CHAPTER 2

MANAGING EXPECTATIONS: INFLATION AND MONETARY POLICY

Online Annexes

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. Note that the group of emerging market economies referred to in the main chapter.

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 (2023), this indicator of firms' inflation expectations is constructed based on a text analysis of earnings calls transcripts for listed firms, denoted as the Earnings-Calls-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 United States, and the simple average for the rest of the economies considered. For the financial market-based measures, it is inferred from the posted prices of inflation-related financial assets.

Online 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
Households' inflation expectation	European Commission; Haver Analytics compilations from the University of Michigan Surveys of Consumers, Bank of England/IPSOS Inflation Attitudes Survey, Fundaçâo Getúlio Vargas
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
Policy-related interest rate	Haver Analytics
Real gross domesti produc percent chagne forecast	Consensus Econmics Inc.
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.

Online 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

Annex Table 2.7.1, 2.7.2

AEs (28): Australia; Austria; Belgium; Canada; Cyprus; Czech Republic; Germany; Spain; Estonia; Finland; France; United Kingdom; Greece; Ireland; Israel; Italy; Japan; Korea; Lithuania; Latvia; Netherlands; Norway; New Zealand; Portugal; Slovak Republic; Slovenia; Sweden; United States

EMEs (20): Argentina; Brazil; Chile; China; Colombia; Georgia; Hungary; Indonesia; India; Mexico; Pakistan; Peru; Philippines; Poland; Russia; Serbia; Thailand; Türkiye; Ukraine; South Africa

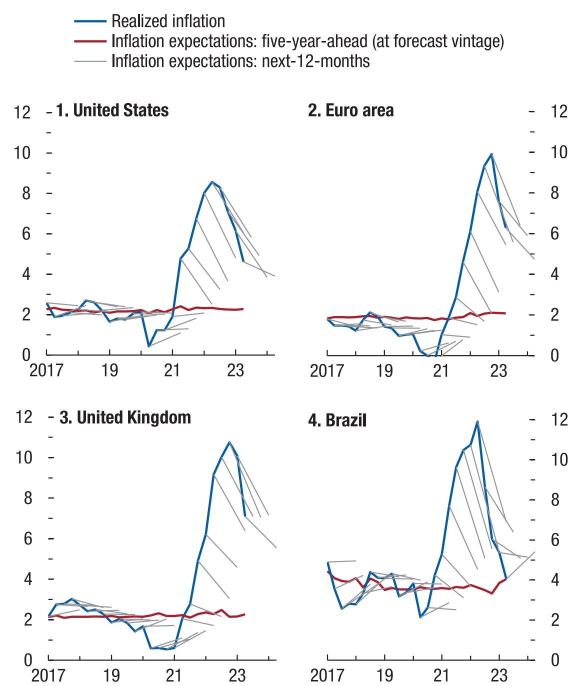
Source: IMF staff compilation.

Note: AEs = advanced economies; EMEs = emerging market economies (economies in the group of emerging market and developing economies that are no income developing countries); 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.

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



Sources: Consensus Economics; 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.

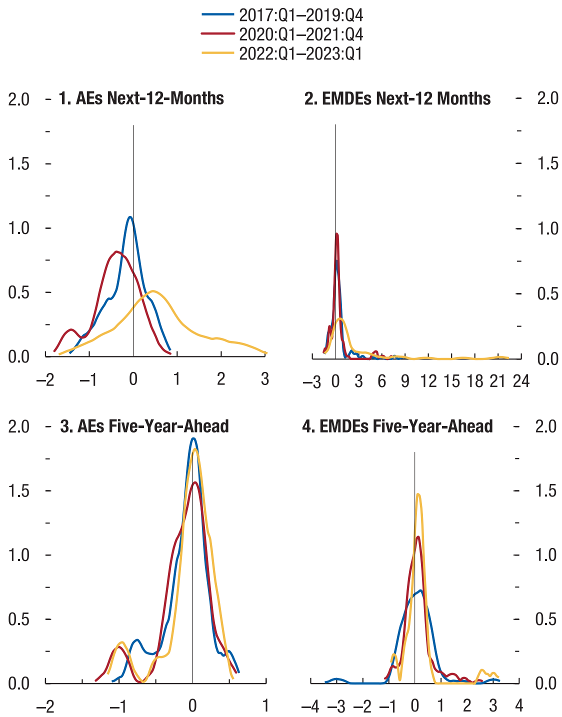
- *Disagreement in inflation expectations across individual forecasters.* Individual beliefs about long-term inflation should be close to each other if expectations are well-anchored, coinciding exactly if they are perfectly anchored (Capistrán and Ramos-Francia 2010; Dovern, Fritsche, and Slacalek 2012; 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.

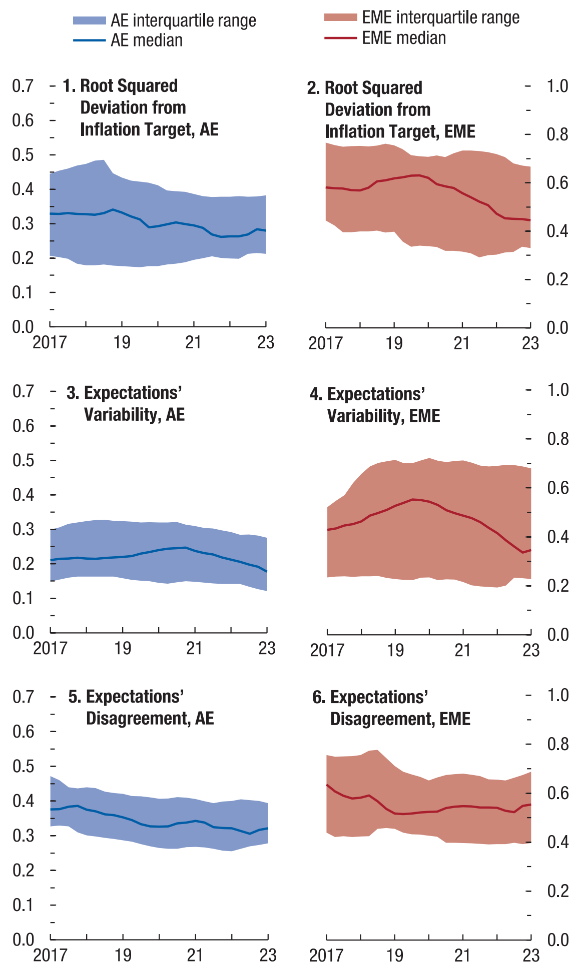
The time window used for the calculation of the three metrics is six years (24 quarters. These measures are computed using three-, five-, and seven-year-ahead inflation forecasts, with the highest value across horizons taken. In general, lower values denote better-anchored long-term expectations across 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.

Online Annex Figure 2.2.2. Next-12-Months and Five-Year-Ahead Inflation Expectations Deviation from Target
(Density)



Sources: Consensus Economics; central bank websites; Haver Analytics; and IMF staff calculations.
Note: Inflation expectations come from professional forecasters. Deviations from inflation targets are denoted in percentage points. 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)



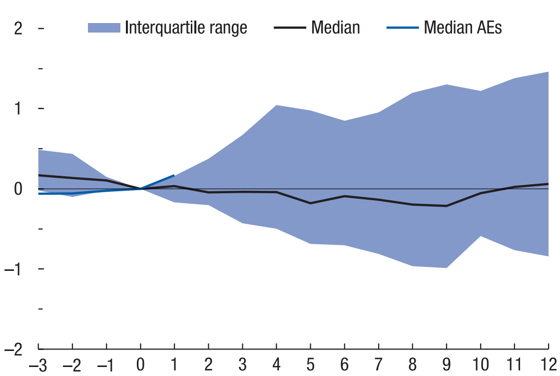
Sources: central bank websites; Consensus Economics; Haver Analytics; and IMF staff calculations.
Note: Inflation expectations are from professional forecasters to maximize sample coverage. Expectations' variability is the rolling standard deviation of longer-term expectations over time. Expectations' 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.

Online 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: Horizontal axes show quarters after the end of the historical episode. 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. AEs = advanced economies.

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

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	Türkiye	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 varying by economy according to their data availability.

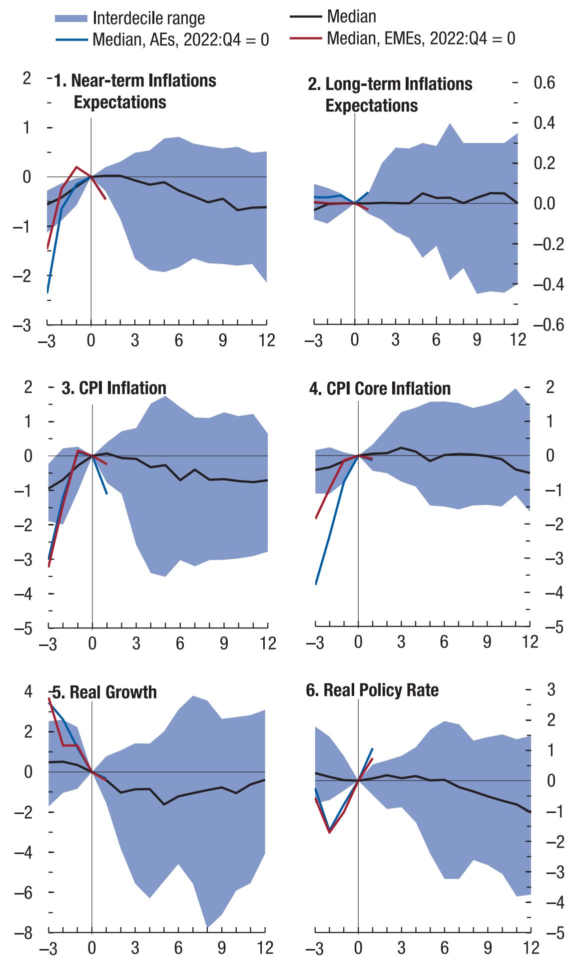
Alternative Definition of Historical Episodes

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.

Online 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; 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 near term 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.

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 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]

[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.

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

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

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:

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

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).

[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

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

	AE Mean groups OLS	AE Common OLS	AE Common IV	EME Mean groups OLS	EME Common OLS	EME 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.

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.

of inflation expectations up to the longest contract term should also be included in the reduced-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) backward-looking learners, who form their expectations based on their recent and past experience; and (2) forward-looking learners, who form their expectations rationally based on full information, which includes the knowledge about the existence of the backward-looking 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:

$$y_t = \alpha_{yL} y_{t-1} + \alpha_{yF} y_{t+1} + \gamma(\pi_{t+1} - r_t) + s_{yt} \qquad \text{(IS Curve)}$$
$$s_{yt} = \rho_\varepsilon s_{y_{t-1}} + \varepsilon_{y_t} \qquad \text{(Demand Shock process)}$$
$$\pi_t = \alpha_{\pi L} \pi_{t-1} + \alpha_{\pi F} \pi_{t+1} + k_\pi w_t + \varepsilon_{\pi t} \qquad \text{(Price PC)}$$
$$\pi_{wt} = w_t - w_{t-1} + \pi_t \qquad \text{(Nominal wage definition)}$$
$$\pi_{wt} = -\alpha_{wL} w_{t-1} + \alpha_{wF} \pi_{wt+1} + K_w y_t + \varepsilon_{wt} \qquad \text{(Wage PC)}$$
$$r_t = \rho r_{t-1} + (1-\rho)(\rho_\pi \pi_{t+1} + \rho_y y_t) + \varepsilon_{rt} \qquad \text{(Policy reaction function),}$$

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.

[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.

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 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 backward-looking learners and forward-looking learners. The backward-looking 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:

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

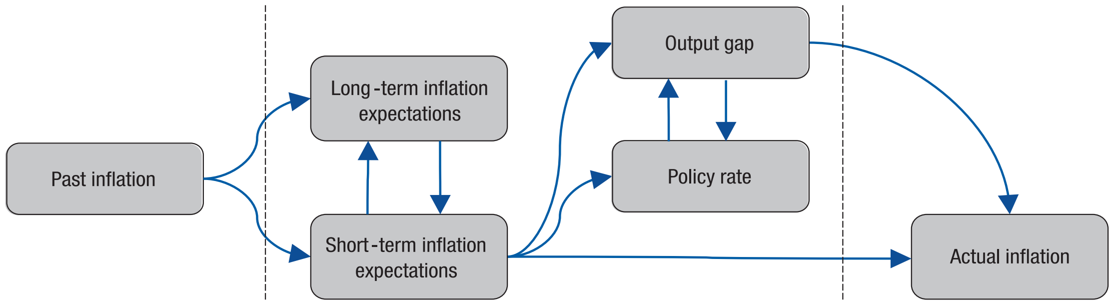
Note that the coefficients in this equation vary over time. They depend on how accurate the forecast is at each period. The learning algorithm follows the updating model developed in Slobodyan and Wouters (2012a; 2012b). Agents use a Kalman filter mechanism to update the coefficients of the forecasting 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, forward-looking learners use all available information, including that there is a share of backward-looking 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: $E_t[\pi_{t+1}] = \pi_{t+1}$;

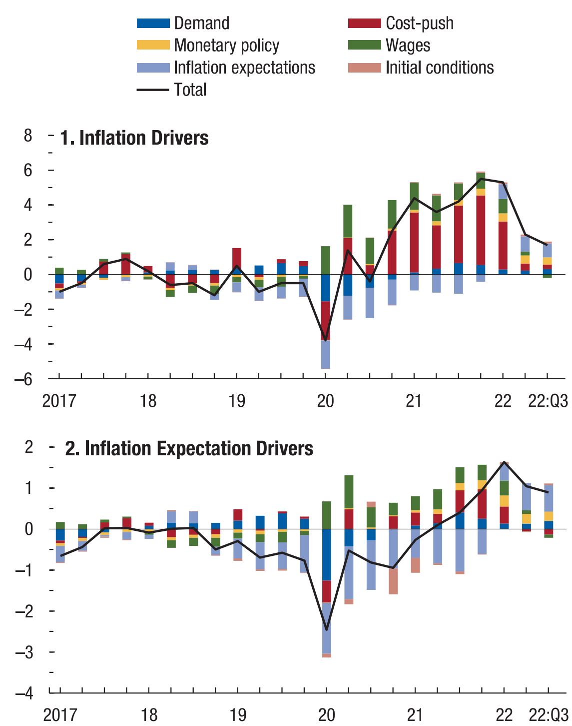
[4] See Erceg and Levine (2003) for a model where the expectations formation process is microfounded using a signal-extraction problem by economic agents, conditional on the credibility of the central bank.

Online 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 backward-looking 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].

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



Source: 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.

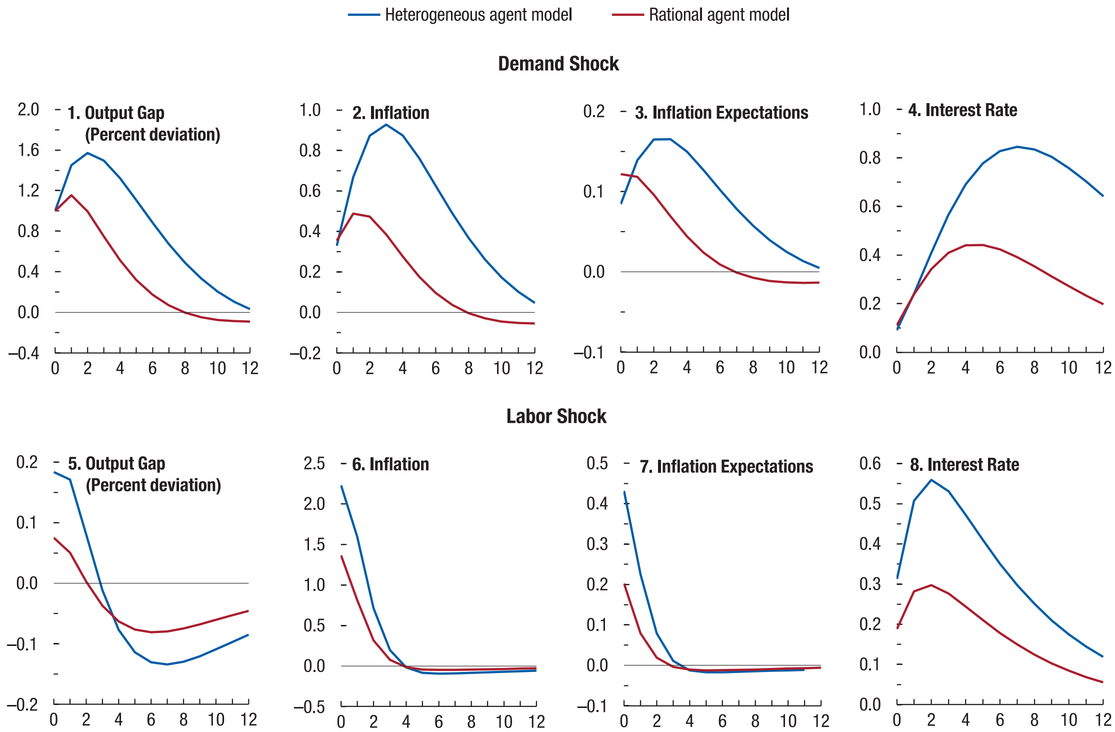
Additional Model Properties

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.

[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.

Online 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 percent 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 percent change in the real wage gap at the impact.

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 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 forward-looking agents. This increment equals the different between the estimated share of the forward-looking learners 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 crosseconomies 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

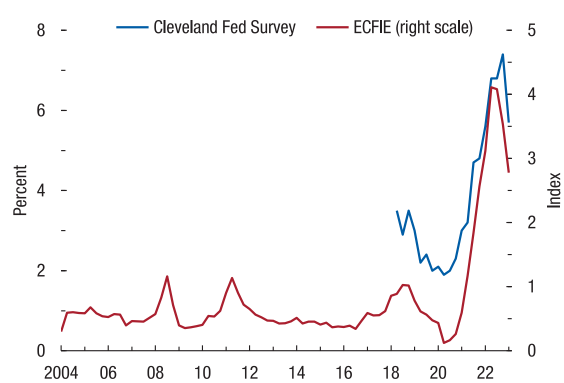
In the chapter, the concept of optimal monetary policy was briefly discussed without a formal definition. This last section defines the optimal monetary policy path as the interest rate path, $\{i_t\}$ for t=1 to ∞, that minimizes the welfare loss function below:

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

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



Sources: Federal Reserve Bank of Cleveland; NL Analytics; S&P Capital IQ; 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.

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

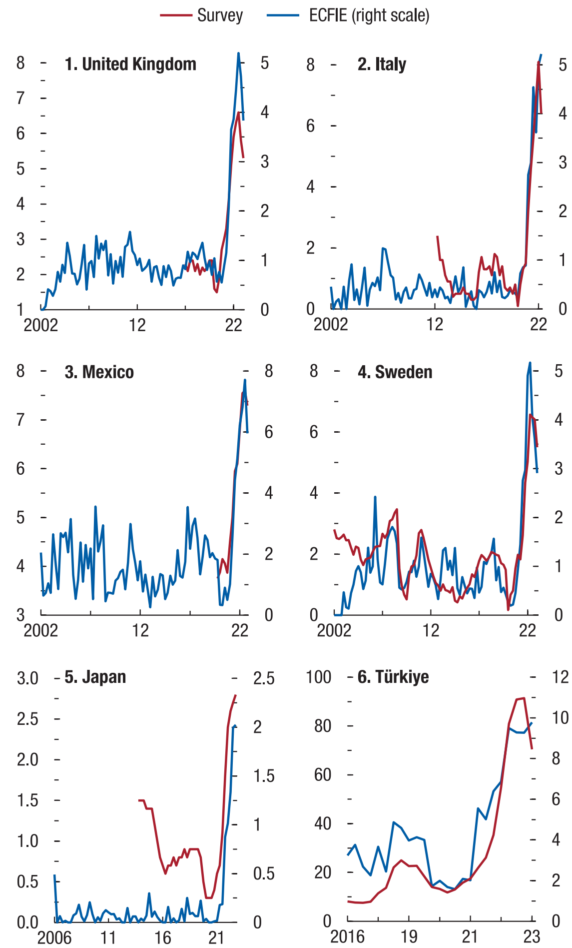
As described in Box 2.1, firms' inflation expectations surveys are scarce (Coibion and others 2020), and the available surveys remain time-consuming to implement and with limited time and firm coverage. The ECFIE index proposed by Albrizio, Dizioli, and Simon (2023) addresses these shortcomings. Furthermore, 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 (2023) for a comprehensive overview.[7] The index captures the intensity of

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

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 calls 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.

Online Annex Figure 2.6.2. ECFIE Cross-Country Validation with Survey-based Next-12-Months Inflation Expectations by Firms

(Percent; index on right scale)



Sources: Bank of England; Bank of Italy; Bank of Japan; Bank of Mexico; Central Bank of the Republic of Türkiye; Sveriges Riksbank; NL Analytic; S&P Capital IQ; 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 Albrizio, Dizioli, Simon (2023) for further details.

[8] See also Hassan and others (2019) and Hassan and others (2022).

[9] See Albrizio, Dizioli, and Simon (2023) 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 forward-looking learners in the economy (equivalently a decrease in the share of backward-looking learners) could influence the effectiveness of monetary policy was presented, finding that a higher share of forward-looking learners 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:

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

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

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:

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

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 $\Delta\tilde{\pi}_t^e$ 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 $\Delta\tilde{\pi}_t^a$ 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:

Online Annex 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)	(2)	(3)	(4)	(5)	(6)
	Pooled	AEs	EMEs	Pooled	AEs	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.

Online Annex 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)	(2)	(3)	(4)	(5)	(6)
	Pooled	AEs	EMEs	Pooled	AEs	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 are 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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