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THE DYNAMICS OF LARGE INFLATION SURGES

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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 following surges tends 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 mild 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. Our findings highlight the challenges monetary authorities face in avoiding persistent inflation dynamics following large inflation surges.

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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 policymakers is the possibility that the high inflation rates observed after the surge will be persistent and that long-run inflation expectations "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, 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 55 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 mild but 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. with the beginning of the surge and remain above their pre-surge levels throughout the disinflation phase. Long-term inflation forecast disagreements do not substantially increase following the surge, which shows that the upward shift in long-term inflation expectations is generalized across forecasters.

Fourth, following 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, 2.6 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 only mildly improve relative to their pre-surge levels 3 years after the surge.

Overall, our evidence suggests that, following surges, governments tend to exhibit a "fear of tightening" (in Calvo and Reinhart (2002)'s idiom)—i.e., by not choosing to tighten monetary or fiscal policies in response to large and persistent inflation increases. 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, such as that of the U.S., 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.

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, 2001, Kehoe and Nicolini, 2022). A common theme that emerges from this body of work is the role of expectations in shaping inflation dynamics.

We contribute to this literature by providing direct evidence on 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) and to study inflation anchoring (e.g., Kumar et al., 2015, Carvalho et al., 2022, Reis, 2022b).[1]

Second, our paper is related to the recent literature on the 2021-2022 inflation surge. To date, the 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.

Finally, our paper is related to the literature that documents the response of inflation and aggregate dynamics to policy shocks (e.g., Christiano, Eichenbaum and Evans, 2005, Ramey, 2016, and references therein). In the spirit of this literature, we document facts that can inform models that study large inflation surges and stabilization policies for these episodes.[2]

[1] 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 a general analysis of the pass-through of inflation expectations on current inflation with arbitrary (non-rational) expectations.

[2] In this sense, our paper is also related to the literature that documents aggregate dynamics following large macroeconomic crises, including work on financial crises (e.g., Cerra and Saxena, 2008, Reinhart and Rogoff, 2009); large devaluations (e.g., Burstein, Eichenbaum and Rebelo, 2005); and sudden stops (e.g., Calvo, Izquierdo and Talvi, 2006).

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, a leading organization that 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. For these variables, we have an unbalanced panel from 1990 to 2019 that contains 55 countries.[3] Using the classification from Uribe and Schmitt-Grohé (2017), our sample of countries features 23 developed-market economies (DMs) and 32 emerging-market economies (EMs).

The macroeconomic data include CPI inflation, real GDP, and unemployment rate 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, detailed in Appendix Table A.1.

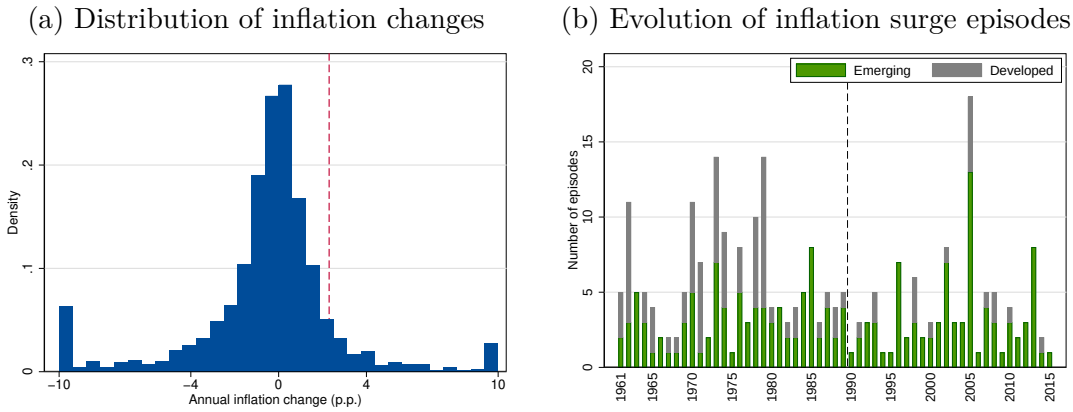
2.2. Episodes studied

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

[3]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, Thailand, Turkey, Ukraine, the United Kingdom, and the United States.

episodes that involve inflation increases in the right tail of their distribution, 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 2.1 p.p. We identify 112 non-overlapping episodes since 1990, detailed in Table A.2. Table 1 reports that these episodes are characterized by a median 3.8 p.p. inflation increase in the first year of the surge episode, from a median inflation level of 3.7% before the surge.

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 red 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. For data sources, see Section 2. The vertical black dotted line marks the year 1990, which is the focus of our analysis in Section 3 because of data availability on inflation expectations.

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 156 non-overlapping episodes, detailed in Appendix Table A.3. Panel (b) of Figure 1 shows the historical evolution of these episodes, with the 1970s exhibiting the most significant number of surges, including the well-studied "Great Inflation." In the post-1990 period, there was a spike of episodes in 2008 in the context of the Global Financial Crisis.

Our empirical analysis also considers an alternative definition of large inflation surge

Table 1: Large Inflation Surge Episodes: Descriptive Statistics

	(1)	(2)
Threshold-defining episodes	Absolute	Relative
Number of episodes	112	53
Median pre-surge inflation level	3.7%	2.4%
Median initial inflation increase during surge	3.8 p.p.	2.7 p.p.
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. Column (1) shows descriptive statistics for the baseline set of episodes, identified with the "absolute criterion" (i.e., those in which annual inflation increases above 2.1 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 A.2 and A.4 detail the set of episodes in each set.

episodes based on country-period-specific thresholds to account for the fact that countries and periods 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.[4] With this "relative criterion," we identify 53 non-overlapping episodes since the 1990s that have available data on inflation expectations (detailed in Appendix Table A.4), which we also study in Section 3.

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 (b) of Figure 1, starting in the 1990s, inflation in DMs has become substantially more stable than that of EMs.

[4]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 $t-9$.

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.[5] Our baseline model estimates (1) using data from 1990 to 2019, 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 hyperinflations for some countries in our sample, we estimate (1) and winsorize inflation, inflation expectations, and interest rates for levels above 100%.[6] Using the estimated coefficients $\{\hat{\beta}_j, \hat{\gamma}_k\}$ from (1), we trace the average dynamics of variable y during inflation surge episodes as $\hat{y}_t = \sum_{k=-K_1}^{\min\{t-1,K_2\}} \prod_{j=0}^{\min\{t-2-k,J\}} \hat{\beta}_j \hat{\gamma}_k$, for $t \geq -K_1 + 1$ and with $t = 1$ corresponding to the beginning of the episode.

3. Dynamics Following Large Inflation-surge Episodes

3.1. Inflation dynamics

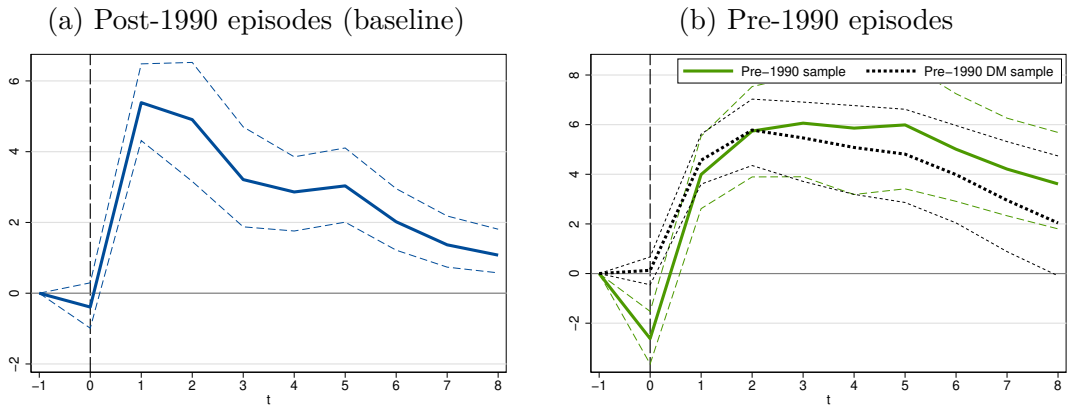
We begin by analyzing the dynamics of inflation following large surge episodes. Panel (a) of Figure 2 shows that inflation tends to exhibit a spike during the first year of the episode (with a 5.4 p.p. average increase) followed by prolonged disinflation. This process tends to

[5] This model 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.

[6] Using the classification of Hanke and Krus (2013), our baseline sample of inflation surge episodes in Table A.2, which starts in 1990, features one hyperinflation episode (Bulgaria in 1997). In addition, some countries in our sample experienced hyperinflations 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).

be faster in the first 2 years following the surge, when inflation declines by more than half its initial increase and is then followed by a 4-year period with inflation rates 1-2 p.p. on average above their pre-surge levels. 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. 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.

Figure 2: Dynamics of Inflation During Large Inflation Surge Episodes



Notes: Dynamics of inflation following large inflation surges, computed as $\hat{\pi}_t = \sum_{k=-1}^{\min\{t-1,4\}} \prod_{j=0}^{\min\{t-2-k,4\}} \hat{\beta}_j \hat{\gamma}_k$ for $t \geq 0$ with the estimated coefficients from the model $\pi_{i,t} = \alpha_i + \sum_{j=0}^{4} \beta_j \pi_{i,t-1-j} + \sum_{k=-1}^{4} \gamma_k D_{i,t-k} + \varepsilon_{it}$, where $\pi_{i,t}$ is the annual CPI inflation in country i and period t; α_i is a country fixed effect; $D_{i,t-s}$ 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. The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 1$). All variables are expressed in percent. Dashed lines report 90% error bands, computed from 1,000 Monte Carlo simulations stratified by country, using the variance-covariance matrix of the estimated coefficients and their asymptotically normal distribution. Panel (a) shows estimates using the post-1990 period. Panel (b) shows estimates for the period 1960-1989; in this panel, the dotted black line restricts the sample to developed market economies (DMs). 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. 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 4.3 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 0.5 p.p. in the year of the surge and reverts to its pre-surge levels 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).

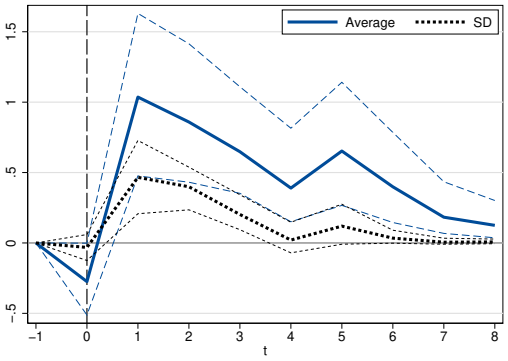
Panel (c) of Figure 3 shows the response of long-term inflation expectations, measured by average 5y5y-forward forecasts. Long-run inflation expectations increase by 0.3 p.p. in the first 2 years of the surge. This increase is persistent, with 5y5y-forward expectations remaining above their pre-crisis level throughout the disinflation phase.[7] 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 re-

[7] 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.

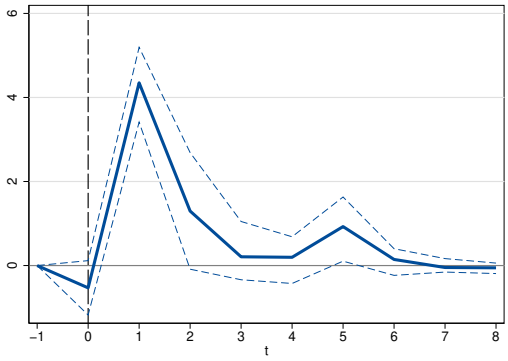
Figure 3: Dynamics of Inflation Expectations During Large Inflation Surge Episodes

Short-term inflation expectations

(a) Mean and SD of 1-year inflation forecasts

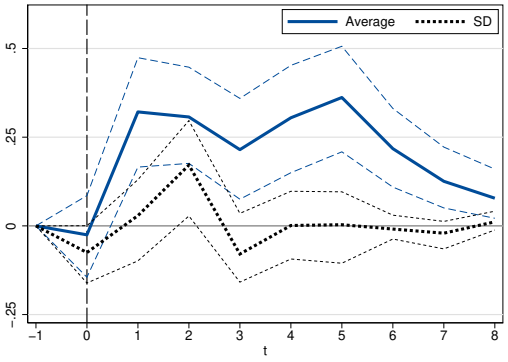


(b) 1-year-ahead inflation forecast errors

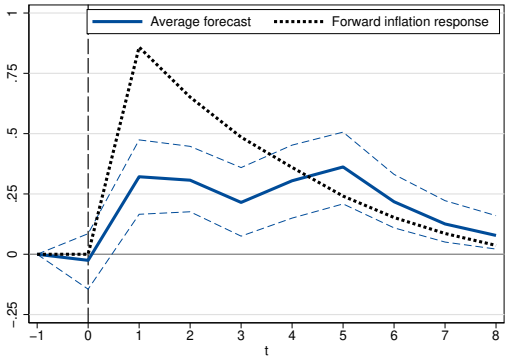


Long-term inflation expectations

(c) Mean and SD of 5y5y inflation forecasts



(d) Mean 5y5y forecasts and inflation response



Notes: Dynamics of inflation expectations following large inflation surges, computed as $\hat{y}_t = \sum_{k=-1}^{\min\{t-1,4\}} \prod_{j=0}^{\min\{t-2-k,4\}} \hat{\beta}_j \hat{\gamma}_k$ for $t \geq 0$ with the estimated coefficients from the model $y_{i,t} = \alpha_i + \sum_{j=0}^{4} \beta_j y_{i,t-1-j} + \sum_{k=-1}^{4} \gamma_k D_{i,t-k} + \varepsilon_{it}$, where $y_{i,t}$ is a variable for country i in period t; α_i is a country fixed effect; $D_{i,t-s}$ 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. The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 1$). All variables are expressed in percent. Panel (a) shows the response 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. Dashed lines report 90% error bands. For variable definitions and data sources, see Section 2.

sponse, followed by a gradual 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 a 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 2.6 p.p. on average following an inflation surge and remain high throughout the disinflation. In spite of these nominal interest rate hikes, real rates—that is, computed 1-year-ahead inflation forecast data—do not increase following the increase in inflation or throughout the disinflation phase.

Panel (b) of Figure 4 shows the response of fiscal balances, revenues, and expenditures, all relative to GDP. Fiscal balances deteriorate by 0.5 p.p. of GDP the year following the inflation surge; this is because expenditure mildly increases and revenues contract following the surge. 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 0.7 p.p. of GDP above its pre-surge levels 4 years after the inflation surge.

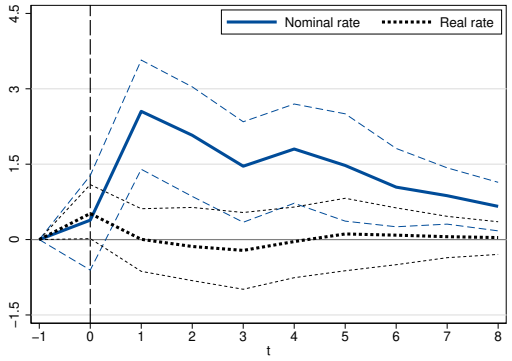
To provide additional context for the monetary and fiscal policies observed following inflation surges, Figure 5 depicts the dynamics of output growth and unemployment during these episodes. Inflation surges tend to occur together with output growth declines and unemployment increases. The latter recovers its pre-surge levels 4 years after the surge, which yields a potential explanation for why governments do not conduct more aggressive monetary and fiscal tightenings immediately after inflation surges.

3.4. Additional results

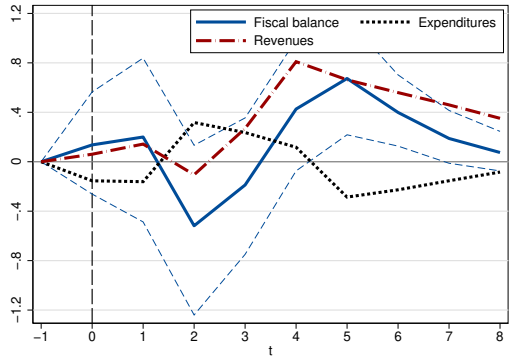
Appendix B shows how the dynamics presented in Sections 3.1-3.3 vary using alternative criteria for identifying large inflation surge episodes and alternative lags and leads structures. Figure B.1 shows the results when we use a higher threshold to identify these episodes (4

Figure 4: Dynamics of Monetary and Fiscal Variables During Large Inflation Surge Episodes

(a) Short-term interest rates



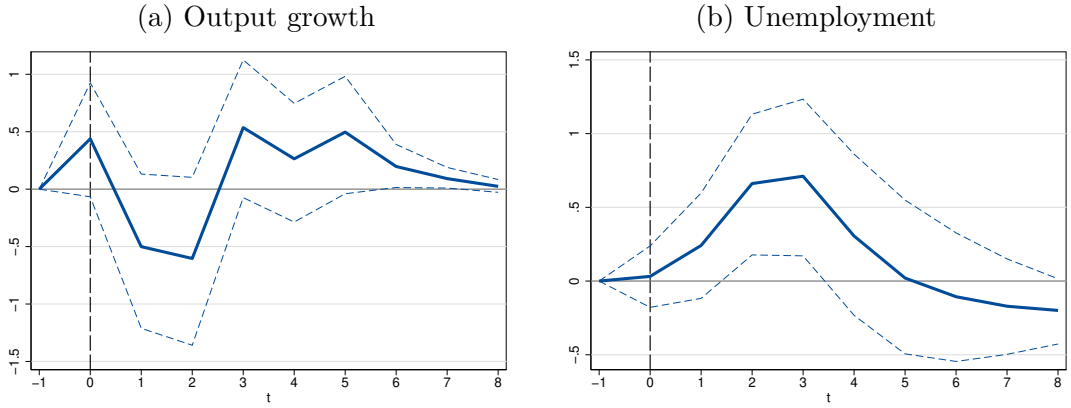
(b) Fiscal balance / GDP



Notes: Dynamics of monetary and fiscal variables following large inflation surges, computed as $\hat{y}_t = \sum_{k=-1}^{\min\{t-1,4\}} \prod_{j=0}^{\min\{t-2-k,4\}} \hat{\beta}_j \hat{\gamma}_k$ for $t \geq 0$ with the estimated coefficients from the model $y_{i,t} = \alpha_i + \sum_{j=0}^{4} \beta_j y_{i,t-1-j} + \sum_{k=-1}^{4} \gamma_k D_{i,t-k} + \varepsilon_{it}$, where $y_{i,t}$ is a variable for country i in period t; α_i is a country fixed effect; $D_{i,t-s}$ 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. Panel (a) shows the response 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. Dashed lines report 90% error bands. For variable definitions and data sources, see Section 2.

p.p. instead of the 2.1 p.p. in our baseline analysis). While the magnitudes of the dynamics during inflation surges are amplified with a higher threshold, the patterns are similar to those of our baseline analysis. Figure B.2 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 again similar to those of our baseline analysis; the main difference is that the relative criterion is associated with an increase of interest rates and fiscal balances prior to the inflation surge. Finally, Figures B.3 and B.4 show similar patterns when we estimate (1) using alternative number of lags and leads.

Figure 5: Dynamics of Economic Activity During Large Inflation Surge Episodes



Notes: Dynamics of economic activity following large inflation surges, computed as $\hat{y}_t = \sum_{k=-1}^{\min\{t-1,4\}} \prod_{j=0}^{\min\{t-2-k,4\}} \hat{\beta}_j \hat{\gamma}_k$ for $t \geq 0$ with the estimated coefficients from the model $y_{i,t} = \alpha_i + \sum_{j=0}^{4} \beta_j y_{i,t-1-j} + \sum_{k=-1}^{4} \gamma_k D_{i,t-k} + \varepsilon_{it}$, where $y_{i,t}$ is a variable for country i in period t; α_i is a country fixed effect; $D_{i,t-s}$ 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. The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 1$). All variables are expressed in percent. In panel (a) the variable $y_{i,t}$ is real GDP and in panel (b) the unemployment rate. Dashed lines report 90% error bands. For variable definitions and data sources, see Section 2.

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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Appendices

A. Additional Tables

Table A.1: Data Sources for Short-term Interest Rates

Variable	Source	Country	Start-End Date
BIS	Policy rate	Argentina, Australia, Brazil, Canada, China, Croatia, Denmark, Hungary, India , Israel, Malaysia, New Zealand Norway, Philippines, Poland, Russia, Saudi Arabia, South Africa, Sweden, Switzerland, Thailand, United Kingdom, United States	1990–2020
IMF	Policy rate	Chile, Hong Kong, Indonesia, Romania, Singapore, Turkey	1990–2020
FRED	Interbank rate	Austria, France, Germany, Greece Italy, Portugal, Spain	1990–2020
	Deposit facility rate	Belgium, Ireland	1999–2020
Bulgarian National Bank	Leonia Plus spliced with base rate	Bulgaria	1992–2020
Central Bank of Colombia	Intervention rate	Colombia	1995–2020
Czech National Bank	2-week repo rate	Czech Republic	1999–2020
Central Bank of Egypt	Discount rate	Egypt	1991-2020
Bank of Estonia	Talibor rate, spliced with ECB Rate	Estonia	1996–2010, 2011-2020
FRED	Interbank rate	Finland	1990–2020
FRED, BIS	Interbank rate, Policy rate	Korea	1991–1998, 1999-2020
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 FRED	Lithuania	2005–2014, 2015-2020
Banxico, BIS	28 days interbank rate slide policy rate	Mexico	1990–1997, 1999–2020
OECD	Short-term rate	Netherlands	1990-2020
Central Bank of Nigeria, IMF	Interbank rate spliced Policy rate	Nigeria	2001-2006, 2007-2020
Central Reserve Bank of Peru	Policy rate	Peru	2003–2020
National Bank of Slovakia, FRED	Basic interest rate spliced with ECB Rate	Slovakia	1993–2008, 2009-2020
Central Bank of Slovenia, FRED	Refinancing rate spliced with ECB rate	Slovenia	2001-2020
Bank of Thailand	Repo rate spliced with basic rate	Thailand	1994–2020
National Bank of Ukraine	Policy rate	Ukraine	1992–2020

Notes: This table shows the data sources for short-term interest rates used in the empirical analysis.

Table A.2: Inflation Surge Episodes in Baseline Sample (post 1990)

Country Name	Year	Country Name	Year	Country Name	Year
Argentina	2002	Indonesia	2001	Philippines	2008
Argentina	2010	Indonesia	2005	Philippines	2018
Argentina	2014	India	1991	Poland	2000
Australia	1995	India	1994	Poland	2004
Australia	2000	India	1998	Poland	2017
Belgium	2008	India	2009	Romania	1996
Bulgaria	1994	India	2020	Romania	2008
Bulgaria	2000	Ireland	2000	Romania	2017
Bulgaria	2004	Ireland	2010	Russian Federation	1998
Bulgaria	2008	Israel	2002	Russian Federation	2008
Bulgaria	2017	Israel	2008	Russian Federation	2015
Brazil	2003	Japan	2014	Saudi Arabia	1991
Brazil	2015	Korea, Rep.	1998	Saudi Arabia	1995
Chile	2008	Lithuania	2008	Saudi Arabia	2008
Chile	2014	Lithuania	2011	Saudi Arabia	2018
China	1992	Lithuania	2017	Singapore	2008
China	2004	Latvia	2004	Singapore	2011
China	2007	Latvia	2007	Slovak Republic	1993
China	2010	Latvia	2011	Slovak Republic	1999
Colombia	2016	Latvia	2017	Slovak Republic	2003
Czech Republic	1993	Mexico	1990	Slovak Republic	2011
Czech Republic	2004	Mexico	1995	Slovenia	2000
Czech Republic	2008	Mexico	2017	Sweden	1990
Egypt, Arab Rep.	1995	Malaysia	1998	Sweden	1993
Egypt, Arab Rep.	2004	Malaysia	2008	Thailand	1998
Egypt, Arab Rep.	2013	Nigeria	1991	Thailand	2008
Egypt, Arab Rep.	2016	Nigeria	2001	Turkey	1991
Estonia	2008	Nigeria	2005	Turkey	1997
Estonia	2017	Nigeria	2008	Turkey	2010
United Kingdom	1990	Nigeria	2016	Turkey	2017
Greece	1990	Norway	2008	Taiwan	2002
Greece	2010	New Zealand	2000	Taiwan	2007
Hong Kong	2004	Peru	2008	Ukraine	1999
Hong Kong	2011	Philippines	1991	Ukraine	2003
Croatia	2008	Philippines	1994	Ukraine	2014
Hungary	1995	Philippines	1998	South Africa	2002
Hungary	2007	Philippines	2004	South Africa	2005
Indonesia	1998				

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 A.3: Inflation Surge Episodes for the period 1960 to 1989

Country Name	Year	Country Name	Year	Country Name	Year
Argentina	1962	Greece	1969	Netherlands	1964
Argentina	1965	Greece	1973	Netherlands	1969
Argentina	1970	Greece	1979	Netherlands	1980
Argentina	1975	Greece	1986	Norway	1962
Argentina	1981	Croatia	1987	Norway	1970
Argentina	1987	Hungary	1979	Norway	1980
Australia	1971	Hungary	1987	New Zealand	1967
Australia	1985	Indonesia	1962	New Zealand	1971
Austria	1980	Indonesia	1973	New Zealand	1974
Austria	1984	Indonesia	1979	New Zealand	1980
Belgium	1974	Indonesia	1983	New Zealand	1985
Bulgaria	1989	Indonesia	1987	Peru	1964
Canada	1973	India	1964	Peru	1968
Canada	1981	India	1970	Peru	1974
Switzerland	1962	India	1977	Peru	1987
Switzerland	1971	India	1983	Philippines	1962
Switzerland	1979	India	1986	Philippines	1970
Chile	1972	Ireland	1961	Philippines	1979
Chile	1983	Ireland	1964	Philippines	1984
Chile	1989	Ireland	1969	Philippines	1987
China	1988	Ireland	1973	Poland	1973
Colombia	1961	Ireland	1979	Poland	1978
Colombia	1966	Israel	1961	Poland	1986
Colombia	1971	Israel	1965	Portugal	1969
Colombia	1985	Israel	1970	Portugal	1981
Denmark	1962	Israel	1977	Portugal	1989
Denmark	1965	Israel	1989	Saudi Arabia	1971
Denmark	1970	Italy	1962	Saudi Arabia	1979
Denmark	1973	Italy	1970	Saudi Arabia	1988
Denmark	1980	Italy	1973	Singapore	1973
Egypt, Arab Rep.	1963	Italy	1979	Singapore	1977
Egypt, Arab Rep.	1969	Japan	1965	Singapore	1980
Egypt, Arab Rep.	1973	Japan	1973	Slovenia	1983
Egypt, Arab Rep.	1977	Japan	1980	Sweden	1962
Egypt, Arab Rep.	1980	Korea, Rep.	1963	Sweden	1970
Egypt, Arab Rep.	1986	Korea, Rep.	1970	Sweden	1974
Egypt, Arab Rep.	1989	Korea, Rep.	1974	Sweden	1980
Spain	1962	Korea, Rep.	1978	Thailand	1961
Spain	1970	Korea, Rep.	1988	Thailand	1966
Spain	1977	Mexico	1973	Thailand	1972
Finland	1962	Mexico	1977	Thailand	1977
Finland	1968	Mexico	1980	Thailand	1980
Finland	1971	Mexico	1986	Turkey	1963
Finland	1980	Malaysia	1963	Turkey	1970
France	1962	Malaysia	1967	Turkey	1974
France	1974	Malaysia	1973	Turkey	1977
France	1980	Malaysia	1980	Turkey	1984
United Kingdom	1961	Nigeria	1964	Turkey	1987
United Kingdom	1971	Nigeria	1974	United States	1973
United Kingdom	1974	Nigeria	1978	United States	1979
United Kingdom	1979	Nigeria	1981	South Africa	1973
Greece	1963	Nigeria	1987	South Africa	1985

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.

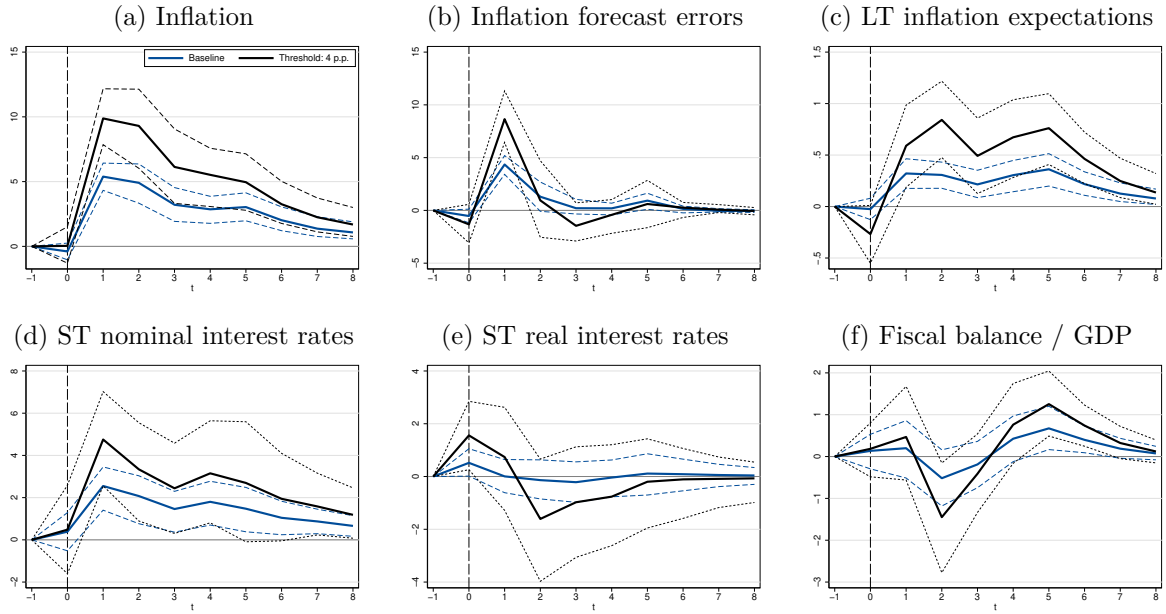
Table A.4: Inflation Surge Episodes Using the Relative Criterion to Identify Episodes

Country Name	Year	Country Name	Year
Argentina	2002	India	1991
Argentina	2014	India	2009
Argentina	2018	Ireland	2000
Austria	2008	Italy	2008
Austria	2011	Japan	2008
Belgium	2005	Japan	2014
Belgium	2008	Lithuania	2008
Brazil	2015	Latvia	2007
Switzerland	2008	Mexico	2017
Chile	2008	Malaysia	1998
China	2007	Malaysia	2008
Colombia	2016	Nigeria	2016
Germany	2007	Netherlands	2001
Denmark	2000	Norway	2008
Denmark	2008	New Zealand	2011
Egypt, Arab Rep.	2008	Russian Federation	2015
Egypt, Arab Rep.	2017	Saudi Arabia	1991
Estonia	2008	Saudi Arabia	2006
Finland	2008	Singapore	2007
France	2008	Sweden	2008
United Kingdom	2008	Thailand	1998
United Kingdom	2011	Turkey	1994
Greece	2010	Turkey	2017
Hong Kong	2008	Taiwan	2007
Hong Konga	2011	Ukraine	2015
Croatia	2008	South Africa	2008
Indonesia	1998		

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.

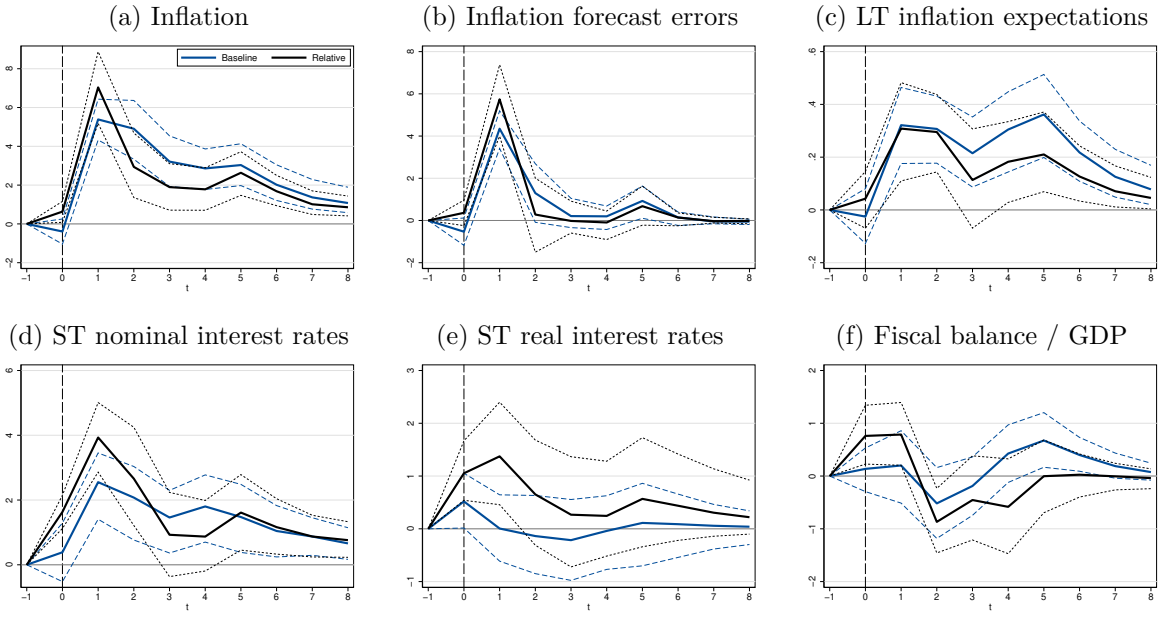
B. Additional Results

Figure B.1: Dynamics Following Large Inflation Surge Episodes Using Alternative Thresholds to Define the Episodes



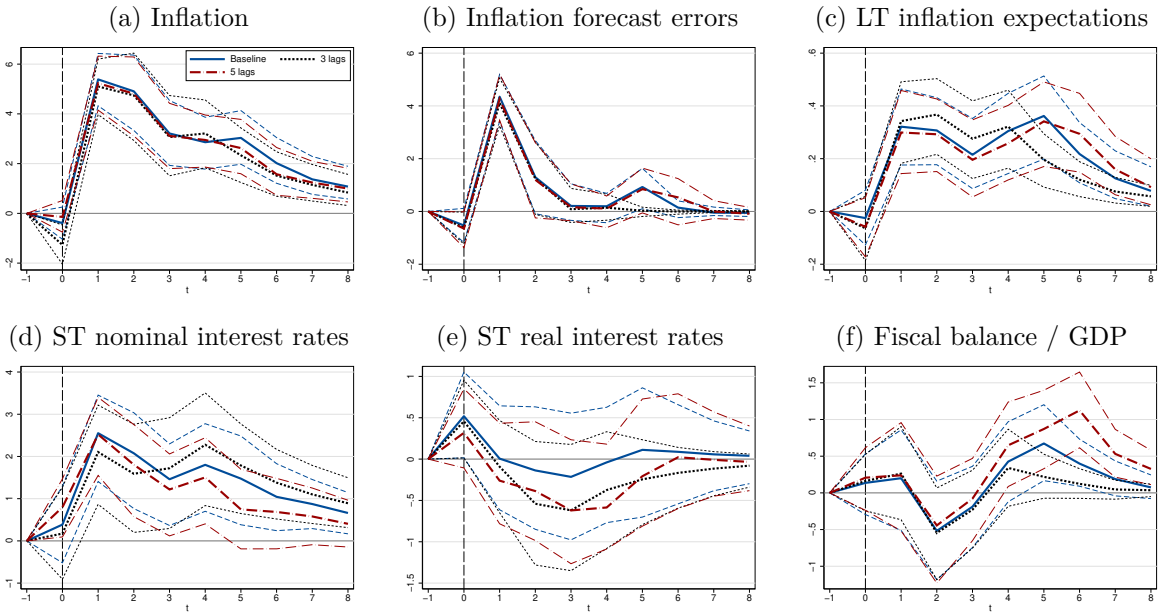
Notes: Dynamics of various variables following large inflation surges using alternative criteria for identifying surge episodes, computed as $\hat{y}_t = \sum_{k=-1}^{\min\{t-1,4\}} \prod_{j=0}^{\min\{t-2-k,4\}} \hat{\beta}_j \hat{\gamma}_k$ for $t \geq 0$ with the estimated coefficients from the model $y_{i,t} = \alpha_i + \sum_{j=0}^{4} \beta_j y_{i,t-1-j} + \sum_{k=-1}^{4} \gamma_k D_{i,t-k} + \varepsilon_{it}$, where $y_{i,t}$ is a variable for country i in period t; α_i is a country fixed effect; $D_{i,t-s}$ 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. The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 1$). All variables are expressed in percent. In panel (a), the variable $y_{i,t}$ is the annual CPI inflation; in panel (b), the inflation 1-year-ahead forecast error, defined as the difference between realized inflation and its previous year's average 1-year-ahead forecast; in panel (c), the average 5y5y-forward inflation forecast; in panel (d), the nominal short-term annual interest rate; in panel (e), the real short-term annual interest rate, computed using data on 1-year-ahead inflation expectations; and in panel (f), the fiscal balance/GDP. Dashed lines report 90% error bands. *Baseline* refers to the main results presented in Section 3, identifying episodes with the "absolute criterion" (i.e., those in which annual inflation increases above 2.1 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.

Figure B.2: Dynamics Following Large Inflation Surge Episodes Using the "Relative Criterion" to Define the Episodes



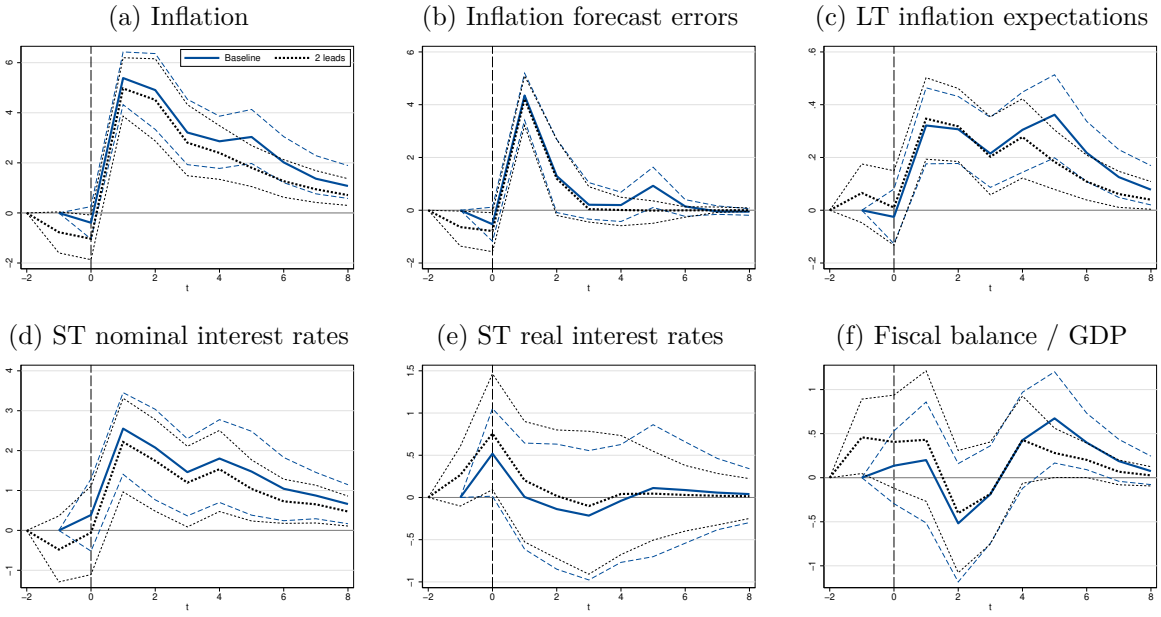
Notes: Dynamics of various variables following large inflation surges using alternative criteria to identify surge episodes, computed as $\hat{y}_t = \sum_{k=-1}^{\min\{t-1,4\}} \prod_{j=0}^{\min\{t-2-k,4\}} \hat{\beta}_j \hat{\gamma}_k$ for $t \geq 0$ with the estimated coefficients from the model $y_{i,t} = \alpha_i + \sum_{j=0}^{4} \beta_j y_{i,t-1-j} + \sum_{k=-1}^{4} \gamma_k D_{i,t-k} + \varepsilon_{it}$, where $y_{i,t}$ is a variable for country i in period t; α_i is a country fixed effect; $D_{i,t-s}$ 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. The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 1$). All variables are expressed in percent. In panel (a), the variable $y_{i,t}$ is the annual CPI inflation; in panel (b), the inflation 1-year-ahead forecast error, defined as the difference between realized inflation and its previous year's average 1-year-ahead forecast; in panel (c), the average 5y5y-forward inflation forecast; in panel (d), the nominal short-term annual interest rate; in panel (e), the real short-term annual interest rate, computed using data on 1-year-ahead inflation expectations; and in panel (f), the fiscal balance/GDP. Dashed lines report 90% error bands. *Baseline* refers to the main results presented in Section 3, identifying episodes with the "absolute criterion" (i.e., those in which annual inflation increases above 2.1 p.p., the 90th percentile of the distribution of inflation changes); *Relative* refers to the results identifying surge episodes 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 the criteria used to identify episodes, variable definitions, and data sources, see Section 2.

Figure B.3: Dynamics Following Large Inflation Surge Episodes Under Alternative Lag Structures



Notes: Dynamics of various variables following large inflation surges, computed as $\hat{y}_t = \sum_{k=-1}^{\min\{t-1,K_2\}} \prod_{j=0}^{\min\{t-2-k,J\}} \hat{\beta}_j \hat{\gamma}_k$ for $t \geq 0$, using alternative number of lags $\{J, K_2\}$, with the estimated coefficients from the model $y_{i,t} = \alpha_i + \sum_{j=0}^{K_2} \beta_j y_{i,t-1-j} + \sum_{k=-1}^{J} \gamma_k D_{i,t-k} + \varepsilon_{it}$, where $y_{i,t}$ is a variable for country i in period t; α_i is a country fixed effect; $D_{i,t-s}$ 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. The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 1$). All variables are expressed in percent. In panel (a), the variable $y_{i,t}$ is the annual CPI inflation; in panel (b), the inflation 1-year-ahead forecast error, defined as the difference between realized inflation and its previous year's average 1-year-ahead forecast; in panel (c), the average 5y5y-forward inflation forecast; in panel (d), the nominal short-term annual interest rate; in panel (e), the real short-term annual interest rate, computed using data on 1-year-ahead inflation expectations; and in panel (f), the fiscal balance/GDP. Dashed lines report 90% error bands. *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 B.4: Dynamics Following Large Inflation Surge Episodes Under Alternative Lead Structures



Notes: Dynamics of various variables following large inflation surges, computed as $\hat{y}_t = \sum_{k=-K_1}^{\min\{t-1,4\}} \prod_{j=0}^{\min\{t-2-k,4\}} \hat{\beta}_j \hat{\gamma}_k$ for $t \geq 0$, using alternative number of leads K_1, with the estimated coefficients from the model $y_{i,t} = \alpha_i + \sum_{j=0}^{4} \beta_j y_{i,t-1-j} + \sum_{k=-K_1}^{4} \gamma_k D_{i,t-k} + \varepsilon_{it}$, where $y_{i,t}$ is a variable for country i in period t; α_i is a country fixed effect; $D_{i,t-s}$ 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. The horizontal axis displays years from the beginning of the inflation surge (represented by $t = 1$). All variables are expressed in percent. In panel (a), the variable $y_{i,t}$ is the annual CPI inflation; in panel (b), the inflation 1-year-ahead forecast error, defined as the difference between realized inflation and its previous year's average 1-year-ahead forecast; in panel (c), the average 5y5y-forward inflation forecast; in panel (d), the nominal short-term annual interest rate; in panel (e), the real short-term annual interest rate, computed using data on 1-year-ahead inflation expectations; and in panel (f), the fiscal balance/GDP. Dashed lines report 90% error bands. *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.