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Causality between Actual and Expected Inflations in Central and Eastern Europe: Evidence Using a Heterogeneous Panel Analysis

Abstract

This study applied a panel Granger non-causality test to explore the causal relationships between actual and expected inflations in Czechia, Hungary, Latvia, Lithuania, Poland, and Romania. These Central and Eastern European (CEE) countries share substantial homogeneity and heterogeneity. The empirical results show significantly positive causalities running from actual to expected inflations in those target countries. However, the effect of the actual inflation on inflation expectations weakens in Hungary and Romania following a financial crisis, and the causality is no longer significant for Czechia, Latvia, Lithuania, and Poland. These results imply strong backward-looking and de-anchored short-term inflation expectations. By contrast, the causality running from expected to actual inflations exists only in certain countries with negative effects. Thus, we find some slight evidence in support of the self-fulfillment of inflation expectations. Empirical results suggest that domestic policies remain important for the management of actual and expected inflations, regardless of the monetary policy regime adopted.

1. Introduction

Changes in expectations of future economic activity are becoming increasingly important in driving economic fluctuations with the unfolding of boom-bust cycles (Leduc and Sill, 2013). For example, the widely adopted theoretical framework of the Philips Curve attributes inflation fluctuations to inflation expectations. Specifically, Paloviita (2009) and Amberger and Fendel (2016) find that the Euro Area (EA) countries have become more forward-looking in the last few decades. In other words, inflation expectation has become a significant determinant of the actual inflation in these countries, thus indicating the self-fulfilling property of inflation expectations. If the self-fulfillment of inflation expectations is combined with the causality running the other way around, i.e., actual inflation causes expectations of future inflation, an economy may fall in the spiral of "inflation-expectation". Consequently, the vicious spiral can induce dynamic and persistent inflation, which imposes substantial costs on the real economic output by making the price mechanism less effective in allocating resources (Friedman, 1977; Payne, 2008; Rahman and Serletis, 2009). These costs may be higher for emerging markets than in developed economies as inflation remains more serious than desired in many of these markets (Chowdhury, 2014). However, as an important part of Europe, Central and Eastern European (CEE) countries are barely investigated regarding the relationship between actual and expected inflations. Damaged by the financial crisis and the associated sovereign debt crisis, the CEE economies suffered and were forced to cut spending and investments. For instance, Western European banks contracted their credit base in Eastern European countries, mainly by rapidly reducing corporate loans (Cull et al., 2013). Meanwhile, most CEE governments responded to the crisis by reducing the share of the payroll going to mandatory private pension savings (Åslund, 2018). These actions contributed to fluctuating inflations as a result of the increased economic uncertainty. Therefore, we were motivated to investigate whether inflation dynamics in CEE countries can be attributed to inflation expectations by testing the nexus between actual and expected inflations.

The importance of inflation expectations is perceived as one of the pillars of the consensus on monetary policy before the global financial crisis (Clarida, 2012; Coibion et al., 2020). Nevertheless, the previous literature dealing with the linkage between actual and expected

inflations generally focuses more on a specific country or on developed economies. Significant linkages between countries, particularly European countries, have been demonstrated. Ignoring the interaction between countries may lead to bias and inconsistency in empirical results. This paper contributes to the extant literature via a panel causality analysis that accounts for both cross-sectional dependence and heterogeneity across six CEE countries: Czechia, Hungary, Latvia, Lithuania, Poland, and Romania. The contribution of this paper is three-fold. First, the panel Granger non-causality test carried out in this research permits for more robust estimations by considering the deviations among countries and the time variation (Pradhan et al., 2014). This method is novel to the literature on actual and expected inflations. Second, we compared causalities between actual and expected inflations before and after the financial crisis. The financial crisis and subsequent sovereign debt crisis have exerted an enormous influence on bank lending behaviors, microfinance business, household loans and saving attitudes of the CEE countries' agents. Hence, the nexus between actual and expected inflations may be different depending on the specific macro-conditions of each country. Third, the data set contained six CEE countries and adopted two regimes of Currency Board and Inflation Targeting for a long period of May 2001 to May 2019, which is mainly based upon the data availability.

We studied CEE countries for several reasons. Many studies suggest that the Inflation Targeting and Currency Board have indeed led to the anchoring of inflation expectations and comparatively low inflation in developed and certain emerging economies. CEE countries were among the first emerging countries to adopt the above two regimes in the late 1990s/early 2000s. However, the experience of CEE countries remains unexplored in the relevant literature. Meanwhile, many CEE countries share a significant degree of economic homogeneity because of the convergence of the European Union (EU) and similar regimes adopted (Khan et al., 2013). Two different monetary policies, i.e., Currency Board and Inflation Targeting, are adopted by these six CEE countries. Differences emerge even under the same regime as a result of variances in the way the framework is implemented, the specific foreign exchange policy and inflation dynamics. Thus, the selection of sample subjects endows both homogeneity and heterogeneity among the countries. Specifically, Czechia, Hungary, and Poland introduced Inflation Targeting in 1998, 1999, and 2001, respectively. These three CEE countries are

relatively similar small open economies with strong regional and historical affinities. They have generally lower average inflation rates than older EU member countries, which affects both the price-stickiness and the updating of inflation expectations (Jarociński, 2010; Xu et al., 2017b).

However, inflation differences also exist in the CEE countries. For example, the average inflation in Romania between 2001 to 2020 was approximately three times larger than that in Czechia. High inflation increases economic uncertainty and hence requires more time and information to be focused on forecasting future inflation (Frohman et al., 1981). Both Czechia and Romania have adopted Inflation Targeting, a practice that strives to achieve price stability and predictability. However, with heterogeneous domestic performances in inflation movements in levels and volatilities, these differences are likely to affect both price settings and the formation of inflation expectations. Consequently, we expected our research to reveal discrepancies in causalities between actual and expected inflations among the CEE countries. Meanwhile, implementation differs across target countries. For example, the Czech National Bank used foreign exchange interventions from November 2013 to April 2017 to achieve inflation targets by devaluing the Czech Koruna. In contrast, in 2008, Hungary implemented a predefined medium-term target instead of a one-year forward target. The heterogeneity between CEE countries has been highlighted recently by the sovereign debt crisis (Chowdhury, 2014; Baxa et al., 2015). Understanding the causalities between actual and expected inflations in these countries is important for the optimal design of policy actions in new emerging economies that pursue stable inflation.

Following a systematic modeling strategy (Chang et al., 2014; Zhang et al., 2016), we tested rather than assumed the cross-section dependence in the panel data. We used two robustness tests. First, we used the balance statistic as a proxy to inflation expectations in order to retest causalities between actual and expected inflations. Second, we analyzed causalities before and after the financial crisis. Our research did not find evidence to support the self-fulfillment of inflation expectations for all target CEE countries. By the same token, we found that causalities running from actual to expected inflations did exist, particularly before the financial crisis. Our empirical findings have noteworthy policy implications for (emerging) countries that pursue stable inflation. Meanwhile, stressing the heterogeneity in the monetary

policy applications in the EU is important for policy makers to take necessary actions for harmonization.

This study proceeds as follows. Section 2 is a literature review. Section 3 explains the methodology. Section 4 describes the corresponding data. Section 5 presents the empirical results. Section 6 provides robustness tests and policy implications. Section 7 concludes.

2. Literature Review

While many studies have tested links between actual and expected inflations, no consensus has been reached. For instance, as a paradigm in analyzing monetary policy, the New Keynesian Phillips Curve (NKPC) assumes that firms are completely forward-looking in pricing and suggests a one-for-one relationship between current realized inflation and expected future inflation (Calvo, 1983). Thus, a causality running from actual to expected inflations is implied in the NKPC. However, the NKPC itself has been criticized for the failure in explaining inflation persistence and the hump-shaped effect of monetary policy (Rudd and Whelan, 2007), thus casting doubts on the linkage between actual and expected inflations. Through introducing the presence of backward-looking firms, the hybrid NKPC accounts for the observed inflation inertia and matches the United States (U.S.) and European data very well (Dupor et al., 2010; Adam and Padula, 2011; Abbas et al., 2016). Although the assumption of backward-looking firms may be unappealing from the theoretical viewpoint, the hybrid NKPC is strongly supported by data and maintains the implication of a co-movement between actual and expected inflations. Another advocate of the overhaul of the NKPC is the Sticky Information Phillips Curve (SIPC). By assuming a sticky information economy, Mankiw and Reis (2002) propose that agents update themselves on current state of economy and compute optimal prices based on periodically updated information. The SIPC asserts that it is the past expectation for now instead of current expectation for future inflation that affects current inflation, thus implying a synchronous movement between actual and expected inflations. Compared with the hybrid NKPC, the SIPC replicates the inflation inertia extremely well from the theoretical viewpoint; but is less effective in capturing inflation dynamics (Laforte, 2007; Coibion, 2010). The ambiguity of theoretical conclusions intensifies the difficulty of central banks in

implementing monetary policies.

Studies using different methods have evidenced the relationship between actual and expected inflations. For example, the causality running from expected to actual inflations is demonstrated by certain literature. Results based on a Vector Autoregression Model (VAR) in Leduc et al. (2007) show that, during the pre-1979 era, temporary shocks to inflation expectations led to a persistent increase in the actual inflation in the U.S., which disappeared after 1979. Further results of impulse responses in Leduc and Sill (2013) imply that expectations of good times in the future lead to current-period rising in inflation. Consequently, inflation expectations in the U.S. appear to be a quantitatively important driver of the actual inflation. Using a similar method, Ueda (2010) found that inflation expectations in Japan and the U.S. adjust more quickly to changes in exogenous prices and monetary policy shocks than to changes in actual inflation, thus revealing the self-fulfillment of inflation expectations. Girardi (2014) illustrates that the exogenous shift in inflation expectations is a significant driver of inflation in the EA. The self-fulfillment of inflation expectations is also supported by dynamic general equilibrium models, which are widely used in empirical analysis. Analogously, considering the time-varying stochastic volatility, Rafiq (2014) reports that much of the rise in inflation volatility is accounted for by a rise in the variance of short-term inflation expectations in the U.K., where inflation expectation has been well-anchored for last two decades. Mavroeidis et al. (2014) also conclude that inflation expectation is a driver of actual inflation. Many studies have tested whether the expectation of high inflation is associated with higher desired consumption, thus supporting an important channel through which inflation expectations affect actual inflation (Bachmann et al., 2015; Coibion et al., 2020).

Conversely, evidence which supports the causality running from actual to expected inflations is also found elsewhere. The adaptive expectation model assumes that inflation expectation is determined by past inflation expectation and currently realized inflation. With the development of the expectations-augmented Phillips curve and the accelerationist hypothesis, the adaptive expectation is widely adopted in empirical and experimental studies (Pfajfar and Santoro, 2010). Past released inflation is believed to work in forming inflation expectations (Lanne et al., 2009, Xu et al., 2016a). A handful of studies imply a causality running from actual to expected inflations rather than the reverse (Chen, 2008; Hubert and

Mirza, 2014; Trehan, 2015).

As evidenced in the literature, inflation expectations may exert positive effects on actual inflation and vice versa, thus indicating a possibility of the spiral of "inflation-expectation". Indeed, a bidirectional causality between actual and expected inflations is illustrated by Debabrata Patra and Ray (2010). They show that persistent price pressures generate inflation expectations and a sustained rise in inflation expectation induces intensified inflation. Similarly, Kim and Lee (2013) note that shocks of inflation expectations affect actual inflation, and actual inflation drives inflation expectations. Some research has queried the relationship between actual and expected inflations. For example, Koop and Onorante (2012) find that the impact of forward-looking inflation expectations on current inflation existed after the 2008 financial crisis. Nevertheless, backward-looking inflation expectations have no effect on current inflation, thus casting doubts on the self-fulfillment of inflation expectations. Rafiq (2014) shows a relatively benign response of inflation expectations to shocks in actual inflation. Using the bootstrap Granger full-sample causality test and sub-sample rolling window estimations, Xu et al. (2016b) report a bidirectional causality between actual and expected inflations in the U.S. in the full-sample period. However, the short-run analysis finds no self-fulfilling inflation expectation.

Unfortunately, little research has been performed on the nexus between actual and expected inflations for CEE countries, particularly the causal relationship. A study by Łyziak and Mackiewicz-Łyziak (2014) reports a relatively high degree of anticipation of future inflation in Austria, Belgium, Estonia, Hungary, Italy, Latvia, Poland, and Slovakia; but found a comparatively low degree in transition economies. Their results suggest the presence of close but heterogeneous relationships between actual and expected inflations across countries. The analysis of Łyziak (2016), in measuring the in-sample inflation forecasting errors, suggests that the model using survey-based inflation expectations of enterprises performs better than rational inflation expectations. The above studies reveal heterogeneous relationships between actual and expected inflations in CEE countries. However, no causal relationship has been estimated.

Related studies using the panel non-causality tests focus on the relationship of inflation with additional factors instead of inflation expectations. For instance, Pradhan et al. (2013) and Pradhan et al. (2015) investigate the causal relations among stock markets, economic growth

and inflation using a panel Granger non-causality test on a sample of 16 Asian countries and the OECD countries, respectively. Pradhan et al. (2014) show new empirical confirmation among the banking region, inflation and economic growth via a panel causality approach. Škare and Caporale (2014) confirm that inflation Granger causes employment and output growth positively in the short run and negatively in the long run applying the panel Granger non-causality test based on the data for 119 countries. Chang and Tsai (2015) find that the effect of globalization on inflation presents a high degree of heterogeneity in 21 OECD countries through a panel Granger non-causality test. By contrast, they find a one-way Granger causality running from inflation to globalization in Hungary and Poland.

3. Methodology

3.1 Inflation expectations

Inflation expectations can be measured based on survey data or on financial market data, and both approaches have advantages and shortcomings (Cunningham et al., 2010). Survey-based inflation expectations are based on the knowledge of respondents operating in the market and address different types of agents who make price and wage setting decisions; but usually are conducted monthly or quarterly. By contrast, market-based inflation expectations are available daily; but are potentially biased due to liquidity risk, inflation risk and institutional distortions. Furthermore, during times of market stress, as experienced following the 2008 financial crisis, certain bias in market-based inflation expectations may generate because of disproportionally distorted nominal yields (Łyziak and Paloviita, 2017). The inflation expectations of householders, based on national surveys, explain the absence of missing disinflation during the Great Recession and the presence of puzzling global inflation dynamics after the financial crisis (Coibion and Gorodnichenko, 2015; Friedrich, 2016). Considering that the actual inflation is available monthly, the high-frequency advantage of market-based inflation expectations is weakened. Therefore, we apply the survey-based inflation expectations in this paper. The Business and Consumer Surveys conducted by the European Commission asks respondents whether they expect prices in the next 12 months to rise faster (C_5), show a similar rise (C_4),

rise less fast (C_3), stay the same (C_2) or decline (C_1). Considering these qualitative answers, we adopt the 5-Category Probability Method proposed by Batchelor and Orr (1988) to measure quantitative inflation expectations of the following 12 months. This method has been commonly used in the previous literature, e.g., Döpke et al. (2008) and Łyziak (2013).

The 5-Category Probability Method (Batchelor and Orr, 1988) obtains quantitative estimates of inflation expectations using qualitative surveys. Assume that respondent i answers the qualitative survey question on inflation expectations based on their personal quantitative belief $\pi_{t,i}^e$ about the inflation over the next 12 months as follows:

$$\begin{cases} \pi_{t,i}^e < -\delta_t : C_1 \\ -\delta_t \le \pi_{t,i}^e < \delta_t : C_2 \\ \delta_t \le \pi_{t,i}^e < \pi_t^r - \eta_t : C_3 \\ \pi_t^r - \eta_t \le \pi_{t,i}^e < \pi_t^r + \eta_t : C_4 \\ \pi_t^r + \eta_t \le \pi_{t,i}^e : C_5 \end{cases} \quad (1)$$

where δ_t and η_t are threshold parameters that are assumed to be identical across respondents, and π_t^r refers to the reference inflation respondents have in mind when opting for category C_4 (show a similar rise). Through imposing a distribution on $\pi_{t,i}^e$, one can infer the mean quantitative inflation expectation π_t^e using the maximum likelihood methodology.

We use the standard assumption that the cross-sectional distribution of $\pi_{t,i}^e$ is normal, i.e., $\pi_{t,i}^e \sim N(\pi_t^e, (\sigma_t^e)^2)$. The solution of the mean inflation expectation for the following 12 months is given by:

$$\pi_t^e = \pi_t^r \left[\frac{G_t^2 + G_t^3}{G_t^2 + G_t^3 - G_t^4 - G_t^5}\right] \quad (2)$$

where $G_t^2 = \Phi^{-1}(1 - c_{5,t} - c_{4,t} - c_{3,t} - c_{2,t})$, $G_t^3 = \Phi^{-1}(1 - c_{5,t} - c_{4,t} - c_{3,t})$, $G_t^4 = \Phi^{-1}(1 - c_{5,t} - c_{4,t})$, $G_t^5 = \Phi^{-1}(1 - c_{5,t})$, c_k denotes the fraction of respondents choosing category C_k, and $k \in [1,2,3,4,5]$. $\Phi(\cdot)$ is the standard normal cumulative distribution function. The running mean of inflation from the beginning of the sample provides a useful proxy for π_t^r (Nielsen, 2003). Łyziak and Mackiewicz-Łyziak (2014) have argued that the running mean of inflation constitutes the best proxy for the reference inflation for most European countries including Hungary, Latvia, Lithuania, and Poland. Hence, we calculate inflation expectations based on the running mean of inflation[1].

[1] The monthly actual inflation rates are excessively fluctuating at the initial stage of the sample period for Czechia

The results regarding inflation expectations are usually presented by the scaled balance statistic, i.e., $c_5 + 0.5c_4 - 0.5c_2 - c_1$. The balance statistic provides qualitative information on the inflation trend in the following 12 months and is not influenced by the assumptions imposed in the quantification methods. Thus, following Łyziak (2013), we also use the balance statistic to measure inflation expectations as a robustness check.

3.2 Panel Granger non-Causality test

The Granger non-causality test is widely adopted in investigating the causal relationship between two variables. In contrast to cross-section and time series data, panel data may have a cross-sectional dependency. The cross-sectional dependence indicates that a shock affecting one country may also affect other countries. Two possible reasons contribute to the cross-section dependence in the relationship between actual and expected inflations. First, the presence of common factors behind global inflation, e.g., business cycles (Ciccarelli and Mojon, 2010). Second, the effect of the spillover of inflationary shocks across countries with close trade linkages. For instance, Germany is the largest trade partner of Czechia, Hungary, Poland, and Romania, and is the second and third largest partner of Lithuania and Latvia, respectively. Trade competition and substitution make them likely to affect each other. Thereby, standard ordinary least-squares are not appropriate for use in analyzing cross-related heterogeneous panel subjects. According to Pesaran (2006), ignoring the cross-section dependence will lead to substantial bias and size distortions. As emphasized by the literature, the linkage between actual and expected inflations is different in distinct countries. Therefore, assuming homogeneous parameters in a panel data setting may fail to capture the heterogeneity across CEE countries and thus lead to misleading results (Breitung, 2005).

The panel causality approach proposed by Emirmahmutoglu and Kose (2011) is based on the Fisher's (1932) Meta-analysis, which has been widely applied to non-stationary heterogeneous panels. The panel causality test with LA-VAR approach allows for non-stationary variables. To test Granger causality between inflation expectations in country i

and Poland. To weaken the effects of unusual values, we include the inflation rates covering the previous 12 months before the starting point of our sample period to calculate the running means of actual inflation for all target countries.

($\pi_{i,t}^{e}$) and corresponding actual inflation ($\pi_{i,t}$), we consider the following heterogeneous panel VAR(k_i) model with two variables $z_{i,t} = (\pi_{i,t}^{e}, \pi_{i,t})'$:

$$z_{i,t} = \mu_i + A_{i1} z_{i,t-1} + \cdots + A_{ik_i} z_{i,t-k_i} + u_{i,t},\ i = 1,2,\dots,N,\ t = 1,2,\dots,T \quad (3)$$

where t is the time period, and μ_i denotes a two dimensional vector of fixed effects. $A_{i1},\dots,A_{ik_i}$ are fixed (2×2) matrices of coefficients that can be different across countries, and $u_{i,t}$ is an error term vector. The lag order k_i is determined via Schwarz Information Criteria (SBC) or Akaike information criteria (AIC), which can differ across countries.

In respect of the Granger non-causality test, the null and alternative hypotheses to test q_i independent linear restrictions on cross-sectional country i are

$$H_0: R_i \alpha_i = 0,\ \forall i \in (1,2,\dots,N) \quad (4)$$

$$H_1: R_i \alpha_i \neq 0,\ i = 1,2,\dots,N_1;\ R_i \alpha_i = 0,\ i = N_1 + 1,\dots,N \quad (5)$$

where R_i is a $(q_i \times 4q_i)$ matrix and 0 denotes a zeros vector with proper dimensions. To test the coefficient restrictions on parameters with non-stationary variables, Emirmahmutoglu and Kose (2011) use the LA-VAR method following Toda and Yamamoto (1995). This method considers the following level VAR ($k_i + d\max_i$) in heterogeneous mixed panels:

$$z_{i,t} = \mu_i + \sum_{\iota=1}^{k_i} A_{i\iota} z_{i,t-\iota} + \sum_{j=k_i+1}^{k_i+d\max_i} A_{ij} z_{i,t-j} + u_{i,t},\ i = 1,2,\dots,N,\ t = 1,2,\dots,T \quad (6)$$

where $d\max_i$ is the maximal order of integration for country i. The hypothesis (5) can be tested using a standard Wald statistic based on equation (7) if variables are integrated at an order not greater than $d\max_i$.

The Fisher statistic (Fisher, 1932) can test the Granger non-causality hypothesis in heterogeneous panels via combining independent tests:

$$\lambda = -2 \sum_{i=1}^{N} \ln(p_i),\ i = 1,2,\dots,N \quad (7)$$

where p_i is the *p*-value of the Wald statistic for country i. The bootstrap approach deals with the cross-correlations among countries and generates empirical distributions of the test statistic λ.

4. Data

In this paper, we adopt the monthly data covering the period of May 2001 to May 2019 during

which both actual and expected inflations are available in Czechia, Hungary, Latvia, Lithuania, Poland and Romania. Identifying the causal relationships between actual and expected inflations is difficult because the measures of the reference inflation can impose certain correlations between current inflation and corresponding expectations. Therefore, apart from using the balance statistic as a robustness check, we make use of the Business and Consumer Surveys to assist in identifying causalities between actual and expected inflations. This survey reports 12-month-ahead expectations which are conducted monthly. Using May 2020 as an example, the survey questionnaires were distributed each month after the release of the Harmonized Indices of Consumer prices (HICP) of the previous month. Then, the questionnaires were returned by May 20th, before the release of the inflation of the current month (May 29th, 2020 for the EU and two weeks later for the other countries). A respondent who is asked about their personal expectations of price changes for the next 12 months does not know the realized inflation for that current month. Thereby, following Leduc (2007), we use the annualized monthly log differences of HICP between June 2020 and May 2020 to measure the actual inflation in May 2020. The data of HICP are available from the European Central Bank (ECB).

In the late 1990s, after severe transitions from centrally planned economies to market economies, target CEE countries emerged into two groups with radically contrasting monetary regimes. The first group includes countries adopting the Currency Board (Estonia, Lithuania, Bulgaria and partly Latvia) and the second one uses the Inflation Targeting (Czechia, Poland, Hungary and later Romania). One of leading arguments for selecting different regimes attributes to the belief about the ability to provide low inflation and to anchor inflation expectations. The Currency Board fixes exchange rates to the leading foreign currency cover full monetary base with liquid foreign reserves. Consequently, the monetary policy cannot be used because the balance sheet of central bank contains no domestic assets, and no open market operation is available. Through maintaining fiscal surpluses and low public debts, the Currency Board believes that it produces high levels of discipline and credibility. Likewise, the Inflation Targeting pursues high credibility and discipline as well as transparency by being active in monetary policy. Focusing on our sample countries, we can say that the Currency Board is generally used in comparatively small and highly open peripherals economies pursuing quick

integration into the monetary system of developed European countries (Khan et al., 2013). For example, the Currency Board was introduced in Lithuania in 1994, attempting to break the influence of Russia and the Russian economy. Countries with Inflation Targeting (Czechia, Poland, Hungary and Romania) have characteristics of Central European countries, sharing certain traditions in economic and monetary policy prior to the period of communism. Czechia, Poland and Hungary began the transition with a fixed inflation rate (to varying degrees) and put much effort into building macroeconomic models and gaining experience for the later implementation of Inflation Targeting. The case of Romania is moderately peculiar with a number of characteristics resembling both Central European countries and Bulgaria that explain oscillations and late implementation of Inflation Targeting. However, with the progress of time and the accession process of EU membership, differences between countries induced by these two monetary policies appear to be undermined.

<Insert Table 1 about here>

Table 1 reports summary statistics of actual and expected inflations for the next 12 months in six CEE countries. We find that Romania has the highest mean and maximum actual and expected inflations, consistent with its complex characteristics in a manner resembling the Central European countries and economies with the Currency Board regime. The means of the actual and expected inflations in Czechia are comparatively smaller than Latvia and Lithuania, both adopting the Currency Board regime. While actual and expected inflations have remained within a close rate of 2% in Lithuania, they are much higher and more volatile in another country belonging to the EA, i.e., Latvia. The actual inflation in Czechia fluctuates the least according to the standard variation, followed by Poland, Hungary, Lithuania, Latvia, and Romania. Similarly, inflation expectations in Poland and Czechia fluctuate less than Hungary, Lithuania and Latvia, and Romania has the most volatile inflation expectations.

<Insert Figure 1 about here>

Figure 1 presents the actual and expected inflations for the next 12 months. Overall, the

movements of quantified inflation expectations are similar to the balance statistics and the actual inflation. For example, both the quantified inflation expectation and the balance statistic exhibit regional peaks in 2007 and 2011 in Czechia, corresponding to the changes in the actual inflation. Nevertheless, we can also observe certain departures of expected inflation from the actual inflation. Specifically, respondents tend to over expect the inflation rates, which has been reported by previous studies (Coibion et al., 2020). For instance, at the initial part of the sample period, the inflation expectations before the year of 2003 are moderately larger than the actual inflation rates in Czechia, Hungary, Lithuania, Poland and Romania. Even so, this observation shows no contradiction to the balance statistic. Thereby, the results based on the probability method generally captures respondents' inflation expectations.

According to Figure 1, actual and expected inflations for the next 12 months across CEE countries show distinct fluctuating characteristics. For example, both actual and expected inflations in Czechia, Latvia and Lithuania fluctuated severely during 2007-2009, when the financial crisis broke out. However, in Hungary and Poland, there is another significant fluctuation during 2003-2006, when the two countries joined the EU. Czechia changed its Czech Koruna to the Euro between November 2013 to March 2017, during which the inflation expectations remained relatively stable and the actual inflation increased significantly. After Lithuania joined the EU in 2014, the actual inflation increased from -1.375% (January 2014) to 4.517% (June 2016), whereas the inflation expectation during the same period decreased from 3.248% to 1.641%. Latvia also adopted the Currency Board after joining the EU in 2014. Contrary to the Lithuanian experience, the increase in actual inflation in Latvia in the following two years was accompanied by relatively stable changes in inflation expectations. Thus, different monetary policies are not sufficient to explain significant differences across these six CEE countries. Table 1 and Figure 1 show observable heterogeneities across countries. Meanwhile, there is a certain homogeneity in economies sharing similar regimes, e.g., increases in actual inflation shortly after joining the EU.

5. Empirical Results

Table 2 displays the empirical results of cross-sectional dependency across six CEE

countries in the last three rows. As indicated in Table 2, for quantified inflation expectations, the values of three different test statistics (CD_{BP}, CD_{LM} and CD) are 255.768, 43.958 and 14.423, respectively. The results provide strong evidence rejecting the null hypothesis of no cross-sectional dependence between actual and expected inflations across countries at the 1% significance level. Similarly, results based on the balance statistic suggest significant cross-sectional dependences. With the negotiation process, legal and normative convergence with the EU that occurred after 2000, the dynamics in expectations of economic agents were affected by the membership itself, thus numbing the differences among countries in terms of inflation (Khan et al., 2013). The CEE has been hit hardest by the financial crisis which occurred around 2008, and the microfinance sectors in different countries show similarities in tackling the associated economic downturn. Also, the higher global inflation is positively correlated with inflation targets, thus making the setting of the inflation target exert an important international dimension (Horváth and Matějů, 2011). Consequently, it is not surprising that these six CEE countries affect each other, thus implying that the panel method is more appropriate than the country-by-country pooled OLS method in measuring the causal relationship between actual and expected inflations across target CEE countries.

<Insert Table 2 about here>

Table 2 also summarizes the Augmented Dickey Fuller (ADF) tests and the integrated properties of actual and expected inflations in all countries. In the empirical estimation, we permit diverse maximum lag lengths for different economies and consent them to diverge through countries in one panel. In harmony with previous literature (Pradhan et al., 2014), this study selects the mixture of lags which minimizes the standard SBC. In this section, we test the full-sample Granger causality for six CEE countries using quantified inflation expectations and the balance statistic. Knowing that the policy shocks from the EU had strong spillover effects on countries outside the EU (Potjagailo, 2017), we also consider actual and expected inflations in Germany[2], which is the main trade/financial partner of all six CEE countries.

[2] The estimation of the panel Granger causalities did include Germany. Since this paper focuses on the

<Insert Table 3 about here>

Table 3 reports the results for the Granger causality tests using full-sample data. Given that lag orders for each country can be different, we calculate the sum of coefficients of independent variables to analyze the relationships between actual and expected inflations. According to the empirical results of the full-sample panel causality tests, the hypothesis that actual inflation does not Granger-cause inflation expectation is rejected for the six CEE countries when using the quantified inflation expectations. Meanwhile, the coefficients of inflation expectations are positive for all target CEE countries, meaning that higher past inflation increases agents' inflation expectations. In other words, the actual inflation is likely to cause changes in inflation expectations among the tested CEE countries. These findings are consistent with previous empirical studies. For instance, overall inflation expectations in the EU are predominantly based on current and past inflations (European Commission, 2014), and agents' expectations react strongly to information about recent inflation (Binder and Rodrigue, 2018). Nonetheless, the results are inconsistent with the wide belief about the ability of two regimes in anchoring inflation expectations. A number of prior studies have supported the anchoring of inflation expectations of target countries. If inflation expectations are well-anchored in inflation targeting countries then economic agents might strongly consider the inflation target when forming their expectations. Consequently, causalities running from actual to expected inflations should not exist. Baxa et al. (2015) noted that inflation expectations in Czechia, Hungary and Poland, where inflation targeting is adopted, are at least partially anchored from 1999-2010. Nevertheless, our panel granger causality tests suggest that short-run inflation expectations are sensitive to the actual inflation, thus indicating that short-term inflation expectations are not well anchored for these three countries adopting the Inflation Targeting.

Positive coefficients align with the findings in Baxa (2015) and Nedeljković et al. (2017),

relationship between actual and expected inflations in the CEE countries, the results for Germany are not reported here but are available upon request.

within which the relationships between actual and expected inflations are positive for Czechia, Hungary and Poland. This finding shows a moderately similar picture to studies for developed countries which imply a causality running from actual to expected inflations. For instance, using the survey data of the U.S., Branch (2004) finds that approximately 44% of agents adopt the adaptive model and 7% use the naive predictor in forming inflation expectations, which argues that agents expect the realization of inflation to occur again. Similar results are achieved using Swedish and Chinese surveys (Maag, 2010; Xu et al., 2017a).

Significant negative causalities running from quantified inflation expectations to the actual inflation are demonstrated in Czechia, Poland and Romania during the full-sample period. Therefore, this suggests that expectations are not self-fulfilling in these three countries because the coefficients of the expected inflations are negative. For the remaining countries, the causality running from expected to actual inflations is not significant. However, the coefficients are negative, except for the case of Lithuania. Theoretically, inflation expectations affect the actual inflation through three channels: the substitution effect, the income effect and the wealth effect (Wickens, 2008), which affect consumptions in different directions. Thereby, the final effect of inflation expectations on the actual inflation is an empirical problem (Ichiue and Nishiguchi, 2015). Two possible reasons can explain the negative or insignificant effects of inflation expectations on the actual inflation. First, consumers may ignore the information on real interest rates because of the bounded rationality (Maćkowiak and Wiederholt, 2015) or may be unable to distinguish between real and nominal interest rates, i.e., the real interest rate illusion (Bachmann et al., 2015). Second, high inflation expectations are expected to lower future real income due to wage rigidities, thus reducing consumers' spending desires and the actual inflation (Burke and Ozdagli, 2013; Bachmann et al., 2015).

For the cross-section dependency in mixed panels, the Fisher test statistics are statistically significant, indicating that the causal link between actual and expected inflations is bidirectional for the six CEE countries. Specifically, positive causalities running from actual to expected inflations are strongly supported. However, possible causalities running from expected to actual inflations are negative for Czechia, Poland and Romania; but are not significant for the other three nations.

6. Robustness Tests

6.1 Results using the balance statistic

The balance statistic is another appropriate measure of the quantitative inflation expectation and is widely used in previous studies, e.g., Łyziak (2013) and Arioli et al. (2017). Maag (2010) suggests that the correlation between balance statistics and quantitative answers to expected inflation exceeds 0.9 for the Swedish survey.

<Insert Table 4 about here>

For the full-sample data that relates to the causality running from actual to expected inflations, the results using the balance statistic are similar to those of quantified inflation expectations with one exception. This exception is Poland, where the causality is not significant, but does have a positive coefficient. Concerning the causality running from expected to actual inflations, the results based on quantified inflation expectations and the balance statistic are moderately different. Negative causalities running from the balance statistic to actual inflation are found in Hungary, Latvia and Poland. The highly significant negative effect of the balance statistic on the actual inflation is consistent with Premik and Stanisławska (2017), in which the buying attitude of Polish consumers are negatively related with inflation expectations. In addition, the signs for coefficients of the six CEE countries based on quantified inflation expectations are generally consistent with results using the balance statistic.

Combining the results of quantified inflation expectations and the balance statistic, the conclusion that inflation expectations are not self-fulfilling in the target CEE countries remains unchanged. Similarly, the Fisher test statistics are statistically significant when using the balance statistic to measure inflation expectations.

6.2 Results pre and post the financial crisis

Apart from using two proxies to measure inflation expectations (balance statistics and quantified inflation expectations), we test the causality between actual and expected inflations in different periods for robustness. The 2008 financial crisis and subsequent sovereign debt

crisis caused enormous influences on the European countries, particularly on CEE countries. Therefore, we test causalities between actual and expected inflations before and after the financial crisis. We choose a breakpoint of October 2009 when the sovereign debt crisis started. The results are summarized in Table 5.

<Insert Table 5 about here>

Before October 2009, the causality running from actual to expected inflations remains significant for all six CEE countries using the quantified inflation expectations. Meanwhile, the coefficients are positive, in line with the full-sample period findings. However, the results for the post-crisis period show significant causalities running from actual to expected inflations only in Hungary and Romania. The financial crisis appears to exert certain effects on the anchoring of inflation expectations, which indicates the possibility that short-term inflation expectations in Czechia, Latvia, Lithuania, and Poland are partially re-anchored after the 2008 financial crisis. This finding is also consistent with the significant forward-looking component in the formation of inflation expectations for the overall EU (European Commission, 2014). The second possible explanation for the insignificant causality running from actual to expected inflations is the comparatively stable state of inflation in the post-crisis period. Dräger (2015) notes that inflation expectations in the stable inflation stage depend on perceived, rather than actual, inflation. As shown in Figure 1, the actual inflation in Czechia, Latvia, Lithuania, and Poland were relatively stable after the financial crisis, whereas inflations in Hungary and Romania were fluctuating dramatically. Thus, insignificant effects of actual inflation on inflation expectations can be explained. Meanwhile, shifts in foreign exchange policies may be another reason for the changes in the causality running from actual to expected inflations. The Czech Koruna was pegged to the Euro from 2013 to 2017, while Latvia and Lithuania adopted the Euro in 2014 and 2015, respectively. Czechia, Latvia, and Lithuania adopted different disinflation strategies, but changes in the effect of actual inflation on inflation expectations are similar for them all, particularly after the financial crisis. This finding aligns with the argument of Baxa et al. (2015) that country-specific modifications impact on the effectiveness of disinflation strategies.

For the causality running from expected to actual inflations, the results for Czechia, Hungary, and Lithuania remain insignificant before and after the financial crisis. For Latvia and Poland, the negative causalities running from expected to actual inflations are no longer significant in the post crisis period. However, a negative causality running from expected to actual inflations appears in Romania after the financial crisis. Apart from possible effects of the real interest rate illusion and wage rigidities, another reason for the negative causality is uncertainty. According to the IQV index (please refer to the Appendix) which quantifies inflation expectation disagreements (Acedański and Włodarczyk, 2016; Xu et al., 2016a), expectations' heterogeneity increased significantly after the financial crisis in Romania. In the post-1990s, before 2005, Romania had no official commitment to a monetary policy strategy (Frömmel et al., 2011). To achieve its primary objective of price stability, the National Bank of Romania improved the discretionary monetary policy and announced the transition to the Inflation Targeting in 2005. However, many deviations from the inflation-targeting in principles were noted (Nenovsky and Villieu, 2011). The negative causality running from expected to actual inflations in the post-crisis period matches the increase in inflation expectations' diversities. Different opinions regarding future inflation can invite agents to speculate, which in turn may delay or distort central banks' actions (Acedański and Włodarczyk, 2016).

The Inflation Targeting appears to be effective in stabilizing inflation expectations' diversity and thus managing inflation through expectations (Capistrán and Ramos-Francia, 2010). Similar to the full-sample results, the self-fulfillment of inflation expectations does not exist before nor after the financial crisis. By contrast, the convergence towards the EU integration is supposed to induce similar economic characteristics among CEE countries, thus weakening the heterogeneity and idiosyncrasy of each economy. Nevertheless, the results imply that the heterogeneity among six CEE countries increased after the financial crisis; but was not large within the group that used the same disinflation strategy as compared with a broader sample of countries (Chang et al., 2014).

In line with the full-sample results, we find significant cross-sectional dependences to be present across six CEE countries, and we find heterogeneous causalities between actual and expected inflations in different economies. Generally, for Currency Board and Inflation

Targeting, short-term inflation expectations appear to be not well-anchored with significant causalities running from actual to expected inflations. The post-crisis results reveal that differences in the performance of both groups in anchoring inflation expectations are increasingly subtle and unsystematic. Inflation expectations in Czechia, Latvia, Lithuania and Poland are better anchored in the post-crisis period. The result contradicts the findings of Nedeljković et al. (2017), who find that the inflation expectation maintains anchored before and after the financial crisis in Czechia, Hungary and Poland. Meanwhile, the financial crisis and sovereign debt crisis appear to undermine the homogeneity of six CEE countries because of the divergence in causalities between actual and expected inflations. The causality running from expected to actual inflations is insignificant for Czechia, Hungary, Lithuania, and Romania, whereas it becomes negatively significant for Romania following the financial crisis. We therefore suggest that the self-fulfillment of inflation expectations is not a threat for CEE countries to manage their inflation expectations.

Our empirical findings have noteworthy policy implications for central banks of (emerging) countries that commit themselves to the management of actual and expected inflations. The empirical sample covers economies adopting both Currency Board and Inflation Targeting, thus considering the heterogeneity and homogeneity of two regimes in testing casualties between actual and expected inflations. The anchoring of inflation expectations is one of the most important benefits of Inflation Targeting and Currency Board as suggested by the theoretical and empirical literature (Blinder et al., 2008). The results in this paper suggest that both regimes have achieved a certain level of success in anchoring short-term inflation expectations after the financial crisis. However, two out of four countries adopting Inflation Targeting, i.e., Hungary and Romania, maintained positive causalities running from actual to expected inflations, showing that the Inflation Targeting does not itself automatically trigger changes in the inflation process (Baxa et al., 2015). Cross-country differences suggest that central bank actions can have additional impacts on the management of inflation expectations. Specifically, the management from other aspects such as central bank communications will benefit the stability of inflation expectations, thus stabilizing the level and volatility of actual inflation (Eusepi and Preston, 2010). Improvements in central banks' transparency and certainty of decisions also help to enhance the anchoring of inflation expectations (Nedeljković

et al., 2017).

One criticism suggests that inflation expectations are no longer essential for the ongoing economy due to a lack of evidence regarding a link between agents' ex-post forecast accuracy and their ex-ante inflation expectations (Clements, 2014). Nevertheless, our empirical results provide robust evidence supporting a close relationship between actual and expected inflations. It remains a question whether the current inflation rate dominates inflation expectations in measuring the real interest rate.

7. Conclusions

There is supportive and contradictory evidence in the literature regarding the self-fulfillment of inflation expectations and the spiral of "inflation-expectation" (Leduc et al., 2007; Xu et al., 2016b). However, the homogeneity between countries has been ignored, which may lead to bias and inconsistency in empirical results. Eastern European New Member Countries of the EU, such as Czechia, Hungary, Latvia, and Poland, are attempting to converge to the average of the European Monetary Union inflation rates to fulfill the Maastricht convergence criterion of 1.5% around. However, they adopt different disinflation strategies. Hence, CEE countries share significant heterogeneities and homogeneities and provide an interesting and important sample to investigate relationships between actual and expected inflations. This article reports on a study that tested the causality between actual and expected inflations in six CEE countries through a panel Granger non-causality test, which is effective in capturing both homogeneity and heterogeneity in different countries. The empirical results indicate robust causalities running from actual to expected inflations in Hungary and Romania before and after the financial crisis, thus confirming the de-anchoring and backward-looking of inflation expectations. Such causality disappears in Czechia, Latvia, Lithuania, and Poland following the financial crisis. Clearly, the anchoring of inflation expectations in these countries is affected by the financial crisis. Possible reasons for such changes include the real interest illusion, wage rigidities and increases in inflation expectation diversities after the financial crisis. By contrast, negative causalities running from expected to actual inflations exist in Czechia, Poland and Romania during 2001 and 2019. Thus, the self-fulfillment of inflation expectations is not a

threat to the management of inflation.

If the causality between actual and expected inflations is homogeneous across countries, the role of domestic policy would be of minor importance. In contrast, if significant differences exist despite a common monetary policy regime, this would be indirect proof that domestic policy and specific issues related to the regime matter for the management of actual and expected inflations. Our empirical results suggest that any difference between the practices of Currency Board and Inflation Targeting was weak for the self-fulfillment of inflation expectations, but comparatively significant in anchoring inflation expectations. For the two countries adopting Currency Board, Latvia and Lithuania, the positive causalities running from actual to expected inflations were insignificant after the financial crisis. However, two out of four countries that adopted the Inflation Targeting maintained significantly positive causalities running from actual to expected inflations. Therefore, it appears that the adoption of Inflation Targeting and Currency Board does not automatically produce stable inflation expectations. It is the way in which these frameworks are implemented that might differ. Policy makers should take necessary heterogeneous actions for harmonization in the EU because of the heterogeneity in monetary policy applications. The credibility of central banks can be improved through untraditional policies such as communications to enhance a manageable inflation expectation.

Certain caveats need to be considered in drawing conclusions from our paper. First, this analysis does not attempt to conclude whether the Inflation Targeting and Currency Board is good or bad since it does not include all economies adopting both regimes. Second, while analyzing the causality between actual and expected inflations, we did our best to investigate available candidates in CEE countries. Our ability to do so was limited by the data at our disposal. The availability of inflation expectations is quite limited for other CEE countries that have not been studied in this paper. Third, we assumed a constant causality in the sample period. However, the anchoring and self-fulfillment of inflation expectations can be time-varying.

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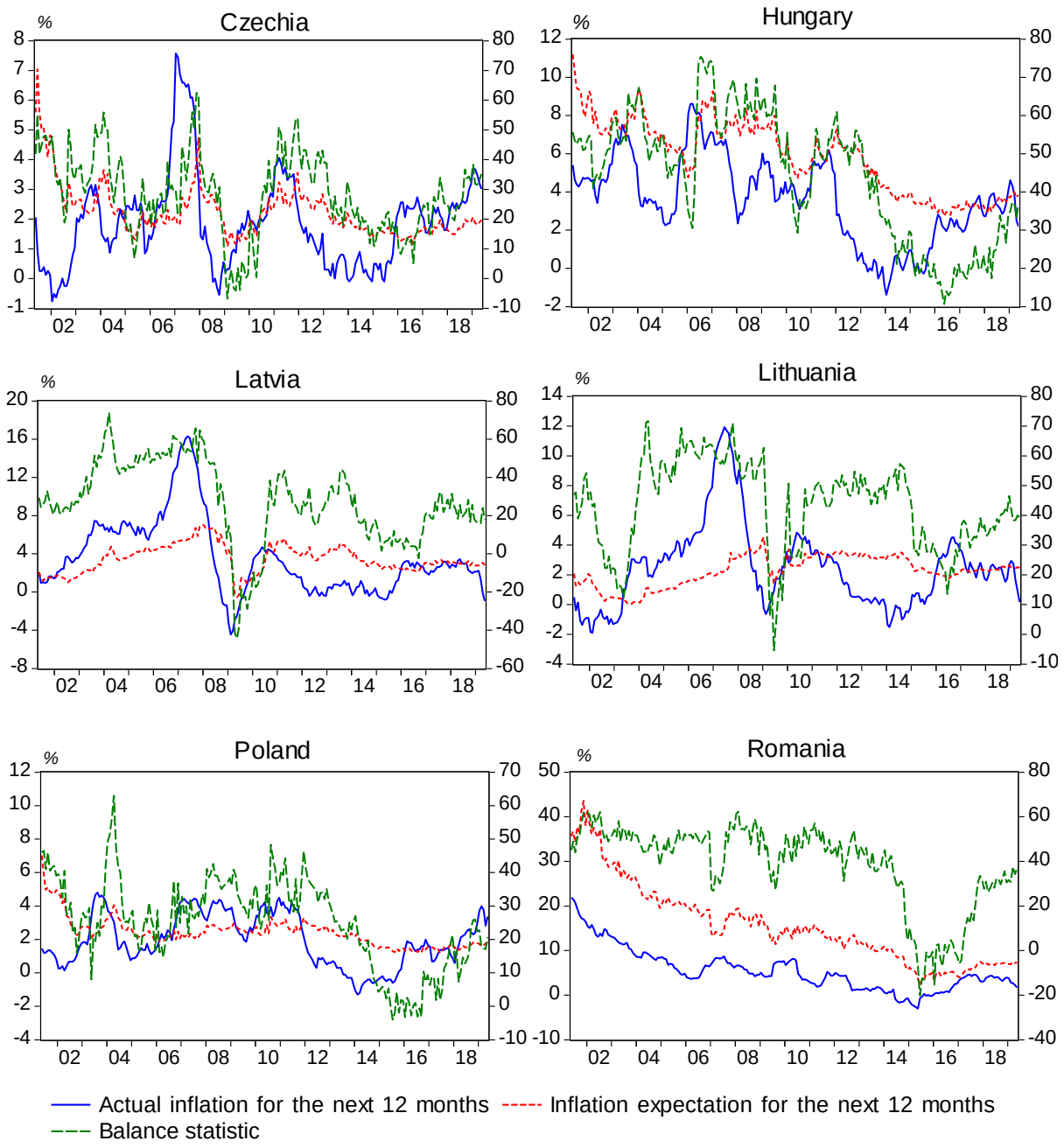

Figure 1 Actual and expected inflation rates for the next 12 months in six CEE countries. Note: Inflation expectations are based on the quantitative method using running means of actual inflation. The left axis denotes the actual and expected inflations in percentage and the right axis represents the balance statistic.

Table 1. Summary statistics of actual and expected inflations for the next 12 months

Countries	Mean	Max	Min	Std. Dev.	Skew.	Kurt.
Actual Inflation						
Czechia	2.029	46.902	-8.861	5.734	2.916	20.463
Hungary	3.861	31.830	-8.774	6.272	1.129	5.835
Latvia	3.960	38.923	-12.213	7.656	0.752	4.832
Lithuania	2.717	35.782	-14.273	6.497	0.919	5.626
Poland	1.995	13.510	-6.314	3.958	0.300	2.922
Romania	6.465	37.654	-26.722	8.392	1.014	5.972
Inflation Expectation						
Czechia	2.248	7.045	1.098	0.878	2.026	8.826
Hungary	5.864	11.193	2.733	1.938	0.039	1.995
Latvia	3.483	7.030	-0.531	1.454	0.142	2.866
Lithuania	2.254	4.533	0.005	1.013	-0.422	2.364
Poland	2.409	7.022	1.172	0.871	1.729	8.043
Romania	15.584	43.610	2.222	9.090	0.940	3.443

Table 2. ADF tests for actual and expected inflations and cross-sectional dependence tests

Country	Inflation		Inflation Expectation			Balance Statistic		
	level	First difference	level	First difference	$d\max_i$	level	First difference	$d\max_i$
Czechia	0.116	0.000	0.001	—	2	0.004	—	2
Hungary	0.000	—	0.076	—	1	0.295	0.000	1
Latvia	0.294	0.000	0.207	0.000	2	0.065	—	2
Lithuania	0.077	—	0.411	0.000	2	0.220	0.000	2
Poland	0.000	—	0.000	—	2	0.132	0.000	2
Romania	0.000	—	0.192	0.000	2	0.340	0.000	2
CD_{BP}				255.768***			278.102***	
CD_{LM}				43.958***			48.036***	
CD				14.423***			15.026***	

Notes: The first six rows in this table report the *p*-values of ADF tests for actual and expected inflations in levels and first differences. $d\max_i$ denotes the maximal order of integration suspected to occur between actual and expected inflations. CD_{BP}, CD_{LM}, and CD are the cross-sectional dependence tests of Breusch and Pagan (1980) and Pesaran (2004, 2006), respectively. *** indicates significance at the 1% level.

Table 3. Panel Granger non-causality test results of CEE countries (quantified inflation expectations)

Wald statistics	H_0: π_{it}^e does not Granger cause π_{it}		H_0: π_{it} does not Granger cause π_{it}^e	
	Coef.	Wald	Coef.	Wald
Czechia	-1.607	3.665**	0.225	6.006**
Hungary	-0.790	1.236	0.139	31.269***
Latvia	-2.533	2.075	0.194	8.025***
Lithuania	0.008	0.511	0.057	13.094***
Poland	-2.019	5.703*	0.145	12.049***
Romania	-2.332	5.672*	0.367	49.551***
Fisher Statistic		25.228**		132.263***

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. This table reports the Wald statistics and significance of the null hypothesis (H_0) using quantified inflation expectations for the full-sample period of May 2001 to May 2019. The critical values of Wald statistics are estimated based on 10,000 bootstraps. Coef. is the sum of coefficients of the independent variable with various lag orders selected by minimizing the SBC.

Table 4. Panel Granger non-causality test results of CEE countries (the balance statistic)

Wald statistics	H_0: π_{it}^e does not Granger cause π_{it}		H_0: π_{it} does not Granger cause π_{it}^e	
	Coef.	Wald	Coef.	Wald
Czechia	-0.637	2.429	2.795	4.565**
Hungary	-0.963	2.898*	1.258	5.926**
Latvia	-0.531	3.897**	1.087	3.958**
Lithuania	-2.087	1.359	3.286	9.626***
Poland	-0.151	11.516***	1.862	3.620
Romania	0.123	1.384	1.389	39.99***
Fisher Statistic	33.346***		82.141***	

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. This table reports the Wald statistics and significance of the null hypothesis (H_0) using the balance statistic to measure inflation expectations for the full-sample period of May 2001 to May 2019. The critical values of Wald statistics are estimated based on 10,000 bootstraps. Coef. is the sum of coefficients of the independent variable with various lag orders selected by minimizing the SBC.

Table 5. Panel Granger non-causality test results of CEE countries (pre and post the financial crisis)

Wald statistics	H_0: π_{it}^e does not Granger cause π_{it}				H_0: π_{it} does not Granger cause π_{it}^e			
	pre-crisis period		post-crisis period		pre-crisis period		post-crisis period	
	Coef.	Wald	Coef.	Wald	Coef.	Wald	Coef.	Wald
Czechia	-1.959	2.147	-1.708	1.212	0.265	5.088**	0.112	1.645
Hungary	1.222	0.127	-2.044	1.618	1.222	7.098***	0.093	14.958***
Latvia	-3.982	4.040**	0.820	0.051	0.149	4.619**	0.287	1.087
Lithuania	-3.507	2.394	3.535	1.835	0.036	8.769***	0.085	0.836
Poland	-1.438	3.234*	-1.595	0.691	0.206	9.809***	0.071	1.279
Romania	-3.905	1.058	-2.257	5.892**	1.329	36.300***	0.171	22.647***
Fisher Statistic	25.063**		21.824*		96.705***		60.596***	

Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. This table reports the Wald statistics and significance of the null hypothesis (H_0) using quantified inflation expectations for subsamples. The pre-crisis period covers May 2001 to October 2009, and the post-crisis period ranges from November 2009 to May 2019. The critical values of Wald statistics are estimated based on 10,000 bootstraps. Coef. is the sum of coefficients of the independent variable with various lag orders selected by minimizing the SBC.

APPENDIX

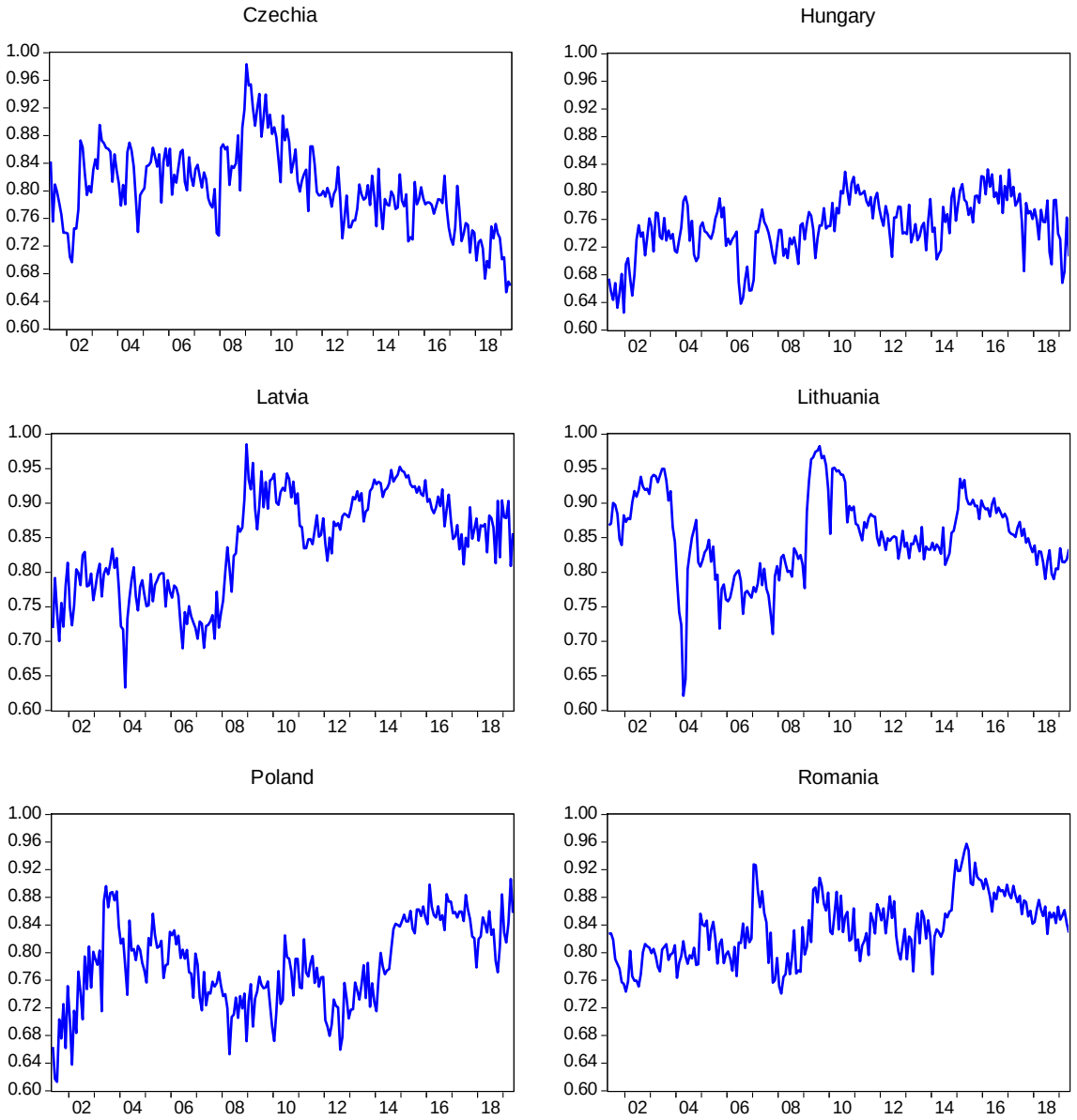

Figure A. IQVs in CEE countries. Note: The IQV quantifies the inflation expectation disagreement of respondents. IQV $= \frac{5}{4}\left(1 - \sum_{i=1}^{5} {c_i}^2\right)$, where c_i is the fraction of answers in category i.