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EXECUTIVE BOARD MEETING

EBS/23/93

September 5, 2023

To: Members of the Executive Board

From: The Secretary

Subject: **October 2023 World Economic Outlook—Analytical Chapter 2 and Online Annex**

Board Action:	Executive Directors' **consideration** (Formal)
Tentative Board Date:	**Tuesday, September 26, 2023**
Publication:	Yes, it is intended that the full set of the World Economic Outlook documents will be released to the public at the time of World Economic Outlook press conference, tentatively scheduled for **Tuesday, October 10, 2023.** The analytical chapters will be made available to the public on the IMF website in advance of the publication of the full document.
Questions:	Mr. Bluedorn, RES (ext. 35392) Ms. Albrizio, RES (ext. 39943)
Additional Information:	The paper will be revised for publication in light of the Executive Board discussion. If Executive Directors have additional comments, they should notify Mr. Bluedorn and Ms. Albrizio by **5:30 p.m. on Friday, September 22, 2023**.

CHAPTER 2

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CHAPTER 2

MANAGING EXPECTATIONS: INFLATION AND MONETARY POLICY

Inflation reached multi-decade highs in many economies in 2022. While headline inflation has since come down as supply chain disruptions have eased and commodity prices declined, core inflation remains elevated. The specter of high inflation becoming embedded in expectations and leading to pricing choices that keep inflation high haunts central banks. This chapter unpacks recent patterns in inflation expectations and studies their role in driving inflation, and the implications for monetary policy. Expectations from professional forecasters, financial markets, households, and a new indicator for firms' views agree about broad inflation dynamics. Historical episodes where inflation expectations rose over a sustained period of at least a year suggest that it takes about three years for inflation and near-term (over the next 12 months) inflation expectations to come back to pre-episode levels on average, given historical monetary policy reactions. Although long-term (five years in the future) inflation expectations have generally remained anchored on average, near-term expectations have risen markedly across economies since 2022. Empirical estimates of the expectations channel point to the growing importance of near-term expectations for understanding inflation dynamics. Using a new macroeconomic model with a mix of forward- and backward-looking learners, analysis shows how economies with greater shares of more backward-looking learners prolong price pressures and diminish the potency of monetary policy, since such agents do not consider the future impacts of monetary policy. The share of backward-looking learners in the economy is estimated to be larger in emerging market than advanced economies. By fostering an increase in the share of forward-looking learners, improvements in monetary policy frameworks and central bank communication strategies can help bring inflation back to target more quickly and at a lower output cost—in other words, it can increase the chances that the economy makes a "soft landing."

Introduction

In the wake of the shocks of the COVID-19 pandemic and Russia's invasion of Ukraine, inflation around the world reached multi-decade highs in 2022, well above central bank targets, particularly in advanced economies (see Chapter 1, Figure 1.6). As policy tightening gradually rebalances aggregate demand towards potential output, supply chain disruptions have eased, and commodity prices have declined, headline inflation is coming down, but underlying price pressures (as captured by core inflation) remain elevated. Professional forecasters expect inflation rates will return closer to central banks' targets in 2024, with a shift in their median deviation toward zero and a sharp narrowing of the distribution (Figure 2.1).[1] However, they also expect that, given the current contractionary stance and anticipated policy action going forward, it will take two to three years for rates to be fully back at targets on average.

Since consumption and investment decisions as well as price and wage-setting processes partly reflect households' and firms' expectations about the future pace of price changes, inflation expectations play a critical role in shaping inflation dynamics. Amid this higher inflation environment, some observers have expressed concerns that expectations could remain elevated

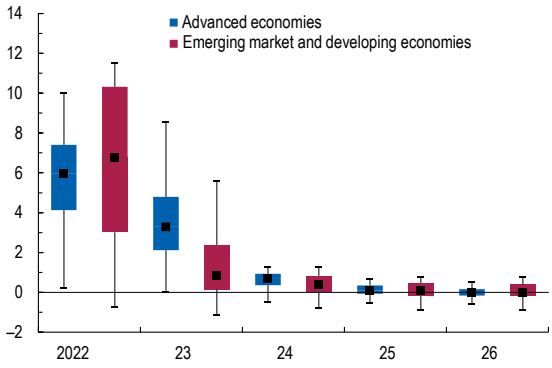
The authors of this chapter are Silvia Albrizio (co-lead), John Bluedorn (co-lead), Allan Dizioli, Christoffer Koch, and Philippe Wingender, with support from Yaniv Cohen, Pedro Simon, and Isaac Warren. Arash Sheikholeslam and Mona Wang provided computational and technical assistance. Yuriy Gorodnichenko was an external consultant. The chapter benefited from comments by Robert Rich and internal seminar participants and reviewers.

[1] Professional forecasters are typically private-sector forecasters and do not include IMF forecasters that contribute to the *World Economic Outlook* (WEO) forecasts. See Consensus Economics' criteria for inclusion in their survey for further details.

or even rise further, and long-term expectations de-anchor from target inflation rates. In turn, expectations that future inflation will rise could feed into current inflation rates, keeping them high. If an expectations channel for inflation is important, it also means that policies that bring expectations down could help to lower inflation more quickly and easily. The idea is that the more effective monetary policymakers are in influencing inflation expectations, the lower the cost in forgone output involved in central banks achieving their inflation objectives (Ball 1994; Sargent 1983). In other words, the expectations channel is critical to whether central banks can achieve the elusive "soft landing" of bringing the inflation rate down to target without a recession.

Figure 2.1. Cross-Economy Deviations of Inflation Expectations from Targets
(Percentage points)

Inflation rates are expected to revert to targets, but only gradually over the next two years.



Sources: Consensus Economics; and IMF staff calculations.
Note: Inflation expectations in the figure are from professional forecasters, in order to maximize economy coverage. For each economy group, the boxes denote the upper quartile, median, and lower quartile of the distribution, while the whiskers show the maximum and minimum within the boundary of 1.5 times the interquartile range.

The relevance of inflation expectations for an economy's inflation dynamics likely depends on the prevailing context and recent experience, as well as on the measures of inflation expectations considered (for example, near- versus long-term mean expectations). In general, when expected inflation is systematically far from actual inflation (that is, the classic rational expectations assumption is violated), what expectations measure is most salient for understanding inflation dynamics is an open question (Werning 2022). When inflation is low and stable at central bank targets, economic agents may become inattentive, reducing the information content of expectations (Coibion and others 2020). This may have characterized the situation in many advanced economies prior to the COVID-19 pandemic (Reis 2021). However, when inflation rises sharply or becomes volatile, then economic agents may become more attentive and expectations may become an important driver of actual inflation.

Motivated by these considerations, this chapter aims to contribute to the large and growing literature on inflation expectations, by examining alternative indicators of inflation expectations, their importance for inflation dynamics, and how their behavior may influence monetary policy effectiveness and vice versa.[2] It will address the following questions:

- How have inflation expectations across different agents and at alternative horizons behaved pre- and post-pandemic across economies? Are there signs of inflation expectations deanchoring since 2021? Or do the rapid interest rate hikes over 2022 appear to have contained risks?

[2] Recent IMF policy contributions on the topic include: Chapter 3 of the October 2018 *World Economic Outlook* (WEO) which concluded that more anchored inflation expectations improve the economic resilience of emerging market economies; Chapter 2 of the October 2021 WEO which presented evidence that long-term inflation expectations remained anchored post-pandemic; and Chapter 2 of the October 2022 WEO which found that the explanatory power of inflation expectations for wages post-pandemic had grown and that strong action by monetary policy to counter inflationary shocks could help ensure expectations remain anchored. Among the notable recent empirical and theoretical contributions on the topic of inflation expectations in the academic literature, see Bems and others (2021), Binder (2017), Coibion and others (2020), and Reis (2020), among many others. See also Kose and others (2019) for another overview of the literature and an examination of expectations in selected emerging market and developing economies. Note that the chapter's focus on expectations should not be taken to suggest that they are the sole driver of inflation dynamics. They are a key contributor, but other factors are also important, as described later.

- How important are expectations in explaining inflation dynamics, particularly since the COVID-19 shock? Does the prevailing level of inflation (high/low) affect the explanatory power of inflation expectations?
- How do expectations affect monetary policy effectiveness and how does policy affect expectations? How does the expectations formation process affect the trade-offs that monetary policymakers face to bring inflation rates back to their targets?

Drawing on empirical and model-based analyses, the chapter's main findings are as follows:

- *Across economic agents, movements in near-term (next-12-months) inflation expectations are broadly aligned, showing a sharp rise in 2022.* Survey-based measures of expectations for professional forecasters and households, financial-market-implied expectations, and this chapter's newly constructed measure of firms' expectations (based on the text analysis of firms' earnings calls) fluctuate differently, but around a common trend.
- *Despite the sharp increase in inflation over 2022 across many economies, long-term (five-year-ahead) inflation expectations in the average economy have remained stable.* According to multiple metrics—including inflation target deviations, expectations' variability, and expectations' disagreement—long-term expectations have remained well-anchored in most economies.
- *Historical episodes characterized by initial periods of persistently rising expectations suggest that expectations come down only slowly*. In these cases, it took about three years for inflation and near-term expectations to return to their pre-episode levels. Notably, real policy rates were lower and are now higher on average compared to past episode dynamics, suggesting that monetary tightening since 2022 has been unusually sharp.
- *Near-term expectations are critical to understanding inflation dynamics and explain a growing share of inflation since 2022*. Using a novel causal identification strategy to estimate Phillips curves, the chapter finds a strong role for inflation expectations in the group of advanced economies. In emerging market economies, lagged inflation is also important, suggesting a greater role for more backward-looking learners. There are also signs that the pass-through from inflation expectations to inflation tends to be higher in periods of higher inflation, such as those experienced of late throughout the world.
- *The properties of the expectations formation process strongly impact the effectiveness of monetary policy, making central banks' understanding of them key.* A newly developed, dynamic stochastic general equilibrium model with a mix of forward- and backward-looking agents that learn demonstrates that the output costs of monetary tightening rise with the share of backward-looking learners in the economy or with the prevailing level of inflation.[3] The analysis also shows that both inflation expectations and inflation would decline modestly quicker with improvements in monetary policy frameworks and communication—such as simpler and more regular messaging and better targeting of audiences—that boost the share of forward-looking learners in the economy. However, such measures may take time or be more difficult to implement than tighter cyclical policies, which come with much higher costs in terms of slowing growth.

[3] In technical terms, the forward-looking learners form their expectations according to the standard, full-information rational expectations assumptions, while the backward-looking learners form their expectations by adaptive learning based on a small statistical model of the variable-of-interest for expectations, updating based on recent, past experiences only. See Online Annex 2.5 for further details.

In general, inflation dynamics depend on the shares of forward versus backward-looking learners in the economy and their influence on expectations. If central banks were to focus solely on bringing inflation down quickly, they would tighten even further and reduce the time to bring inflation rates back to targets by two years, but at the cost of a sharper economic slowdown. When policymakers choose policies to take account of the trade-offs between the objectives of inflation close to target, output at potential, and smooth policy rate paths (helping manage financial stability concerns), a scenario for a representative advanced economy facing today's inflation cirumstances suggests that it is likely to take about three to four years for inflation and expectations to converge back to the central bank's target.[4]

Given the role of central banks in influencing the transmission of monetary policy, the chapter's findings suggest that they benefit from having clear understandings of the expectations formation processes at work in their economies and tailoring their communications strategy accordingly, in parallel with structural reforms to reinforce central bank independence and transparency. Managing expectations better could require investing more in data collection and monitoring of expectations, including across different agents. Technological improvements mean that alternative methods of measuring expectations—such as the text-based analysis of firms' earnings calls pioneered here—may make this more feasible.

Some caveats to the analysis and findings in this chapter should be highlighted. First, data availability contraints the empirical analysis of inflation expectations across exercises and particularly of comparisons across agents. To ensure the broadest sample coverage, the chapter takes a macroeconomic perspective and focuses on mean expectations, typically from professional forecasters, rather than the distribution or behavior of individual-level expectations which are not widely available.[5] This may be preferrable since the analysis can provide more practical insights for policymakers who likely face many of the same data constraints. Second, the causal interpretation of the Phillips curve estimates is conditional on the assumptions of the instrumental variables estimation strategy based on lags. As detailed in the online annex, the findings are largely robust to varying the timing of the instruments, providing some comfort. However, if the underlying assumptions do not hold, then the estimates should be interpreted as associational. Third, if there have been structural breaks in the behavior of the economy, then the empirical and historical analyses may not be as informative. State dependence in the Phillips curve analysis addresses one possible form of break. The model-based analysis also affords some insurance against this, incorporating a limited form of structural change through learning. Fourth, the model-based analysis findings on the impact of improved monetary policy frameworks and communications on expectations and inflation are illustrative. The mapping

[4] Note that this conclusion is based on a stylized social welfare function (see Online Annex 2.7 for more details). See Chapter 1 of the April 2023 *Global Financial Stability Report* (GFSR) for a discussion of the financial stability implications of the monetary policy stance and their impact on central bank choices.

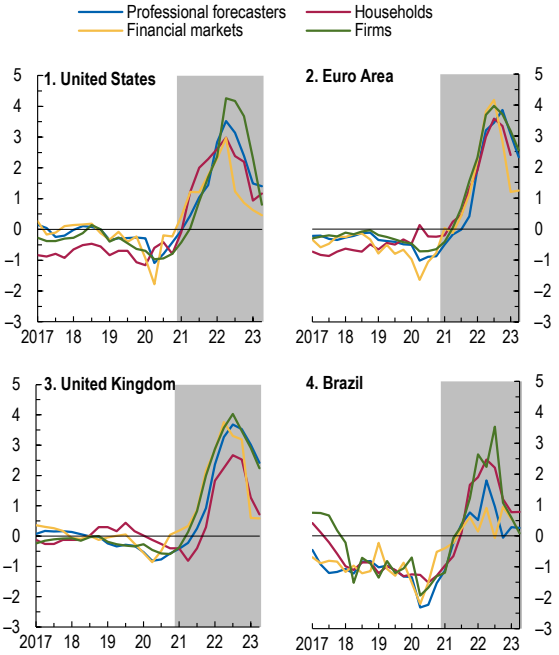
[5] Although this chapter focuses on mean inflation expectations to have a broad country coverage, the distribution of expectations across individuals might also play an important role. See Reis (2023) and Clements, Rich, and Tracy (2023) for arguments on the importance of disagreements in expectations across individuals and agents for inflation. Many of the latest studies dive into the microeconomic data on inflation expectations by individuals for specific economies, contrasting their properties across agents or undertaking random-controlled trials to identify influences on expectations. See Andre and others (2022), Candia and others (2023), D'Acunto and others (2020), Weber and others (2022), and Weber and others (2023) for recent examples.

from an increase in the share of forward- compared to backward-looking agents in the economy to monetary policy framework and communications improvements is stylized.[6]

The chapter begins by presenting patterns in inflation expectations, focusing on the post-pandemic recovery. It compares them with the observed patterns after historical episodes where expectations rose over an extended period. The chapter then uses a novel identification approach to study the channel from expectations to inflation and how well recent inflation dynamics can be explained by expectations. The penultimate section describes the results of a model-based analysis with a mix of forward and backward-looking learning agents to examine how the expectations process may influence the conduct of monetary policy and vice versa. The final section suggests potential policy actions in light of the chapter's findings.

Figure 2.2. Next-12-Months Mean Inflation Expectations by Economic Agent
(Z-score, standard deviations from the mean)

Economic agents agree on the broad dynamics of near-term inflation expectations. The sharp increases in 2022 were unusual compared to the experience of the last 20 years.



Sources: Consensus Economics; Haver Analytics; European Commission; NL Analytics; S&P Capital IQ; and IMF staff calculations.
Note: The figure shows z-scores (variable minus its mean, all divided by its standard deviation) calculated over the period 2004:Q1 to 2023:Q2 at quarterly frequency. Shaded areas in each panel highlight the period from 2021 onward, when realized inflation began notably rising.

Recent Patterns in Inflation Expectations

This section first compares the recent behavior of inflation expectations across professional forecasters, financial markets, households, and firms for selected economies. It then analyses the evolution of near- and long-term inflation expectations of professional forecasters. Finally, it sets current macroeconomic dynamics into historical perspective by comparing them to past episodes when both near- and long-term inflation expectations rose over a sustained period.

Expectations on Broad Inflation Dynamics Similar Across Agents

Different economic agents may not have the same inflation expectations, reflecting their different information sets, attention, and priorities, among other factors. This sub-section shows how indicators of near-term inflation expectations across agents (professional forecasters, financial markets, households, and firms) have behaved since 2017 for a selected set of four major economies for which comparable data are available (Figure 2.2).[7] To address the scarcity of data on firm-level expectations across economies and time, a new indicator of firms' inflation

[6] Although the chapter demonstrates that improvements in monetary policy frameworks and communications are consistent with an increase in the share of forward-looking learners, it cannot exclude that other institutional or structural interventions could also be associated with a change in the expectations formation process (for example, in educational attainment, fiscal frameworks, and governance, and so on). However, a full examination of these alternative interventions lies outside the scope of this chapter.

[7] As noted in the introduction, the lack of widely available on inflation expectations—particularly from financial markets, households, and firms—limits the economy and time coverage of the various analytical exercises considered in the chapter.

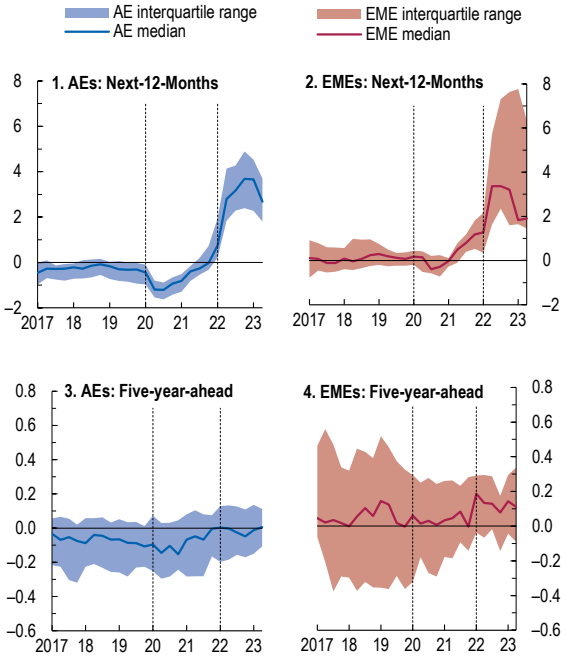
expectations is constructed using text analysis of their earnings calls (see Box 2.1 for details). For comparability, expectations by agent-type are transformed into z-scores.[8]

Across economies, the four agents' near-term expectations display broadly similar patterns, agreeing on the inflation upswing from 2021 but with some variation in the timing. They concur that inflation peaked in 2022 and is now on the downswing. Each of the indicators by agent across economies reach two-and-a-half to over four standard deviations, pointing to the extraordinary size of the rise in inflation expectations during the post-pandemic recovery compared to the experience since the early 2000s.

Different agents' inflation expectations exhibit slightly different properties. Households' inflation expectations appear noisier, leading and lagging movements in other agents' expectations (for the euro area and the United Kingdom respectively). Financial-market-implied inflation expectations, derived from inflation-indexed bonds or inflation swaps, have continuous real-time availability, but disentangling the signal on expectations from the fluctuating risk premium is challenging (chapter 1 of April 2023 GFSR). Firms' near-term inflation expectations tend to mark the upper bound of the cross-agents' expectations range during the recent inflation surge. Professional forecasters' expectations convey more signal but may suffer from herding and strategic behavior (Reis 2023).

Figure 2.3. Cross-Economy Distribution of Mean Inflation Expectations over Time
(Percentage point deviation from target)

Near-term inflation expectations shot up rapidly from 2022 but are now reverting, while long-term inflation expectations have moved only marginally, but in a narrowing range.



Sources: Central bank websites; Consensus Economics; Haver Analytics; and IMF staff calculations.
Note: Mean inflation expectations in the figure are from professional forecasters. Economies are included in the sample based on data availability. See Online Annex 2.1 for details. AE = advanced economy; EME = emerging market economy.

Typically, professional forecasters' expectations fall somewhere between the more volatile, yet continuously available, market-implied and noisier household expectations. They also have the advantage of the broadest coverage among expectations measures, across economies, time, and forecast horizon. As such, the analyses of the chapter mostly use the expectations of professional forecasters.

Near-term Inflation Expectations Above Targets, Long-term Contained

When looking at a larger set of economies, a consistent picture emerges: near-term inflation expectations in deviation from central banks' targets rose while deviations of long-term expectations, have been broadly stable (Figure 2.3).[9]

For advanced economies, the period prior to the COVID-19 pandemic was marked by a mild undershoot of inflation expectations relative to target both in the near and long terms (Figure

[8] The z-score transformation takes a variable and subtracts its sample mean, then divides the resulting quantity by the sample standard deviation of the variable. It is unit-free and implicitly range-adjusted, allowing for ready comparison of the dynamics across different variables.

[9] Central bank inflation targets are either explicit or implicit; see the Online Annex 2.1 for further details on data sources.

2.3, panels 1 and 3). Near-term expectations rose markedly after 2021. If anything, long-term expectations in advanced economies have moved closer to inflation targets since the pandemic.

For emerging market economies, the distribution of near-term inflation expectations is somewhat wider and skewed to the upside, indicating greater variation in inflation experiences, particularly in recent quarters (Figure 2.3, panel 2). Median long-term inflation expectations moved up by a modest 10 basis points (Figure 2.3, panel 4). The interquartile range for long-term expectations narrowed and shifted up somewhat. Overall though, the patterns suggest that long-term inflation expectations have remained stable.[10]

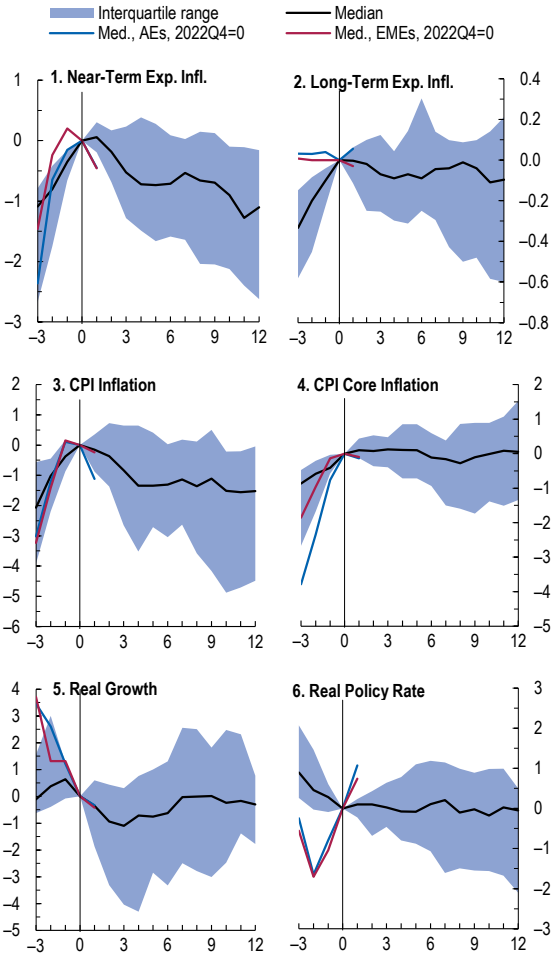
For both advanced and emerging market economies, multiple metrics of inflation expectations anchoring—related to the average absolute deviations from target, variability of expectations over time, and disagreement about expectations across individuals—suggest that long-term inflation expectations have stayed anchored despite recent rises in inflation (see Online Annex 2.2). Although reassuring, this anchoring of long-term expectations should not be taken for granted—it likely reflects in part the active response of policymakers to dampen price pressures.

History Suggests It Can Take Time for Inflation and Near-term Expectations to Come Down

Long-term inflation expectations have remained stable, but how unusual are the current paths of other major macroeconomic variables? To put into historical context, the chapter compares the recent experience to that observed after historical episodes where near- and long-term inflation expectations were rising for at least a year (Figure 2.4).

Figure 2.4. Historical Episodes with Persistently Rising Near- and Long-Term Inflation Expectations
(Percentage points relative to level at end of episode)

After past episodes in which inflation expectations rose persistently for a year or more, it took about three years on average for inflation and near-term expectations to come back down to pre-episode levels. Compared with that in these historical episodes, recent long-term inflation expectations have been unusually stable and real policy rate paths sharper across economy groups.



Sources: Consensus Economics and IMF staff calculations.
Note: Horizontal axes show quarters after the end of the historical episode. All rates are expressed in annual terms. Near-term inflation expectations (panel 1) are expected inflation rates over the subsequent year on a rolling basis. Long-term inflation expectations (panel 2) are expected inflation rates in five years' time. Real policy rates are interest rates based on expected inflation. Inclusion as a historical episode requires four quarters in which both near- and long-term inflation expectations are rising. The sample spans 1989:Q4 to 2023:Q1, with exact time coverage varying by economy. A total of 32 historical episodes are identified, with 16 from AEs and 16 from EMEs. See Online Annex 2.3 for further details. AEs = advanced economies; CPI = consumer price index; EMEs = emerging market economies; Exp. = expectations; Infl. = inflation; Med. = median.

Paths for actual inflation in the current conjecture are so far in line with historical medians, while near-term inflation expectations displayed a sharper increase and a faster decline compared to previous episodes. After inflation expectations persistently rose over a year, economies subsequently tended to see a gradual but slow decline in

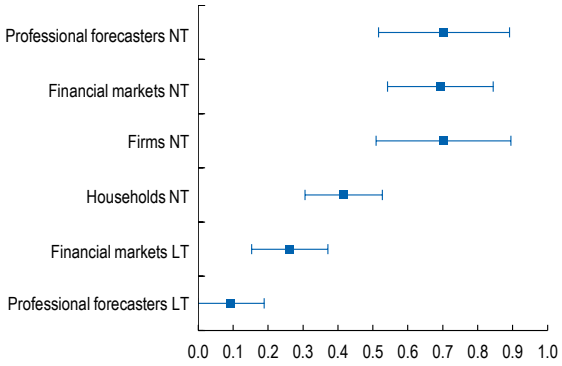
[10] A statistical comparison across the three regimes separated by the two vertical red lines also suggests that deviations of long-term inflation expectations from target have remained broadly stable.

headline inflation and near-term inflation expectations. Both typically take about three years to revert to their pre-episode levels, while core inflation remained stickier. However, there is a large variability across experiences, as seen in the interquartile ranges.

In contrast, recent paths for real policy rates and long-term inflation expectations appear different than the median of past episodes. On the one hand, real policy rates in 2022 were well-below the comparative paths of earlier episodes, partly due to the sharp and large rise in inflation. On the other hand, real rates are now well-above the historical median, reflecting rapid monetary tightening and the latest falls in headline inflation. Unlike earlier episodes, long-term inflation expectations have been unusually stable coming into the recent high inflation regime. This is consistent with and supports the chapter's findings on the recent stability and (so far) solid anchoring of long-term expectations.

Figure 2.5. Estimated Effects of Alternative Inflation Expectations Measures on Current Inflation
(Standardized regression coefficients)

Near-term measures of inflation expectations can better predict current inflation than longer-term measures. Expectations of firms, financial markets, and professional forecasters show similar performances.



Source: IMF staff calculations.
Note: The figure shows standardized coefficients from linear regressions estimated by pooled times series for the United Kingdom, United States, and euro area using quarterly data from 1991:Q2 through 2023:Q1. The dependent variable is quarterly headline inflation, seasonally-adjusted at an annualized rate. See Online Annex 2.4 for details on the regression specification and additional control variables. Horizontal lines show 90 percent confidence intervals with heteroskedasticity-robust standard errors. LT = long-term (five-year-ahead; for financial markets is next-5-years) inflation expectations; NT = near-term (next-12-months) inflation expectations.

The Role of Expectations in Inflation Dynamics

To better understand the role of expectations in inflation dynamics, this section considers a hybrid price Phillips curve framework that relates current inflation to a set of drivers, including inflation expectations, lagged inflation, and the output gap.[11] The section first assesses the explanatory power of different agents' expectations for inflation and the relative importance of near- versus long-term expectations. Second, an instrumental variables approach is used to identify the causal impact of inflation expectations on inflation. Third, using the causal estimates, the section shows the contributions of different drivers to recent inflation dynamics for average advanced and emerging market economies. Finally, the section explores whether the effect of expectations on inflation changes with the prevailing level of inflation.[12]

Near-term Expectations Matter Most for Inflation

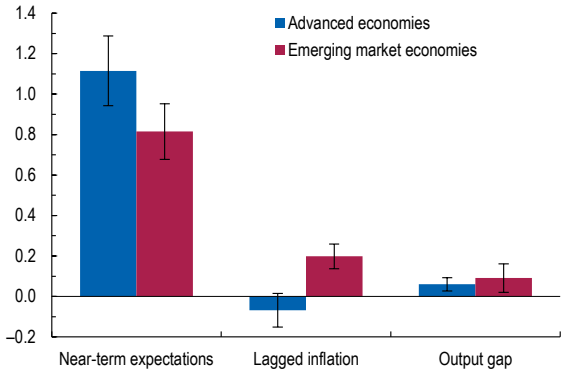
When considered one-by-one, alternative measures of inflation expectations (by agents or horizons) show different abilities to explain inflation when using the hybrid Phillips curve model (Figure 2.5). The coefficient estimates represent the change in inflation associated with a one

[11] See Chapter 3 of the October 2018 WEO, Chapter 2 of the October 2021 WEO, and Chapter 2 of the October 2022 WEO for recent analyses looking at cross-economy estimates of Phillips curves (for prices and wages). Dao and others (2023) use a similar approach to analyze inflation developments in the United States and the euro area. See the Online Annex 2.4 for further details on the estimation and analysis.

[12] Other potential important dimensions in modeling the Phillips curve relationship such as time-varying coefficients, nonlinearities, structural breaks, the influence of higher-order moments of measured expectations as well as alternative measures of slack are left for future work.

Figure 2.6. Key Coefficients of the Hybrid Phillips Curve
(Regression coefficients)

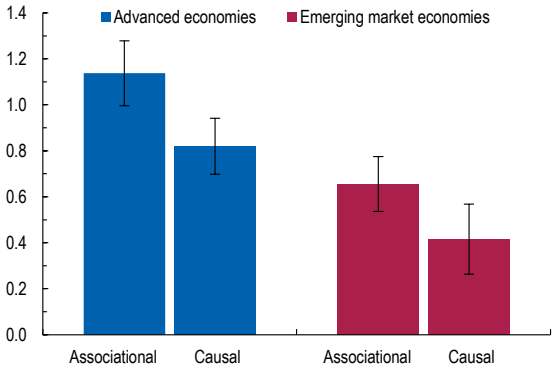
Near-term inflation expectations play a larger role in explaining current inflation in advanced economies than in emerging market economies.



Source: IMF staff calculations.
Note: The figure shows coefficients from linear regressions estimated by pooled times series using quarterly data from 1991:Q2 through 2023:Q1. The dependent variable is quarterly headline inflation, seasonally-adjusted at an annualized rate. See Online Annex 2.4 for details on the regression specification and additional control variables. The whiskers show the 90 percent confidence intervals with Driscoll-Kraay standard errors.

Figure 2.7. Associational versus Causal Estimated Effects of Inflation Expectations on Current Inflation
(Regression coefficients)

Accounting for the influence of current inflation on expectations of future inflation in the Phillips curve reduces the estimated effects of inflation expectations on current inflation by about 30 percent across economy groups.



Source: IMF staff calculations.
Note: The figure shows coefficients from linear regressions estimated by pooled times series using quarterly data from 1991:Q2 through 2023:Q1. The dependent variable is quarterly headline inflation, seasonally-adjusted at an annualized rate. Associational estimates are computed by ordinary least squares, while causal estimates are computed using an instrumental variables approach. Models include economy and time fixed effects along with additional control variables. See Online Annex 2.4 for further details on the specification and instrumental variables strategy.

standard deviation increase in the indicated measure of expectations.[13] The first finding is that long-term inflation expectations have lower predictive power than near-term measures. Both the financial market-based and the professional forecasters' five-year-ahead inflation expectations have smaller standardized coefficients than the other measures (Figure 2.5, top two set of dots and whiskers). These results are consistent with recent work that finds a small role for long-term expectations on current inflation (Hajdini 2023; Werning 2022). Second, there is remarkable consistency across professional forecasters, financial markets, and firms' near-term inflation expectations (Figure 2.5, bottom three dots and whiskers). These results imply that a one standard deviation increase in expectations is associated with a 0.7 standard deviation increase in current inflation.[14] Finally, the coefficient for households' near-term expectations falls somewhere between those for near- and long-term expectations of other agents.

In light of these findings and crucially because of broader economy and time coverage, the baseline specification of the hybrid Phillips curve is estimated with near-term inflation expectations from professional forecasters (Figure 2.6). The estimated relationship suggests that a one percentage point rise in near-term expectations is associated with a 1.1 percentage point rise in current inflation among advanced economies, while for emerging market economies the rise is about 0.8 percentage points. Lagged inflation has little explanatory power in advanced economies (slightly negative but not statistically different from zero), whereas in emerging market economies, the carryover from the previous quarter's inflation (around 0.2 percentage

[13] The coefficients are standardized to accounts for the volatility of different measures, and to allow for a comparison of inflation forecasts to the new index of firms' inflation expectations which is based on a different scale. Because of data availability, this comparison can only be done for the United States, the United Kingdom, and the euro area.

[14] Coefficients for inflation expectations unadjusted for volatility range from 1.1 to 1.4. The estimated coefficients for long-term expectations are lower than those for near-term expectations. Excluding the post-2019 period results in lower estimated coefficients, but similar patterns.

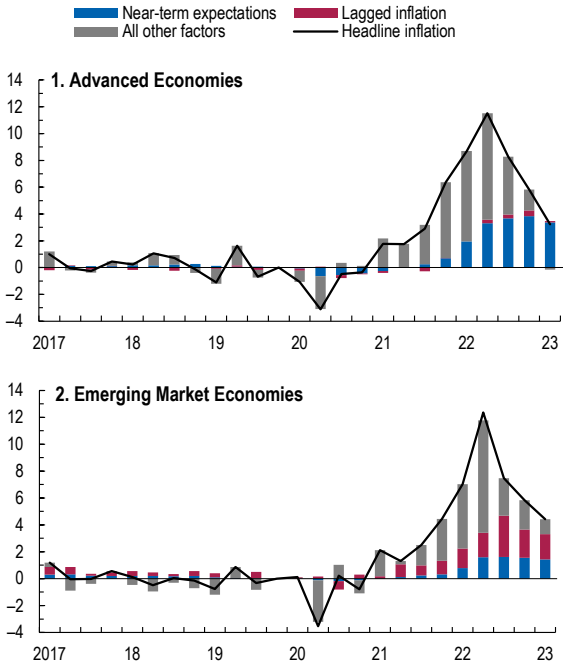
points) is statistically significant.[15] Finally, the output gap has a statistically significant relationship with current inflation for both economy groups, but is somewhat larger for the group of emerging market economies.

Expectations' Role for Inflation May Be Smaller Than Simple Statistical Associations Suggest

The previous results document statistical associations between current inflation and near-term inflation expectations—they do not account for the possibility that current inflation could drive expectations of future inflation or that an omitted factors could be driving both. To address these shortcomings and estimate the causal effect of expectations on inflation (the expectations channel), an instrumental variables (IV) strategy based on lags of near-term inflation expectations and the output gap is used to re-estimate the hybrid Phillips curve. The strategy leverages the facts that these variables display serial correlation over time (current values are strongly related to their past values) and that lags of these variables do not directly impact current inflation under the hybrid Phillips curve specification.[16]

Figure 2.8. Contributors to Recent Inflation Dynamics
(Percentage point deviation from 2019:Q4)

A decomposition of the recent dynamics of headline inflation reveals the growing importance of near-term inflation expectations.



Source: IMF staff calculations.
Note: Bars in the figure show the contributions to average headline inflation by economy group relative to the contributions observed in 2019:Q4. Contributions are calculated using coefficients estimated by instrumental variables pooled time series with quarterly data over 1991:Q2–2023:Q1. Solid black lines in each panel show the average seasonally-adjusted annualized quarter-on-quarter headline consumer price index inflation observed relative to 2019:Q4. The "All other factors" category includes the contributions from time fixed effects (common global factors), all other explanatory variables, and the regression residual. See Online Annex 2.4 for details on the specification and estimation.

The causal estimates of the effects of near-term expectations on current inflation are about 30 percent lower in magnitude than the associational estimates (Figure 2.7). This implies that some of the observed variation in near-term inflation expectations reflects reverse causation (that is, higher current inflation drives up expectations of future inflation) or omitted factors that affect both current inflation and expectations. By removing these biases, the IV estimates provide a more accurate assessment of the expectations channel. For the average advanced economy, inflation would rise by about 0.8 percentage points for a one percentage point rise in near-term expectations. The pass-through estimate for the average emerging market economy is about 0.4

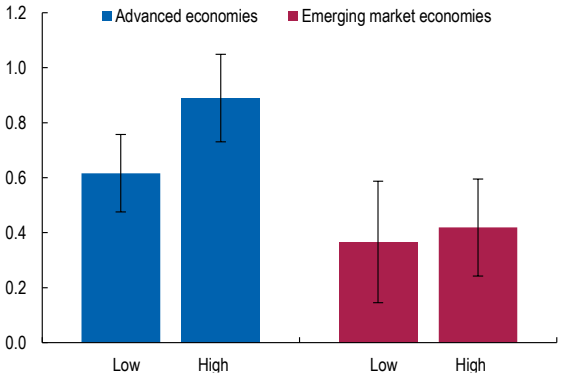
[15] Chapters 3 and 2 of the October 2016 and October 2021 WEO, respectively, and Kamber, Madhusudan, and Morley (2020) also find higher coefficients for lagged inflation in hybrid Phillips curves in emerging market economies compared to advanced economies. Forbes, Gagnon, and Collins (2021) demonstrate that the coefficients on lagged inflation decrease when panel estimates include only advanced economies. These studies do not explore potential causes, but the higher prevalence of price indexation in many emerging market economies may account for these findings (Céspedes and others 2005; Frankel 2010; Kganyago 2023). In addition, weaker monetary policy frameworks on average could also contribute to the smaller relative role of expectations. It might also be rational for adaptive learners to rely more on past inflation when indexation is more prevalent, and the credibility of policymaking institutions is lower. Improvements in monetary policy frameworks and communications in emerging market economies over the past 15 years (see Box 2.2) suggest that lagged inflation could play a reduced role in their inflation dynamics going forward. Finally, emerging market economies might suffer from larger measurement error on inflation expectations, which would lead to an attenuation bias and lead to a relatively more important estimated role for lagged inflation.

[16] See Online Annex 2.4 for further details on the model specification, instrumental variables strategy, its performance and key results, and robustness checks. The IV estimates are stable across time periods.

percentage points. The difference in magnitudes, combined with differences in the relationship of current inflation with past inflation, suggest that expectations formation in emerging market economies on average tends to be more backward-looking than what is observed in advanced economies.

Figure 2.9. State-Dependent Pass-through from Expectations to Inflation
(Regression coefficients)

The pass-through (or effect) from inflation expectations to current inflation is higher when the prevailing level of inflation is higher across economy groups. The difference in pass-through by prevailing level of inflation is larger for advanced economies.



Source: IMF staff calculations.
Note: Bars in the figure show the average estimated coefficients from regressions of headline inflation on inflation expectations by economy group, interacted with an indicator for whether lagged headline inflation was above an economy's median inflation level over the sample period. Estimation is via instrumental variables using quarterly data over 1991:Q2–2023:Q1. See Online Annex 2.4 for further details on the regression specification and estimation. The whiskers show the 90 percent confidence interval using heteroskedasticity-robust standard errors.

Expectations Explain an Increasing Share of Recent Inflation Dynamics

The contribution to recent inflation dynamics of the expectations channel can be calculated using the causal estimates of the hybrid Phillips curve (Figure 2.8). For the average advanced economy, factors other than expectations and lagged inflation initially drove most of the increase in inflation that took place over 2021–22 (Figure 2.8, panel 1). These include common global factors, such as the economic disruptions caused by the COVID-19 shock, large swings in commodity prices, and global supply chain issues, as well as the economy-specific effects of energy prices and the output gap (which may in turn reflect domestic aggregate demand measures). Even so, the figure reveals a large and growing role for near-term inflation expectations in explaining inflation dynamics in the most recent quarters.[17] In contrast, lagged inflation had a small role.

Turning to the average emerging market economy, once again factors other than expectations and lagged inflation were responsible for the peak in inflation in 2022 (Figure 2.8, panel 2). On average, expectations have played a significant but smaller role in accounting for headline inflation than among advanced economies. On the other hand, lagged inflation explained almost half of the average rise in inflation since the first quarter of 2020.

Higher Inflation Environment, Higher Pass-through from Expectations

The final exercise in the section consists of estimating whether the passthrough from inflation expectations to current inflation varies by the level of inflation: Are there signs of a nonlinearity or state dependence in the effect of expectations on inflation? In both advanced and emerging market economies, the estimated passthrough is higher when inflation is elevated (above its economy-specific sample median; Figure 2.9). The difference is particularly large, increasing from 0.6 when inflation is low (below its economy-specific sample median) to 0.9 when inflation is high, and statistically significant for advanced economies. These results imply that the expectations channel may be even more important in accounting for inflation dynamics at present, while inflation remains high.

[17] Other factors have remained relevant in recent quarters despite a net contribution approaching zero as shown by the gray bars in Figure 2.8.1. This is because the pass-through from lower energy prices has been offset by other factors, mainly captured by quarterly fixed effects.

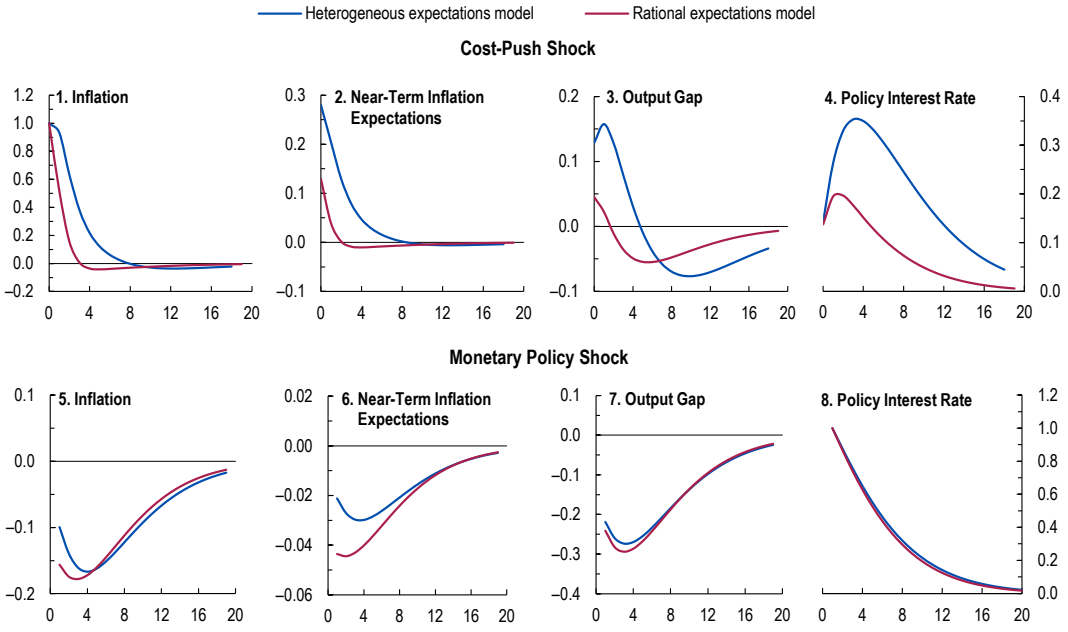
Expectations Formation and Monetary Policymaking

This section explores the question of how inflation expectations affect monetary policy effectiveness and how different policies can affect expectations. It uses a semi-structural model to illustrate how the expectations formation processes in an economy interact with monetary policy actions, affecting the dynamics of inflation, expectations, and economic activity.

The analysis extends the standard dynamic stochastic general equilibrium model with expectational learning by Alvarez and Dizioli (2023). The model includes price and wage Phillips curves (relating price and wage inflation to expectations, the gap between real wages and productivity, and economic slack), an IS curve (relating output to the nominal interest rate and inflation expectations), and a monetary policy reaction function.[18] Two new features are incorporated into the model. First, heterogenous agents or a mix of backward- and forward-looking learners with different information sets are added. Backward-looking learners form their expectations based on their recent experience (backward-looking), while forward-looking learners form their expectations rationally based on full information about the economy, including the share of backward-looking learners. This means that forward-looking learners will behave more like backward-looking learners as the share of backward-looking learners rises in the economy.[19] Second, inspired by Blanchard and Bernanke (2023), near-term expectations are

Figure 2.10. Macroeconomic Responses to Shocks Conditional on Agents' Expectations Formation
(Percentage points)

Following a cost-push shock, inflation expectations are more sensitive when the economy has a mix of forward- and backward-looking learners (heterogenous expectations) than when it has only forward-looking learners (rational expectations). Inflation is also more persistent. Monetary policy is less effective, as backward-looking learners do not take account of the effects of interest rate rises on future marginal costs.



Source: IMF staff calculations.
Note: Numbers on the horizontal axes in the panels represent quarters after the shock at time 0. Panels 1–4 show the impulse responses to a cost-push shock that increases inflation by 1 percentage point. Note that the output gap increases after this shock, because potential output falls by more than real GDP. Panels 5–8 show the impulse responses to a temporary monetary policy shock that increases the policy rate by 100 basis points. Note that the monetary policy shock's impact on inflation peaks after five quarters in the heterogenous-expectations model and after three quarters in the rational-expectations model.

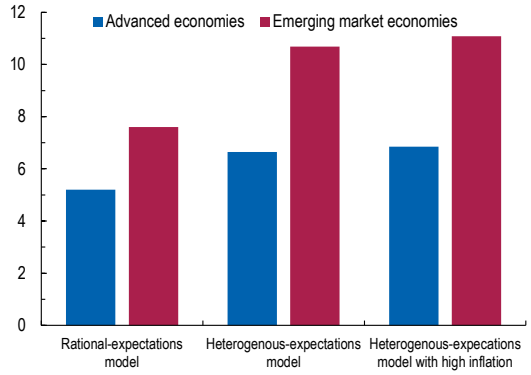
[18] See Online Annex 2.5 for more details about the model, its structure, and its estimation.

[19] Other expectations formation processes are possible (for example, completely anchored, unresponsive inflation expectations). The chapter does not aim to be exhaustive. It illustrates instead how a plausible mix of two highly relevant kinds of processes may impact developments.

influenced by long-term expectations and vice versa. The main additional assumption is that long-term expectations only impact inflation through their effect on near-term expectations. An alternative model allowing for only forward-looking learners is also considered for comparison. The two models—heterogenous expectations and forward-looking learners or rational expectations-only—are estimated for two representative economies (advanced and emerging market) to help capture the structural differences between these two groups. With heterogenous agents, the estimated shares of backward-looking learners are about 20 percent for the advanced economy and about 30 percent for the emerging market economy, with the remainder being forward-looking learners.

Figure 2.11. Sacrifice Ratios under Alternative Expectations Processes
(Percent of output forgone to lower inflation by one percentage point)

Sacrifice ratios are larger when economies include a mix of forward- and backward-looking learners (heterogenous expectations), as monetary policy is less effective in that case. Emerging market economies tend to have higher shares of backward-looking learners, pushing up their ratios. Higher prevailing inflation slightly worsens the ratio, as backward-looking learners raise their expectations.



Source: IMF staff calculations.
Note: The sacrifice ratios in the figure are calculated under the assumption that monetary policy is implemented to bring the inflation rate down by 1 percentage point over three years. See Online Annex 2.5 for further details on the dynamic stochastic general equilibrium model.

More Backward-looking Learners Prolong Inflation and Weaken Monetary Policy Transmission

The propagation of shocks to the economy depends upon how expectations are formed. Following an identical cost-push shock (for example, a surprise rise in energy and commodity prices, an unanticipated supply chain disruption raising input costs, or other supply-side shocks), inflation is persistently higher when there are heterogenous agents in the economy, as compared to an economy with only forward-looking learners. With a share of backward-looking learners in the economy, inflation expectations respond more to a cost-push shock and are stickier. Backward-looking learners assume that higher current inflation means that future inflation will be persistently higher. This prolongs the price pressures compared to the economy with forward-looking learners who know that the cost-push shock is transitory and do not change their inflation expectations much (Figure 2.10, top row). Moreover, with heterogenous agents, monetary policy has less power initially to influence inflation (Figure 2.10, bottom row). The main reason is that backward-looking learners do not consider the impact of monetary policy on future marginal costs, unlike forward-looking learners. Without this forward-looking component, monetary policy can only influence expectations through its direct effects on the output gap.

Sacrifice Ratio Higher with More Backward-looking Learners or Higher Inflation

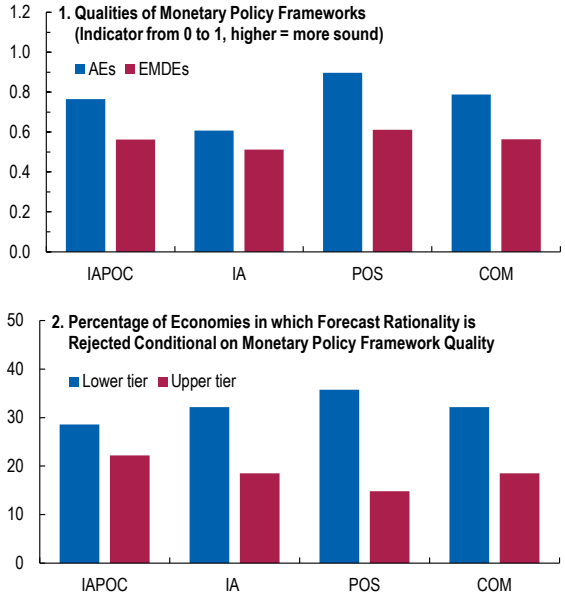
The combination of more prolonged inflationary episodes following a cost-push shock and less powerful monetary policy implies that achieving a given level of inflation reduction over a given period will be more costly in output forgone. This will be reflected in the level of the sacrifice ratio, defined here as the percent of output forgone to achieve a one percentage point faster reduction in the inflation rate over a three-year period (Figure 2.11).[20] First, the sacrifice ratio is

[20] Tetlow (2022) reports a wide range of sacrifice ratio estimates for advanced economies with a mode of 7 (similar to that presented here) across 40 different models and slightly different definitions. That said, the chapter's focus is on the qualitative comparison across cases.

larger in the heterogeneous agents' model than in the rational expectations model with only forward-looking learners (regardless of the economy group). The main reason for this increased sacrifice ratio is the weaker inflation expectations channel for monetary policy when there are more backward-looking learners in the economy. Second, the sacrifice ratio also tends to be higher for an emerging market than an advanced economy, as it is estimated to have a higher share of backward-looking learners. Third, when there are heterogenous agents, the economy's dynamics become state-dependent. In a high-inflation environment, backward-looking learners behave as though inflation will be permanently higher, entailing a slight endogenous inflation de-anchoring and making monetary policy's job harder (Figure 2.11, rightmost bars).[21]

Figure 2.12. Soundness of Monetary Policy Frameworks and Forecast Rationality Tests across Economies

Monetary policy frameworks in advanced economies score higher along multiple dimensions, on average, than do those in emerging market and developing economies. Forecast rationality is statistically rejected more often for economies that have lower-quality monetary policy frameworks.



Sources: Unsal, Papageorgiou, and Garbers (2022); and IMF staff calculations.
Note: Panel 1 shows the mean of the indicator by economy group for which data is available (2007–21). Panel 2 of the figure shows the share of economies (among those with expectations from professional forecasters) for which a simple forecast rationality test (Lovell 1986) rejects the hypothesis of rational expectations. See Online Annex 2.7 for further details. AEs = advanced economies; EMDEs = emerging market and developing economies; IAPOC = Overall Monetary Policy Framework index, which is composed of three pillars: Independence and Accountability (IA), Policy and Operational Strategy (POS), and Communications (COM).

Monetary Policy Framework and Communications Improvements Ease Disinflation

The estimated model offers a laboratory to consider how alternative policy interventions help hasten the decline in inflation. The first intervention examined is one that would lead to an increase in the share of forward-looking learners in the economy.[22] How might such a shift be achieved? .

Recent studies suggest that improvements in monetary policy frameworks—encompassing central bank independence, transparency, and their communications strategies—can increase agents' attention to and understanding of monetary policy actions, helping to make inflation expectations more forward-looking (Carotta, Mello, and Ponce 2023; Coibion and others 2020). The Central Bank of Brazil's recent decision to adopt a continuous (rather than calendar-year) three percent inflation rate target from 2025 onwards is a concrete example of an improvement in operational effectiveness and communications strategy, helping to reduce uncertainty and enhance monetary policy effectiveness. Additional examples of improvements in communications strategies include the Central Banks of Uruguay and Pakistan actions to announce their pre-set monetary policy meeting calendar in advance since 2020. Additional examples of improvements in operational effectiveness include the Central Banks of Chile and

[21] To get closer to current conditions, a high-inflation environment is simulated by running the model for 8 periods with inflation 2 percentage points above target to establish the initial conditions for the scenario.

[22] Several studies over the past years indicate that most individuals do not understand the central bank's role in the economy and how policy rate changes impact the economy, suggesting that their expectations may be distorted. See among others, Coibion, Gorodnichenko, and Weber (2022); ECB (2021); Kumar and others (2015); and Van der Cruijsen, Jansen, and de Haan (2015). Andre and others (2022) find that over a sample of 6,500 US households, households on average believe that a rise in the central bank's policy interest rate would increase inflation.

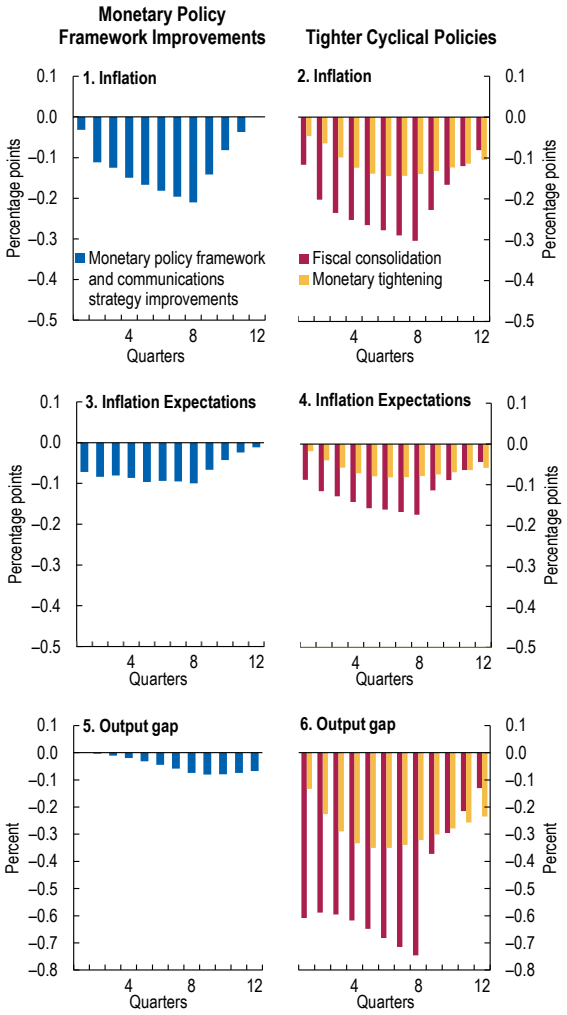
Thailand decisions to state their primary policy objective as price stability, with clearly defined numerical targets since 2019. Through the lens of the model, the chapter quantifies the potential effects of such interventions in a stylized, illustrative manner.

Moreover, an association exists between the qualities of the monetary policy framework in an economy and the likelihood that a simple forecast rationality test of mean inflation expectations is rejected (Figure 2.12; see also Online Annex 2.7). When the monetary policy framework is weaker (in terms of central bank independence, transparency, and communications), the share of economies where forecast rationality of expectations is rejected tends to be higher, consistent with a greater incidence of backward-looking learners.[23] Further bolstering the evidence on the importance of the soundness of monetary policy frameworks, a negative association exists between the size of deviations of near-term inflation expectations (or realized inflation rates) from targets and the quality of the monetary policy framework. As monetary policy frameworks improve, the deviations from target are smaller, implying that inflation comes back to target more quickly on average (see Online Annex 2.7).

Although there has been a notable trend towards improving frameworks in emerging market and developing economies (Box 2.2), the quality of monetary policy frameworks and communications is higher on average in advanced economies than in emerging market and developing economies. As such, the analysis of the policy intervention considers a decline in the share of backward-looking learners in the economy equal to the difference between the shares of backward-looking learners in the representative emerging market versus advanced economy.[24] With a higher share of forward-looking learners, the same monetary policy tightening path as under the baseline would have stronger effects on inflation expectations (Figure 2.13, left column). Monetary policy is more effective not

Figure 2.13. Policy Interventions to Hasten the Reduction of Inflation and Inflation Expectations
(Deviation from baseline)

Improvements in the monetary policy framework and communications strategy that boost the share of forward-looking learners in the economy improve the trade-off between lowering inflation and fostering growth through their effects on the expectations channel. Tighter cyclical policies—fiscal consolidation and monetary tightening—also lower inflation and inflation expectations, but at a higher output cost.



Source: IMF staff calculations.
Note: The "Improved monetary policy framework" intervention assumes that the share of forward-looking learners increases, compared with the baseline, by the difference in the estimated shares in the advanced versus the emerging market economy models. The "Fiscal consolidation" intervention assumes that fiscal spending is cut by 1 percent of GDP for two years and monetary policy does not try to offset the effects of the fiscal efforts. The "Monetary tightening" intervention assumes an initial 100 basis points rise in the policy rate on impact that then declines endogenously. See Online Annex 2.5 for details on the dynamic stochastic general equilibrium model and its calibration.

[23] The monetary policy framework indicators come from Unsal, Papageorgiou, and Garbers (2022). See also Box 2.2.

[24] The difference in the share of backward-looking learners is about 8 percent.

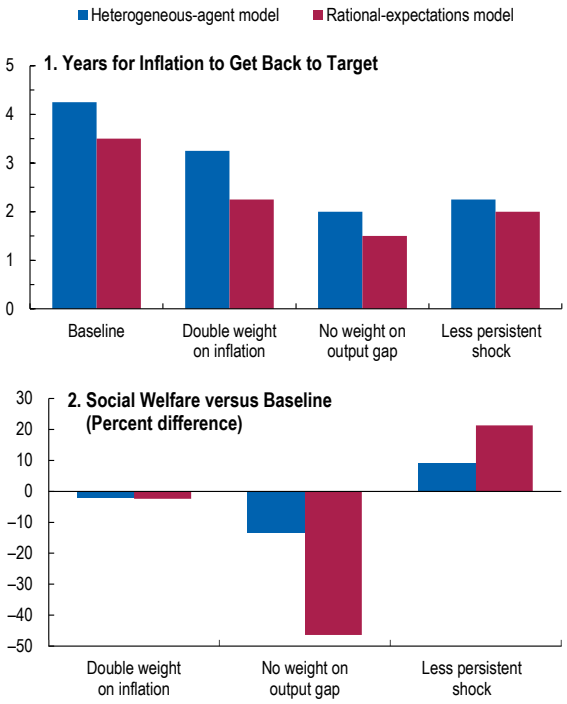
only because forward-looking learners understand the impacts on future marginal costs, but also because they know that that there is a lower share of backward-looking learners in the economy, and hence become even more forward-looking. These results are consistent with findings highlighted in Box 2.1, where US monetary policy is found to be more effective in shaping expectations when firms are more attentive to monetary policy than the average firm in the sector, and therefore are more forward-looking The faster transmission to inflation expectations translates into a lower realized inflation path and importantly a "softer" landing, with only small additional output costs.

In contrast, even tighter cyclical policies (either monetary or fiscal) as additional interventions also help dampen inflation and expectations, but come with larger output costs (Figure 2.13, right column). While the two cyclical policy interventions are not strictly comparable, they both work in part through generating lower aggregate demand initially.[25] Over time then, the inflation lowering effects of tightening feed into inflation expectations, further lowering realized inflation.

Although an improvement in monetary policy framework and communications comes with markedly lower output costs due to its primary impacts on expectations and their formation, difficulties in implementing these interventions in a timely and effective manner mean that they are not silver bullets and should be seen as complementary to usual monetary policy actions.

Figure 2.14. Policy Objectives, Social Welfare, and Expectations Formation

After a cost-push shock, the time it takes inflation to get back to target in an economy depends on the formation of expectations and the central bank's objectives. A greater share of backward-looking learners in the economy draws out the timeline, regardless of policy objectives. A comparison with a stylized social welfare function suggests that a faster path may come with costs unless driven by less persistent shocks.



Source: IMF staff calculations.
Note: The figure assumes that a cost-push shock raises inflation 2 percentage points above target initially. The shock has an estimated half-life of 14 quarters. In the baseline scenario, the central bank's policy seeks to minimize welfare loss, as measured by a stylized social welfare function. The latter includes an interest rate smoothing term and weighs output gap and inflation deviations equally. Panel 2 welfare baselines differ by the expectations formation process. For an identical welfare function, social welfare is about 20 percent higher with rational than with heterogenous expectations, reflecting enhanced policy effectiveness and lower endogenous persistence of shocks. See Online Annex 2.5 for further details on the assumed objective and social welfare functions and other aspects of the dynamic stochastic general equilibrium model. The "Less-persistent shock" scenario reduces the half-life of the shock to 6.5 quarters.

Moreover, the role of fiscal policy for inflation and inflation expectations is likely more complex than what can be captured by the illustrative model here. As shown in the empirical analysis in Box 2.2, worse fiscal positions (that is, higher public debt and persistent deficits) can reduce the effectiveness of sounder monetary policy frameworks in lowering inflation expectations in emerging market and developing economies. In other words, more sustainable fiscal positions are associated with lower average inflation expectations. Even so, there may be conditions under which fiscal support measures may help to lower inflation or at least smooth out a sharp inflationary shock, as seen in Box 2.3's analysis of the fiscal relief measures to offset

[25] Specifically, the illustration assumes standard unit policy interventions on impact, with policy persistence properties that differ across the fiscal and monetary interventions as described in the note to Figure 2.13. Learning dynamics in the model also imply that the evolution of the system can depend on the specific properties of the intervention, as well as the prevailing context. See Online Annex 2.5 for further details.

the energy shock in Europe in 2022. Consumers' perceived or expected persistence of these measures is critical to how they affect the path of inflation.

Monetary Policy Faces Inflation-Output Trade-Offs

In the current context where core inflation in many countries is more persistent than initially anticipated, an important question policymakers face is the timeline to bring inflation back to target. This sub-section illustrates how a central bank's optimal choices, one that minimizes a stylized welfare loss function, would vary with its objectives and the properties of the underlying shocks in the context of the illustrative model. The baseline case assumes that the central bank seeks to minimize a function that equally weights the welfare losses from the output gap and inflation target deviations, alongside a smoother policy rate path.[26] In the heterogeneous agents' model, the central bank under the baseline would opt to calibrate the policy rate path to bring inflation back to target in about four years (Figure 2.14, panel 1).[27] If the central bank were to accelerate this process and decided to double the weight of inflation in its objective function, then it would aim for inflation to come back to target in about three years. In a more extreme case where the central bank only cares about inflation, it would choose to bring inflation back to target in two years. However, this later choice entails lower welfare if society in fact values equally both minimal output gaps and inflation target deviations (Figure 2.14, panel 2).[28] Finally, if there were only forward-looking learners in the economy, then it would be optimal to bring inflation back to target in about three years. Overall, even if the cost-push shock were half as persistent as under the baseline assumptions, it would still be optimal to wait about two years to bring inflation back to target. All these scenarios show that in the presence of a persistent cost-push shock and partially backward-looking expectations, it may be optimal to use a more extended timeline over which inflation is brought to target.

Conclusions

Near-term inflation expectations rose sharply in many economies amid the economic recovery from the pandemic and after the large cost-push shocks of 2022 (from the surprise rises in energy and commodity prices and supply chain disruptions). The rise in expectations was broadly synchronous rise across professional forecasters, financial markets, households, and firms. In contrast, long-term expectations have remained broadly stable on average, with no signs of de-anchoring. Past episodes with jointly rising near- and long-term inflation expectations over a sustained period indicate it took about three years on average for inflation and near-term expectations to return to pre-episode levels, although there is wide variability across episodes.

An estimated hybrid Phillips curve suggests that near-term inflation expectations play a more prominent role in explaining current inflation than long-term expectations. Over recent quarters,

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[26] Specifically, the exercise assumes that the central bank minimizes a welfare loss function that values interest rates smoothing and equally weights output and inflation deviations (a quadratic loss function). The central bank is also assumed to know the expectations formation process in the economy and has full information on the path of future cost-push shocks. See Online Annex 2.7 for more details on the exercise.

[27] Since shock persistence is highly uncertain, this section presents two scenarios assuming different degrees of persistence. If the shock turns out to be less persistent, monetary policy will be able to bring inflation back to target sooner than four years (Figure 2.14, panel 2).

[28] The welfare losses clearly depend on the weights that each society would put to inflation target and output gap deviations.

the drivers of inflation have shifted from underlying cost-push shocks toward inflation expectations, particularly for the average advanced economy. For the average emerging market economy, expectations play a smaller—but still significant—role than lagged inflation. This is particularly relevant, since the pass-through of expectations to inflation increases when inflation is already elevated, such as the present time.

More generally, the analysis underlines the critical role of the expectations formation process for inflation dynamics and the conduct of monetary policy. With a larger share of backward-looking learners in the economy, mean expectations are more persistent and can get stuck at a higher level when inflation is higher for a sustained period. This stickiness reduces the potency of monetary policy and increases the sacrifice ratio (or cost in terms of output forgone) compared to a case where expectations are purely forward-looking and forward-looking.

Given the greater inflation persistence implied by having a share of backward-looking learners in the economy, it could take up to four years to get inflation back to its target if central banks equally weigh the welfare losses from inflation deviating from target with those from output gaps. If the central bank were to disregard the output gap effects of its actions and tighten more and faster, the analysis suggests they could bring inflation back to target in two years, but at the cost of lower output.

Taken together, the chapter's results and recent findings suggest that monetary policymakers benefit from having a clear understanding of the nature of expectations processes at play in their economies. Improved data on expectations could involve close monitoring and enhanced collection of information on expectations across economic agents, particularly near-term which appear more important for current inflation dynamics. The performance of a novel measure of firms' inflation expectations derived from text analysis of firms' earnings calls presented in this chapter points to how technological developments have made it more feasible and cost-effective to extract timely information on expectations.

Improvements to monetary policy frameworks—particularly those that enhance central bank independence and transparency—and communication strategies have the scope to boost the share of forward-looking learners in the economy and thereby the effectiveness of monetary policy (Dincer, Eichengreen, and Geraats, 2022). Recent literature suggests that exposure to news improves the precision of perceptions and expectations, increases confidence, and lowers dispersion of beliefs (Lamla and Vinogradov 2019). Haldane, Macaulay, and McMahon (2020) recommend that central bank communications strategies should start with the 3E's: Explanation, Engagement, and Education. Focusing on household and firms, other recent contributions suggest addressing inattention by taking account of audience segmentation and using sources of communication that have been identified as most relevant for people with more backward-looking expectations—for example, television in the United States and euro area (see Coibion and others 2020, Weber and others 2022, D'Acunto and others 2020, among others). They also suggest shaping messages that are simple and repeated often, investing in financial literacy education, emphasizing the goal and not the instruments (for example, the European Central Bank President Draghi's 2012 "whatever it takes" speech), and targeting the message to the conjuncture. These communication strategies can help economic agents become aware of, understand, and internalize the effects of monetary policy decisions.

Box 2.1. Firms' Inflation Expectations, Attention, and Monetary Policy Effectiveness

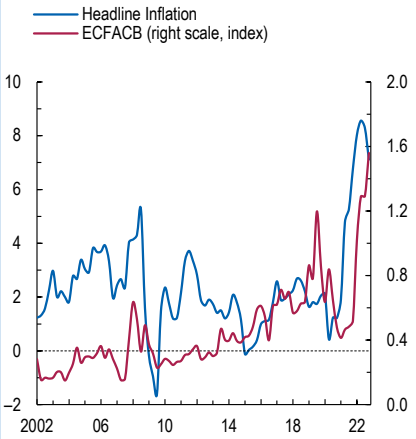
The inflation expectations channel can improve where firms pay greater attention to monetary policy and develop a stronger understanding of what it means for their business prospects. However, surveys of firms' inflation expectations are scarce and time-consuming to implement (Coibion and others 2020). This box introduces a new firm-level index of near-term inflation expectations based on text analysis of firms' earnings calls, and presents preliminary findings on how firms' attention to inflation can influence the effectiveness of monetary policy.

An index of firm's attention to monetary policy is built using a text analysis of firms' earnings calls, Details of its construction feature in Albrizio, Dizioli, and Simon (forthcoming) and are similar to the firm-level index of inflation expectations, as described in Online Annex 2.6,. Specifically, an index for US firms' attention to the Federal Reserve is constructed based on the frequency of sentences discussing monetary policy in their earnings call transcripts (Figure 2.1.1, for an aggregate picture).

Dynamic responses are estimated by local projections to assess the effect of a monetary policy shock on a firm's inflation expectations, conditional on the firm's attentiveness to monetary policy.

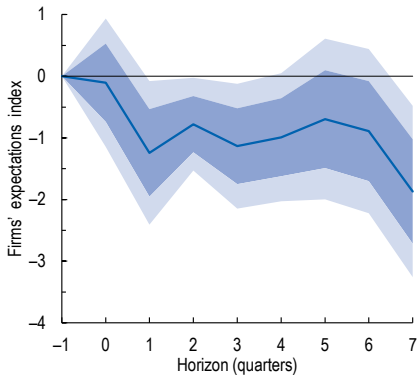
[1] Attentiveness by firm is de-meaned by sectoral average attentiveness in the regression. By de-meaning and adding time fixed effects, the interaction between the monetary policy shock and attention reflects the marginal effect of monetary tightening on a firm's inflation expectations from it being more attentive. More attentive firms decrease their inflation expectations by about 1 percent of a standard deviation more than the average after four quarters (Figure 2.1.2).[2] This corresponds to an amplification of about one-fourth to the sector's average negative response. The results bolster the chapter's argument that monetary policy is more effective when the monetary policy framework and communication strategies help to improve agents' trust in the central bank and their understanding of its monetary policy decisions.

Figure 2.1.1. US Inflation and Firms' Attention to the Federal Reserve
(Percent; unless noted otherwise)



Sources: NL Analytics; S&P Capital IQ; and IMF staff calculations.
Note: The figure shows an index of firms' attention to the central bank (right scale), extracted from earnings call transcripts and actual inflation (left scale). The index is calculated by applying text-based analysis using transcripts of US-based companies' earnings calls and measures the intensity of discussion related to the Federal Reserve.

Figure 2.1.2. Role of Attention in Monetary Policy Effectiveness
(Percent of ECFIE standard deviation)



Sources: Haver Analytics; NL Analytics; S&P Capital IQ; S&P Compustat; and IMF staff calculations.
Note: The line in the figure is the estimated cumulative impulse response
to a one-standard-deviation contractionary monetary policy shock for a firm that is one standard deviation above the average firm attentiveness in its sector. Shaded areas represent 68 (outer) and 90 percent (inner) confidence intervals.

The authors of this box are Silvia Albrizio, Pedro Vitale Simon, and Allan Gloe Dizioli.

[1] The specification includes an interaction between the US monetary policy shock measure (from Acosta 2023) and the attention index, firm and time fixed effects, and firm-level controls, based on Ottonello and Windberry (2020). Firm-level controls include: sales growth, leverage, employment, total assets, share of current assets of total assets. Standard errors are two-way clustered by firms and time.

[2] The shocks have been scaled to have unit standard deviation.

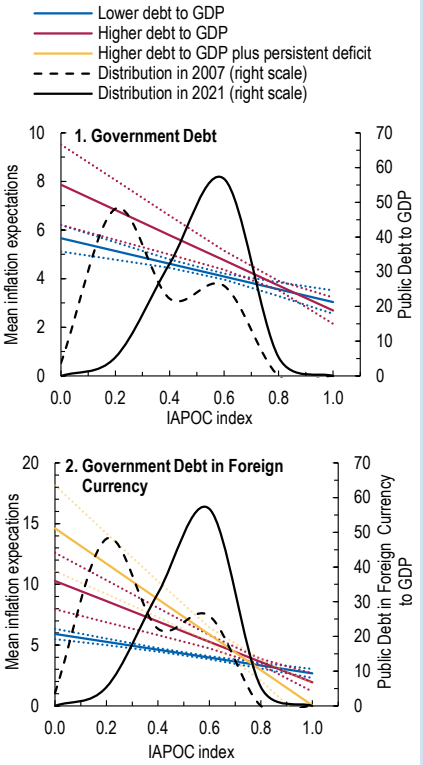
Box 2.2. Fiscal Imprudence and Inflation Expectations: The Role of Monetary Policy Frameworks

Fiscal imprudence—high levels of public debt to GDP—is generally regarded as having the potential to generate uncertainty and influence inflation expectations by eroding perceptions of monetary policy credibility and independence.[1] That much has been clear since the work of Sargent and Wallace (1981) and Leeper (1991). This box empirically examines how the level of inflation expectations is related to an economy's monetary policy framework, given the level of public debt.

In this study, the soundness of monetary policy frameworks is captured by a new index developed by Unsal, Papageorgiou, and Garbers (2022).[2] It shows that even after accounting for economy-specific controls and time-invariant characteristics, higher public debt is associated with expectations of higher inflation, given a specific level of monetary policy framework (Figure 2.2.1, panel 1).[3] This heightened impact is even more evident when focusing on the stock of public debt in foreign currency, and exacerbated more when fiscal deficits are persistent (Box Figure 2.2.1, panel 2). However, as monetary policy frameworks are improved (as seen with the shift in the IAPOC index distribution in emerging market and developing economies over the past 15 years), inflation expectations become less sensitive to the level and composition of public debt or persistent fiscal deficits.

Overall, the study findings indicate that difficulties posed by higher public debt levels for managing inflation expectations in emerging market and developing economies could be helped by adopting strong monetary policy frameworks. Whereas monetary policymaking in many of these economies is better equipped than 15 years ago to serve as an anchor of stability, the adoption of a prudent fiscal policy approach remains key to effective preparation for challenges and to avoid the risk of fiscal dominance in future.

Figure 2.2.1. Inflation Expectations in Emerging Market and Developing Economies: Monetary Policy Frameworks and Public Debt Interactions
(Percent)



Sources: Consensus Economics; Unsal, Papageorgiou, and Garbers (2022); and IMF staff calculations.
Note: The panels show the marginal effects of monetary policy framework changes (according to the IAPOC [Overall Monetary Policy Framework] index) on mean inflation expectations, conditional on the ratio of total (foreign-currency) government debt to GDP. "Higher/lower" debt is the average debt to GDP, conditional on its being above (below) the sample mean. Estimates are from a fixed-effects panel regression across economies of mean inflation expectations on the interaction of the IAPOC index score and debt to GDP. Distributions represent the density of the IAPOC index for the assessed economies in 2007 (dashed) and 2021 (solid), with a rightward shifting indicating improvement.

The authors of this box are Omer Akbal, Mariarosaria Comunale, Marina Conesa, Chris Papageorgiou, and Filiz Unsal.

[1] See Brandao-Marques and others (2023) for a recent empirical study of the issue and Bianchi and Melosi (2022), Bianchi, Faccini, and Melosi (2022), and Cochrane (2022) for theoretical arguments.

[2] The IAPOC index and its subindicators quantify the soundness of monetary policy frameworks across countries through three pillars: Independence and Accountability (I and A), Policy and Operational Strategy (P and O), and Communications (C). This comprehensive index enables a multidimensional characterization of monetary policy frameworks—going beyond monetary policy or exchange rate regime classifications—across 13 advanced economies and 37 emerging market and developing economies. See Unsal, Papageorgiou, and Garbers (2022) for further details. The data set has been updated to 2021.

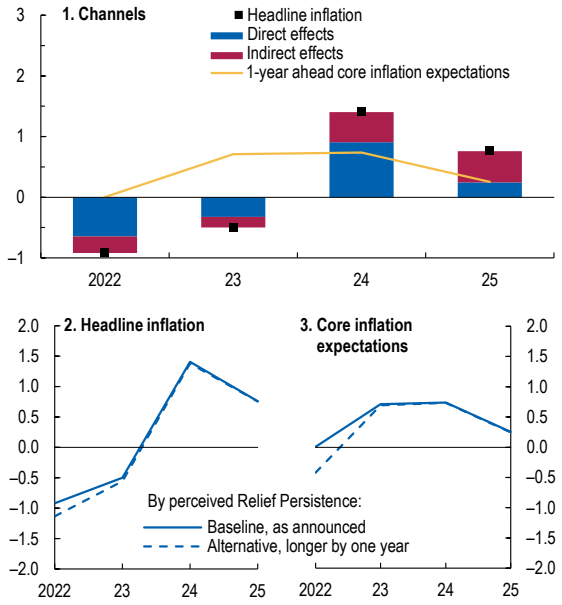
[3] Advanced economies do not show this differential sensitivity to debt levels over different IAPOC index scores.

Box 2.3. Energy Subsidies, Inflation, and Expectations: Unpacking Euro Area Measures

Several European economies have used energy subsidies, tax cuts, and price caps to help smooth the impact of recent shocks to energy prices on incomes and inflation. The effectiveness and desirability of such measures depends on many factors beyond the scope of this box, including their impact on energy markets, resource misallocation, and fiscal sustainability, as well as details of the policy design. One important channel is inflation expectations. Temporary energy subsidies directly lower inflation today but increase it after they expire when pent-up price pressures can surge. These policies can also indirectly boost inflation today since expectations of higher future inflation may affect price-setting today. Thus, the expectations channel may reduce the effectiveness of subsidies in reducing inflation.

A model from the IMF's Flexible System of Global Models (FSGM) is used to simulate the impacts on expected and realized inflation of announced energy relief measures (price subsidies and caps) in the euro area.[1] The simulation assumes that the sharp upward shock to energy prices in 2022 is temporary and unwinds. It also includes the indirect effects of energy prices on core inflation through the supply chain.

Figure 2.3.1 Marginal Impacts of Fiscal Measures for Relief from the Energy Price Shock on Inflation and Expectations
(Percentage point deviation from no-measures scenario)



Sources: Dao and others (2023); and IMF staff calculations.
Note: Panel 1 shows the marginal impacts on inflation of announced fiscal relief measures for energy, using the IMF's Flexible System of Global Models. The blue bars show the direct effects of measures (subsidies, tax cuts, or price caps on consumer energy prices) and the red bars show the indirect effects from changes in aggregate demand, supply chain costs, and core inflation expectations. The baseline in panel 2 assumes fiscal relief measures last in 2022 as originally announced. The alternative assumes that households misperceive and expect measures will last longer, but then in 2023 they realize their error and adjust to the announced path.

The model estimates that fiscal relief measures lowered euro area inflation by 0.9 percentage points in 2022 and by half a percentage point in 2023 (Figure 2.3.1, panel 1). Although additional fiscal borrowing to finance the subsidies boosts demand, its effect on core inflation is more than offset by the reduction in supply chain costs. These fiscal measures only smooth out the inflation impact of the energy shock over time, leading to a rise in inflation over 2024–25 as energy subsidies expire. The measures have a net neutral effect on core inflation expectations in 2022 but increase them by 0.7 percentage points over 2023–24. These findings assume, however, that agents are fully understand the temporary nature of the subsidies. What if agents misperceive and think that the subsidies will last for a year more than announced? In this alternative scenario, expectations fall more in 2022 (Figure 2.3.1, panel 2). Subsidies also lead firms to lower their prices by more in 2022 because they now expect core inflation to be lower in 2023. The fall in inflation expectations increases the impact of fiscal policy on inflation from -0.9 to -1.1 percentage points in 2022 and from -0.5 to -0.6 percentages points in 2023. But once agents realize their error and correct, inflation and expectations bounce back, highlighting the role of the expectations channel.

The author of this box is Chris Jackson

[1] See Dao and others (2023) for further details on the structure of the model and simulation calibration.

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CHAPTER 2

MANAGING EXPECTATIONS: INFLATION AND MONETARY POLICY

Online Annex

Online Annexes 2.1–2.7 provide details regarding the data sources, variable transformations, analytical approaches (empirical and model-based), and sensitivity analyses and robustness checks of the findings presented in the main text. Selected additional and complementary findings are also exhibited.

Online Annex 2.1 Data Sources, Sample Coverage, and Variable Definitions

Key data sources used in the chapter are listed in Online Annex Table 2.1.1. The empirical analyses undertaken are at quarterly frequency unless indicated otherwise. This means that source data at annual or monthly frequency are either mapped to or aggregated to quarterly frequency (for example, in the case of near-term inflation expectations from professional forecasters). The samples of economies underlying the estimation and/or calibration for each analytical exercise exhibited in the figures are provided in Online Annex Table 2.1.2.

Inflation expectations considered in the descriptive statistics and empirical analyses come from the below sources:

- *Consensus Forecast (CF) surveys of professional forecasters.* Monthly CF surveys contain information on a current- and next-calendar-year expected inflation (that is, fixed-event forecasts). The next-12-months or near-term expected inflation is constructed as the weighted sum of monthly vintages, following the standard approach in the literature (see Buono and Formai 2018, Methodological Appendix). When mapped to the quarterly frequency, the expectation as of the first month within the quarter-of-interest is used (that is, for the first quarter, the January observation is used; for the second quarter, the April observation is used. CF surveys at a quarterly frequency also provide calendar-year forecasts of inflation further out, including the three-, five-, and seven-year-ahead. Given the longer horizon, the fixed-event and fixed-horizon concepts will largely coincide; no further adjustment is made to these longer horizon expectations.
- *Financial market-based inflation expectations.* Near-term and long-term inflation expectations are derived from indexed bond and inflation swaps at the one-year and five-year maturities. They are therefore average annualized expected inflation rates over the time period of the associated financial asset. As they require deeper financial markets, these are available only for a small subset of economies on a consistent basis. The chapter exhibits series and estimates from the United States, United Kingdom, euro area, and Brazil.
- *Household surveys.* Near-term inflation expectations are based on replies to questions on the expected average inflation in the next 12 months.
- *Index of firms' inflation expectations.* Taken from Albrizio, Dizioli, and Simon (forthcoming), this indicator of firms' inflation expectations is constructed based on a text analysis of earnings call transcripts for listed firms, denoted as the Earnings-Call-based Firm Inflation Expectations (ECFIE) index. The ECFIE captures near-term inflation expectations. See Online Annex 2.6 for a brief description of the methodology used.

As noted in the chapter, the empirical analyses largely use mean inflation expectations—inflation expectations by economic agent that are aggregated to the economy level. In the case of survey-based measures, it is typically the average (weighted-mean or median) over individual observations. For the ECFIE, the market-cap weighted measure is used. For the financial market-based measures, it is inferred from the posted prices of inflation-related financial assets.

Annex Table 2.1.1. Data Sources

Indicator	Sources
Inflation (headline and core)	Haver Analytics; International Monetary Fund, World Economic Outlook database
Inflation Expectations: Professional Forcasters	Consensus Economics Inc.
Inflation Expectations: Households	Haver Analytics; European Commission; Reserve Bank of New Zealand
Inflation Expectations: Market-based	Bloomberg
Inflation Expectations: Firms	Albrizio, Dizioli and Simon 2023, NL Analytics, S&P Capital IQ
Additional Sources for Recent Patterns in Inflation Expectations and Anchoring	
Inflation Targets	Haver Analytics; central bank websites
Additional Sources for the Role of Expectations in Inflation Dynamics	
Output gap	World Economic Outlook
Nominal effective exchange rates	Bloomberg
Global Energy Prices	International Monetary Fund, Primary Commodity Price System
Additional Sources for Expectations Formation and Monetary Policymaking	
Monetary Policy Framework: IAPOC and subindexes	Unsal, Papageorgiou, and Garber (2022)
Output gap	International Monetary Fund, World Economic Outlook database
Annualized quarterly PCE inflation for the USA and CPI inflation for Brazil.	Haver Analytics;
Real wage gap as measured by the quarterly and annualized de-trended Employment Cost Index (ECI) deflated by PCE inflation for the USA.	Haver Analytics;
One-year and ten-years inflation expectations.	Cleveland FED for the USA and Banco Central do Brasil for Brazil.

Source: IMF staff compilation.

Annex Table 2.1.2. Sample of Economies Included in Analytical Exercises

Figure 2.1

AEs (30): Australia; Austria; Belgium; Canada; Cyprus; Czech Republic; Estonia; Finland; France; Germany; Greece; Ireland; Israel; Italy; Japan; Korea; Latvia; Lithuania; Netherlands; New Zealand; Norway; Portugal; Slovak Republic; Slovenia; Spain; Sweden; Switzerland; Taiwan Province of China; United Kingdom; United States

EMDEs (32): Albania; Argentina; Armenia; Azerbaijan; Bangladesh; Brazil; Chile; China; Colombia; Dominican Republic; Egypt; Georgia; Hungary; India; Indonesia; Kazakhstan; Mexico; Moldova; Nigeria; Pakistan; Paraguay; Peru; Philippines; Poland; Romania; Russia; Serbia; South Africa; Sri Lanka; Thailand; Türkiye; Vietnam

Figure 2.2

Brazil; Euro area, United Kingdom; United States

Figure 2.3

AEs (22): Australia; Canada; Switzerland; Czech Republic; Germany; Spain; Estonia; France; United Kingdom; Italy; Japan; Korea; Lithuania; Latvia; Netherlands; Norway; New Zealand; Slovak Republic; Slovenia; Sweden; Taiwan Province of China; United States

EMEs (14): Brazil; Chile; China; Colombia; Hungary; Indonesia; Mexico; Peru; Philippines; Poland; Romania; Russia; Thailand; Türkiye

Figure 2.4

Historical episodes of jointly rising near- and long-term inflation expectations identifed from the available data for the below economies. See Online Annex 2.3 for the 32 identified episodes (subject to exclusion of hyperinflation and wartimes).

AEs (33): Australia, Austria, Belgium, Canada, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong SAR, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Netherlands, New Zealand, Norway, Portugal, Singapore, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Taiwan Province of China, United Kingdom, United States

EMEs (25): Argentina, Brazil, Bulgaria, Chile, China, Colombia, Egypt, Euro Area, Hungary, India, Indonesia, Malaysia, Mexico, Nigeria, Peru, Philippines, Poland, Romania, Russia, Saudi Arabia, South Africa, Thailand, Türkiye, Ukraine, Venezuela

Figure 2.5

Euro area; United Kingdom; United States

Figure 2.6

AEs (32): Australia, Austria, Belgium, Canada, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong SAR, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Netherlands, New Zealand, Norway, Portugal, Singapore, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States.

EMEs (21): Brazil, Chile, China, Colombia, Ecuador, Hungary, India, Indonesia, Kazakhstan, Malaysia, Mexico, Moldova, Peru, Philippines, Poland, Romania, Russia, South Africa, Thailand, Ukraine, Vietnam.

Figure 2.7, 2.8, 2.9, Table 2.4.1, 2.4.2

AEs (31): Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong SAR, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Netherlands, New Zealand, Norway, Portugal, Singapore, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States.

EMEs (17): Brazil, Chile, China, Colombia, Hungary, India, Indonesia, Malaysia, Mexico, Peru, Philippines, Poland, Romania, Russia, South Africa, Thailand, Ukraine.

Figure 2.10, 2.13, 2.14, Annex Figure 2.5.2, 2.5.3

Representative advanced economy based on the United States.

Figure 2.11.

Representative emerging market economy based on Brazil, advanced economy based on United States.

Figure 2.12.

AEs: Australia, Austria, Belgium, Canada, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Malta, Netherlands, New Zealand, Norway, Portugal, Slovak Republic, Slovenia, Spain, Sweden, United Kingdom, United States

EMDEs: Argentina, Armenia, Brazil, Chile, China, Colombia, Georgia, Ghana, Hungary, India, Indonesia, Jamaica, Kazakhstan, Kenya, Kyrgyz Republic, Malawi, Malaysia, Mauritius, Mexico, Moldova, Mozambique, Nigeria, Pakistan, Peru, Philippines, Poland, Russia, Rwanda, Serbia, South Africa, Tanzania, Thailand, Türkiye, Uganda, Ukraine, Uruguay, Zambia

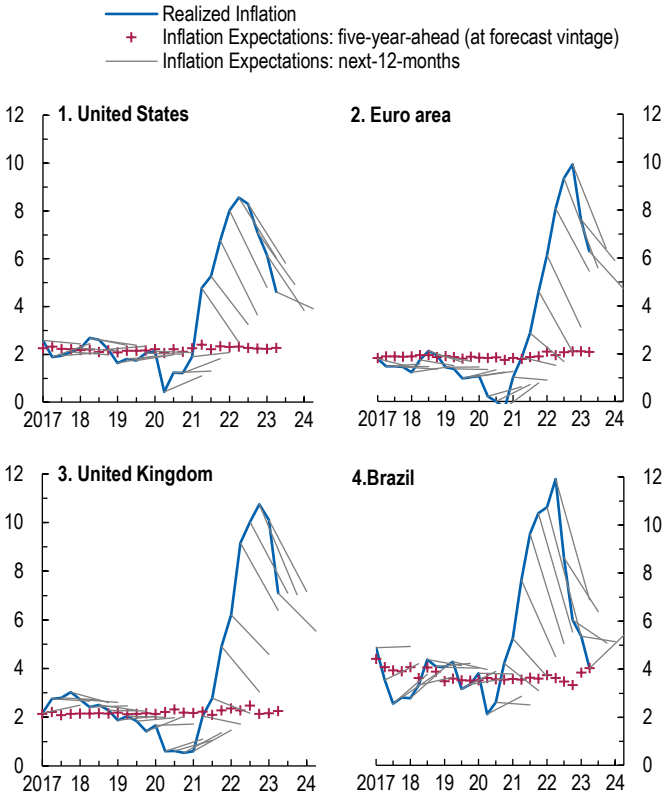
Source: IMF staff compilation.

Note: AEs = advanced economies; EMEs = emerging market economies; EMDEs = emerging market and developing economies.

Online Annex 2.2. Additional Stylized Facts and the Anchoring of Long-Term Inflation Expectations

Online Annex Figure 2.2.1 shows near-term and long-term inflation expectations from professional forecasters for the four economies exhibited in Figure 2.2 (Brazil, euro area, United Kingdom, and United States). Long-term expectations are highly stable, while near-term expectations are much more changeable. Online Annex Figure 2.2.2 shows the distribution of near- and long-term inflation expectations from professional forecasters over the three different time periods (pre-, during, and post-pandemic) delineated in Figure 2.3. Kolmogorov-Smirnov tests of the differences in distribution across the three periods indicate that long-term expectations have not significantly shifted.

Annex Figure 2.2.1 Realized Inflation and Next-12-Months and Five-Year-Ahead Inflation Expectations by Professional Forecasters
(Percent)



Source: Consensus Forecasts; World Economic Outlook; and IMF staff calculations.

Building on earlier contributions to the literature (Bems and others 2021) and chapter 3 of the October 2018 WEO, three complementary metrics aimed at capturing the degree of anchoring of inflation expectations were calculated, updated to the latest available data:

- *Root-mean-squared deviation of mean inflation expectations from target*. If inflation expectations are well-anchored, beliefs about future inflation should be, on average, close to the monetary authority's inflation target (Demertzis, Marcellino, and Viegi 2012; Kumar and others 2015). The root-mean-squared deviation of the mean inflation expectation at horizon h from the inflation target over the time window ω of fixed-length T is given by:

$$\sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(\pi_t^{e,h}-\pi^*\right)^2}, \qquad with\ \ h=3,\ldots,7; \quad t\in\omega$$

in which π^* is the central bank's inflation target for inflation-targeting economies or the one-year moving average of 10-year-ahead inflation forecasts ($\pi_t^{e,10}$) otherwise. The closer to zero this indicator is, the better-anchored expectations are.

- *Standard deviation of mean inflation expectations.* If inflation expectations are well-anchored, revisions of agents' long-term inflation expectations should be smaller, and thus long-term expectations more stable over time (Kumar and others 2015). The standard deviation of the mean inflation expectation for horizon h over the time window ω of fixed-length T is:

$$\sqrt{\frac{1}{T-1}\sum_{t=1}^{T}\left(\pi_t^{e,h}-\bar{\pi}^{e,h}\right)^2}, \qquad with\ \ h=3,\ldots,7; \quad t\in\omega$$

  in which $\bar{\pi}^{e,h}$ is the average of inflation expectations for horizon h over window ω.

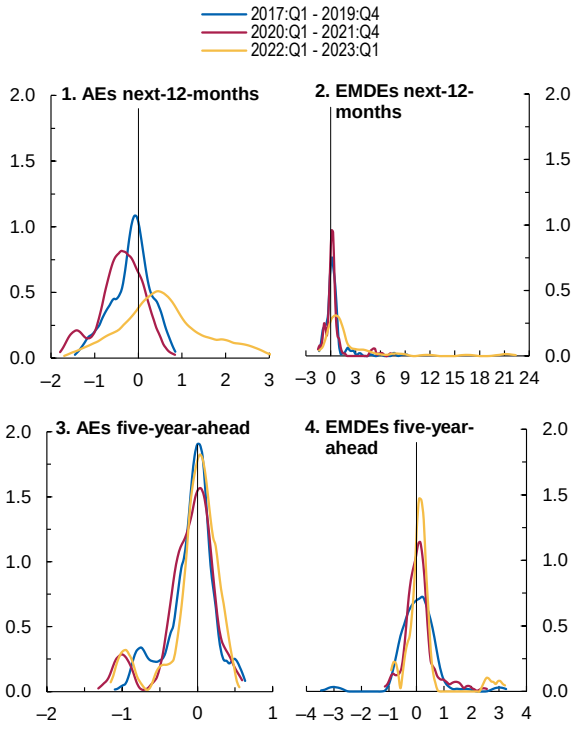
- *Disagreement in inflation expectations across individual forecasters.* Individual beliefs about long-term inflation should be close to each other if expectations are well-anchored, coinciding exactly if they are perfectly anchored (Capistrán and Ramos-Francia 2010; Dovern, Fritsche, and Slacalek 2012; Ehrmann 2015; Kumar and others 2015). The disagreement across forecasters is captured by the standard deviation of h-year-ahead inflation expectations by individual forecasters in each period t averaged over the time window ω:

$$\frac{1}{T}\sum_{t=1}^{T}\sqrt{\frac{1}{J-1}\sum_{j=1}^{J}\left(\pi_{j,t}^{e,h}-\pi_t^{e,h}\right)^2}, \qquad with\ \ h=3,\ldots,7; \quad t\in\omega$$

  in which $\pi_{j,t}^{e,h}$ denotes the inflation expectation of agent j at time t for horizon h and $\pi_t^{e,h}$ is the average across forecasters for that horizon over the time window.

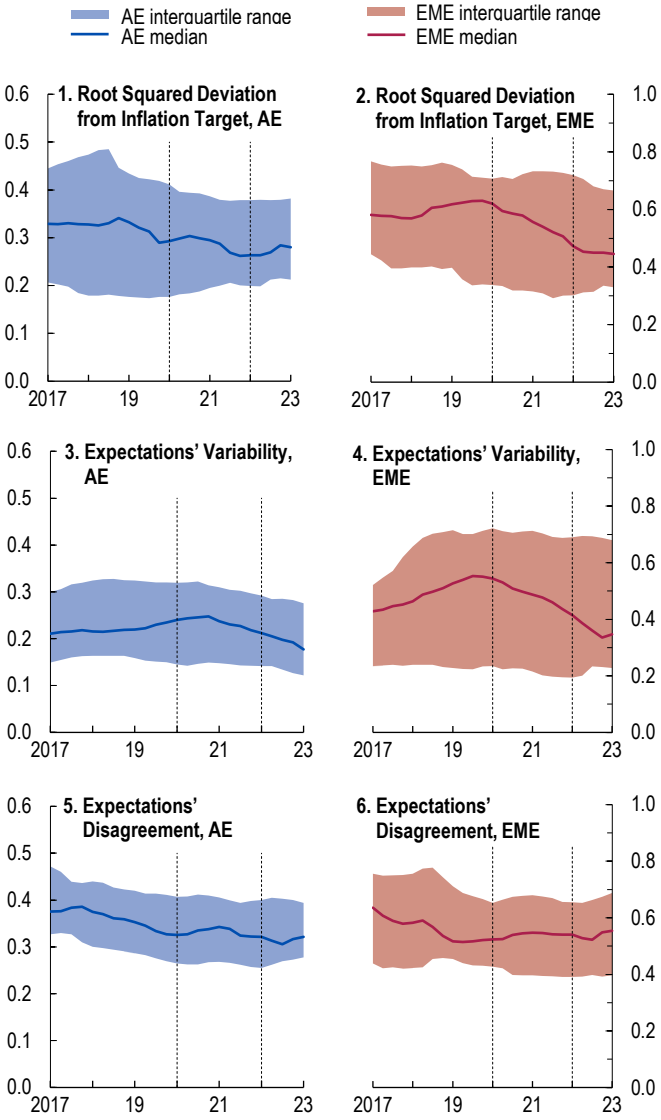
The time window used for the calculation of the three metrics is six years (24 quarters. These measures are computed using three-, five-, and seven-year-ahead inflation forecasts, with the highest value across horizons taken. In general, lower values denote better-anchored long-term expectations across the three metrics. The results are displayed in Online Annex Figure 2.2.3. Although the three metrics capture distinctive characteristics of the behavior of inflation expectations, the overall picture is consistent across metrics.

Annex Figure 2.2.2. Next-12-Months and Five-Year-Ahead Inflation Expectations by Professional Forecasters by Period
(Percentage points deviation from target)



Sources: Consensus Forecast; central bank websites; Haver Analytics; and IMF staff calculations.
Note: AEs = advanced economies; EMDEs = emerging markets and developing economies.

Online Annex Figure 2.2.3. Metrics on the Anchoring of Long-Term Inflation Expectations
(Percentage points)



Sources: Consensus Economics; central bank websites; Haver Analytics; and IMF staff calculations.
Note: Inflation expectations are from professional forecasters to maximize sample coverage. Expectations' variability is the rolling standard deviation of longer-term expectations over time. Expectations' disagreement is the rolling standard deviation of longer-term inflation expectations across individual forecasters. The window is over the past six years. AE = advanced economies; EME = emerging market economies.

Online Annex 2.3. Historical Episodes of Sustained Rises in Near- and Long-term Inflation Expectations and Robustness

Historical episodes for comparison with the current macroeconomic dynamics as chosen based on a joint rise both near- and long-term inflation expectations (from professional forecasters; Consensus Forecasts) for a sustained period, here defined as four sequential quarters. Figure 2.4 plots the median outcome and interquartile ranges across the identified episodes, as well as the medians over the latest inflationary episode for the groups of advanced and emerging market and developing economies respectively. The 32 historical episodes identified (16 in advanced economies and 16 in emerging market economies) are listed in Online Annex Table 2.3.1.

Online Annex Figure 2.3.1 shows the evolution of the unemployment rate gap for the historical episodes in the advanced economy sample, where there is full coverage in the employment data. The historical experience in advanced economies suggests there is an upside risk to the unemployment gap going forward, as seen in the upward skew of the interquartile range.

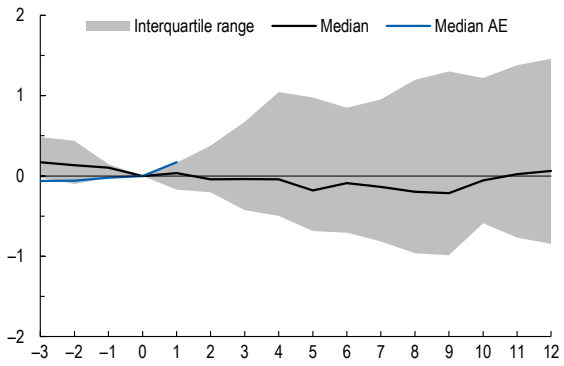
Annex Table 2.3.1. Identified Historical Episodes of Persistently Rising Near- and Long-term Inflation Expectations

Advanced Economies		Emerging Market Economies	
Economy	End-Episode Quarterly Date	Economy	End-Episode Quarterly Date
Australia	2005:Q4	Argentina	2010:Q4
Australia	2010:Q2	Bulgaria	2011:Q1
Germany	1997:Q4	Brazil	2003:Q1
Spain	2006:Q2	Brazil	2008:Q2
Euro Area	2008:Q2	China	2004:Q1
Hong Kong	2004:Q4	Indonesia	1998:Q2
Italy	2011:Q2	Indonesia	2002:Q2
Japan	2004:Q2	Malaysia	2010:Q2
Japan	2011:Q2	Malaysia	2013:Q4
Lithuania	2011:Q2	Poland	2007:Q2
Latvia	2011:Q2	Russia	2008:Q2
Netherlands	2001:Q2	Thailand	2004:Q4
Norway	2001:Q2	Thailand	2010:Q2
Norway	2008:Q1	Turkey	2008:Q4
New Zealand	2008:Q2	Venezuela	1994:Q4
Singapore	2008:Q2	Venezuela	1998:Q4

Source: IMF staff calculations.

Note: Historical episodes require 4 quarters of both near-and long-term inflation expectations (from professional forecasters) are rising. The underlying sample spans 1989:Q4 to 2023:Q1, with exact time coverage

Annex Figure 2.3.1 Historical Episodes of Persistently Rising Inflation Expectations: Unemployment Rate Gap in Advanced Economies
(Percentage points relative to end of episode level)



Sources: Consensus Economics; and IMF staff calculations.
Note: The unemployment rate gaps for the historical episodes are only shown for the advanced economy sample due to data availability constraints. The natural rate of unemployment is calculated using a two-sided HP filter at quarterly frequency. AE = advanced economies.

Alternative Definition of Historical Episodes

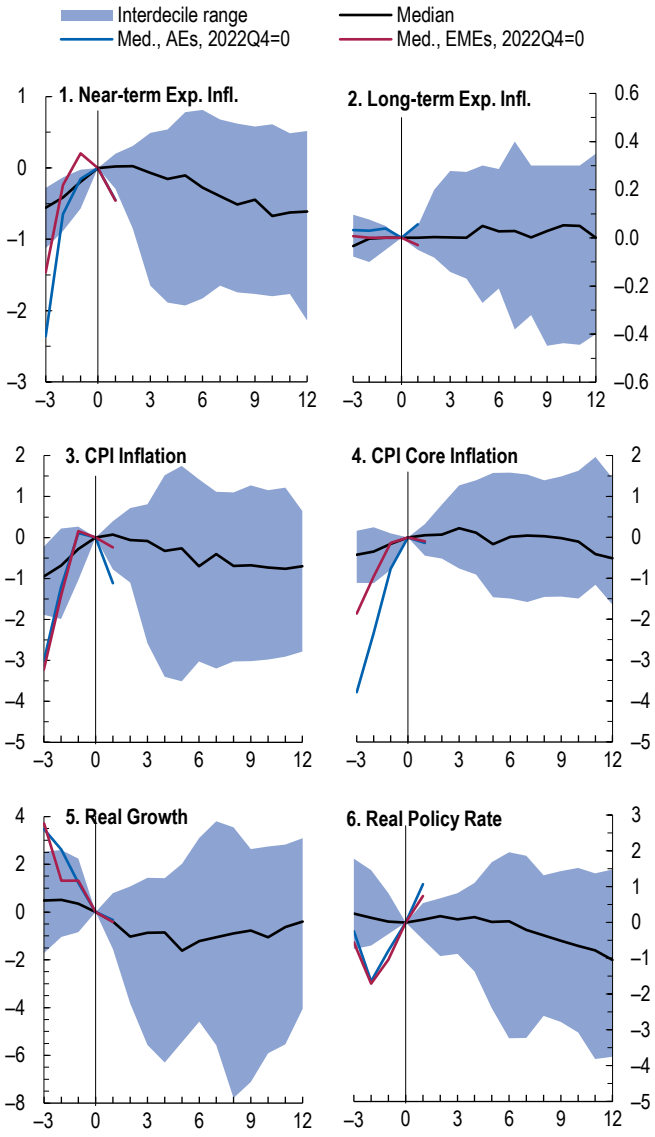
To consider how robust the patterns from the identified historical episodes where near- and long-term inflation expectations were both rising persistently, an alternative definition was investigated, where long-term inflation expectations were instead broadly stable rather than rising, similar to their recent average behavior for the group of advanced economies.

Specifically, the alternative episodes were required to have persistently rising near-term expectations for four contiguous quarters (as in the historical episodes presented in the main chapter and described above), while long-term inflation expectations were: (1) neither persistently rising nor falling over the same period; and (2) the absolute magnitude of changes in long-term expectations by quarter were no larger than 7 basis points (the maximum absolute quarterly change in long-term expectations observed for the median advanced economy over 2022). These criteria identify 42 historical episodes over the available data, with 36 coming from advanced economies and only six from emerging market economies. Online Annex Figure 2.3.2 exhibits the patterns observed over these historical episodes.

Overall, the patterns appear largely similar across the main chapter definition of historical episodes of rising expectations and the alternative shown here. Long-term expected inflation stayed broadly stable on average in the aftermath for the set of these alternative historical episodes, while risks were balanced. Similar to the episodes presented in the main chapter, near-term expected inflation and headline inflation took about three years to come back down to their pre-episode level (t = -3) on average. Core inflation comes down at about the same pace, somewhat faster than what was observed in the main chapter episodes. Real growth also declined on average, by about two percentage points about four to five quarters after the end of the episode (t = 0) on average, while risks are more

Annex Figure 2.3.2. Historical Episodes with Persistently Rising Near-term Inflation Expectations and Stable Long-term Expectations

(Percentage points relative to level at end of episode)



Sources: Consensus Economics; WEO; and IMF staff calculations.
Note: Horizontal axes show quarters after the end of the historical episode. Near-term inflation expectations (panel 1) are expected inflation rates over the subsequent year on a rolling basis (next-12-months). Long-term inflation expectations (panel 2) are expected inflation in five years' time. Real policy rates are ex ante real interest rates based on expected inflation. Inclusion as a historical episode requires 4 quarters of neat-erm inflation expectations rising and broadly stable long-term expectations (defined as no absolute change greater than 7 basis points, similar to the average advanced economy over the 2022:Q4 episode). The sample spans 1989:Q4 to 2023:Q1, with exact time coverage varying by economy. A total of 42 episodes are identified, with 36 from advanced economies and 6 from emerging market economies. The interdecile range is the difference between the 90th and 10th percentiles of the distribution. AEs = advanced economies; CPI = consumer price index; EMEs = emerging market economies; Exp. = expectations; Infl. = inflation; Med. = median.

skewed to the downside. The current episode suggests a sharper slowing on average than these earlier, alternative episodes. The real (ex ante) policy rate tended to remain steady on average, but coming down slowly by about one percentage point on average after three years. The comparison with the current episode also suggests a drop and then sharp rise, similar to the main chapter episodes' comparison.

Online Annex 2.4 Hybrid Phillips Curve Analysis

Baseline Specification

Following several recent *World Economic Outlook* chapters (October 2018 Chapter 3, October 2021 Chapter 2 and October 2022 Chapter 2), the hybrid Phillips curve relates the annualized quarter-on-quarter, seasonally-adjusted headline CPI inflation ($\pi_{c,t}$) to lagged inflation ($\pi_{c,t-1}$), near-term (next-12-months) inflation expectations from Consensus Forecasts ($E_{c,t}\pi_{c,t+h}$), and the output gap ($y_{c,t}$) using panel data. As control variables, the linear regression also includes changes in global energy prices and in the nominal effective exchange rates ($X_{c,t}$), as well as economy and time fixed effects. The baseline regression allows all estimated coefficients to be economy-specific, except for the time fixed effects, which are included to capture common global factors. The chapter reports the average coefficients by economy groups.

The hybrid Phillips curve specification is:

$$\pi_{c,t} = \gamma_c\, \pi_{c,t-1} + \beta_c E_{c,t}\pi_{c,t+h} + \theta_c y_{c,t} + \delta_c X_{c,t} + \alpha_c + \tau_t + \varepsilon_{c,t}. \qquad (2.4.1)$$

This is estimated at the quarterly frequency using an unbalanced (across economies) panel starting in 1991:Q2 at the earliest and including observations through 2023:Q1. The sample excludes periods of hyperinflation in a small number of emerging market economies prior to 1997. Up to 32 advanced economies and 21 emerging market economies are included in the analysis, depending on data availability. Coefficients in the baseline, associational regressions are estimated via ordinary least squares (OLS) with Driscoll-Kraay standard errors shown.

Causal Estimation

OLS estimation of the hybrid Phillips curve treats inflation expectations as exogenous. As discussed in Mavroeidis, Plagborg-Møller, and Stock (2014), this relies on strong assumptions regarding the timing and measurement of expectations, as well as the nature of the disturbance term in Equation 2.4.1. To relax the assumption of strict exogeneity, we posit a simple expectations formation model given by:

$$E_{c,t}\pi_{c,t+h} = \gamma_{c,1}\pi_{c,t} + \gamma_{c,2}E_{c,t-1}\pi_{c,t+h} + e_{c,t}. \qquad (2.4.2)$$

The first term of Equation 2.4.2 allows for expectations to respond to current inflation $\pi_{c,t}$, while the second term reflects their intrinsic persistence. The survey error $e_{c,t}$ is assumed to be white noise. Coibion and Gorodnichenko (2015) show that this formulation can accommodate a reduced form representation for either sticky (Mankiw and Reis 2002) or incomplete (Woodford

2003) information. They also provide empirical support for Equation 2.4.2 against the alternative assumption of full-information rational expectations (FIRE).[1]

Assuming exogeneity for the output gap can also be problematic (McLeay and Tenreyro 2020; Barnichon and Mesters 2021). To address this, we rely on a standard formulation of the IS curve which is also used in section 2.5 below

$$y_{c,t} = \alpha_{c,1} y_{c,t-1} + \alpha_{c,2} E_{c,t} y_{c,t+h} - \alpha_{c,3}\left(i_{c,t} - E_{c,t}\pi_{c,t+h}\right) + \Omega_c X_{c,t} + u_{c,t}. \qquad (2.4.3)$$

Equation 2.4.3 relates the current level of the output gap $y_{c,t}$ to its lagged value, today's expected value of the future output gap $E_{c,t}y_{c,t+h}$, the real rate of interest $i_{c,t} - E_{c,t}\pi_{c,t+h}$, other cost-push factors captured by $X_{c,t}$ and the error term. Equations 2.4.1 through 2.4.3 give rise to a system of simultaneous equations for current inflation, inflation expectations, and the output gap, confirming that the OLS estimates of the hybrid Phillips curve will be biased under more general assumptions.[2]

In keeping with the semi-structural interpretation of the hybrid Phillips curve (for example, Adam and Padula 2011; Coibion, Gorodnichenko and Kamdar 2018), we also note the expectations lags for inflation and output, the lagged output gap, and the current nominal interest rate in Equations 2.4.2 and 2.4.3 do not directly affect current inflation. This motivates the use of these variables as instruments for current expectations and current output gap.

After some manipulation, it is possible to express the expected value of future inflation and the output gap in Equations 2.4.2 and 2.4.3 as functions of pre-determined and exogenous variables only. The following can then be used as first stages for our instrumental variables (IV) estimation:

$$\begin{aligned} E_{c,t}\pi_{c,t+h} &= \eta^{\pi}_{c,1}\pi_{c,t-1} + \eta^{\pi}_{c,2}E_{c,t-1}\pi_{c,t+h} + \eta^{\pi}_{c,3}y_{c,t-1} + \eta^{\pi}_{c,4}E_{c,t-1}y_{c,t+h} + \eta^{\pi}_{c,5}i_{c,t} \\ &\quad + \mathrm{H}^{\pi}_{c}X_{c,t} + \delta^{\pi}_{c} + \tau^{\pi}_{t} + \epsilon^{\pi}_{c,t}, \\ y_{c,t} &= \eta^{y}_{c,1}\pi_{c,t-1} + \eta^{y}_{c,2}E_{c,t-1}\pi_{c,t+h} + \eta^{y}_{c,3}y_{c,t-1} + \eta^{y}_{c,4}E_{c,t-1}y_{c,t+h} + \eta^{y}_{c,5}i_{c,t} \\ &\quad + \mathrm{H}^{y}_{c}X_{c,t} + \delta^{y}_{c} + \tau^{y}_{t} + \epsilon^{y}_{c,t}. \end{aligned} \qquad (2.4.4)$$

The passthrough estimates for inflation expectations β_c and the output gap θ_c using the IV approach are unbiased under the assumption that the lags of expectations for inflation and the output gap, the lagged output gap, and the current nominal interest rate are uncorrelated with $\varepsilon_{c,t}$ in Equation 2.4.1. Online Annex Table 2.4.1 shows both the OLS and IV coefficient estimates for Equation 2.4.1, along with diagnostic statistics on the validity and strength of the identifying assumptions (overidentification and weak identification tests).

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[1] In general, the hybrid Phillips curve will not be micro-founded under non-rational expectations. However, Adam and Padula (2011) show that if survey expectations follow the law of iterated expectations—a weaker assumption than full-information rational expectations (FIRE)—the standard specification remains valid. Coibion and Gorodnichenko (2012, 2015) provide evidence that this is the case for the United States. More generally, several alternatives to the FIRE assumption for expectations formation have been proposed. Among these are sticky information (Mankiw and Reis 2002), noisy information (Woodford 2003), adaptive learning (Sims 2003, Alvarez and Dizioli 2023), higher-order beliefs (Angeletos and La'O 2009) and k-level thinking (Farhi and Werning 2019). See Angeletos and Lian (2023) for a recent literature review.

[2] Fuhrer (2017) and Alvarez and Dizioli (2023) use a similar approach but directly solve the system of equations using Bayesian estimation. Endogeneity is also sometimes offered as a justification for using lagged two-steps-ahead forecasts (Mavroeidis, Plagborg-Møller, and Stock 2014) or long-term instead of near-term expectations (Baba and others 2023) when undertaking Phillips curve estimation.

Robustness Checks

Hybrid Phillips curves are usually expressed as functions of current values of expectations and the output gap. However, it possible that under alternative assumptions the Phillips curve could include lags of expectations as well, which would violate the assumptions of the IV strategy described above. Musy (2021) shows that with multi-period Taylor contracts and indexation, lags of inflation expectations up to the longest contract term should also be included in the reduced-

Online Annex Table 2.4.1 Least Squares and Instrumental Variables Estimates of the Hybrid Phillips Curve

	AE	AE	AE	EME	EME	EME
	Mean groups OLS	Common OLS	Common IV	Mean groups OLS	Common OLS	Common IV
Consensus 12-months	1.137***	1.242***	0.819***	0.655***	0.885***	0.416***
	(0.102)	(0.104)	(0.084)	(0.109)	(0.091)	(0.104)
Output gap	0.063**	0.058**	0.118***	0.127**	0.086*	0.142*
	(0.020)	(0.021)	(0.023)	(0.044)	(0.039)	(0.056)
Lagged inflation	-0.086	-0.096*	-0.006	0.256***	0.179***	0.347***
	(0.051)	(0.047)	(0.042)	(0.049)	(0.039)	(0.049)
R-squared	0.695	0.717	0.478	0.667	0.681	0.564
Countries	31	31	31	17	17	17
Observations	3379	3379	3379	1757	1757	1757
First stage F-stat Expectations			1744.705			249.607
First stage F-stat Output gap			477.631			91.604
Overidentification (p-value)			0.936			0.210
Endogeneity (p-value)			0.000			0.006

Source: IMF staff calculations.
Note: Coefficients estimated by pooled time series using quarterly data from 1991Q2 through 2023Q1. See Annex Table 2.1.2 for the lists of economies included in AE and EME. All regressions also include country and time fixed effects, and changes in global energy prices and nominal effective exchange rate depreciation interacted with country fixed effects. Excluded instruments for the IV models are: lagged 12-month ahead expecations for inflation and GDP growth, lagged output gap and policy interest rates. Driscoll-Kraay standard errors in parentheses. First stage F-stat report values from the Sanderson-Windmeijer test for weak identification. Overidentification reports for the p-value of the Hansen J-statistic for the joint null hypothesis of instrument validity. Endogeneity reports the p-value of the null hypothesis that the endogenous regressors can be treated as exogenous.
* p<0.10, **p<0.05, ***p<0.01.

Online Annex Table 2.4.2 Robustness Checks for Instrumental Variables Estimates of the Hybrid Phillips Curve

	OLS	OLS	OLS	OLS	IV	IV	IV	IV
Included inflation expectations lags	0	0-3	0-5	0-7	0	0-3	0-5	0-7
Consensus 12-months	1.187***	1.268***	1.255***	1.265***	0.849***	0.852***	0.743***	0.768***
	(0.102)	(0.101)	(0.101)	(0.101)	(0.084)	(0.206)	(0.191)	(0.227)
Output gap	0.056**	0.025	0.025	0.020	0.113***	0.104**	0.126***	0.125**
	(0.021)	(0.020)	(0.021)	(0.021)	(0.024)	(0.033)	(0.035)	(0.038)
Lagged inflation	-0.105*	-0.192**	-0.191**	-0.197**	-0.018	-0.038	0.008	0.004
	(0.052)	(0.061)	(0.061)	(0.061)	(0.043)	(0.091)	(0.086)	(0.102)
R-squared	0.703	0.742	0.742	0.741	0.485	0.483	0.426	0.425
Observations	3338	3338	3338	3338	3338	3338	3338	3338
First stage F-stat expectations					1849.650	8.936	11.635	8.041
First stage F-stat output gap					474.383	19.493	23.346	18.105
Overidentification (p-value)					0.697	0.520	0.936	0.779
Endogeneity (p-value)					0.000	0.031	0.005	0.014

Source: IMF staff calculations.
Note: Coefficients estimated by pooled time series for advanced economies using quarterly data from 1991Q2 through 2023Q1. See Annex Table 2.1.2 for the lists included economies. The coefficienst for Consensus 12-months show the sum of the individual coefficients on all included lags. All regressions also include country and time fixed effects, and changes in global energy prices and nominal effective exchange rate depreciation interacted with country fixed effects. Excluded instruments for the IV models are: lagged 12-month ahead expecations for GDP growth, lagged output gap and policy interest rates as well as the first lag following the longest included lag for inflation expectations (e.g. the column denoted by IV 0-3 uses the fourth lag of inflation expectation as excluded instrument). Driscoll-Kraay standard errors in parentheses. First stage F-stat report values from the Sanderson-Windmeijer test for weak identification. Overidentification reports for the p-value of the Hansen J-statistic for the joint null hypothesis of instrument validity. Endogeneity reports the p-value of the null hypothesis that the endogenous regressors can be treated as exogenous.
* p<0.10, **p<0.05, ***p<0.01.

form hybrid Phillips curve. To guard against the possibility that the exclusion restriction on lagged expectations is violated, we extend the lag operator for expectations in Equation 2.4.1 and instrument current expectations with the first excluded lag (for example, lags 1 to 3 are included and lag 4 is used as excluded instrument). Online Annex Table 2.4.2 shows the robustness of the baseline IV estimation for advanced economies when using 4, 6, and 8 lags as instruments.[3] Using up to 8 lags provides strong evidence against such a source of bias given that wage contracts rarely exceed 1 year (and even less for prices).

Online Annex 2.5 Introducing the Heterogenous Agent Model of Expectations Formation: Properties of the Model and Scenario Analysis

In the context of high and persistent core inflation, there is a concern that expectation formation might become more backward looking. There is a growing literature that has explored deviations from the standard rational expectations (RE) assumption. There is large evidence that some agents don't pay attention to inflation and others form expectations just extrapolating past inflation. The model presented here goes in this direction and assumes that the economy is populated by two kinds of agents: (1) adaptive learners, who form their expectations based on their recent experience; and (2) rational agents, who form their expectations rationally based on full information, which includes the knowledge about the existence of the adaptive learners.

The workhorse model used here is a semi-structural model variation of the model by Galí, Smets, and Wouters (2012) and Berg, Karam, and Laxton (2006), which is a standard New Keynesian model that includes wage and price Phillips curves (PC). The same model is also used in Dizioli and Wang (2023) and Alvarez and Dizioli (2023). The equilibrium equations for each country in the linearized system are given by:

$$y_t = \alpha_{yL} y_{t-1} + \alpha_{yF} y_{t+1} + \gamma(\pi_{t+1} - r_t) + s_{yt} \quad \text{(IS Curve)}$$

$$s_{yt} = \rho_{\varepsilon} s_{y_{t-1}} + \varepsilon_{y_t} \quad \text{(Demand Shock process)}$$

$$\pi_t = \alpha_{\pi L} \pi_{t-1} + \alpha_{\pi F} \pi_{t+1} + k_{\pi} w_t + \varepsilon_{\pi t} \quad \text{(Price PC)}$$

$$\pi_{wt} = w_t - w_{t-1} + \pi_t \quad \text{(Nominal wage definition)}$$

$$\pi_{wt} = -\alpha_{wL} w_{t-1} + \alpha_{wF} \pi_{wt+1} + K_w y_t + \varepsilon_{wt} \quad \text{(Wage PC)}$$

$$r_t = \rho r_{t-1} + (1-\rho)(\rho_{\pi} \pi_{t+1} + \rho_y y_t) + \varepsilon_{rt} \quad \text{(Policy reaction function),}$$

where y is the output gap (measure of slack), π is quarter-on-quarter, annualized core inflation rate, r is the nominal monetary policy interest rate, w is the constant composition real wage gap (real wage deviations from labor productivity growth) and π_w is real wage inflation.

One addition to the standard New Keynesian framework is the modeling of near- and long-term expectations, which is inspired by Blanchard and Bernanke (2023).[4] The main assumptions in these equations are that near and long-term expectations depend on each other and that long-term expectations only impact current inflation indirectly through their effect on near term

[3] The same robustness checks for emerging market economies suffer from weak identification due to lower persistence in expectations, so the results are not reported.

[4] See Erceg and Levine (2003) for a model where the expectations formation process is microfounded using a signal-extraction problem by economic agents, conditional on the credibility of the central bank.

expectations. The model also tracks observable measures of near- and long-term expectation through measurement equations. Online Annex Figure 2.5.1 summarizes the main contemporaneous connections in the base model.

$$\pi_{t+1} = \alpha_{1\pi L}\pi_{t-1} + \alpha_{2\pi F}\pi^*_{t+1} + \varepsilon_{\pi t} \quad \text{(expectation equation)}$$

$$\pi^*_t = \alpha^*_{1\pi L}\pi_{t-1} + \alpha^*_{2F}\pi^*_{t-1} + \varepsilon^*_{\pi_t} \quad \text{(long run expectation equation)}$$

$$\pi_{t+1} = \pi^{obs}_{t+1} + \varepsilon^{obs}_{t+1} \quad \text{(measurement equations)}$$

$$\pi^*_{t+1} = \pi^{* obs}_{t+1} + \varepsilon^{* obs}_{t+1} \quad \text{(measurement equations)}$$

The other important change to the standard New Keynesian framework is the partial deviation from the rational expectations (RE) assumption. The economy is populated by adaptive learners and rational expectations agents. The adaptive learner agents do not use all available information to project the future. Instead, they use a small number of variables and simple statistical models to form their expectations. In particular, they use an AR(2) process:

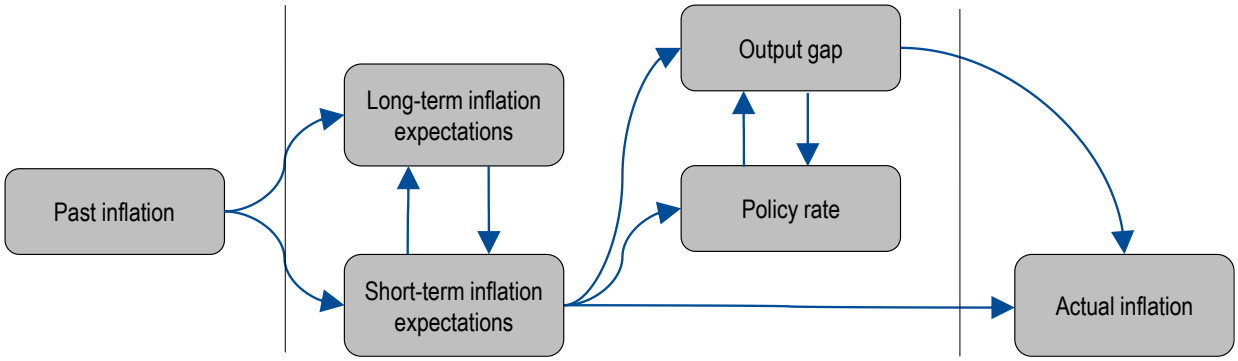
$$E_t[x_{t+1}] = \alpha_t + \beta^1_t x_t + \beta^2_t x_{t-1} \quad \text{(forecasting equation)}$$

Note that the coefficients in this equation vary over time. They depend on how accurate the forecast is at each period. The learning algorithm follows the updating model developed in Slobodyan and Wouters (2012a; 2012b). Agents use a Kalman filter mechanism to update the coefficients of the forecasting equation, and the learning vector evolves according to:

$$B_{t|t} = B_{t|t-1} + P_{t|t-1}X_{t-1}[\Sigma_t + X'_{t-1}P_{t|t-1}X_{t-1}]^{-1} * \text{(forecast errors)},$$

where the $B_{t|t}$ is a vector that stacks all the coefficients of the AR(2) processes, $P_{t|t-1}$is the covariance matrix and Σ_t is the variance-covariance matrix of the AR(2) equation residuals. Meanwhile, rational expectation agents use all available information, including that there is a share of adaptive learners populating the economy, when forming their expectations. Their expected value is a complicated function of the parameters. In other words, in the absence of unanticipated shocks in period t, the RE agents' expectations for next period are given by: $E_t[\pi_{t+1}] = \pi_{t+1}$;

Annex Figure 2.5.1. Model Structure and Connections



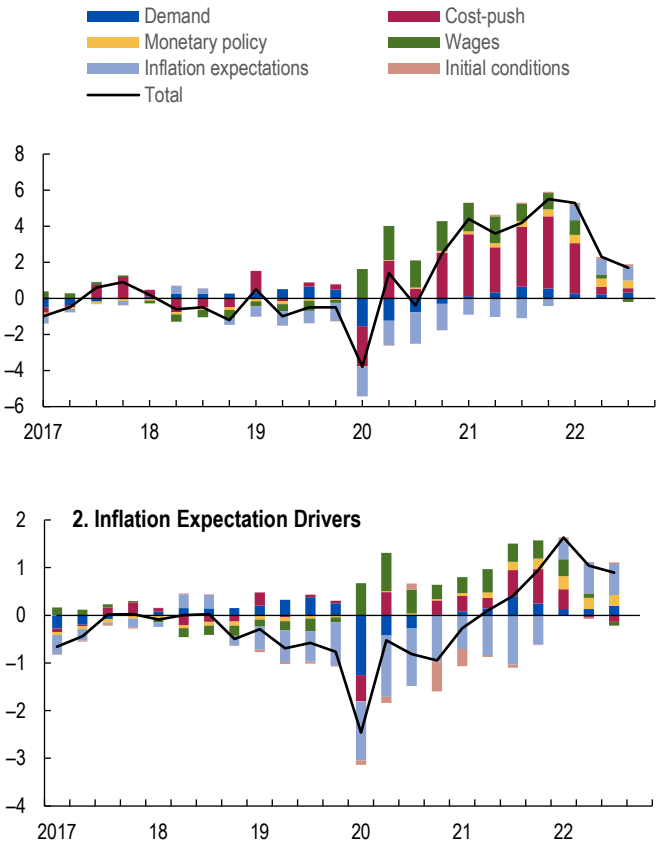
The model described above is estimated with Bayesian methods and quarterly macroeconomic data from 2000:Q1 to 2019:Q4 for Brazil and the USA. The observable variables used in the model estimation include the output gap, as calculated by IMF staff in the WEO database, annualized quarterly PCE inflation, the real wage gap, as measured by the quarterly and annualized de-trended Employment Cost Index[5] (ECI) deflated by PCE inflation and the one-year and ten-years inflation expectations data as measured by the Cleveland FED. The main advantage of these expectations series is the combination of real-time information, including data from financial markets and from surveys. Other than all the structural parameters described in the main equations, the learning speed and the fraction of adaptive learning agents are also estimated. Using the same set of macroeconomic data, the heterogenous agent and the full-information rational expectations model were estimated[6].

Additional Model Properties

This subsection of the annex presents some more of the model properties that were not discussed in the main chapter. A historical decomposition of the model's variables is usually used to validate a model's properties and predictions.

Through the lenses of the heterogenous agents' model, the increase in inflation after the Covid-19 shock was mostly driven by a large cost-push shock that persisted from the last quarter in 2020 to the first half of 2022 (Online Annex Figure 2.5.2). This was probably associated with the supply disruptions caused by the pandemic and the Russian invasion of Ukraine. At the same time, inflation expectations initially pushed inflation down for most of the pandemic. Only in the last part of 2022 that inflation expectations started to contribute positively to

Annex Figure 2.5.2. Historical Decomposition of Inflation and Inflation Expectation Drivers
(Percent)

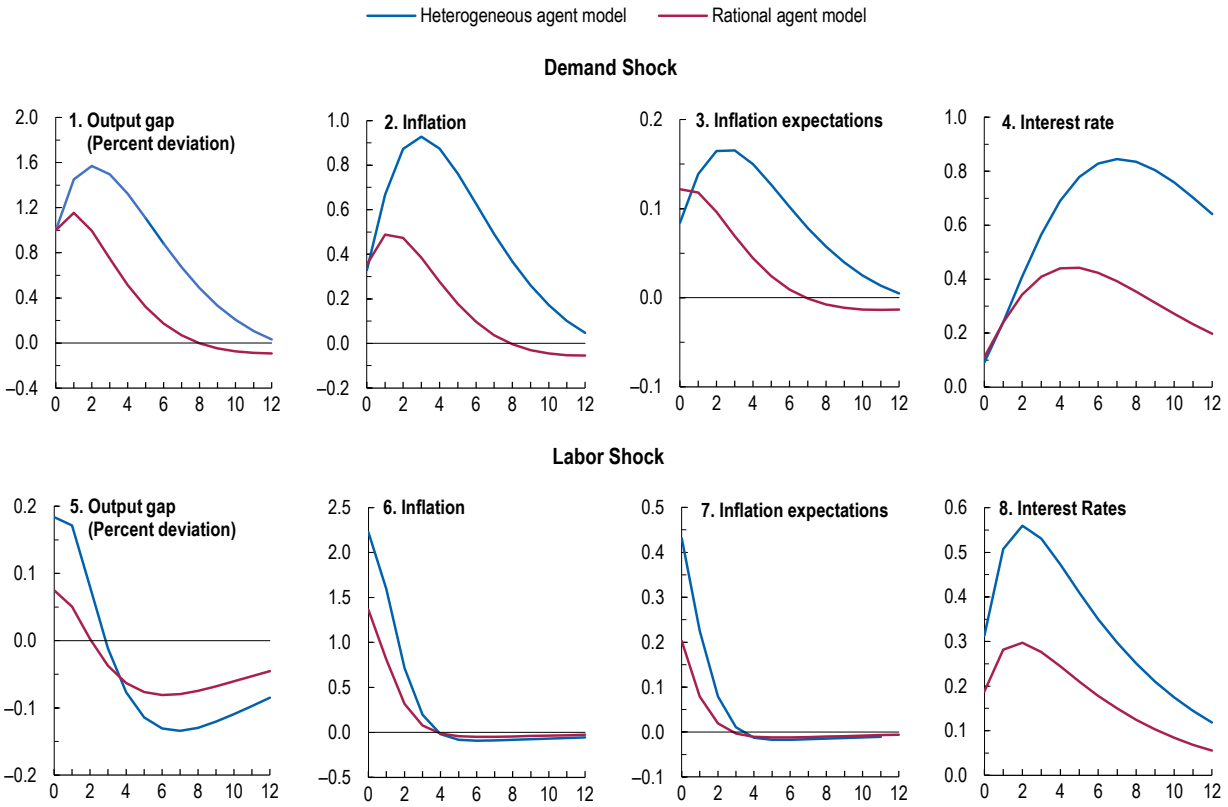


Sources: IMF staff calculations.
Note: The figure shows the representative advanced economy model's structural shock decomposition for inflation and inflation expectations. It shows that the increase in inflation was initially driven by cost push shocks and then inflation expectations became more prominent. The inflation expectations shock decomposition shows that the contribution of inflation expectations was initially negative, but it became positive as realized inflation came in higher.

[5] The choice for the ECI as the observable variable for nominal wage was based on a partial correction in earnings for changes in the composition of the labor force.

[6] The estimation of both models allows comparability based on the data. For example, the estimated coefficients in the FIRE model assigned larger values to backward looking components of the Phillips curve.

Annex Figure 2.5.3. Impulse Response Functions for Other Types of Shocks
(Percentage points, unless noted otherwise)



Source: IMF staff calculations.
Note: The demand shock charts are the Impulse Response Functions of the selected variables to a 1% change in the output gap at the impact. The labor cost shock charts are the Impulse Response Functions of the selected variables to a 1% change in the real wage gap at the impact.

inflation. Meanwhile, demand and monetary policy had a positive but small contribution to inflation in 2021 and 2022.

Turning to near term inflation expectations deviations from target, cost-push and wage cost shocks were initially important drivers for the increase in inflation expectations in 2021, and monetary policy became more important in 2022. Own inflation expectations shocks initially maintained inflation expectations below target at the beginning of the pandemic before turning to positive contributions to inflation expectations as the above target inflation started to feed into higher inflation expectations giving a higher role for inflation inertia.

The main chapter discussed how the heterogenous agent model compares to the rational agents' model benchmark once the economy is hit by a supply shock (cost-push shock) or a monetary policy shock. The economy can also be hit by a pure demand and shock and by other supply shocks, a wage cost shock (Online Annex Figure 2.5.3). Following a pure demand shock, the output gap has a larger hump-shaped response in the heterogenous agents' model. This response reflects a larger estimated shock persistency and more inertial expectations. This prolonged output persistence leads to a larger and more persistence response of both, inflation, and inflation expectations, despite larger monetary policy tightening. Like the cost push shock discussed in the main chapter, a wage cost shock leads to higher initial inflation in the

heterogenous agents' model. This higher inflation feeds into inflation expectations and prolong the inflationary spell.

Monetary Policy Framework

As discussed in the chapter, improvements in monetary policy framework and communication strategies can also contribute to reduce inflation faster by shaping expectations. The underlying mechanism is that more informed agents can better understand central banks' objectives and intentions and the monetary policy transmission mechanisms, and thereby agents become more forward-looking. Figure 2.14 in the chapter shows that at the aggregate there is a positive association between countries where the mean inflation expectations pass the rationality test and better central banks' monetary policy framework. The rationality test builds on the concept that rational expectations imply that agents consider all the pre-determined variables available to forecasts inflation (Lovell 1986). Thus, regressing future inflation on inflation expectations and lagged inflation, the latter should not be significant since the information is already included in agents' expectations.

To test the rationality across economies, the following regression was estimated:

$$\pi_{i,t} = \alpha_i \cdot \pi^{e}_{t|i,t-4} + \beta_i . \pi_{i,t-5} + \varepsilon_{i,t}$$

where i indexes economies, t indexes quarters, and ε is a mean-zero error term. $\pi^{e}_{t|t-4,i}$ is the expected inflation in time t conditional on information set $t-4$ for country i. If the expectations in economy i are rational, the coefficient β_i should be equal to zero, which means that the expectation of inflation ($\pi^{e}_{t|i,t-4}$) for inflation ($\pi_{i,t}$) in time t incorporated all available information when it was formed at time $t-4$.

We find that the share of economies where the hypothesis of mean rationality is rejected is higher within the group of better communication framework-countries. The quality of **the** monetary policy framework and its dimensions is capture by the IAPOC index (Unsal, Papageorgiou, and Garbers 2022). The overall indicator is an average of three pillars: Communication, Independence and Accountability and Policy and Operational Strategy. A simple comparison of the mean of these indicators across country groups, reveal that advanced economies have better monetary policy framework than emerging markets and developing economies (Figure 2.12). Therefore, the scenario of the improvement in the framework is calibrated by increasing the share of rational agent. This increment equals the different between the estimated share of the rational expectation agents in the representative advanced economy and the estimated share in the representative emerging market economy.

As underlined in the chapter, recent literature emphasizes the role of communication, not intended just as announcements of the monetary policy decision, but in terms of a comprehensive communication strategy, tailoring the tools, the content and the format to the audience and the conjuncture. Analytically, we capture these dimensions and their cross-economies heterogeneity relying on the IAPOC indicator on CB communication. The index includes different aspects, from the communication tools used to the frequency of the communication, the stakeholders' involvement and the discussion of decisions and risks.

Optimal Monetary Policy Decisions

In the chapter, the concept of optimal monetary policy was briefly discussed without a formal definition. This last section defines the optimal monetary policy path as the interest rate path, $\{i_t\}$ for t=1 to ∞, that minimizes the welfare loss function below:

$$\sum_{t=j}^{\infty} \beta^t (0.9(i_t - i_{t-1})^2 + (y_t - 0)^2 + (\hat{\pi}_t - 0)^2) ,$$

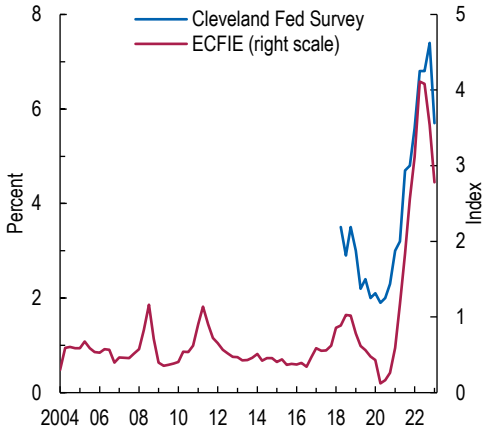
note that, in its benchmark formulation, it is assumed an equal weights for output gap (y_t) and inflation deviations from target $(\hat{\pi}_t)$. The first term in this function also highlights the value of interest rate smoothing. Other implicit assumptions are that the central bank has full knowledge of the current shocks hitting the economy, know all the future shocks that will hit the economy and have full knowledge of how their actions impact expectations.

In the estimated AL model, the central bank has three channels to influence inflation. The standard direct channel in which a tighter policy cools-off demand, lowering the output gap and hence inflation. The other two channels operate through inflation expectations. By tightening policy, the central bank lowers current inflation that enters the forecasting equation, lowering next period expectations. Finally, the central bank can also affect the agents learning, the coefficients in the forecasting equation. By seeing less inflation this period than they have expected, households update their model of how past inflation matters for future inflation.

Online Annex 2.6 Firms' Inflation Expectations: Construction and Validation of the ECFIE

As described in Box 2.1, firms' inflation expectations surveys are scarce (Coibion and others 2020), and the available surveys remain time-consuming to implement and with limited time and firm coverage. The ECFIE index proposed by Albrizio, Dizioli, and Simon (forthcoming) addresses these shortcomings. Furthermore, it meets the desirable of a valuable firms' survey proposed by Candia and others (2023). The criteria are 1) high frequency, such as monthly or quarterly; 2) sufficiently large, more than 350 firms; 3) representative of the economy. See Albrizio, Dizioli, and Simon (forthcoming) for a comprehensive overview.[7]

Annex Figure 2.6.1. US ECFIE Index and Survey-based Firms' Inflation Expectations



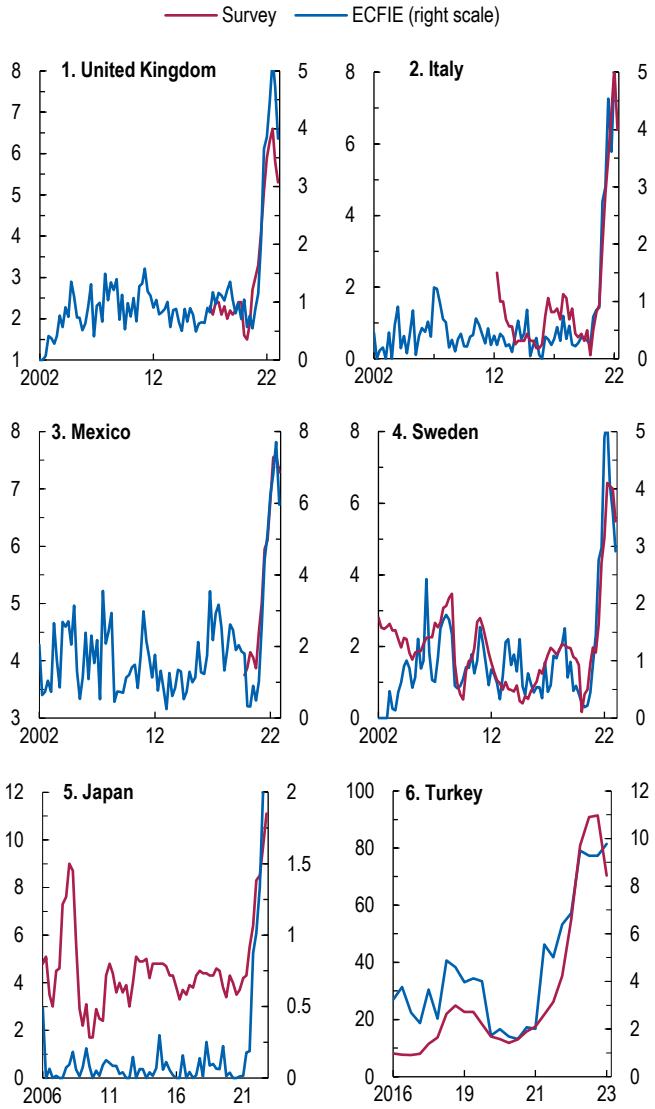
Sources: S&P Capital IQ; NL Analytic; Cleveland Fed; and IMF staff calculations.
Note: The figure shows ECFIE Index according to the information content extracted from the earnings call (right scale) and the US firms' survey is conducted by the Cleveland Fed (left scale) for US. The ECFIE is calculated from a text analysis using transcripts of US based companies. ECFIE = earnings call firm inflation expectations.

[7] Firms' earnings calls are regular conference calls by managers with stakeholders to discuss current and future firm performance and risks.

The index captures the intensity of discussions about the expectations of near-term inflation. The more firms talk about expected inflation, the more concerned they are about higher inflation in the future. This implies that the index is positively correlated with expected inflation. The index is built in two steps: first, through GPT and human judgment, two sets of keywords related to inflation and expectations are identified. Second, using a "bag-of-words" approach, the frequency of sentences simultaneously including any keywords of these two sets in the earnings call transcripts is calculated.[8] The index has a 0.97 correlation with the Federal Reserve Bank of Cleveland's survey-based index of non-financial businesses expectations, validating its interpretation (Online Annex Figure 2.6.1). Similar high correlations are obtained for other advanced economies and emerging market economies (Online Annex Figure 2.6.2).[9] Finally, the index also has power in predicting realized inflation, with a one-unit increase in the index associated with a 2 percentage points increase in inflation on impact, which then lasts for three quarters.

Annex Figure 2.6.2 ECFIE Cross-Country Validation with Survey-bsed Next-12-Months Inflations Expectations by Firms

(Percent; index on right scale)



Sources: S&P Capital IQ, NL Analytic, Bank of England, Italy Central Bank, Mexico Central Bank, Sweden Central Bank, Japan Central Bank, Turkey Central Bank and IMF staff' calculations.
Note: Next-12-months inflation expectations by firms come from existing survey-based measures, available for selected economies, shown in annualized percent. The ECFIE measure is an index, with a higher number indicating higher inflation. See the discussion and Dizioli, Simon, and Albrizio (forthcoming) for further details.

[8] See also Hassan and others (2019) and Hassan and others (2022).
[9] See Albrizio, Dizioli, and Simon (forthcoming) for the full set of external validity tests.

Online Annex 2.7 Near-Term Inflation Expectations and Monetary Policy Frameworks

In the model-based analysis, an illustrative scenario of how an increase in the share of rational agents in the economy (equivalently a decrease in the share of adaptive agents) could influence the effectiveness of monetary policy was presented, finding that a higher share of rational agents would result in increased monetary policy effectiveness. The chapter argued that improvements in a central bank's monetary policy framework and communications strategies could help foster such an increase, by enhancing economic agents' understanding of the economy, monetary policy's effects, and the central bank's objectives and actions. To bolster this interpretation, this annex investigates the empirical relationship between the soundness of monetary policy frameworks and communications strategies with deviations of inflation and inflation expectations from central bank targets.

With increasing central bank credibility and monetary policy effectiveness, deviations of inflation and expectations from central bank targets should be smaller and the time spent away from targets should also be lower. This would mean that there should be a negative association between inflation target deviations (or specifically, the absolute distance of inflation and expectations from targets) and the soundness of monetary policy frameworks across economies and central banks. The distance from the inflation target by economy-time is defined as:

$$\Delta\tilde{\pi}^{a}_{i,t} = \sqrt{(\pi_{i,t} - Central\ Bank\ Inflation\ Target_i)^2}$$

$$\Delta\tilde{\pi}^{e}_{i,t} = \sqrt{(E_t(\pi_{i,t}) - Central\ Bank\ Inflation\ Target_i)^2}$$

Where a indicates the deviation of actual inflation (quarterly, seasonally-adjusted, and year-on-year at an annualized rate) from target and e indicates the deviation of expected near-term (next-12-months) inflation from target.

To study this association, the following linear regressions are estimated over the sample period 2007:Q1 to 2019:Q4, for which the monetary policy framework soundness indicators are available before the COVID-19 shock:

$$\Delta\tilde{\pi}^{k}_{t} = \beta^{k} \cdot MPF_{i,t} + \nu^{k}_{i} + \varepsilon^{k}_{i,t} \qquad (2.7.1)$$

where $k \in \{a, e\}$, i indexes economies, t indexes quarters, ν is an economy fixed effect (accounting for possibly different inflationary shock incidence across economies), and ε is a mean-zero error term. MPF is the IAPOC index of monetary policy framework soundness from Unsal, Papageorgiou, and Garbers (2022) that ranges from 0 to 1, with higher values indicating a better designed framework. For the estimation, the dependent variables $\Delta\tilde{\pi}_t$ and $\Delta\tilde{\pi}^{e}_{t}$ are winsorized at the 2.5 percent level to account for outlier observations.

Estimates of the coefficients β^{k} for actual root mean-squared deviations from inflation targets $\Delta\tilde{\pi}^{a}_{t}$ are presented in Online Annex Table 2.7.1, where each observation is treated equally, and in Online Annex Table 2.7.2, where each observation in the regression receives a weight according to the 2022 PPP-adjusted GDP of its associated economy:

Table 2.7.1 Actual and Expected Inflation Dispersion and Monetary Policy Framework Quality

Variable	$\Delta\tilde{\pi}^{a}_{i,t}$			$\Delta\tilde{\pi}^{e}_{i,t}$		
	(1) Pooled	(2) AEs	(3) EMEs	(4) Pooled	(5) AEs	(6) EMEs
IAPOC	-4.35***	-3.50*	-4.78**	-1.47	-0.94	-1.73
(p-value)	0	-0.07	-0.02	-0.11	-0.31	-0.16
Observations	1,992	1,132	860	1,992	1,132	860
R-squared	0.32	0.18	0.28	0.36	0.23	0.36
Adj. R-squared	0.3	0.16	0.26	0.35	0.21	0.34

Note: This table presents estimates of the regression coefficient β^{k} of the IAPOC index as specified in equation 2.7.1. The sample is 2007:Q1 to 2019:Q4.
*** p <0.01; ** p <0.05; * p <0.1.

Table 2.7.2 Realized and Expected Inflation Deviations from Target and Monetary Policy Framework Quality – Regressions Weighted by 2020 PPP-GDP Weights Regressions

Variable	$\Delta\tilde{\pi}^{a}_{i,t}$			$\Delta\tilde{\pi}^{e}_{i,t}$		
	(1) Pooled	(2) AEs	(3) EMEs	(4) Pooled	(5) AEs	(6) EMEs
IAPOC	-3.51***	-2.44***	-5.38**	-1.67**	-1.05***	-2.75***
(p-value)	0	0	-0.02	-0.01	0	-0.02
Observations	1,992	1,132	860	1,992	1,132	860
R-squared	0.27	0.1	0.23	0.28	0.14	0.28
Adj. R-squared	0.25	0.08	0.21	0.26	0.12	0.26

Note: This table presents estimates of the regression coefficient β^{k} of the IAPOC index as specified in equation 2.7.1. The sample is 2007:Q1 to 2019:Q4.
*** p <0.01; ** p <0.05; * p <0.1.

Overall, these estimates an indicative of a negative association between monetary policy framework quality and the deviations from target of actual inflation and near-term inflation expectations. When observations are equally-weighted in the estimation, this relationship is strongly statistically significant in the case of actual inflation deviations from target, while on the borderline of almost statistical significance in the case of expected inflation deviations from target (Online Annex Table 2.7.1). The estimates range from −4.78 (actual deviations for emerging market economies) and −0.94 (near-term expected deviations for advanced economies). A rise in the IAPOC score (monetary policy framework improvement) from the level of the median emerging market economy to that of the median advanced economy (roughly equal to the interquartile range of the IAPOC) corresponds to a change of about 0.2 in

the IAPOC index (which ranges from 0 to 1). Using the emerging market economy group estimates from the actual deviations from target estimation, such a change would imply an almost one percentage point lower deviation of actual inflation from target. Given that the median actual deviation of inflation from target is about a percentage point, these estimates are also economically sizable.

Note that the estimation sample excludes the period from 2020 onwards, after which the world was hit by multiple large shocks (COVID-19 shock, the war in Ukraine, financial market turbulence, and so on). As actual inflation and near-term inflation expectations are likely still driven primarily by shocks rather than firmly on their adjustment path, the roles of monetary policy frameworks and convergence to inflation targets over the period is blurred. If included in the estimation sample, the standard errors of the estimates are markedly larger, with no statistical significance of the estimates.

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