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Inflation Targeting and the Anchoring of Inflation Expectations in the CEE Countries

Summary: This paper studies the time evolution in the degree and level of anchoring of inflation expectations in four Central and Eastern European inflation targeting countries. The results suggest that the degree of anchoring of inflation expectations increased gradually in all countries over the last decade, while the level of implied inflation targets moved towards the official target. The extent of anchoring increased more strongly in the first years following the IT adoption and more gradually over the later period. We also find that smooth changes of the official target had a positive impact on anchoring.

Key words: Inflation targeting, Monetary policy, Credibility, Time-varying parameter VAR, Mixture innovation model.

JEL: E52, E58.

Over the past decade, inflation targeting (IT) has become the dominant monetary policy regime[1]. The literature has argued that the regime's ability to improve the quality of institutions, reduce the public's assessment of future inflation and enhance the stability of inflation expectations will lead to a lower average inflation level and volatility, lower volatility of real economic activity and thus, improved trade-off between output and inflation (see Lars E. O. Svensson 2000 and Carl E. Walsh 2009, among others). The anchoring of inflation expectations and their alignment with the publicly announced target are the key elements for a successful implementation of

[1] Other regimes such as nominal GDP targeting, price level targeting or a simple Bagehot's rule have been suggested in the literature in connection with the recent crises (see the discussion in Lucrezia Reichlin and Richard Baldwin 2013), but none of them have yet been implemented in practice.

IT, particularly if the regime is used as a tool to enhance the disinflation processes in high-inflation countries. Several studies reviewed below suggest that the IT adoption has indeed led to the anchoring of inflation expectations in developed and some emerging market economies (EM). However, the experience of the Central and Eastern European (CEE) IT countries is still largely unexplored in the relevant literature. The CEE countries were among the first EMs to adopt the IT regime in the late 1990s/early 2000s and understanding the evolution of expectations anchoring in them is important for the optimal design of policy actions in new EM targeters. The CEE countries also differ among themselves in various respects (the design of the IT regime, foreign exchange regime, inflation dynamics), thus offering heterogeneity to be explored.

This paper studies the time evolution of the degree and level of anchoring of inflation expectations in four CEE IT countries (Czech Republic, Hungary, Poland and Serbia). Building upon the existing literature, both measures are estimated using a novel mixture innovation time-varying parameter VAR model (TVP-VAR) with stochastic volatility (Gary Koop, Roberto Leon-Gonzalez, and Rodney W. Strachan 2009), which allows for different time dynamics of the anchoring effects of IT. We find that the degree of anchoring of inflation expectations increased in all countries over the last decade, while the level of implied inflation targets moved towards the official target. The extent of anchoring increased more strongly in the first years following the IT adoption and more gradually over the later period.

The rest of the paper is organized as follows. Section 1 briefly summarizes the relevant literature. Section 2 outlines our empirical methodology. Stylized data facts are presented in Section 3. Section 4 presents the empirical results and Section 5 presents the concluding remarks.

1. Short Literature Review and Context of the Paper

Despite theoretical advantages, the existing empirical evidence on the macroeconomic effects of the IT regime is mixed. Laurence Ball and Niamh Sheridan (2005), Shu Lin and Haichun Ye (2007), and Helder Ferreira de Mendonça and Gustavo José de Guimarães e Souza (2012) argue, *inter alia*, that the adoption of IT did not contribute to improving economic performance in the group of developed countries. The finding is not surprising given their sound economic performance over the precrisis sample. The evidence on developing and emerging economies (EM) is less clear. On the positive side, Carlos Eduardo S. Goncalves and Joao M. Salles (2008), Lin and Ye (2009), de Mendonça and de Guimarães e Souza (2012), and Siok Kun Sek and Wai Mun Har (2012) find that the EM IT countries had larger drops in inflation and output volatility compared to the non-IT countries. On the other hand, Ricardo D. Brito and Brianne Bystedt (2010) argued that IT did not improve economic performance (in terms of inflation and output growth) in developing economies once the output-inflation trade-off is taken into account. Philip Arestis and Malcolm Sawyer (2013) also find that the difference in macroeconomic performance between the two groups of countries (IT and non-IT) appears to be small in their sample. Kosta Josifidis et al. (2014) provide additional evidence on the increased importance of exchange rate in an IT framework in developed and some emerging economies after the crisis.

The lack of consensus on the IT effects on EMs is related to different levels of central banks' credibility at the time when the IT regime was adopted (for a more detailed discussion see Svensson 2010). Given a long high inflation history, central banks in EMs typically have lower initial levels of credibility which, with the IT regime's focus on inflation, implies a negative link between the introduction of IT and output performance. As credibility improves, lower and stable inflation can be achieved with smaller output costs. Central banks' credibility is directly reflected in the degree of anchoring of inflation expectations and the extent of their alignment with the publicly announced target. Several studies have analyzed the effects of IT on inflation expectations in developed countries. An early paper by David R. Johanson (2002) finds the significant effect of IT on reducing the level of inflation expectations but not their volatility. The subsequent literature provided more supportive evidence in favor of expectations anchoring. Influential papers by Refet S. Gürkaynak et al. (2007), and Gürkaynak, Andrew T. Levin, and Eric T. Swanson (2010) find that long-term expectations (derived from bond yields) in IT countries (UK, Canada, Chile and Sweden) are not significantly affected by macroeconomic news, which is the case in non-IT countries (US). More recently, Maria Demertzis, Massimiliano Marcellino, and Nicola Viegi (2009) have shown that inflation targeting contributed to increasing disconnect between the past inflation and inflation expectations, while the provision of a specific numerical target helped anchoring expectations in the euro area, Israel and Sweden. Despite the importance of credibility for the achievement of the main regime's objectives, only Carlos Capistran and Manuel Ramos-Francia (2010) analyzed the impact of the IT regime on the expectations in EMs. They show that the introduction of IT reduced the dispersion and helped anchor inflation expectations in their sample of Latin American and Asian EMs. The experience of the CEE inflation targeting countries and the time evolution in the anchoring effects of IT are still largely unexplored in literature. This paper aims to fill this gap.

2. Empirical Methodology

In this section we will first present our empirical model and then discuss technical details of empirical estimation.

To measure the anchoring effects in the IT regime we build on Demertzis, Marcellino, and Viegi (2012) and assume time-varying relation between the inflation and the inflation expectations in a general bivariate VAR(p) model:

$$\pi_t = a_{ot} + a_t(L)\,\pi_{t-1} + b_t(L)\,\pi^e_{t-1} + e_{1t}, \quad (1)$$

$$\pi^e_t = c_{ot} + c_t(L)\,\pi_{t-1} + d_t(L)\,\pi^e_{t-1} + e_{2t}, \quad (2)$$

where π_t is the actual inflation at time t, π^e_t is the inflation expectation for the next period formed at time t, while the VAR parameters are allowed to evolve over time. This simple empirical form can be used to identify the degree of anchoring inflation expectations and the level at which these expectations are anchored. We model the expectation formation mechanism following Antulio N. Bomfim and Glenn D. Rudebusch (2000), and assume that inflation expectations for the next period are the weighted average of the long-term target perceived by the private sector at time t (π_t*), and the last period's inflation rate:

$$\pi^{e}_{t} = \lambda_t \pi_t^{*} + (1- \lambda_t) \pi_{t-1}. \quad (3)$$

The aggregate expectation formation mechanism in (3) essentially implies that economic agents have heterogeneous beliefs about the capacity of the central bank to achieve the target and what the long-run target value is[2]. The dispersion of inflation beliefs is consistent with our focus on the period immediately after the introduction of new policy (IT) and high inflation history of the CEE countries. The mechanism is also in line with John B. Taylor (1993) who discusses the limitations of the rational expectation hypothesis during the transition period after the introduction of new policy.

The parameter λ_t measures the degree of anchoring, i.e. the weight that economic agents put on the long-term implied target. In the extreme case, if $\lambda_t = 0$, the inflation target does not enter the private sector's formation of expectations. On the other end, as lambda approaches one over time, the expectations are more anchored and less influenced by temporary inflation shocks. However, the level at which the agent's expectations are anchored (π_t^{*}) may deviate from the target communicated by the central bank, which can put additional pressure on prices. Hence, gauging the full anchoring effects requires looking at the evolution of both, λ_t and π_t^{*}. Within the IT regime it is expected to see an increase in the expectations anchoring (λ_t increases) and movement of the perceived target (π_t^{*}) closer to the one announced officially by the central bank.

$$\pi^{e}_{t} = c_{ol}/(1-d_t(L)) + c_t(L)/(1-d_t(L))\pi_{t-1}. \quad (4)$$

By equating the terms in Equations (3) and (4) we get:

$$\lambda_t = 1-(c_t(L)/(1-d_t(L)), \quad (5)$$

$$\pi_t^{*} = c_{ol}/[(1-d_t(L))\, \lambda_t]. \quad (6)$$

Equations (5) and (6) imply that we can recover the estimates of the anchoring effects from the estimated VAR parameters. We will now move on to describe the estimation procedure.

In order to take into account the changes in the monetary regime and different volatility of exogenous shocks in the economy over time, the VAR coefficients in (1) and (2) are allowed to change throughout the sample. The simplest way to model the changes in the parameters is to estimate the VAR model with several structural brakes. Although this allows testing the impact of some important events on expectations anchoring, the main disadvantage is that one needs to specify the dates of changes prior to the estimation which would limit the study to a small number of exogenously defined events. An alternative is to estimate Equations (1) and (2) following Giorgio E. Primiceri's (2005) TVP-VAR approach with stochastic volatility (used to study the evolution of the monetary policy transmission mechanism) which assumes gradual changes in the conditional mean parameters and error covariance matrix. Since our sample includes the CEE countries where the level of central bank credibility at the start of the IT regime was lower relative to developed ones; the pe-

[2] For a similar mechanism in the foreign exchange rate context see Paul De Grauwe and Marianna Grimaldi (2006).

riod of global financial crisis; the actual changes in the official target level, and the periods of no change or abrupt change cannot be ruled out *a priori*. In order to avoid imposing an a priori time structure we use a mixture innovation TVP-VAR model with stochastic volatility proposed by Koop, Leon-Gonzalez, and Strachan (2009), which allows for all three states of parameter evolution (no change, abrupt or gradual change) at a given period.

The TVP-VAR outlined in Equations (1) and (2) can be represented in the state space form, with the measurement equation:

$$y_t=\alpha_t y_{t-1}+\varepsilon_t, \tag{7}$$

and state equation:

$$\alpha_{t+1}=\alpha_t+K_{1t}\eta_t, \tag{8}$$

where y_t is the vector of dependent variables $[\pi_t\ \pi_t^e]$, α_t is the vector of state variables, i.e. VAR coefficients $a_t(L)$, $b_t(L)$, $c_t(L)$ and $d_t(L)$, ε_t is the vector of errors $[e_{1t}\ e_{2t}]$ which are $N(0,H_t)$, η_t are independent $N(0,Q_t)$ vectors, and K_{1t} is an independent binary innovation term that controls for structural breaks in the conditional mean parameters.

To capture the impact of changes in macroeconomic volatility, we also allow the variances and covariances to change over time. Following Primicieri (2005) we can use triangular reduction of the measurement error covariance matrix, H_t:

$$A_t H_t A'_t=\Sigma_t\Sigma'_t, \tag{9}$$

where Σ_t is a diagonal matrix with elements $\sigma_{j,t}$, for $j = 1,.., p$ and A_t is lower triangular matrix.

The dynamics of Σ_t and A_t are specified by using additional state equations. Let $\sigma_t = (\sigma_{1,t},..., \sigma_{p,t})$ and $h_{j,t} = \ln(\sigma_{j,t})$ then the evolution of Σ_t is given as follows:

$$h_{t+1} = h_t+K_{2t}u_t, \tag{10}$$

where u_t is $N(0,W)$ and analogous to Equation (8), K_{2t} is the term that controls for structural breaks in the conditional variance.

Stacking the unrestricted elements of A_t, by rows into $p(p-1)/2$ vector $a_t = (a_{21,t}, a_{31,t}, a_{32,t}, ..., a_{p(p-1),t})$ their dynamics are assumed to follow:

$$a_{t+1} = a_t+K_{3t}\zeta_t, \tag{11}$$

where ζ_t is $N(0,C)$, C is block diagonal as in Primiceri (2005) and K_{3t} guides the breaks in covariances. All error terms (u_t, ε_t, η_t and ζ_t) are assumed independent from each other and over time.

The mixture innovation aspect of the model allows for an unknown number of breaks in the model parameters. The process is governed by a sequence of random binary latent variables $K_t = (K_{1t}, K_{2t}, K_{3t})'$. More concretely, if $K_{t,j}$ takes value 0, the parameters in group j will remain constant at time t, while $K_{t,j} = 1$ leads to time t change in this group of parameters. In this way, the model nests a wide range of VAR models. If $K_{1,t} = K_{2,t} = K_{3,t} = 1$, for all t, then the model collapses to TVP-VAR with stochastic volatility (Primiceri 2005). If $K_{1,t} = K_{2,t} = K_{3,t} = 0$ for all t, the model reduces to a standard VAR with constant parameters. In between the borderline cas-

es, it allows that the parameters of VAR (hence, of anchoring measure(s)) are constant over a period and then gradually or abruptly evolve over other periods. The data determine the probability of observing a change in each parameter group at time t, independently of the breaks in other groups and over time, where we assume Bernoulli distributional prior, $p(K_{t,j}=1)= p_{t,j}$ following Koop, Leon-Gonzalez, and Strachan (2009).

The priors for the state vectors and hyper parameters are calibrated following Primiceri (2005) and Koop, Leon-Gonzalez, and Strachan (2009). We use normal distribution priors for the state variables (α_t, h_t, a_t), based on a training sample as in Primiceri (2005). The only exception are the estimates for Serbia where we draw uninformative priors from N(0,I) due to a short sample size. The priors for hyperparameters Q, W and C are Inverse Wishart distributions. The scale matrices are calibrated following the choices in Primiceri (2005) and Koop, Leon-Gonzalez, and Strachan (2009), while the degree of freedom parameters are set to small values (1 + dimension of the matrix) to keep limited weight on the prior beliefs. Finally, we use non-informative priors on the probabilities of breaks occurring at every observation t. They are drawn from beta distribution prior $B(\beta_{1j}, \beta_{2j})$ for j = 1,2,3, where parameters β_{1j}, β_{2j} govern the prior beliefs about the frequency of parameter changes. In line with Koop, Leon-Gonzalez, and Strachan (2009) we choose both β parameters equal to 1 which implies the a priori 50% probability of the break occurring in any period.

3. Data and Stylized Facts

This section discusses the data and number of empirical facts on the relationship between inflation and inflation expectations in the inflation targeting countries of Central and Eastern Europe (Czech Republic, Hungary, Poland and Serbia).

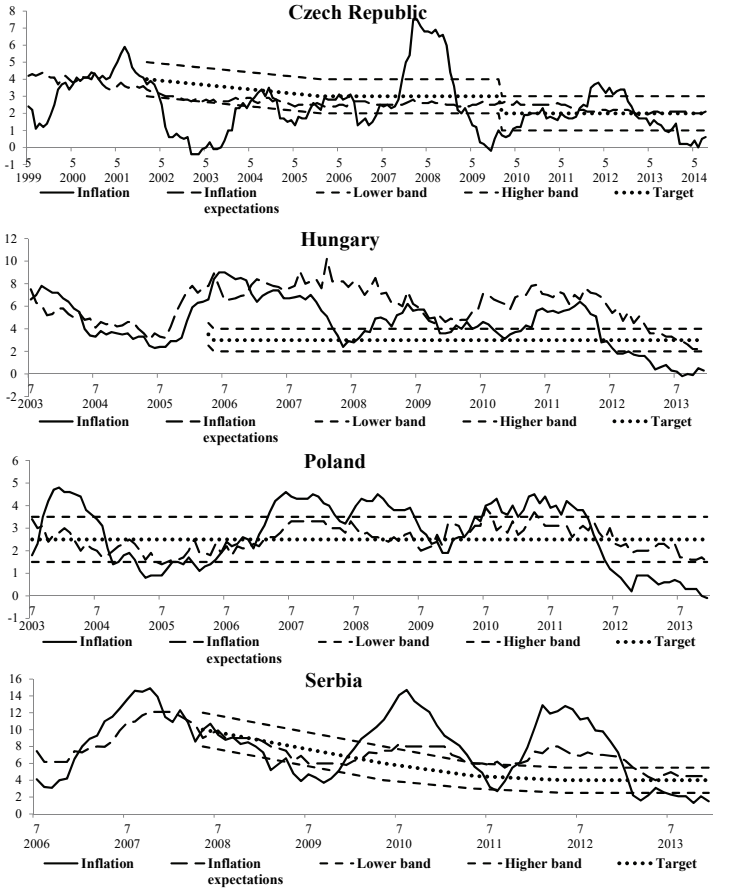
The majority of the data on inflation expectations come, for compatibility reasons, from the European Commission (2014)[3], while the data on inflation are from the Eurostat (2014)[4] database. The only exception is Serbia, where the data is taken from the central bank's inflation report statistics. The longest time period for which all data are available is May 1999 - August 2014 for the Czech Republic. The samples for Hungary and Poland cover the period from March 2004 to August 2014. The data for Serbia are available from March 2007 to August 2014.

After the period of nominal exchange rate targeting at the onset of the transition process, all four countries adopted the IT regime at the later stages of transition. The Czech Republic adopted IT in 1997, Poland in 1998 and Hungary in 2001. Hungary differs from the other two countries to the extent that it also kept the *de facto* nominal exchange rate target in the form of the target zone *vis-à-vis* the euro until 2008. In line with the late transition start in 2000, Serbia moved to fully-fledged IT in 2009 at the comparable stage of its transition process *vis-à-vis* other three countries. In terms of the foreign exchange regime, Poland moved to the free floating re-

[3] **European Commission.** 2014. Economic Forecasts. https://ec.europa.eu/info/business-economy-euro/economic-performance-and-forecasts/economic-forecasts_en (accessed September 22, 2014).
[4] **Eurostat.** 2014. Database. http://ec.europa.eu/eurostat (accessed September 23, 2014).

gime already in 2000, Hungary in 2008, while the Czech Republic and Serbia maintained some form of the managed float exchange rate regime (Josifidis, Jean-Pierre Allegret, and Emilija Beker Pucar 2009).

Looking at the sample relationship between inflation and inflation expectations reveals that a gradual reduction in highly persistent inflation expectations coincided with a decrease in the inflation target in the Czech Republic (Figure 1). Interestingly, the long-term inflation expectations were below the target announced officially by the central bank in a large part of the sample (until the end of 2009), when the official inflation target was lowered to 2%. On average, the inflation expectations still exceeded the actual rate of inflation (Table 1).



Source: European Commission (2014) and National Central Banks.

Figure 1 Inflation and Inflation Expectations

By 2012, the expectations converged to the target and remained close to the level thereafter. Over the entire period, the inflation expectations appeared disconnected from the current inflation as suggested by their low correlation (0.28).

The inflation expectations in Poland fluctuated around the target of 2.5% over the past decade, with three distinct periods. The expectations undershoot the official target between late 2004 and November 2007. The trend was reversed over the following period with the expectations being largely above the official target until 2013, when they again dropped to the levels below the target. The dynamics in some part mimic the actual inflation, which was confirmed by a high sample correlation between the two series (0.7). Despite the correlated movements, the inflation expectations averaged below the actual inflation and were very close to the target.

Inflation in Hungary has been very volatile over the last decade. Although the drops in inflation did not lower the expectations until recently, the correlation between the two series is high (0.66) as the peaks in the actual inflation were matched by an increase in the expectations. For most of the sample the inflation expectations remained well above the official target and actual inflation – over the past decade the average expectations were 1.5 percentage points higher compared to the average inflation.

Serbia faced the highest and most volatile inflation rates among the countries under study. This was also reflected in the expectations formation, although the magnitude of expectation changes remained moderate. A high correlation between the two series of 0.76 points to a low average degree of anchoring. Although the inflation expectations were far more persistent, the agents expected the inflation rate of 7.5% on average, i.e. only 0.5 percentage points lower than the average inflation rate.

Table 1 Summary Statistics and Unit Root Test Results

	Czech Rep.		Poland		Hungary		Serbia	
	Infl.	Exp.	Infl.	Exp.	Infl.	Exp.	Infl.	Exp.
Mean	2.44	2.76	2.74	2.52	4.52	6.04	7.96	7.43
Median	2.25	2.60	3.00	2.50	4.35	6.30	8.40	7.25
Max	7.50	4.40	4.80	3.90	9.00	10.20	14.90	12.10
Min	-0.40	1.90	-0.10	1.40	-0.20	2.20	1.30	4.00
St. dev.	1.72	0.60	1.40	0.57	2.18	1.71	3.85	1.95
Correl. with inflation	-	0.28	-	0.70	-	0.66	-	0.76
KPSS[A]	0.14	0.44*	0.21	0.22	0.39*	0.22	0.21	0.37*
DF-GLS[B]	-2.6***	-0.6	-2.0**	-1.8*	-1.8*	-2.0**	-2.5**	-1.7*
Zivot-Andrews[C]	0.00	0.01	0.01	0.00	0.01	0.00	0.02	0.07
Sample	1999M5-2014M8		2004M3-2014M8		2004M3-2014M8		2007M3-2014M8	

Notes: [A] Tests null hypothesis of stationarity; [B] *t*-stat; [C] *p*-value; * significant at 90%, ** 95% and *** 99%; Infl.: actual inflation rate; Exp.: inflation expectations.

Source: Authors' calculations.

The stylized facts that may have an impact on the level or dynamics of anchoring can be summarized as follows. First, with the exception of the Czech Republic, the inflation expectations are highly correlated with the actual inflation in all countries, which may indicate a lower degree of anchoring around the target. Figure 1 shows high inflation volatility in all countries, while Table 1 confirms that the volatility of both inflation and inflation expectations is high, especially in Serbia and Hungary. Second, the countries in the sample diverge in terms of the level of infla-

tion expectations as well as in terms of the gap between inflation and expectations. While the inflation expectations in the Czech Republic and Poland fluctuate close to the target, the expectations exceeded the target set by the central banks in the large portion of the sample in Hungary and Serbia. This may indicate the higher level of the implied target, i.e. the target perceived by economic agents (π^*). Finally, different approaches used in setting the target may have an influence on both the degree of anchoring and the level around which inflation expectations are anchored. In our sample, the Czech Republic, Hungary and Serbia had similar evolution of targets – first, year-end targets were set, then the central banks gradually reduced the targets until they finally moved to a continuous target. On the other hand, Poland did not change the target over the sample.

4. Results

We start by checking the order of integration of individual series. Table 1 presents the results from the Denis Kwiatkowski et al. (KPSS) (1992) test of a null hypothesis that an observable time series is stationary, and the Dickey-Fuller GLS test of the unit root null. To control for potential structural breaks in the series we implement the Eric Zivot and Donald W. Andrews (1992) unit root test with unknown break times. The combined results suggest the stationarity of all series with the exception of the inflation expectations for the Czech Republic for which the evidence is mixed.

We estimated the model using an MCMC algorithm of Koop, Leon-Gonzalez, and Strachan (2009)[5]. We simulated 50000 draws with the burn-in sample of 10000 and selected every 10th observation in order to limit the impact of the sampler's auto-correlation. This gave us the final MCMC sample of 4000 draws. The analysis of the autocorrelations of the final sample for each parameter suggests a good mixing of the chain. In addition, the shape of parameter posteriors for the conditional mean parameters of interest suggests that the data were informative relative to the priors. We do not report these results for space considerations; they are available from the authors.

Table 2 reports the fit of the model using the posterior means of the probabilities of breaks in the conditional mean parameters and the expected value of the log-likelihood as in Bradley P. Carlin and Thomas A. Louis (2000) and Koop, Leon-Gonzalez, and Strachan (2009). The latter is preferred to the marginal likelihood due to its lesser sensitivity to prior information. In addition to mixture innovation TVP-VAR (MI TVP) we estimated Primiceri's (2005) TVP-VAR with gradual changes (GRAD) and the standard VAR with time-invariant parameters for each country. We estimated each model using 1 to 4 lags of the endogenous variables and chose the number of lags in the benchmark model, based on the expected value of the log-likelihood. The estimates of anchoring effects are qualitatively and often quantitatively similar across the employed lag structures and we only reported the results for benchmark models.

The results in Table 2 provide strong evidence on the time evolution of the VAR parameters, since the expected value of the log-likelihood is significantly lower

[5] The estimation was done by adapting their Matlab file for our framework. We are grateful to the authors for making it available.

for the standard VAR in all four countries. In addition, the posteriors of the transition probabilities suggest a high probability (around and above 90%) of changes in the conditional mean parameters over time in all countries. Indeed, the performance of MI TVP and GRAD (which imposes the transition probabilities equal to one) appears to be close to the slight advantage of the MI TVP model based on the expected value of the log-likelihood. Given the strong statistical evidence for the presence of time dynamics in the VAR parameters, we constructed the series of the time-varying degree of anchoring (λ) and the level of implied target (π^*) using the estimated parameters from the MI TVP. These are reported in Figure 2 together with the 68% credible intervals.

Table 2 Model Comparison

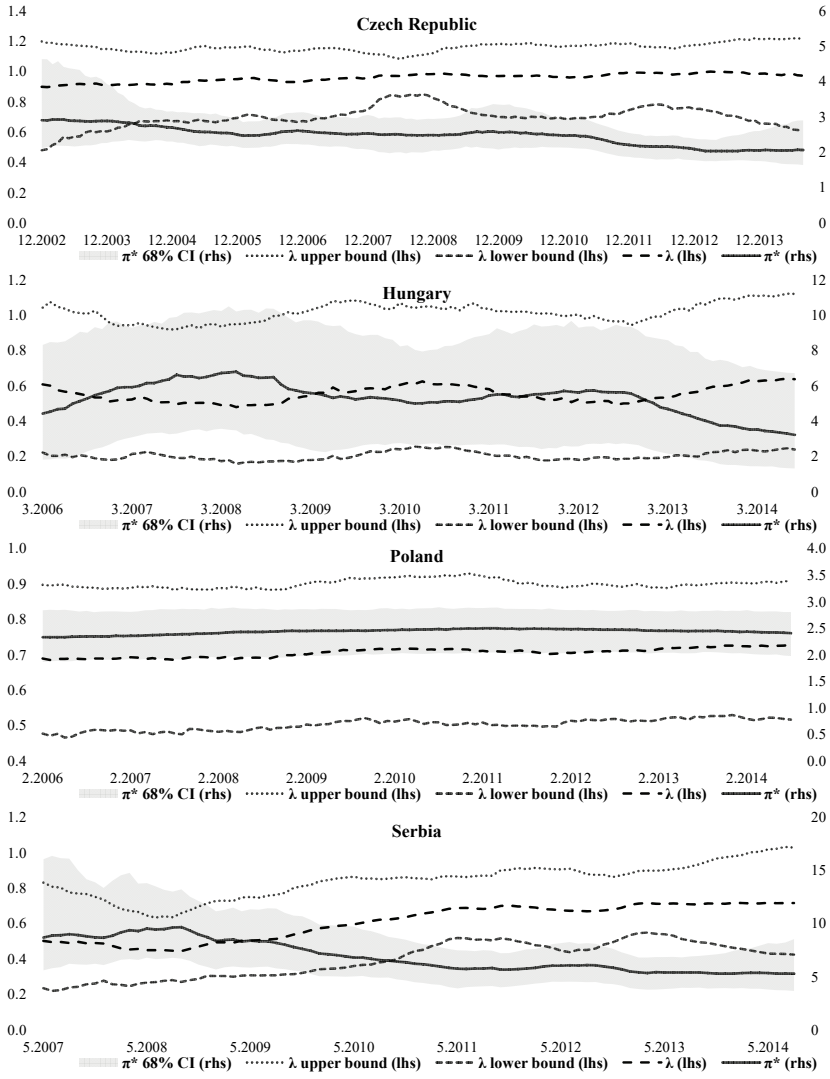
	MI TVP			GRAD			VAR		
	$E(p_1\|Y)$	E(L|Y)	Lag	$E(p_1\|Y)$	E(L|Y)	Lag	$E(p_1\|Y)$	E(L|Y)	Lag
CZ	0.89	2.58	3	1	1.98	3	0	-96.2	3
HU	0.88	3.40	4	1	2.95	4	0	-4.38	3
PL	0.98	4.12	3	1	3.66	3	0	-1.96	3
SR	0.91	4.05	2	1	3.56	2	0	-20.10	2

Notes: $E(p_1|Y)$: posterior mean of the transition probabilities; E(L|Y): expected log-likelihood; Lag: number of lags of the dependent variable in benchmark specification.

Source: Authors' calculations.

Figure 2 shows that the anchoring of inflation expectations increased gradually over time with the maturity of the IT regime in all countries. The degree of anchoring in the Czech Republic already reached high levels in 2003, five years after the IT adoption. The change from the year-end to the declining inflation target, which was gradually reduced, supported further growth in the degree of anchoring. By the end of 2005, when the continuous target was introduced for the first time, λ was equal to 0.95. The improvement primarily came from the lower impact of inflation on inflation expectations. By 2010, when the target was lowered to 2%, the degree of anchoring reached 0.97 and fluctuated closely around that level over the remaining part of the sample. The largest rise (by 1.8) in the degree of anchoring is observed in the first quarter of 2008. This matches (in time) the beginning of the period of higher transparency of the Czech central bank's policy communication which made public the voting records of the Executive Board meetings, and started to provide a forecast-consistent interest-rate path over the same period. The movements in the implied target closely followed the inflation expectations dynamics. It moved below the official target prior to the target's reduction in 2010, and eventually converged to the level slightly above the official target (2.04) in 2012. Interestingly, due to the relatively low impact of the past inflation on the formation of expectations, the periods of target over and undershooting did not have a significant impact on the anchoring measures.

The degree of anchoring improved gradually over the last decade in Poland (from 0.68 to 0.73). Looking at the dynamics shows that a drop in inflation below the target over 2005-2007 had a limited impact on the degree of anchoring. λ_t slightly improved over 2009-2010 and more strongly (by 2.1) from 2013 onwards. The im-



Source: Authors' calculations.

Figure 2 Time-Varying Degree of Anchoring (λ) and Implied Target (π^*)

plied target was at the level below the target communicated by the central bank with a gradual movement towards the official target until 2010 and another slow divergence afterwards.

The degree of anchoring fluctuated over time in Hungary with the overall rising path at the end of the sample. After the initial decline, λ grew gradually from 2008, two years after the introduction of the continuous target. The growth was interrupted in mid-2010 and the degree of anchoring decreased until 2013 when it started to grow again, outpacing the initial level. The uncovered pattern can be associated

with several key events. The abandonment of the foreign exchange target zone in 2008 and communicated focus on the inflation target by the central bank seem to have supported expectations anchoring. Higher uncertainty surrounding the central bank's decisions in 2011 and 2012 was associated with the fall in the degree of anchoring. The level of the implied target was also volatile and closely followed the actual expectations. For most of the sample it was above the target band and approached the actual target level in 2013 in line with the falling inflation expectations.

Among the countries in the sample Serbia recorded the strongest improvement in terms of the degree of anchoring, in line with the adoption of the IT regime in 2009. At the time of the IT adoption, the inflation was on a declining path, the degree of anchoring was moderate (0.45) and the implied target was close to the actual inflation level. The degree of anchoring grew gradually over the sample to reach 0.72 in 2014. The highest growth was recorded in the first years of the IT regime (2009 and 2010). High inflation volatility after 2011 had a limited impact on the degree of anchoring, given the moderate growth of inflation expectations that followed the target band overshooting. The largest monthly increases in λ (by 3.3) occurred at the end of 2012/early 2013, the period when the central bank changed its communication policy and the structure of open market operations. The reduction in the implied target accompanied the rise in the degree of anchoring. Although the inflation expectations were above the target for most of the post-2011 period, the implicit anchor reached the upper bound of the target band in 2013 and continued slowly to decrease.

Overall, the results suggest that the expectations have become more anchored over the course of the IT regime in all four countries. Although the results should not be interpreted in the strictly causal way, the extent of anchoring increased more strongly in the first years following the IT adoption and more gradually over the later period. The improvement mostly came from the increasing disconnect between the past inflation and inflation expectations, increased persistence in the expectation formation and reduction in the gap between the two series.

The results also highlight the differences in the degree of anchoring and the level of the implied anchor between the countries. The Czech Republic, the forerunner in the adoption of the regime, reached the high level of anchoring already in the mid-2000s. Despite the improvement over the past decade, inflation expectations are still not fully anchored in other countries. The implied anchor has only recently equaled the central bank's target in Hungary, while it is still close to the upper target band in Serbia, which was the last to adopt the regime. On the other hand, the implied target in Poland was below the target set by the central bank for much of the period of the analysis. The dynamics of the target band supports a stronger increase in the anchoring degree in line with the evidence from the Czech Republic and Serbia around the time of a gradual target reduction.

5. Concluding Remarks

We studied the evolution in the degree and level of anchoring of inflation expectations in four CEE IT countries over the past decade. We found that the degree of anchoring increased in all countries over the last decade, while the level of implied inflation targets moved towards the official target. The extent of anchoring increased

more strongly in the first years following the IT adoption and more gradually over the later period. Despite similar timing of the IT regime adoption, there are significant differences in the degree of anchoring and the level of the implied anchor between the countries.

The results have several policy implications. First, an increase in the level and the degree of anchoring implies a positive association between the IT regime and the inflation expectations dynamics, more stronger at the early periods of the regime. Second, cross-country differences and changes over time suggest that central bank actions within the IT regime can have an additional impact on the expectations. Our event-type analysis of the documented changes highlights a positive association between the improvements in the central bank's transparency (Czech Republic, Serbia) and expectations anchoring. Higher uncertainty following the central bank's decisions is associated with a reduction in the degree of anchoring as in Hungary. Third, an additional impact on the expectations in the future may come from a further reduction in the inflation target in Poland, Hungary and Serbia. This is especially relevant for Poland where the implied target is below the one set by the central bank over the extended period. Fourth, the fact that the anchoring effect was the strongest in the Czech Republic and Serbia around the time of gradual target reduction suggests that the countries could use the disinflationary path of inflation to gradually reduce the target once the other preconditions are satisfied.

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