

Performances of selected European economies in achieving their inflation targets: The non-stationary discrete choice model approach

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ABSTRACT

Measurement of the performances of inflation targeting (IT) frameworks has been of interest to researchers ever since IT began to be implemented as a monetary policy strategy. The purpose of this paper is to evaluate the impact of domestic and international determinants on success in achieving inflation targets of the selected European economies. Our methodological framework is based on the application of a non-stationary discrete choice model. For this research, four European economies are considered: Czech Republic, Hungary, Poland and Serbia. Their results regarding IT policy can provide a useful benchmark for similar economies that are either planning to adopt the same monetary policy framework or have begun to apply it recently. Our findings indicate that IT success is primarily under the control of monetary policymakers by key policy rate mechanism, but that the impact of additional domestic and international factors that are not easily managed by the central bank like budget balance, exchange rate, growth rate, current account balance, labor cost growth, loans, Harmonized Index of Consumer Prices, inflation, and GDP gap of the Eurozone, can be also significant. Consequently, monetary policymakers need to take into account a wide range of inflation factors, including foreign spillover effects, so that tools for their neutralization can be helpful in achieving the targeted goals.

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inflation targeting, inflation drivers, non-stationary ordered probit model, monetary policy, spillover effects

JEL CLASSIFICATION INDICES

C25, C54, E31, E52, E58

1. INTRODUCTION

Inflation targeting (IT) represents a monetary policy regime that has been implemented in many countries of different development stages in the last three decades. Its fundamental feature is defining and publicly announcing a numerical goal for the inflation rate. Numerous studies have dealt with the efficiency of this approach and the factors of its success from the onset of its implementation, i.e., they have analysed different aspects of the performances of an IT regime. This is not an easy task due to the fact that central banks' loss functions are not obvious at the first glance.

In this paper, we focus on the achievement of inflation target as a main goal of monetary policy in the countries that have adopted this strategy. We aim at identifying the inflation drivers and determining how monetary policy can cope with them. The following four European economies are considered: Czech Republic, Hungary, Poland and Serbia. They are small open economies that went through a process of transition from centrally-planned to market economies, while experiencing some strong economic shocks.

Research question of our research is stated as follows: Have IT monetary strategies in the observed countries been successful and what are the determinants of the announced targets' achievement? We constructed and analysed three research hypotheses:

- H₁: IT monetary strategies in the observed countries have been successful in the observed period;
- H₂: Besides common covariates, fiscal policy has significant impact on the performance of IT regime;
- H₃: International spillovers can contribute to tendencies in inflation and consequently to IT success.

Our paper employs the methodology of a non-stationary discrete choice model (Park – Phillips 2000; Hu – Phillips 2004; Phillips et al. 2007). This is a consequence of the fact that the public is usually focused on the discrete outcomes (the goal is achieved or not achieved) in strategy performance evaluation, whereas the deviations within each outcome are not perceived as so important. In addition, we were aware of the high possibility of non-stationary processes in the covariate space. Each country is treated separately. Although these economies have many common characteristics, their idiosyncratic components contribute substantially to the final outcomes. We opted for an individual country approach, because it enables a careful and thorough examination of each economy and dynamic adjustment of domestic inflation. In addition, it allows for larger flexibility in choosing a set of significant explanatory variables. In this way, we not only econometrically identified factors that are common across different economies but also detected those economic influences that are country specific. This



econometric set-up represents our key contribution to the literature on IT policy. It should be emphasized that an ordered probit model is not often used in macroeconomics. We were able to find only one paper that assessed the performance of the IT policy based on a similar specification, but within a panel framework. In the paper of [Hove et al. \(2017\)](#) quarterly panel data for 15 countries were examined to investigate the impact of monetary, fiscal and financial institutions on the IT.

Besides the methodological contribution to the literature, our findings are also consistent with the theoretical literature specific to the small open economies. Our results suggest that IT performances in achieving the planned targets of inflation rate depend not only on the monetary policy measures, especially changes in the key policy rate, but also on other macroeconomic variables that are not under the direct control of central banks. These inflation drivers can be divided into domestic and international ones. This has comprehensive repercussions on policy-making. Although shocks that hit one economy and influence inflation dynamics are sometimes sufficient to induce failures in achieving targets, central banks have to carefully monitor them and be proactive in policymaking. We provided a wide list of potential inflation drivers in the observed economies consistent with the economic theory and estimated their impact on the probability that an inflation target is either fulfilled or not fulfilled.

The paper is organized as follows. An overview of the literature is given in Section 2. Section 3 briefly describes the methodology used. The data are discussed in Section 4. The main empirical results are presented in Section 5, and Section 6 offers a review of our robustness analysis. We discuss the results and derive policy implications in Section 7. Concluding remarks are given in Section 8.

2. LITERATURE REVIEW

New Zealand was the first country to introduce this monetary framework in 1989. Shortly after, many developed countries followed that approach. Due to the fact that this strategy has become highly popular even in the developing countries, nowadays, the IT framework is widely adopted in both developed and developing countries. New lines of research have been established, especially those in the empirical field.

Many research studies have analysed IT as a monetary strategy in a broad sense. [Bernanke – Mishkin \(1997\)](#) argue that IT is characterized by a bounded discretion. The precondition for the success of this regime is consensus of all parties about the primary goal. Special emphasis has to be put on the analysis of the contribution of fiscal responsibility to the success of IT, because the effects of fiscal insolvency can place a considerable burden on price stability ([Mishkin 2000, 2008](#)). In addition, [Walsh \(2009\)](#) and [Svensson \(2010\)](#) argue that IT is never ‘strict’ but always ‘flexible’. The monetary policymakers either implicitly or explicitly put some weight on the stabilization of the real economy, besides primary goal.

The empirical research papers are usually concerned about the broad IT strategy performances. One strand of the literature has investigated the factors that affect the likelihood of adopting IT. [Carare et al. \(2002\)](#) argue that there were different initial conditions of adopting IT and that the industrial countries have benefited from well-developed financial markets and experience in using market-based instruments for implementing monetary policy contrary to the emerging market countries. Similar line of investigation was performed by [Mishkin \(2004\)](#),



who analysed whether IT could work in the emerging market economies which have weak fiscal and financial institutions, low credibility of monetary institutions, vulnerability to sudden stops etc. He concluded that the developed countries are not protected to the problems with their institutions, but there is a difference in the degree of the problem in emerging market countries. Most studies in this area focused on finding the effects of the macroeconomic variables on the probability of IT adoption (e.g. Gonçalves – Carvalho 2009; Roger 2009; Samarina – de Haan 2014). The most observed result is that high inflation and its volatility, high volatility of GDP, low budget deficits, a flexible exchange rate, and high openness are expected to have positive effects on the probability of IT adoption.

Second strand of the literature analyses the features of the IT strategy by focusing on the groups of countries sorted by their development level. Beaudry – Ruge-Murcia (2017) showed that the mean rate of inflation in Canada was the lowest among the observed developed IT countries except Sweden. Regarding inflation volatility, standard deviation of inflation in Canada was also the smallest in the sample. Andersson – Jonung (2017) analysed the proper tolerance band for an IT country and concluded that the size of the tolerance band varies, but it was usually of the target magnitude ± 1 or 2 percentage points (pp). For the emerging economies, the band was, in general, slightly larger than for the developed countries.

The third strand of the literature has dealt with the influence of the IT strategy on macroeconomic performances (such as inflation, output growth and their volatilities). Many authors have found that inflation targeters experienced a decrease in the average inflation rate and its volatility after the adoption of this monetary regime.¹ Batini – Laxton (2007) found that IT policy significantly lowered the inflation rate, its expectations and volatility, based on data for the 1985–2004 period for 31 emerging economies of which 21 are IT targeters. Lin – Ye (2009) argued that a significant decline in average inflation rate and reduction of inflation volatility were observed due to the IT policy on the data for 52 developing economies (13 targeters) for the 1985–2005 period. Yamada (2013) investigated the impacts of exchange rate regimes and IT on inflation rates in 121 emerging and developing countries for the period of 1995–2007 by application of the propensity score matching technique and concluded that an IT regime works well, especially in lowering inflation rate. Ayres et al. (2014) found a weak influence of IT on GDP growth. They analysed a set of 51 developing countries, including 17 explicit inflation targeters. Nojković – Petrović (2015) analysed the behaviour of central banks in 6 emerging European economies, regarding policy operationalization and found that these central banks change their policy rates in discrete fashion, i.e., only when the deviation between its unobservable optimal rate and actual rate crosses certain threshold values. Wang (2016) employed the propensity score matching method for a sample of CEE countries from 1990 to 2010 and found that the IT framework can help increase GDP per capita. Ardakani et al. (2018) argued that IT reduces the sacrifice ratio and interest rate volatility in the developed economies and enhances fiscal discipline in both the industrial and developing countries. However, the impact of IT on fiscal discipline in the industrial countries is significantly larger than in the developing economies.

¹A brief summary of literature review about influence of the IT strategy on macroeconomic performances is given in the Table S1 in Supplementary material available here: <https://doi.org/10.7910/DVN/UQIX6C>.



Kose et al. (2018) concluded that IT has negligible effects on GDP growth. Fratzscher et al. (2020) analysed the characteristics of IT as a shock absorber. The overall sample consisted of 76 countries over the period of 1980Q1–2015Q4. They found that this strategy improves the macroeconomic performances following exogenous shocks. Kim – Yim (2020) stated that the IT central banks have not always been successful in meeting the inflation targets, although IT has been successful in reducing the inflation rate. Quantitatively, the absolute value of deviation of the actual inflation rate from the target was an annual average of 2 pp in their observed sample of 19 IT central banks. Duong (2021) investigated the performance of IT framework in the emerging market economies by difference-in-difference approach using a balanced panel data of 54 countries with 15 IT countries for the period of 2002–2010. The overall conclusion is that IT is not supposed to be the best monetary strategy for all countries, but the emerging economies can anchor the inflation when the economy has hit by the exogenous uncertainties. Smaga (2021) analysed potential procyclicality of the official interest rate changes towards the financial cycle on data covering the period of 1995–2016 in 21 countries (among which were Czech Republic, Hungary and Poland) and the euro area. Based on the matrix of potential relations between IT strategy and financial cycle phase, the conclusion is that the price and financial stability objectives were conflicting only in 10% of the cases, usually when inflation was below the target and the credit cycle was in expansion.

To the best of our knowledge, the only paper that follows similar methodological framework as that used in our paper is by Hove et al. (2017). Based on the quarterly data for 15 IT emerging market economies from 1991 to 2008 they investigated the impact of monetary, fiscal and financial institutions on IT. A stationary panel ordered logit model was estimated. They show a positive impact of central bank independence, fiscal responsibility, and financial sector development on price stability. Specifically, 1% increase in the index of central bank independence implies a 0.11 pp decrease in the probability of the inflation rate being above the target, a 0.16 pp increase in the probability that it will be in the targeted band, and 0.05 pp increase in the probability that it will be below the target. A 1% increase in the budget deficit implies a 0.007 pp increase in the probability of the inflation rate being above the target, a 0.005 pp decrease in the probability that it will be in the targeted band, and 0.001 pp decrease in the probability that it will be below the target band.

Finally, it should be stated that empirical analyses are usually performed on either developed countries or developing countries that are part of some political and/or economic union, such as the EU. These countries are analysed as a group and the common link is generalization to all developing countries. Most of the above-mentioned research studies are concerned with the three EU countries (Jonas – Mishkin 2005; Batini – Laxton 2007; Lin – Ye 2009; Ayres et al. 2014; Hove et al. 2017; Kim – Yim 2020; Smaga 2021; Duong 2021). However, Serbia is also included in a few panels (Yamada 2013; Nojković – Petrović 2015; Wang 2016; Ardakani et al. 2018). That was one more motivation for us to investigate this issue for this group of countries separately by employing state-of-the-art methodology.

In summary, our paper aims at fulfilling the observed gaps in the literature. Our research tends to investigate the IT performances in the observed countries from different angle and with employment of different methodology from empirical strand of literature on IT, which gives better insight into a wide range of factors influencing IT. We also find the gap in the literature related to the narrow focus on the developed countries or on the developing countries as bulks, and accordingly, we assess the IT strategies performance separately for these



countries allowing for their specificities. Although few of the observed countries adopted IT framework earlier than our data series begin, we extracted the longest possible period for the analysis (2005Q1–2021Q2 for Czech Republic, Hungary and Poland, and 2009Q1–2021Q2 for Serbia), allowing for initial adjustments in the respective IT frameworks. Finally, we were able to identify the determinants of IT success which are usually neglected in the literature, like fiscal factors.

3. METHODOLOGY

The performances of IT policies in achieving inflation targets can be analysed by an ordered probit model with the following form:

$$y_t^* = x_t' \beta_0 + \varepsilon_t \quad (1)$$

where y_t^* denotes the latent dependent variable, x_t is a vector of explanatory variables with dimensions $k \times 1$, β_0 is a vector of true (underline) parameters, and ε_t is the regression error, $t = 1, \dots, n$. As y_t^* is the latent dependent variable it cannot be observed. In practice, we observe the indicator variable y_t , which takes the following values:

$$\begin{aligned} y_t &= 0 \text{ if } y_t^* \in (-\infty, \sqrt{n}\mu_0^1) \\ y_t &= 1 \text{ if } y_t^* \in (\sqrt{n}\mu_0^1, \sqrt{n}\mu_0^2) \\ &\vdots \\ y_t &= J-1 \text{ if } y_t^* \in (\sqrt{n}\mu_0^{J-1}, \sqrt{n}\mu_0^J) \\ y_t &= J \text{ if } y_t^* \in (\sqrt{n}\mu_0^J, \infty) \end{aligned}$$

The choice of the lowest value is arbitrary, which implies that the ranking for the indicator variable does not have to start with 0. The choice depends on the researcher's preferences, and it does not have an influence on the results. The difference between categories has an ordinal character. Threshold parameters (cut points) are multiplied by \sqrt{n} for avoidance of trivial solutions; i.e., thresholds are dependent on the sample size. This correction is made in cases of the presence of non-stationary variables in the set of explanatory variables (Hu – Phillips 2004).

To capture inflation target deviations, we define the indicator variable y_t according to the triple-choice specification. It takes three possible values $(-1, 0, 1)$, depending on the actual inflation rate in comparison to the target value. If the inflation rate in the given quarter is below the target level, then the dependent variable takes the value -1 ; if the inflation rate belongs to the target band, then the dependent variable takes the value 0 ; and if the inflation rate is above the target level, then the dependent variable takes the value 1 . Further discussion on this variable is given in Section 4.

The asymptotic theory developed by Park – Phillips (2000), Hu – Phillips (2004) and Phillips et al. (2007) is applied when the set of explanatory variables contains both stationary



and unit-roots' processes, which is common in the macroeconomic time series. In our empirical work, the vector of explanatory variables contains variables both from the monetary policy domain and the fiscal policy domain, in addition to other control variables. A full description of the explanatory variables is provided in Section 5 and in [Appendix](#).

As is the case in the standard probit model, this kind of model assumes that the error term has standardized normal distribution. The model can be estimated by the maximum likelihood method, which, in practice, is usually carried out through the optimization methods. The probability of every outcome can be calculated and to be positive, the threshold parameters must be ordered, i.e., $\mu_0^{j+1} > \mu_0^j$. The sum of the probabilities by definition is 1, and F represents the standardized normal distribution. The correction of the thresholds (z) is calculated as $z = O_p(\sqrt{n})$, where O_p represents the order in probability, which means that the set of the values z is stochastically bounded.

$$P_0(x_t; \theta_0) = 1 - F(x' \beta_0 - z \mu_0^1) \quad (2)$$

$$P_j(x_t; \theta_0) = F(x' \beta_0 - z \mu_0^j) - F(x' \beta_0 - z \mu_0^{j+1}), \text{ for } j = 1, \dots, J-1 \quad (3)$$

$$P_J(x_t; \theta_0) = F(x' \beta_0 - z \mu_0^J) \quad (4)$$

The estimated coefficients of the explanatory variables do not have a direct interpretation, although their signs have. Marginal effects ($\hat{v}_{j,x}$) can be calculated in the following way:

$$\hat{v}_{j,x} = \hat{p}_j \left(x; \hat{\theta}_n \right) \hat{\beta}_n \quad (5)$$

In the developed form, the marginal effects are calculated based on the following equations, where $j = 1, \dots, J-1$ and φ is a density function that corresponds to the standardized normal distribution. They are computed for the arithmetic values of the explanatory variables, which is common in the literature.

$$\frac{\partial P[y=0]}{\partial x_k} = -\beta_k \varphi(z \mu_0^1 - \beta' x) \quad (6)$$

$$\frac{\partial P[y=j]}{\partial x_k} = \beta_k \left[\varphi(z \mu_0^j - \beta' x) - \varphi(z \mu_0^{j+1} - \beta' x) \right] \quad (7)$$

$$\frac{\partial P[y=J]}{\partial x_k} = \beta_k \varphi(z \mu_0^J - \beta' x) \quad (8)$$

Based on the previous equations of the marginal effects, the sign of the coefficient will be the same as the sign of the marginal effect of the highest outcome of the dependent variable, opposite to the sign of the marginal effect of the lowest outcome, whereas the sign(s) of the marginal effect(s) of middle outcomes cannot be observed *a priori* without knowledge of the difference between the density functions. Given that the sum of the probabilities is equal to 1, the sum of the marginal effects is 0 ([Greene – Hensher 2010: 120](#)).



4. DATA

Our empirical analysis is conducted on the data from four countries, three of them are central European countries and members of the EU, the Czech Republic, Hungary and Poland. The fourth country is Serbia, which is a south-eastern European country and has an official status as candidate for the EU. We have opted to perform research on these countries' data because they have many characteristics in common. At this point we can emphasize trade openness, geographical closeness which increases correlation of economic shocks' spillovers between the countries, size of the country and history of IT. They have chosen to conduct monetary policy based on the IT strategy, which requires coordination between the fiscal and the monetary policies. As a direct implication of this strategy, all observed countries accepted the policy of a flexible (or a managed flexible) exchange rate. Although the central bank sometimes intervenes on the exchange market, the exchange rate is not the official goal of monetary policy. However, the exchange rate channel is one of the main channels of transmission in monetary policy, and its relevance cannot be neglected in the process of policymaking. We intend to investigate if there are any differences in type or size of shocks that have impact on the monetary strategy between the EU member countries and the candidate country that adopted the IT framework. In addition, all the sample countries are small open economies. This makes them vulnerable to external shocks. In the past, they had persistent current account deficits and were victims of remarkable sudden capital stops. Finally, they used to belong to the socialist block and went through the process of transition to market economies.

We briefly describe the characteristics and history of IT monetary strategy implementation in these countries. The *Czech National Bank* (CNB) was the first from the block of transition economies to introduce an IT regime in 1998. The CNB Monetary Strategy document (1999) clearly stated the reasons for adopting this monetary strategy. This strategy is supportive to dynamic growth and price stability that are not mutually exclusive. The initial period of regime implementation was characterized by headline IT and the goal of targeting zones in the discrete periods of time. From the beginning of 2002, the central bank changed the way it defines the goal. First, the CNB started to target inflation measured by Consumer Price Index (CPI). Second, it introduced the target for every month as a continuously defined goal. Another change happened with the application from the beginning of 2006. The central bank started to define the goal as central parity, with allowed deviations of 1 pp in both directions. The numerical value of the goal was changed to $2\% \pm 1$ pp from January 2010, since then there have been no other changes.

National Bank of Hungary (MNB) began to target inflation formally in June 2001, when it determined a target for the end of that year and the next year. Prior to IT, MNB used the narrow-band crawling peg exchange rate system, introduced in 1995. Its primary aim was to break the adverse trend of inflation expectations and establish the credibility of monetary policy. This monetary policy regime was successful in bringing down the rate of inflation up to 1999. However, after that, there was no further decline in the rate of inflation. The MNB drafted a proposal for the Government on the establishment of a system providing greater independence for monetary policy in pursuing a relatively faster and more effective anti-inflationary policy ([Quarterly report on inflation 2001](#)). The main argument behind IT adoption was that under the regime of inflation targeting, the MNB can give guidance to economic agents by projecting a disinflation path over a horizon of several years. The difference between this country and other



observed countries is the method of goal definition. Specifically, the goal was determined in discrete fashion as parity at the end of each year up to the end of 2007. After that, the goal was set continuously but without any allowed deviation. The target has been defined as central parity with allowed deviations from 2015. Therefore, in comparison with other observed countries, the MNB defined its goal for a long period of time either in the discrete periods of time or continuously without any deviations. This makes the regime rigid and influences the chances of the central bank fulfilling its own goal.

The *National Bank of Poland* (NBP) has been targeting inflation since 1999. The choice of this monetary policy strategy was supported by the NBP's Medium-Term Strategy of Monetary Policy (1999–2003): the monetary policy goal is explicit and understandable to economic agents; this system enhances the policy credibility; this strategy allows for minimizing the social cost of inflationary expectations; the system allows for greater flexibility in applying the monetary policy instruments; it allows for the policy focus on domestic variables and can periodically insulate the economy from external shocks and speculative attacks; central bank can tailor its actions to the specific nature of the shock; and it allows for flexible reactions to changing velocity of money ([National Bank of Poland 1998](#)). The initial goal was to reduce the inflation rate below 4% by the end of 2003. The central bank changed the way the target is defined from the beginning of 2004. Since then, the goal has been defined as central parity of 2.5% with allowed deviations of 1 pp in both directions.

The *National Bank of Serbia* (NBS) gradually started the transition to an IT framework in 2006. The key advantages of adopting IT strategy are described in the Memorandum on Inflation Targeting as a Monetary Strategy (2008): defining the inflation target allows for more transparency; the band indicates the comfort zone for inflation and provides for the fact that there will occasionally be smaller shocks causing short-term volatility of inflation, but not requiring a monetary policy response; setting a midpoint helps better anchor inflation expectations; the target is continuous, enabling inflation to be monitored at all times; targets are set for several years ahead to ensure focus on medium-term price stability. Initially, the central bank defined its goal as a target band with central parity. The following year it changed its definition of the goal to central parity with allowed deviations. The goal has been set continuously. It has been lowered steadily, and it was $3\% \pm 1.5$ pp at the end of the period of observation.

In our research the data used for modelling the IT success using non-stationary discrete choice models cover the period of 2005Q1–2021Q2 for the Czech Republic, Hungary and Poland and 2009Q1–2021Q2 for Serbia. The time spans have been influenced both by the constraints on data availability and by the necessity to exclude the initial transition periods of IT implantation. In the case of Serbia, we use the overall period of official IT since gradual implementation started in 2006. Data for the study are extracted from [BRUEGEL think thank database \(2022\)](#), [Czech National Bank database \(2022\)](#), [EUROSTAT database \(2022\)](#), [National Bank of Hungary database \(2022\)](#), [National Bank of Poland database \(2022\)](#), [National Bank of Serbia database \(2022\)](#).

As already explained within the model set-up, the dependent variable takes three possible values (−1, 0, 1): −1 if the inflation rate is lower than the target level, 0 if the inflation rate is in the target band, and 1 if the inflation rate is above the target level. Further assumptions are made. As can be seen from the history of IT in the sample countries, goals can be defined differently: in discrete units of time or continuously, as a targeting zone, as central parity with



allowed deviations, and as a targeting band with central parity. We assume that the goals are defined continuously and in the form of targeting zones (bands). Therefore, to assess if the goal is fulfilled, it is not important how close the actual inflation rate is to the central parity, as long as it is in the target band. That assumption is not rigorous in the cases of the Czech Republic, Poland and Serbia, as most of the changes in the definitions of the goals were made before the period of observation. However, that assumption has major repercussions in the case of Hungary, where the central bank has started to define the goal continuously with allowed deviations from 2015. For the purpose of this analysis, we assume that the goal in the Hungarian case was defined continuously (which has been the case since 2008) and with allowed deviations of ± 1 pp from the central parity (which is actual from 2015). Figures 1–4 depict the values of the dependent variable based on the above-mentioned assumption.

These figures give foundation for initial assessment of first research hypothesis. Although the inflation rate in the observed countries were above or below the announced target during many quarters, i.e., percentage of quarters when inflation rate was in the targeted range was 54.8% in Czech Republic, 38.7% in Hungary, 41.9% in Poland and 39.1% in Serbia, we cannot *a priori* conclude that the IT strategies in these countries were not successful. This ‘success ratio’ is similar to other developing countries. Also, it neglects the impact of transitory shocks on which central bank usually does not react. Therefore, more deep analysis is needed in order to assess the performances of the IT strategies in the observed countries. We used the set of regressors to explain the probability that inflation will be in the targeted zone.

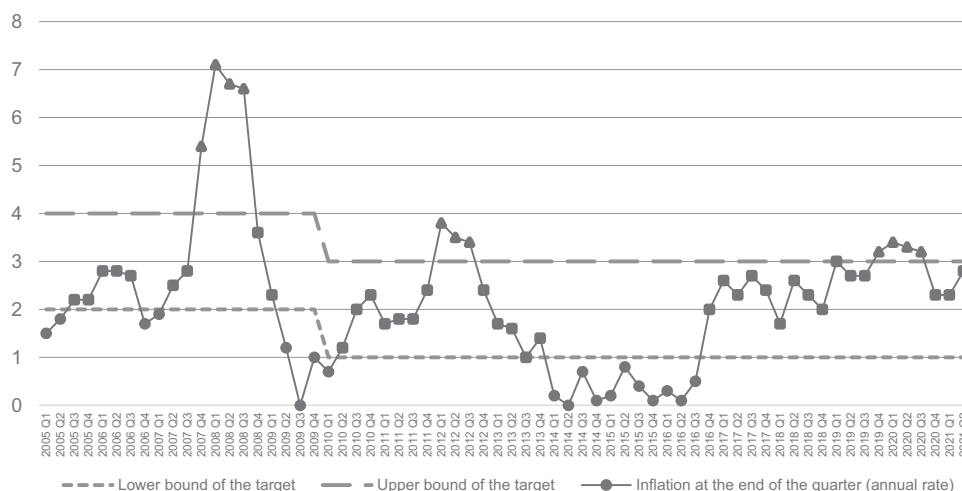


Fig. 1. Inflation tendency and given values of the dependent variable in the Czech Republic

Notes: Triangle points represent that inflation was above the target (the dependent variable takes the value 1); Square points represent that inflation was in the target (the dependent variable takes the value 0); Circle points represent that inflation was below the target (the dependent variable takes the value -1).

Source: Adjusted according to the goals defined by monetary strategy and data on inflation.



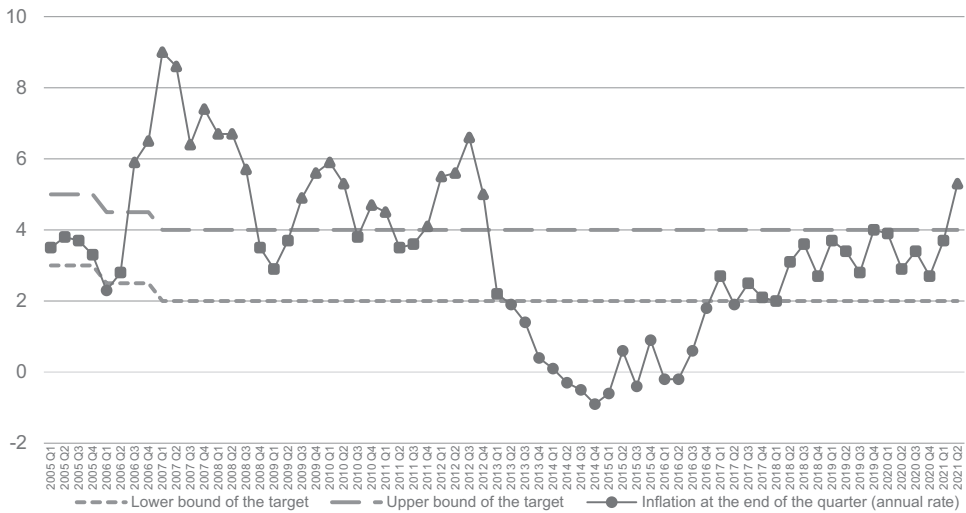


Fig. 2. Inflation tendency and given values of the dependent variable in Hungary

Notes: Triangle points represent that inflation was above the target (the dependent variable takes the value 1); Square points represent that inflation was in the target (the dependent variable takes the value 0); Circle points represent that inflation was below the target (the dependent variable takes the value -1).

Source: Adjusted according to the goals defined by monetary strategy and data on inflation.

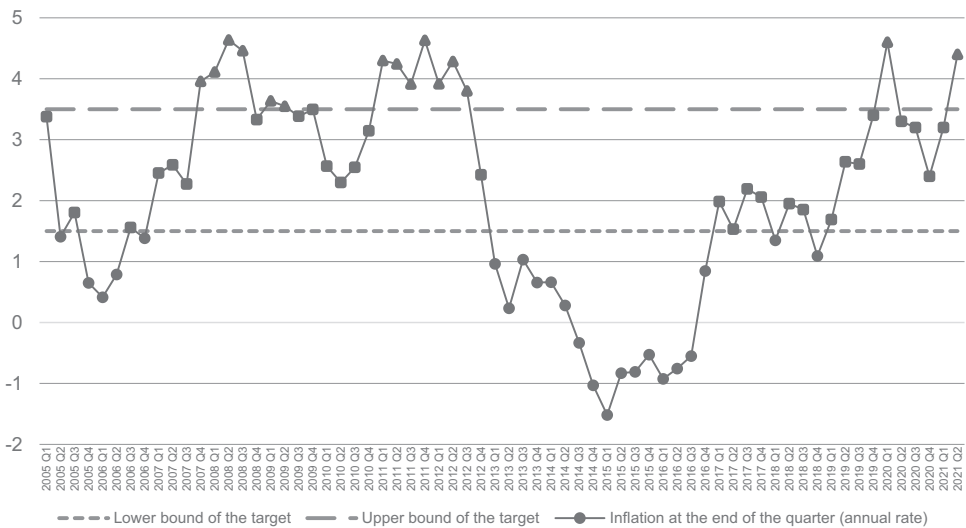


Fig. 3. Inflation tendency and given values of the dependent variable in Poland

Notes: Triangle points represent that inflation was above the target (the dependent variable takes the value 1); Square points represent that inflation was in the target (the dependent variable takes the value 0); Circle points represent that inflation was below the target (the dependent variable takes the value -1).

Source: Adjusted according to the goals defined by monetary strategy and data on inflation.



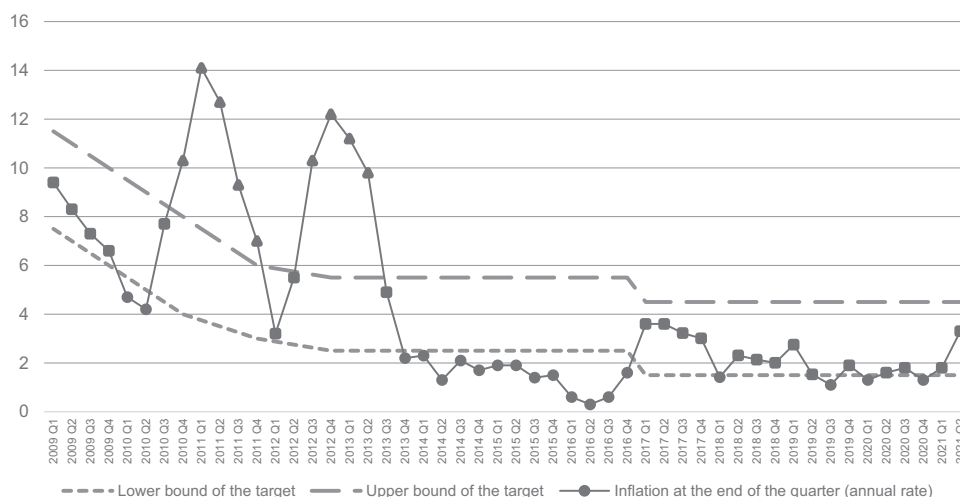


Fig. 4. Inflation tendency and given values to dependent variable in Serbia

Notes: Triangle points represent that inflation was above the target (the dependent variable takes the value 1); Square points represent that inflation was in the target (the dependent variable takes the value 0); Circle points represent that inflation was below the target (the dependent variable takes the value -1).

Source: Adjusted according to the goals defined by monetary strategy and data on inflation.

5. RESULTS AND DISCUSSION

The probability of IT success is modelled by a set of explanatory variables that represent fundamental macroeconomic variables with a strong foundation in economic theory. These are key policy rate, past inflation, budget balance, real effective exchange rate (REER) gap, growth rate, M_3 , M_3 growth, current account balance, labour cost growth, and loans to non-monetary sectors. The details about sources of data and construction of variables are given in [Appendix](#). To make our analysis robust, we include covariates that can be used as control variables. These are HICP (Harmonized Index of Consumer Prices) and GDP gap of Eurozone. Specific features of each economy are taken into account in the modelling. All variables are tested for unit-root presence with mixed results: some of them are stationary processes, whereas others are unit-root processes.² Estimated non-stationary ordered probit models are presented in [Table 1](#).

All estimated coefficients have expected signs, although they do not have a direct interpretation. The variables common to all sample countries are key policy rate and past inflation. All regressors appear with lags, in the sense that their changes effects are observed later. Basically, today's inflation is under the influence of past policy measures. Time lags in monetary policy can be quite long, depending on many factors. We find that a change in the key policy rate, which is

²The detail results of unit root tests are available in Supplementary material in Table S2 here: <https://doi.org/10.7910/DVN/UQIX6C>.



Table 1. Estimated non-stationary ordered probit models

Variable/Thresholds	Czech Republic	Hungary	Poland	Serbia
Key policy rate [-4]	-0.4286 (0.0467)	-0.3906 (0.0518)	-1.0286 (0.0037)	-0.5331 (0.0000)
Inflation [-1]	1.1522 (0.0001)	1.2135 (0.0000)	1.1735 (0.0000)	0.7370 (0.0000)
Budget balance [-1]		-0.2287 (0.0070)		
Budget balance [-2]			-0.1580 (0.0346)	
Budget balance [-4]	-0.1093 (0.0897)			-0.1210 (0.0311)
REER gap [-2]		-0.0567 (0.0458)		-0.0828 (0.0811)
Growth rate [-3]			0.2776 (0.0194)	
M ₃ [-2]	0.0552 (0.0486)			
M ₃ growth [-4]			0.4480 (0.0053)	
Current account balance [-2]				-0.7177 (0.0018)
Current account balance [-3]	-0.2068 (0.0105)			
Current account balance [-4]			-0.4955 (0.0069)	
Labour cost growth [-4]	0.0787 (0.0428)			
Loans [-1]		0.0925 (0.0802)		
Threshold 1	5.5049 (0.0148)	5.7287 (0.0057)	1.5572 (0.0489)	2.6763 (0.0062)
Threshold 2	8.4188 (0.0007)	9.4681 (0.0005)	4.8346 (0.0000)	7.1332 (0.0002)
Period of analysis	2005Q1–2021Q2	2005Q1–2021Q2	2005Q1–2021Q2	2009Q1–2021Q2

Notes: Values in the square brackets represent the lags of the variable. Values in the brackets represent *P* values. Thresholds are stated in the overall amount without correction for time-series length. Standard errors are robust (Hubert–White correction) and corrected for degrees of freedom.

Source: Authors' calculations.



the main instrument of monetary policy in the IT framework, influences the dependent variable with four lags in all countries, as per the usual assumption in the theory of monetary policy. Inflation inertia is confirmed by our estimation.

One more variable that appears in all regressions is budget balance. This could counteract the traditional theories of inflation, but it is certainly an observed phenomenon, especially in the developing economies (Mishkin 2000, 2008; Kose et al. 2018). The budget balance affects inflation indirectly through the demand-side of the economy. Outside time lags in this case are usually shorter than in the monetary policy case. They depend on types of fiscal stimuli, as has been well-proven in the economic theory and empirical studies. It is a proof that the fiscal variables can influence monetary policy goals and that the fiscal policymakers' indiscipline can induce spillover effects on other macroeconomic variables, which is investigated in our second hypothesis.

The real effective exchange rate gap is found to play a significant role in the cases of Hungary and Serbia. This means that the movement of REER over the estimated trend can trigger inflation and, consequently, affect the probability of IT success. The exchange rate can sometimes be a buffer for international spillovers, but sometimes it has a direct effect on inflation because it is the main transmission mechanism channel in small open economies, especially when other channels are not fully developed. Ardakani et al. (2018) argue that central banks in the developing economies do consider exchange rate volatility and in some scenarios their ability to control the inflation rate may also be dependent on a stable exchange rate regime, contrary to the developed countries. This variable can be observed as a control variable, as the exchange rate is not officially the goal of the central banks that target inflation.

The growth rate is found to be significant in the case of Poland. It can be an important determinant of inflation, and most economists agree that this variable partially determines the domestic inflation. Standard macroeconomic models exploit the usual relation between inflation and GDP growth.

The monetary aggregate M_3 and its growth is statistically significant in both the Czech Republic and Poland. This regressor belongs to the set of monetary policy variables. However, tendencies in macroeconomics in the last few decades have shown a loss in connection between the monetary aggregates and inflation. This is especially observable in the small open economies. Jonas – Mishkin (2005) argue that IT also has the advantage that stability in the relationship between money and inflation is not critical to its success. However, the acceleration of the M_3 aggregate can to some extent trigger inflation, which is the reason for including these variables in the models' specifications. Both because the monetary aggregates are not in the set of goals of any of the observed countries and because the central banks certainly do not have full control over them, we see these covariates as a control variables.

As all sample countries are small open economies, it was reasonable to investigate the influence of current account balance on inflation dynamics, especially where the exchange rate gap was not significant. Gertler et al. (2010) suggest that while monetary policy is usually not the cause of changes in the current account balance, there are potentially important implications of these imbalances for the management of monetary policy. Imbalances in the current account can induce adjustments through the exchange rate, and consequently, put pressure on the domestic inflation. Current account balance was estimated to be significant in all the studied economies except Hungary.



Labour cost growth is often used in the research studies and reveals the impact of wage inflation on the overall CPI. This influence depends on the labour market characteristics like structural determinants, labour unions strength, labour market flexibility, etc. We find its significance in the case of the Czech Republic.

Finally, the effects of loans of banks to non-monetary sectors is considered as being the demand-side driver of inflation. We find them to be significant in the case of Hungary. A deeper look at these time-series reveals that this variable moves almost one for one with the inflation rate in Hungary, opposite to all the other countries in our study.

It should be emphasized that other relevant variables were considered as covariates, but they do not appear to be significant. The possible explanation is that their effects on inflation are indirectly transmitted through other variables, potentially the variables from the supply-side. Though these variables can partially contribute to the current account balance, spillovers from the supply-side shocks tended not to stimulate inflation in the global economy in the observed period. In addition, from the sphere of political macroeconomics, we do not find elections to be important, as they can be partially encompassed by the budget balance as an explanatory variable. Regarding the unemployment rate non-significance, historically, there has often been some trade-off between inflation and unemployment. In research studies unemployment rate has been one of the explanatory variables, suggesting the presence of the “classical” Phillips curve. However, in the last few decades unemployment rate is not so often used in the macro-economic models related to monetary policy primary due to New Keynesian Phillips curve development, which focuses on GDP gap instead of unemployment rate. Unemployment rate has disappeared from the model specifications in the related mainstream empirical literature, due to its strong correlation with the economic activity. In the related New Keynesian Phillips curve literature, in the last decade there is a robust evidence emphasizing the significance of the Phillips curve flattening both in the advanced countries, and in the developing small open economies, indicating that inflation is now less sensitive to the changes in economic activity, and consequently even less to the changes of unemployment rate. This can impose a substantial problem for conducting monetary policy due to the weaker and prolonged impact of monetary policy measures on inflation.

All estimated models perform statistically well. This can be seen in [Table 2](#).

One of the measures of the quality of estimated discrete choice models is their accomplishment in prediction of outcomes. This is summarized in [Table 3](#), which provides correct and incorrect estimations. This table shows very good predictability of the estimated models.

Marginal effects derived from the estimated models are given in [Table 4](#). These effects measure the influence of a one-unit change in the explanatory variable on the probability that inflation will be within/above/below the targeted goal.

Expected effects are achieved for all countries in the sample, and the values of the marginal effects and their signs are in accordance with the findings in the economic research studies. The increase (decrease) in the key policy rate (four quarters back) for 1 pp reduces (increases) the probability that current inflation will be above the target band by 4.47 pp in the case of the Czech Republic, 5.27 pp. in the case of Hungary, 4.27 pp. in the case of Poland and 0.53 pp in the case of Serbia. Also, it increases (decreases) the probability that it will be in the target band by 4.07 pp in the case of Hungary, and decreases (increases) the probability that it will be in the target band by 3.10 pp in the case of the Czech Republic, 16.92 pp. in the case of Poland and 4.16 pp. in the case of Serbia. Finally, it increases (decreases) the probability that it will be below



Table 2. Statistical features of the estimated models

	Indicator	Czech Republic	Hungary	Poland	Serbia
Pseudo R^2	McFadden's	0.4508	0.6608	0.6100	0.6532
	Adjusted McFadden's	0.3531	0.5868	0.5199	0.5498
	Cox-Snell's	0.5907	0.7629	0.7304	0.7468
	Nagelkerke's	0.6851	0.8603	0.8268	0.8507
LR statistic	Value (P value)	55.3922 (0.0000)	89.2261 (0.0000)	81.2662 (0.0000)	63.1920 (0.0000)
	Count R^2	0.7419	0.8065	0.7742	0.8478
	Adjusted Count R^2	0.4286	0.6842	0.6111	0.7407
Information criteria	AIC	1.3467	0.9644	1.0962	1.0337
	Finite Sample AIC	4.0637	3.0385	3.8132	3.9811
	SC	1.6212	1.2046	1.3707	1.3120

Source: Authors' calculations.

the target band by 7.57 pp. in the case of the Czech Republic, 1.19 pp. in the case of Hungary, 21.19 pp. in the case of Poland and 4.69 pp. in the case of Serbia. A similar explanation can be made for other used variables.

The estimated effects lead to several conclusions. The probability that the inflation rate is in the targeted zone depends primarily on the monetary factors, but it also depends on other determinants that are not under the direct control of the monetary policymaker. In other words, monetary policy retains its main role in achieving price stability, but price stability and, consequently, IT success are impacted by additional factors that cannot be easily neutralized by the monetary policy measures in the absence of correct expectations. The results are as expected and are generally in accordance with the recent empirical study of [Hove et al. \(2017\)](#). Their estimated marginal effects are in the same direction, but of a higher magnitude.

The magnitudes of the marginal effects between the observed countries are different, and that justifies our decision to observe the countries separately, with their own specifics that shape the overall results. The estimated marginal effects across the countries differ to some extent, which can be explained by the different levels of monetary policy effectiveness based on the financial development. In the developed countries, the most important channel of transmission of monetary policy measures is the interest rate channel. In the developing open economies, the exchange rate channel usually takes over that role. One additional explanation of the effectiveness of the key policy rate in inflation stabilization can be found in the level of dollarization of the observed economies. In our sample, the level of dollarization in Hungary and Serbia is considerably higher than in the Czech Republic and Poland. Inflation inertia is significant and has high marginal effect on the computed probability. However, in Serbia, inflation in the observed period shows high volatility in comparison with other countries. We have to emphasize the effects of budget balance. It is shown that fiscal responsibility can significantly



Table 3. Correct and incorrect estimations

	Dependent variable	Number of observations	Correct estimations	Incorrect estimations	Percentage of correct estimations	Percentage of incorrect estimations
Czech Republic	−1	17	14	3	82.35	17.65
	0	34	29	5	85.29	14.71
	1	11	3	8	27.27	72.73
	Total	62	46	16	74.19	25.81
Hungary	−1	17	14	3	82.35	17.65
	0	24	18	6	75.00	25.00
	1	21	18	3	85.71	14.29
	Total	62	50	12	80.65	19.36
Poland	−1	21	18	3	85.71	14.29
	0	26	21	5	80.77	19.23
	1	15	9	6	60.00	40.00
	Total	62	48	14	77.42	22.58
Serbia	−1	19	15	4	78.95	21.05
	0	18	16	2	88.89	11.11
	1	9	8	1	88.89	11.11
	Total	46	39	7	84.78	15.22

Source: Authors' calculations.

contribute to the success of an IT framework, and that justifies the necessity to develop coordination mechanisms between monetary and fiscal policy. These mechanisms can be either institutional or operational, but we argue that they are necessary in the IT countries. Change of REER is an important determinant of IT success, especially in the countries where exchange rate transmission mechanism channel is dominant in monetary policymaking. Appreciation (depreciation) significantly decreases (increases) the probability that inflation will be above the target. Growth rate, M_3 , M_3 growth, labour cost growth and loans positively affect the probability of inflation overshoots, and vice versa. Finally, a rise in the current account balance decreases the probability of inflation overshoots, and vice versa.

Based on the constructed models, we have estimated the corresponding index functions. They are visually presented in Figures 5–8, with marked correct and incorrect predictions.

Figure 5 shows that the model correctly predicted 46 out of 62 observations in the Czech Republic. The incorrect predictions were usually the ones in those quarters when a change in the outcome of the dependent variable occurred.



Table 4. Estimated marginal effects

Variable	Outcome	Czech Republic	Hungary	Poland	Serbia
Key policy rate [-4]	-1	0.0757	0.0119	0.2119	0.0469
	0	-0.0310	0.0407	-0.1692	-0.0416
	1	-0.0447	-0.0527	-0.0427	-0.0053
Inflation [-1]	-1	-0.2036	-0.0371	-0.2417	-0.0648
	0	0.0834	-0.1266	0.1931	0.0575
	1	0.1202	0.1637	0.0487	0.0073
Budget balance [-1]	-1		0.0070		
	0		0.0239		
	1		-0.0308		
Budget balance [-2]	-1			0.0326	
	0			-0.0260	
	1			-0.0066	
Budget balance [-4]	-1	0.0193			0.0106
	0	-0.0079			-0.0094
	1	-0.0114			-0.0012
REER gap [-2]	-1		0.0017		0.0073
	0		0.0059		-0.0065
	1		-0.0076		-0.0008
Growth rate [-3]	-1			-0.0572	
	0			0.0457	
	1			0.0115	
M ₃ [-2]	-1	-0.0098			
	0	0.0040			
	1	0.0058			
M ₃ growth [-4]	-1			-0.0923	
	0			0.0737	
	1			0.0186	
Current account balance [-2]	-1				0.0631
	0				-0.0560
	1				-0.0071

(continued)



Table 4. Continued

Variable	Outcome	Czech Republic	Hungary	Poland	Serbia
Current account balance [-3]	-1	0.0365			
	0	-0.0150			
	1	-0.0216			
Current account balance [-4]	-1			0.1021	
	0			-0.0815	
	1			-0.0206	
Labour cost growth [-4]	-1	-0.0139			
	0	0.0057			
	1	0.0082			
Loans [-1]	-1		-0.0028		
	0		-0.0096		
	1		0.0125		

Note: Marginal effects are calculated for arithmetic values of regressors.

Source: Authors' calculations.

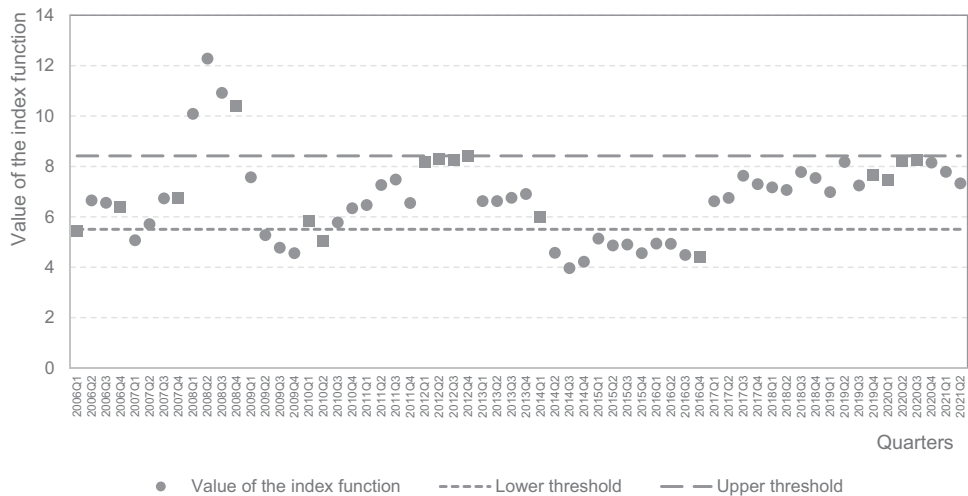


Fig. 5. Estimated index function: the Czech Republic

Note: Circle points are correctly predicted observations by the estimated model, whereas square points are incorrectly predicted observations.

Source: Authors' calculations.



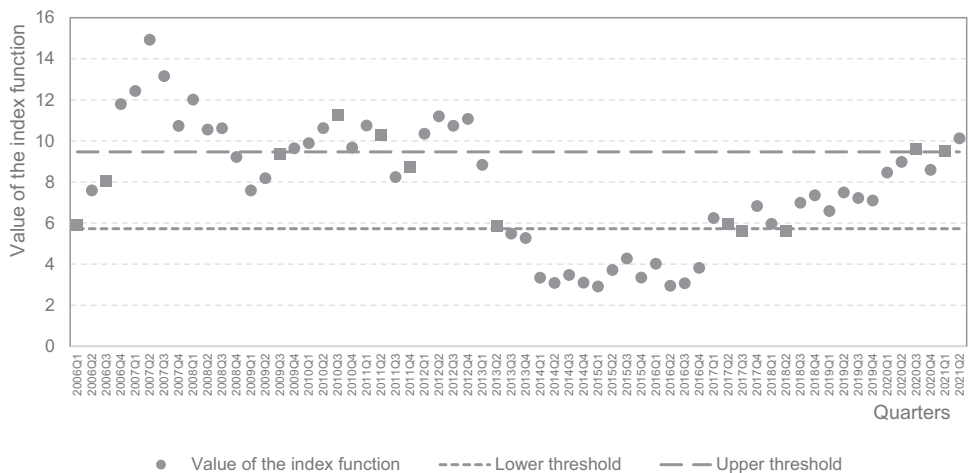


Fig. 6. Estimated index function: Hungary
Note: Circle points are correctly predicted observations by the estimated model, whereas square points are incorrectly predicted observations.
Source: Authors' calculations.

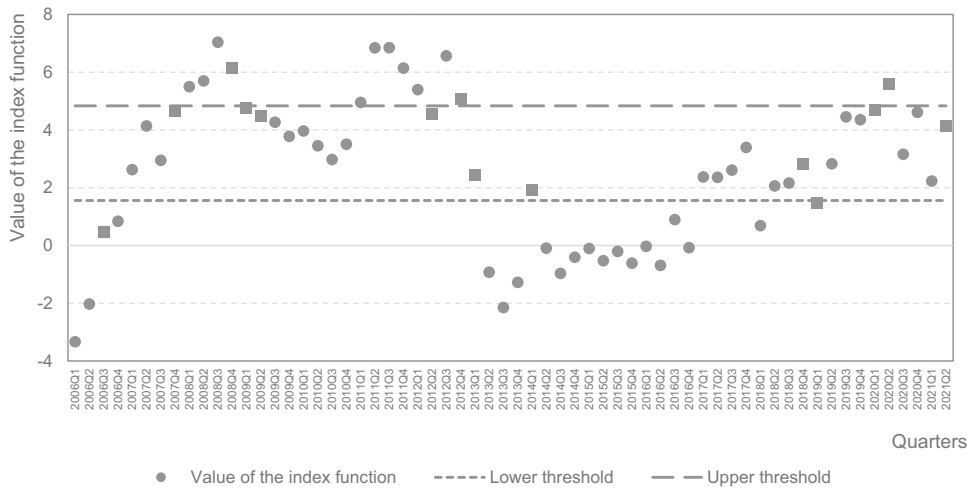


Fig. 7. Estimated index function: Poland
Note: Circle points are correctly predicted observations by the estimated model, whereas square points are incorrectly predicted observations.
Source: Authors' calculations.

Figure 6 indicates that the model incorrectly predicted only 12 out of 62 observations in the case of Hungary. Again, the incorrect predictions were usually those in the periods when we observed the change in the outcome of the dependent variable.



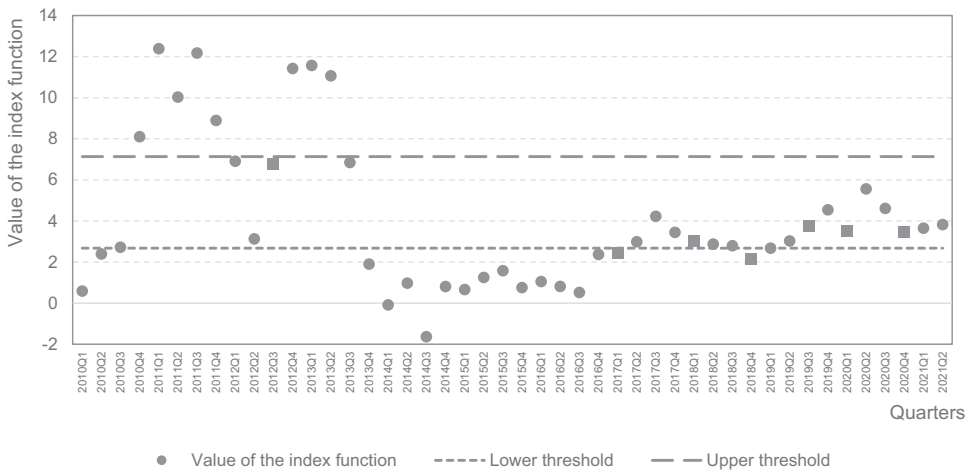


Fig. 8. Estimated index function: Serbia

Note: Circle points are correctly predicted observations by the estimated model, whereas square points are incorrectly predicted observations.

Source: Authors' calculations.

Figure 7 shows that the model correctly predicted 48 observations and incorrectly predicted 14 observations in Poland. The incorrect predictions were usually close to the thresholds.

According to Figure 8, the estimated model incorrectly predicted only 7 out of 46 observations in the case of Serbia. This means that the model matches the real data by 84.78%.

6. ROBUSTNESS ANALYSIS

Cross-border spillovers and external factors impacting inflation are found to be substantial in some countries, especially the small open economies. In traditional economic theory, spillover effects can occur, but they mainly depend on the exchange rate framework. Woodford (2007) states that the countries with a flexible exchange rate that have independent monetary policies can successfully neutralize the international shocks on the domestic economy. However, the exchange rate is not always a convenient absorber of the shocks, and it is sometimes affected by the monetary policy measures that do not have to account for specific international shocks. Therefore, spillovers are sometimes unavoidable. Borio – Filardo (2007) argue that the models of inflation used in the research studies are too 'country-centric'. Similarly, Rey (2015) claims that independent monetary policy in the small open economies faces a 'dilemma' instead of the familiar 'trilemma'. One more observed phenomenon related to the international drivers of inflation is the flattening of the Phillips curve (Nagy – Tengely 2018). Finally, many research studies have analysed the spillovers in the European countries. They state that the small economies are net receivers of inflation from the Euro area (Iossifov – Podpiera 2014; Hałka – Szafranek 2015; Szafranek – Hałka 2019).

The results of the studies showing that domestic inflation can sometimes be triggered and driven by the international determinants have motivated us to investigate the effects and



magnitudes of these factors on inflation in the observed countries. We expect to find, at least small magnitude spillovers from their most important trading partners. The economies considered in our sample belong to the group of countries being closely associated with the other countries of the EU, and especially those in the Eurozone.

Spillovers can sometimes be partially absorbed by the exchange rate adjustments; however, in many cases, they may have a direct influence on inflation. Therefore, we extend our original models presented in Section 5 by international factors of domestic inflation. Along with the variables included to explain the probability of inflation success in the baseline models' specifications, lagged values of the Eurozone HICP and the Eurozone GDP gap are added to capture the international spillover effects. The first variable is included in the models of IT success analysis in the cases of Czech Republic and Hungary, and the second is included in the cases of Poland and Serbia. These variables can be a source of remarkable shocks to the domestic inflation rates, because they are exogenous and sometimes not fully absorbed by the monetary policy measures in these economies. In these countries, REERs have been relatively stable over the observed period and the monetary policy measures have been correlated, thus opening a space for spillovers to emerge. The speed of transmission depends on many factors, but the spillovers from HICP inflation can sometimes be faster than are those from the Eurozone GDP, in which case the linkages are indirect. In addition, monetary policy effectiveness influences the speed of spillovers, as the transmission channels in these countries are not equally developed. More effective monetary policy implies greater space for neutralization of any kind of shocks, even the international ones. The results are presented in Table 5.

The alternative specifications differ from the baseline specifications by the control variables related to the Eurozone economic conditions, i.e., the HICP and the GDP gap of the Eurozone. Other components of the models' specifications are unchanged. All estimated coefficients are significant with the expected signs, which contributes to the acceptance of the third research hypothesis. The inclusion of additional variables improves the significance of already used variables in many cases. Statistical measures are shown in Table 6. Almost all statistical indicators suggest better characteristics of the alternative models, except for *Schwarz criterion*. Alternative models' specifications make our baseline results robust, as the differences in the statistical measures and estimated model coefficients are not high in any direction.

Table 7 of correct and incorrect estimations indicates relatively high precision of all estimated model specifications for all outcomes. The results are improved for the Czech Republic, Hungary and Serbia, which is in accordance with our findings that the new model specifications have higher explanatory power in this case. The percentage of correct estimations remains same for Poland. The same insights are observable in the estimated index functions of the alternative specifications.³

As already mentioned, one of the main results of the research can be derived by the estimation of marginal effects. The results are shown in Table 8.

The marginal effects of fundamental variables changed slightly due to the inclusion of additional variables. Nevertheless, differences in the marginal effects' estimates are not high. New variables are relevant for the IT success to be assessed, although their impact is not dominant. The comparison of the marginal effects of the additional variables across four

³Estimated index functions are available in Supplementary material on Figures S1–S4 here: <https://doi.org/10.7910/DVN/UQIX6C>.



Table 5. Estimated non-stationary ordered probit models (alternative models)

Variable/Thresholds	Czech Republic	Hungary	Poland	Serbia
Key policy rate [-4]	-0.4720 (0.0436)	-0.5277 (0.0142)	-1.0302 (0.0028)	-0.6180 (0.0000)
Inflation [-1]	1.0814 (0.0002)	1.3258 (0.0000)	1.3036 (0.0000)	0.8491 (0.0000)
Budget balance [-1]		-0.3295 (0.0013)		
Budget balance [-2]			-0.2877 (0.0169)	
Budget balance [-4]	-0.1287 (0.0636)			-0.1587 (0.0072)
REER gap [-2]		-0.1085 (0.0048)		-0.0895 (0.0716)
Growth rate [-3]			0.2188 (0.0489)	
M ₃ [-2]	0.0823 (0.0148)			
M ₃ growth [-4]			0.4896 (0.0052)	
Current account balance [-2]				-0.7501 (0.0023)
Current account balance [-3]	-0.1675 (0.0577)			
Current account balance [-4]			-0.4530 (0.0150)	
Labour cost growth [-4]	-0.0724 (0.0838)			
Loans [-1]		0.0928 (0.0961)		
HICP [-1]		2.3380 (0.0236)		
HICP [-2]	1.2118 (0.0999)			
GDP gap of Eurozone [-2]			0.1916 (0.0786)	0.1034 (0.0933)

(continued)



Table 5. Continued

Variable/Thresholds	Czech Republic	Hungary	Poland	Serbia
Threshold 1	8.6377 (0.0045)	8.3767 (0.0003)	2.0616 (0.0369)	2.6102 (0.0145)
Threshold 2	11.6869 (0.0002)	12.6226 (0.0000)	5.4216 (0.0000)	7.4760 (0.0009)
Period of analysis	2005Q1–2021Q2	2005Q1–2021Q2	2005Q1–2021Q2	2009Q1– 2021Q2

Notes: Values in the square brackets represent the lags of the variable. Values in the brackets represent *P* values. Thresholds are stated in the overall amount without correction for time-series length. Standard errors are robust (Hubert–White correction) and corrected for degrees of freedom.

Source: Authors' calculations.

Table 6. Statistical features of estimated alternative models

	Indicator	Czech Republic	Hungary	Poland	Serbia
Pseudo R^2	McFadden's	0.4668	0.7013	0.6307	0.6764
	Adjusted McFadden's	0.3529	0.6124	0.5256	0.5524
	Cox–Snell's	0.6036	0.7828	0.7421	0.7589
	Nagelkerke's	0.7000	0.8829	0.8401	0.8644
LR statistic	Value (<i>P</i> value)	57.3629 (0.0000)	94.6837 (0.0000)	84.0282 (0.0000)	65.4360 (0.0000)
	Count R^2	0.7742	0.8710	0.7742	0.8261
	Adjusted Count R^2	0.5000	0.7895	0.6111	0.7037
Information criteria	AIC	1.3472	0.9086	1.0839	1.0284
	Finite Sample AIC	4.8087	3.6256	4.5455	4.9203
	SC	1.6560	1.1831	1.3927	1.3464

Source: Authors' calculations.

countries indicates that these magnitudes depend on the development of the transmission channels of monetary policy, exchange rate volatility, and international linkages. As expected, the marginal effects are the smallest in the case of Serbia, but having in mind that Serbia is not yet a member of the EU, the spillover effects are being realized very fast, which can be explained by the history of the highest current account deficits among the sample countries.



Table 7. Correct and incorrect estimations (alternative models)

	Dependent variable	Number of observations	Correct estimations	Incorrect estimations	Percentage of correct estimations	Percentage of incorrect estimations
Czech Republic	–1	17	13	4	76.47	23.53
	0	34	29	5	85.29	14.71
	1	11	6	5	54.55	45.46
	Total	62	48	14	77.42	22.58
Hungary	–1	17	16	1	94.12	5.88
	0	24	21	3	87.50	12.50
	1	21	17	4	80.95	19.05
	Total	62	54	8	87.10	12.90
Poland	–1	21	18	3	85.71	14.29
	0	26	21	5	80.77	19.23
	1	15	9	6	60.00	40.00
	Total	62	48	14	77.42	22.58
Serbia	–1	19	16	3	84.21	15.79
	0	18	14	4	77.78	22.22
	1	9	8	1	88.89	11.11
	Total	46	38	8	82.61	17.39

Source: Authors' calculations.

7. POLICY IMPLICATIONS

Before deriving conclusions about the success of IT, it is crucial to understand the reasons for any substantial deviations of actual from the targeted inflation. The explanation is rooted both in the domestic and in the external economic circumstances that affected actual inflation dynamics.

The central banks still have control over inflation dynamics, but they do not have full control. Therefore, the effectiveness of monetary policy must be strengthened by the development of a transmission mechanism channel, which is immanent to the developed countries. In the absence of this process, monetary policy *per se* cannot be a guarantee of monetary and macroeconomic stability.

Our research confirms the significance of the fiscal factors for the success of the IT regime. It is clearly shown that fiscal responsibility is important for price stability. Interactions between fiscal and monetary policymakers are occurring both because of the overlapping of controllable sets of goals and the spillover effects of policy measures undertaken. This is a sufficient reason for coordination between monetary and fiscal policy and it is in line with the novel theories of



Table 8. Estimated marginal effects (alternative models)

Variable	Outcome	Czech Republic	Hungary	Poland	Serbia
Key policy rate [-4]	-1	0.0768	0.0062	0.1889	0.0340
	0	-0.0332	0.0530	-0.1449	-0.0301
	1	-0.0436	-0.0592	-0.0441	-0.0039
Inflation [-1]	-1	-0.1761	-0.0157	-0.2391	-0.0468
	0	0.0761	-0.1331	0.1833	0.0414
	1	0.0999	0.1488	0.0558	0.0054
Budget balance [-1]	-1		0.0039		
	0		0.0331		
	1		-0.0370		
Budget balance [-2]	-1			0.0528	
	0			-0.0405	
	1			-0.0123	
Budget balance [-4]	-1	0.0209			0.0087
	0	-0.0091			-0.0077
	1	-0.0119			-0.0010
REER gap [-2]	-1		0.0013		0.0049
	0		0.0109		-0.0044
	1		-0.0122		-0.0006
Growth rate [-3]	-1			-0.0401	
	0			0.0308	
	1			0.0094	
M ₃ [-2]	-1	-0.0134			
	0	0.0058			
	1	0.0076			
M ₃ growth [-4]	-1			-0.0898	
	0			0.0688	
	1			0.0209	
Current account balance [-2]	-1				0.0413
	0				-0.0365
	1				-0.0048

(continued)



Table 8. Continued

Variable	Outcome	Czech Republic	Hungary	Poland	Serbia
Current account balance [-3]	-1	0.0273			
	0	-0.0118			
	1	-0.0155			
Current account balance [-4]	-1			0.0831	
	0			-0.0637	
	1			-0.0194	
Labour cost growth [-4]	-1	-0.0118			
	0	0.0051			
	1	0.0067			
Loans [-1]	-1		-0.0011		
	0		-0.0093		
	1		0.0104		
HICP [-1]	-1		-0.0276		
	0		-0.2347		
	1		0.2623		
HICP [-2]	-1	-0.1973			
	0	0.0853			
	1	0.1120			
GDP gap of Eurozone [-2]	-1			-0.0351	-0.0057
	0			0.0269	0.0050
	1			0.0082	0.0007

Note: Marginal effects are calculated for arithmetic values of regressors.

Source: Authors' calculations.

inflation. Fiscal policy has both direct and indirect impacts on the monetary policy goal, and therefore, central banks must consider fiscal tendencies. Many central banks already do that on a regular basis, and some of them even prepare special statements on their fiscal policy stance. The CNB pays special attention to coordination between the policies in the CNB Monetary Strategy Document (1999). The MNB analyses the tendencies in budget deficit and debt and conducts research studies of fiscal policy issues on a regular basis. It prepares background analyses for the duties of the Fiscal Council and issues a publication called the 'Public Finance Report' every year. The NBP has regularly published opinions on the budget proposals since 2005, i.e. it directly discusses fiscal tendencies. In the Opinion of the Monetary Policy Council Concerning



the Draft 2005 Budget Act (2004), it is clearly stated that stability of public finances is a fundamental precondition for sustainable growth. In recent years a step forward has been made. In the Opinion of the Monetary Policy Council on the 2019 Draft Budget Act (2018), the solutions in fiscal policy are analysed from the perspective of coordination between policy-makers. It is explicitly stated that fiscal policy can influence the goal of monetary policy. The NBS promotes coordination between monetary and fiscal policy in the main documents related to the process of IT. In the Agreement on inflation targeting between government and the central bank, the government commits to conduct sustainable and predictable fiscal policy in accordance with the targeted inflation. In the Memorandum on Inflation Targeting as a Monetary Strategy (2008) it is stated that the environment of law and stable inflation is a process that requires the coordinated actions of central bank and government because the inflation dynamics is their joint responsibility.

Besides the fiscal factors, monetary policymakers must not be myopic and consider that inflation is under their full control. This is especially important, as the observed countries are small open economies that are under the impact of international factors. It has been shown that these countries' economies are tightly connected to the stance of the economy of the Eurozone. Sometimes accomplishment or failure to achieve the inflation target is not the full responsibility of the monetary policymaker, due to either a favourable or an unfavourable macroeconomic environment. It is generally recognized that in the open economies such as the observed countries, the exchange rate represents not only an important monetary policy transmission channel but also an important channel of transmission of the external shocks. Therefore, policy-makers have to be cautious and make appropriate buffers for bad times; moreover, considerable research focus must be placed on international factors besides the domestic ones.

The success of IT can also depend on the supply-side shocks. If central bank that targets inflation implicitly follows the flexible IT framework, these shocks have the undesirable features, and consequently, the central bank is confronted with a trade-off when it has to decide on priorities. Our analysis shows that the demand-side shocks are dominant, but monetary policy-makers must be aware of full spectrum of the shocks. One of the main advantages of inflation targeting monetary strategy is the flexibility of central bank to react to unexpected shocks that influence economic cycles. This advantage can and should be exploited.

The COVID-19 pandemic was a big challenge to the central banks. Central banks have been under pressure to accommodate monetary stance in accordance with the size of that large shock. In the developed countries where monetary policy has been conducted in an unconventional way in the past few years due to the effective zero lower bound, the expansionary monetary policy measures have been made. In coordination with the fiscal policy measures that significantly absorbed initial shock in 2020/Q2, the monetary policy response in the observed countries of our sample has been to some extent different due to the macroeconomic stance which allowed for dominant conventional policy measures, with the support of other policy instruments. Inflation under control and key policy rates above the effective zero lower bound have given the manoeuvre space for the observed central banks to minimize the effects of the pandemic on economic activity jointly with the fiscal policymakers, except for the initial shock in 2020/Q2. The pandemic has influenced both supply and demand side of the economy, but most economists agree that the effects from the demand side have been dominant. This makes the task of the central banks easier, with no trade-off decisions. Although this shock has been one of the most challenging in the recent times, the central banks in the observed countries have



had wide range of policy measures, including the key policy rate, as main policy instrument, to combat with the crisis, and these measures partially neutralize the shocks that hit the economies around the world.

These models have highlighted the occurrence of time lags in economic policy implementation, which is consistent with the economic theory. Because of that, policymakers should always dedicate special attention to projections of inflation and scenario analyses with respect to uncertainty about shocks that hit one economy. Bearing in mind that lags in policy implementation are long for monetary policy, it is important that the central bank correctly forms and manages expectations of some variables of interest. Central banks have to continuously search for tools for influencing the inflation expectations (Szyszko 2017). In the observed countries, monetary policymakers must be more transparent in promoting the targets to the public and explaining both the method and the importance of goal achievement, bearing in mind the economic history of these countries and the process of their transition to market economies.

Most of the central banks from the sample countries, except the CNB, do not have explicitly defined escape clauses in their monetary strategies. Exceptions usually refer to exceptional and unpredictable factors that cause deviation from the inflation target and for which the central bank cannot bear the responsibility. Extreme supply-side shocks usually fall into this category. Jonas – Mishkin (2005) point out that too much focus on hitting inflation targets at any price could trigger substantial instability of the monetary policy instruments and damage economic performance. Central banks should develop the appropriate procedures and transparently determine and bound the framework when this clause is applied.

It has to be mentioned that the primary goal is clearly stated and easily measurable in the monetary policy strategies of the observed central banks. On the other hand, we are aware of the implicit dual mandate of the IT central banks. However, the achievement of the second goal is not so clear and measurable. This means that due to the unknown loss function of the particular central bank, we cannot fully place responsibility on the central bank for occasional failures in achievement of the inflation target. We stated justified and unjustified causes for deviations of inflation from the target in many quarters.

8. CONCLUSION

We have employed a non-stationary ordered probit model to analyse the data from four European countries that target inflation, i.e., the Czech Republic, Hungary, Poland and Serbia. The purpose of the study was to assess performances and domestic and international factors of achieving their announced inflation targets.

Based on the empirical results, we can argue that the success of IT is mainly under the control of monetary policymakers who can rely on conventional monetary policy. However, there is a wide range of other inflation drivers that are not controllable by the central bank. Besides common ones, we argue that fiscal policy and international spillovers are very important in achieving inflation targets. Bearing in mind the uncertainty under which the central bank operates in policymaking, complex and reliable monitoring and forecasts must be made regularly to react to specific economic shocks.

Our research contributes to the current discussion of IT by undertaking individual country analysis that is based on a large set of explanatory variables, and thus, considers specific



characteristics of each economy. Results are obtained for a time-period that includes recent data, up to mid-2021.

We are aware that our research has some limitations. Greater attention can be put on the differentiation between controllable and non-controllable deviations from inflation targets. Additionally, some institutional features can be potentially included in the analysis. Finally, effects of the unconventional monetary policy measures were not investigated. These issues can be addressed in the next research studies.

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APPENDIX

Data sources and variable construction

Variable	Explanation of variable construction	Sources
Key policy rate	Key policy rate at the end of the quarter.	databases of observed countries' central banks.
Inflation	CPI inflation at the end of the quarter.	databases of observed countries' central banks.
Budget balance	Budget balance in terms of GDP. Sign (+) corresponds to budget surplus and sign (–) corresponds to budget deficit. All data are seasonally adjusted (CENSUS X12).	EUROSTAT for EU countries; for Serbia calculations are based on data from the National Bank of Serbia.
REER gap	Hamilton filter (Hamilton 2018) employed on real effective exchange rate (51 trading partners, 2007M12 = 100). Indirect quotation is used: sign (+) corresponds to appreciation, sign (–) corresponds to depreciation.	BRUEGEL database.
Growth rate	Percentage change of GDP compared to same period in previous year. All data are seasonally adjusted (CENSUS X12).	EUROSTAT database.
M ₃	M3/GDP. All data are seasonally adjusted (CENSUS X12).	databases of observed countries' central banks.
M ₃ growth	Growth rate of M ₃ /GDP. All data are seasonally adjusted (CENSUS X12).	databases of observed countries' central banks.
Current account balance	Current account balance in terms of GDP. Sign (+) corresponds to current account surplus and sign (–) corresponds to current account deficit. All data are seasonally adjusted (CENSUS X12).	EUROSTAT database.
Labour cost growth	Percentage change of wages and salaries (Labour Cost Index) compared to same period in previous year. All data are seasonally adjusted (CENSUS X12).	EUROSTAT database.
Loans	Banks' loans to non-monetary sectors in terms of GDP. All data are seasonally adjusted (CENSUS X12).	Calculations based on data from the National Bank of Hungary.
HICP	HICP of the Eurozone countries (EA11-1999, EA12-2001, EA13-2007, EA15-2008, EA16-2009, EA17-2011, EA18-2014, EA19-2015).	EUROSTAT database.

(continued)



Continued

Variable	Explanation of variable construction	Sources
GDP gap of Eurozone	Hamilton filter employed on percentage change of GDP of the Eurozone countries (EA11-1999, EA12-2001, EA13-2007, EA15-2008, EA16-2009, EA17-2011, EA18-2014, EA19-2015) compared to same period in previous year. All data are seasonally adjusted (CENSUS X12).	EUROSTAT database.

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