What Financial Markets in the CEE Region Tell Us about Inflation Expectations

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Abstract

Inflation expectations have become a significant concern for monetary policy settings in the CEE region due to the sharp rise in inflation. The absence of market-based inflation expectations complicates the assessment of anchoring inflation expectations in the economy, especially during periods of extreme shock. The experience of the EM space with more developed financial markets allows for the estimation of unobserved long-term inflation expectations in the CEE region replicating market-based expectations. A panel regression model was used to estimate long-term marked-based inflation expectations in Czechia, Poland, and Hungary. The results show that market-based inflation expectations in the CEE region have significantly lower volatility compared to survey-based expectations, which are often used as proxy variables by central banks for monetary policy decision-making. The results are indicating that survey-based inflation expectations cannot be used as a proxy for long-term inflation expectations due to significantly different developments and characteristics that could lead to erroneous monetary policy decisions.[2]

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CEE region, inflation expectations, panel regression	*https://doi.org/10.54694/stat.2025.17*	*E31, D84, C33*

INTRODUCTION

A reliable and accurate estimate of inflation expectations is a key issue for any central bank given the impact of inflation expectations on inflation and economic activity. Moreover, inflation expectations can serve as an indicator of the horizon at which the central bank's target is expected to be reached. Thus, overall, they are an important indicator for the decision-making of the central bank itself (Grothe and Meyler, 2015) and often enter the macroeconomic models of monetary policymakers. The estimation and measurement of inflation expectations is thus a key issue in the concept of inflation targeting.

There are two main ways of measuring inflation expectations: (1) survey-based expectations and (2) market-based expectations. Survey-based expectations are often based on questionnaire surveys of households, firms or professional forecasters. As an example, we can refer to the ECB survey

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of professional forecaster (ECB, 2024). Market-based expectations, on the other hand, are based on market data from which market inflation expectations can be effectively extracted. Two types of financial market tools are commonly used for this purpose, inflation-linked interest rate swaps (IRS) that measure expectations directly, and the difference between nominal and inflation-linked government bond yields. The use of inflation-linked bonds to gauge inflation expectations has a history dating back to the 1980s, with the UK being a pioneer by issuing index-linked gilts (Liu et al., 2015). The US introduced Treasury Inflation-Protected Securities (TIPS) in 1997, which have since become a key instrument for observing market-based inflation expectations. Inflation swaps, another important tool, are more recent but have grown in prominence, offering a more direct measure of inflation expectations by allowing market participants to trade inflation risk.

This study focuses on market-based measures of inflation expectations in Central and Eastern European (CEE) countries with their own currency and semi-developed financial markets, i.e. Czechia, Poland and Hungary. All these countries have in common having own currency and monetary policy, an active local currency government bond market and, on the other hand, the absence of tradable financial instruments from which inflation expectations can be derived. Given that inflation within emerging economies such as the CEE countries is relatively high and volatile, it is particularly difficult to distinguish between nominal and real variables over time. Moreover, it is the absence of market instruments that createscompounds this problem. In the absence of such instruments, surveys with a typically one-year horizon are often used as a proxy variable for long-term inflation expectations by central banks and market participants. However, in the caseexample of developed countries (DM) where both instruments are available, different behaviour can be observed, implying (Gerlach et al., 2011; Henry et al., 2023) that surveys are not a suitable proxy for inflation expectations, which are of key importance for monetary policy decisions.

Thus, the aim of this paper is to estimate market-based inflation expectations in the CEE countries in the absence of financial instruments that reflect these expectations, to identify the factors that affect these expectations and to compare with survey-based inflation expectations. In a first stage, the model will be estimated on emerging economies (EM) where financial instruments reflecting these expectations are available, such as interest rate swaps or government bonds linked to CPI developments with sufficient liquidity. The model should identify global and local factors influencing the evolution of these instruments in financial markets and then transfer these relationships to CEE countries using panel regression. This work should result in a more accurate measurement of inflation expectations and their retrospective assessment and comparison with available survey-based measures of expectations in the context of monetary policy.

The first chapter shows the state of research in this area where the emphasis is on advanced economies with more developed financial markets, while emerging markets are as yet under-covered in this sense. In general, there is no consensus on the best way to measure inflation expectations, and typically comparing market-based and survey-based expectations has different results. However, it is clear from the evidence in the literature that it is a good idea to look at both options or to combine them. The available literature points to technical or liquidity problems with inflation expectations, which complicates the situation for central banks as the main users within the inflation targeting concept. The second section discusses the challenges of inflation expectations and shows not only the difference between DM and EM space but also within EM, where we can find a difference in the development of financial markets and the availability of survey-based inflation expectations. Nevertheless, this provides an opportunity to take the experience from one side of EM and apply it to less developed countries or countries with less developed financial markets. In the third section, we then estimate a panel regression model explaining market-based inflation expectations using data from South Africa, Brazil, Mexico and Chile. We then apply the estimated model to data from the CEE region, i.e., Czechia, Poland, and Hungary, which have sufficient data but lack market-based inflation expectations in financial markets.

1 RELATED LITERATURE

Previous work has focused mainly on the measurement of inflation expectations themselves and the anchoring of inflation expectations. Comparisons are often made between countries with different monetary policies and regimes (Castelnuovo, 2003; Demertzis 2010).

A significant part of the literature is devoted to comparing and contrasting market-based and survey-based measures of inflation expectations. Gerlach et al. (2011) point out that both survey-based and market-based measures of expectations have advantages and disadvantages. Surveys for long-term inflation expectations typically cover a long-time horizon and are often compiled at a three- or six-month frequency, which complicates their usefulness. Market-based expectations are usually available on an intraday basis, based on trading on financial markets. In addition, market-based expectations reflect the current position of the financial market and market participants, whereas in a questionnaire survey, the participant has no financial incentive to provide credible answers. Of course, both methods have their technical problems. Survey-based measures of expectations are sensitive to the number of respondents. Market-based measures of expectations depend on market liquidity, which can be low precisely in stressed situations when accurate measurement of inflation expectations is crucial.

Mandel and Vejmelek (2025) examines the inflation expectations of financial analysts and corporate managers in the Czech Republic from 1999 to 2024. The authors find that the formation of expectations differs between the two groups: corporate managers rely more on adaptive reasoning, while financial analysts pay closer attention to the Czech National Bank's (CNB) one-year inflation forecasts. Neither group fully meets the criteria for rational expectations, and their yearly inflation expectations contain systematic errors. The findings suggest that inflation expectations are shaped differently by financial analysts and corporate managers, with neither group fully adhering to rational expectations.

Diercks et al. (2023) examine the forecasting performance of inflation swaps and survey-based expectations over a one-year horizon. The study finds that inflation swaps, using US data as an example, provide a better inflation forecast in most cases. It also shows that earlier studies (Ang et al., 2006; Bacchetta et al., 2009) showed the poor performance of inflation swaps as forecasts have been distorted by liquidity problems during the periods of elevated volatility. When these periods are excluded, swaps have significantly better predictive performance. Moreover, we show that a combination of survey-based and market-based measures of expectations improves the inflation forecast with roughly equal weight for both explanatory variables.

Also, Banbura et al. (2021) show that the inclusion of inflation expectations in any form improves the inflation forecast in the short run, demonstrating its relevance for monetary policy and decision-making. The improvement in forecast accuracy is not typically large but statistically significant. Both short- and long-term inflation expectations provide useful information for inflation forecasting. In particular, the inclusion of expectations improves the upward bias correction in periods of low inflation, making the model more robust, especially in periods of high volatility.

Grothe and Meyler (2015) contribute to this literature by analysing and comparing the predictive power of market-based and survey-based measures. Focusing on the euro area and the United States, the authors use inflation swaps and the survey of professional forecasters to represent market-based and survey-based expectations, respectively. Their analysis demonstrates that both measures are informative predictors of inflation at shorter-term horizons (one and two years), suggesting that both market participants and professional forecasters provide valuable insights into future inflation dynamics. This implies that both measures are relevant for policymakers.

Also, Chen et al. (2022) examine the systematic biases present in survey-based inflation forecasts. It identifies a persistent overestimation of future inflation rates by respondents, attributed to psychological and behavioural factors such as anchoring and availability heuristics. These biases have significant implications for economic policy-making, potentially leading to suboptimal decisions by relying on inaccurate data. The paper advocates for methodological improvements in survey design and data collection to mitigate these biases, thereby enhancing the reliability of inflation expectations and supporting more effective monetary policy. Accurate inflation forecasting is crucial for economic stability and growth, underscoring the importance of addressing these biases in survey data.

Reis (2020) shows evidence of high business-cycle fluctuations in inflation expectations in the US data, which are influenced by monetary policy and driven by disagreement across population groups and disagreement among market traders. It also shows a greater ability of market-based expectations, or the ability of market participants to learn better from past and sticky information, while survey-based household expectations are often biased over longer periods of time.

Some studies focus on the technicalities and challenges of deriving inflation expectations from financial instruments. Fleming and Sporn (2013) point out the difference between inflation expectations derived from inflation swaps and inflation-indexed government bonds. In theory, these expectations should be the same, but in practice, we see deviations due to market frictions and financial market technicals. Christensen and Gillan (2011) explain that, in the case of the United States, this difference can be explained by financing costs for inflation buyers and hedging costs for inflation sellers. Moreover, in the case of bonds, the market price and the inflation expectations derived from it are influenced by Treasury supply.

Deacon and Derry (1994) demonstrate, using the example of the UK with a developed financial market and liquid instruments reflecting inflation expectations, several problems in deriving these expectations. In particular, in the inflation-linked bond market, despite the high development and liquidity of the financial market, there is an absence of some maturities, which creates a problem in constructing the full yield curve. Of course, various methods of interpolation can be employed here, but the issue of term premia still remains. The second problem is the tax aspect, which is different for each investor, which can create damage to the yield curve and mispricing of inflation expectations embedded in the price of a given bond. However, the Bank of England is a good example here of working with market-based inflation expectations that enter into the central bank's decision-making process.

Liu et al. (2015) address the challenge of imperfect information in market-based measures of inflation expectations, specifically in the UK where instruments reference inflation. To better understand inflation expectations, the authors develop a no-arbitrage term structure model. This model decomposes the forward inflation curve into inflation expectations, the expected spread between financial instrument and inflation, and estimates of risk premia, further broken down into inflation and liquidity risk premia. By modelling liquidity premia and estimating the spread, this research provides valuable insights for policymakers and market participants seeking to extract accurate inflation expectations from market data.

Other studies analyse the determinants and role of inflation expectations. El-Shagi (2011) compares market-expected inflation with econometric inflation forecasts using several forecasting techniques in the environment of ten developed countries from 1988 to 2007. The results show very clear overperformance of market expectations, but not significant. The paper concludes that the rational expectations hypothesis cannot be rejected. Furthermore, it could be shown that expectations are not only based on the past development of inflation but that further economic indicators are considered by market participants. Also, expectations seem to capture certain nonlinearities in inflation behaviour very well compared to forecasts, leading to far better results in times of high inflation and in times of increasing inflation.

The study of Cerisola and Gelos (2005) examines the macroeconomic determinants of survey inflation expectations in Brazil since the adoption of inflation targeting in 1999. The results show that inflation targeting has anchored inflation expectations significantly. But it also shows that, in addition to inflation targeting, fiscal policy plays a role in shaping inflation expectations. The importance of past inflation in determining expectations appears to be relatively low, and the overall empirical evidence does not suggest the presence of substantial inertia in the inflation process. Sousa and Yetman (2016) discuss how inflation expectations are measured in emerging countries (EM) and the approach of central banks. They point out the absence of financial market-derived inflation expectations in most emerging countries. Although they argue that inflation expectations become more anchored over time in these countries, inflation expectations measured through surveys introduce a number of problems and potential errors in assessing the anchoring of expectations and hence jeopardise the effectiveness of monetary policy.

While the existing literature provides valuable insights into the measurement, determinants, and role of inflation expectations, it has primarily focused on developed economies with well-established financial markets. Research on inflation expectations in emerging market economies, particularly those in the CEE region, remains limited. To address this gap, this paper aims to estimate market-based inflation expectations in CEE countries, which lack financial instruments that directly reflect these expectations. By employing a panel regression model built on the experience of emerging economies with more advanced financial markets, this study seeks to identify the factors that influence inflation expectations in the CEE region. Furthermore, it will compare these estimates with available survey-based inflation expectations, providing a more accurate measurement and retrospective assessment of inflation expectations in the context of monetary policy in these countries. This approach will contribute to a more nuanced understanding of inflation dynamics in emerging markets and provide valuable insights for policymakers in the CEE region.

2 CHALLENGES IN MEASURING INFLATION EXPECTATIONS

Given the relatively high and volatile inflation rates in emerging market economies, the distinction between nominal and real variables is particularly important when comparing long-term government bond yields and interest rate swap levels across countries and time. In DM economies, there is typically a deep and liquid market for inflation-linked government bonds and inflation interest rate swaps from which inflation expectations can be derived on a daily basis with different time horizons. Unfortunately, these instruments are not available in CEE countries and typically only survey-based measures of inflation expectations can be used.

However, in large EM economies, financial markets provide a limited supply of inflation-linked tools that can provide guidance on how market inflation expectations evolve in type-similar economies and can be used to estimate these expectations in CEE countries. Although previous research (Fleming and Sporn, 2013) shows that inflation swaps offer the best unbiased estimates of market inflation expectations, in emerging economies, when such instruments exist, it is always inflation-linked government bonds. However, these do not always provide an unbiased reading of market inflation expectations due to variations in the inflation risk premium and market technicals such as limited liquidity or supply. Nonetheless, there is no alternative in EM space at the moment and these shortcomings will have to be taken into account when evaluating the results of this paper.

At the moment, inflation-linked government bonds are only available in five countries with sufficiently developed financial markets and history which determines the sample used in this paper: South Africa (*sa*), Brazil (*bra*), Mexico (*mex*), Chile (*chil*) and Turkey. Due to the currency crisis in Turkey resulting in an extreme inflation profile including inflation expectations, this country will be excluded from further research in this paper.

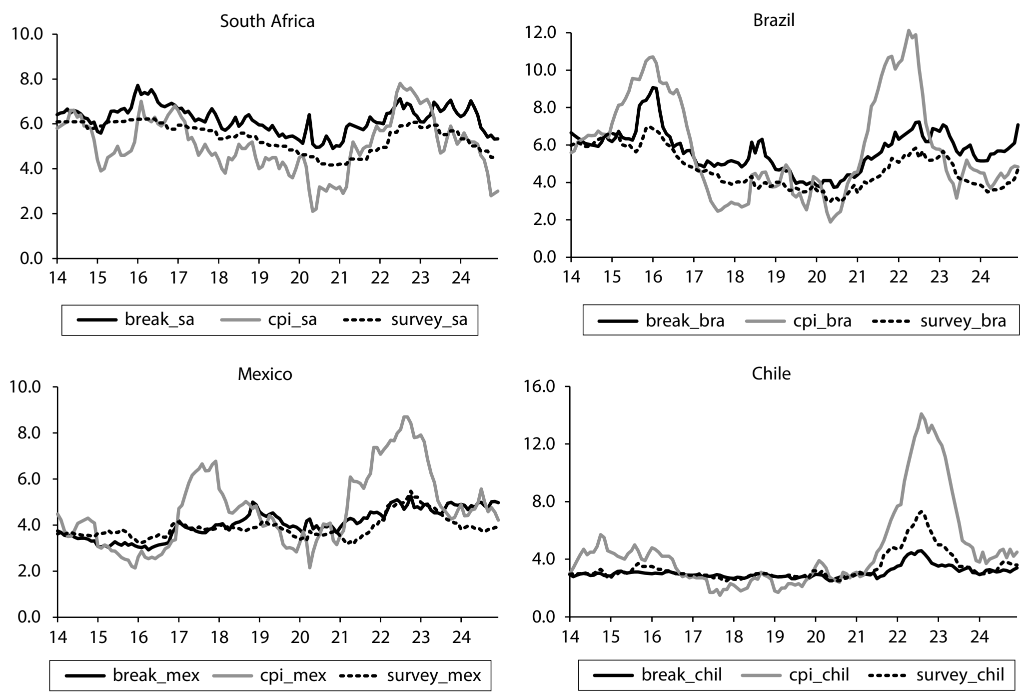
For most EM countries, in the absence of market-based measures of inflation expectations, it is common practice to use survey-based measures of inflation expectations with a one-year horizon as a proxy for long-term expectations. The countries mentioned are the only ones in the EM space that can offer both options. Thus, their reading (Figure 1) suggests that they are developing differently suggesting that survey-based inflation expectations are not a good proxy for long-term expectations.

The correlation analysis (Table 1) reveals systematic differences in predictive capacity: market-based expectations (*break*) demonstrate stronger alignment with actual inflation across all sample countries. For instance, in Brazil, market-based expectations show a much stronger correlation with actual inflation versus survey measures. Similarly, Chile exhibits near-perfect correlation of market-based measures of inflation expectations and actual inflation. These patterns persist even when controlling for crisis periods, consistent with Dierks et al. (2023) who found market measures outperformed surveys when excluding liquidity-distorted periods.

The structural divergence is visually apparent in Figure 1, where survey expectations overreact to transient inflation shocks while market-based measures maintain closer alignment with fundamental trends. This echoes findings from Grothe and Meyler (2015) that market prices incorporate forward-looking risk premia absent in surveys and aligns with Mandel and Vejmelek (2025) Czech evidence of survey respondents' adaptive biases. Overall, this evidence is confirming market-based measures of inflation expectations superior information content than survey-based measures of inflation expectations.

To obtain market-based inflation expectations for CEE countries with no market for inflation-linked instruments, inflation expectations can be estimated using available data in combination with the relationships observed in countries with more developed financial markets. To explain market-based inflation expectations, we choose variables that in theory contain some form of information about inflation or are indirectly driven by inflation developments in a given country. Using data from the EM space that has inflation-linked instruments available (South Africa, Brazil, Mexico and Chile), we estimate the relationship of 10y market-based measure of inflation expectations (*break)* with actual consumer inflation (*cpi)*, 1y ahead inflation survey (*survey)*, 10y nominal sovereign bond yield (*yield*), 5y credit default swaps (*cds*) and 10y market-based inflation expectations in DM countries (*break_global*). For the purposes of this paper, the *break_global* is taken to be the simple average of 10y market-based inflation expectations in the US and euro area. We first conduct the analysis using a country-specific model and then estimate a panel regression model of the behaviour of market inflation expectations. We then compare the fitted against actual market-implied inflation expectations, which we then apply to CEE countries.

Figure 1 Market-based measures of inflation expectations derived from inflation swaps versus actual inflation and 1y-ahead survey-based measure (YoY%, 2014–2024)



Source: Macrobond, Bloomberg

The explanatory variables were systematically chosen through an iterative process balancing theoretical foundations, empirical validation, and data constraints. Core determinants of market-based inflation expectations were identified using established frameworks from inflation expectation literature. Actual consumer inflation (*cpi*) serves as the adaptive expectations anchor, while survey measures (*survey*) capture short-term consensus views, following evidence that professional forecasts retain predictive value at one-year horizons. Nominal bond yields (*yield*) incorporate Fisher equation components, and credit default swaps (*cds*) account for country risk premia influencing inflation pricing. Global inflation expectations (*break_global*) reflect cross-border transmission effects documented in emerging markets research. Practical constraints necessitated prioritizing variables with consistent coverage across both baseline EM countries and CEE economies. Alternative candidates like exchange rates showed limited explanatory power in preliminary regressions and were excluded through general-to-specific reduction.

Table 1 Inflation versus expectations correlation matrix

	Survey	Break
cpi_sa	0.694	0.747
cpi_bra	0.305	0.729
cpi_mex	0.716	0.642
cpi_chil	0.742	0.892

Source: Authors' Author's calculations

3 MODEL SPECIFICATION: PANEL REGRESSION APPROACH

Panel data refer to data sets containing several observations for each sampling unit. This could be generated by pooling time-series observations across a variety of cross-sectional units (Baltagi, 2021; Hiestand, 2005). Panel regression models offer several advantages over traditional time series and cross-sectional models. Firstly, they allow for the control of time-invariant unobserved heterogeneity, which can be a significant source of bias in traditional models. This is achieved by incorporating entity-specific intercept terms, which capture the unique characteristics of each entity. Secondly, panel regression models provide a more flexible framework for analysing dynamic relationships between variables. Cross-sectional models, limited to a single point in time, cannot adequately capture the evolution of relationships over time. Panel models, on the other hand, can incorporate time lags and dummy variables for specific time periods to capture the changing nature of relationships. Finally, panel regression models can address the issue of omitted variable bias by incorporating time-varying independent variables. This is particularly useful in situations where traditional fixed effects models may be prone to bias due to the presence of time-varying omitted variables.

$$\gamma_{it} = \alpha_i + \beta X_{it} + \mu_t + \varepsilon_{it}, \tag{1.1}$$

where:

γ_{it} is the dependent variable for entity i at time t,
α_i is the entity-specific intercept, capturing the unique characteristics of entity i,
βX_{it} is the linear combination of independent variables for entity i at time t,
μ_t is the time-specific effect, representing the impact of factors that vary over time,
ε_{it} is the error term, capturing unobserved factors that affect γ_{it} but are not captured by the independent variables.

In this model, the entity-specific intercepts, α_i, are assumed to be fixed over time. This implies that the unique characteristics of each entity remain constant throughout the observation period.

To ensure the validity of the panel regression model and the interpretation of its results, several econometric tests should be conducted before applying it. These tests address various aspects of the data and the assumptions underlying the model. Before proceeding with panel regression, it is essential to check whether the pooled OLS assumptions are met. This involves testing for homoscedasticity, normality of errors, no autocorrelation, and lack of multicollinearity.

$$var(\varepsilon it) = \sigma^2, \forall i, t, \tag{1.2}$$

$$\varepsilon it \sim N(0, \sigma^2), \tag{1.3}$$

$$cov(\varepsilon it, \varepsilon jt) = 0, \forall i, t, s, \tag{1.4}$$

$$\det(\mathrm{Xit}) \neq 0, \forall \mathrm{i, t}. \tag{1.5}$$

After establishing the validity of the pooled OLS assumptions, additional tests are needed to verify the suitability of the panel regression model. These tests specifically address the model's assumptions, including the fixed effects assumption, serial correlation, unit roots, and Hausman test. Beyond the standard tests, additional diagnostic checks can be conducted to further evaluate the performance of the panel regression model. These include heteroscedasticity-robust standard errors. By conducting these econometric tests, one can gain confidence in the validity of panel regression models and the reliability of inferences drawn from the analysis.

The redundant fixed effects test, also known as the Hausman test, is used to determine whether the fixed-effects (FE) or random-effects (RE) model is more appropriate for a given panel data set. The test compares the statistical significance of the entity-specific effects () between the two models. The redundant fixed effects test compares the likelihood ratio (LR) test statistic between the fixed-effects and random-effects models:

$$LR = -2ln\big(L(RE)/L(FE)\big), \tag{1.6}$$

where:

L(RE) is the likelihood of the random-effects model,

L(FE) is the likelihood of the fixed-effects model,

If the LR statistic is greater than the critical value, then the null hypothesis of the random-effects model is rejected, and the fixed-effects model is preferred.

The redundant fixed effects test is a valuable tool for selecting the most appropriate panel data model, particularly when the relationship between the dependent variable and the independent variables may be affected by unobserved entity-specific characteristics. By comparing the explanatory power of the two models, this test helps researchers identify the model that better captures the underlying relationships and provides more reliable inferences.

4 MODELLING INFLATION EXPECTATIONS IN FINANCIAL MARKETS

To estimate the country-specific models first, we run simple linear regressions on 10y market-based measures of inflation expectations (Table 3) using monthly data with a sample from 2014M01 to 2024M12 (N = 132), which is given by data availability especially the short trading history of inflation-linked financial instruments. All time series come from the Bloomberg and Macrobond databases. The time series are seasonally adjusted where necessary. A unit root test is performed to assess the properties of the used series. The results of the Augmented Dickey Fuller (ADF) test show that all-time series are integrated of order one, I(1), in line with others studies (Table 2). Thus, for the purposes of model estimation, series employed in the form of a first difference logarithm to ensure stationarity.

Table 2 List of variables and tests of stationarity

Variable	Median	Max	Min	S.D.	ADF			
					Level		First difference	
					t-Stat	Prob	t-Stat	Prob
BREAK_SA	6.29	7.72	4.90	0.60	–2.365	0.154	–9.273	0.000
BREAK_BRA	5.69	9.07	3.74	1.11	–2.045	0.268	–8.728	0.000
BREAK_MEX	4.04	5.26	2.93	0.63	–1.217	0.666	–11.066	0.000
BREAK_CHIL	2.98	4.59	2.52	0.40	–2.227	0.198	–9.143	0.000
CPI_SA	2.07	2.90	1.00	0.36	–1.839	0.360	–8.728	0.000
CPI_BRA	1.27	2.86	0.48	0.53	–2.053	0.264	–6.329	0.000
CPI_MEX	5.05	7.80	2.10	1.23	–1.881	0.341	–8.424	0.000
CPI_CHIL	4.83	12.13	1.88	2.68	–2.382	0.149	–3.614	0.007
SURVEY_SA	4.44	8.70	2.13	1.63	–0.967	0.764	–4.919	0.000
SURVEY_BRA	3.95	14.10	1.50	2.95	–1.714	0.422	–8.744	0.000
SURVEY_MEX	5.61	6.22	4.17	0.63	–1.627	0.466	–6.119	0.000
SURVEY_CHIL	4.42	6.99	2.95	1.07	–2.054	0.264	–6.704	0.000
YIELD_SA	3.80	5.46	3.17	0.47	–1.643	0.458	–10.262	0.000
YIELD_BRA	3.00	7.30	2.50	1.00	–1.680	0.439	–8.889	0.000
YIELD_MEX	2.55	18.00	0.00	4.69	–0.802	0.815	–8.903	0.000
YIELD_CHIL	2.40	18.40	–1.60	4.98	–1.751	0.403	–9.439	0.000
CDS_SA	3.10	25.70	–1.40	6.26	–3.700	0.105	–9.185	0.000
CDS_BRA	3.42	16.76	–3.46	4.66	–2.407	0.138	–8.207	0.000
CDS_MEX	9.09	12.35	7.46	1.16	–2.449	0.103	–9.413	0.000
CDS_CHIL	11.40	16.37	6.57	2.21	–2.308	0.171	–9.673	0.000
BREAK_GLOBAL	7.21	10.19	5.50	1.34	–1.890	0.336	–8.045	0.000

Source: Macrobond, author's calculations

Lags were included in the model estimation however they proved to be non-significant or did not improve the quality of the model much. Since the goal is to find a model built on a time series that indicates inflation expectations rather than a model that explains inflation expectations, the criteria for selecting variables is based primarily on their correlation with inflation expectations and their availability.

Table 3 Country-specific market-based inflation expectations models

	South Africa	Brazil	Mexico	Chile
CPI	0.097* (0.008)	0.038* (0.001)	0.049* (0.025)	–0.180* (0.000)
SURVEY	0.703* (0.000)	0.176* (0.000)	0.271* (0.001)	0.624* (0.000)
YIELD	0.170* (0.000)	0.304* (0.000)	0.411* (0.000)	–0.047 (0.218)
CDS	0.002* (0.010)	0.003* (0.000)	–0.001 0.254)	0.008* (0.000)
BREAK_GLOBA	0.082* (0.039)	0.369* (0.000)	–0.125** 0.093)	0.775* (0.000)
N	132	132	132	132
Adj. R-squared	0.849	0.952	0.817	0.701

Notes: * coefficient statistically significant at 5% level, ** at 10% level.
Source: Author's calculations

Given that country-specific models have proven sufficiently robust, one can on their experience estimate a panel regression model that can incorporate all the data obtained for all the mentioned cross sections of interest over time and stack them and run a panel regression model. Several variants of the model were estimated (Table 5) without and with CDS, representing the country risk premium, and fixed effects, showing the differences between the countries included in the panel.

All cross-sectional time series (N = 4) were tested with panel unit root LLC and IPS tests (Table 4: Levin, Lin and Chu, 2002; Im, Pesara and Shin, 2003) and standard time series were tested with the conventional ADF unit root test. Most of the results showed stationarity of the time series at a 5% significance level and some were well below 10%. However, in the analyses, we consider FE or RE in the model, which handles potential problems with non-stationary variables by controlling for individual or group-specific trends, mitigating the spurious regression problem.

Table 4 LLC and IPS panel unit root tests

Method	Stat.	Prob.
Im, Pesaran and Shin (W-stat)	–2.911	0.002
Levin, Lin & Chu (t-stat)	–0.810	0.029

Source: Author's calculations

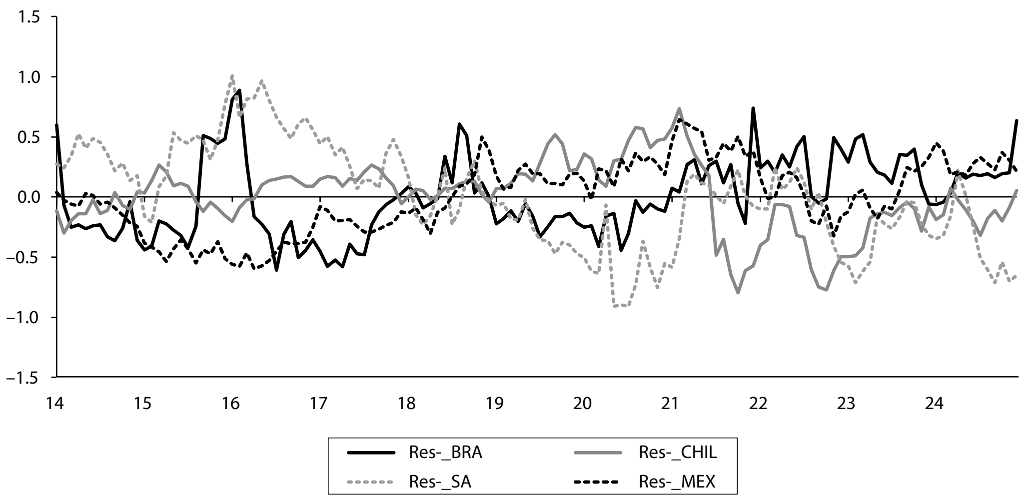
One of the assumptions underlying ordinary least squares estimation is that all observations have the same error variance and that errors are uncorrelated with one another. Although the estimated models do not show a significant correlation across observations and differential variance, cross-sectional weighting (estimated generalized least square) was employed here to avoid heteroskedasticity. Here, the estimates confirmed more statistically significant estimates. The panel model including CDS and fixed effects has proven to be the BEST variant with decent robustness with no major flaws. Relevant tests confirm the decision to employ the fixed effect in this case, which improves the accuracy of the estimation. The resulting model is thus sufficiently robust and can be applied to data from Czechia, Poland and Hungary. The graph (Figure 2) and correlation matrix (Table 6) show model residuals randomly distributed and concentrated around zero with no apparent trend.

Table 5 Panel regression market-based inflation expectations model

Panel regression results				
Fixed effects	**N**	**Y**	**N**	**Y**
CDS	**N**	**N**	**Y**	**Y**
CPI	−0.084* (0.000)	0.046* (0.000)	−0.086* (0.000)	0.034* (0.007)
SURVEY	0.664* (0.000)	0.300* (0.000)	0.552* (0.000)	0.307* (0.000)
YIELD	0.308* (0.000)	0.279* (0.000)	0.234* (0.000)	0.252* (0.000)
CDS			0.004* (0.000)	0.001* (0.002)
BREAK_GLOBAL	−0.143* (0.000)	−0.133* (0.002)	0.132* (0.002)	−0.032** (0.066)
C		1.174* (0.000)		1.049* (0.000)
_BRA-C		−0.007		0.011
_CHIL-C		−0.412		−0.397
_SA-C		0.748		0.693
_MEX-C		−0.335		−0.307
N	528	528	528	528
Adj. R-squared	0.912	0.943	0.926	0.945
AIC	1.463	0.726	1.368	0.712

Notes: * coefficient statistically significant at 5% level, ** at 10% level.
Source: Author's calculations

Figure 2 Resulted model residuals



Source: Author's calculations

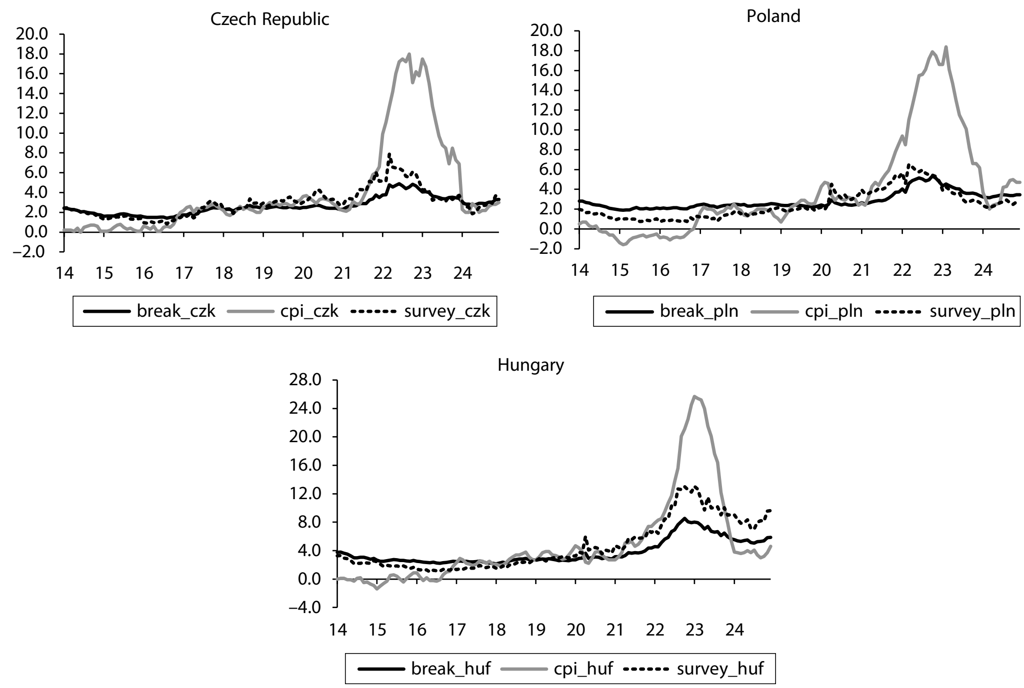
Table 6 Residual correlation matrix

	_bra	_chil	_sa	_mex
_bra	1.000	−0.185	−0.043	−0.144
_chil	−0.185	1.000	−0.157	−0.230
_sa	−0.043	−0.157	1.000	−0.119
_mex	−0.144	−0.230	−0.119	1.000

Source: Author's calculations

As a result of the estimated panel regression model, we can see the development of annual inflation, survey-based inflation measures of expectations for the 1y horizon and estimated market-based inflation expectations for the 10y horizon as output from the estimated model (Figure 3), which can be considered as long-term inflation expectations.

Figure 3 Estimated market-based inflation expectations vs actual inflation and 1y-ahead survey (%)



Source: Author's calculations

In the case of the Czech Republic, we see that both types of inflation expectations remain anchored close to the central bank's 2% inflation target at the beginning of the period when year-on-year inflation was only slightly above zero. Later in the 2017–2019 period, both types of inflation expectations stay close to the central bank's inflation target. In 2020, there is a noticeable increase in survey-based inflation expectations while market-based expectations remain stable. At the same time, despite an initial slight increase, actual inflation subsequently falls again. More interesting then is the period 2021–2023 when actual inflation rises significantly into double digits to which survey-based expectations respond significantly more with a peak at 7.87% in March 2022 while market-based expectations peak only nine months later at 5.13%. It is also worth noting that market-based expectations later decline more slowly than survey-based expectations despite the steep decline in actual inflation in 2023. Thus, at the end of the period under review, market-based expectations remain close to survey-based inflation expectations.

Similar results can be seen in Poland. More interesting here is the period 2014–2016 when the price level was in deflation with a peak in March 2015 at –1.50%. Survey-based inflation expectations are well below the central bank's inflation target of 2.50% in this period. However, market-based expectations remain close to the inflation target during this period. Again, we see a temporary increase in actual inflation and survey-based expectations in 2020, while marked-based expectations remain roughly stable. Also, in the 2021–2023 period, we see survey-based expectations rise significantly faster following rising actual inflation. As in the Czech Republic, survey-based expectations then fall faster relative to market-based expectations at the end of the observation period, where market-based expectations remain higher.

The results in Hungary show the same divergence of inflation expectations at the beginning of the period under review. However, here market-based expectations come in below survey-based expectations for the short term in 2014 but both are well below the central bank's inflation target of 3.00% following actual inflation of around zero over the period. In 2020, as in the Czech Republic and Poland, we may see a rise in survey-based expectations even though actual inflation and market-based expectations remain broadly stable. In the period 2021–2023, as in the other countries, survey-based expectations are followed by a rapid rise in actual inflation well above the rise in market-based expectations. However, here we can see that, in contrast to the results in the Czech Republic and Poland, survey-based inflation expectations remain above market-based expectations throughout the period, which is likely explained by significantly higher actual inflation keeping survey-based expectations elevated.

In general, we can draw several conclusions here. (1) The results show significantly lower volatility of estimated market-based inflation expectations compared with survey-based expectations. This is consistent with expectations given that these should be more long-term expectations whereas the survey corresponds to a one-year horizon. It can also be explained by the more sophisticated source of inflation expectations i.e. financial markets, whereas in the case of surveys, it is households. (2) Estimated market-based inflation expectations show a significantly higher correlation with actual inflation (Table 5) compared with survey-based inflation expectations in all countries examined. The relationship between actual inflation and market-based inflation expectations is an almost perfect positive correlation with a coefficient close to 1. In particular, in the Czech Republic and Poland, the difference in the strength of the relationship between the two types of inflation expectations with actual inflation is striking. In Hungary, the relationship is more similar but still marked-based expectations proved to be more correlated with actual inflation. Although this would need further research, it can be assumed here that market-based inflation expectations would have better predictive power for actual inflation compared to survey-based expectations.

Table 7 Inflation versus expectations correlation matrix

	Survey	Break
cpi_czk	0.797	0.935
cpi_pln	0.833	0.943
cpi_huf	0.844	0.866

Source: Author's calculations

Also, (3) based on the results, we can say that in Czechia, Poland and Hungary the relationship between inflation, inflation expectations in the economy, their anchoring and the success of the central bank's inflation targeting concept is most similar to Chile from the baseline sample of countries based on which the panel regression model was estimated. This is consistent with the assumptions of all the economies mentioned in this study given that Chile is the most similar to the CEE region countries in terms of the size and openness of the economy and the advancedness and setting of monetary policy. Finally, (4) the main question at the beginning of this paper is whether the central bank can use survey-based expectations with shorter horizons as a proxy in the absence of long-term inflation expectations. Here, the analysis shows that the two types of inflation expectations have different paths at different times, sometimes with significant variation. Thus, if survey-based inflation expectations are used, decision-makers may misjudge inflation dynamics, resulting in monetary policy errors.

CONCLUSION

Inflation expectations have become a key issue for monetary policy settings due to the sharp rise in inflation in the CEE region. Given the low level of financial markets in this region, the absence of market-based inflation expectations significantly complicates the assessment of the anchoring of inflation expectations in the economy. Moreover, this problem intensifies during periods of extreme shock, when it is difficult to identify whether it is on the supply or demand side. Yet in such a situation, it is more important than usual to identify in a timely manner whether inflation expectations are detached or not for the central bank.

The experience of the EM space with more developed financial markets provides enough information and experience to estimate unobserved long-term inflation expectations in the CEE region replicating market-based expectations. A panel regression was used to estimate a model of inflation expectations based on data from South Africa, Brazil, Mexico and Chile. Subsequently, this model was used to estimate long-term marked-based inflation expectations in Czechia, Poland and Hungary. Market inflation expectations derived from 10y inflation swaps, actual inflation, survey-based inflation expectations, 10y government bond yield, 5y credit default swaps and global market-based inflation expectations were employe to construct the panel regression model. The resulting model proved more robust with fixed effects included.

The results show that market-based inflation expectations in the CEE region have significantly lower volatility compared to survey-based inflation expectations, which are often used as proxy variables by central banks for monetary policy decision-making. At the same time, the correlation of estimated market-based expectations is significantly higher with actual inflation compared to survey-based expectations, especially in the Czech Republic and Poland, while the difference in correlation is not as significant in Hungary. It can thus be assumed that estimated market-based inflation expectations should provide better forecasting power than survey-based expectations. The results also show that compared to the original sample of countries used to estimate unobserved market-based expectations, the CEE region most closely matches Chile in terms of the characteristics of inflation expectations and their anchoring. Overall, we thus conclude that survey-based inflation expectations cannot be used as a proxy for long-term inflation expectations due to significantly different developments and characteristics that could lead to erroneous monetary policy decisions.

Looking forward, estimated unobserved market-based inflation expectations may have more applications in setting monetary policy or valuing fixed income securities, which could be the focus of further research in this area.

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