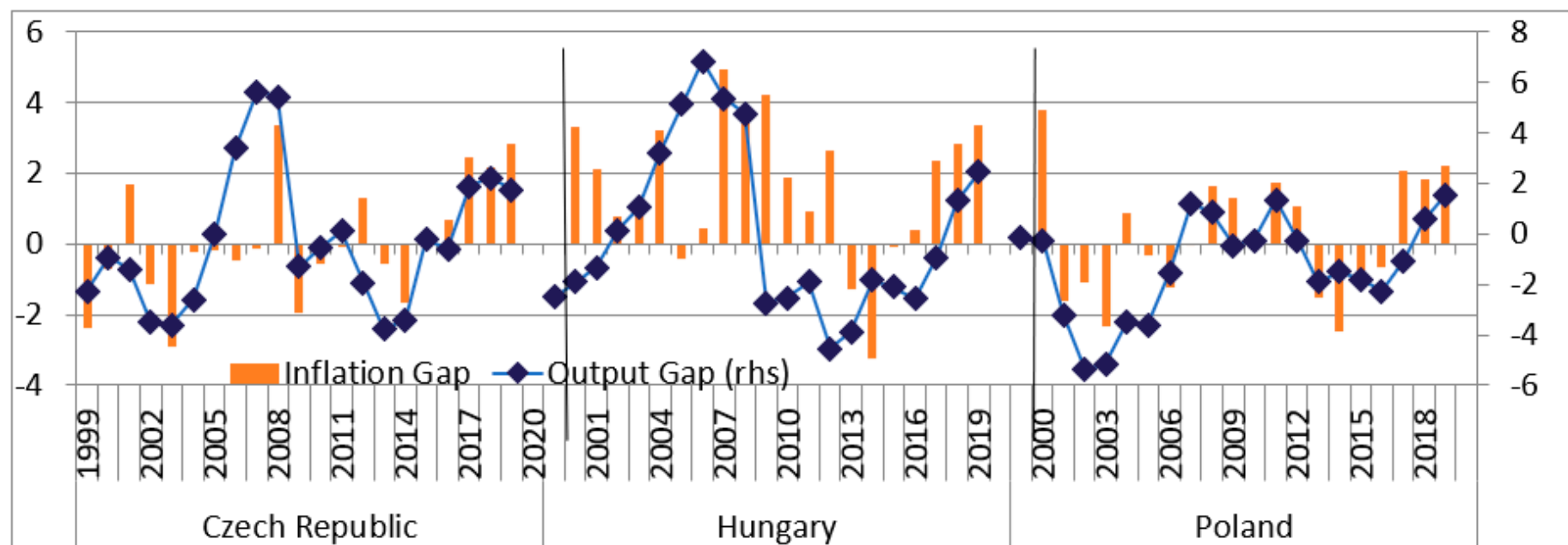
Peak Negative Cross-Correlations

	Samples	
Country	1999Q1-2019Q4	2010Q1-2019Q4
CZE	−0.38*(t,t+17)	−0.57*(t,t−11)
HUN	−0.24*(t,t+20)	−0.61*(t,t+14)
POL	−0.53*(t,t+20)	−0.64*(t,t−18)

Figure 3. Inflation gap and output gaps in the Czech Republic, Hungary, and Poland: 1998–2020. Source: See Figure 1. Data on both axes are in percent. The inflation gap is calculated as the difference between the annualized CPI inflation and the respective country's inflation target. The output gap is based on central bank estimates. Data are quarterly. The table below shows the peak negative unconditional cross-correlations between current inflation gap, labeled t in parentheses, and lagged (t−#) or lead (t+#) output gap for the full sample and the crisis sample (2010–2019). For example, the value of −0.38 for CZE indicates, for the full sample, that the peak negative correlation between current inflation gap and the output gap occurs with the value of the output gap 17 quarters into the future. The same peak negative correlation for the crisis sample for CZE is −0.57 for current inflation, and the output gap is 11 quarters in the past. * indicates that the correlations are statistically significant at least at the 10% level.

4.3. Stylized Facts III: Extended Taylor Rules

We first 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 2019 and unlike the ECB and central bank in advanced economies, the three central banks did not engage in QE-style interventions nor did any of the central banks examined reach the effective lower bounds (viz., negative interest rates).[20] This makes it easier to rely on conventional style policy rules to investigate the time-varying policy stances of the Czech, Hungarian, and Polish central banks.

Mackiewicz-Łyziak (2016) detects regime switches from active to passive monetary policy practices in the countries examined. A passive regime is characterized 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 global phenomenon and has increased since the GFC. Monetary policies in the three countries suggest significant interest rate smoothing (e.g., see Mackiewicz-Łyziak (2016) for the countries examined in the present study), but in unusual circumstances, such as a perceived speculative attack or the global financial crisis, monetary policies tend to switch in favor of an active regime where the interest rate reaction to expected inflation or output gaps is stronger (Mackiewicz-Łyziak 2016, p. 134).[21]

However, owing in part to disagreement about estimates from instrument rules, the existing literature relies on simpler versions of the reaction function than the one derived in Equation (5). There is a vast amount 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. A similar problem applies to estimates of the real exchange rate gap. In recent years, Taylor rules must also confront the decline in the neutral real interest rate.[22] Whether this phenomenon is restricted to advanced economies alone remains in question though there is some evidence that it has declined in some emerging markets (e.g., as in Brazil and Mexico, see Perrelli and Roache 2014; Carrillo et al. 2018). Beyond these considerations, the extant literature dealing with emerging market economies has also considered whether estimated Taylor rules are subject to structural breaks (e.g., Yilmazkuday 2008) or are subject to non-linearities (e.g., Klose 2019).

Central banks often prefer to discuss the implications of the Taylor rule in some calibrated form. An advantage of this approach is that the performance of such rules tends to be robust both to non-linearities and structural breaks (e.g., Orphanides 2003). For example, this may be one reason why the Federal Reserve's Tealbook ("Report to the FOMC on Economic Conditions and Monetary Policy") follows this strategy in preparing options for the setting of the Fed funds rate. Some applications to emerging market economies, including the three countries considered in this paper, either add an exchange rate variable, much as is conducted in Equation (5) above, or separately estimate an exchange rate equation since this variable is considered an additional instrument of monetary policy (e.g., see Galimberti and Moura 2013; Yilmazkuday 2008).

We do not intend to wade into the debate about best methodology to estimate the Taylor rule. Instead, we adopt the strategy of generating varieties of calibrated Taylor rules not only akin to the thick modeling strategy of Granger and Yeon (2004) but also the approach taken by many central bankers to publicly explain the stance and strategy of monetary policy.[23] Two sets of traditional policy rules are considered. The first set of Taylor rules (TRs) rely on Taylor's original paper (Taylor 1993) where both the inflation and output gaps are equally weighted in the central bank's reaction function. The second set is modified by increasing the weight on the output gap as suggested by Taylor (1999). In this case, the central bank is required to raise the policy rate by more than the increase in inflation to prevent inflation expectations from rising. Since the various alternatives considered produce broadly comparable results, and to conserve space, we focus on a representative set of results. Traditionally, the neutral real interest rate is assumed to be 2%.

However, in view of a growing consensus that neutral real interest rates have also fallen in EME, we also consider a version with a time-varying neutral real rate. We adopt a version of the approach used by Holston et al. (2017) in estimating neutral real interest rates.[24]

Next, since we argue that the exchange rate plays a separate role in setting the stance of monetary policy, we extend the set of Taylor rules described above by adding a real exchange rate gap. This is consistent with Equation (5) above. The calibrated extended rules use the coefficient values that Taylor (1993, 1999) posited. In the case of the real exchange rate, there is no consensus about the size of the coefficient, but empirical evidence suggests that the coefficient is small, and 0.1 is mentioned as a good estimate of the weight on the real exchange rate ω_t (e.g., see Engel and West (2006)). Equations (6) and (7) below encompass the variety of Taylor (1993) and Taylor (1999) rules considered, both in traditional and extended forms.[25]

$$i_t = 2 + \pi_t + 0.5(\pi_t - \pi_t^*) + 0.5x_t \tag{6}$$

$$i_t = 2 + \pi_t + 0.5(\pi_t - \pi_t^*) + +0.5x_t + 0.1e_t \tag{7}$$

$$i_t = 2 + \pi_t + 0.5(\pi_t - \pi_t^*) + x_t \tag{8}$$

$$i_t = 2 + \pi_t + 0.5(\pi_t - \pi_t^*) + x_t + 0.1e_t \tag{9}$$

The π^* is proxied either by the stated inflation target or the inflation criterion of the EU Commission in their convergence reports. The output gap x_t is constructed from real GDP data 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 each of the three central banks. Finally, we also consider 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.[26]

We first begin by describing the behavior of the different calibrated policy rates.[27] We then discuss differences between calibrated and observed policy rates, which we refer to as gaps, to determine whether these are informative about the flexible nature of inflation targeting adopted in the three countries. In so doing, we follow the approach of Hofmann and Bogdanova (2012) though, in contrast to these authors, we consider a larger number of calibrated rules, output gap proxies, as well as the case with a time-varying neutral real interest rate.

Comparing the results for Equations (6) to (9), both the standard and extended varieties, the relatively higher responsiveness of the output gap seems to provide a better fit of the actual stance of monetary policy over time in all three countries (CZE, HUN, and POL). Substituting current inflation and a constructed output gap does not appear to make a noticeable difference in the evolution of the policy rate. Nevertheless, there are differences between the more forward-looking and standard TRs at the beginning of the sample (viz., 1998–2002), around the GFC, and again in the aftermath of the ESDC.

Figure 4 presents some results. Comparing the standard and forward-looking versions of the TR, we find that estimates of Equations (6) to (9) for CZE are sharply higher during the GFC for the former than for the latter. Otherwise, the recommended policy rates parallel each other. In the case of Hungary, there are persistent gaps between the Taylor rules given by Equations (6) to (9) with the same phenomenon emerging during the GFC as in the Czech experience. However, for the period 2012–2017, Equation (6) generates policy rates persistently lower than when a forward-looking version is considered. For Poland, estimates resemble those for Hungary's case although estimates using Equation (6) are now persistently higher than for the forward-looking version of the same specification, at least during the period of the ESDC. Finally, when the domestic inflation target (π^*) is replaced by EU convergence criterion estimates, two results emerge that differ somewhat from the others: persistent gaps between the backward- and forward-looking versions emerge for all three economies, with the forward-looking version much lower than backward-looking specification during the GFC, with a reversal taking place during the ESDC.
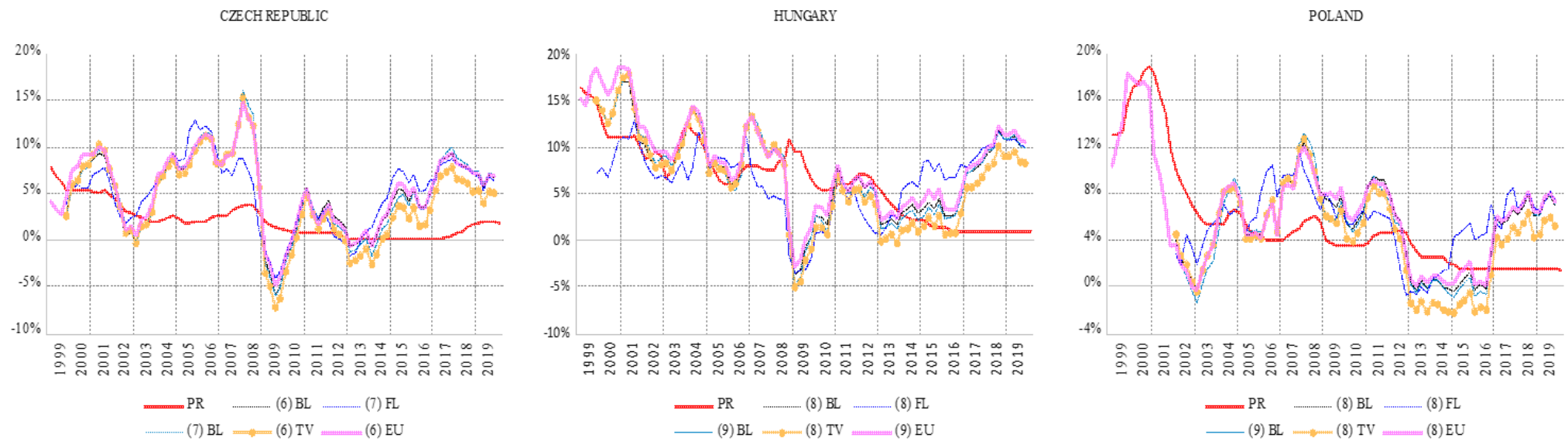
Figure 4. Policy rates and select Taylor rule estimates, 1999–2019. Note: (6) to (9) refer to the equation numbers in the main text. PR is the central bank policy rate, BL signifies backward-looking version, FL is the forward-looking version, TV is the case where the neutral rate is time varying (it is assumed constant in Equation (6)), and EU refers to the case where π^* is the EU convergence criterion inflation rate (also time varying). The BL versions rely on observed inflation values, and the FL versions use inflation expectations to estimate the inflation gap.

Overall, gaps between observed and recommended policy rates, at least according to the Taylor rule, suggest considerable flexibility in the response of all three central banks to two large shocks that took place in the two decades since inflation targeting was introduced. Figure 5 plots these gaps for each country as these are also informative about the link between what the Taylor rule recommends relative to the observed policy rate and the role played by the hypothesized correlations between inflation and the output and exchange rate gaps. The results are broadly consistent with the stylized facts discussed earlier and are also in line with the results of Hofmann and Bogdanova (2012) and Taylor (2019). More precisely, as indicated in the table below Figure 5, and with the exceptions of two cases out of the twenty-seven estimated correlations for the full, pre-, and post-GFC samples, all are negative and statistically significant. Hence, when the observed policy rates are less than the recommended ones (the gap is negative), all gaps tend to be positive. This is true for all samples considered. However, correlations are weaker for inflation post-GFC, except for Poland, are largely unchanged for the output gap across all three central banks and are higher post-GFC for the real exchange rate gap.
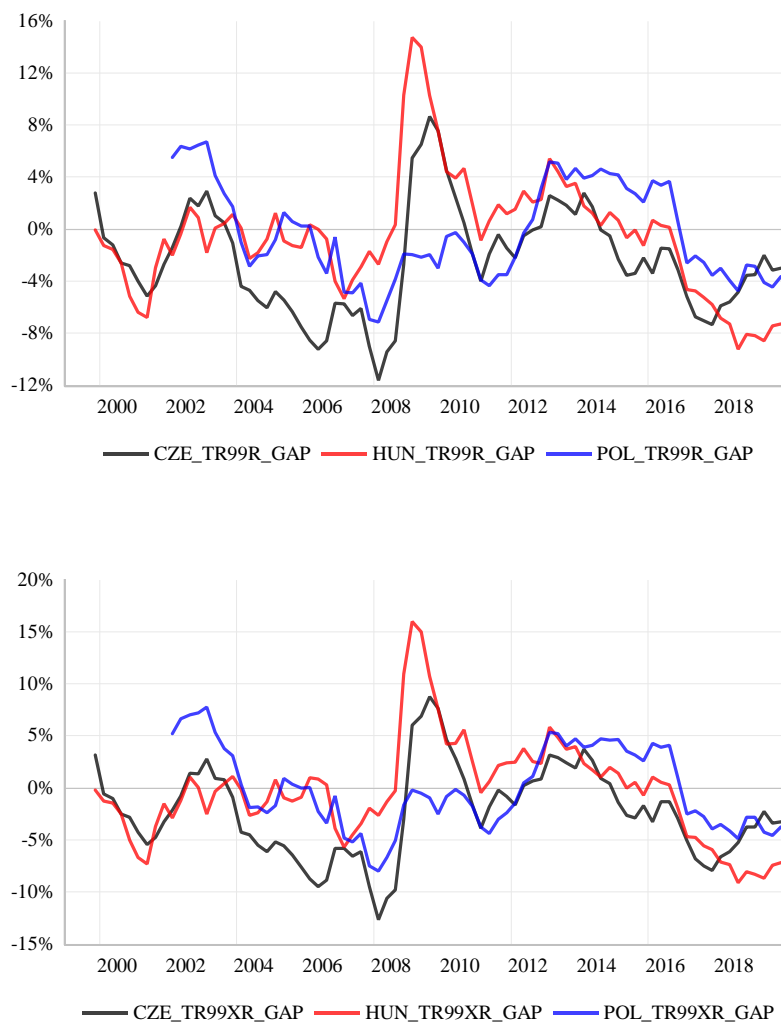

Figure 5. *Cont.*

	Correlation (TR99XR, $\pi - \pi^*$)			Correlation (TR99XR, x)			Correlation (TR99XR, ω)		
	Full	Pre–2009.12	Post–GFC	Full	Pre–2009.12	Post–GFC	Full	Pre–2009.12	Post–GFC
CZE	−0.57(0.00)	−0.73(0.00)	−0.36(0.02)	−0.85(0.00)	−0.85(0.00)	−0.86(0.00)	−0.53(0.00)	−0.38(0.01)	−0.73(0.00)
HUN	−0.13(0.24)	−0.34(0.00)	0.02(0.93)	−0.80(0.00)	−0.80(0.00)	−0.81(0.00)	−0.35(0.00)	−0.45(0.00)	−0.45(0.00)
POL	−0.60(0.00)	−0.55(0.00)	−0.66(0.00)	−0.85(0.00)	−0.88(0.00)	−0.82(0.00)	−0.46(0.00)	−0.55(0.00)	−0.32(0.00)

Figure 5. Taylor rule gaps: observed versus recommended policy rates. Note: CZE, HUN, and POL are the country codes previously defined. TR stands for the Taylor rule. TR99 is the Equation (7) version of the Taylor rule while TR99XR is Equation (9). GAP refers to the difference between the observed and recommended policy rates. Hence, as shown in Figure 4, a negative GAP means that the observed policy rate is lower than the recommended one. *p*-values for the correlations are shown in parentheses. *x* is the output gap, and *e* is the real exchange rate.

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 an exchange rate appreciation that exceeds the equilibrium proxy and would serve to dampen both the inflation and output gaps in the future. This suggests that central banks in all three economies actively contributed to business cycle stabilization thanks to the implementation of a flexible form of inflation targeting.

4.4. Estimated Taylor Rules and Local Projections

Han and Wei (2018) derive an extended Taylor rule where the exchange rate also plays a role. They demonstrate that purely flexible exchange rates are not sufficient to prevent external shocks from being transmitted to a domestic economy, especially of the small open variety. This is precisely the reason, as argued above, that the de facto monetary policy regime in the Czech Republic, Hungary, and Poland is sensitive to exchange rate movements. Moreover, the degree of capital mobility combined with the influence of foreign interest rates also play a role in how the stance of domestic monetary policy is set. Finally, Han and Wei's (2018) specification also permits a role for uncertainty in the form of the VIX, a measure of the expected volatility of equity prices in the S&P500 stock market index. Accordingly, the following specification is estimated via OLS.

$$i_{jt} = c_j + \alpha_0 \left(\pi_{jt} - \pi_{jt}^* \right) + \alpha_1 x_{jt} + \alpha_3 reer_{jt} + \beta_0 \Delta VIX_t + \beta_1 \left(D_{jt} * \Delta i_t^{\text{€}} \right) + \eta_{jt} \quad (10)$$

where most of the terms were previously defined (see Equations (6) and (7)) and where *j* = *CZE, HUN, POL*, the real exchange rate is given by *reer*, $\Delta i_t^{\text{€}}$ is the change in the ECB's policy rate, and D_{jt} is a dummy variable capturing the degree of capital mobility using the widely used Chinn–Ito series. Table 1 provides two sets of estimates depending on whether expected or observed inflation rates are used to estimate the inflation gap. In the former case, the extended Taylor rule is of the forward-looking variety; otherwise, the policy rule is viewed as being backward-looking. For the Czech Republic, we also include a separate dummy variable set equal to 1 for the November 2013–April 2017 period when the central bank committed to using the exchange rate as an additional monetary policy instrument by preventing, if not attempting to weaken, pressure on the Czech koruna to appreciate. This variable proved to be statistically insignificant in all estimated specifications.

Several insights can be drawn from the results shown in Table 1. First, backward-looking models perform slightly better statistically than forward-looking versions based on the explanatory power of the specifications tested. Moreover, estimated coefficients tend to be more in line with those predicted by theory. Except for the Czech Republic, the exchange rate plays a significant role with an appreciation of the real exchange rate associated with a loosening of monetary policy. Indeed, more capital mobility and a rise in the ECB policy rate (i.e., $D_t * \Delta i_t^{\text{€}}$) combine to loosen monetary policy in Hungary. The

opposite is found for Poland and the Czech Republic. Also notable, in the case of the backward-looking estimates, is that all three central banks react appropriately to positive inflation gaps by tightening domestic monetary policy. The output gap is significant in the backward-looking versions of the model in all three economies and, as theory predicts, also generates a tightening of monetary policy when the gap is positive. Finally, uncertainty, in the form of a rise in the VIX, is seen as tightening monetary policy in Hungary and Poland but not in the backward-looking specification for the Czech Republic.

Table 1. Extended Taylor rule estimates: backward- and forward-looking specifications.

Variable	CZE		HUN		POL	
	Forward-Looking	Backward-Looking	Forward-Looking	Backward-Looking	Forward-Looking	Backward-Looking
i_{t-1}	−0.09 (0.02) *	−0.08 (0.02) *	−0.05 (0.03)	−0.01 (0.03)	−0.09 (0.02) *	−0.13 (0.02) *
π_t^{gap}	0.004 (0.01)	0.06 (0.01) *	−0.07 (0.03) @	0.13 (0.05) *	−0.04 (0.01) *	0.14 (0.02) *
y_t^{gap}	−0.03 (0.01) *	0.04 (0.01) *	−0.05 (0.02) @	0.08 (0.03) *	−0.05 (0.01) *	0.03 (0.02) †
$reer_t^{gap}$	0.007 (0.007)	−0.004 (0.006)	−0.04 (0.02) @	−0.06 (0.02) *	−0.01 (0.01)	−0.01 (0.007) †
VIX_t	−0.009 (0.005)	−0.005 (0.004)	0.03 (0.01) †	0.04 (0.01) *	0.003 (0.006)	0.01 (0.006) @
$D_t * \Delta i_t^{€}$	0.81 (0.30) *	0.51 (0.27) @	−2.53 (0.87) *	−1.94 (0.85) @	0.47 (0.17) *	0.76 (0.16) *
ER_COMMIT	−0.07 (0.08)	−0.06 (0.07)	NA	NA	NA	NA
Constant	0.23 (0.06) *	0.06 (0.05)	0.24 (0.20)	−0.25 (0.22)	0.41 (0.08) *	0.40 (0.10) *
$\overline{R^2}$	0.32	0.47	0.20	0.22	0.60	0.63
F-stat	6.37 (0.00)	12.79 (0.00)	4.39 (0.00)	4.72 (0.00)	19.01 (0.00)	20.87 (0.00)

Note: * means statistically significant at the 1%; @, 5%; †, 10% level of significance. Standard errors in parentheses except for the F-stat (*p*-values in parentheses). Variable definitions are given in the text. D is a [0, 1] dummy variable set to 1 if capital is free to move and 0 if there are capital flow restrictions. The Ka_open series from the Chinn–Ito index is used (=0 for limited or no capital mobility; =1 for full capital mobility). ER_COMMIT is a dummy variable = 1 for the November 2013 (i.e., 2013 Q4)–April 2017 (i.e., 2017 Q1) period when the Czech National Bank committed to an upper limit to the koruna. The dependent variable is in first differences due to the unit root property of the nominal interest rate.

Finally, an objection that can be raised by the results presented so far is that they offer an incomplete picture of the interaction between the core variables in the model used to make the case for the form of inflation targeting adopted in the three countries studied here. Accordingly, we also estimate local projections (LPs), introduced by Jordà (2005),[28] which is a widely used methodology to estimate impulse responses from vector autoregressions (VARs). The intuition behind the technique is that the impact of a shock in the current period (the impulse) can be traced out from forecasts of the dependent variable of interest in the future (the response). Because many impulse responses are possible when estimated from a VAR, we report the responses only to key determinants in the central bank's reaction function, namely the inflation, output, and real exchange rate gaps. The VAR is defined as follows:

$$X_{jt} = [i_{jt}, (\pi_{jt} - \pi_{jt}^*), x_{jt}, reer_{jt}] \tag{11}$$

where all the variables were previously defined. The LPs are then obtained by estimating

$$i_{jt+h} = \mu_{jt} + \beta_h X_{jt-i} + D_t \times \Delta i_t^{€} + \zeta_{jt} \tag{12}$$

where $h = 0, \ldots, 10$ is the horizons for the linear projection, and X is defined in Equation (11). The local projection impulse responses of i_j with respect to X are $\{\beta\}_{h \geq 0}$. Figure 6 displays the impulse responses.
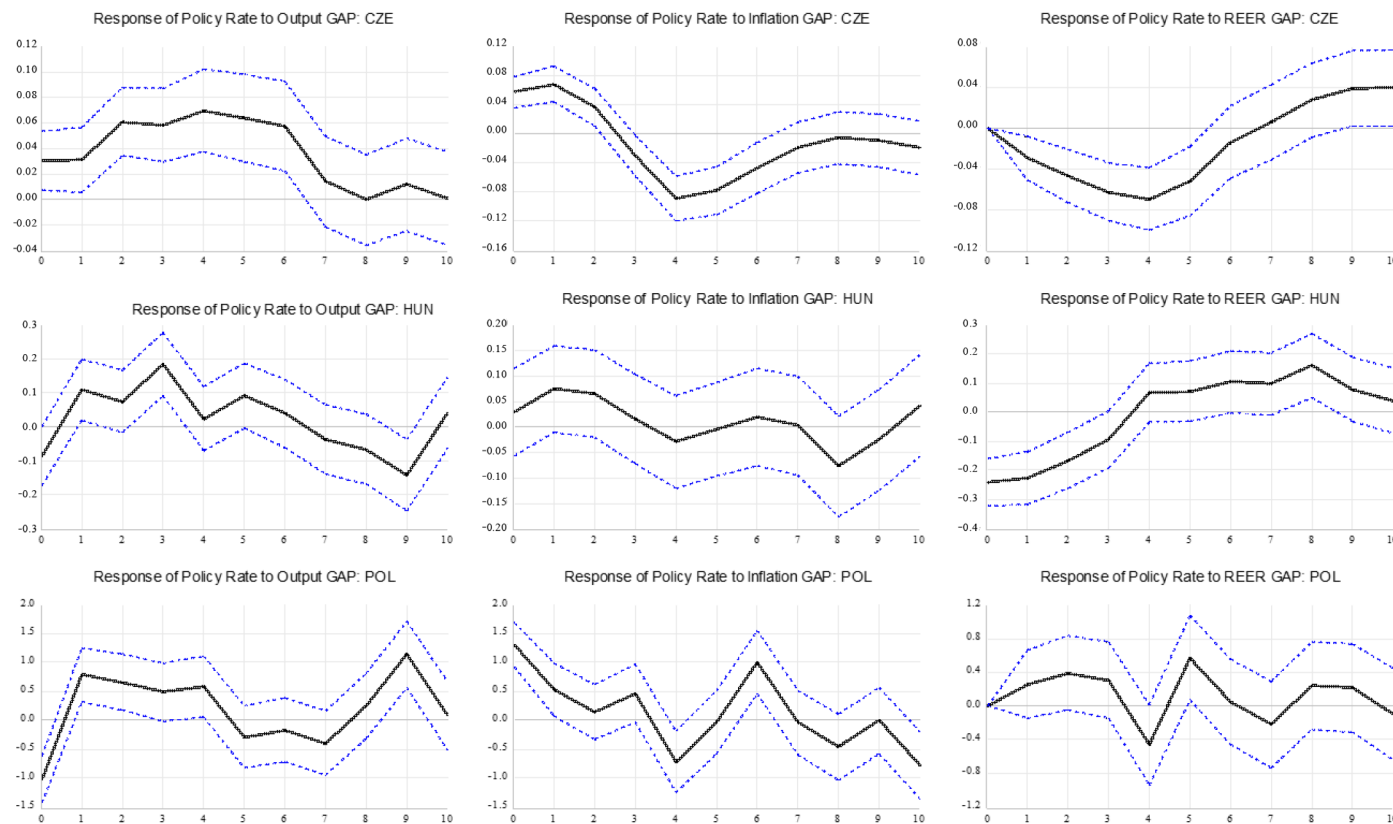
Figure 6. Selected impulse response functions from local projections: the influence of shocks on policy rate changes. Note: The response of the policy rate in CZE (1st row), HUN (2nd row), and POL (3rd row) to shocks from inflation, output, and real exchange rate gaps (all in first differences). The 68% marginal confidence intervals are shown as dashed lines. The VARs were estimated via a Cholesky decomposition in the following order: output gap, inflation gap, real exchange gap, the domestic policy rate, and the euro area policy rate as exogenous. Various lag selection criteria pick 1 lag.

For the Czech Republic, we observe a rise in the policy rate when there is a positive shock to the output gap (column 1). The same result holds for Hungary though the size of the tightening is small and temporary as is true for Poland. A positive shock to the inflation gap (column 2) also leads to a tightening of monetary policy at first in the Czech Republic and Poland, but there is no statistically significant response in the case of Hungary. Finally, and especially for some of the arguments made in the paper, there is a loosening of monetary policy in the Czech Republic and Hungary in the first few quarters when the exchange rate appreciates. However, the confidence intervals suggest statistically insignificant responses for Poland. Generally, the LP results parallel the results shown in Table 1. Hence, flexible IT implies not only a response to the inflation and output gaps but a recognition that exchange rate shocks also impact the stance of monetary policy.

5. Summary and Conclusions

How monetary policy is actively implemented has a major impact on macroeconomic risks, namely changes in interest rates, inflation rates, and exchange rates. However monetary policy is sometimes discussed separately from the traditional theoretical framework of macroeconomics. The central bank's policy independence gives the outside observer the misconception that monetary policy can be independent of any kind of real economic considerations. This misunderstanding also reinforces the view among some analysts that an inflation targeting central bank ignores other macroeconomic factors when setting the stance of monetary policy. In the case of small open economies of the emerging market variety, this attitude often translates into assuming output and inflation gaps alone dictate the stance of monetary policy.

We begin with a simple theoretical model of monetary policy to fix ideas. The model is used to understand the links between real economic activity, inflation rate, and exchange rate in an emerging market economy. We then apply the implications of the model to data for the Czech Republic, Hungary, and Poland. Standard macroeconomics of the inflation targeting framework is concerned with a potential conflict between exchange rate targeting and inflation targeting and favors a benign neglect for exchange rate concerns. As opposed to this approach, we demonstrate empirically that real exchange rate developments can play an important role in how the stance of monetary policy is set in all three countries considered alongside the traditional inflation and output gap variables. This "flexible" approach in implementing inflation targeting in the Czech Republic, Hungary, and Poland helped to manage external shocks to macroeconomic risks.

That said, the exchange rate does not entirely succeed in shielding the domestic economy from external shocks. How monetary policy is set in the ECB can also play a role. This is perhaps unsurprising since all three countries in this study are someday expected to adopt the euro, and the single currency area is their most important trading partner. However, the time horizon for euro adoption has lengthened considerably and it is no longer a priority for the Czech Republic, Hungary, and Poland.

Until the euro is adopted in these countries, economic uncertainty has a significant challenge for the effectiveness of monetary policy (Liosi 2023, p. 13). Liosi (2023) did not deal with accession countries like the Czech Republic, Hungary, and Poland, but assessed six factors (real output rate, inflation rate, interest rate, monetary policy, and financial market uncertainty) for the Eurozone core and peripheral countries and found that interest rates had an "enduring effect on uncertainty" (Liosi 2023, p. 13).

The results of this paper indicate that implementation of policies that contribute to reducing macroeconomic risks must take into consideration such key risk factors like the exchange rate risk. This fact suggests that monetary policy implementation in these economies will have a special function in business cycle stabilization and require that inflation targeting remain flexible. As in Han and Wei (2018), all three countries considered in our study conduct monetary policy with the recognition that shocks leave them between the dilemma and trilemma. Monetary policy independence also requires incorporating exchange rate influences in a framework that aims for inflation control. Since all three

central banks have reached high levels of transparency, one policy implication is that when the time comes to more closely align to the euro or someday adopt the euro, the exchange rate transition will have to be carefully thought through. Perhaps the experience of the original creation of the euro and the settling of the exchange rate when the new currency was introduced will offer policy makers some lessons. Economic and political circumstances at the time will no doubt loom large.

Whether the results of our study extend to other emerging market economies is unclear but is left for future research. Subsequent research will also have to confront how UMPs introduced during the pandemic were used as an additional device consistent with flexible inflation targeting. Moreover, it remains to be seen how current geopolitical considerations, which contributed to the ongoing inflation shocks, will impact the continued use of flexible inflation targeting. Finally, research should also consider other methodologies (e.g., structural models, DSGE models) to further test the validity of our interpretation of the monetary policy strategies adopted in the three countries considered.

Notes

[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, but not zero inflation.

[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 that form 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 data in real time (e.g., Croushore 2011; Orphanides 2001).

[3]   We also point out that while UMPs created policy challenges for the central banks examined in this study, the new variants can be accommodated within the same flexible inflation targeting policy framework. Moreover, the role of the exchange rate is unaffected by UMPs. Instead, versions of QE further underscore what it means to be flexible in an IT framework.

[4]   The model represents the policy maker's desire for exchange rate stability relying on a standard form of central bank objective to minimize inflation output gap and exchange rate volatility. However, from Equation (1), we observe that the exchange rate has no consequences for the simplified model, which focuses on the basics of inflation targeting no matter how the exchange rate variable is specified or interpreted.

[5]   Most central banks, at least until the financial crisis of 2008–2009, used an interest rate as an instrument to tighten or loosen policy. Other than some advanced economies that reached the zero lower bound (ZLB), or even negative nominal interest rates, the strategy has not changed; although, many central banks avail themselves of other instruments to complement the policy rate instrument. Indeed, the pandemic spurred the spread of UMPs beyond advanced economies. See, for example, Fratto et al. (2021).

[6]   In other words, changes in interest rates affect inflation and output developments through changes in aggregate demand.

[7]   For example, Carlin and Soskice (2014) refer to a version of Equation (1) as a monetary rule (MR), which, together with the Phillips curve and the IS curve of Equation (2), creates a three-equation model of the economy. Economic policy is then derived from the central bank loss function. Note, however, that their basic model does not incorporate exchange rate effects.

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

9 "QE is similar to OMOs (open market operations) in the sense that it involves CBs to acquire assets, however, it is different from conventional OMOs in three important ways: first it was undertaken not to achieve a target policy rate, …; second, it involved purchase of far larger range of securities than OMO …; third, it was aimed at segments of the financial markets that were seen as having been unduly weakened by the financial crisis." (Lombardi et al. 2018, p. 1233).

10 It is worth reminding the reader that, post-GFC, the focus in the Maastricht Treaty on goods and services inflation may well be misplaced. Financial asset prices play a larger role in monetary policy today. Convergence, as defined in the Maastricht Treaty, may well provide a misleading signal of the degree of actual economic integration between member and candidate economies. Moreover, 8 years since the GFC, the accumulated economic and financial distortions due to heavy central bank interventions also cloud the picture about how best to evaluate convergence.

11 The appendix in Bordo and Siklos (2021) contains the dating and details about inflation targeting regimes around the world.

12 We do not separately consider the role played by central bank independence or transparency. However, both these characteristics would provide additional support for our hypothesis since both have risen substantially over the period considered. For example, data from Romelli (2022) show that central bank independence rose from 0.62 in 1991 to 0.80 in 2017 in the Czech Republic; from 0.42 in 1991 to 0.75 in 2017 in Hungary; and from 0.79 in 1997 to 0.85 in Poland in 2017. The maximum degree of central bank independence is one. Turning to central bank transparency, data from Dincer et al. (2019) reveal that transparency went from 7.5 in 1998 to 14 by 2015 in the Czech Republic; from 4.5 to 12.5 in Hungary over the same period; and from 3.5 to 11 again over the 1998–2015 period in Poland. Maximum transparency would yield a score of 15.

13 One of the Maastricht conditions of entry into the Eurozone is meeting an inflation objective. The EU Commission and the ECB regularly update the reference inflation value for Eurozone entry via convergence reports generally every two years. While convergence involves several quantifiable criteria, the academic profession has tended to focus on inflation performance since this is reflected in many of the other convergence indicators (viz., interest rates and exchange rates), at least according to economic theory. History also suggests that there is judgment also involved especially concerning the timing of admission into the euro (e.g., see Mody 2018; Brunnermeier et al. 2016). See https://ec.europa.eu/info/business-economy-euro/euro-area/enlargement-euro-area/convergence-reports_en (accessed on 10 January 2023).

14 See http://europa.eu.int/comm/enlargement/negotiations/chapters/chap11 (accessed on 10 January 2023).

15 Golinelli and Rovelli (2005) demonstrated progress toward convergence to the EU reference inflation rate in the period of their study (quarterly from January 1991 to January 2001). Siklos' (2010) findings for the period of January 1995–April 2007 also suggest progress toward convergence throughout. Such a convergence implies a positive contribution of monetary policy to economic stabilization.

16 For a detailed description of the inflation targeting framework and maintaining the exchange rate system in the countries considered, see Ciżkowicz-Pękała et al. (2019).

17 In Hungary between 1995 and 2001, a crawling peg exchange rate system with a fluctuation band of $\pm 2.5\%$ guided monetary policy. The band of exchange rate fluctuations was widened to $\pm 15\%$ 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 until 20 June 2008, when floating was introduced.

18 In Norway, a small open economy like the three considered in this paper, the Norges Bank relies on six criteria to generate an appropriate future interest rate path. The second of these "rules" 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 and Solberg-Johansen 2006, p. 119). This strategy is one that is common across most inflation targeting central banks.

19 Versions of Figure 3 in terms of the differential between observed and either targeted inflation or the Maastricht inflation reference rate or changes in inflation and output gaps (also, see Figure 2) convey the same insights as Figure 3.

20 Policy rates did briefly come close to, but did not reach, zero during the height of the pandemic.

21 The debate about the stochastic properties of nominal interest rates and central bank policy rates has abated since the GFC but remains incompletely resolved with, on balance, evidence favorable to the interest rate smoothing phenomenon. Inter alia, see Romero-Ávila (2007) and Coibion and Gorodnichenko (2012).

22 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. The recent review of the policy strategy of the ECB, the most relevant for the three central banks studied here, also highlights this result.

23 Poole (1999) is a classic illustration. We note that we also estimated but do not show a variety of Taylor rules, using OLS, but allowing for structural breaks and incorporating interest rate smoothing. None of the results based on estimated Taylor rule overturn the conclusion that the central banks in the three countries considered followed a flexible inflation targeting strategy with a view to stabilize output gap fluctuations.

24 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*. In a second version, R* is also impacted by the output gap. Since there is considerable uncertainty around estimates of R*, we use the same estimates for all three countries.

25   They are also the same as the ones the Fed reports in its Tealbook ("Report to the FOMC on Economics Conditions and Monetary Policy").

26   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.

27   Some academics (e.g., see Svensson (2003)) have long recommended that central banks publish their reaction functions, and the issue was formally raised when legislative proposals were made to do so in the US (see, for example, Nikolsko-Rzhevskyy et al. 2015).

28   Also, see Plagborg-Møller and Wolf (2019) and Barnichon and Brownlees (2019).

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