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The Dynamics of Large Inflation Surges

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Abstract: We empirically characterize episodes of large inflation surges that have been observed worldwide in the last three decades. We document four facts. (1) Inflation surges tend to be persistent, with the duration of disinflation exceeding that of the initial inflation increase. (2) Surges are initially unexpected but followed by a gradual catch-up of average short-term expectations with realized inflation. (3) Long-term inflation expectations tend to exhibit increases that persist throughout disinflation. (4) Policy responses are characterized by hikes in nominal interest rates but no tightening of real rates or fiscal balances. In sum, episodes of large and persistent inflation tend to occur with government responses that depart from the prescriptions of textbook policy rules, and that instead exhibit a "fear of tightening."

JEL classification: E31, E40, F40

Key words: inflation surges, inflation expectation, fiscal and monetary policy

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1 Introduction

Following decades of low and stable inflation, the 2021-22 U.S. inflation surge returned inflation-stabilization policies to center stage. A key concern that emerged among academics and policy-makers is the possibility that the high inflation rates observed after the surge will be persistent and that long-run inflation expectations will "unanchor" (e.g., Blanchard, 2022; Reis, 2022a,b; Steinsson, 2022). In this context, a critical question faced by countries across the world is what set of monetary and fiscal policies can credibly lead to fast and durable disinflation (e.g., Cochrane, 2022a,b; Gopinath, 2022).

In this paper, we contribute to this debate by providing international evidence on the patterns that characterize the episodes of large inflation surges observed in the last three decades. We begin by identifying episodes that involve inflation increases in the right tail of the distribution (e.g., the 90th percentile, which is associated with an average 5 p.p. inflation increase). We then conduct an event time study using data on short- and long-run inflation expectations from surveys of professional forecasters since 1990 for 56 countries and other macroeconomic data to characterize their dynamic response following large inflation surges.

We document four facts about these episodes. First, inflation tends to be persistent: Surges are often followed by high inflation rates for several years after their peak. The shape of inflation follows an "inverted-swoosh" pattern, with the average duration of disinflation lasting 3 to 4 years and being 3 times longer than the initial inflation increase.

Second, inflation surges are initially unexpected but followed by a gradual catch-up of average short-term expectations with realized inflation: 1-year-ahead average forecast errors experience a spike during the first year of the inflation surge of a magnitude similar to that of the inflation increase and then revert to close to their pre-surge levels in the following 2 years. Short-term expectations disagreements, measured by the cross-sectional standard deviation of 1-year forecasts, also increase after the surge and dissipate 3 years later, which indicates that the catch-up of short-term expectations with realized inflation is generalized across forecasters.

Third, long-term inflation expectations tend to exhibit persistent increases following the inflation surge. Average 5-year-5-year (5y5y)-forward forecasts (i.e., the average expected inflation over the 5-year period that begins 5 years from each date) exhibit an initial increase

around 0.3 p.p. at the beginning of the surge and remain above their pre-surge levels throughout the disinflation phase. This increase is more pronounced in episodes with a higher inflation change; for example, episodes with an initial inflation increase above 4 p.p. (associated with an average 10 p.p. inflation increase) feature a 1 p.p. increase in 5y5y-forward average inflation forecasts.

Fourth, following inflation surges, monetary policy tends to exhibit little sign of tightening. Although short-term nominal interest rates show a significant and persistent increase (peaking, on average, 1.4 p.p. above their pre-surge levels), given the rise in inflation expectations, real interest rates do not increase relative to their pre-surge levels. Policy tightenings are also not observed on the fiscal side, with fiscal balances that tend to deteriorate initially and improve only mildly relative to their pre-surge levels 3 years after the surge.

While we are not interpreting the data through a structural model, our evidence suggests that episodes of large and persistent inflation tend to occur with government responses that depart from the prescriptions of textbook policy rules, and which instead are consistent with "fear of tightening" (in Calvo and Reinhart (2002)'s idiom), i.e., choosing not to tighten monetary or fiscal policies. In this regard, it is worth mentioning that large inflation surge episodes in the last three decades were often observed in emerging market economies, in which governments' commitment problems tend to have an important influence on policy conduct. Although a stronger institutional environment could generate more credibility and faster stabilization, the international evidence we document suggests that the current concerns that motivate our paper regarding inflation persistence and expectations' unanchoring are hard to dismiss.[1]

Related literature. Our paper is related to several strands of the literature; first, to the literature on large inflationary episodes and their subsequent stabilization. This includes work on hyperinflation, pioneered by Cagan (1956) and further studied by Sargent and Wallace (1981); Marcet and Nicolini (2003); and Sargent, Williams and Zha (2009), among others, and work on more moderate inflation increases (e.g., Dornbusch and Fischer, 1993; Calvo and Végh, 1999; Sargent,

[1] Our findings for monetary policy during inflation surges are consistent with those documented in Clarida, Gali and Gertler (2000) and Coibion and Gorodnichenko (2011) for the U.S. in the pre-Volcker years, when the Federal Reserve let the real short-term interest rate decline as anticipated inflation rose.

2001; Kehoe and Nicolini, 2022). Closer to our work, Boschen and Weise (2003) conduct an empirical investigation of the motives behind the start of inflation episodes in OECD economies since 1960, which provides evidence for the policy-mistake hypothesis, the international transmission of inflation, and political business cycles. Related to this, Bowdler and Nunziata (2006) study the role of openness and Domaç and Yücel (2005) incorporate emerging economies in the analysis.[2] A common theme that emerges from this body of work is the role of monetary and fiscal policy, together with expectations, in shaping inflation dynamics. We contribute to this literature by providing direct evidence on interest rates and inflation expectations during large inflationary episodes.

In this vein, our paper also contributes to the growing body of research that uses data from forecast surveys to characterize inflation expectations (e.g., Mankiw, Reis and Wolfers, 2003; Pesaran and Weale, 2006; Coibion and Gorodnichenko, 2012, 2015).[3] Our study of long-term inflation expectations also contributes to the literature on inflation unanchoring (e.g., Kumar et al., 2015; Carvalho et al., 2022; Reis, 2022b), which is often discussed as a central cost of inflation surges.

Finally, our paper is related to the recent literature on the 2021-2022 inflation surge. To date, evidence that informs the current debate has focused on U.S. historical data (Bianchi, Faccini and Melosi, 2020; Schmitt-Grohé and Uribe, 2022) or international evidence from the post-Covid inflation surge (e.g., Di Giovanni et al., 2022; Bunn et al., 2022). We complement this body of work with international evidence that characterizes large inflation surge episodes in the last three decades.

[2]International organizations, such as the IMF and the BIS, have long worked to understand inflation episodes and their determinants, including the role of expectations (see, for example, Hamann and Prati, 2002; Fischer, Sahay and Végh, 2002; Saboin, 2018; Yetman, 2020; Moessner and Takáts, 2020). This interest has been reinvigorated by the recent global inflation surge. For example, Ari et al. (2023) characterize episodes of disinflation; Mojon, Nodari and Siviero (2023) show that the speed of disinflation has been in line with past international experiences; and Goel and Tsatsaronis (2022) use Consensus Economics forecasts to document global trends of long-term inflation expectations.

[3]A body of work associated with empirical research on inflation expectations studies monetary policy in models that depart from full-information rational expectations. This includes models of information frictions (e.g., Mankiw and Reis, 2002; Sims, 2003; Woodford, 2003); learning (e.g., Evans and Honkapohja, 2012; Eusepi and Preston, 2018; Farmer, Nakamura and Steinsson, 2021); level-k thinking (e.g., Farhi and Werning, 2019; Vimercati, Eichenbaum and Guerreiro, 2021); reflective expectations (García-Schmidt and Woodford, 2019); diagnosis expectations (Bordalo et al., 2020; L'Huillier, Singh and Yoo, 2021); and absence of common knowledge (Angeletos and Lian, 2018), among others. See also Werning (2022) for an analysis of the pass-through of inflation expectations on current inflation with arbitrary (non-rational) expectations.

2 Data and Methodology

2.1 Data

Our analysis combines publicly available macroeconomic data with proprietary data on inflation expectations at annual frequency. We obtain the latter from Consensus Economics, which has collected international surveys of professional forecasters since 1989; the data have been used in the literature to document the empirical patterns of inflation forecasts and inflation anchoring (e.g., Coibion and Gorodnichenko, 2012; Carvalho et al., 2022; Bems et al., 2021). Using these data, we measure short-term CPI inflation expectations with 1-year-ahead forecasts and long-term expectations with 5y5y-forward forecasts. The macroeconomic data include CPI inflation, real GDP, and unemployment rates from the World Bank's World Development Indicators (WDI); fiscal balance, revenue, and expenditure over GDP from the International Monetary Fund's World Economic Outlook (WEO); and short-term interest rates from the Bank for International Settlement, the Federal Reserve Economic Data (FRED), WEO, OECD, Eurostat, and national sources. Using the data on nominal interest rates and inflation forecasts, we construct real interest rates using the formula $\frac{1+i_{j,t}}{1+\pi^e_{j,t}}$, where $i_{j,t}$ represents the nominal interest rate for country j in period t, and $\pi^e_{j,t}$ is the average 1-year-ahead inflation forecast. Also, we conduct a robustness analysis to construct real interest rates using data on realized inflation. Finally, our analysis incorporates core CPI inflation data from the World Bank's Global Economic Monitor (GEM) database, as well as the commodity price index from the World Bank's Global Database of Inflation, which enhances the breadth of our inflationary trend assessment.

We restrict our sample of countries to those that have Consensus data and obtain an unbalanced panel from 1990 to 2019 that contains 56 countries.[4] Using the classification of Uribe and Schmitt-Grohé (2017), our sample of countries features 24 developed-market economies (DMs) and 32 emerging-market economies (EMs). For a more detailed description of the data,

[4]The countries included in our sample are Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, China, Colombia, Croatia, Czech Republic, Denmark, Egypt, Estonia, Finland, France, Germany, Greece, Hong Kong, Hungary, India, Indonesia, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Malaysia, Mexico, Netherlands, New Zealand, Nigeria, Norway, Peru, Philippines, Poland, Portugal, Romania, Russia, Saudi Arabia, Singapore, Slovak Republic, Slovenia, Spain, South Africa, Sweden, Switzerland, Taiwan, Thailand, Turkey, Ukraine, the United Kingdom, and the United States.

see Online Appendix Tables A1 and A2.

2.2 Episodes studied

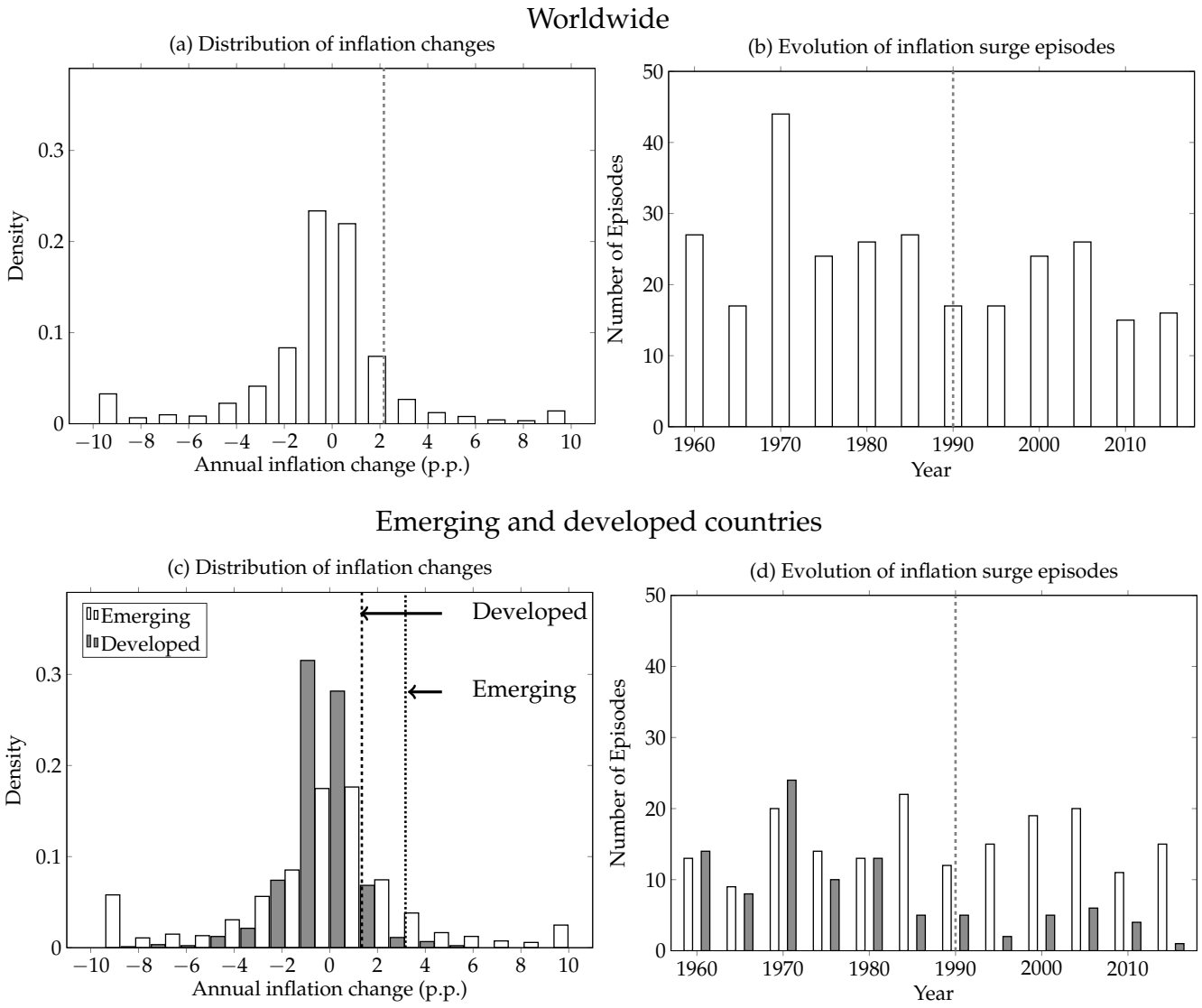
Our goal is to study the dynamics of inflation, expectations, and other macroeconomic variables following significant increases in inflation. For this, our baseline analysis focuses on episodes that involve inflation increases in the right tail of their distribution, as depicted in Panel (a) of Figure 1 for the countries in our sample since 1990. In particular, we define the beginning of a large inflation surge episode as a year in which annual inflation increases above the 90th percentile of this distribution, which is 2.2 p.p. We identify 118 non-overlapping episodes since 1990, detailed in Table A4 in the Appendix. Table 1 reports that these episodes are characterized by a median 3.5 p.p. inflation increase in the first year of the surge episode, from a median inflation level of 3.4% before the surge. Panel (c) of Figure 1 reports the distribution of inflation changes in developed and emerging economies. Emerging economies are characterized by a larger average increase in inflation than developed economies (3.2% vs. 1.3%) and a more dispersed distribution of inflation changes.

To provide more historical context for our analysis, we use the same criterion to identify inflation-surge episodes in the pre-1990 period. In this period, we identify 165 non-overlapping episodes, detailed in Appendix Table A7. Panel (b) of Figure 1 shows the historical evolution of these episodes and Panel (d) decomposes the evolution of inflation-surge episodes into those observed in developed- and emerging-market economies. The 1970s exhibit the most significant number of surges, in both developed and emerging economies and including the well-studied "Great Inflation." During the 1980s, the number of surges in developed economies declines, as these economies started shifting toward central bank independence and inflation targeting. As a consequence, the majority of inflation surge episodes in our post-1990 sample are observed in emerging economies (79% of these episodes, reported in Table 1).[5]

Our empirical analysis also considers an alternative definition of large inflation surge episodes based on country-period-specific thresholds to account for the fact that countries and periods

[5]Appendix Figure B1 shows that OECD countries, which are a set of countries frequently analyzed in the literature, exhibit a pattern similar to those observed in developed economies.

FIGURE 1. DISTRIBUTION OF INFLATION CHANGES AND HISTORICAL EVOLUTION OF LARGE SURGE EPISODES



Notes: Panel (a) shows the distribution of annual changes in CPI inflation for the countries in our sample since 1990, in percentage points. The vertical dotted line marks the 90th percentile of the distribution, which we use as the threshold to define large inflation surge episodes in our baseline analysis. Panel (b) shows the number of large inflation surge episodes for the countries in our sample using our baseline definition every 5 years from 1960 to 2018. The vertical dotted line marks the year 1990, which is the focus of our analysis in Section 3 because of data availability on inflation expectations. Panels (c) and (d) plot the same variables as Panels (a) and (b) for emerging and developed countries. For data sources, see Section 2.

are characterized by different inflation volatility. In this alternative approach, we define the beginning of a large inflation surge episode as a year in which the annual inflation in a country increases by more than 1.65 standard deviations from its mean during the last 10 years.[6] With this "relative criterion," we identify 53 non-overlapping episodes since the 1990s that have available data on inflation expectations (detailed in Appendix Table A8), which we also study in Section 3.[7]

TABLE 1. LARGE INFLATION SURGE EPISODES: DESCRIPTIVE STATISTICS

	(1)	(2)
Threshold-defining episodes	Absolute	Relative
Number of episodes	118	53
Median pre-surge inflation level	3.4%	2.4%
Median initial inflation increase during surge	3.5%	2.7%
Average years to maximum inflation	1.5	1.1
Average years to disinflation	4.4	3.2
Share of episodes in emerging markets	79%	51%

Notes: This table shows descriptive statistics for the set of inflation surge episodes identified in the period 1990-2019 with available data on inflation expectations. Column (1) shows descriptive statistics for the baseline set of episodes, identified using the "absolute criterion " (i.e., those in which annual inflation increases above 2.2 p.p.– the 90th percentile of the distribution of inflation changes); Column (2) shows descriptives for episodes identified with the "relative criterion" (i.e., those in which the annual inflation in a country increases by more than 1.65 standard deviations from its mean during the last 10 years). For more details on these criteria and data sources, see Section 2. Appendix Tables A4 and A8 detail the set of episodes in each set.

Table 1 shows that the two criteria for defining inflation surges lead to a different composition of episodes. Based on an absolute threshold, the baseline definition leads to a sample that includes a majority of EM episodes; with the relative criterion, roughly half of the episodes are from DMs. This is because, as illustrated in Panel (d) of Figure 1, starting in the 1990s, inflation in DMs has become substantially more stable than that of EMs.

[6]More precisely, for each country i, we identify the set of periods $t \in [1, T_i]$ such that $\Delta\pi_{i,t} > \mu^{\pi}_{i,t} + 1.65\sigma^{\pi}_{i,t-1}$, where $\pi_{i,t}$ is the inflation of country i in period t; T_i denotes the last year with available data for country i; and $\mu^{\pi}_{i,t}$ and $\sigma^{\pi}_{i,t}$ are the average and standard deviation of annual inflation changes computed from period t to period $t-9$. Figure B2 reports the distribution of thresholds across episodes obtained under this criterion, which features a median of 4.5 p.p.

[7]For our goal of studying the dynamics of large inflation surges, a disadvantage of the "relative criterion" is that it identifies episodes with relatively minor increases in inflation that occur in countries with stable inflation (e.g., Denmark's 2000 episode, featuring a 0.4% increase in inflation). For this reason, we use the absolute threshold for our baseline results and report the results under the relative criterion in the robustness analysis.

2.3 Empirical model

We conduct an event time study to document the dynamics of macroeconomic variables during large inflation surge episodes by estimating the following model:

$$y_{i,t} = \alpha_i + \sum_{j=0}^{J} \beta_j y_{i,t-1-j} + \sum_{k=-K_1}^{K_2} \gamma_k D_{i,t-k} + \varepsilon_{it}, \tag{1}$$

where $y_{i,t}$ is a variable for country i in period t; α_i is a country fixed effect; $D_{i,t}$ is a dummy variable that takes the value 1 if country i experiences the beginning of an inflation surge episode in period t and 0 otherwise; and ε_{it} is a random error term.[8] Since episodes of inflation surges are not exogenous, the model estimation offers descriptive evidence on the dynamics of variables of interest, conditional on the occurrence of inflation surges at different time horizons. For the dependent variable, $y_{i,t}$, we use CPI inflation, the mean and standard deviation of inflation expectations (over different horizons), real GDP growth, the unemployment rate, nominal and real interest rates, fiscal balance, revenue, and expenditure over GDP. Our baseline model estimates (1) using data from 1990 to 2019, clustering standard errors at the country level, with $K_1 = 1$ and $K_2 = J = 4$; we also estimate models with a longer lag and lead structure in our robustness analysis. To avoid the influence of hyperinflation for some countries in our sample, when estimating (1), we winsorize inflation, inflation expectations, and interest rates for levels above 100%.[9]

After estimating (1), our analysis proceeds by tracing the estimated dynamics of each variable during inflation surge episodes. Specifically, we compute the estimated dynamics for variable y_τ, using the estimated coefficients from (1), with the following recursive expression (akin to an

[8] As detailed in Tables A1 and A2, for each country, different variables have different data coverage. For our baseline results, we estimate the empirical model for each variable by using all data available for that variable. Section 3.4 reports the results when using the same sample for all variables. Empirical model 1 is similar to that used by Cerra and Saxena (2008) to characterize the dynamics of economic activity following financial crises and Guntin, Ottonello and Perez (2020) for those following sudden stops.

[9] Using the classification of Hanke and Krus (2013), our baseline sample of inflation surge episodes in Table A4, which starts in 1990, features one hyperinflation episode (Bulgaria in 1997). In addition, some countries in our sample experienced hyperinflation episodes in the late 1980s (Argentina, Brazil, Poland, Peru), which implies that they exhibit outliers for inflation and interest rates in the early 1990s. We winsorize the data to avoid the influence of these observations when estimating (1).

estimated impulse-response function):

$$\hat{y}_\tau = \sum_{j=0}^{J} \hat{\beta}_j \hat{y}_{\tau-1-j} + \sum_{k=-K_1}^{K_2} \hat{\gamma}_k D_{\tau-k} \quad \text{for} \quad \tau \geq -K_1 \tag{2}$$

where $\{\hat{\beta}_j\}_{j=0}^{J}$ and $\{\hat{\gamma}_k\}_{-K_1}^{K_2}$ are the estimated coefficients from (1); D_τ takes the value 1 for $\tau = 0$ and 0 otherwise; and $\hat{y}_t = 0$ for $\tau < -K_1$.

3 Dynamics Following Large Inflation-surge Episodes

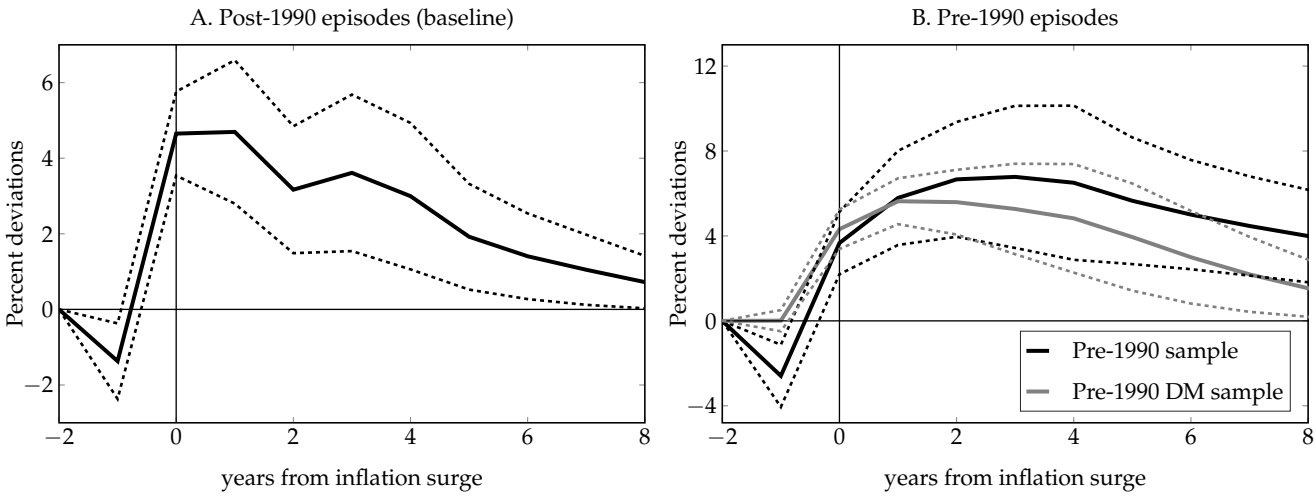
This section presents a set of empirical facts that characterize the dynamics of large inflation-surge episodes, including the patterns of inflation, inflation expectations, economic activity, interest rates, and fiscal balances. It is worth highlighting that our evidence is descriptive, aimed at providing a set of empirical regularities that can used to inform models and policy design.

3.1 Inflation dynamics

We begin by analyzing the dynamics of inflation following large surge episodes. Panel (a) of Figure 2 shows that inflation tends to exhibit a spike during the first year of the episode (with a 5 p.p. average increase) followed by prolonged disinflation, with average inflation rates of more than 2 p.p. above their pre-surge levels in the next 5 years following the surge. The average duration of disinflation (i.e., the number of periods it takes to return to pre-surge levels of inflation, reported in Column (1) of Table 1) is 4.4 years—roughly 3 times longer than the average duration of the inflation increase following a surge.[10] Panel (b) of Figure 2 shows that the relatively long duration of disinflation relative to the period of inflation increase is also observed if we estimate (1) in the pre-1990 sample (not included in our baseline estimation), which provides more external validity for this phenomenon.

[10]The brevity of the inflation increase relative to the disinflation period is reminiscent of the findings documented in McKay and Reis (2008), who show that contractions in employment in the U.S. tend to be briefer and more violent than expansions.

FIGURE 2. DYNAMICS OF INFLATION DURING LARGE INFLATION SURGE EPISODES



Notes: These figures show the estimated dynamics of inflation during large inflation surges, computed using the estimated coefficients from (1), with the recursive expression (2), and using the annual CPI inflation as the dependent variable. Panel (a) shows estimates using the post-1990 period. Panel (b) shows estimates for the period 1960-1989; in this panel, the gray line restricts the sample to developed market economies (DMs). The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 0$). All variables are expressed in percent. Dotted lines report 90% error bands, computed using the Delta method. For variable definitions and data sources, see Section 2.

3.2 Inflation expectations dynamics

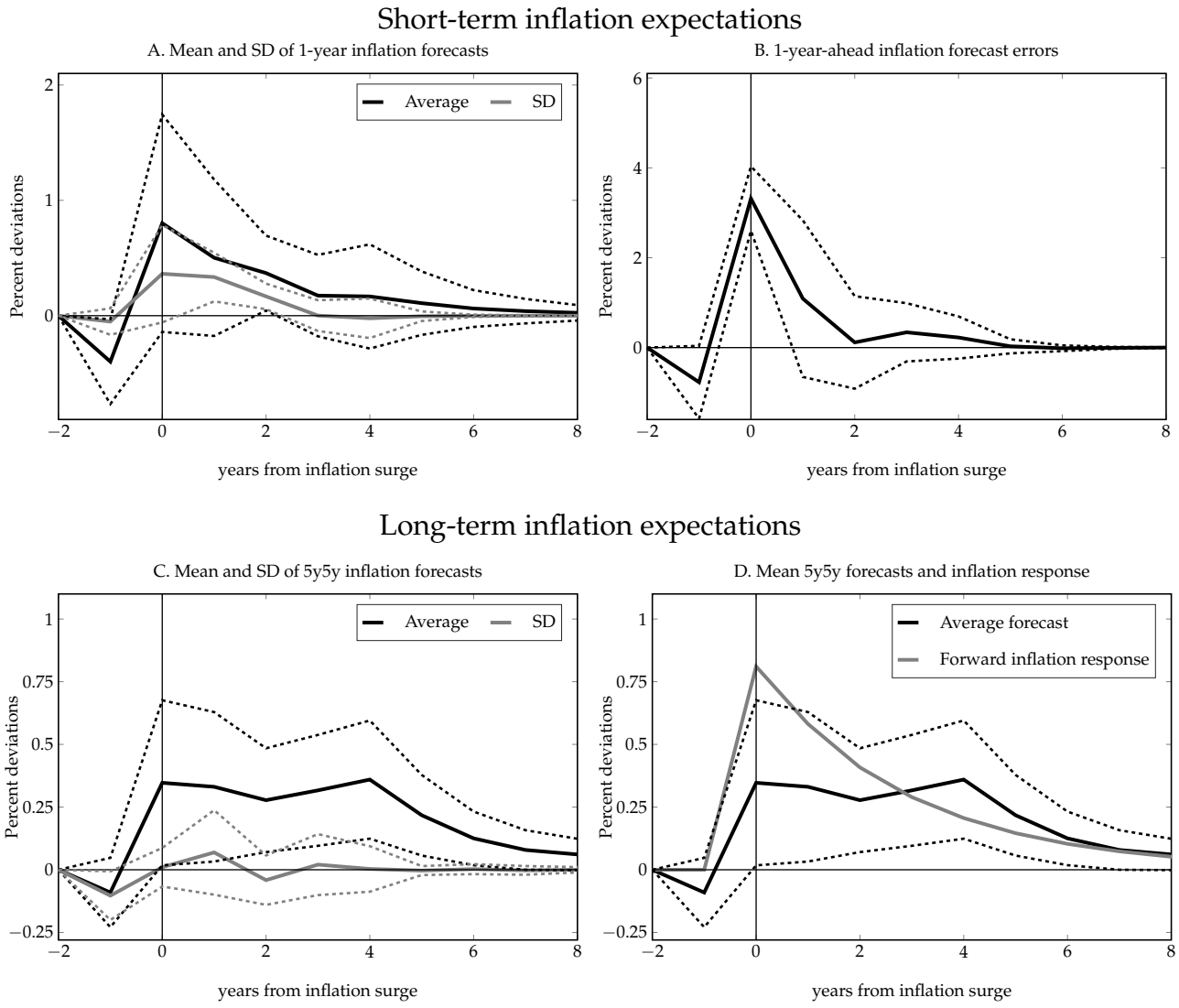
The second dimension of our analysis is the dynamics of inflation expectations. Panel (a) of Figure 3 shows that short-term inflation expectations, measured by average 1-year-ahead forecasts, significantly increase following the surge.[11] To quantify this increase relative to that of realized inflation, Panel (b) reports the response of 1-year-ahead forecast errors, constructed as the difference between realized inflation and the previous year's 1-year average expected inflation. Forecast errors increase by 3.3 p.p. in the first year of the episode, which suggests that inflation surges tend to be largely unexpected. Forecast errors then revert to their pre-surge level 2 years after the surge. The persistence of forecast errors observed in the year after the surge is consistent with prior studies that use data from inflation forecast surveys, which have documented an underreaction of consensus forecasts to economic shocks (e.g., Coibion and Gorodnichenko, 2012). Panel (a) also shows the response of inflation-forecast disagreements, measured by their cross-sectional standard deviation. This variable increases by 0.4 p.p. in the year of the surge and reverts to its pre-surge level 3 years after. As argued by Coibion and Gorodnichenko (2012), this increase in disagreements following economic shocks is consistent with sticky information models (e.g., Mankiw and Reis, 2002).

Panel (c) of Figure 3 shows the response of long-term inflation expectations, measured by average 5y5y-forward forecasts. Long-run inflation expectations initially increase by 0.3 p.p., and remain above their pre-crisis level throughout the disinflation phase.[12] To put this increase in long-run inflation expectations into perspective, Panel (d) compares the response of average 5y5y-forward forecasts with that of the average inflation response over the same 5y5y-forward horizon (computed using the dynamics of inflation following surges estimated from (1), reported in Panel (a) of Figure 2 as $\frac{1}{5}\sum_{j=6}^{10}\hat{\pi}_{t+j}$). This figure shows that long-term inflation expectations exhibit an initial underreaction relative to the average inflation response, followed by a gradual

[11] It is worth noting that, because the data on inflation and inflation expectations have different coverage, the increase in inflation expectations reported in Panel (a) of Figure 3 cannot be directly compared with that of inflation, reported in Panel (a) of Figure 2. Appendix Figure B3 reports the dynamics of inflation for the subset of episodes with inflation expectations, which exhibit less persistent dynamics, more in line with those from inflation expectations.

[12] Reis (2022b) defines the loss of the inflation anchor as a situation in which long-term inflation expectations differ from the central bank's target. Under the assumption that long-term inflation expectations are aligned with central banks' targets in the year before the inflation surge, our results would imply that economies tend to unanchor following the inflation surge under this metric. However, data on the central bank's targets are not widely available for the set of episodes in our sample.

FIGURE 3. DYNAMICS OF INFLATION EXPECTATIONS DURING LARGE INFLATION SURGE EPISODES



Notes: These figures show the estimated dynamics of inflation expectations and forecast errors during large inflation surges, computed using the estimated coefficients from (1), with the recursive expression (2). The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 0$). Panel (a) shows the dynamics of the 1-year-ahead average inflation forecast and the standard deviation of 1-year-ahead inflation forecasts; panel (b) that of the forecast error, defined as the difference between realized inflation and its previous year average 1-year-ahead forecast; panel (c) that of the 5y5y-forward average inflation forecast or the standard deviation of 5y5y-forward inflation forecasts; and panel (d) that of the 5y5y-forward average inflation forecast and forward inflation response computed as $\frac{1}{5}\sum_{j=6}^{10}\hat{\pi}_{t+j}$ for $t \geq 0$, where $\hat{\pi}_{t+j}$ comes from the dynamics of inflation following inflation surges episodes described in Figure 2; the latter is computed using the dynamics of inflation following surges estimated from (1), reported in Panel (a) of Figure 2, over the same 5y5y-forward horizon. All variables are expressed in percent. Dotted lines report 90% error bands, computed using the Delta method. For variable definitions and data sources, see Section 2.

catch-up, which implies that long-term inflation expectations end up capturing the inflation persistence observed following inflation surges. In addition, Panel (c) shows that except for a spike 1 year after the beginning of the surge, long-term expectations disagreements do not substantially increase, which suggests that the upward shift in long-term inflation expectations is generalized across forecasters.

3.3 Monetary and fiscal policy dynamics

The third dimension of our analysis is the dynamics of monetary and fiscal policies. Panel (a) of Figure 4 shows that short-term nominal interest rates increase by 1.4 p.p. on average following an inflation surge and remain high throughout the disinflation. In spite of these nominal interest rate hikes, real rates do not increase following the increase in inflation or throughout the disinflation phase.[13]

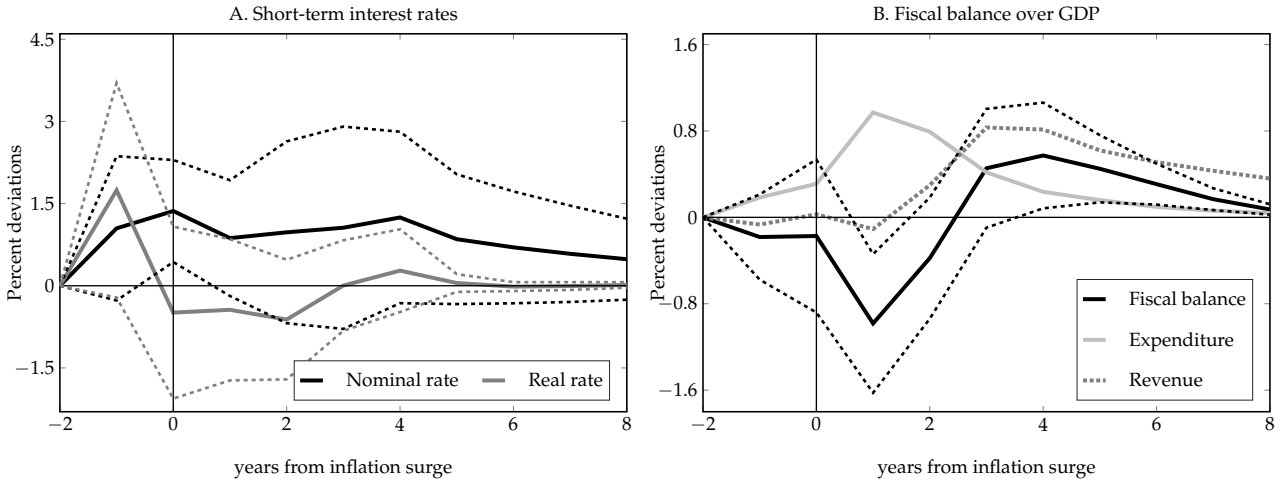
Panel (b) of Figure 4 shows the response of fiscal balances, revenues, and expenditures, all relative to GDP. Fiscal balances deteriorate by 0.2 p.p. of GDP the year following the inflation surge; this is because expenditures-to-GDP increase while revenues-to-GDP are stable following the surge.[14] Two years after the surge, fiscal revenue starts recovering and government expenditure starts contracting; this leads to a strengthening of fiscal balances, which peaks at 0.6 p.p. of GDP above their pre-surge levels 4 years after the inflation surge.

To provide additional context for the monetary and fiscal policies observed following inflation surges, Figure 5 depicts the dynamics of output growth and unemployment during these episodes. Panel (a) of Figure 5 shows that inflation-surge episodes tend to occur together with output growth declines, with an average of 0.9 p.p. below its mean and a trough the year after the inflation surge. Panel (b) shows that inflation surges are characterized by increases unemployment rate, of 1 p.p. on average. This increase is persistent, with unemployment rates

[13] As detailed in Section 2, our baseline results compute interest rates using 1-year-ahead inflation forecast data. Appendix Figure B4 shows that our findings that real interest rates do not increase during inflation surges are robust to using realized inflation instead of expected inflation to compute real rates. Additionally, Figure B5 reports the results for 1-year-ahead nominal interest rate forecasts (from the Consensus Economics data), which exhibit a similar pattern to those of observed interest rates.

[14] The "Inflation Reduction Act of 2022," passed following the recent U.S. inflation surge, was projected to have an impact qualitatively consistent with these patterns, such as an increase in fiscal spending and deficits for its first years (see the estimates by CBO (2022) and PWBM (2022)).

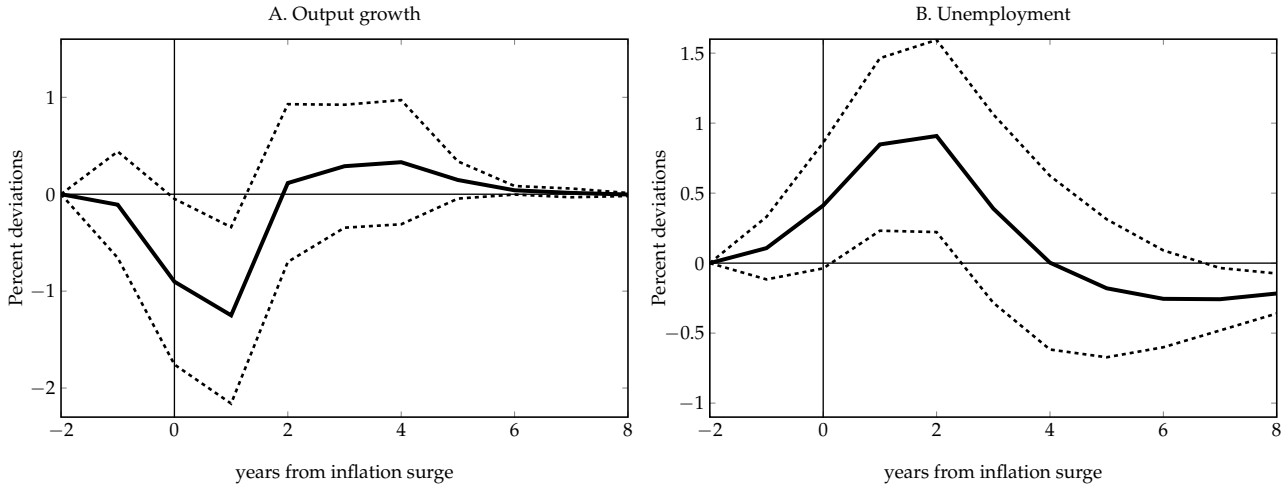
FIGURE 4. DYNAMICS OF MONETARY AND FISCAL VARIABLES DURING LARGE INFLATION SURGE EPISODES



Notes: These figures show the estimated dynamics of short-term interest rates and fiscal variables during large inflation surges, computed using the estimated coefficients from (1), with the recursive expression (2). The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 0$). Panel (a) shows the dynamics of nominal and real short-term annual interest rates; the latter is defined as $r_{j,t} \equiv \frac{1+i_{j,t}}{1+\pi^e_{j,t}}$, where $i_{j,t}$ is the nominal interest rate for country j in period t and $\pi^e_{j,t}$ is the average 1-year-ahead inflation forecast (using data on inflation expectations from professional forecasters); panel (b) shows that of the fiscal balance/GDP, fiscal revenues/GDP, and fiscal expenditure/GDP. All variables are expressed in percent. Dotted lines report 90% error bands, computed using the Delta method. For variable definitions and data sources, see Section 2.

recovering their pre-surge levels 4 years after the surge. Overall, these patterns suggest that inflation surges in our sample tend occur in the presence of "supply shocks," i.e., those that simultaneously increase inflation and decrease output growth.[15]

FIGURE 5. DYNAMICS OF ECONOMIC ACTIVITY DURING LARGE INFLATION SURGE EPISODES



Notes: These figures show the estimated dynamics of economic activity during large inflation surges, computed using the estimated coefficients from (1), with the recursive expression (2). The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 0$). Panel (a) shows the dynamics of real GDP and (b) that of the unemployment rate. All variables are expressed in percent. Dotted lines report 90% error bands, computed using the Delta method. For variable definitions and data sources, see Section 2.

3.4 Additional results

Figure 6 shows the dynamics presented in Sections 3.1-3.3 when we use a higher threshold to identify large inflation surge episodes (4 p.p. instead of the 2.2 p.p. in our baseline analysis). While the patterns are similar to those of our baseline analysis, the magnitudes of the dynamics

[15]To analyze this further, Tables A9 and A10 report the set of episodes characterized by below-average GDP growth (which are more likely to be primarily driven by supply shocks) and those characterized by above-average GDP growth rates (which are more likely to be primarily driven by demand shocks). The former include well-studied economic crisis episodes, such as emerging-market sudden stops in the 1990s and the Global Financial Crisis of 2008. Appendix Figure B6 shows how the dynamics presented in Sections 3.1-3.3 vary for these two types of episodes. These results indicate that the decline in real interest rates and fiscal balances is larger in episodes characterized by below-average GDP growth, which is consistent with the idea that "fear of tightening" might be induced by concerns regarding economic activity. We discuss this further in Section 3.4.

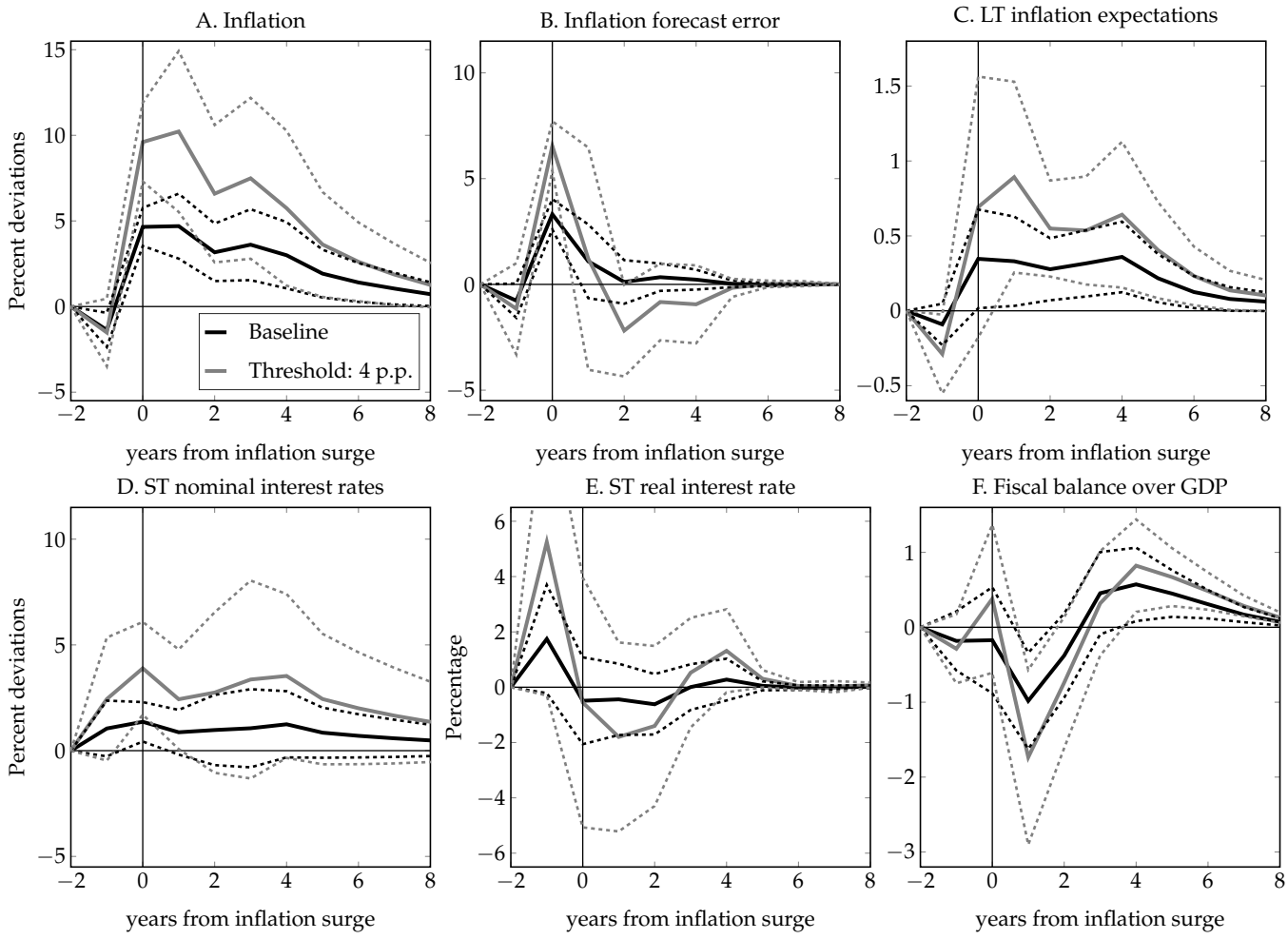
are amplified for episodes that involve a larger increase in inflation. In this regard, it is worth noting that episodes with an initial inflation increase above 4 p.p. feature a 0.9 p.p. increase in 5y5y-forward average inflation forecasts, which suggests a more considerable unanchoring of long-term expectations.

Appendix B shows how the dynamics presented in Sections 3.1-3.3 vary for alternative criteria for identifying large inflation surge episodes and alternative samples. First, Figure B7 depicts the results when we use the "relative criterion" to identify episodes defined in Section 2, which measures inflation changes relative to a country's standard deviations. The dynamic patterns are similar to those of our baseline analysis; the main difference is that the relative criterion is associated with an increase in interest rates and fiscal balances prior to the inflation surge. Figure B8 also shows similar patterns in the set of OECD countries, which is a benchmark of countries frequently considered in the literature. Figure B9 compares the dynamics of inflation surges in emerging and developed economies. These results indicate that inflation surges are significantly smaller or more short-lived in advanced economies, even though they do not exhibit larger increases in nominal interest rates or fiscal balances. Finally, Figure B10 shows that we obtain similar results when we restrict all variables to have the same sample; the main difference is that inflation exhibits less persistent dynamics, more in line with those from inflation expectations.

To study the role of commodity prices in driving our results, Figures B11 and B12 depict the results for inflation surge episodes characterized by different levels of commodity price increases. In this exercise, we use data on commodity prices obtained from the World Bank (further detailed in Appendix A) and identify episodes in which the change in commodity prices in the first year of the inflation surge is above and below its historical mean; Appendix Tables A5 and A6 report the set of episodes in each group. These results indicate similar dynamics in episodes of low- and high-commodity-price inflation, with the main difference being that the magnitude of the inflation surge and the contraction in the economy are larger in episodes that feature low commodity price inflation.[16] Complementing this analysis, Figure B13 shows the results when we identify episodes using core inflation (i.e., excluding energy and food prices)

[16]To understand this phenomenon, it is worth noting that, as shown in Appendix Table A6, most low-commodity-price-inflation episodes feature a contraction in commodity prices, which in emerging markets is often associated with a contraction in economic activity and an inflation surge.

FIGURE 6. DYNAMICS FOLLOWING LARGE INFLATION SURGE EPISODES USING ALTERNATIVE THRESHOLDS TO DEFINE THE EPISODES



Notes: These figures show the estimated dynamics of various variables during large inflation surges, computed using the estimated coefficients from (1), with the recursive expression (2). The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 0$). Panel (a) shows the dynamics of the annual CPI inflation; panel (b) that of the inflation 1-year-ahead forecast error, defined as the difference between realized inflation and its previous year's average 1-year-ahead forecast; panel (c) that of the average 5y5y-forward inflation forecast; panel (d) that of the nominal short-term annual interest rate; panel (e) that of the real short-term annual interest rate, computed using data on 1-year-ahead inflation expectations; and panel (f) that of the fiscal balance/GDP. All variables are expressed in percent. Dotted lines report 90% error bands, computed using the Delta method. *Baseline* refers to the main results presented in Section 3, which identifies episodes using the "absolute criterion" (i.e., those in which annual inflation increases above 2.2 p.p., the 90th percentile of the distribution of inflation changes); *Threshold: 4 p.p.* refers to results when inflation surge episodes are identified using a 4 p.p. threshold. For more details on the criteria used to identify episodes, variable definitions, and data sources, see Section 2.

instead of headline inflation (for data sources, see Appendix A). Similar to our baseline exercise, we identify episodes in which the increase in core inflation is above the 90th percentile of its distribution (i.e., 1.3 percent). The results are similar to our baseline, with the main difference being that the increase in headline inflation is smaller than in our baseline analysis.

Figures B14 and B15 show that the patterns documented in the baseline analysis are also similar if we exclude episodes that occurred during the Global Financial Crisis or if we exclude European economies. Figure B16 reports similar results to those in our baseline when we use quarterly data (detailed in Table A3) in the estimation of (1) instead of annual data, albeit with noisier estimates. Finally, Figures B17 and B18 show similar patterns when we estimate (1) using an alternative number of lags and leads.

Finally, although the primary goal of our paper is to document the empirical patterns that characterize inflation surge episodes, Appendix C discusses how our findings can be interpreted through the lens of the New Keynesian model. In this framework, if the monetary authority is benevolent but lacks commitment and there is a sufficiently large cost of output gap relative to inflation, the optimal response to "cost-push shocks" implies increasing nominal interest rates less than one-to-one with inflation, departing from Taylor (1993)'s prescriptions. Thus, a lack of commitment, together with a significant cost of business cycle fluctuations relative to inflation, can provide a rationale for the "fear of tightening" observed in the data.

4 Conclusion

This paper documents stylized facts that characterize the large inflation surges observed worldwide over the last three decades. Overall, our findings show that several concerns raised during the 2021-22 U.S. inflation surge—such as the persistence of inflation and unanchoring of inflation expectations—are echoed in recent international experiences.

Our empirical evidence can inform models of inflation expectations and stabilization policies. A natural question that arises from our analysis is why governments do not appear to tighten monetary and fiscal policies more aggressively in response to large inflationary increases, particularly for typical values of the relative weights of inflation and output gap stabilization

in welfare loss functions (e.g., Woodford, 2002, 2011; Gali, 2015). We leave the combination of models with our empirical evidence for future research.

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The Dynamics of Large Inflation Surges

Online Appendix—Not for Publication

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Contents of the Online Appendix

A Additional Tables

A.1 Data Sources and Definitions

Consensus Forecasts At present, Consensus conducts a survey of long-term expectations every 3 months (in January, April, July and October). An example of the current survey and release schedule can be found on the Consensus website. However, for most of our sample, the long-term survey was only conducted twice a year, in April and October, and for some countries and years the data is only available once a year (typically from the October survey). Data is collected separately for four regions: G7 & Western Europe, Eastern Europe, Asia Pacific and Latin America. The precise variable definitions and timing of each survey varies by year and region. The documentation states that "in the majority of cases GDP growth, Consumption, Investment, Production and Inflation forecasts are for the average percentage change over the prior calendar year, and for real rather than nominal changes." We use the first available survey in the year to minimize the extent to which the short-term forecast is already partially knowable by the time of the survey. Each long-term survey reports forecasts for six specific years and one 5-year period. For example, a survey from October 15, 2018 for Argentina reports a forecast for the years 2018,..., 2023 (with the 2019 value being our '1-year-ahead' inflation) and one value for 2025-2029 (what we call the 5y5y-forward forecast).

TABLE A1. DATA DESCRIPTION: SOURCES AND VARIABLES

Description	Source	Start-End Date	Number of Countries	Number of Years per Country	Frequency
Unemployment, total (% of total labor force)	WDI	1960–2019	56	39.4	Annual
Real Gross Domestic Product (constant LCU)	WDI	1960–2019	56	50.8	Annual
	FRED	1960–2020	Taiwan		Annual
Inflation expectations , X =1 to 10 years	Consensus	1990–2019	56	20.9	Monthly
CPI Inflation	WDI$^{(i)}$	1960–2021	56	52.6	Annual
	FRED	1990–2020	Taiwan		Annual
Expenditure over GDP	IMF	1980–2020	56	28.8	Annual
Revenue over GDP	IMF	1980–2020	56	29.1	Annual
Fiscal balance over GDP	IMF	1980–2020	56	28.7	Annual
Core CPI inflation rate	GEM	1994–2020	11	18.9	Annual
	WB Inflation Database	1971–2020	44	36.1	Annual
Commodity price index	WB commodity price database	1961–2020	56	53.0	Annual

Notes: Main variables involved in the analysis, its sources, and coverage. (i) For Argentine CPI inflation, we use Cavallo (2013) for the period 2007 to 2017. The unemployment rate is computed using the average monthly unemployment rate. For inflation expectations, we use the first observation in the year. For inflation and core inflation, we use the growth rate of the average CPI index during the year. The commodity price index is the average during the year. Real gross domestic product denotes the total production in a year. Similar criteria apply to expenditure, revenue, and fiscal balance.

TABLE A2. DATA SOURCES FOR SHORT-TERM INTEREST RATES

Variable	Source	Country	Start-End Date
BIS	Policy rate	Brazil, China, Croatia, Colombia, Czech Republic, Denmark, Iceland, India, Israel, Japan, Macedonia, Malaysia, New Zealand, Philippines, Poland, Russia, Saudi Arabia, Serbia, South Africa, Sweden, Switzerland, United Kingdom, United States	1990–2020
IMF	Monetary Policy-related interest rate	Burkina Faso, Chile, Costa Rica, Dominican Republic, Fiji, Gambia, Ghana, Georgia, Honduras, Hong Kong, Hungary, Indonesia, Iraq,Jamaica, Nepal, Norway, Niger,Romania, Singapore, Suriname, Turkey	1990–2020
IMF	Discount rate	Peru, Thailand	2003–2020, 1990–2020
FRED	Interbank rate	Austria, Finland, France, Germany, Greece, Ireland, Italy, Korea, Netherlands, Portugal, Slovenia, Spain	1990–2020
	Deposit facility rate	Belgium	1999–2020
Central Bank of the Argentine Republic	15 days interest rate	Argentina	1990–2020
Bulgarian National Bank	Leonia Plus spliced with base rate	Bulgaria	1992–2020
Central Bank of Egypt	Discount rate	Egypt	1991–2020
Bank of Estonia	Talibor rate spliced with ECB Rate	Estonia	1996–2010, 2011–2020
Eurostat, FRED	Day-to-day rate spliced with ECB rate	Latvia	2005–2014, 2015–2020
Bank of Lithuania FRED	Repo rate spliced with ECB rate	Lithuania	2005–2014, 2015–2020
Banxico, BIS	28 days interbank rate slide policy rate	Mexico	1990–1997, 1999–2020
Central Bank of Nigeria, IMF	Interbank rate spliced Policy rate	Nigeria	2001-2006, 2007–2020
National Bank of Slovakia, FRED	Basic interest rate spliced with ECB Rate	Slovakia	1993–2008, 2009–2020
Central Bank of the Republic of China (Taiwan)	Discount rate	Taiwan	1991–2020
National Bank of Ukraine, IMF	Policy rate spliced with Policy rate	Ukraine	1992–2020

Notes: This table shows the data sources for short-term interest rates used in the empirical analysis. The short-term interest rates in the BIS and IMF are end-of-the-year interest rates. We constructed the interest rates of national sources following the same criteria.

TABLE A3. DATA DESCRIPTION – QUARTERLY SAMPLE: SOURCES AND VARIABLES

Description	Source	Start-End Date	Number of Countries	Number of Quarters per Country	Frequency
Unemployment, total	IMF	1980–2020	33	130.1	Quarterly[a]
(% of total labor force)	GEM	1993–2020	22	106.2	Quarterly
	ILO	1986–2020	New Zealand	149	Quarterly
Real Gross Domestic Product	IMF	1980–2020	30	143.1	Quarterly annualized growth rate[a]
(constant LCU)	GEM	1993–2020	26		Quarterly annualized growth rate
CPI inflation	IMF	1980–2020	52	220.6	Quarterly annualized growth rate[a]
	GEM	1993–2020	Taiwan	118	Quarterly annualized growth rate
	WB Inflation Database	1970–2020	China, Russia	140	Quarterly annualized growth rate[a]
	Inflacion Verdadera	1960–2017	Argentina	140	Quarterly annualized growth rate[a]
Expenditure over GDP	IMF	1980–2020	32	84.2	Quarterly[a]
Revenue over GDP	IMF	1980–2020	32	84.2	Quarterly[a]
Fiscal balance over GDP	IMF	1980–2020	32	84.2	Quarterly, constructed from above
Core CPI inflation	GEM	1993–2020	10	83.2	Quarterly annualized growth rate
	WB Inflation Database	1970–2020	43	157.2	Quarterly annualized growth rate[a]

Notes: Quarterly variables used in the analysis, its sources, and coverage.
[a]: Seasonal adjustment performed on interpolated data using X-13ARIMA-SEATS seasonal adjustment software from the U.S. Census Bureau.

A.2 Inflation episodes

TABLE A4. INFLATION SURGE EPISODES IN THE BASELINE SAMPLE (POST-1990)

Country Name	Year	Δ inflation	Country Name	Year	Δ inflation	Country Name	Year	Δ inflation
Argentina	2002	26.9	Hungary	1995	9.4	Philippines	1998	3.6
Argentina	2005	5.2	Hungary	2007	4	Philippines	2004	2.5
Argentina	2014	17.6	Indonesia	1998	52.2	Philippines	2008	5.4
Australia	1995	2.7	Indonesia	2001	7.8	Philippines	2018	2.5
Australia	2000	3	Indonesia	2005	4.4	Poland	2000	2.7
Belgium	2008	2.7	India	1991	4.9	Poland	2004	2.7
Bulgaria	1994	23.2	India	1994	3.9	Poland	2017	2.7
Bulgaria	2000	7.7	India	1998	6.1	Portugal	2010	2.2
Bulgaria	2004	3.8	India	2009	2.5	Romania	1996	6.6
Bulgaria	2017	2.9	India	2020	2.9	Romania	2008	3
Brazil	2000	2.2	Ireland	2000	4	Romania	2017	2.9
Brazil	2003	6.3	Ireland	2010	3.6	Russian Federation	1998	12.9
Brazil	2015	2.7	Israel	2002	4.6	Russian Federation	2008	5.1
Switzerland	1990	2.2	Israel	2008	4.1	Russian Federation	2015	7.7
Chile	2008	4.3	Japan	2014	2.4	Saudi Arabia	1991	2.8
Chile	2014	2.9	Korea, Rep.	1998	3.1	Saudi Arabia	1995	4.3
China	1992	2.8	Lithuania	2004	2.3	Saudi Arabia	2008	5.7
China	2004	2.7	Lithuania	2008	5.2	Saudi Arabia	2018	3.3
China	2007	3.2	Lithuania	2011	2.8	Singapore	2008	4.5
China	2010	3.9	Lithuania	2017	2.8	Slovak Republic	1993	13.4
Colombia	2016	2.5	Latvia	2004	3.2	Slovak Republic	1999	3.9
Czechia	1993	9.7	Latvia	2007	3.6	Slovak Republic	2003	5.4
Czechia	2004	2.6	Latvia	2011	5.5	Slovak Republic	2011	3
Czechia	2008	3.5	Latvia	2017	2.8	Slovenia	2000	2.8
Egypt, Arab Rep.	1995	7.6	Mexico	1990	6.6	Sweden	1990	3.9
Egypt, Arab Rep.	2004	6.8	Mexico	1995	28	Sweden	1993	2.4
Egypt, Arab Rep.	2013	2.4	Mexico	2017	3.2	Thailand	1998	2.4
Egypt, Arab Rep.	2016	3.4	Malaysia	1998	2.6	Thailand	2008	3.2
Estonia	2008	3.8	Malaysia	2008	3.4	Turkiye	1991	5.7
Estonia	2017	3.3	Nigeria	1991	5.6	Turkiye	1997	5.3
Finland	2011	2.2	Nigeria	2001	11.9	Turkiye	2010	2.3
United Kingdom	1990	2.3	Nigeria	2005	2.9	Turkiye	2017	3.4
Greece	1990	6.8	Nigeria	2008	6.2	Taiwan	2002	2.5
Greece	2010	3.5	Nigeria	2016	6.7	Taiwan	2007	2.7
Hong Kong SAR, China	2004	2.4	Norway	2008	3	Ukraine	1999	12.1
Hong Kong SAR, China	2008	2.3	New Zealand	2000	2.7	Ukraine	2003	4.4
Hong Kong SAR, China	2011	3	Peru	2008	4	Ukraine	2014	12.3
Croatia	1998	2.2	Philippines	1991	7.1	South Africa	2002	3.8
Croatia	2008	3.2	Philippines	1994	3.7	South Africa	2005	2.8
Croatia	2017	2.3						

Notes: This table shows the set of inflation surge episodes used in our baseline analysis, identified in 1990-2019, and with available data on inflation expectations. For details on identifying these episodes and data sources, see Section 2.

TABLE A5. INFLATION SURGE EPISODES WITH HIGH COMMODITY-PRICE GROWTH (WITHIN THE BASELINE SAMPLE)

Country Name	Year	Δ commodity prices	Country Name	Year	Δ commodity prices
Argentina	2005	29.8	Latvia	2007	13
Australia	1995	7.8	Latvia	2011	30
Australia	2000	32.4	Latvia	2017	16.3
Belgium	2008	30.7	Mexico	1990	8.8
Bulgaria	2000	32.4	Mexico	1995	7.8
Bulgaria	2004	24.3	Mexico	2017	16.3
Bulgaria	2017	16.3	Malaysia	2008	30.7
Brazil	2000	32.4	Nigeria	2005	29.8
Brazil	2003	17	Nigeria	2008	30.7
Switzerland	1990	8.8	Norway	2008	30.7
Chile	2008	30.7	New Zealand	2000	32.4
China	2004	24.3	Peru	2008	30.7
China	2007	13	Philippines	2004	24.3
China	2010	23.7	Philippines	2008	30.7
Czechia	2004	24.3	Philippines	2018	18.7
Czechia	2008	30.7	Poland	2000	32.4
Egypt, Arab Rep.	1995	7.8	Poland	2004	24.3
Egypt, Arab Rep.	2004	24.3	Poland	2017	16.3
Estonia	2008	30.7	Portugal	2010	23.7
Estonia	2017	16.3	Romania	1996	8.7
Finland	2011	30	Romania	2008	30.7
United Kingdom	1990	8.8	Romania	2017	16.3
Greece	1990	8.8	Russian Federation	2008	30.7
Greece	2010	23.7	Saudi Arabia	1995	7.8
Hong Kong SAR, China	2004	24.3	Saudi Arabia	2008	30.7
Hong Kong SAR, China	2008	30.7	Saudi Arabia	2018	18.7
Hong Kong SAR, China	2011	30	Singapore	2008	30.7
Croatia	2008	30.7	Slovak Republic	1999	7.3
Croatia	2017	16.3	Slovak Republic	2003	17
Hungary	1995	7.8	Slovak Republic	2011	30
Hungary	2007	13	Slovenia	2000	32.4
Indonesia	2005	29.8	Sweden	1990	8.8
Ireland	2000	32.4	Thailand	2008	30.7
Ireland	2010	23.7	Turkiye	2010	23.7
Israel	2008	30.7	Turkiye	2017	16.3
Lithuania	2004	24.3	Taiwan	2007	13
Lithuania	2008	30.7	Ukraine	1999	7.3
Lithuania	2011	30	Ukraine	2003	17
Lithuania	2017	16.3	South Africa	2005	29.8
Latvia	2004	24.3	**Average**		22.5

Notes: This table shows the set of inflation surge episodes within our baseline set of episodes (detailed in A4) that feature an increase in global commodity prices at the beginning of the inflation surge ($t = 0$) above their historical mean. For details on identifying these episodes and data sources, see Section 2.

TABLE A6. INFLATION SURGE EPISODES WITH LOW COMMODITY-PRICE GROWTH (WITHIN THE BASELINE SAMPLE)

Country Name	Year	Δ commodity prices
Argentina	2002	-.2
Argentina	2014	-7.5
Bulgaria	1994	3.2
Brazil	2015	-36.7
Chile	2014	-7.5
China	1992	-2.4
Colombia	2016	-10.5
Czechia	1993	-4
Egypt, Arab Rep.	2013	-3.5
Egypt, Arab Rep.	2016	-10.5
Croatia	1998	-21.4
Indonesia	1998	-21.4
Indonesia	2001	-8.7
India	1991	-9.2
India	1994	3.2
India	1998	-21.4
India	2009	-33.4
India	2020	-20.5
Israel	2002	-.2
Japan	2014	-7.5
Korea, Rep.	1998	-21.4
Malaysia	1998	-21.4
Nigeria	1991	-9.2
Nigeria	2001	-8.7
Nigeria	2016	-10.5
Philippines	1991	-9.2
Philippines	1994	3.2
Philippines	1998	-21.4
Russian Federation	1998	-21.4
Russian Federation	2015	-36.7
Saudi Arabia	1991	-9.2
Slovak Republic	1993	-4
Sweden	1993	-4
Thailand	1998	-21.4
Turkiye	1991	-9.2
Turkiye	1997	-4.9
Taiwan	2002	-.2
Ukraine	2014	-7.5
South Africa	2002	-.2
Average		-11.2

Notes: This table shows the set of inflation surge episodes within our baseline set of episodes (detailed in A4) that feature an increase in global commodity prices at the beginning of the inflation surge ($t = 0$) below their historical mean. For details on identifying these episodes and data sources, see Section 2.

TABLE A7. INFLATION SURGE EPISODES FOR THE PERIOD 1960 TO 1989

Country Name	Year	Δ inflation	Country Name	Year	Δ inflation	Country Name	Year	Δ inflation
Argentina	1962	12.4	Greece	1969	2.5	Nigeria	1981	10.8
Argentina	1965	6.5	Greece	1973	11.1	Nigeria	1987	5.6
Argentina	1970	6	Greece	1979	6.5	Netherlands	1964	2.6
Argentina	1975	75.8	Greece	1986	3.7	Netherlands	1969	3.7
Argentina	1987	9.9	Hong Kong SAR, China	1987	2.3	Netherlands	1980	2.3
Australia	1964	2.2	Croatia	1987	50	Norway	1962	3.1
Australia	1971	2.7	Hungary	1979	4.3	Norway	1970	7.7
Australia	1985	2.8	Hungary	1982	2.2	Norway	1975	2.3
Austria	1980	2.6	Hungary	1987	3.4	Norway	1980	6.4
Austria	1984	2.3	Indonesia	1962	86.3	New Zealand	1967	3.3
Belgium	1974	5.7	Indonesia	1972	2.3	New Zealand	1971	3.9
Belgium	1980	2.2	Indonesia	1979	8.1	New Zealand	1974	2.9
Bulgaria	1989	4	Indonesia	1983	2.4	New Zealand	1980	3.5
Canada	1972	2.3	Indonesia	1987	3.5	New Zealand	1985	9.2
Canada	1981	2.3	India	1964	10.4	Peru	1964	3.7
Switzerland	1962	2.5	India	1967	2.3	Peru	1968	9.3
Switzerland	1971	3	India	1970	5.7	Peru	1973	2.3
Switzerland	1979	2.6	India	1977	15.9	Peru	1987	7.9
Chile	1972	57.7	India	1983	4	Philippines	1962	4.2
Chile	1983	17.3	India	1986	3.2	Philippines	1970	12.4
Chile	1989	2.3	Ireland	1961	2.3	Philippines	1979	10.2
China	1988	11.6	Ireland	1964	4.3	Philippines	1984	40.3
Colombia	1961	2.5	Ireland	1969	2.7	Philippines	1987	2.9
Colombia	1966	9.1	Ireland	1973	2.8	Poland	1973	2.6
Colombia	1971	5	Ireland	1979	5.6	Poland	1978	3.2
Colombia	1977	14	Israel	1961	4.6	Poland	1986	5
Colombia	1985	7.9	Israel	1965	2.5	Portugal	1969	2.7
Denmark	1961	2.2	Israel	1970	3.7	Portugal	1981	3.2
Denmark	1965	2.4	Israel	1977	3.3	Portugal	1989	2.6
Denmark	1970	3	Israel	1989	4	Saudi Arabia	1971	4.3
Denmark	1973	2.7	Italy	1962	2.6	Saudi Arabia	1979	2.7
Denmark	1980	2.7	Italy	1970	2.3	Saudi Arabia	1988	2.5
Egypt, Arab Rep.	1963	3.7	Italy	1973	5	Singapore	1973	17.6
Egypt, Arab Rep.	1969	5.1	Italy	1979	2.7	Singapore	1977	5
Egypt, Arab Rep.	1973	3	Japan	1965	2.9	Singapore	1980	4.5
Egypt, Arab Rep.	1977	2.4	Japan	1973	6.8	Slovenia	1983	10.1
Egypt, Arab Rep.	1980	10.9	Japan	1980	4.1	Sweden	1962	2.6
Egypt, Arab Rep.	1986	11.8	Korea, Rep.	1963	14.1	Sweden	1970	4.3
Egypt, Arab Rep.	1989	3.6	Korea, Rep.	1970	3.6	Sweden	1974	3.2
Spain	1962	4.9	Korea, Rep.	1974	21.1	Sweden	1980	6.5
Spain	1970	3.6	Korea, Rep.	1978	4.4	Thailand	1961	8.2
Spain	1977	6.9	Korea, Rep.	1988	4.1	Thailand	1966	3.9
Finland	1962	2.7	Mexico	1973	7.1	Thailand	1972	4.4
Finland	1968	3.8	Mexico	1977	13.2	Thailand	1977	3.5
Finland	1971	3.7	Mexico	1980	8.2	Thailand	1980	9.8
Finland	1980	4.1	Mexico	1986	28.5	Turkiye	1963	2.5
France	1962	2.9	Malaysia	1963	3	Turkiye	1970	3
France	1974	6.3	Malaysia	1967	3.6	Turkiye	1974	10
France	1980	2.9	Malaysia	1970	2.3	Turkiye	1977	8.5
United Kingdom	1961	2.4	Malaysia	1973	7.3	Turkiye	1983	2.3
United Kingdom	1968	2.2	Malaysia	1980	3	Turkiye	1987	4.2
United Kingdom	1971	3.1	Malaysia	1988	2.3	United States	1973	2.9
United Kingdom	1974	6.8	Nigeria	1964	3.6	United States	1979	3.6
United Kingdom	1979	5.2	Nigeria	1974	7.3	South Africa	1973	3
Greece	1963	3.7	Nigeria	1978	6.6	South Africa	1985	4.8

Notes: This table shows the set of inflation surge episodes identified in the period 1960-1989. For details on identifying these episodes and data sources, see Section 2.

TABLE A8. INFLATION SURGE EPISODES IDENTIFIED USING THE "RELATIVE CRITERION"

Country Name	Year	Δ inflation	Country Name	Year	Δ inflation
Argentina	2002	26.9	India	1991	4.9
Argentina	2014	17.6	India	2009	2.5
Argentina	2019	19.3	Ireland	2000	4
Austria	2008	1	Italy	2008	1.5
Austria	2011	1.5	Japan	2008	1.3
Belgium	2005	.7	Japan	2014	2.4
Belgium	2008	2.7	Lithuania	2008	5.2
Brazil	2015	2.7	Latvia	2007	3.6
Switzerland	2008	1.7	Mexico	2017	3.2
Chile	2008	4.3	Malaysia	1998	2.6
China	2007	3.2	Malaysia	2008	3.4
Colombia	2016	2.5	Nigeria	2016	6.7
Germany	2007	.7	Netherlands	2001	1.8
Denmark	2000	.4	Norway	2008	3
Denmark	2008	1.7	New Zealand	2011	1.7
Egypt, Arab Rep.	2008	9	Russian Federation	2015	7.7
Egypt, Arab Rep.	2017	15.7	Saudi Arabia	1991	2.8
Estonia	2008	3.8	Saudi Arabia	2006	1.7
Finland	2008	1.6	Singapore	2007	1.1
France	2008	1.3	Sweden	2008	1.2
United Kingdom	2008	1.1	Thailand	1998	2.4
United Kingdom	2011	1.4	Turkiye	1994	33.9
Greece	2010	3.5	Turkiye	2017	3.4
Hong Kong SAR, China	2008	2.3	Taiwan	2007	2.7
Hong Kong SAR, China	2011	3	Ukraine	2015	36.6
Croatia	2008	3.2	South Africa	2008	3.9
Indonesia	1998	52.2			

Notes: This table shows the set of inflation surge episodes identified using the "relative criterion" (i.e., those in which the annual inflation in a country increases by more than 1.65 standard deviations from its mean during the last 10 years) in the period 1990-2019. For details on identifying these episodes and data sources, see Section 2.

TABLE A9. INFLATION SURGE EPISODES WITH LOW GDP GROWTH (WITHIN THE BASELINE SAMPLE)

Country Name	Year	Growth - average	Country Name	Year	Growth - average
Argentina	2002	-13.1	Lithuania	2008	-1.5
Argentina	2014	-4.8	Latvia	2011	-1.2
Belgium	2008	-1.2	Latvia	2017	-.5
Brazil	2003	-.9	Mexico	1995	-8.5
Brazil	2015	-5.6	Mexico	2017	-.1
Chile	2008	-.4	Malaysia	1998	-12.8
Chile	2014	-2.4	Malaysia	2008	-.6
Colombia	2016	-1.1	Nigeria	1991	-4
Czechia	1993	-1.8	Nigeria	2016	-6
Egypt, Arab Rep.	2004	-.3	Norway	2008	-1.7
Egypt, Arab Rep.	2013	-2.2	Philippines	1991	-4.6
Egypt, Arab Rep.	2016	0	Philippines	1998	-4.6
Estonia	2008	-9.2	Russian Federation	1998	-6.4
United Kingdom	1990	-.8	Russian Federation	2015	-3.1
Greece	1990	-.6	Saudi Arabia	1995	-3.2
Greece	2010	-6.1	Saudi Arabia	2018	-.7
Hong Kong SAR, China	2008	-1.1	Singapore	2008	-3.7
Hungary	1995	-.6	Slovak Republic	1993	-1.8
Hungary	2007	-1.8	Slovak Republic	1999	-3.8
Indonesia	1998	-17.8	Slovak Republic	2011	-1
Indonesia	2001	-1.1	Sweden	1990	-1.2
India	1991	-4.8	Sweden	1993	-4.1
India	2020	-11.7	Thailand	1998	-11.7
Ireland	2010	-3.9	Thailand	2008	-2.3
Israel	2002	-3.8	Turkiye	1991	-3.8
Israel	2008	-.4	Ukraine	2014	-9.1
Japan	2014	-.6	**Average**		-3.9
Korea, Rep.	1998	-10.1			

Notes: This table shows the set of inflation surge episodes within our baseline set of episodes (detailed in A4) that feature a GDP growth rate at the beginning of the inflation surge ($t = 0$) below the country's historical mean. For details on identifying these episodes and data sources, see Section 2.

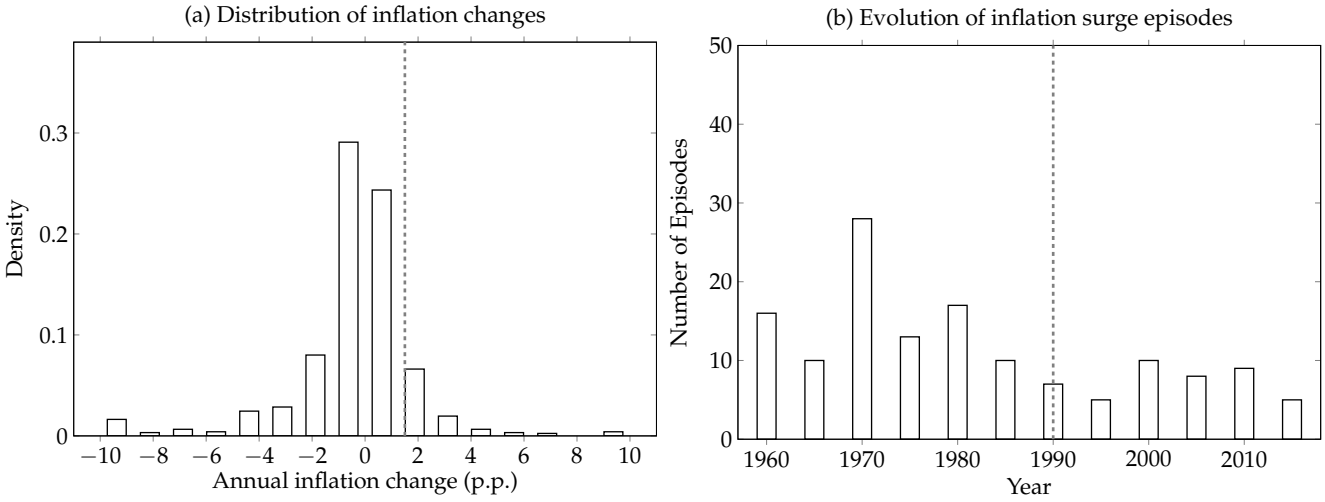
TABLE A10. INFLATION SURGE EPISODES WITH HIGH GDP GROWTH (WITHIN THE BASELINE SAMPLE)

Country Name	Year	Growth - average	Country Name	Year	Growth - average
Argentina	2005	6.6	Mexico	1990	3
Australia	1995	1	Nigeria	2001	1.6
Australia	2000	1	Nigeria	2005	2.1
Bulgaria	1994	.8	Nigeria	2008	2.4
Bulgaria	2000	3.6	New Zealand	2000	.1
Bulgaria	2004	5.5	Peru	2008	5.4
Bulgaria	2017	1.8	Philippines	1994	.2
Brazil	2000	2.4	Philippines	2004	2.4
Switzerland	1990	2.1	Philippines	2008	.2
China	1992	5.1	Philippines	2018	2.2
China	2004	1	Poland	2000	.9
China	2007	5.1	Poland	2004	1.4
China	2010	1.5	Poland	2017	1.5
Czechia	2004	3	Portugal	2010	.5
Czechia	2008	.8	Romania	1996	1.8
Egypt, Arab Rep.	1995	.2	Romania	2008	7.2
Estonia	2017	1.7	Romania	2017	6.1
Finland	2011	1	Russian Federation	2008	4.1
Hong Kong SAR, China	2004	5.5	Saudi Arabia	1991	11.6
Hong Kong SAR, China	2011	1.6	Saudi Arabia	2008	2.8
Croatia	1998	.4	Slovak Republic	2003	1.8
Croatia	2008	.1	Slovenia	2000	1.2
Croatia	2017	1.5	Turkiye	1997	3
Indonesia	2005	1	Turkiye	2010	3.9
India	1994	.8	Turkiye	2017	3
India	1998	.3	Taiwan	2002	.8
India	2009	2	Taiwan	2007	2.2
Ireland	2000	3.8	Ukraine	1999	.8
Lithuania	2004	2.4	Ukraine	2003	10.5
Lithuania	2011	1.9	South Africa	2002	1.7
Lithuania	2017	.1	South Africa	2005	3.3
Latvia	2004	4.5	**Average**		2.6
Latvia	2007	6.2			

Notes: This table shows the set of inflation surge episodes within our baseline set of episodes (detailed in A4) that feature a GDP growth rate at the beginning of the inflation surge ($t = 0$) above the country's historical mean. For details on identifying these episodes and data sources, see Section 2.

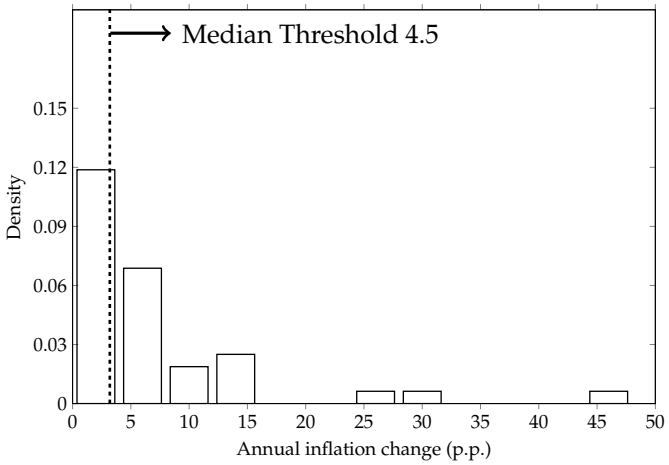
B Additional Results

FIGURE B1. DISTRIBUTION OF INFLATION CHANGES AND HISTORICAL EVOLUTION OF LARGE SURGE EPISODES: OECD COUNTRIES



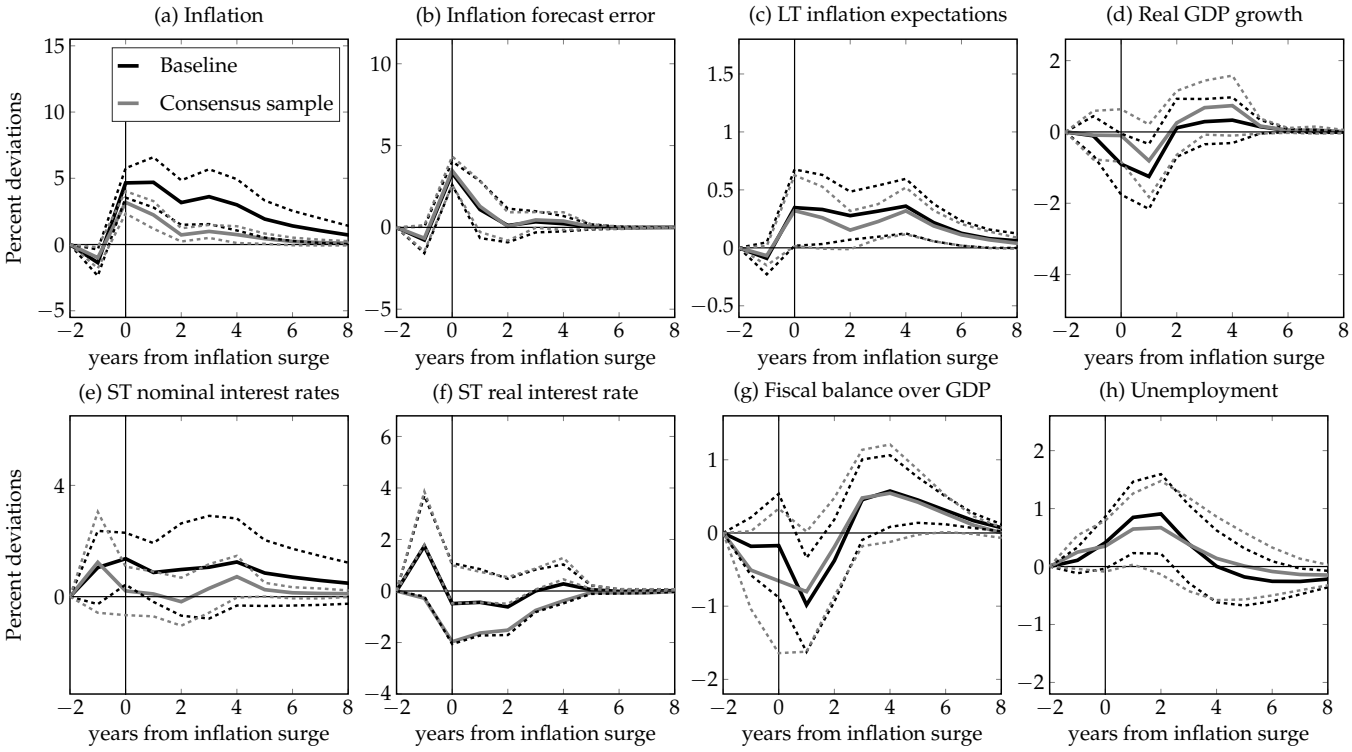
Notes: Panel (a) shows the distribution of annual changes in CPI inflation for the set of OECD countries in our sample since 1990, in percentage points. The vertical dotted line marks the 90th percentile of the distribution of inflation changes for the OECD sample (1.5 p.p.). Panel (b) shows the number of large inflation surge episodes for the set of OEDC countries in our sample using our baseline definition every 5 years from 1960 to 2018. The vertical dotted line marks the year 1990, which is the focus of our analysis in Section 3. For data sources, see Section 2.

FIGURE B2. DISTRIBUTION OF INFLATION THRESHOLDS IN THE RELATIVE CRITERIA



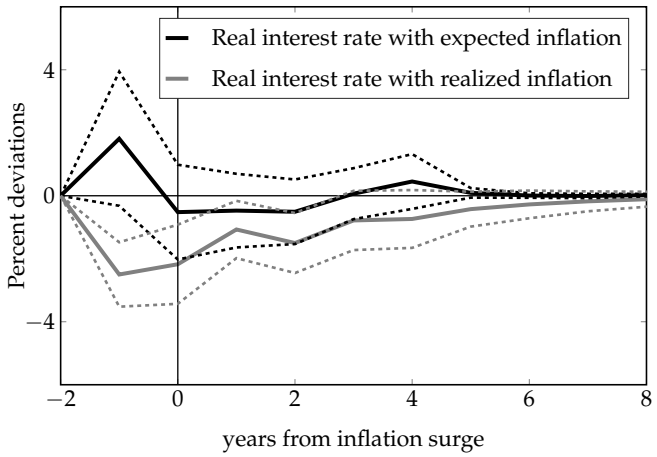
Notes: This figure shows the distribution of inflation thresholds under the "relative criterion" to identify large inflation surges. For each episode, the threshold is defined as $\mu^{\pi}_{i,\tau_{i,j}} + 1.65\sigma^{\pi}_{i,\tau_{i,j}-1}$, where $\mu^{\pi}_{i,t}$ and $\sigma^{\pi}_{i,t}$ are the average and standard deviation of annual inflation changes computed from period t to period $t-9$, and $\tau_{i,j}$ is the year beginning episode j in country i. The vertical dotted line marks the median of the distribution of thresholds. For variable definitions and data sources, see Section 2.

FIGURE B3. DYNAMICS FOLLOWING LARGE INFLATION SURGE EPISODES: SAMPLE WITH CONSENSUS-ECONOMICS DATA AVAILABLE



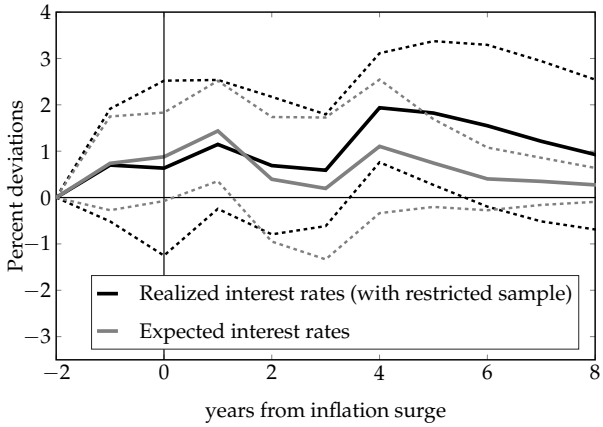
Notes: These figures show the estimated dynamics of various variables during large inflation surges, computed using the estimated coefficients from (1), with the recursive expression (2). The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 0$). Panel (a) shows the dynamics of the annual CPI inflation; panel (b) that of the inflation 1-year-ahead forecast error, defined as the difference between realized inflation and its previous year's average 1-year-ahead forecast; panel (c) that of the average 5y5y-forward inflation forecast; panel (d) that of real GDP growth; panel (e) that of the nominal short-term annual interest rate; panel (f) that of the real short-term annual interest rate, computed using data on 1-year-ahead inflation expectations; panel (g) that of the fiscal balance/GDP; and panel (h) that of the unemployment rate. All variables are expressed in percent. Dotted lines report 90% error bands, computed using the Delta method. *Baseline* refers to the main results presented in Section 3, which includes all available data for each variable; *Consensus sample* refers to results restricting the estimation sample to periods with available data for all variables. For more details on the criteria used to identify episodes, variable definitions, and data sources, see Section 2.

FIGURE B4. DYNAMICS OF MONETARY POLICY DURING LARGE INFLATION SURGE EPISODES: ALTERNATIVE REAL INTEREST RATES



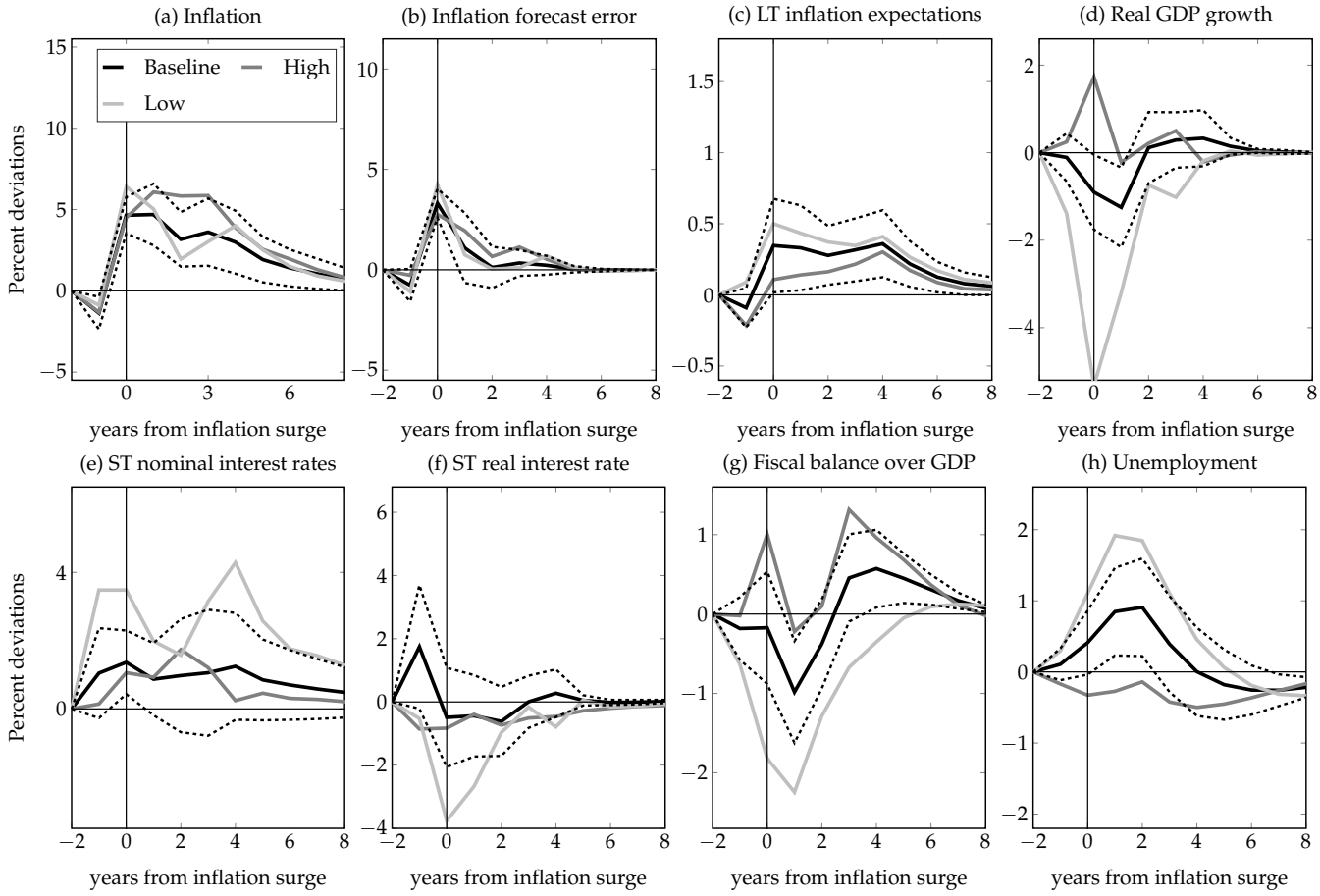
Notes: This figure shows the estimated dynamics of short-term interest rates during large inflation surges, computed using the estimated coefficients from (1), with the recursive expression (2). The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 0$). *Real interest rate with expected inflation* refers to the real interest rate computed as $r_{j,t} \equiv \frac{1+i_{j,t}}{1+\pi^e_{j,t}}$, where $i_{j,t}$ is the nominal interest rate for country j in period t and $\pi^e_{j,t}$ is the average 1-year-ahead inflation forecast (using data on inflation expectations from Consensus Economics). *Real interest rate with realized inflation* refers to the real interest rate computed as $r_{j,t} \equiv \frac{1+i_{j,t}}{1+\pi_{j,t+1}}$, where $\pi_{j,t}$ is the realized inflation in period t. All variables are expressed in percent. Dotted lines report 90% error bands, computed using the Delta method. We restrict the sample in the estimation of the empirical model with the real interest rate using realized inflation to be the same as the one with expected inflation. For variable definitions and data sources, see Section 2.

FIGURE B5. DYNAMICS OF MONETARY POLICY DURING LARGE INFLATION SURGE EPISODES: REALIZED AND EXPECTED NOMINAL INTEREST RATES



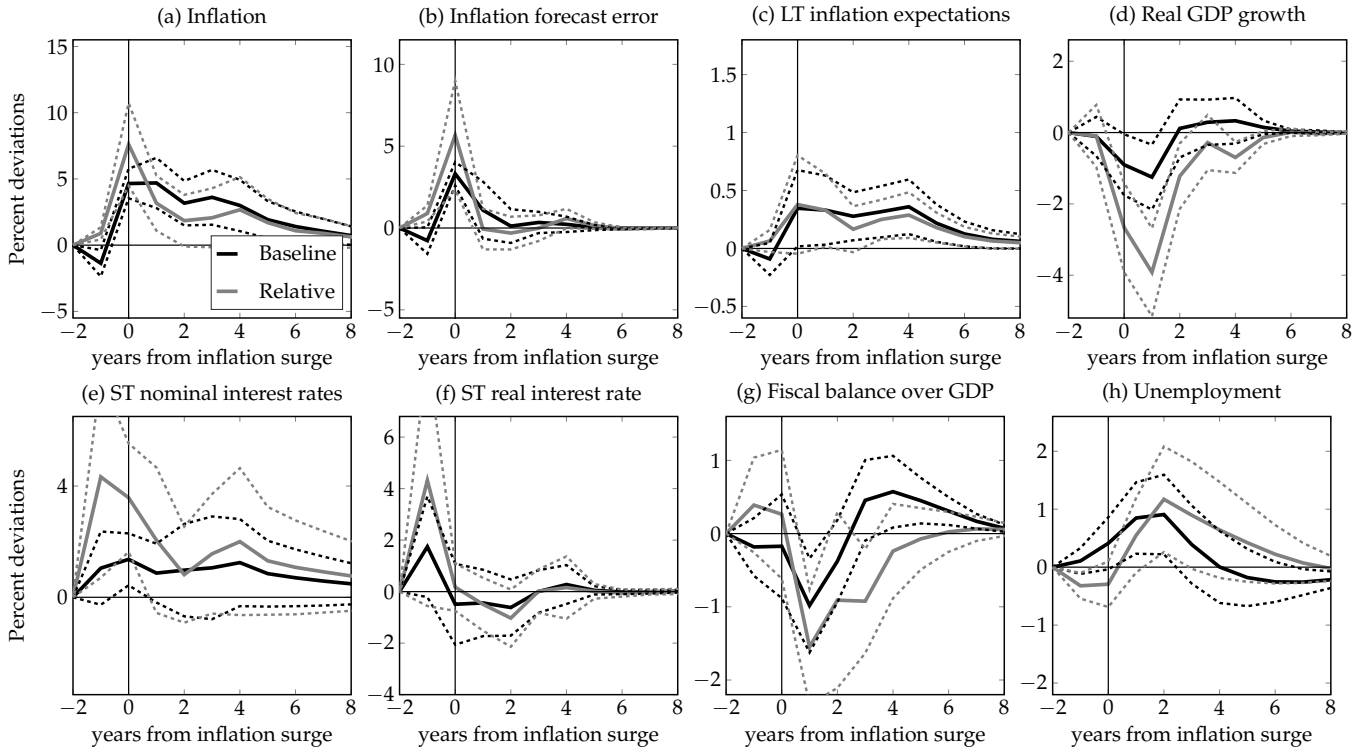
Notes: These figures show the estimated dynamics of various variables during large inflation surges, computed using the estimated coefficients from (1), with the recursive expression (2). The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 0$). *Expected interest rates* refers to the 1-year-ahead average short-term interest-rate forecast from Consensus Economics. *Realized interest rates (with restricted sample)* refers to nominal short-term annual interest rates, restricted to the sample with available expected interest-rate data. All variables are expressed in percent. Dotted lines report 90% error bands, computed using the Delta method. For variable definitions and data sources, see Section 2.

FIGURE B6. DYNAMICS FOLLOWING LARGE INFLATION SURGE EPISODES: HIGH AND LOW GDP GROWTH



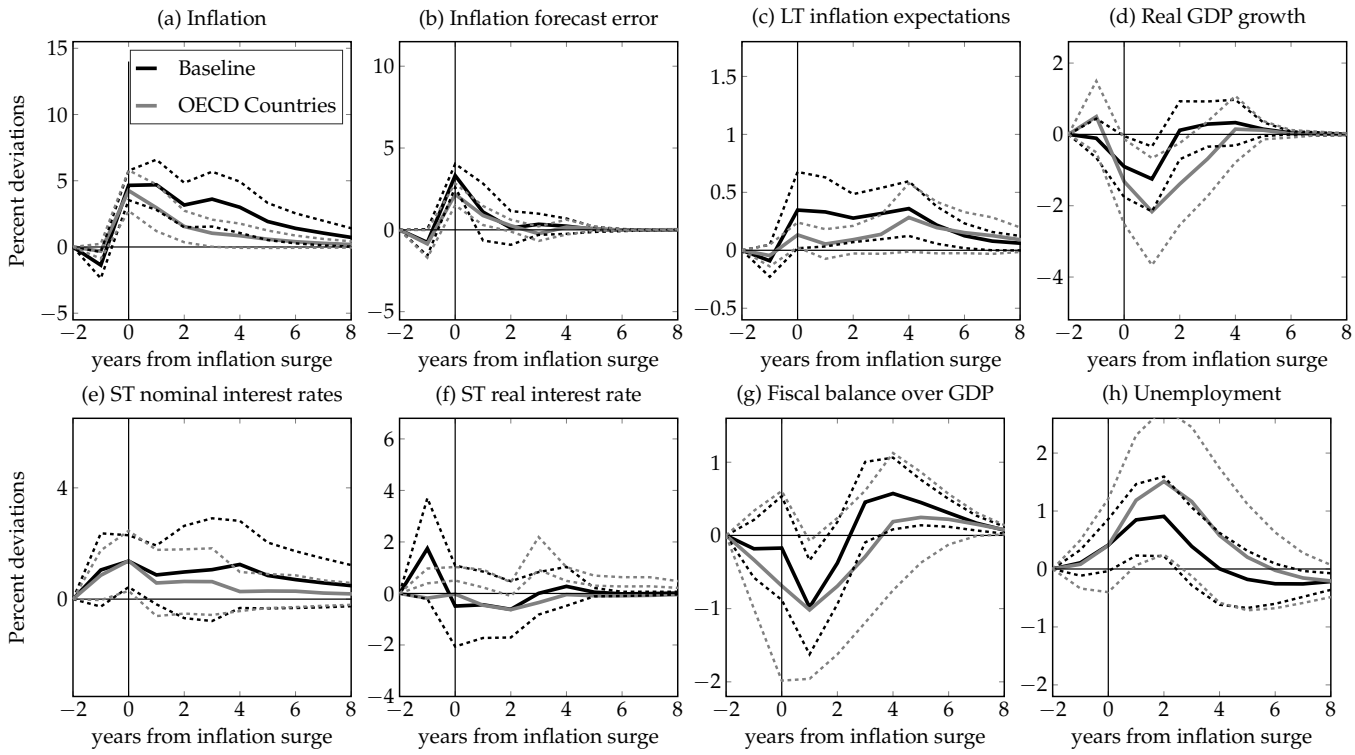
Notes: These figures show the estimated dynamics of various variables during large inflation surges, computed using the estimated coefficients from (1), with the recursive expression (2). The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 0$). Panel (a) shows the dynamics of the annual CPI inflation; panel (b) that of the inflation 1-year-ahead forecast error, defined as the difference between realized inflation and its previous year's average 1-year-ahead forecast; panel (c) that of the average 5y5y-forward inflation forecast; panel (d) that of real GDP growth; panel (e) that of the nominal short-term annual interest rate; panel (f) that of the real short-term annual interest rate, computed using data on 1-year-ahead inflation expectations; panel (g) that of the fiscal balance/GDP; and panel (h) that of the unemployment rate. All variables are expressed in percent. Dotted lines report 90% error bands, computed using the Delta method. *Baseline* refers to the main results presented in Section 3; *High* and *Low* refer, respectively, to the results estimating the empirical model for the subset of episodes featuring GDP growth at the beginning of the inflation surge ($t = 0$) above and below the country's mean. See Tables A9 and A10 for details of these episodes. For more details on the criteria used to identify episodes, variable definitions, and data sources, see Section 2.

FIGURE B7. DYNAMICS FOLLOWING LARGE INFLATION SURGE EPISODES USING THE "RELATIVE CRITERION" TO DEFINE THE EPISODES



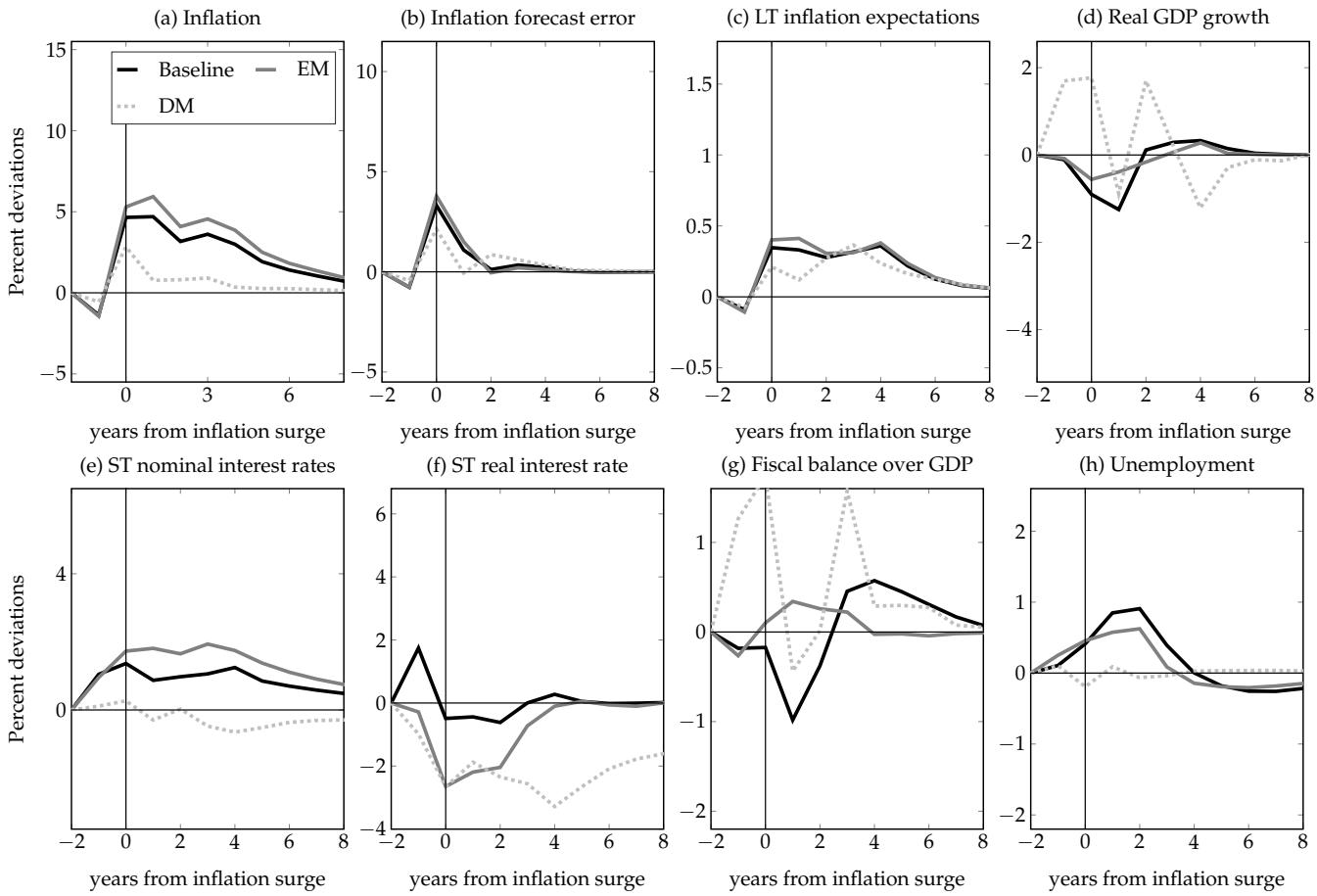
Notes: These figures show the estimated dynamics of various variables during large inflation surges, computed using the estimated coefficients from (1), with the recursive expression (2). The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 0$). Panel (a) shows the dynamics of the annual CPI inflation; panel (b) that of the inflation 1-year-ahead forecast error, defined as the difference between realized inflation and its previous year's average 1-year-ahead forecast; panel (c) that of the average 5y5y-forward inflation forecast; panel (d) that of real GDP growth; panel (e) that of the nominal short-term annual interest rate; panel (f) that of the real short-term annual interest rate, computed using data on 1-year-ahead inflation expectations; panel (g) that of the fiscal balance/GDP; and panel (h) that of the unemployment rate. All variables are expressed in percent. Dotted lines report 90% error bands, computed using the Delta method. *Baseline* refers to the main results presented in Section 3, which identify episodes with the "absolute criterion" (i.e., those in which annual inflation increases above 2.2 p.p., the 90th percentile of the distribution of inflation changes); *Relative* refers to results that identify surge episodes using the "relative criterion" (i.e., those in which the annual inflation in a country increases by more than 1.65 standard deviations from its mean during the last 10 years). For more details on the criteria used to identify episodes, variable definitions, and data sources, see Section 2.

FIGURE B8. DYNAMICS FOLLOWING LARGE INFLATION SURGE EPISODES: OECD COUNTRIES



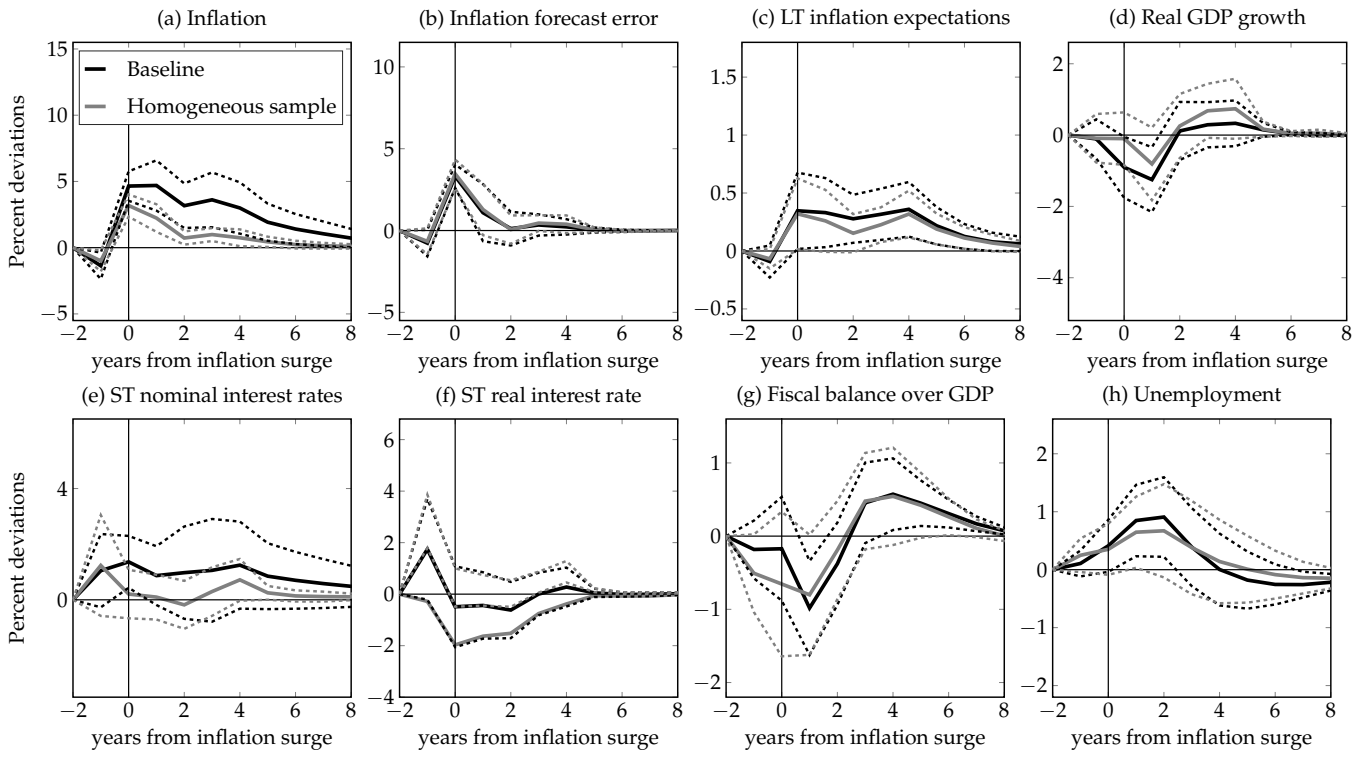
Notes: These figures show the estimated dynamics of various variables during large inflation surges, computed using the estimated coefficients from (1), with the recursive expression (2). The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 0$). The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 0$). Panel (a) shows the dynamics of the annual CPI inflation; panel (b) that of the inflation 1-year-ahead forecast error, defined as the difference between realized inflation and its previous year's average 1-year-ahead forecast; panel (c) that of the average 5y5y-forward inflation forecast; panel (d) that of real GDP growth; panel (e) that of the nominal short-term annual interest rate; panel (f) that of the real short-term annual interest rate, computed using data on 1-year-ahead inflation expectations; panel (g) that of the fiscal balance/GDP; and panel (h) that of the unemployment rate. All variables are expressed in percent. Dotted lines report 90% error bands, computed using the Delta method. *Baseline* refers to the main results presented in Section 3, which includes all available data for each variable; *OECD Countries* refers to the results estimating the empirical model only for the set of OECD countries in our sample. For more details on the criteria used to identify episodes, variable definitions, and data sources, see Section 2.

FIGURE B9. DYNAMICS FOLLOWING LARGE INFLATION SURGE EPISODES: EMERGING AND DEVELOPED ECONOMIES



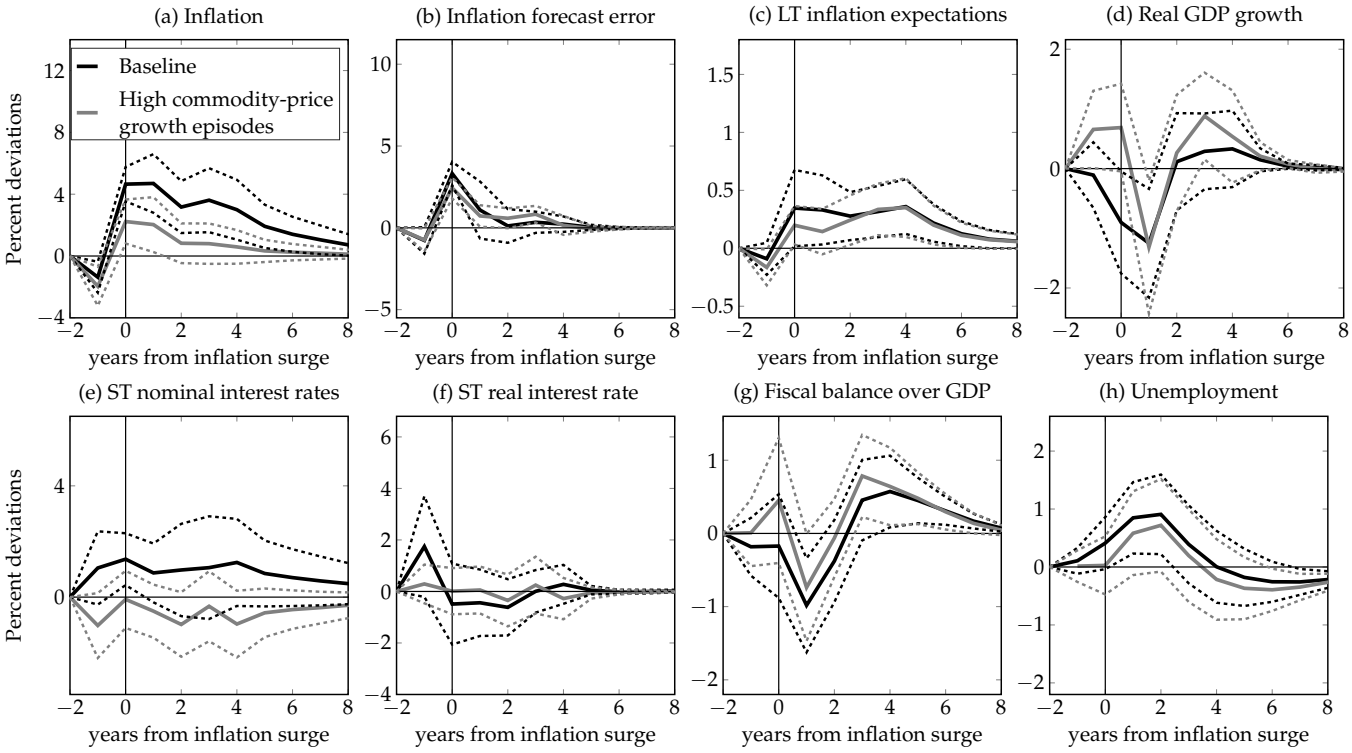
Notes: These figures show the estimated dynamics of various variables during large inflation surges, computed using the estimated coefficients from (1), with the recursive expression (2). The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 0$). All variables are expressed in percent. Panel (a) shows the dynamics of the annual CPI inflation; panel (b) that of the inflation 1-year-ahead forecast error, defined as the difference between realized inflation and its previous year's average 1-year-ahead forecast; panel (c) that of the average 5y5y-forward inflation forecast; panel (d) that of real GDP growth; panel (e) that of the nominal short-term annual interest rate; panel (f) that of the real short-term annual interest rate, computed using data on 1-year-ahead inflation expectations; panel (g) that of the fiscal balance/GDP; and panel (h) that of the unemployment rate. All variables are expressed in percent. Dotted lines report 90% error bands, computed using the Delta method. *Baseline* refers to the main results presented in Section 3; *EM* and *DM* refer, respectively, to the results estimating the empirical model only for the set of emerging and developed economies in our sample. For more details on the criteria used to identify episodes, variable definitions, and data sources, see Section 2.

FIGURE B10. DYNAMICS FOLLOWING LARGE INFLATION SURGE EPISODES: HOMOGENEOUS DATA SAMPLE



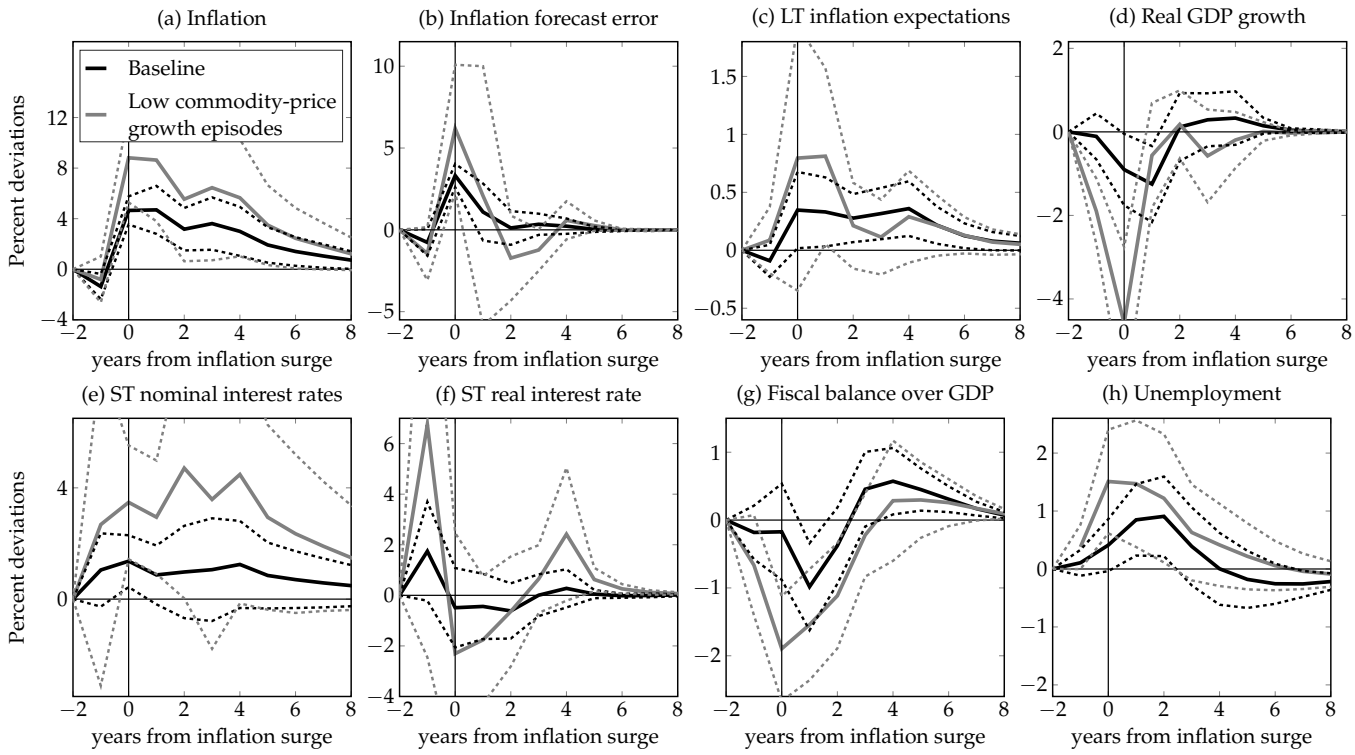
Notes: These figures show the estimated dynamics of various variables during large inflation surges, computed using the estimated coefficients from (1), with the recursive expression (2). The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 0$). Panel (a) shows the dynamics of the annual CPI inflation; panel (b) that of the inflation 1-year-ahead forecast error, defined as the difference between realized inflation and its previous year's average 1-year-ahead forecast; panel (c) that of the average 5y5y-forward inflation forecast; panel (d) that of real GDP growth; panel (e) that of the nominal short-term annual interest rate; panel (f) that of the real short-term annual interest rate, computed using data on 1-year-ahead inflation expectations; panel (g) that of the fiscal balance/GDP; and panel (h) that of the unemployment rate. All variables are expressed in percent. Dotted lines report 90% error bands, computed using the Delta method. *Baseline* refers to the main results presented in Section 3, which includes all available data for each variable; *Homogeneous sample* refers to results restricting the estimation sample to periods with Consensus Economics data available. For more details on the criteria used to identify episodes, variable definitions, and data sources, see Section 2.

FIGURE B11. DYNAMICS FOLLOWING LARGE INFLATION SURGE EPISODES: HIGH COMMODITY-PRICE GROWTH EPISODES



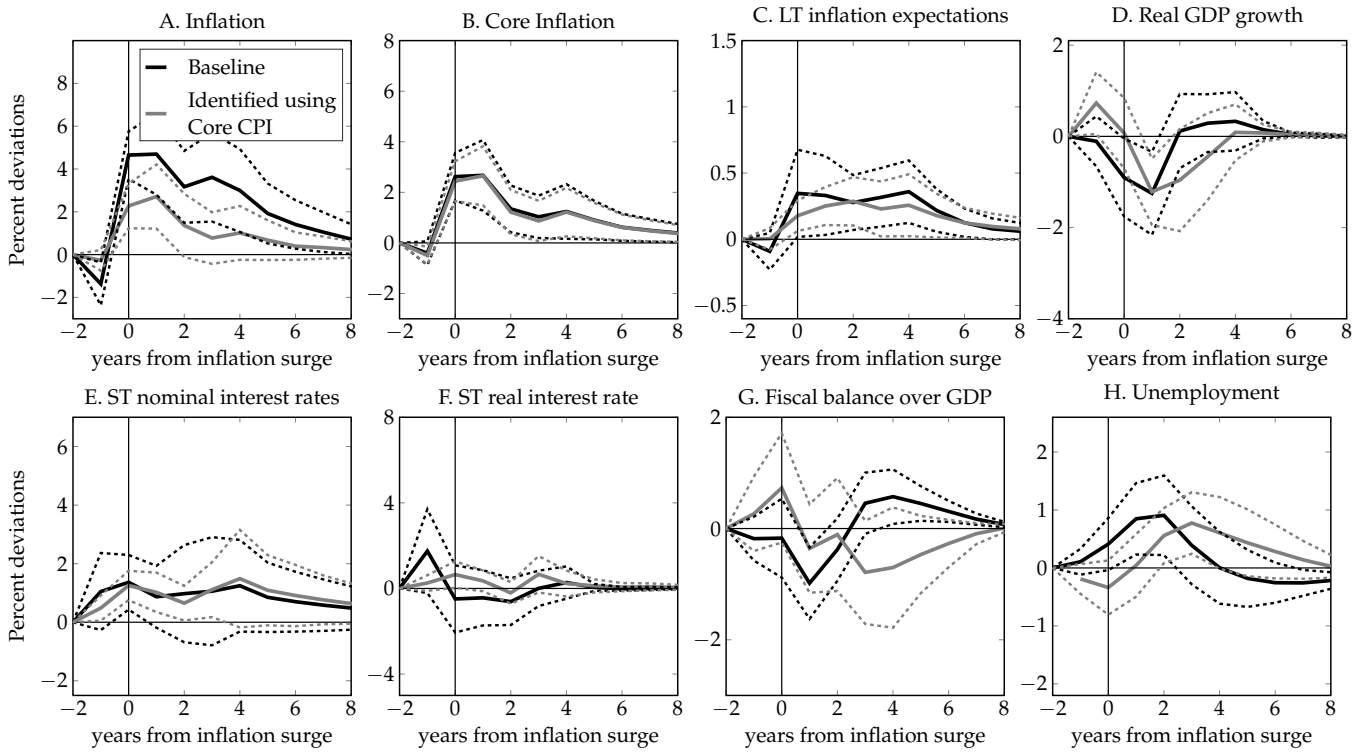
Notes: These figures show the estimated dynamics of various variables during large inflation surges, computed using the estimated coefficients from (1), with the recursive expression (2). The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 0$). Panel (a) shows the dynamics of the annual CPI inflation; panel (b) that of the inflation 1-year-ahead forecast error, defined as the difference between realized inflation and its previous year's average 1-year-ahead forecast; panel (c) that of the average 5y5y-forward inflation forecast; panel (d) that of real GDP growth; panel (e) that of the nominal short-term annual interest rate; panel (f) that of the real short-term annual interest rate, computed using data on 1-year-ahead inflation expectations; panel (g) that of the fiscal balance/GDP; and panel (h) that of the unemployment rate. All variables are expressed in percent. Dotted lines report 90% error bands, computed using the Delta method. *Baseline* refers to the main results presented in Section 3; *High commodity-price growth* refers to results that estimate the empirical model for the subset of episodes featuring an increase in global commodity prices at the beginning of the inflation surge ($t = 0$) above their historical mean. See Table A5 for details of these episodes. For more details on the criteria used to identify episodes, variable definitions, and data sources, see Section 2.

FIGURE B12. DYNAMICS FOLLOWING LARGE INFLATION SURGE EPISODES: LOW COMMODITY-PRICE GROWTH EPISODES



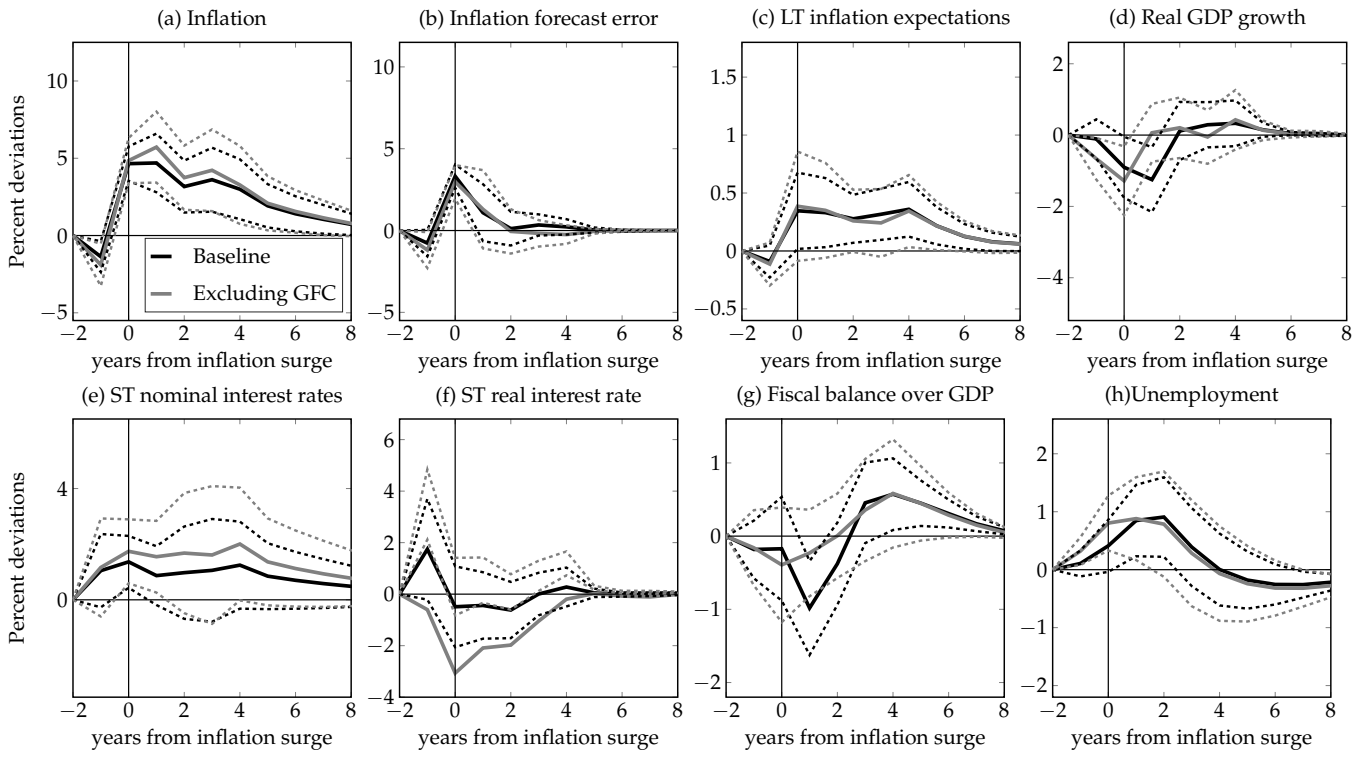
Notes: These figures show the estimated dynamics of various variables during large inflation surges, computed using the estimated coefficients from (1), with the recursive expression (2). The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 0$). Panel (a) shows the dynamics of the annual CPI inflation; panel (b) that of the inflation 1-year-ahead forecast error, defined as the difference between realized inflation and its previous year's average 1-year-ahead forecast; panel (c) that of the average 5y5y-forward inflation forecast; panel (d) that of real GDP growth; panel (e) that of the nominal short-term annual interest rate; panel (f) that of the real short-term annual interest rate, computed using data on 1-year-ahead inflation expectations; panel (g) that of the fiscal balance/GDP; and panel (h) that of the unemployment rate. All variables are expressed in percent. Dotted lines report 90% error bands, computed using the Delta method. *Baseline* refers to the main results presented in Section 3; *Low commodity-price growth* refers to results that estimate the empirical model for the subset of episodes featuring an increase in global commodity prices at the beginning of the inflation surge ($t = 0$) below their historical mean. See Table A6 for details of these episodes. For more details on the criteria used to identify episodes, variable definitions, and data sources, see Section 2.

FIGURE B13. DYNAMICS FOLLOWING LARGE INFLATION SURGE EPISODES IDENTIFIED USING CORE INFLATION



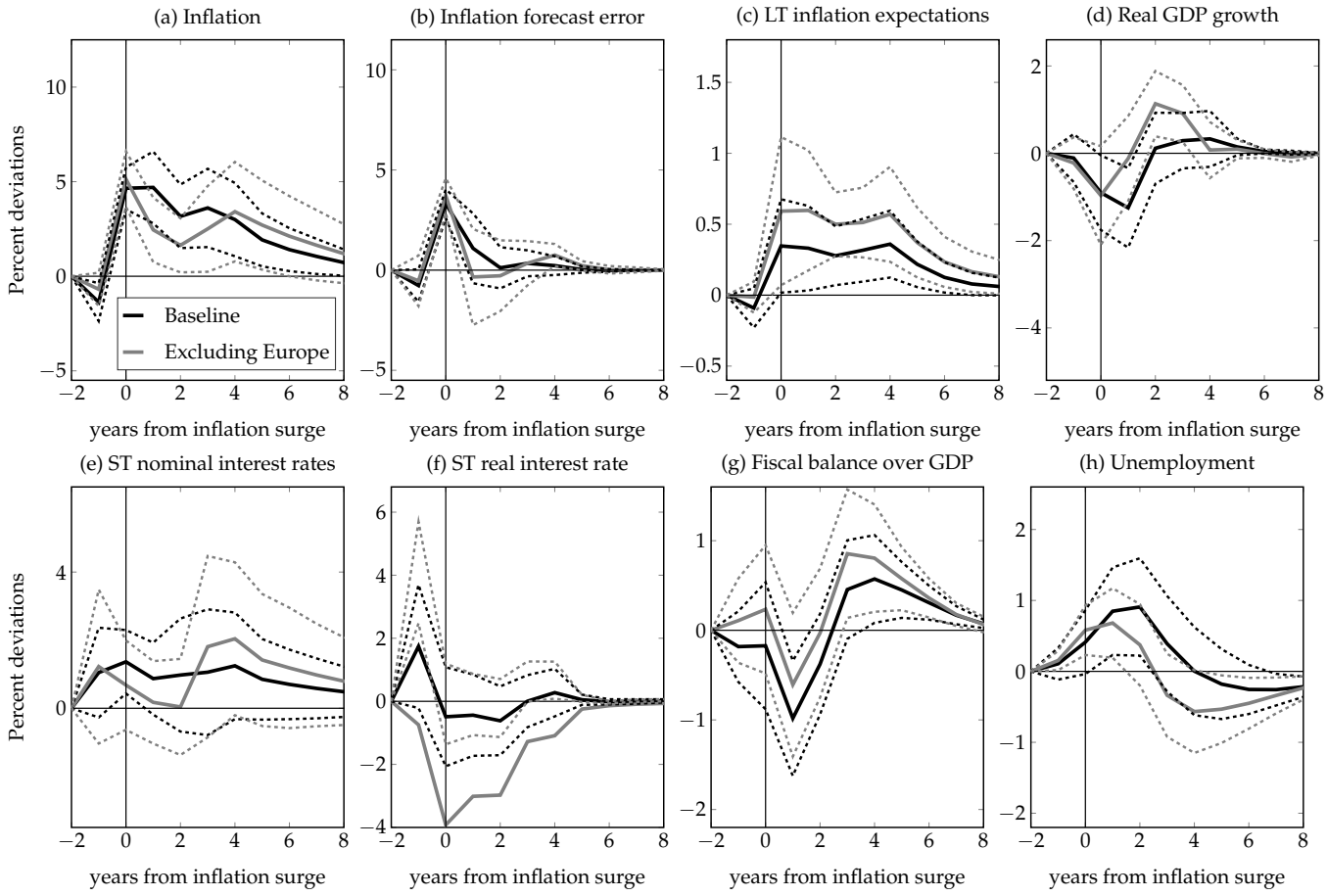
Notes: These figures show the estimated dynamics of various variables during large inflation surges, computed using the estimated coefficients from (1), with the recursive expression (2). The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 0$). Panel (a) shows the dynamics of the annual CPI inflation; panel (b) that of the inflation 1-year-ahead forecast error, defined as the difference between realized inflation and its previous year's average 1-year-ahead forecast; panel (c) that of the average 5y5y-forward inflation forecast; panel (d) that of real GDP growth; panel (e) that of the nominal short-term annual interest rate; panel (f) that of the real short-term annual interest rate, computed using data on 1-year-ahead inflation expectations; panel (g) that of the fiscal balance/GDP; and panel (h) that of the unemployment rate. All variables are expressed in percent. Dotted lines report 90% error bands, computed using the Delta method. *Baseline* refers to the main results presented in Section 3; *Identified using Core CPI* refers to results identifying large inflation surge episodes using core inflation. For more details on the criteria used to identify episodes, variable definitions, and data sources, see Section 2.

FIGURE B14. DYNAMICS FOLLOWING LARGE INFLATION SURGES EXCLUDING EPISODES DURING THE GLOBAL FINANCIAL CRISIS



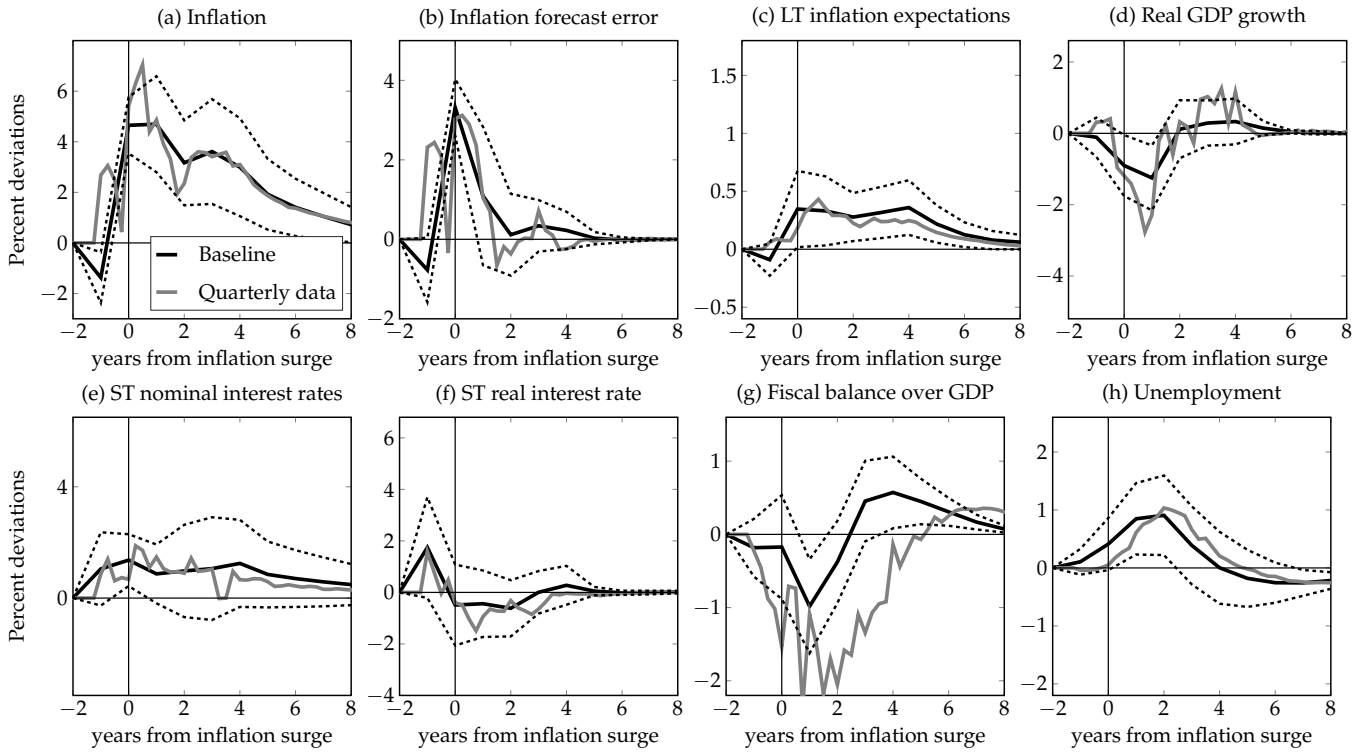
Notes: These figures show the estimated dynamics of various variables during large inflation surges, computed using the estimated coefficients from (1), with the recursive expression (2). The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 0$). Panel (a) shows the dynamics of the annual CPI inflation; panel (b) that of the inflation 1-year-ahead forecast error, defined as the difference between realized inflation and its previous year's average 1-year-ahead forecast; panel (c) that of the average 5y5y-forward inflation forecast; panel (d) that of real GDP growth; panel (e) that of the nominal short-term annual interest rate; panel (f) that of the real short-term annual interest rate, computed using data on 1-year-ahead inflation expectations; panel (g) that of the fiscal balance/GDP; and panel (h) that of the unemployment rate. All variables are expressed in percent. Dotted lines report 90% error bands, computed using the Delta method. *Baseline* refers to the main results presented in Section 3; *Excluding GFC* refers to results that estimate the empirical model excluding inflation surges that occurred during the global financial crisis (i.e., which started between 2007 and 2009). For more details on the criteria used to identify episodes, variable definitions, and data sources, see Section 2.

FIGURE B15. DYNAMICS FOLLOWING LARGE INFLATION SURGE EPISODES EXCLUDING EUROPEAN ECONOMIES



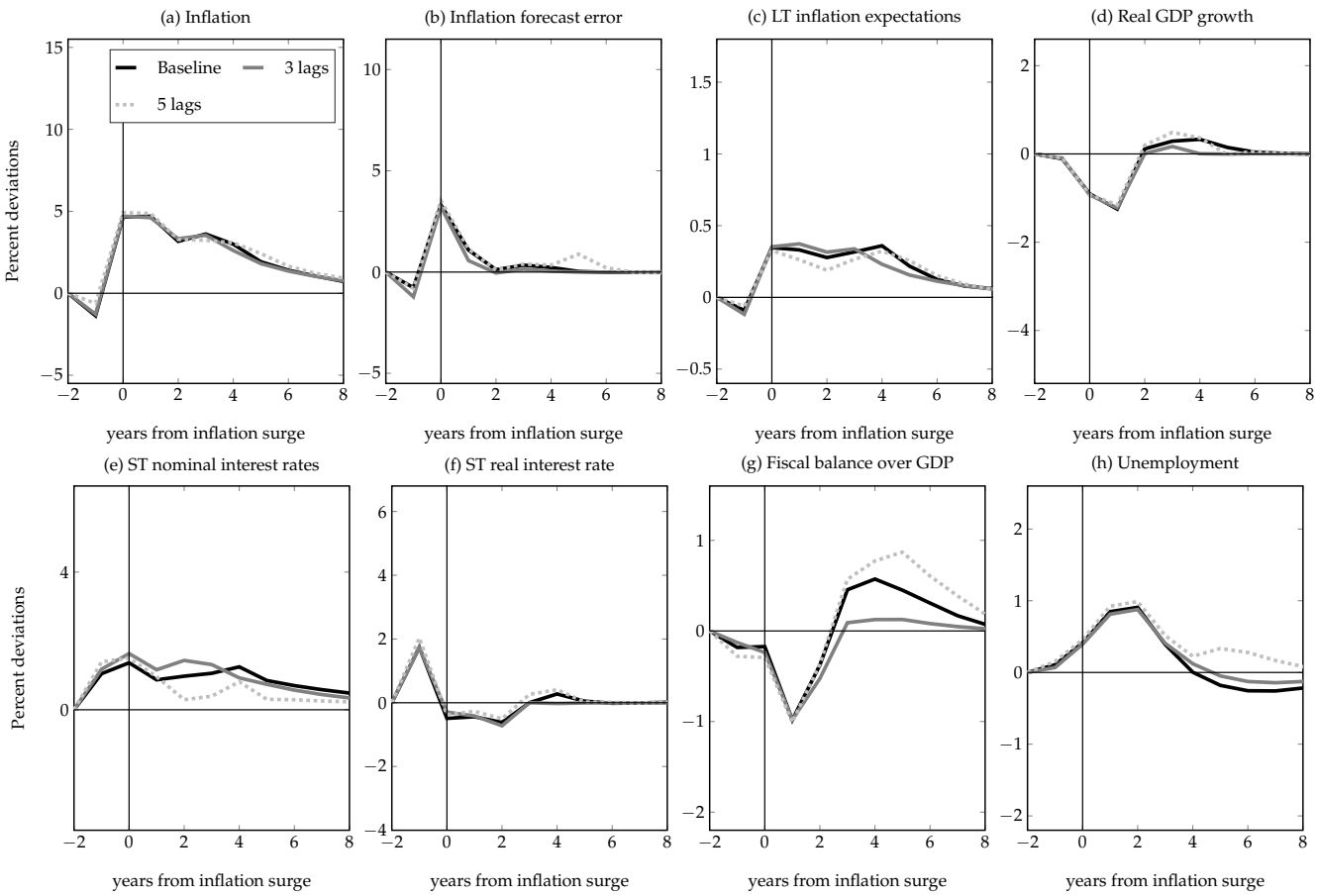
Notes: These figures show the estimated dynamics of various variables during large inflation surges, computed using the estimated coefficients from (1), with the recursive expression (2). The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 0$). Panel (a) shows the dynamics of the annual CPI inflation; panel (b) that of the inflation 1-year-ahead forecast error, defined as the difference between realized inflation and its previous year's average 1-year-ahead forecast; panel (c) that of the average 5y5y-forward inflation forecast; panel (d) that of real GDP growth; panel (e) that of the nominal short-term annual interest rate; panel (f) that of the real short-term annual interest rate, computed using data on 1-year-ahead inflation expectations; panel (g) that of the fiscal balance/GDP; and panel (h) that of the unemployment rate. All variables are expressed in percent. Dotted lines report 90% error bands, computed using the Delta method. *Baseline* refers to the main results presented in Section 3; *Excluding Europe* refers to results that estimate the empirical model excluding European economies. For more details on the criteria used to identify episodes, variable definitions, and data sources, see Section 2.

FIGURE B16. DYNAMICS FOLLOWING LARGE INFLATION SURGE EPISODES: QUARTERLY AND ANNUAL DATA



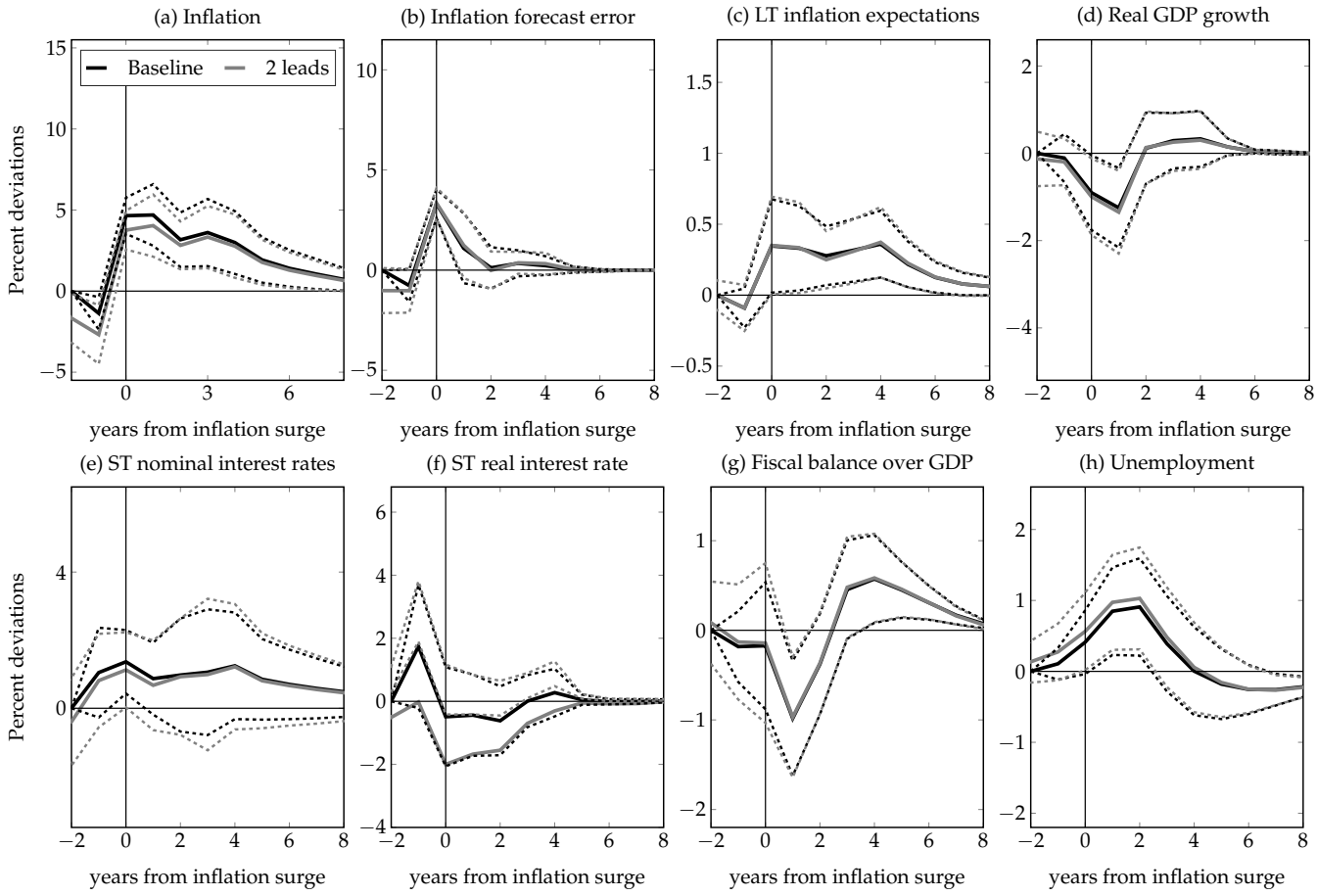
Notes: These figures show the estimated dynamics of various variables during large inflation surges, computed using the estimated coefficients from (1), with the recursive expression (2). The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 0$). Panel (a) shows the dynamics of the annual CPI inflation; panel (b) that of the inflation 1-year-ahead forecast error, defined as the difference between realized inflation and its previous year's average 1-year-ahead forecast; panel (c) that of the average 5y5y-forward inflation forecast; panel (d) that of real GDP growth; panel (e) that of the nominal short-term annual interest rate; panel (f) that of the real short-term annual interest rate, computed using data on 1-year-ahead inflation expectations; panel (g) that of the fiscal balance/GDP; and panel (h) that of the unemployment rate. All variables are expressed in percent. Dotted lines report 90% error bands, computed using the Delta method. *Baseline* refers to the main results presented in Section 3, using annual data; *Quarterly data* refers to results estimating the model using quarterly data. For more details on the criteria used to identify episodes, variable definitions, and data sources, see Section 2.

FIGURE B17. DYNAMICS FOLLOWING LARGE INFLATION SURGE EPISODES UNDER ALTERNATIVE LAG STRUCTURES



Notes: These figures show the estimated dynamics of various variables during large inflation surges, computed using the estimated coefficients from (1), with the recursive expression (2). The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 0$). Panel (a) shows the dynamics of the annual CPI inflation; panel (b) that of the inflation 1-year-ahead forecast error, defined as the difference between realized inflation and its previous year's average 1-year-ahead forecast; panel (c) that of the average 5y5y-forward inflation forecast; panel (d) that of real GDP growth; panel (e) that of the nominal short-term annual interest rate; panel (f) that of the real short-term annual interest rate, computed using data on 1-year-ahead inflation expectations; panel (g) that of the fiscal balance/GDP; and panel (h) that of the unemployment rate. All variables are expressed in percent. Dotted lines report 90% error bands, computed using the Delta method. *Baseline* refers to the main results presented in Section 3, from estimating (1) with $J = K_2 = 4$; *3 lags* and *5 lags* refer, respectively, to results from estimating (1) with $J = K_2 = 3$ and $J = K_2 = 5$. For more details on the criteria used to identify episodes, variable definitions, and data sources, see Section 2.

FIGURE B18. DYNAMICS FOLLOWING LARGE INFLATION SURGE EPISODES UNDER ALTERNATIVE LEAD STRUCTURES



Notes: These figures show the estimated dynamics of various variables during large inflation surges, computed using the estimated coefficients from (1), with the recursive expression (2). The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 0$). Panel (a) shows the dynamics of the annual CPI inflation; panel (b) that of the inflation 1-year-ahead forecast error, defined as the difference between realized inflation and its previous year's average 1-year-ahead forecast; panel (c) that of the average 5y5y-forward inflation forecast; panel (d) that of real GDP growth; panel (e) that of the nominal short-term annual interest rate; panel (f) that of the real short-term annual interest rate, computed using data on 1-year-ahead inflation expectations; panel (g) that of the fiscal balance/GDP; and panel (h) that of the unemployment rate. All variables are expressed in percent. Dotted lines report 90% error bands, computed using the Delta method. *Baseline* refers to the main results presented in Section 3, from estimating (1) with $K_1 = 1$; *2 leads* refer to results from estimating (1) with $K_1 = 2$. For more details on the criteria used to identify episodes, variable definitions, and data sources, see Section 2.

C Theoretical Framework

The purpose of this section is to provide an economic environment in which optimal monetary policy implies a reduction of the real nominal rate during inflation surges. We use the standard New Keynesian model (see Gali, 2015) to show that if the monetary authority lacks commitment and has large welfare losses from output-gap fluctuations, then the real interest rate decreases following cost-push shocks. The model reproduces the joint dynamics of inflation, output, and nominal and real interest rates.

Environment. The model is a two-equation standard New Keynesian model. The environment features a representative agent and a continuum of firms denoted by $i \in [0, 1]$. The household has preferences over consumption C and labor N

$$\mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\log(C_t) - \frac{N_t^{1+\varphi}}{1+\varphi} \right) \right]$$

where β is the discount factor. Aggregate consumption consists of a Dixit-Stiglitz aggregator across the goods produced by each firm with the elasticity of substitution ϵ. On the production side, there is a continuum of firms that operate in monopolistic competitive markets. Each firm chooses its prices with a Calvo-style price adjustment constraint where $1 - \theta$ of firms are allowed to adjust prices each period. Firms produce output y with labor l using a decreasing-returns-to-scale production technology $y_{it} = l_{it}^{1-\alpha}$. There is a subsidy $1 + \tau = \frac{\epsilon}{\epsilon - 1}$ on firms' revenue.

The equilibrium conditions, log-linearized around zero inflation, are

$$\tilde{y}_t = \mathbb{E}_t \left[\tilde{y}_{t+1} \right] - (i_t - \mathbb{E}[\pi_{t+1}] - r^n), \tag{C.1}$$

$$\tilde{\pi}_t = \kappa \tilde{y}_t + \beta \mathbb{E}_t \left[\tilde{\pi}_{t+1} \right], \tag{C.2}$$

where $\tilde{y}_t$ denotes the output gap–i.e. the log difference between the actual output and the hypothetical output without friction in price adjustment. r^n is the natural interest rate (see Goodfriend and King, 1997). Inflation is denoted by $\tilde{\pi}_t$. Finally, κ depends on the frequency of

price adjustment and strategic complementarities due to decreasing returns to scale

$$\kappa = \frac{(1-\theta)(1-\beta\theta)}{\theta}\frac{1+\varphi+\alpha}{1-\alpha+\alpha\epsilon}.$$

Equation (C.1) is the Euler equation and Equation (C.2) is the Phillips curve. Following Woodford (2011), we evaluate economic outcomes using a quadratic loss function

$$-\frac{1}{2}\mathbb{E}_0\left[\sum_{t=0}^{\infty}\beta^t\left(\tilde{\pi}_t^2+\Psi\tilde{y}_t^2\right)\right],$$

where γ is the cost of output gap volatility relative to inflation volatility. Finally, we assume an exogenous labor wedge η_t–i.e. a wedge between the marginal rate of substitution between consumption and leisure and the marginal product of labor, which translates to a cost-push shock in the Phillips curve

$$\tilde{\pi}_t = \kappa\tilde{y}_t + \beta\mathbb{E}_t\left[\tilde{\pi}_{t+1}\right] + \eta_t,$$

where η_t following an AR(1) process with persistence ρ and innovations σ

$$\eta = \rho\eta_{t-1} + \sigma\xi_t.$$

Optimal monetary policy without commitment. We study the optimal monetary policy without commitment in the presence of cost-push shocks, where the central bank is benevolent but cannot credibly announce plans for the future. We describe the central bank using dynamic programming. Let $V(\eta)$ be the present discounted value of the optimal policy under commitment. Given an inflation function $\Pi(\eta)$ and output gap function $Y(\eta)$, the central bank's problem is

$$V(\eta) = \max_{\tilde{\pi},\tilde{y},i} -\frac{1}{2}\left(\tilde{\pi}^2+\Psi\tilde{y}^2\right) + \beta\mathbb{E}_{\eta'}\left[V(\eta')|\eta\right] \tag{C.3}$$

subject to (C.1) and (C.2)

$$\begin{aligned}\pi &= \kappa\tilde{y} + \beta\mathbb{E}_{\eta'}\left[\Pi(\eta')|\eta\right] + \eta,\\ \tilde{y} &= \mathbb{E}_{\eta'}\left[Y(\eta')|\eta\right] - (i - \mathbb{E}_{\eta'}\left[\Pi(\eta')|\eta\right] - r^n).\end{aligned}$$

Since the central bank chooses the interest rate, we can discard the interest rate as a control variable in (C.3) along with the Euler equation. Thus, the central bank's problem is given by

$$V(\eta) = \max_{\tilde{\pi},\tilde{y}} -\frac{1}{2}\left(\tilde{\pi}^2 + \Psi\tilde{y}^2\right) + \beta\mathbb{E}_{\eta'}\left[V(\eta')|\eta\right], \text{ s.t. } \pi = \kappa\tilde{y} + \beta\mathbb{E}_{\eta'}\left[\Pi(\eta')|\eta\right] + \eta \quad \text{(C.4)}$$

With the central bank problem (C.4), we can define a recursive equilibrium with no commitment. *A recursive equilibrium with no commitment is a set of policy functions* $\tilde{\pi}(\eta)$, $\tilde{y}(\eta)$, $\Pi(\eta)$, *and a value function* $V(\eta)$ *such that: (i) Given* $\Pi(\eta)$, $V(\eta)$ *is the solution of* (C.4) *with optimal policy* $\tilde{\pi}(\eta)$, $\tilde{y}(\eta)$ *and (ii) rational expectations holds, i.e.,* $\Pi(\eta) = \pi(\eta)$.

From the optimality condition in (C.4), we have that

$$\begin{aligned}\tilde{y}(\eta) &= -\frac{\kappa}{\Psi}\tilde{\pi}(\eta), \\ \tilde{\pi}(\eta) &= \frac{\Psi\beta}{\Psi+\kappa^2}\mathbb{E}_{\eta'}\left[\tilde{\pi}(\eta')|\eta\right] + \frac{\Psi}{\Psi+\kappa^2}\eta.\end{aligned} \quad \text{(C.5)}$$

Using the law of motion for the cost-push shock $\mathbb{E}_{\eta'}[\eta'|\eta] = \rho\eta$, and a linear guess and verify, we have that

$$\tilde{y}(\eta) = -\frac{\kappa}{\kappa^2 + \Psi(1-\beta\rho)}\eta, \quad \text{(C.6)}$$

$$\tilde{\pi}(\eta) = \frac{\Psi}{\kappa^2 + \Psi(1-\beta\rho)}\eta. \quad \text{(C.7)}$$

Equations (C.6) and (C.7) describe the economic trade-offs following a cost-push shock. To understand this trade-off, let us start with a myopic agent or i.i.d. cost-push shocks, i.e., $\beta = 0$ or $\rho = 0$. In this case, after a positive cost-push shock, the central bank will accommodate the interest rate to increase inflation by a proportion of $\frac{\Psi}{\kappa^2+\Psi}$ of the shock and decrease the output gap by a proportion $\frac{\kappa}{\kappa^2+\Psi}$ of the shock. Intuitively, if the cost of inefficient business cycles is high enough—i.e., a high Ψ—then most of the cost-push shock increases inflation, i.e., $\lim_{\Psi\to\infty}(\frac{\Psi}{\kappa^2+\Psi}, \frac{\kappa}{\kappa^2+\Psi}) = (1, 0)$. When $\beta > 0$ and $\rho > 0$, the forward-looking Phillips curve implies a larger elasticity of inflation and output gap with respect to the shock but a similar economic mechanism between inflation and output gap.

Before studying the implementation of the optimal plan without commitment, it is useful to

see the real interest rate following a cost-push shock. From the Euler equation (C.1), we find that the real interest rate is given by

$$i(\eta) - \mathbb{E}_{\eta'}[\tilde{\pi}(\eta')|\eta] = r^n + \mathbb{E}_{\eta'}[\tilde{y}(\eta)|\eta] - \tilde{y}(\eta) = r^n + \frac{\kappa(1-\rho)}{\kappa^2 + \Psi(1-\beta\rho)}\eta.$$

Observe that if the cost of output gap fluctuations is large relative to inflation or the slope of the Phillips curve is small enough, there is a weak response of the real interest rate following the cost-push shock. The joint dynamics of inflation, the output gap, and real interest rate reproduce our main empirical finding during inflation surges qualitatively when Ψ is large enough.

"Fear of Tightening." With the previous analysis, we are ready to apply the theory to our empirical analysis of inflation surges. From the Euler equation, the optimality condition (C.5), and the fact that $\mathbb{E}_t[\pi_{t+1}] = \pi_t$ and $\mathbb{E}_t[\tilde{y}_{t+1}] = \tilde{y}_t$, we have that

$$\begin{aligned} i_t &= r^n + \mathbb{E}_t[\tilde{y}_{t+1}] - \tilde{y}_t + \mathbb{E}_t[\tilde{\pi}_{t+1}] \\ &= r^n + -\frac{\kappa}{\Psi}\rho\tilde{\pi}_t + \frac{\kappa}{\Psi}\tilde{\pi}(\eta)\tilde{\pi}_t + \rho\pi_t \\ &= r^n + \underbrace{\left((1-\rho)\frac{\kappa}{\Psi} + \rho\right)}_{=\phi_\pi}\pi_t \end{aligned}$$

Observe that the optimal policy without commitment can be implemented with a Taylor rule that depends on (ρ, κ, Ψ).[17] If $\frac{\kappa}{\Psi} < 1$, then the model features "fear of tightening"–i.e. a weak response of interest rates to inflation.

[17] As this policy can depart from the Taylor principle for determinacy, to implement the optimal allocation, the monetary authority could resort to "sophisticated policies" which specify actions outside of the equilibrium path (see Atkeson, Chari and Kehoe, 2010).