Understanding Inflation Expectations in the Czech Economy: Data, Drivers, and Policy Implications*

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We investigate inflation expectations and their measures amid the 2022 surge in the Czech Republic. Using data and econometric analyses, we explore how inflation expectations are formed and how they may affect inflation developments. To capture the overall trend of inflation expectations in the Czech economy, we develop a Common Inflation Expectations index. Additionally, we extend the CNB's g3+ core projection model by incorporating endogenous expectation premiums that reflect elevated inflation expectations. Utilizing the Common Inflation Expectations index and the modified model, we construct a simulation that provides policy-relevant outcomes when addressing high inflation.

JEL Codes: C32, C50, E31, E37, E50.

1. Introduction

Inflation targeting is a widely employed monetary policy framework among central banks in developed economies. The central bank's inflation target serves as the nominal anchor, establishing the

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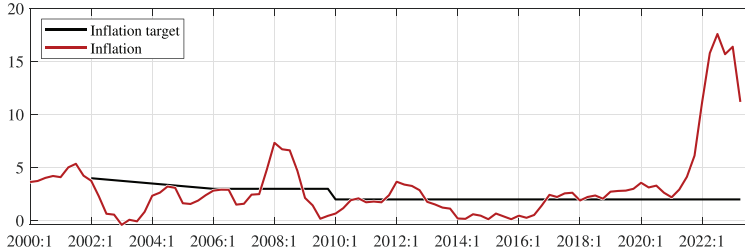
foundation for the formation and guidance of inflation expectations. When inflation expectations are well-anchored (that is, aligned with the inflation target), policymakers can take a less aggressive stance in their response to inflationary shocks. This is because the gravity of the nominal anchor prevents medium- and long-term inflation expectations and inflation itself from deviating substantially from the inflation target (Coibion et al. 2020). Hence, the extent to which inflation expectations deviate from the central bank's inflation target can serve as a measure of the central bank's success in anchoring inflation expectations.

Weakly anchored or even de-anchored inflation expectations can spark numerous adverse effects in the economy. These adverse effects include increased uncertainty, overall macroeconomic and financial instability, and reduced effectiveness of monetary policy instruments mirrored in lower central bank's ability to conduct countercyclical policy. Furthermore, de-anchored inflation expectations can compel the monetary authority to adopt an aggressive monetary policy approach to considerably alter monetary conditions, thereby inflicting additional (and not negligible) macroeconomic costs. These effects and considerations highlight the importance of monitoring inflation expectations as an integral part of monetary policy.

Inflation expectations attract significant attention particularly during times of exceptionally rising prices. The most recent surge in inflation in 2022 and 2023 is no exception. This is documented by numerous studies published in the past couple of years, focusing on various aspects of inflation expectations, such as their measures (see, for example, Ahn and Fulton 2020 or Binder, Janson, and Verbrugge 2023) and stylized facts (see Candia, Coibion, and Gorodnichenko 2023, 2024; Coibion, Gorodnichenko, and Weber 2023; D'Acunto, Malmendier, and Weber 2023; Garcia and Gimeno 2024; or Savignac et al. 2024).[1] There is a vast body of research on the role of inflation expectations in monetary policy conduct and de-anchoring (refer to Coibion, Gorodnichenko, and Weber 2022; Reis 2022, 2023; Bundick and Smith 2023; Carvalho et al. 2023; Carvalho and Nechio 2023; D'Acunto et al. 2024; Dietrich 2024; Pedersen 2024; or Shahzad, Orsi, and Sharma 2024). The studies find mixed evidence regarding

[1]We discuss stylized facts of Czech inflation expectations in comparison with other countries in Section 2.

Figure 1. CPI Inflation in the Czech Republic (YoY, in %)



Note: The inflation target is not shown prior to 2002, as the target inflation rate was defined in terms of net inflation during that time.
Source: Czech Statistical Office; Czech National Bank.

inflation expectation de-anchoring in recent years, suggesting that households, in particular, are more prone to this phenomenon, as they pay more attention to volatile components of the consumer basket among others. Once inflation expectations are de-anchored, the path to disinflation can be challenging, as they are typically viewed as important in affecting short-term inflation dynamics. The studies confirm that communicating a numerical inflation objective better anchors expectations. Central banks should persistently strive to build knowledge and trust among the population, as this allows for more effective monetary transmission.

This work provides empirical findings, insights, and conclusions associated with inflation expectations in the Czech economy especially during the period 2022 to 2023. The situation in the Czech economy in 2022 and 2023, marked by inflation attaining values close to 18 percent (see Figure 1), raised concerns about the broader macroeconomic environment (see Franta and Vlček 2024) and sparked discussions about expectations developments. Our work contributes to the ongoing debate by presenting the Czech National Bank's experience. We focus on inflation expectations and their relation to inflation, and implications for monetary policy setting, while excluding other potential concerns such as central bank credibility.

Inflation expectations in the Czech economy were long considered to be well-anchored, leading the Czech National Bank (CNB) to base its analytical and projection tools on this assumption. Although inflation expectations have been regularly monitored, they were only

assessed qualitatively and were not explicitly integrated into the CNB's analytical framework. In response to the 2021–22 inflationary episode, we have conducted empirical analyses and extended the existing core projection structural model. Given the central bank's previous practice, we start our exposition by outlining the baseline specifications that assume anchored inflation expectations. This approach is intended to make our findings more accessible and the results easier to implement in other settings.

Our assessment delivers the following results. We formulate inflation expectation indices that are practical (and hence relatively simple and intuitive) for macroeconomic and monetary policy analysis. These indices indicate the degree of inflation expectations anchoring and portray the overall inflation expectations in the economy. The inflation expectations deviation index implies that years 2022 and 2023 in the Czech economy can be described as a period of heightened inflation expectations with an initially weak degree of anchoring. The concluding months of 2023 point to a normalization of the situation, as the degree of anchoring of inflation expectations increased. Our estimates indicate, among other things, that increased short-term inflation expectations have played a significant role in the recent inflation surge.

Furthermore, we extend the CNB's g3+ core projection structural model to accommodate heightened inflation expectations and steer an appropriate policy response. We encapsulate the effects of elevated expectations in the g3+ model via one primary and one supplementary channel, while employing a newly constructed Common Inflation Expectations (CIE) index that reflects the overall trend of inflation expectations in the Czech economy. The primary channel incorporates the impact of an inflation expectations bias affecting the expectation component in the New Keynesian Phillips curve. The supplementary channel accounts for exchange rate dynamics in the extraordinary macroeconomic environment. We demonstrate how the information conveyed by the CIE index can be integrated into the CNB's core projection model and showcase the usefulness of model simulations in policy discussions.

The paper is structured as follows. It begins with a description of the data. This is followed by an introduction to inflation expectations indices and several empirical analyses of inflation expectations in the context of the Czech economy. The subsequent section presents

how the newly constructed CIE index is used within the g3+ model and describes the extensions of the model. The concluding section provides a summary of our key findings.

2. Development of Inflation Expectations

The only sources of inflation expectations data in the Czech economy are surveys conducted among households, firms, and financial market analysts. Since the evolution and unique characteristics of these expectations vary across groups, it is crucial to extract and interpret the information specific to each group accordingly.

2.1 Households

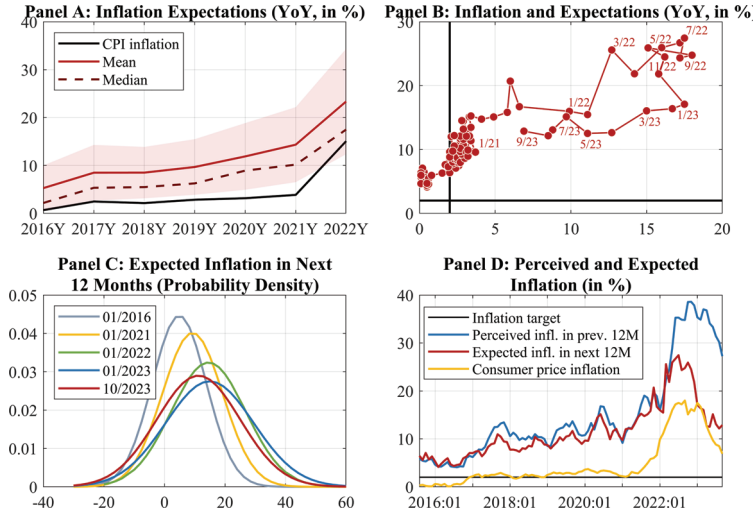
The inflation expectations of Czech households can be described by data from the European Commission's Business and Consumer Surveys.[2] The data, available at monthly frequency, cover responses from 1,000 participants to 15 questions regarding their perceived and expected economic developments, as well as the socioeconomic attributes of the respondents. The survey questionnaire consists of a qualitative part with fixed answers and a quantitative part that asks for numerical values for perceived inflation in the past 12 months and expected consumer inflation over the next 12 months. We focus on data from quantitative answers, as they offer exact numerical information in contrast to qualitative answers.[3]

The survey data reveal that households consistently show upward bias in their one-year inflation expectations compared with the CNB's inflation target. The average value hovered around 10 percent between 2016 and 2020, but there was a significant shift in 2021 (see panel A in Figure 2). Notably, the median responses were consistently 4 to 5 percentage points lower than the mean value, suggesting that most respondents tended to report low rather

[2]More details can be found on the European Commission's website: https://economy-finance.ec.europa.eu/economic-forecast-and-surveys/business-and-consumer-surveys_en.

[3]The questionnaire regarding the socioeconomic status of the households interviewed and their perception of economic developments in the Czech Republic can be found here: https://economy-finance.ec.europa.eu/system/files/2022-11/questionnaires_cz_cons_cz.pdf.

Figure 2. Inflation Expectations of Households



Note: The shaded area in panel A corresponds to standard deviations at each time point. The horizontal and vertical axes in panel B display the CPI and expected inflation, respectively. The solid black lines highlight 2 percent values reflecting the CNB's inflation target.
Source: Czech Statistical Office; European Commission's Business and Consumer Surveys.

than high extreme values, resulting in a skew toward lower figures. Panel B of Figure 2 shows a sudden surge in expectations of over 18 percent when headline inflation went above 10 percent. However, households' inflation expectations have been gradually normalizing toward their long-term average since the end of 2022. These patterns suggest short-term adaptive behavior among households, where their expectations tend to mirror current inflation developments.

Moreover, the standard deviation, a measure of the dispersion of answers, has shown a consistent increase over time. The recent surge in inflation expectations has not only triggered a pronounced shift in the distribution of the reported answers but has also resulted in a substantial flattening of the entire distribution (see Figure 2, panel C). While households in 2023 anticipated higher inflation, there was an inherent increase in disagreement. Despite the partial normalization of inflation expectations during 2023, their values remained scattered compared with historical standards.

From a long-term viewpoint, both perceived and expected inflation among households consistently surpass the ex post measured reality. This holds true even during periods when inflation closely aligns with or falls below the CNB's target for a prolonged period (see Figure 2, panel D). Despite the considerable gap between perceived and expected inflation compared with measured inflation, they exhibit similar trends over time.[4] This suggests that while households' perceptions reflect economic developments well, especially in terms of periods of low and high inflation, there is a notable discrepancy in magnitude compared with the actual reality. Concerning the recent period of inflation, it appears that households perceived the rapid increase in inflation in 2022 as temporary and adjusted their inflation expectations accordingly. Following the peak of inflation in late 2022 and early 2023, the close relationship between perceived and expected inflation reestablished itself in 2023. This relationship is underscored by a fairly stable correlation coefficient of around 0.7 between perceived and expected inflation, with an exception for the anomalous year of 2022, as illustrated in Figure 3.

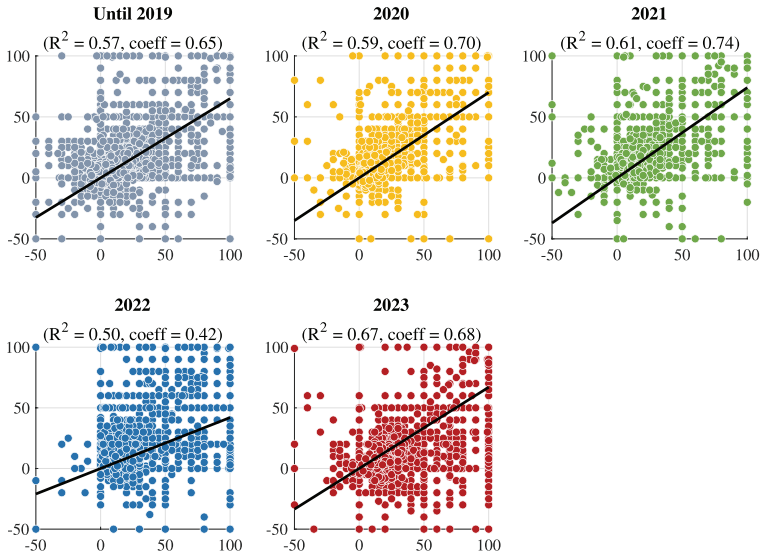
2.2 Firms

The data on the inflation expectations of firms originate from a survey carried out jointly by the Confederation of Industry of the Czech Republic and the Czech National Bank. Around 150 firms are surveyed on a quarterly basis in contrast to the monthly statistics obtained from households and financial market analysts. The survey covers expectations in one- and three-year horizons. We exclude the highest and lowest 5 percent of the values to ensure a more cohesive sample.

As shown in panel A of Figure 4, firms' inflation expectations for both short and long horizons remained within the 1 percent to 4 percent range until 2021. Notably, the data reveal a consistent pattern where firms systematically anticipated higher inflation at the three-year horizon compared with the one-year horizon, with an average difference of nearly 1 percentage point. This pattern could be a reflection of firms' pricing strategies, which aim to offset current

[4]The seminal work by Muth (1961) outlines the basic mechanisms of expectation formation, providing insights into why such patterns might arise.

Figure 3. Correlation between Perceived and Expected Inflation of Households

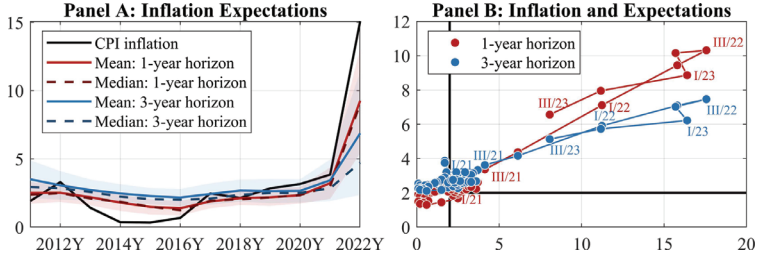


Note: The horizontal and vertical axes display perceived and expected year-over-year CPI inflation, respectively.
Source: European Commission's Business and Consumer Surveys; authors' calculations.

and anticipated short-term inflation pressures within future price adjustments.[5] After the inflation surge in 2021, there was a significant rise in both expectations. At the same time, the positioning of short- and long-term inflation expectations shifted, with three-year expectations reflecting lower values than those for the one-year horizon. In 2022, there was a noticeable increase in the dispersion of responses compared with previous years, indicating heightened uncertainty about future economic prospects. Furthermore, the mean and median values of three-year inflation expectations suggest that more extreme values are observed during high-inflation periods compared with standard times when means and medians are close to

[5]This hypothesis is supported by D'Acunto, Malmendier, and Weber (2023), who document that firms consider the current and future overall economic situation when forming expectations about inflation.

Figure 4. Inflation Expectations of Firms (YoY, in %)



Note: The shaded area in panel A corresponds to standard deviations at each time point. The horizontal and vertical axes in panel B display the CPI and expected inflation, respectively. The solid black lines highlight 2 percent values reflecting the CNB's inflation target.
Source: Czech Statistical Office; survey conducted by the Confederation of Industry of the Czech Republic and the CNB.

each other. This suggests that the sample exhibits more variability during times of high inflation.

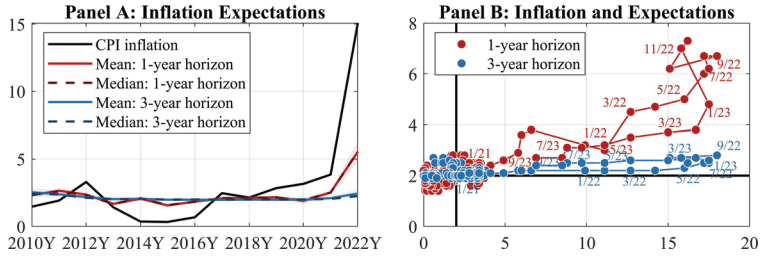
A noteworthy surge in both expectations occurred in 2021, coinciding with headline inflation surpassing 5 percent, as plotted in panel B of Figure 4. Trend inflation gained momentum in subsequent quarters, particularly at the one-year horizon, aligning with observed inflation which reached double-digit figures. This movement is considered exceptionally robust from a historical standpoint. Despite the ongoing downward trend in headline inflation, the latest data indicate that firms' expectations remain elevated. The decline in these expectations toward pre-2021 levels has been slow and incremental. This persistent elevation suggests that the inflationary pressures of 2021 and 2022 have had a lasting influence on firms' outlooks, even though more recent inflation figures have begun to moderate.

2.3 Financial Market Analysts

The inflation expectations of financial market analysts originate from the CNB's Financial Market Inflation Expectations survey.[6]

[6]The summary outcomes of the CNB's Financial Market Inflation Expectations survey can be found here: https://www.cnb.cz/en/financial-markets/inflation-expectations-ft/.

Figure 5. Inflation Expectations of Financial Market Analysts (YoY, in %)



Note: The shaded area in panel A corresponds to standard deviations at each time point. The horizontal and vertical axes in panel B display the CPI and expected inflation, respectively. The solid black lines highlight 2 percent values reflecting the CNB's inflation target.
Source: Czech Statistical Office; CNB's Financial Market Inflation Expectations survey.

The survey typically includes 16 to 18 respondents, predominantly macroeconomists affiliated with banks and other private financial institutions based in the Czech Republic. A few analysts from financial institutions located abroad also contribute to the survey results. The survey covers inflation expectations at one- and three-year horizons.

The evolution of inflation expectations among financial market analysts in panel A of Figure 5 offers several key and interesting insights. First, financial market analysts exhibit a high degree of coherence, as indicated by the consistently low standard deviations, even during high-inflation periods. This is particularly evident at the one-year horizon, suggesting that analysts may leverage analytical tools and a variety of forecasting approaches to provide a relatively consistent inflation outlook for the upcoming year. Second, three-year inflation expectations, which remained at 2 percent between 2012 and 2020, reflect the respondents' understanding of the central bank's policies.[7] Similar to other respondent groups, inflation expectations at the one-year horizon experienced a significant increase from 2021 onward. At the same time, expectations at the three-year

[7]The downward trend in long-term expectations until 2010 can be attributed to a gradual shift in the inflation target from 6 percent to 2 percent.

horizon also experienced a slight upward shift. Considering the well-informed status of financial market analysts about the central bank's operation, including the inflation target value, even minor changes in their long-term inflation expectations should be carefully monitored. Such changes could potentially signal a decrease in the clarity of the central bank's behavior or even a loss of credibility.

Panel B of Figure 5 reveals a narrative similar to that observed in firms' inflation expectations. The graph shows inflation expectations for financial market analysts for the one- and three-year horizons against headline inflation. The deviations from their long-term values became more pronounced as soon as annual headline inflation hit 7 percent. Starting in late 2022, there has been a gradual reversal of inflation expectations toward the inflation target at both horizons. However, these expectations continue to remain at high levels.

2.4 Stylized Facts and Some International Evidence

Overall, Czech survey data in standard times can be characterized by the following stylized facts. First, household inflation expectations exhibit a distinctive upward bias relative to the CNB's inflation target. This stylized fact aligns with survey results from other countries. For example, Coibion, Gorodnichenko, and Weber (2022) document an upward bias in inflation expectations among U.S. households, while D'Acunto, Malmendier, and Weber (2023) confirm this fact for U.S. and European survey data. Second, Czech firms tend to report long-term inflation expectations above the inflation target, though with a smaller margin than households, and they show less disagreement. This finding is consistent with Savignac et al. (2024), who investigate the inflation expectations of French firms. Additionally, Candia, Coibion, and Gorodnichenko (2024) report that U.S. managers' expectations are distinct from those of households or professional forecasters and are neither well-anchored nor consistent with full-information rational expectations. Third, financial market analysts provide the most reliable outlooks at the one-year horizon and align their long-term inflation expectations with the central bank's target. They also form the most coherent group.

With the outbreak of the inflation surge, inflation expectations increased considerably among Czech agents, accompanied by greater

dispersion in the reported values. This trend is consistent with Coibion, Gorodnichenko, and Weber (2023), who report that U.S. household inflation expectations following the COVID-19 pandemic were marked by increased disagreement and heightened uncertainty about future inflation. At the same time, short-term expectations among Czech agents began to gradually decline toward the inflation target shortly after the peak in observed inflation. This pattern aligns with international evidence. For instance, Garcia and Gimeno (2024) show that a significant portion of the high inflation observed between 2021 and 2023 in Latin American (LATAM) economies (Brazil, Chile, Colombia, Mexico, and Peru) was largely driven by transitory factors and long-term expectations remained anchored.

The shift in inflation expectations over the 2022–23 period, as indicated by survey results, prompts important questions about the nature of this change. What insights can we distill from this shift? Could we interpret it as inflation expectations being de-anchored from the central bank's target? Or is it a natural phenomenon that high inflation brings about an equal or even more pronounced change in inflation expectations?

3. Inflation Expectations Indices

To assess the degree of inflation expectations anchoring, we begin by formulating an inflation expectations deviation index. This index, though subject to some degree of uncertainty, provides an indication of whether the inflation expectations remain anchored. By de-anchoring, we refer to situations where expectations deviate significantly from the inflation target, surpassing certain critical thresholds. Unlike a simple comparison between inflation expectations and the inflation target, the inflation expectations deviation index accounts for deviations that are typical for a given inflation period, without suggesting a risk of de-anchoring. We construct separate indices for each group of economic agents covered in the surveys.

Additionally, we aim to derive an indicator that tracks the common movements in inflation expectations across the entire economy. Given the multiple sources of inflation expectations, each reflecting the views of different economic agents, this data may have diverse

implications for inflation and monetary policy responses. To eliminate potential ambiguity in the interpretation of inflation expectations data, we introduce the Common Inflation Expectations index. Additionally, the CIE index proves to be useful for monitoring and disciplining model-consistent inflation expectations within our g3+ core projection model (see Section 5). It is crucial to acknowledge that while the CIE index provides a straightforward descriptive measure of the evolution of inflation expectations, it does not offer insights into the degree of inflation expectations anchoring.

3.1 Inflation Expectations Deviation Index

Inspired by the literature on central banks' credibility, we formulate an inflation expectations deviation index as the measure of the degree of anchoring. Svensson (2000) argues that high credibility is achieved when private inflation expectations align with the inflation target. Thus, monetary authority with an explicit inflation target is able to assess credibility and the degree of anchoring of inflation expectations via the expected inflation–inflation target gap.

However, periods of instability necessitate modifications to conventional methods. To make the concept more applicable, Cecchetti and Krause (2002) formulate a policy credibility index that measures the deviations of expected inflation from the target level set by the central bank while accounting for extreme values. According to their definition, full credibility (a high degree of inflation expectations anchoring) is achieved when expected inflation is in line with or lower than the target, decreases when inflation values are higher than the target, and completely vanishes when inflation exceeds 20 percent. Recent adaptations of a similar measure of credibility include definitions by Abib et al. (2022) and Carvalho and Nechio (2023). These adaptations set the credibility threshold to the upper level of the inflation target's tolerance band.

Periods of low- and high-inflation rates and data constraints in the Czech Republic require adjustments in formulating the inflation expectations deviation index. Several periods before 2020 were even characterized by inflation rates below the inflation target. Hence, we aim to design an inflation deviation signal accounting for deviations in both directions. Additionally, we must contend with limited offer of financial instruments, which restricts our ability to develop a

measure based on implied forward-looking inflation expectations. In general, we define our symmetric directional inflation expectations deviation index $DevI_t$, $0 \geq DevI_t \leq 1$, as follows:

$$DevI_t = \begin{cases} 0 & \text{if} \quad \pi^{T-} < E_t[\pi_{t+s}] < \pi^{T+}; \\ 1 \quad \text{or} \quad -1 & \text{if} \quad E_t[\pi_{t+s}] > \pi^{max} \quad \text{or} \\ & \quad E_t[\pi_{t+s}] < \pi^{min} \quad \text{respectively}; \\ \dfrac{E_t[\pi_{t+s}] - \pi^{T+}}{\pi^{max} - \pi^{T+}} & \text{if} \quad \pi^{T+} \leq E_t[\pi_{t+s}] \leq \pi^{max}; \\ \dfrac{E_t[\pi_{t+s}] - \pi^{T-}}{\pi^{T-} - \pi^{min}} & \text{if} \quad \pi^{T-} \geq E_t[\pi_{t+s}] \geq \pi^{min}, \end{cases} \tag{1}$$

where π_t is the observed year-over-year (YoY) expected inflation rate, π^{max} and π^{min} represent the maximum and minimum thresholds, π^{T+} and π^{T-} are the upper and lower bounds, and s corresponds to the one- or three-year horizon.

The inflation expectations deviation index is zero when inflation expectations align with the target, that is, within the upper and lower bounds π^{T+} and π^{T-}. Values 1 and –1 resemble situations where inflation expectations are de-anchored upward or downward, which occurs when inflation expectations exceed the upper maximum or lower minimum limits π^{max} and π^{min}. The index takes values of between 0 and 1 (–1 and 0) when inflation expectations are above (below) the lower (upper) bound but stay below (above) the upper maximum (lower minimum) boundary. We characterize such situations as a lower degree of inflation expectations anchoring. Overall, the absolute value of the deviation index $|DevI_t|$ increases with the deterioration of inflation expectations anchoring. We construct individual indices for households, firms, and financial market analysts for both one- and three-year horizons using the data presented in Section 2.

Given that the Czech economy has undergone significant economic transitions over the past 30 years, and that the CNB has adjusted its inflation target value to these changes, it is essential to account for these factors when constructing the indices. Failing to do so could result in false alarms about the degree of anchoring. Therefore, we center the underlying time series (and thus also

indices) around the inflation target values. Technically, we demean the data by the inflation target as follows:

$$E_t[\pi^{adj}_{t+s}] = E_t[\pi_{t+s}] - \pi^{tar}_{t+s}, \tag{2}$$

where π^{tar}_{t+s} is the inflation target. We also adjust inflation expectations of households for the systematic long-term upward shift relative to the inflation target.[8]

The maximum and minimum thresholds, π^{max} and π^{min}, are derived from distribution of adjusted inflation expectation responses over multiple economic cycles. These thresholds are identified by analyzing the points in the distribution where frequent observations give way to outliers, often referred to as "histogram breaks." In this context, the maximum threshold corresponds to the point where inflation expectations deviate notably from common patterns, signifying outlier behavior. Conversely, the minimum threshold is chosen symmetrically to ensure a balanced measurement of deviations both above and below the target. The corresponding histograms illustrating these breaks are provided in Figure 6, while the precise thresholds and tolerance bounds are detailed in Table 1.[9]

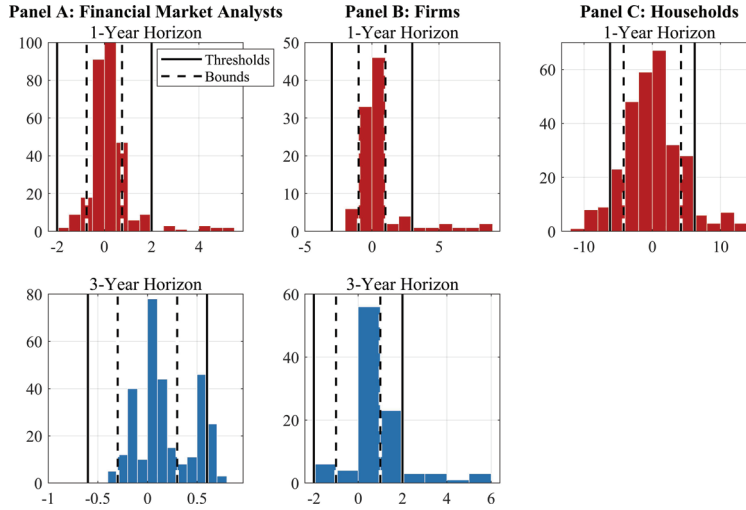
Figure 7 presents the inflation expectations deviation indices for all agents in our sample. Upon examining panel A, we infer that the indices for financial market analysts imply a low degree of anchoring of inflation expectations at the one-year horizon in 2022. However, the subsequent downward trend in the index has coincided with a decrease in inflation expectations. The corresponding index for the three-year horizon indicates a relatively high erosion of expectations anchoring, while inflation expectations have been noticeably deviating from the 2 percent target since 2022.

Panel B of Figure 7 summarizes the indices for firms. The inflation expectations deviation indices suggest a possible de-anchoring of expectations in 2022–23, regardless of their time horizon (three years or one year). Even with the easing of inflationary pressures in the economy in 2023, both deviation indices remain elevated, failing to

[8] Also, considering the wide dispersion of households' responses, we exclude data above the 75th percentile and below the 25th percentile to obtain a more coherent sample.

[9] For instance, inflation expectations of financial market analysts at the one-year horizon adjusted for the inflation target indicate a break equal to 2 percent.

Figure 6. Distributions of Inflation Expectations, Bounds, and Thresholds



Note: The graphs display adjusted data from surveys as described in Section 3.
Source: CNB's Financial Market Inflation Expectations survey; survey conducted by the Confederation of Industry of the Czech Republic and the CNB; European Commission's Business and Consumer Surveys.

revert to pre-2021 levels. Indices for firms suggest more pronounced persistence and a lower degree of anchoring compared with those for financial market analysts. The exceptional period of escalating inflation during 2021 and 2022 drove expectations to even higher levels, particularly for the three-year horizon. It is crucial to approach these results cautiously since firms affect future prices through pricing decisions, and their inflation outlooks may reflect their intended actions.

Finally, panel C of Figure 7 highlights a notably higher level of volatility in households' inflation expectations and the corresponding deviation index compared with other agents. Similar to other groups, households' one-year inflation expectations reached potentially de-anchored levels in 2023. However, the latest survey data suggest a rapid correction in the trend, indicating a swift return toward the high degree of anchoring in response to stabilizing economic conditions.

Table 1. Thresholds and Bounds of Inflation Expectations Deviation Indices

	Thresholds and Bounds			
	π^{min}	π^{T-}	π^{T+}	π^{max}
Financial Market Analysts (One-Year Horizon)	–2	–0.75	0.75	2
Financial Market Analysts (Three-Year Horizon)	–0.6	–0.3	0.3	0.6
Firms (One-Year Horizon)	–3	–1	1	3
Firms (Three-Year Horizon)	–2	–1	1	2
Households (One-Year Horizon)	–6.2	–4.2	4.2	6.2

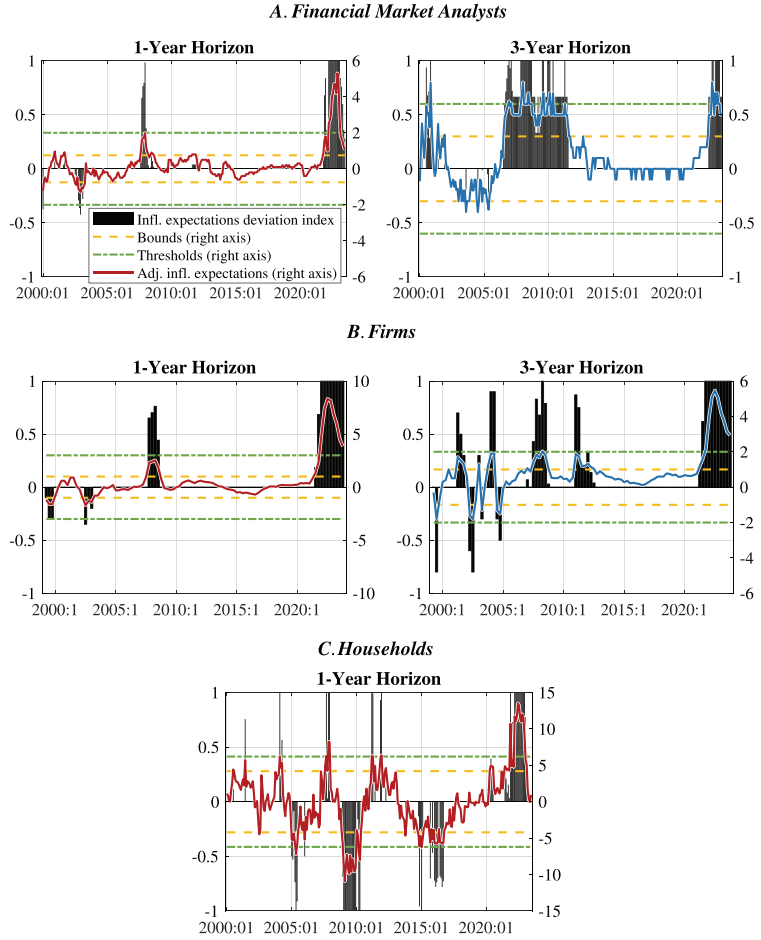
Note: The displayed numbers correspond to inflation expectations adjusted for the inflation target (and, in the case of households, also for the systematic long-term upward shift), as presented in Section 3.

In conclusion, the inflation expectations deviation indices collectively indicate a limited degree of inflation expectations anchoring across agents and horizons in the Czech economy during 2022–23. All proposed indices suggest a potential de-anchoring at the one-year horizon in 2022. However, as inflation started declining, corresponding expectations also decreased concurrently. This pattern suggests a connection between observed price dynamics and inflation expectations, indicating the partially adaptive nature of inflation expectations over the shorter horizon. Regarding the three-year horizon, the inflation expectations deviation indices convey a generally low degree of inflation expectations anchoring, on average, over the past two years. This implies that, over the medium term, inflation expectations have exhibited a level of persistence and have not been fully anchored to the central bank's target.

3.2 Common Inflation Expectations Index

As discussed previously, there are multiple sources of inflation expectations measures. To deliver a straightforward message, we construct a single indicator called the Common Inflation Expectations (CIE) index, as named by Ahn and Fulton (2020), that captures the common component of movements in inflation expectations across the

Figure 7. Inflation Expectations and Inflation Expectations Deviation Indices



Note: The displayed series resemble inflation expectations adjusted for the inflation target (and, in the case of households, also for the systematic long-term upward shift), as presented in Section 3.
Source: Authors' calculations.

economy. Ahn and Fulton (2020) constructed an economy-wide indicator for the United States based on information from more than 20 variables, including surveys, market-based measures, and other inflation expectations-related data. The authors used the dynamic

factor model approach to extract the central tendency from inflation expectations data as the first factor.

In our case, the data set is much less comprehensive, primarily due to limitations in the Czech financial markets, which lack complex financial instruments. For example, we do not have data on instruments like Treasury constant maturity securities, as is available in the United States. Additionally, Czech financial markets are shallower and less liquid than those of other developed countries. Instead, we utilize surveys of inflation expectations from households, firms, and financial market analysts. For households, we employ the same procedure as mentioned earlier and remove the data above the 75th and below the 25th percentile.[10]

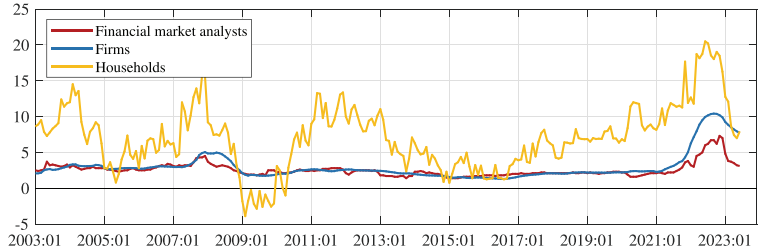
We restrict our data sources to surveys focused solely on one-year horizons to construct a composite index that offers a straightforward interpretation. This decision is also supported by our objective to apply the index in simulations with our core dynamic stochastic general equilibrium (DSGE) model g3+ (see Section 5), which is built on the assumption that the central bank reacts to expected deviations of inflation from its target at the one-year horizon.[11] As illustrated in Figure 8, the development of the selected inflation expectations is diverse. On one hand, expectations of firms and financial market analysts—the two agents in the economy most familiar with overall economic developments—display a strong comovement. On the other hand, households anticipate, on average, higher inflation, and their assessment of future price changes is more volatile and noisier than the other two.

We employ a principal component analysis (PCA) to find the single representative index of one-year horizon inflation expectations for the Czech economy. The first principal component, which we interpret as economy-wide inflation expectations index, captures over 80 percent of the variance in the original data set, indicating

[10]To check the sensitivity of the cutoff parameter, we also inspect different cutoff levels (namely 1 percent, 5 percent, 10 percent, 15 percent, and 20 percent). The choice of the cutoff level affects the mean of the remaining distribution, but particular series are level-shifted.

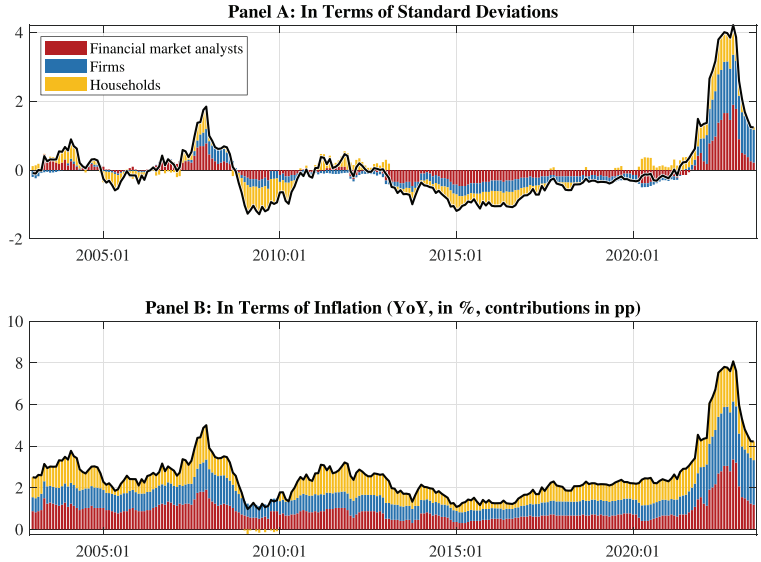
[11]We also tested the index by combining both types of horizons. The results from the subsequent analyses, presented in Section 4, were nearly identical to those obtained using the index based solely on one-year horizon expectations.

Figure 8. One-Year-Ahead Inflation Expectations (YoY, in %)



Source: CNB's Financial Market Inflation Expectations survey; survey conducted by the Confederation of Industry of the Czech Republic and the CNB; European Commission's Business and Consumer Surveys.

Figure 9. Common Inflation Expectations (CIE) Index



Source: Authors' calculations.

that it effectively summarizes the common movements in the surveyed expectations. This CIE index, along with its decomposition, is presented in Figure 9 (panel A).

The PCA-extracted CIE (PCA-CIE) index, by its construction, is expressed in standard deviations, with zero representing the sample-wide average. However, this metric is not particularly useful for daily forecasting or analyses. Moreover, it complicates interpretation for policymakers, making communication unnecessarily difficult. To enhance its applicability and ease of interpretation, we convert the PCA-CIE index into terms of price growth. This conversion into an inflation-like measure is complex and requires "destandardization." We begin by determining the parameters needed for the conversion. Specifically, we need to identify the standard deviation of observed inflation that meets the following criteria:

(i) the period is after 2010 (since then, the CNB has pursued an inflation target of 2 percent);
(ii) the mean of inflation (shifted 12 months ahead) is approximately 2 percent (and thus corresponds with the CNB's official inflation target).

The episode satisfying these two criteria is 2010–20, with the average inflation 12 months ahead around 2 percent and a standard deviation of 1.3. Next, we evaluate the mean of the PCA-CIE index over the identified period. As it is slightly negative (–0.4), the PCA-CIE index is shifted up by this constant so that the mean is zero and corresponds to the 2 percent inflation target over the 2010–20 period. Using these parameters, the CIE index in terms of the inflation measure is expressed as follows:

$$CIE_t = (CIE_t^{PCA} + 0.4) \times 1.3 + 2 \tag{3}$$

and is displayed in panel B of Figure 9.

The CIE index highlights various episodes in the Czech economy over the last 20 years. The most recent period of heightened inflation is particularly extraordinary, surpassing even past periods of surges, with inflation expectations reaching a peak of around 8 percent in the second half of 2022. Our decomposition analysis reveals that expectations from all economic agents significantly contributed to the overall elevation of inflation expectations in 2022. However, the situation normalized in 2023, primarily due to a correction in household expectations, bringing general expectations closer to 4 percent.

While firms and financial market analysts also lowered their expectations, they remain elevated. This scenario has significant implications for monetary policy, which are further discussed in detail in Section 5. The persistently elevated expectations among firms and financial market analysts indicate an ongoing challenge for monetary policymakers in managing inflation expectations and steering them toward the central bank's 2 percent inflation target.

4. Understanding Inflation and Inflation Expectations

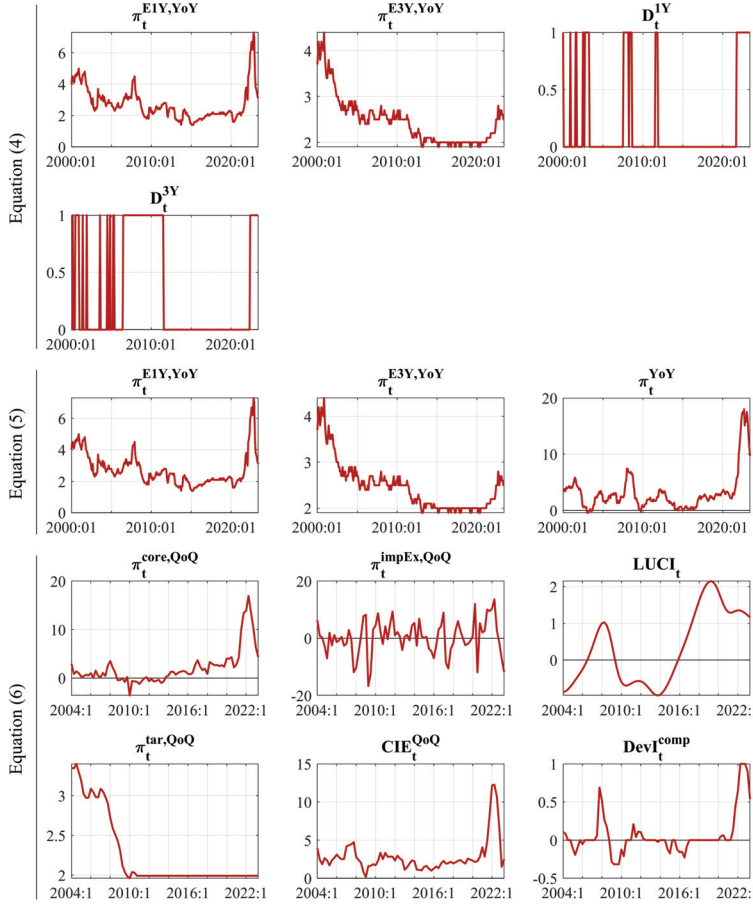
Inflation expectations play a crucial role in understanding the recent inflation upsurge, and it is vital to discern any changes in the formation of these expectations over the years 2022–23. First, we analyze the elasticity between one-year inflation expectations and three-year-ahead expectations. Additionally, we examine how inflation expectations behave in both low- and high-inflation periods. Further, we explore the connection between inflation expectations and the current dynamics of inflation. Lastly, we investigate the determinants of core inflation developments through the lens of the Phillips curve. We base our econometric analyses on the inflation expectations of financial market analysts.[12] Data used in estimations are summarized in Figure 10.

4.1 The Elasticity between Short- and Long-Term Inflation Expectations

The prevailing perspective in the literature, as reflected in studies such as Yetman (2020) and Corsello, Neri, and Tagliabracci (2021), suggests that developments in medium-term inflation expectations are considered independent of short-term ones. In an environment with a credible central bank, long-term inflation expectations—typically in the range of two to three years—should align closely with the inflation target, regardless of observed inflation. This implies

[12]It is noteworthy that we consider financial market analysts the most relevant and informed agents regarding the central bank's objectives, making their data particularly informative. Therefore, even slight shifts in financial market analysts' expectations, especially at the three-year horizon, warrant attention from central banks.

Figure 10. Data Used in Estimations in Section 4



Note: $\pi_t^{E,1Y}$ is inflation expectations of financial market analysts, one-year horizon (YoY); $\pi_t^{E,3Y}$ is inflation expectations of financial market analysts, three-year horizon (YoY); D_t^{1Y} is a dummy based on inflation expectations deviation index for financial market analysts, one-year horizon; D_t^{3Y} is a dummy based on inflation expectations deviation index for financial market analysts, three-year horizon; π_t^{YoY} is CPI inflation (YoY); $\pi_t^{core,QoQ}$ is core inflation (QoQ, annualized); $\pi_t^{impEx,QoQ}$ is import inflation excluding food and energy (QoQ, annualized); $LUCI_t$ is the labor utilization composite index; $\pi_t^{tar,QoQ}$ is the inflation target (QoQ, annualized) (used in variant (E2)); CIE_t^{QoQ} is the CIE index (QoQ, annualized) (used in variants (E3, E4)); $DevI_t^{comp}$ is the composite inflation expectations deviation index (used in variant (E4)).

that the effective management of inflation expectations ensures the autonomy of expectations over longer horizons from short-term ones and prevents long-term expectations from deviating significantly from the inflation target.

However, this narrative might change in a high-inflation environment. The dynamics of expectations could be influenced differently under conditions of elevated inflation. The impact of a prolonged period of high inflation on the interplay between short- and medium-term expectations may introduce complexities that deviate from conventional understanding in a low-inflation environment.

To investigate how elasticity changes under different degrees of inflation expectations anchoring, we use the inflation expectations deviation index as a dummy variable. Since we have separate deviation indices for one-year and three-year horizons, reflecting different impacts on inflation expectations anchoring, we introduce dummy variables for each horizon: D_t^{1Y} for the one-year horizon and D_t^{3Y} for the three-year horizon. These dummy variables take the value of zero when the inflation expectations are fully anchored, and the value of one otherwise.

The model for three-year inflation expectations $\pi_t^{E,3Y}$ is formulated as follows:

$$\begin{aligned}\pi_t^{E,3Y} = {} & \beta_0 + \beta_0^{1Y} D_t^{1Y} + \beta_0^{3Y} D_t^{3Y} \\ & + (\beta_1 + \beta_1^{1Y} D_t^{1Y} + \beta_1^{3Y} D_t^{3Y}) \pi_t^{E,1Y} + \epsilon_t, \end{aligned} \tag{4}$$

where β_0 represents the baseline inflation term premium, and β_0^{1Y} and β_0^{3Y} capture additional premiums when inflation expectations are de-anchored at the one-year or three-year horizon, respectively. Similarly, the baseline elasticity β_1 describes the relationship between one-year and three-year inflation expectations under full anchoring. However, this elasticity can change when inflation expectations become de-anchored, as reflected by the terms β_1^{1Y} and β_1^{3Y}, which adjust the elasticity based on the anchoring state of each horizon.

The data set covers the period of January 2000–June 2023, that is, more than 20 years. The results of model estimation are summarized in Table 2.

The estimation results reveal a slightly positive relation between long- and short-term inflation expectations when both are

Table 2. Elasticity between One- to Three-Year Inflation Expectations

Variable	
Full Degree of Anchoring	
Intercept	0.74***
	(0.0613)
$\pi_t^{E,1Y}$	0.66***
	(0.1091)
Weak Degree of Anchoring in 1Y	
(Intercept + D_t^{1Y})	2.35***
	(0.0613)
($\pi_t^{E,1Y} + D_t^{1Y} \times \pi_t^{E,1Y}$)	0.08
	(0.1193)
Weak Degree of Anchoring in 3Y	
(Intercept + D_t^{3Y})	1.11**
	(0.1423)
($\pi_t^{E,1Y} + D_t^{3Y} \times \pi_t^{E,1Y}$)	0.58***
	(0.1337)
Weak Degree of Anchoring in 1Y and 3Y	
(Intercept + $D_t^{1Y} + D_t^{3Y}$)	2.71***
	(0.1423)
($\pi_t^{E,1Y} + D_t^{1Y} \times \pi_t^{E,1Y} + D_t^{3\&} \times \pi_t^{E,1Y}$)	–0.01
	(0.1405)
Observations	282
R^2	0.78

Note: The numbers in parentheses represent standard errors. Statistical significance is indicated as follows: *$p < 0.10$ (significant at the 10 percent level), **$p < 0.05$ (significant at the 5 percent level), and ***$p < 0.01$ (significant at the 1 percent level).
Source: Authors' calculations.

well-anchored. Altogether with the intercept, the short-term expectations align with long-term ones at 2 percent on average. However, when the one-year horizon shows a lower degree of anchoring, elasticity drops significantly (from 0.66 to 0.08), while the intercept

increases. This suggests that elevated short-term expectations transmit to long-term expectations with reduced intensity but at a higher baseline level. In contrast, when three-year expectations become less anchored, the elasticity remains similar to the anchored state, but an additional premium emerges (rising from 0.74 to 1.10). When both short- and long-term expectations are elevated simultaneously, the elasticity approaches zero, and the premium exceeds the 2 percent target. When the premium exceeds the inflation target, it indicates that inflation expectations, particularly long-term ones, are becoming detached from the central bank's target, which can pose central bank credibility problem, as mentioned by Resler (1980).

4.2 How Current Inflation Affects Inflation Expectations

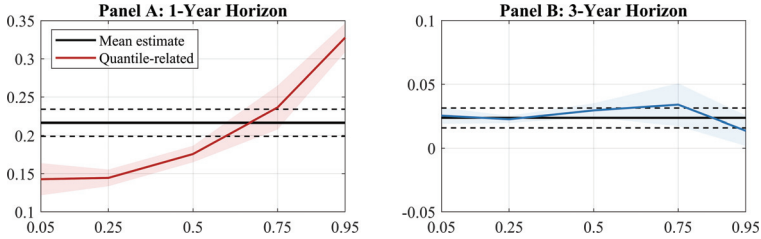
The evidence presented by Resler (1980) indicates that when a country experiences highly accelerating inflation, the most recent rate of inflation observation becomes more important for inflation expectation formation, while long-term anchors play a less important role. Therefore, policies that can successfully lower current inflation could gain important long-run outcomes by simultaneously inducing a reduction in inflation expectations. To examine how current inflation dynamics affect inflation expectations in high- and low-inflation periods, we employ a quantile regression approach and estimate the model in the following form:

$$\pi_t^{EiY,YoY} = \beta_0^i + \beta_1^i \pi_t^{YoY} + \epsilon_t, \tag{5}$$

where inflation expectations $\pi_t^{EiY,YoY}$ for the one- or three-year horizon are related to the year-over-year inflation rate π_t^{YoY}. The quantile approach is suitable, as it handles heteroskedasticity present in the recent inflation data and is robust against outliers in the response variable. Also, it can discover predictive relationships between variables in case of a weak link or no link between their means. Further, the quantile regression helps to explore asymmetry in periods of high and low inflation. In our analysis, we focus on examining the changes of the elasticity, β_1, in different inflation environments rather than on its value. Should there be any estimation bias originating from omitted variables, we assume it to be the same over quantiles.

Compared with previous estimations, we base this analysis on the data covering the period of January 2009–October 2023. The

Figure 11. Relationship between Inflation and Expectations—Quantile Regression



Note: The horizontal line displays quantiles. The shaded areas represent the 95 percent confidence interval of quantile estimates and the dashed lines represent the 95 percent confidence bands of the mean estimate.
Source: Authors' calculations.

results of the estimations for one- and three-year expectations are summarized in Figure 11. Additionally, we also provide mean estimates to examine how quantile estimates behave in relation to the average ones. The mean estimates indicate the slightly positive effect of current inflation on the evolution of short-term expectations (refer to panel A), suggesting the existence of an adaptive mechanism. In contrast, the impact of current inflation developments on three-year expectations is negligible (refer to panel B).

The quantile estimates for the one-year horizon reveal that periods with elevated expectations (as indicated by higher quantiles) exhibit higher elasticity. This suggests that current inflation strongly affects one-year expectations during these periods compared with standard ones. However, this pattern is not mirrored in long-term expectations, where there is only a negligible (almost zero) relationship between current inflation and inflation expectations, regardless of the quantiles considered.

4.3 Core Inflation Dynamics

As core inflation is the fundamental inflation component, central bankers pay special attention to its developments. Czech core inflation began to rise in mid-2021, peaking at double-digit figures by summer 2022—levels not seen in decades. During this period, the CNB's forecasts exhibited significant positive errors, indicating that

core inflation was driven by factors beyond the standard economic fundamentals.

To improve understanding of these dynamics, we estimate a Phillips curve (PC) model, following the framework of Beneš and N'Diaye (2004). The model links quarter-over-quarter (QoQ) annualized core inflation, $\pi_t^{core,QoQ}$, to its lag $\pi_{t-1}^{core,QoQ}$; a measure of economic slack represented by the labor utilization composite index, $LUCI_t$ as presented by Brůha, Ruschka, and Šolc (2024); quarter-over-quarter annualized import price inflation excluding food and energy prices, $\pi_t^{QoQ,impEx}$; and various measures of inflation expectations gathered in vector X_t. The adopted PC takes the following form:

$$\pi_t^{core,QoQ} = \beta_1 \pi_{t-1}^{core,QoQ} + \beta_2 LUCI_t + \beta_3 \pi_t^{impEx,QoQ} + \beta X_t + \epsilon_t. \tag{6}$$

We first estimate the model without inflation expectations and then introduce three specifications of inflation expectations:

(E1) no inflation expectations (traditional PC);

(E2) inflation expectations proxied by the inflation target (quarter-over-quarter, annualized);

(E3) inflation expectations proxied by the CIE index (quarter-over-quarter, annualized);

(E4) inflation expectations proxied by the CIE index (quarter-over-quarter, annualized) with extended pass-through.[13]

For the purposes of the (E4) specification, an interaction term of the CIE index and a composite inflation expectations deviation index is constructed and used as an explanatory variable. Based on individual inflation expectations deviation indices presented in Subsection 3.1, we construct a composite inflation deviation index

[13]By the term "extended pass-through," we refer to a change in the elasticity between inflation expectations and actual inflation. Economic agents may be more sensitive to price level movements in a high-inflation environment and may adjust prices with greater magnitude than when inflation is closer to the central bank's target.

using the individual deviation indices and weights retrieved from the construction of the CIE index. The composite inflation deviation index then scales inflation expectations as captured by the CIE index, which leads to their extended pass-through into core inflation in times of a deterioration of inflation expectations anchoring.

The data set spans 2004:Q1–2023:Q2, covering nearly 20 years. A rolling window regression of 15 years is used to capture the evolution of core inflation's drivers. The estimation results are summarized in Table 3.

Initial estimate (E1) of traditional PC suggests high persistence, which even increased to unity after mid-2021. At the same time, elasticity to economic slack β_2 decreased and lost significance during the high-inflation period. After adding the inflation target as a proxy for inflation expectations (E2), the estimated coefficients remained stable until mid-2021, after which the lagged inflation elasticity β_1 increased, indicating core inflation became more self-sustaining. The economic slack β_2 and inflation expectations elasticity β_3 declined to zero, losing statistical significance.

To assess performance of our Philips curves, we use averages of the estimated coefficients before mid-2021[14] to retrieve residuals of this form of PC, plotted in Figure 12 (yellow line). Both specifications fit the data well except during the core inflation spike after mid-2021.

Several factors may explain the model's performance shortcomings, including:

(i) omitted variable bias (for example, energy prices since an extraordinarily large energy price shock hit the domestic economy);

(ii) time-varying pass-through of inflation expectations to inflation developments;

(iii) some variables might be inappropriately approximated (for example, the assumption that inflation expectations remain well anchored at the inflation target might be too strong).

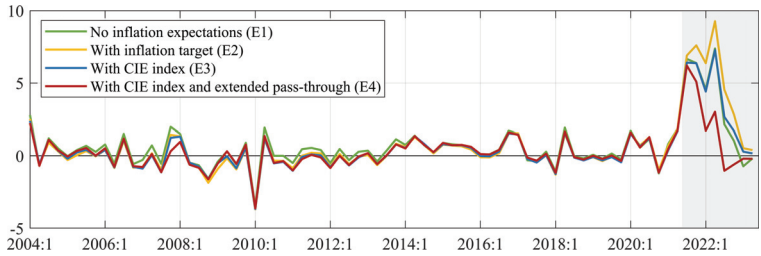
[14]The estimated coefficients proved to be relatively stable before mid-2021.

Table 3. Phillips Curve Estimates

	(E1)		(E2)		(E3)		(E4)	
Variable	**Pre-21:Q3**	**21:Q3+**	**Pre-21:Q3**	**21:Q3+**	**Pre-21:Q3**	**21:Q3+**	**Pre-21:Q3**	**21:Q3+**
π_{t-1}^{core}	0.64***	0.94***	0.47***	0.92***	0.51***	0.76***	0.52***	0.64***
	(0.11)	(0.08)	(0.13)	(0.09)	(0.12)	(0.10)	(0.12)	(0.13)
$LUCI_t$	0.44**	0.25	0.58***	0.25	0.53***	0.33	0.49***	0.48**
	(0.19)	(0.22)	(0.19)	(0.23)	(0.18)	(0.21)	(0.19)	(0.24)
$\pi_t^{imp,ex}$	0.01	0.07**	0.01	0.07**	0.01	0.05	0.01	0.05*
	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)	(0.03)
π_t^{tar}			0.16***	0.07				
			(0.06)	(0.10)				
CIE_t					0.15***	0.24***	0.13**	0.21**
					(0.06)	(0.09)	(0.06)	(0.09)
$CIE_t \times DevI_t^{comp}$							0.35	0.36*
							(0.26)	(0.21)
No. of Windows	11	8	11	8	11	8	11	8
Obs./Window	60	60	60	60	60	60	60	60
Average R^2	0.67	0.85	0.71	0.86	0.71	0.88	0.72	0.88

Note: Pre-21:Q3 period marks the average of rolling window estimates covering quarters 2004:Q1 until 2021:Q2. 21:Q3+ period covers the average of rolling window estimates related to quarters 2021:Q3 until 2023:Q2. The numbers in parentheses represent average standard errors. Statistical significance is indicated as follows: $*p < 0.10$ (significant at the 10 percent level), $**p < 0.05$ (significant at the 5 percent level), and $***p < 0.01$ (significant at the 1 percent level).
Source: Authors' calculations.

Figure 12. Residuals from Estimated Phillips Curves (QoQ annualized growth rate, in %)



Note: Residuals are retrieved from PCs with fixed coefficients; the shaded area highlights the period starting mid-2021.
Source: Authors' calculations.

To identify contribution of inflation expectations to explaining the inflation surge, we estimate the PC with the CIE index (E3) and with the modified pass-through of inflation expectations (E4).[15] The model with CIE index (E3) shows an improved fit compared with the basic PC model (E1), particularly after mid-2021, demonstrating a more significant role of inflation expectations in core inflation developments. Adjusting the pass-through based on inflation anchoring (E4) further explains much of the inflation dynamics, although some part remains unexplained, especially in the second half of 2021, likely due to high energy prices affecting production costs.

In conclusion, elevated inflation expectations significantly contributed to the recent inflation surge but do not fully explain the observed levels of inflation. The inclusion of the CIE index enhances the understanding of inflation dynamics, providing a nuanced view of expectations. Integrating it into the PC model with a more flexible pass-through of inflation expectations improves the model's accuracy in capturing inflation trends, especially during periods of increased economic uncertainty.

[15] We also conducted alternative estimations using individual series instead of the CIE index. The estimation with the CIE index consistently produced the lowest residuals, outperforming individual series by several percentage points.

5. Extending the CNB's Core Projection Model with Elevated Inflation Expectations

Using the previous outcomes, we amend the CNB's g3+ core projection model to translate the findings regarding the inflation expectations into monetary policy implications. The g3+ model, a microfounded New Keynesian dynamic stochastic general equilibrium (NK DSGE) model, assumes rational expectations, meaning that model agents—households, firms, and policymakers—form expectations based on a comprehensive understanding of the economy, including the model and its parameters. However, this assumption may not always align perfectly with reality, as expectations derived from survey results might deviate from those implied by the model.[16] This might be due to limited informational resources; agents might have incomplete knowledge about the economy and insufficient ability to understand and interpret it, for example, due to large shocks (Borgea, Bardsen, and Maih 2020). While the discrepancy between model- and data-based expectations is typically negligible in standard times, it has become more significant in the past two years due to elevated inflation, becoming increasingly relevant for policy analyses using our core forecasting model. In light of this, we modify, among others, the mechanism of forming inflation expectations in the g3+ model to bring model inflation expectations closer to survey results and to be able to assess the macroeconomic effects associated with elevated inflation expectations.

Research in the area of expectations is vast, often seeking to reconcile observed reality with various approaches to modeling expectations. Notable contributions include Sims (2003), who introduces the concept of rational inattention. Slobodyan and Wouters (2012) delve into learning mechanisms within a large NK DSGE model. Evans and Honkapohja (2007) also suggest that a learning mechanism can be a factor behind the inflation persistence and advocate for more aggressive monetary policy response if inflation

[16]The g3+ model assumes limited information rational expectations (see Brázdik et al. 2020), but the potential discrepancy remains.

expectations persistently deviate from the rational expectations. Heterogeneity in expectations is explored by De Grauwe (2011). Bertasuite, Massaro, and Weber (2020) analyze the policy implications of behavioral expectations. Additionally, Borgea, Bardsen, and Maih (2020) implement the Markov-switching mechanism in expectations. All these studies attempt to challenge the traditional paradigm of rational expectations in DSGE model frameworks, striving to bring expectation formation closer to reality. However, from the practical standpoint of professional forecasters, these methods may be beyond the scope, as they fundamentally alter the nature of the modeling framework in use.

Nonetheless, there are practical policy-oriented papers at the intersection of elevated/de-anchored inflation expectations, offering what we consider a more plausible way of adjusting inflation expectations in the modeling framework without completely altering the underlying assumption of rational expectations. For instance, Argov et al. (2007) assume that inflation expectations are a weighted combination of forward-looking and backward-looking components. Simultaneously, they differentiate between low- and high-inflationary episodes, ensuring that model inflation expectations behave differently during periods of high inflation than in standard times. Similarly, Beneš et al. (2017) implement an approach where the lack of central banks' credibility leads to de-anchored inflation expectations. Alichi et al. (2009) introduce a mechanism in which inflation expectations switch between the official inflation target and the perceived elevated inflation target. This mechanism ensures that household-formed inflation expectations deviate from those of the central bank, allowing for a more assertive policy response to bring inflation expectations (and inflation) back to the official target. Coibion and Gorodnichenko (2015) incorporate the U.S. inflation expectations survey data into the New Keynesian Phillips curve (NKPC) and find that the rise in the household inflation expectations can explain the missing disinflation of 2009–11. Their findings highlight possible benefits of integrating available information about the inflation expectations into the NKPC for economic analysis.

5.1 Modeling Elevated Inflation Expectations within the NKPC

Our approach is close to the one proposed by Alichi et al. (2009) and leads to a modification of the pricing equation in the model, the NKPC.[17] The original Phillips curve in the consumer sector in the g3+ model is formulated as follows:

$$\pi_t^N = \frac{1}{1+\beta}\pi_{t-1}^N + \frac{\beta}{1+\beta}\mathbb{E}_t(\pi_{t+1}^N) + \frac{(1-\beta\xi_C)(1-\xi_C)}{\xi_C}\mu_C mc_{C,t}^r + \epsilon_t^C, \tag{7}$$

where π_t^N is net inflation[18] with $E_t(\pi_{t+1}^N)$ being its expected value, $mc_{C,t}^r$ represents real marginal costs in the consumer sector, β is the discount factor, ξ_C is the Calvo parameter in the consumer sector, μ_C represents a fixed markup, and ϵ_t^C is the price shock. Thus, inflation is determined by its backward-looking element, forward-looking element, and the pricing policy of firms up to an exogenous shock.

We modify the forward-looking component of the Phillips curve by introducing an additional element that captures the anticipated deviation of inflation from the official central bank's target. This new term influences the mechanisms for forming inflation expectations, in addition to those derived under model-based rational expectations. Importantly, it does not alter the official inflation target, indicating that the central bank's role remains consistent with the baseline model, and it remains committed to the same numerical

[17]Unlike Alichi et al. (2009), we do not specify two distinct regimes of inflation expectations in the economy (anchored and high-inflationary) or model the nonlinear switching process between them. Instead, we consider a continuous inflation expectations process. In addition to the complexities associated with a highly nonlinear macroeconomic model, we also found it challenging to define a high-inflationary regime for the Czech economy based on historical experience. The only significant high-inflationary episode before 2021 occurred in the early 1990s, during the transition from a centrally planned to a market economy. We concluded that this episode was too unique and specific to influence the formation of inflation expectations today.

[18]Net inflation is calculated as the growth in prices in the unregulated part of the consumer basket adjusted for changes in indirect taxes and for the abolition of subsidies.

value of the target. The modified version of Equation (7) is given as follows:

$$\pi_t^N = \frac{1}{1+\beta}\pi_{t-1}^N + \frac{\beta}{1+\beta}\mathbb{E}_t(\pi_{t+1}^N + \pi_{t+1}^{dev}) + \frac{(1-\beta\xi_C)(1-\xi_C)}{\xi_C}\mu_C mc_{C,t}^r + \epsilon_t^C, \quad (8)$$

where π_{t+1}^{dev} is the anticipated deviation of inflation from the official central bank's target. It is modeled as an autoregressive process of order one, AR(1), with a component reflecting observed deviations of inflation from the target in the past:[19]

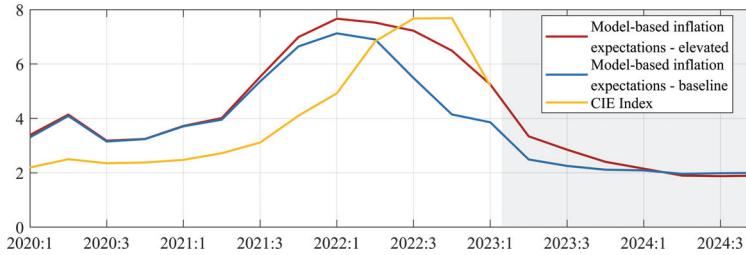
$$\pi_t^{dev} = \rho_{\pi^{dev}}\pi_{t-1}^{dev} + (1-\rho_{\pi^{dev}})\nu_{\pi^{dev}}\frac{\pi_{t-1}^4 - \pi_{t-1}^{tar}}{4} + \epsilon_t^{\pi^{dev}}. \quad (9)$$

Here, π_t^4 is the year-over-year inflation rate, π_t^{tar} is the year-over-year inflation rate target; $\rho_{\pi^{dev}}$ and $\nu_{\pi^{dev}}$ are the AR parameter and the elasticity, respectively; and $\epsilon_t^{\pi^{dev}}$ is a shock. The elasticity $\nu_{\pi^{dev}} \in [0,1]$ governs the intensity of the pass-through of the observed inflation target misalignment into the expected inflation. Setting $\nu_{\pi^{dev}}$ to zero results in no endogenous mechanism of elevated inflation expectations, while keeping it at one leads to the full pass-through. We limit $\rho_{\pi^{dev}}$ to be in interval $(0,1)$.[20] It is important to mention that the model specification is symmetric, that is, inflation expectations are altered upward (downward) in cases where inflation has been above (below) the target in the past.

[19] We also considered an alternative specification with the distributed effect of past deviations of observed inflation from the target: $\pi_t^{dev} = \rho_{\pi^{dev}}\pi_{t-1}^{dev} + (1-\rho_{\pi^{dev}})\nu_{\pi^{dev}}\sum_{i=1}^4(\pi_{t-i}^4 - \pi_{t-i}^{tar})/4 + \epsilon_t^{\pi^{dev}}$. This specification would increase inflation expectations persistence, resulting in additional inflationary pressures that are slower in response but more challenging to manage. However, we found that the persistence of the π_t^{dev} could be effectively adjusted using the $\rho_{\pi^{dev}}$ parameter, rendering the additional persistence feature unnecessary.

[20] Allowing $\rho_{\pi^{dev}}$ to take one would permanently enable inflation expectations to deviate from the target should there be no appropriate policy response and could indicate a long-run de-anchoring of inflation expectations. At the same time, such a setting leads to the nonstationarity of the model. We do not want to explore this ground, as we are not identifying de-anchored inflation expectations in the Czech Republic but elevated ones characterized by a low degree of anchoring.

Figure 13. Model-Based Inflation Expectations and the CIE Index (Expected Inflation at the One-Year Horizon, YoY, in %)



Note: The shaded area depicts the forecast horizon.
Source: Authors' calculations.

An appropriate calibration of the AR process in Equation (9) allows us to bring model-based inflation expectations closer to the underlying CIE index. Additionally, the introduction of an exogenous shock enables us to incorporate additional information on top of the endogenous mechanism, such as outcomes from additional analyses or expert views. Figure 13 illustrates the role of elevated inflation expectations in the modeling framework and the use of the CIE index.[21] While model-consistent inflation expectations began to increase significantly in 2021, similar to the CIE index, they started to decrease in 2022, whereas the CIE index had yet to peak. A positive difference between the CIE index and model-consistent inflation expectations emerged, indicating the risk of elevated inflation expectations with a low degree of anchoring. The calibration of the modified model with elevated inflation expectations is chosen such that model-consistent inflation expectations align more closely with the course of the CIE index in 2022 and especially in the first quarter of 2023. In the first quarter of 2023, model-consistent inflation

[21]It is important to note that model-based inflation expectations don't directly match survey-based ones because they are derived differently. Surveys reflect respondents' one-year forecasts without consistency requirements with other economic outlooks or past behavior, while model-based expectations are based on selected data and conditioning information to ensure internal consistency. Even though the model framework can place more weight on specific issues via expert judgment, these differences make direct one-to-one comparisons difficult.

expectations at the one-year horizon are thus roughly 1.5 percentage points higher than in the baseline scenario.

Our structural implementation of the modified formation of inflation expectations into the model represents the primary mechanism through which elevated inflation expectations manifest themselves. However, additional channels can be considered when assessing the broader economic impact of elevated inflation expectations (see Subsection 5.2).

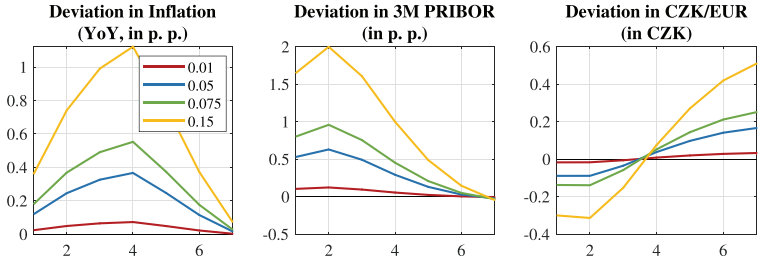
5.1.1 Simulating Impacts of Elevated Inflation Expectations

In the extended model, higher inflation expectations lead to higher inflation primarily through the price-setting behavior of firms. This expectation-driven inflation becomes self-reinforcing: as firms and households act on their elevated expectations, actual inflation rises, which further validates their expectations. However, the central bank responds to these elevated expectations by increasing interest rates, which tightens monetary conditions. The increase in interest rates lead to an appreciation of the Czech koruna, as the interest rate differential with the euro opens. This currency appreciation helps mitigate some of the inflationary pressure by reducing import prices. Thus tighter monetary conditions are necessary to steer inflation back to the target.

The elasticity parameter $\nu_{\pi^{dev}}$ controls the intensity of the pass-through of the observed inflation-target misalignment. A higher value of $\nu_{\pi^{dev}}$ implies a stronger link between expectations and realized inflation, leading to a more significant inflationary impact.

The model simulations, shown in Figure 14, highlight that higher values of elasticity result in more pronounced inflationary effects and require a more aggressive monetary policy response. We do not present impulse response functions for specific shocks because the endogenous mechanism of elevated inflation expectations manifests primarily through the identification of shocks during the filtering stage. The initial conditions of the forecast play a crucial role in shaping the outcomes. Therefore, we compare the baseline scenario with alternative simulations featuring elevated inflation expectations under varying parameterizations and present the results as deviations from the baseline. This approach is consistent across other model modifications (see the next subsection).

Figure 14. Results for Extended Model with Elevated Inflation Expectations



Note: The trajectories presented above are the differences with respect to the baseline simulation without elevated inflation expectations. The simulations are based on calibration $\rho_{\pi^{dev}} = 0.5$ and different values of $\nu_{\pi^{dev}}$.
Source: Authors' calculations.

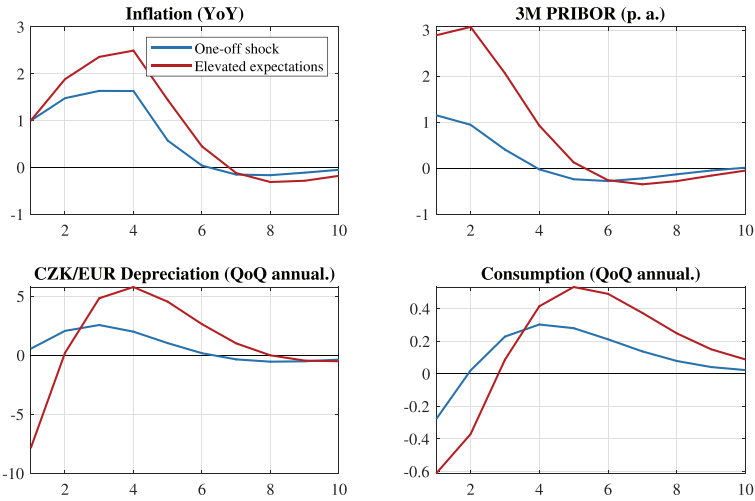
While inflation ultimately converges to the target, the adjusted path differs significantly for the policy response in initial quarters of simulation.

5.1.2 Inflation Dynamics: One-Off Shock vs. Elevated Inflation Expectations

In the following exercise, we illustrate the difference between a situation where an increase in inflation results from a one-off nonpersistent shock in the Phillips curve and a situation where an increase in inflation is interpreted as a manifestation of elevated inflation expectations. Figure 15 shows the responses to a one-off cost-push shock and a shock in expected inflation that both deliver a 1 percentage point increase in year-over-year CPI inflation on impact.

In the scenario of a cost-push shock, inflation rises as a result of an upward shift in firms' profit margins. In the periods following the shock, the impact of inflation persistence initially dominates, leading to continued slight growth in year-over-year inflation. However, the subsequent decline in profit margins, coupled with the effects of monetary tightening, eventually prevails, causing inflation to return to the target in the subsequent quarters. The monetary restriction and transmission operate through two primary channels: exchange rate appreciation and the suppression of domestic demand.

Figure 15. One-Off Cost-Push Shock vs. Shock in Inflation Expectations (deviation, in %)



Note: The impulse responses presented here are based on the extended model with calibration $\rho_{\pi^{dev}} = 0.5$ and $\nu_{\pi^{dev}} = 0.1$. The responses are measured in percentage deviations from the steady state.
Source: Authors' calculations.

In the second case, following the shock in inflation expectations, the profit margin experiences an endogenously driven increase. Consequently, the subsequent decline in the profit margin back to the steady state is more gradual, maintaining year-over-year CPI inflation at higher levels than the cost-push shock scenario. Consequently, a more substantial monetary policy response is required to guide inflation (and expectations) back to the 2 percent target at the monetary policy horizon. The impact on exchange rate appreciation and the moderation of domestic demand, as reflected in households' consumption, is also more pronounced compared with the transitory price shock.

5.2 Additional Impacts via the UIP Condition

Empirical studies, such as International Monetary Fund (2018), Levieuge, Lucotte, and Ringuedé (2018), or Carrière-Swallow et al. (2021), show that high inflation and conversely inflation expectations

lead to overall higher macroeconomic fragility and instability potentially triggering capital outflows from the economy. As a result, the exchange rate may come under pressure and weaken. The exceptionality of the situation also plays a role. Historically, Czech inflation targeting has been successful since the Global Financial Crisis in 2008. The surge in inflation of 2021–23 can be seen as an extraordinary event, adding further pressure on the exchange rate. Therefore, we consider the additional impact of the elevated inflation expectations on the exchange rate via the uncovered interest rate parity (UIP) condition.[22] To enhance feedback between elevated inflation expectations and exchange rate developments, we implemented approach as used by Chansriniyom, Epstein, and Nalban (2020).

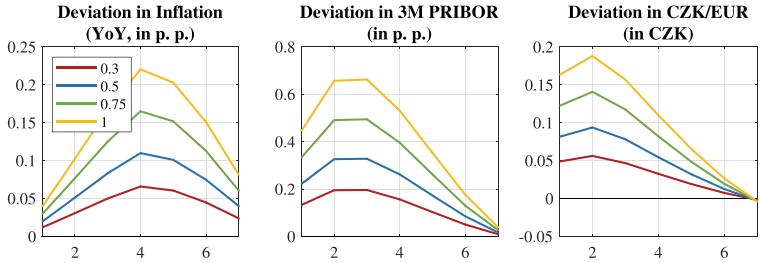
We add an additional risk premium term to the UIP condition that reflects perceived deviation of inflation from the target π_t^{dev}, which is weighted by the elasticity ν_{uip}. If the deviation increases (decreases), the pressure to weaken (strengthen) the exchange rate becomes stronger. Therefore, the model specification is symmetric, similar to the adjustment of the price equation. The modified UIP condition has the form

$$\begin{aligned} i_t - i_t^* = \rho_s \mathbb{E}_t \left(\Delta s_{t+1}\right) - (1-\rho_s)\Delta s_t \\ + 2(1-\rho_s)\Delta s_{SS} + \nu_{uip}\pi_t^{dev} + \kappa_t^{uip}, \end{aligned} \tag{10}$$

where i_t and i_t^* stand for domestic and foreign nominal interest rates; Δs_t and Δs_{SS} are the depreciation of the CZK/EUR exchange rate and its steady-state rate, respectively; κ_t^{uip} includes exchange rate shocks (short- and long-term ones) and the effect of the net foreign asset position (nominal trade balance); ρ_s governs the forward-looking nature of the UIP condition; and $\nu_{uip} \in [0, 1]$ regulates the pass-through of elevated inflation expectations into the exchange rate developments.

[22]The simulation of elevated inflation expectations without considering the additional effects via the UIP condition initially results in a stronger currency than in the baseline simulation. This is in contradiction to the empirical studies presented in the past. As discussed further, the strength of the "UIP channel" is governed by the selected parameterization and offers high flexibility in the strength of this particular effect.

Figure 16. Extended Model with Elevated Inflation Expectations and Modified UIP Condition



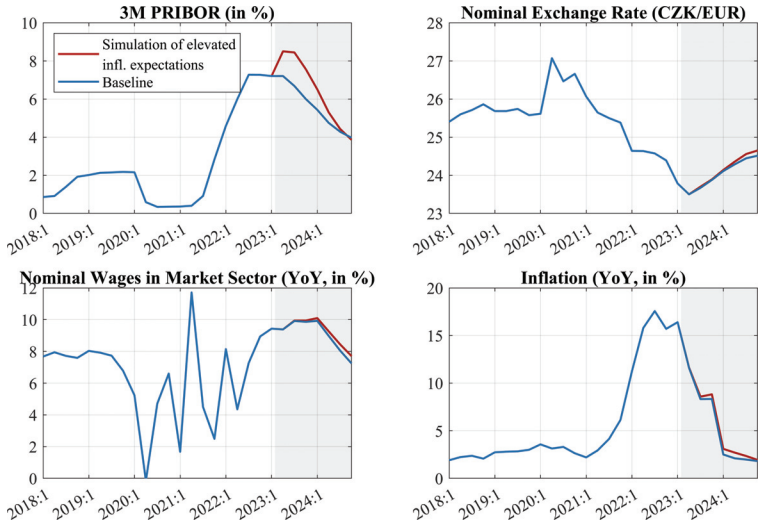
Note: The trajectories presented above are the differences with respect to the simulation with elevated inflation expectations and no change in the UIP condition. The simulations are based on calibration $\rho_{\pi^{dev}} = 0.5$, $\nu_{\pi^{dev}} = 0.1$ and different values of ν_{uip}.
Source: Authors' calculations.

Figure 16 illustrates the characteristics of the extended model with elevated inflation expectations and an additional impact through the UIP condition, as outlined in Equation (10). An additional pro-inflationary effect arises from the latent pressure for a more pronounced weakening of the Czech koruna against the euro. However, this effect is considered in the endogenous reaction of the central bank, resulting in higher interest rates. The additional monetary policy tightening largely offsets the depreciation of the Czech koruna. The increased interest rate differential enhances the attractiveness of the koruna, preventing significant depreciation and ensuring the achievement of the inflation target within the monetary policy horizon. The primary impact of this channel is, therefore, evident in the central bank's response through interest rates, with other effects remaining relatively subdued. Thus, in the case of elevated inflation expectations, the policy response should be more substantial not only due to expectations themselves but also because of their implications for exchange rate depreciation.

5.3 Monetary Policy Simulation

To stress the importance of the extended g3+ model with elevated inflation expectations according to the CIE index, we present a version of a monetary policy simulation from the CNB's Monetary

Figure 17. Simulation of Elevated Inflation Expectations



Note: The shaded area represents the forecast horizon.
Source: Authors' calculations.

Policy Report in spring 2023.[23] The simulation shows the macroeconomic effects in the event of inflation tending to decline more gradually than considered in the baseline scenario due to elevated inflation expectations. The calibration of the extended model to $\rho_{\pi^{dev}} = 0.5$ and $\nu_{\pi^{dev}} = 0.072$ was chosen so that inflation expectations in the model approximate the course of the CIE index in 2022 and especially in 2023:Q1. We additionally assume that the deviation of inflation expectations from the 2 percent target is reflected in a deterioration in sentiment on the foreign exchange market, which increases the risk premium and exerts additional depreciation pressure on the koruna. To model this, we set the elasticity ν_{uip} to 1.[24]

Figure 17 presents the baseline forecast from CNB's Monetary Policy Report in spring 2023 alongside the simulation with elevated

[23]The original simulation is presented in the Monetary Policy Report in spring 2023. Here, we present a simplified version of the simulation without additional assumptions related to interest rate developments.

[24]A particular calibration may reflect a specific inflationary period and may thus change over time.

inflation expectations. Elevated inflation expectations fundamentally influence economic agents' decisions, leading to additional inflationary pressures in the economy, particularly in faster nominal wage growth. The heightened risk premium also contributes to increased depreciation pressure, resulting in a weaker koruna over the forecast horizon. In response, the central bank implements interest rate hikes. While this reaction is not entirely effective in fully offsetting the impact of elevated inflation expectations, it is adequate to bring inflation back to the target, albeit with a slight delay compared with the baseline scenario.

6. Conclusion

Inflation expectations and their steering via central banks' actions are the key to successful and efficient monetary policy operating within the inflation-targeting regime and framework. The recent period of high inflation has prompted us to thoroughly examine inflation expectations, with the aim of understanding their fundamentals and development as well as, and more importantly, discerning the implications for monetary policy decision-making. To address elevated inflation expectations, we conducted several analyses to assess the degree of inflation expectations anchoring over the years 2022–23. Furthermore, our goal was to comprehend how inflation expectations are formed and how they contribute to inflation developments, both in high- and low-inflation environments. Additionally, we developed an economy-wide inflation expectations index (the CIE index) to provide a concise expectations indicator with a clear interpretation of the inflation expectations data. Furthermore, we adjusted our g3+ structural core projection model to endogenously incorporate elevated inflation expectations. This adjustment allowed us to offer relevant policy recommendations.

Our work yields results across multiple dimensions. The analyses revealed that different groups (households, firms, and financial markets) perceive inflation differently, leading to distinct expectation formation. This diversity contributes to uncertainties surrounding expectations. The inflation expectations deviation indices indicated periods of a low degree of short-term expectations anchoring. This suggests that expectations, particularly in the short term, may not align closely with established targets. The findings highlighted the

adaptive formation of inflation expectations in the short term, with a more pronounced inflation pass-through during high-inflation periods. This adaptive behavior underscores the responsiveness of expectations to current economic conditions. Moreover, our analysis of core inflation dynamics using the Phillips curve identified short-term inflation expectations as a primary driver behind the recent inflation surge in the Czech economy. Despite changes in short-term expectations, there are no substantial observed changes in the formation of inflation expectations over a longer horizon compared with more standard times. The construction of a simulation utilizing the g3+ extended projection model and the CIE index provided policy-relevant insights for addressing high inflation. This approach enables a more nuanced understanding of the potential effects of policy measures in the context of elevated inflation expectations.

The extended version of the CNB's g3+ core projection model, allowing for aligning with the characteristics of the CIE index, provides a practical tool for understanding how inflation expectations influence inflation. Although survey-based inflation expectations may demonstrate nonlinear behavior and time-varying elasticities in different phases of economic cycles, this tool creating alternate scenarios has proven to be valuable for supporting real-time policy analysis. In fact, the resulting scenario was included in the Czech National Bank's Monetary Policy Report in spring 2023.

Confirming de-anchored inflation expectations with certainty is challenging, but the rise of elevated inflation expectations presents significant risks, requiring an active monetary policy response. It is essential for the central bank to closely monitor short-term inflation expectations, as their propagation into long-term expectations may be detrimental and burdensome for achieving the central bank's objectives, such as meeting the inflation target. In an environment of elevated short-term inflation, the central bank should employ advanced analytical and projection tools that explicitly account for this information. Relying solely on standard modeling assumptions, such as anchored inflation expectations, may prove counterproductive. Instead, effective communication and decisive policy actions are vital to tightening monetary conditions and guiding inflation back to target within the monetary policy horizon. Proactive measures are essential to prevent elevated expectations from worsening the overall inflationary environment.

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