

Understanding the International Rise and Fall of Inflation Since 2020

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This paper analyzes inflation dynamics in 21 advanced and emerging market economies since 2020. We decompose inflation into core inflation as measured by the weighted median inflation rate, and headline shocks—deviations of headline inflation from core. Headline shocks occurred largely on account of energy price changes, although food price changes and indicators of supply chain problems also played a role. We explain the evolution of core inflation with two factors: the strength of macroeconomic conditions—measured by the unemployment gap, the output gap, and the ratio of job vacancies to unemployment—and the pass-through into core inflation from past headline shocks. We conclude that the international rise and fall of inflation since 2020 largely reflected the direct and pass-through effects of headline shocks. Macroeconomic conditions generally played a secondary role. In the United States, disinflation has so far occurred despite substantial estimated price pressures from strong macroeconomic conditions.

Introduction

After three decades of price stability, world inflation surged to unexpectedly high levels in 2021 and 2022, reaching 9.5 percent year-on-year in the third quarter of 2022, up from 4.2 percent a year earlier. The phenomenon was global: inflation in advanced economies rose from 3.5 percent to 7.9 percent over the same period, while in emerging market and developing economies, it rose from 4.9 percent to 10.8 percent.² Even Japan, previously unable to raise inflation, experienced an inflation rate close to 4 percent in the fourth quarter of 2022, up from 0.5 percent a year earlier.

Most policymakers and economists failed to predict the intensity and persistence of this inflation surge and were slow to react. By 2022, inflation had become an acute problem for central bankers. What followed was one of the most synchronized tightening of monetary policy on record. Advanced economies and emerging markets alike raised policy rates. Then, almost as suddenly as it rose, world inflation started to ebb, decreasing to 5.8 percent by the fourth quarter of 2023 on a year-on-year basis. In advanced economies, inflation decreased to 3.1 percent, while in emerging markets and developing economies, the decrease was more modest, to 8.0 percent.

This rise—and subsequent fall—of global inflation has triggered numerous studies on the drivers of inflation, most of which focus on specific countries.³ But the rise and fall of inflation was global and this suggests that a global analysis is needed. In this paper, we examine the behavior of inflation for 21 advanced and emerging market economies.

¹ The views expressed here are those of the authors and do not necessarily represent those of the IMF, its Management and Executive Board, or IMF policy. Ignacio Gallardo and Ziyang Han provided excellent research assistance.

² These rates are PPP-weighted averages based on headline inflation data in the April 2024 IMF *World Economic Outlook* database.

³ A notable exception is the study by Bernanke and Blanchard (2024a) who focus on eleven advanced economies.

Two broad explanations are competing. The first one is that inflation rose at the same time in most countries because they were subjected—to varying degrees—to a similar sequence of shocks: the COVID-19 pandemic, mobility restrictions, and the associated set of economic policy measures—especially the extent of fiscal and monetary support. This explanation emphasizes domestic drivers. More generous fiscal and monetary support, tighter labor markets or less-well anchored inflation expectations would translate into higher inflation.

The second explanation is that inflation rose everywhere at the same time because global causes were at play, not because local shocks were identical across countries. The surge in energy and food prices, rendered especially acute following Russia’s unprovoked invasion of Ukraine, triggered an energy crisis with features similar to that of the oil price shocks of the 1970s, a series of events that were also caused by geopolitical events. The 1970s crises too sparked a sharp increase in global inflation, which lasted well into the following decade. Higher exposure to the surge in oil, gas or food prices would then account for the stronger surge in domestic inflation.

The two explanations are not neatly orthogonal. For instance, global energy prices—which declined precipitously in early 2020 had rebounded to their 2018 peak by August 2021, when worries about a possible invasion of Ukraine by Russia started to surface. They then approximately doubled by August 2022.⁴ The initial rebound may have reflected strong global demand fueled by pandemic-related support programs. Nevertheless, most countries, in isolation, are unable to impact global commodity prices, and hence the question of whether domestic factors or global ones are the main drivers of their inflation trajectories remains valid. That said, the effect of global factors, such as international energy prices, on domestic inflation would also depend on local policies such as administrative price measures and subsidies.

We start with a cross-sectional examination, which we then complement with country-level analysis. In the cross-sectional analysis, we examine the relation between headline and core inflation, and inflation expectations with two variables that feature prominently in discussions of inflation during the pandemic: country-specific energy price inflation and labor market tightness. For each country, we measure the change in a twelve-month specific measure of inflation (headline, core, expectations) between December 2020 and the country-specific peak of headline inflation (“the rise”), and then the change in that measure of inflation from the aforementioned peak to March 2024 (“the fall”). We correlate these changes with measures of the change in energy price inflation and labor market tightness over the same two sub-periods. This allows us to explore the correlation between country-specific drivers of inflation within each episode, and also across the two episodes.

For the country-level analysis, a central feature of our approach is that we decompose headline inflation into core (underlying) inflation, and deviations of headline from core. Building on work by Ball, Leigh, and Mishra (2022) and Dao and others (2023) for the United States and the euro area, respectively, we seek to explain core inflation by long-term inflation expectations and the level of tightness in the labor market, and to explain the non-core component of headline inflation by relative price changes in energy and other industry-specific changes. We also study the pass-through over time from these relative price shocks to core inflation, which can occur through the effects of headline inflation on wages, near-term inflation expectations, and costs of

⁴ Text refers to the International Monetary Fund Global price of energy index.

production. Our measure of core inflation is the weighted median inflation, which systematically strips out the effects of unusually large price changes in certain—possibly time-varying—industries. This variable isolates the core component of inflation more effectively than a more traditional core measure that excludes food and energy prices when, as during the COVID-19 era, volatile shocks also emanated from sectors other than food and energy (see Ball and others 2021).

We begin with a country-level exploration of the empirical drivers of headline inflation shocks, the deviation of headline inflation from core inflation. We find that three factors played a dominant role across the 21 countries we study: energy price inflation, food price inflation, and shipping cost inflation, as measured by the Harper charter rate. Taken together, these three variables account for between 21 percent and 94 percent of the variation in headline inflation shocks, depending on the country, with energy price inflation by far the dominant factor.

Next, we study the behavior of core inflation. We estimate the relationship between the inflation gap, defined as the difference between core inflation and longer-term expected inflation, as a function of macroeconomic slack (measured by the unemployment gap, the output gap, and the ratio of job vacancies to unemployment) and the passthrough of headline inflation shocks into core inflation. Importantly, we allow for nonlinearities, both for the relation with macroeconomic slack and for the relation between headline inflation shocks and core inflation. Recent theoretical work has emphasized the importance of such nonlinearities.⁵

Putting together our estimated results for headline inflation shocks and core inflation, we assess how much of the rise—and subsequent fall—in headline inflation can be attributed to inflation expectations, macroeconomic slack, headline inflation shocks (including those due to energy prices), and the passthrough of headline inflation shocks to core inflation.

We conclude that relative price shocks (notably to the price of energy) and their pass-through into core played a dominant role in driving the inflation movements. Macroeconomic strength and changes in longer-term inflation expectations contributed modestly on average. We also find significant country-specific variation around these results, with, notably, the US disinflation occurring, so far, despite substantial continuing price pressures from strong macroeconomic conditions.

1. The Rise and Fall of Inflation

To set the stage for our empirical analysis, we first document the rise and fall in headline inflation, core inflation, and inflation expectations since 2020.

⁵ See, for example, Benigno and Eggertsson (2023). In earlier work, Ball and Mankiw (1994) theorize that relative price shocks have asymmetric effects on overall inflation in the presence of menu costs and trend inflation.

Figure 1 summarizes the evolution of inflation and inflation expectations, as well as their distribution for 21 countries for which we have both headline and core (weighted median) inflation.⁶ The figure reports the sample median as well as the interquartile range.

For the median economy in the sample, headline inflation rose from 0.7 percent (at a twelve-month rate) in December 2020 to a peak of 8.6 percent in August 2022, before falling to 3.1 percent in March 2024—a sizeable reversion toward the pre-pandemic (2017-2019) median of 2.0 percent. The dispersion of headline inflation across economies, measured by the interquartile range (shaded area) widened as the median level of inflation rose and then narrowed as it receded.

Core inflation moved more moderately than headline inflation for the median economy. It rose from 1.2 percent in December 2020 to a peak of 6.2 percent in February 2023, before falling to 2.8 percent in March 2024.

Short-term (twelve-month-ahead) inflation expectations—which we measure based on forecasts of professional forecasters surveyed by Consensus Economics—moved by even less than headline inflation. They rose from a median of 1.6 percent in December 2020 to a peak of 5.6 percent in August 2022, then declined to 2.9 percent in March 2024.⁷

Longer-term inflation expectations have been broadly stable, with the cross-country median stable at 2.1 percent between December 2020 and March 2024.⁸ This anchoring of longer-term expectations is consistent with the notion that inflation targets have been credible as a result of clear monetary policy communication and restrictive policies, which other studies have analyzed.⁹

Figure 1 also reports the international evolution of two factors that have featured prominently in discussions of pandemic-era inflation: energy price inflation and labor market tightness, measured here by the deviation of unemployment from its natural rate—the unemployment gap.¹⁰

⁶ Headline inflation refers to CPI inflation except for the euro area, where it refers to HICP inflation. Weighted median inflation data come from the Federal Reserve Bank of Cleveland for the United States; Statistics Canada for Canada; and are computed by IMF staff for the remaining cases.

⁷ Monthly Consensus Economics surveys contain information on current- and next-calendar-year expected inflation. We construct twelve-month-ahead or near-term expected inflation series as the weighted sum of monthly vintages following Buono and Formai (2018).

⁸ Longer-term expectations are measured using ten-year forecasts from Consensus Economics except for the United States, for which they are measured using ten-year forecasts from the Federal Reserve Bank of Philadelphia Survey of Professional Forecasters, and for the euro area, where they are measured based on five-year forecasts from the ECB Survey of Professional Forecasters.

⁹ See, for example, Gáti (2022).

¹⁰ Estimates of the natural rate come from IMF staff or, where unavailable, are obtained using the Hodrick-Prescott filter. The IMF staff natural rate estimates come from the April 2024 *World Economic Outlook* (WEO) database at the annual frequency. For cases where these estimates are unavailable, we apply the Hodrick-Prescott filter to unemployment data and forecasts through 2029 (to address the end-point problem) from the April 2024 WEO database at the annual frequency with a conventional smoothing parameter (λ) of 100. For our monthly analysis, we allocate these annual natural rate estimates to June of each year and interpolate between these months.

We see that energy consumer price inflation moved closely with the aforementioned rise and fall of headline inflation, although by an approximately six times larger magnitude.¹¹ From December 2020 to its peak in June 2022, energy price rose by 44 percentage points to a peak of 38 percent (at a twelve-month rate) before largely dissipating in the second half of 2023. Energy prices rose sharply following Russia’s invasion of Ukraine in February 2022.

As to labor market tightness, the unemployment gap declined during the period that inflation rose, but co-movement with inflation is less striking. For the median economy, the unemployment gap fell from 0.8 percentage point in December 2020, indicating a weak labor market, to a low of –0.3 percentage point in November 2023, indicating a tighter-than-normal market. However, because the median unemployment gap continued to decline even after headline inflation had peaked and was falling, it is less closely associated with inflation dynamics during this period than is energy price inflation.

Overall, this initial examination suggests that the rise and fall of headline inflation occurred jointly with a large movement in energy price inflation as well as with a more gradual movement in core inflation. Inflation expectations rose over short-term horizons but remained stable over longer-term ones, suggesting that forecasters generally perceived the rise in inflation as temporary.

2. Cross-Section Evidence: The Roles of Energy Prices and of Economic Slack

We next provide a cross-sectional assessment of how the aforementioned correlates of inflation—energy prices and labor market tightness—related to the rise and fall of inflation. This is a natural starting point for examining international drivers, both at the local and at the global levels.

Figure 2 focuses on two periods covering, first, the rise in headline inflation from December 2020 to its country-specific peak of headline inflation; and, second, the fall in headline inflation from the peak to March 2024. Red country labels indicate the rising inflation period; blue labels indicate the disinflation phase.

The first panel of Figure 2 (top-left) reports the relation between the change in headline inflation and the change in energy price inflation. We see a positive relation for each period with R-squared statistics of, respectively 12 percent and 15 percent.¹² A much stronger relation, with an R-squared of 75 percent holds when considering the co-movement between the two periods jointly in a pooled regression.

Figure 2 also reports a puzzling lack of correlation between changes in energy price inflation and core inflation across countries (top-right panel). When the change in energy price inflation is regressed on the change in core (weighted median) inflation, the R-squared is zero for both the inflation rise and disinflation periods. This lack of correlation occurs despite numerous

¹¹ “Energy” denotes the Energy component of the CPI except for the euro area, where it denotes the HICP Electricity, Gas and Other Fuels component.

¹² Annex Table 1 reports the months with the country-specific peaks in headline inflation for each of the 21 economies considered, which we use for the paper’s analysis. For most countries, the peak in the twelve-month headline inflation rate occurred in the second half of 2022. Annex Table 2 reports the bivariate estimation results underlying the regression lines in Figure 2.

hypothetical channels through which movements in energy prices could pass through into changes in core inflation, including wages or other costs of producing output, as emphasized by Blanchard (2022), di Giovanni and others (2022), and Bernanke and Blanchard (2024b), among others.¹³ The co-movement between energy price inflation and core inflation is visible when the two periods are considered jointly in a pooled regression, but the absence of a within-period cross-country correlation is surprising.¹⁴ (As we discuss in what follows, this puzzle resolves after accounting for country-specific differences in the strength of energy-price pass-through.)

Figure 2 (lower-left panel) illustrates how energy price changes have been correlated with changes in twelve-month-ahead inflation expectation across countries. Again, the relation is weaker for each period's cross section than in a pooled regression.

Finally, to examine the role of macroeconomic conditions in shaping inflation, Figure 2 reports the bivariate relation between the change in core inflation and the change in the unemployment gap (lower-right panel). Again, the cross-sectional relation is weak. The results have the expected sign, with falling unemployment associated with higher core inflation. However, the strength of the relation is weak, even when the two periods are considered jointly in a pooled regression.

Overall, the pooled regression analysis based on co-movement between the two periods is consistent with the notion that energy price movements have played a central role in driving inflation and inflation expectations since 2020. The analysis also confirms that movements in labor market tightness have, on average, played a relatively minor role. However, the cross-country analysis within each period provides much less definitive evidence, suggesting that country-specific sensitivities to energy prices may be playing a central role.

To make progress on such country-specific sensitivities, we now move from cross-sectional exploration to country-by-country analysis.

3. Inflation Drivers at the Country Level

Our framework for studying inflation at the country level extends the approach of Ball, Leigh, and Mishra (2022) and Dao and others (2023) who focused on inflation in the United States and the euro area to more economies. We decompose headline inflation into core inflation and deviations of headline from core.

$$(1) \quad \text{headline inflation} = \text{core inflation} + \text{headline shocks}$$

As already mentioned, our measure of core (underlying) inflation is weighted median inflation, which strips out the effects of unusually large price changes in certain industries.

Figure 3 reports this decomposition for the 21 economies in the sample. It reports the change in headline inflation (twelve-month rate) from December 2020 to the country-specific peak (left

¹³ Relatedly, Ball, Leigh, and Mishra (2022) and Dao and others (2023) present evidence that energy price movements passed through to core inflation in the United States and the euro area during the post-pandemic surge.

¹⁴ The strong correlation in the pooled regression primarily reflects the correlation within countries across episodes and surges and falls of core inflation.

panel) and its fall from the peak to March 2024 (right panel). We see that in most (though not all) cases, both the rise and the fall in headline inflation reflected contributions (in the same direction) from headline inflation shocks and from core inflation.

3.1. Explaining Headline Shocks

We now seek to explain the headline inflation shocks focusing on ten candidate variables that have featured prominently in discussions of inflation since the onset of the pandemic. The candidates include the afore-mentioned energy price inflation, as well as measures of supply chain disruptions and shortages, measures of the severity of COVID-19-related lockdowns, and changes in the prices of specific industries, such as food and auto-related industries.¹⁵

Table 1 reports a heat map with the R-squared statistics for bivariate relations between the monthly headline inflation shocks and each of the ten candidate variables considered for each of the 21 economies, as well as for a pooled regression.

We see that the three variables with the most explanatory power are, in order of importance (based on the R-squared from the pooled regression): relative energy-price inflation, defined as energy price inflation minus median inflation; relative food-price inflation, measured as food price inflation minus median inflation, and global shipping costs, measured by the Harper charter rate. To highlight the relative size of the R-squared statistics, the table's elements are color coded, with a darker shade indicating a better fit. The R-squared statistic for energy price inflation is the highest for 17 out of the 21 economies considered.

Annex Table 3 reports multivariate regressions for the three top variables identified in Table 1. In these multivariate regressions, the estimated coefficient on energy price inflation is positive and statistically significant in all 21 cases. Food price inflation also has a positive and statistically significant coefficient estimate in eleven cases. The results for shipping costs are statistically significant in seven cases. The overall explanatory power for the three variables, measured by the R-squared statistic, ranges from 21 percent for Malaysia to 94 percent for India. Annex Figure 1 reports the actual and fitted values of the monthly headline inflation shocks for each of the 21 economies based on the three variables used in the multivariate regressions. The fitted value of headline shocks based on the three variables generally follow the actual values closely.

Figure 4 reports a decomposition of the twelve-month headline inflation shocks (derived from the monthly fitted values) based on the country-by-country estimation results. Once again, we see that energy price inflation plays, in most cases, a dominant role in explaining the rise of headline inflation shocks through the (country-specific) peak, as well as the fall from the peak to the latest observation. Food and shipping costs contribute to headline inflation shocks in the same direction for most cases, with some exceptions, including India.¹⁶

¹⁵ Ball, Leigh and Mishra (2022) conclude that, for the United States, headline shocks during 2020-22 primarily reflected energy price inflation as well as supply chain disruptions and sharp movements in car-related industries.

¹⁶ Although the R-squared is high for India (Annex Table 3), yet there is a significant residual (difference between actual and predicted headline shock) reported in Figure 4. This reflects variation over time in the estimated error term. In particular, there is a large negative error term estimated for March 2024 and a small positive one for the peak in April 2022. Hence the difference is a large negative residual reported in the last row of the right panel "Fall from Peak to Latest" in Figure 4.

In Annex Table 4 we also present a version of the multivariate regressions based on the country-specific top three variables identified based on the R-squared statistics in Table 1.¹⁷ For 17 out of 21 countries, energy price inflation is the most important driver of headline inflation shocks, while there is more cross-country variation in the second and third most important headline shock drivers. For example, for the United States, as in Ball, Leigh, and Mishra (2022), we find high explanatory power from a combination of three variables: changes in energy prices; backlogs of work; and changes in prices in auto-related industries. A regression of headline shocks on these variables has an R-squared of 93 percent for the United States. For India, a combination of food-price shocks, backlogs of work, and supplier delivery times has high explanatory power, with an R-squared of 93 percent.

3.2. Explaining Core Inflation

To understand the evolution of core inflation for each economy, we use a Phillips curve framework that focuses on the role of three variables: expected inflation, macroeconomic conditions, and headline-inflation shocks. The equation estimated is:

$$(2) \quad \pi = \pi^e + f(Y) + g(H) + \varepsilon$$

where π is the monthly annualized core (weighted median) inflation rate; and π^e is expected inflation. We follow studies such as Hazell and others (2022) by measuring expected inflation with longer-term survey expectations. As in Ball, Leigh and Mishra (2022), when estimating the Phillips curve specifications, we assume that core inflation responds one-for-one to movements in longer-term expected inflation.¹⁸

The Y term denotes the strength of macroeconomic conditions averaged over the current and previous eleven months. Our baseline measure for Y is the IMF staff estimate of the unemployment gap averaged over the current and previous 11 months. For the emerging market economies in the sample, however, monthly data for unemployment are only available for a relatively short period or not available at all, and so for those cases our measure of Y is the output gap—the gap between actual real GDP and estimated potential real GDP—which is available for a longer period. We construct the output gap using quarterly real GDP data—we interpolate between the quarterly observations to obtain a monthly series—and IMF staff estimates of potential output.¹⁹ Both the unemployment gap and the output gap are conventional measures of macroeconomic conditions in the literature.

For the United States, however, we follow recent studies and measure macroeconomic conditions based on the ratio of vacancies to unemployment (V/U). This approach is preferable to the unemployment gap for the COVID-19 period in light of the substantial shift in the US Beveridge curve relation between vacancies and unemployment, as illustrated in Annex Figure 4. As Ball, Leigh and Mishra (2022) explain, this Beveridge curve shift implies a corresponding

¹⁷ Annex Table 5 lists the top three variables identified for each country. Annex Figures 2 and 3 document, respectively, the corresponding actual and fitted values and the decomposition exercise.

¹⁸ This one-for-one relation is, as Ball, Leigh, and Mishra (2022) explain, consistent with the derivation by Hazell and others (2022) in a New Keynesian framework under the assumption that shocks to the unemployment gap and cost-push shocks are transitory.

¹⁹ The IMF staff potential output estimates come from the April 2024 WEO database at the annual frequency. For our monthly analysis, we allocate these annual potential output estimates to June of each year and interpolate between these months.

upward shift in the conventional unemployment-based Phillips curve, with higher inflation for any given level of unemployment. Using the conventional (unemployment gap) specification in this context would thus fail to adequately account for the rise in inflation due to this shock. Annex Figure 4 also illustrates the Beveridge curve for three other economies for which we have data on job vacancies—the euro area, the United Kingdom, and Canada. We conclude that Canada also experienced a shift in the Beveridge curve during the pandemic. Accordingly, our measure of Y is the average ratio of vacancies to unemployment over the current and previous eleven months for both the United States and Canada. For the remaining economies, the conventional unemployment gap (or output gap) specification remains appropriate.

The H term is the average of headline inflation shocks over the current and previous 11 months, and its inclusion in equation (2) captures the pass-through of these headline shocks to core inflation.

The $f(\cdot)$ and $g(\cdot)$ terms are functions which allow for non-linearities in a flexible way. We explore the possibility of nonlinearities by considering both quadratic and cubic functions. For the United States and Canada, the two economies with a V/U specification, we follow Ball, Leigh and Mishra (2022) and consider cubic functions for $f(\cdot)$ and $g(\cdot)$ for our baseline estimation results.²⁰ For the remaining economies, we follow Dao and others (2023) and consider quadratic functions. In two cases (the United Kingdom and Italy), however, we find no evidence of such nonlinearities—the quadratic terms are statistically insignificant—and therefore estimate a linear specification. The specifications include a constant term unless it is found to be statistically indistinguishable from zero.²¹

Based on data availability, our estimation of Phillips curves focuses on fourteen economies.²² Annex Table 6 reports the estimation results for each of the fourteen economies. The table also indicates the measure of slack used as well as the first year of the sample.

In most cases, the equation for the monthly core inflation rate fits well, with an adjusted R -squared statistic above 40 percent in most (9 out of 14 cases). The main exception is Japan, for which the Phillips curve equation estimated has an adjusted R -squared statistic of less than 5 percent and the estimate of the slope coefficients are highly imprecise. For the United States and the euro area, the results are similar to those of, respectively, Ball, Leigh and Mishra (2022) and Dao and others (2023), which were based on a shorter sample.

To illustrate the estimation results, Figure 5 reports the slope functions over the economies' respective samples. In several, though not all, cases we see that the relationship with macroeconomic conditions is nonlinear, with a steeper slope when the output is above potential

²⁰ Such non-linearities have been shown to be highly relevant for euro area and US inflation during the pandemic, as in Ball, Leigh, and Mishra (2022) and Dao and others (2023).

²¹ Based on the V/U specification, in the absence of estimates of the natural rate of V/U , a constant term is necessary. A constant term can also arise due to measurement error in π^e , or if the unemployment gap, output gap or headline-inflation shocks terms have a non-zero mean. For the purposes of decomposing the change in inflation over time in the decomposition exercise that follow further below, the constant term will play no role.

²² The ten advanced economies are Canada, the euro area, France, Germany, Italy, Japan, Spain, Sweden, the United Kingdom, and the United States. The four emerging market economies are Brazil, Chile, India, and Poland.

and when labor markets are tight.²³ The relation between core inflation and macroeconomic conditions in our analysis can in principle reflect channels that run beyond the labor market. To shed light on the possibility of such other channels, Annex Figure 5 reports, for the United States, the slope function between V/U and core inflation. First as in our baseline estimation results, and then after controlling for wage growth in the equation. We see that the slope of the relation between V/U and core inflation flattens after controlling for wage growth but remains significant economically and statistically. This result suggests that the V/U variable reflects broader macroeconomic conditions that relate to the prices of goods and services beyond the relation with wages. We also see strong evidence of nonlinearity in the relationship between core inflation and headline inflation shocks (H) in most cases. In addition, there is evidence of asymmetry, with positive headline shocks associated with a stronger movement in core inflation and negative headline shocks associated with a relatively decline in core inflation. Such nonlinearities—with larger relative price shocks causing proportionately larger aggregate price inflation responses—arise in a number of models.²⁴

As Annex Table 7 reports, these results are robust, changing little, on average across countries when outlier observations are excluded (using Cook’s distance method). Importantly, however, our results reveal the importance of measuring core inflation using weighted median inflation: when repeating the estimation using the traditional measure of core inflation based on excluding food and energy prices (XFE)—the fit of the core inflation equation drops by more than half, as Annex Table 8 reports. The adjusted R-squared drops from an average of 45 percent across countries for the baseline equation for monthly annualized core inflation using weighted median inflation to only 18 percent when using XFE inflation.²⁵ Studies that find that “outlier-exclusion” measure of core, such as medians and trimmed means, are more closely related to macroeconomic conditions, including the unemployment rate, than are “fixed-industry exclusion” measures, such as XFE inflation, include, for the euro area, Ball and Mazumder (2011) and, for the United States, Verbrugge (2021).

3.3. Accounting for the Rise and Fall in Headline Inflation

We now conduct an accounting exercise for the sources of the rise and fall in headline inflation since December 2020 based our estimation results. In this exercise, we augment the fitted values for core inflation based on the estimation results reported in Annex Table 6 with the fitted

²³ In Annex Table 6, a positive coefficient estimate for the unemployment gap quadratic term indicates that in a more overheated economy with a larger negative unemployment gap (and, therefore, a larger squared unemployment gap) the associated rise in inflation is greater.

²⁴ See examples of such models under footnote 5.

²⁵ In related work (Dao and others 2023) we also report additional estimation results for the euro area with the degree of labor market tightness measured by the ratio of vacancies to unemployed (V/U). Data for V/U for the euro area are available for a shorter sample starting in 2006 and at the quarterly frequency. The results with V/U for the euro area are less stable than with the unemployment gap. They lose statistical significance when outlier observations are discarded. By contrast, the results based on the unemployment gap are similar when discarding outliers. Estimation results for the euro area indicate a similarly strong fit when based on the output gap (as measured in IMF staff) instead of the unemployment gap, and when higher orders of nonlinearity (cubed terms) are included in the specification.

values for headline-inflation shocks based on the estimation results reported in Annex Table 3. We derive twelve-month inflation rates from the fitted values for monthly annualized rates.²⁶

Figure 6 reports the results for four large economies—the United States, the euro area, the United Kingdom, and Brazil.

We see that much of the rise in US headline inflation to its peak in June 2022 (at a twelve-month rate) reflects the onset of headline inflation shocks (grey bars)—notably to the price of energy—and the pass-through into core inflation (orange and gold bars).²⁷ A strengthening in macroeconomic conditions (red bars) plays a sizeable but secondary role. These US results are for CPI inflation, and Annex Figure 6 repeats the exercise for PCE inflation, yielding similar results.

The decline in US headline inflation since June 2022 entirely reflects the fading of the headline inflation shocks and of the associated passthrough. The contribution of macroeconomic strength to US inflation increases after June 2022, reflecting our estimated lagged relation between macroeconomic conditions and core inflation and the persistently strong economy. The twelve-month average of V/U that enters our equation for monthly core inflation does not peak until January 2023, and stays well above its 2020 level thereafter. In addition, to derive fitted values of twelve-month inflation, we use the fitted values from our equation for monthly core inflation for the current and past eleven months. As a result of these calculations, the estimated contribution of macroeconomic conditions to twelve-month inflation in March 2024 reflects the average level of V/U for the 24-month period ending in March 2024, which is greater than its corresponding average through June 2022. At the same time, the contribution of macroeconomic conditions to US *monthly* inflation has declined since June 2022, as the lower panel of Figure 7 reports.

For the other three economies reported in Figure 6, the contribution of macroeconomic strength is significantly smaller than for the United States. For these economies, the pass-through of energy price inflation shocks into core inflation (orange bars) has played a larger role in explaining the rise of inflation.²⁸ The subsiding of energy price inflation likewise explains a larger part of the subsequent disinflation. For Brazil and the United Kingdom, the pass-through of relative price shocks to products other than energy (golden bars) has played a role that is approximately equal to that of energy price pass-through.

Figure 8 reports the decomposition results for all fourteen economies. The left panel reports a decomposition of the change in headline inflation (twelve-month rate) from December 2020 to the country-specific peak, and the right panel decomposes the change from the peak to the latest observation (March 2024).

²⁶ To decompose the headline-inflation shocks into the part due to energy price fluctuations and the part due to other factors, we use the fitted values reported in Figure 4. To derive the pass-through effects, we take these fitted values of headline-inflation shocks and combine them with the pass-through coefficient estimates reported in Annex Table 6. For the pass-through effects of other headline-inflation shocks, we take the part of the headline-inflation shocks not explained by energy prices reported in Figure 5 and, similarly, combine them with the pass-through coefficient estimates.

²⁷ For the United States, the results for June 2022 in Figure 6 show substantial pass-through from past headline shocks not associated with energy prices (golden bars). This contribution reflects the temporary run-up in shipping costs earlier in the pandemic, and the lagged pass-through relation with core inflation.

²⁸ In related work for the euro area, Pallara and others (2023) also find that past energy shocks have driven up core inflation.

For most countries, the results highlight the dominant role of energy price shocks and their pass-through into core in driving headline inflation. On average, these two components together account for about 47 percent and 60 percent of the rise and fall of headline inflation, respectively. The results also reveal significant differences in the magnitude of this factor across economies. For example, for Germany, the direct contribution of energy price inflation is nearly three times larger than for France, and the associated pass-through contribution is about 45 percent larger. This finding is consistent with the conclusion of Dao and others (2023) that differences in the implementation of energy price measures between these two countries, with France relying more on energy price-suppressing measures than Germany, contributed materially to different inflation outcomes across the two economies.

The strength of macroeconomic conditions (red bars) and changes in longer-term inflation expectations (blue bars) contribute only modestly to explaining the rise and fall in inflation in most cases. The share of macroeconomic strength in accounting for the rise in inflation is below 9 percent on average, and the decline in inflation occurs despite a modest *strengthening* in macroeconomic conditions. In some cases, such as India, the positive contribution of macroeconomic conditions to the rise in inflation from December 2020 to its peak reflects recovery from a negative output gap in 2020 rather than a positive output gap. For Japan, the direct contribution of headline inflation shocks (principally from food price movements in this case) accounts for almost the entire change in inflation since 2020. This result reflects the flat Phillips Curve slope coefficients estimated for Japan.

In complementary work for eleven advanced economies, Blanchard and Bernanke (2024a) similarly conclude that most of the movement in inflation since 2020 can be explained by price shocks, and not by pressure from the labor market. Our two studies come very much to the same conclusions, with minor but interesting differences, such as a larger quantitative role that we find for V/U in explaining price pressures in the United States. This difference reflects the inclusion of V/U in our equation for overall core inflation, while the approach of Bernanke and Blanchard focuses on the relationship of V/U with wage inflation. As already mentioned, in Annex Figure 5, we report that V/U has explanatory power for core inflation beyond its relationship with wage growth, consistent with it reflecting broader macroeconomic strength beyond the labor market. The figure also illustrates our finding of non-linearity, with a stronger V/U contribution to inflation at higher levels of V/U, in line with recent theoretical model predictions (Benigno and Eggertsson 2023, for example), while the Bernanke and Blanchard estimates are for a linear specification.

4. Adjusting Cross-section Estimates for Country-specific Coefficients

We saw in Section 3 that the estimates of core inflation equation coefficients vary substantially across economies. We now revisit the puzzling lack of correlation between core inflation and energy price inflation across countries reported in Section 1 (in Figure 2; top right panel)—despite a strong global co-movement—and ask whether adjusting for country-specific coefficients resolves the puzzle.

The top panel of Figure 9 repeats the puzzle, this time for the fourteen economies for which we have core inflation equation estimates. It plots the change in core inflation on the vertical axis and the change in energy price inflation on the horizontal axis. For both the period covering the rise in headline inflation (red line) and for the subsequent disinflation period (blue line) changes

in energy price inflation and core inflation are uncorrelated across countries. The R-squared statistics are only 0.1 percent and 2 percent for the rise and fall periods, respectively. Poland provides a good example of the puzzle: it has a rise in energy price inflation of 36 percentage points in the period covering the rise in inflation followed by a fall of 39 percentage points in the disinflation phase—near the cross-country average. However, Poland’s core inflation rises by much more and then falls by much more than the simple cross-section estimates can explain.

The second panel of Figure 9 shows a resolution of the puzzle. It repeats the exercise, but this time the horizontal axis reports the contribution to core inflation from energy price inflation based on the estimated core inflation equation. These estimated contributions correspond, for each country, to those already reported in Figure 8 (orange bars). We see that the fit is now tight, with an R-squared of 51 percent and 46 percent in the inflation rise and fall samples, respectively. Again, Poland is a good example. Its large rise in core inflation is now explained almost entirely by the fact that its energy pass-through coefficients are particularly large. In other words, Poland *did* experience a larger rise in core inflation than other countries, but this is what we should expect based on its strong pass-through sensitivity to energy-price inflation.²⁹

Conclusion

Our results strongly suggest that global drivers, especially the sharp movement in energy prices, played a dominant role in driving the international rise and fall in inflation since 2020. Local policies also played a role. First, the transmission of headline shocks to underlying inflation was shaped by local characteristics. It is only after accounting for country-specific passthrough coefficients that our analysis is able to account for the rise and fall in inflation both within and across countries. Second, local policies, especially monetary policy, had a critical role to play. Throughout this episode, long-term inflation expectations remained very well anchored. This suggests central banks retained credibility and this helped to avoid wage-price spirals.

Further research should help to elucidate the drivers of global factors. For energy prices, the spike following Russia’s invasion of Ukraine is consistent with the notion that geopolitical factors rather than near-term economic factors played a dominant role, as in several past historical episodes. However, the contribution of macroeconomic policies, including fiscal and monetary stimulus, in raising energy prices could also be explored. Investigating the underlying determinants of the diversity of Phillips curve coefficients that we find is another priority.

There is one important exception to the broad pattern described above: the United States. In this case, more than for the other countries that we consider, strong macroeconomic conditions have continued to put pressure on underlying inflation even as the effects of earlier headline inflation shocks have faded. The strength of US aggregate demand likely reflects many contributing factors, including an expansionary fiscal stance, large household savings accumulated during the pandemic, and a high share of fixed rate mortgages, which have

²⁹ Annex Figures 7, 8, and 9 repeat this exercise for the other relations reported in Figure 2, with the results again indicating an improvement in fit—though to a lesser extent than for core inflation given a better initial fit—after accounting for country-specific coefficients. In a similar exercise, Ball, Leigh, and Loungani (2017) find that accounting for country-specific coefficients in Okun’s Law resolves the puzzling lack of correlation across countries in unemployment and output during the Great Recession of 2008-2009.

buffered households against increases in policy rates. Disentangling the relative contributions of these factors is a priority for future research.

Turning to the future, we do not conduct forecasts in this paper. However, our results suggest that, conditional on no further headline inflation shocks; unemployment, output, and vacancy-to-unemployment ratios returning to their normal levels; and longer-term expectations remaining anchored, inflation should converge to its target-consistent level within twelve months. Among major economies, for the euro area, the United Kingdom, and Brazil, where earlier relative price shocks and their pass-through effects have largely faded, and where macroeconomic conditions have contributed only modestly to inflation, a convergence to target inflation rates over this horizon appears plausible. By contrast, in the United States, where strong macroeconomic conditions are estimated to be contributing materially to inflation persisting above target-consistent levels, a cooling of labor markets with either higher unemployment or a fall in vacancies appears necessary for the convergence of inflation to target over this horizon.

References

- Ball, Laurence M., and N. Gregory Mankiw. 1994. "Asymmetric Price Adjustment and Economic Fluctuations." *The Economic Journal* 104 (March): 247–61.
- Ball, Laurence M., Daniel Leigh, Prakash Loungani. 2017. "Okun's Law: Fit at 50?" *Journal of Money, Credit and Banking*. Vol. 49, No. 7 (October 2017), pp. 1413-1441.
- Ball, Laurence M., Daniel Leigh, and Prachi Mishra. 2022. "Understanding U.S. Inflation during the COVID-19 Era." *Brookings Papers on Economic Activity* (Fall): 1–54.
- Ball, Laurence M., Daniel Leigh, Prachi Mishra and Antonio Spilimbergo. 2021. "Measuring U.S. Core Inflation: The Stress Test of COVID-19." NBER Working Paper 29609, National Bureau of Economic Research, Cambridge, MA.
- Benigno, Pierpaolo, and Gauti. B. Eggertsson. 2023. "It's Baaack: The Surge in Inflation in the 2020s and the Return of the Non-Linear Phillips Curve." NBER Working Paper 31197, National Bureau of Economic Research, Cambridge, MA.
- Bernanke, Ben, and Olivier Blanchard. 2024a. "An Analysis of the Post-pandemic Inflation in Eleven Economies." Peterson Institute for International Economics Working Paper. May 2024.
- Bernanke, Ben, and Olivier Blanchard. 2024b. "What Caused the U.S. Pandemic-Era Inflation?" *American Economic Journal: Macroeconomics*. Forthcoming.
- Blanchard, Olivier. 2022. "Why I Worry About Inflation, Interest Rates, and Unemployment." Peterson Institute for International Economics. Realtime Economic Issues Watch.
- Buono, Ines, and Sara Formai. 2018. "New Evidence on the Evolution of the Anchoring of Inflation Expectations." *Journal of Macroeconomics* 57: 39–54.

Dao, Mai Chi, Allan Dizioli, Chris Jackson, Pierre-Olivier Gourinchas, and Daniel Leigh. 2023. "Unconventional Fiscal Policy in Times of High Inflation." IMF Working Paper 23/178, International Monetary Fund, Washington, DC.

di Giovanni, Julian, Şebnem Kalemli-Özcan, Alvaro Silva, and Muhammed A. Yildirim. 2022. "Global Supply Chain Pressures, International Trade and Inflation." NBER Working Paper No. 30240, National Bureau of Economic Research, Cambridge, MA.

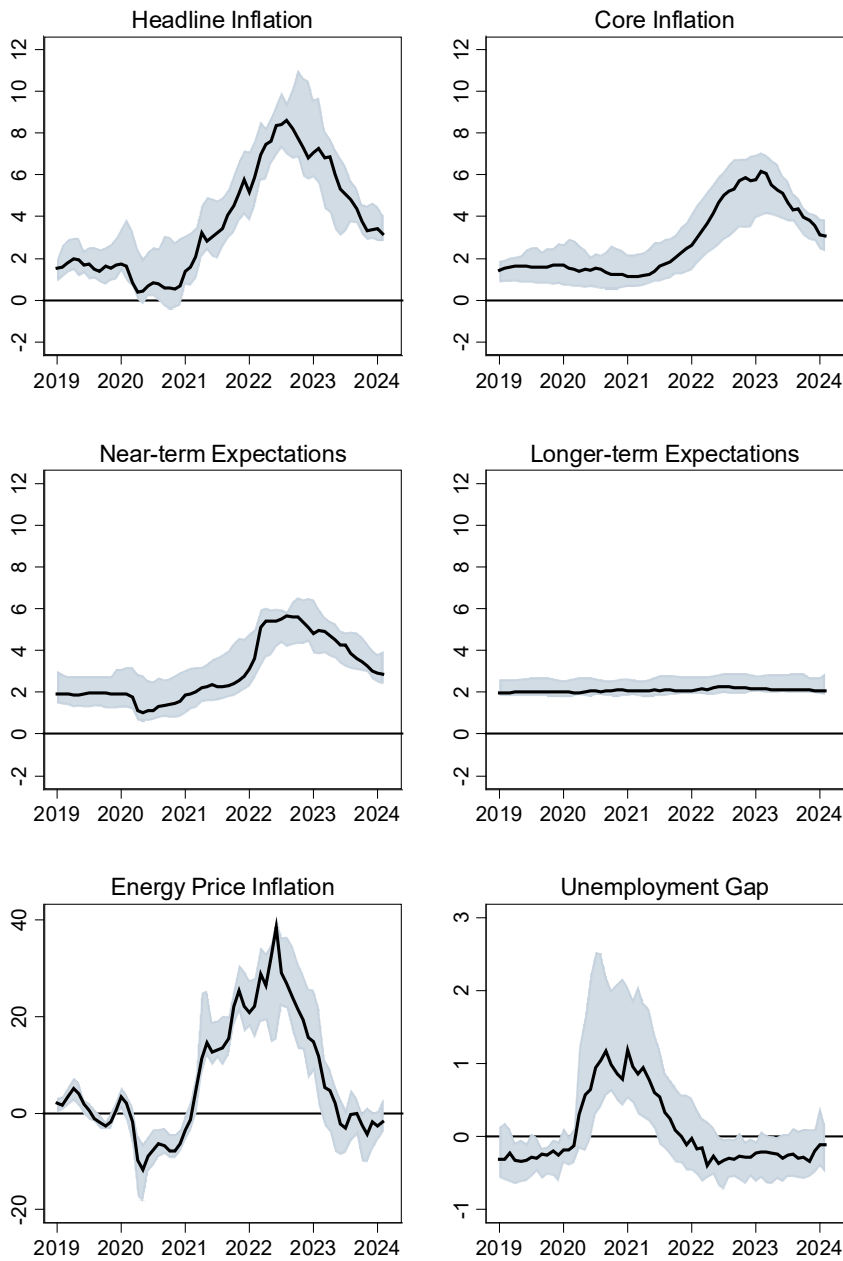
Gáti, Laura. 2022. "Monetary Policy and Anchored Expectations: an Endogenous Gain Learning Model." ECB Working Paper Series No 2685. July 2022.

Pallara, Kevin, Luca Rossi, Massimiliano Sfregola, and Fabrizio Venditti. 2023. "The Impact of Energy Shocks on Core Inflation in the US and the Euro Area." VoxEU.org. Aug 14 2023.

Verbrugge, Randal J. 2021. "Is It Time to Reassess the Focal Role of Core PCE Inflation?" Working Paper 21-10, Federal Reserve Bank of Cleveland, Cleveland, OH.

Figure 1. Rise and Fall of Headline and Core Inflation, and of Inflation Expectations, 2020–2024

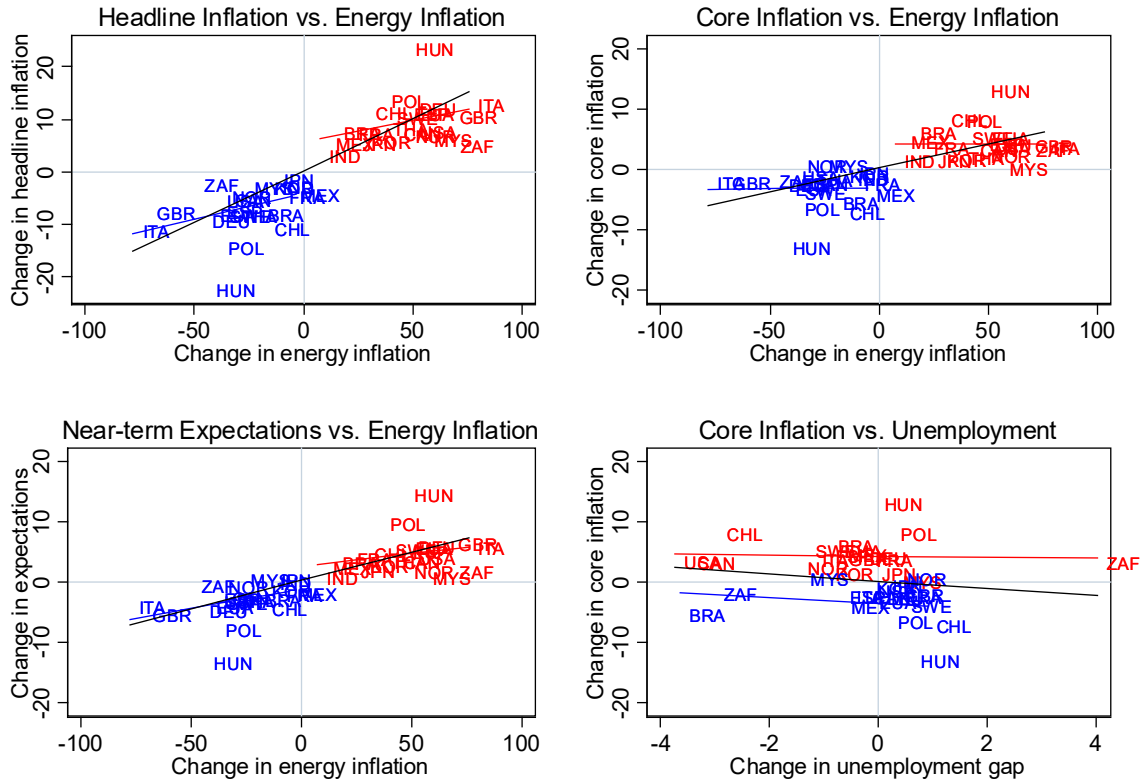
(Twelve-month rate; percent; and percent of labor force)



Sources: Haver analytics; Federal Reserve Bank of Cleveland; Statistics Canada; and authors' calculations.

Note: Chart reports median and interquartile range (shading) for 21 economies. "Core inflation" is the weighted median inflation rate. "Near-term expectations" based on twelve-month ahead forecast derived from Consensus Economics forecasts. "Longer-term expectations" denotes ten-year forecast from Consensus Economics except for United States, where it denotes ten-year forecast from Federal Reserve Bank of Philadelphia Survey of Professional Forecasters, and euro area, where it denotes five-year forecast from ECB Survey of Professional Forecasters. "Energy price inflation" denotes twelve-month energy consumer price inflation. Unemployment gap denotes difference between monthly unemployment rate and natural unemployment rate, available for 20 countries (except India).

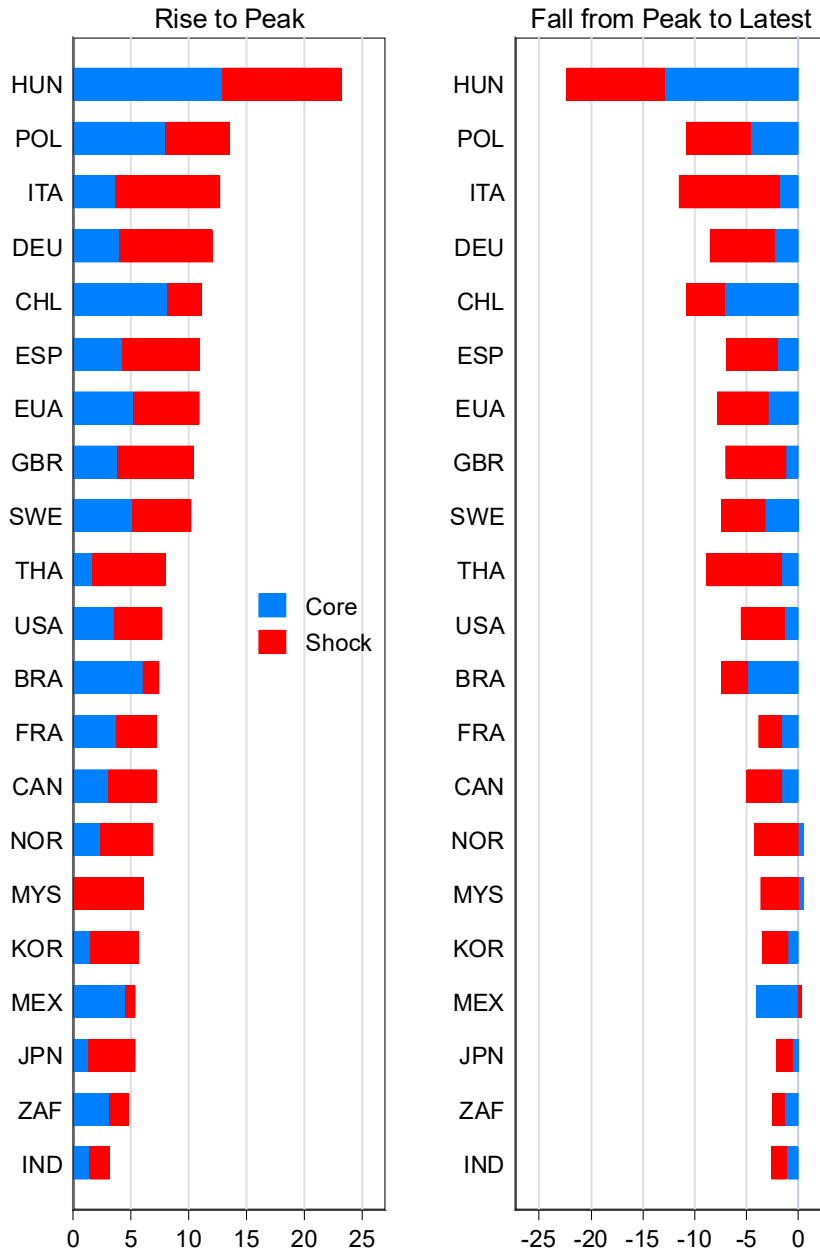
Figure 2. Cross-Section Evidence: The Role of Energy Price Inflation and Unemployment
(Percentage points)



Sources: Haver analytics; Federal Reserve Bank of Cleveland; Statistics Canada; and authors' calculations. Note: "Core inflation" denotes the weighted median inflation rate. "Near-term expectations" are based on twelve-month-ahead forecast derived from Consensus Economics forecasts. Red labels denote changes from December 2020 to month of the country-specific peak in headline inflation, with red line indicating the associated linear regression. Blue labels denote the change from country-specific peak to the latest value (March 2024), with blue line indicating the associated linear regression. Black line indicates pooled regression across both time intervals. Data labels indicate International Organization for Standardization (ISO) country codes except for EUA (euro area).

Figure 3. Decomposition of Change in Headline Inflation, Core Inflation, and Headline Inflation Shocks, 2020–2024, for 21 Economies

(Decomposition of change in twelve-month headline inflation from December 2020 to peak in twelve-month headline inflation; and from peak to March 2024; percentage points)



Sources: Haver analytics; Federal Reserve Bank of Cleveland; Statistics Canada; and authors' calculations.
 Note: Core inflation is the weighted median inflation rate. Data labels in the figure use International Organization for Standardization (ISO) country codes except for EUA (euro area).

Table 1. Explaining Headline Inflation Shocks, January 2020 – March 2024
R-squared Statistics for Bivariate Regressions of Headline Inflation Shocks on Correlates
 (Dependent variable: monthly headline inflation shock)

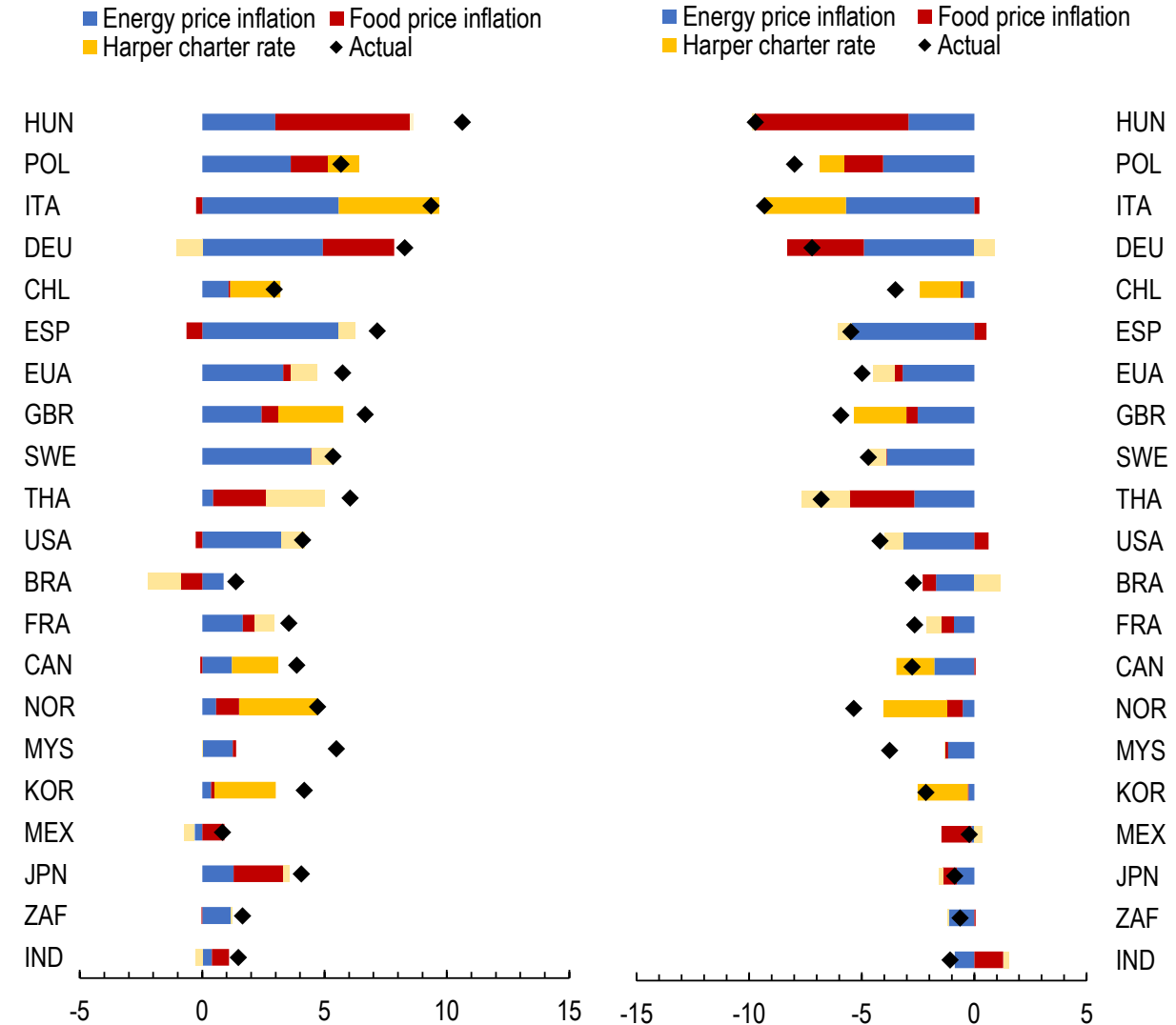
	Energy price inflation	Food price inflation	Harper charter rate	Backlogs of work	Global supply chain pressure index	Suppliers' delivery times	COVID-19 deaths, monthly	Dollar exchange rate, % change	NEER, % change	Weighted average of car inflation
Brazil	0.380	0.061	0.038	0.172	0.004	0.110	0.021	0.108	0.060	0.139
Canada	0.579	0.011	0.096	0.357	0.008	0.021	0.042	0.124	0.085	
Chile	0.217	0.039	0.217		0.157		0.026	0.004	0.013	
Euro area	0.623	0.015	0.221	0.165	0.086	0.125		0.131	0.069	
France	0.499	0.006	0.130	0.094	0.047	0.051	0.168	0.028	0.030	0.019
Germany	0.458	0.117	0.106	0.018	0.017	0.042	0.079	0.089	0.025	0.000
Hungary	0.565	0.438	0.192		0.015	0.267	0.325	0.005	0.007	0.009
India	0.002	0.923	0.001	0.020	0.004	0.100	0.002	0.006	0.003	
Italy	0.700	0.181	0.126	0.050	0.080	0.074	0.165	0.026	0.000	0.056
Japan	0.168	0.305	0.065	0.059	0.004	0.007	0.091	0.000	0.008	0.001
Korea	0.057	0.225	0.113		0.007	0.018	0.033	0.009	0.016	
Malaysia	0.183	0.015	0.011		0.001	0.023	0.011	0.105	0.050	
Mexico	0.486	0.193	0.001	0.011	0.001	0.009	0.003	0.079	0.049	0.000
Norway	0.334	0.053	0.056		0.031	0.053	0.005	0.003	0.013	
Poland	0.696	0.147	0.240		0.101	0.053	0.103	0.084	0.048	
South Africa	0.469	0.003	0.011	0.000	0.003	0.051	0.000	0.036	0.001	0.549
Spain	0.761	0.006	0.102	0.078	0.048	0.134	0.016	0.019	0.018	0.005
Sweden	0.748	0.004	0.137		0.042	0.034	0.067	0.000	0.003	0.000
Thailand	0.621	0.157	0.104		0.052	0.050	0.028	0.025	0.028	
United Kingdom	0.551	0.124	0.263	0.167	0.105	0.035	0.250	0.019	0.002	0.009
United States	0.682	0.002	0.081	0.486	0.114	0.229	0.015	0.000	0.038	0.315
Pooled	0.270	0.127	0.068	0.061	0.025	0.013	0.001	0.000	0.000	0.000

Note: Relative energy, food, and auto-related price inflation variables are computed by subtracting median inflation from energy, food, and auto-related price inflation, respectively, in monthly annualized terms. Backlogs of work and suppliers' delivery times are taken from IHS Markit Economics. The Harper charter rate reflects the worldwide price evolution of the charter market for container ships, and this variable is taken from Harper Petersen Holding GmbH. The global supply chain pressure index variable is sourced from Federal Reserve Bank of New York. COVID-19 deaths are from the Oxford Covid-19 Government Response Tracker.

Figure 4. Headline Shock Decomposition
(Twelve-month rates; percentage points)

1. Rise to Peak Inflation

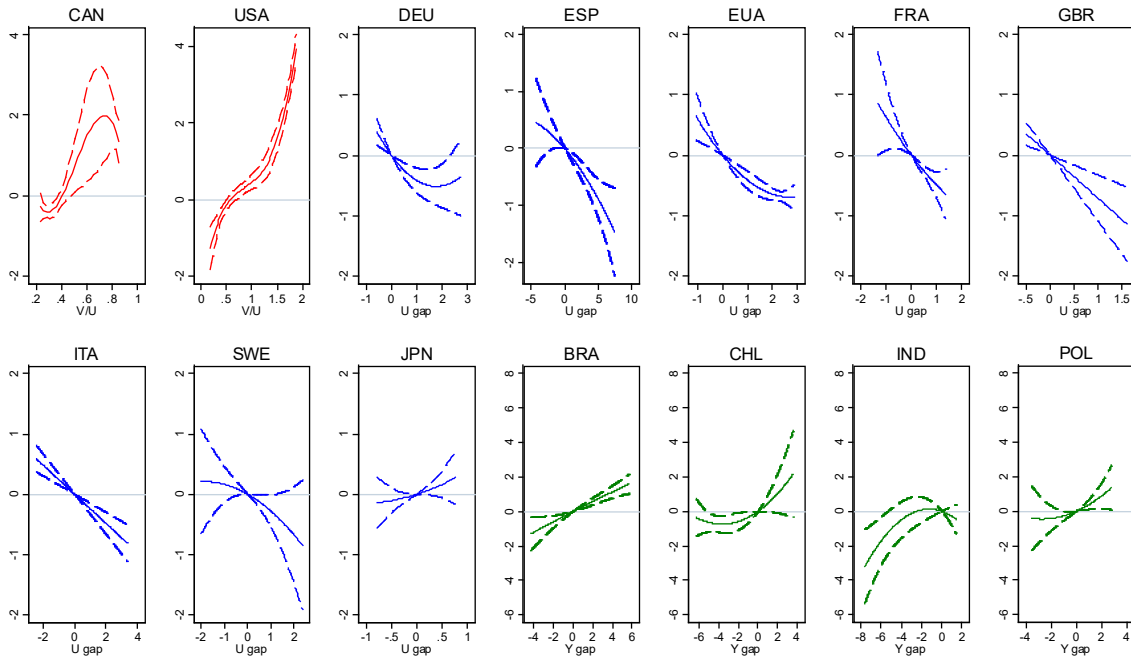
2. Fall from Peak to Latest



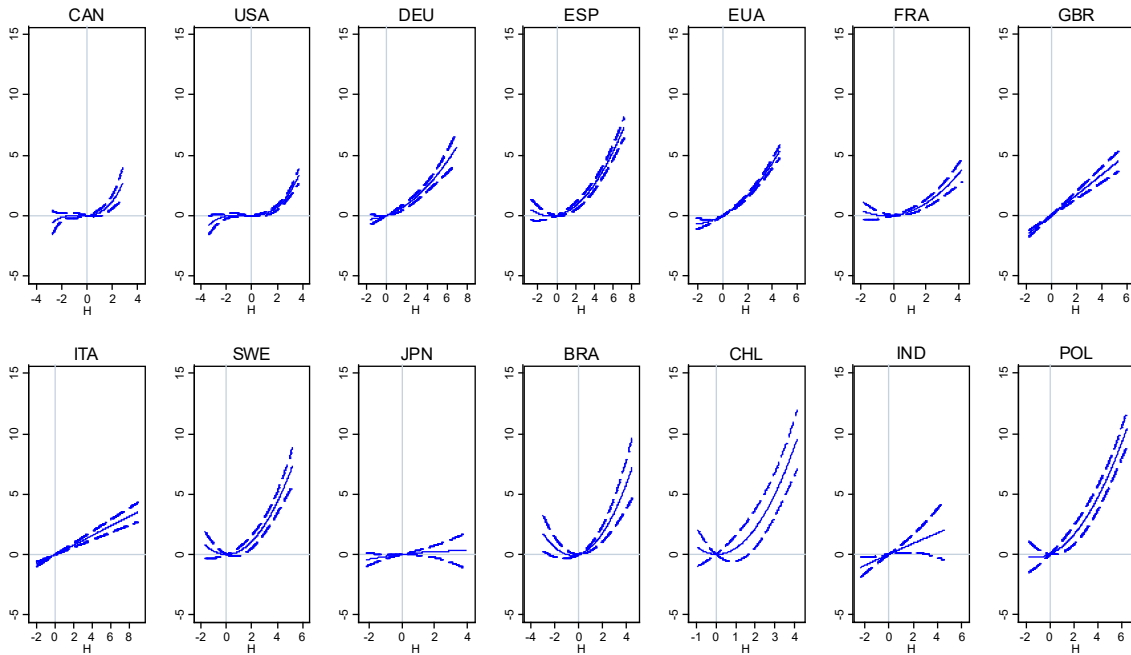
Notes. The estimated coefficients in Annex Table 3 are used to compute the predicted values of the headline inflation shock for each country based on three drivers: relative energy inflation, relative food inflation, and the Harper charter rate. The twelve-month averages for the predicted components are then computed. The bars reported in the figure are calculated as changes in the twelve-month predicted values from the initial value in December 2020 to the date of the peak in twelve-month headline inflation and from the peak to the latest datapoint (March 2024). The lighter shades for the Harper charter rate denote statistically insignificant effects from Annex Table 3. The initial, peak, and latest dates are as in Figure 4. The “Actual” values for each country correspond to the “Shock” bars in Figure 4.

Figure 5. Estimated Inflation Gap as a Function of Slack and Headline Inflation Shocks
(Percentage points; monthly data)

Panel A: Estimated inflation gap vs. economic slack measures



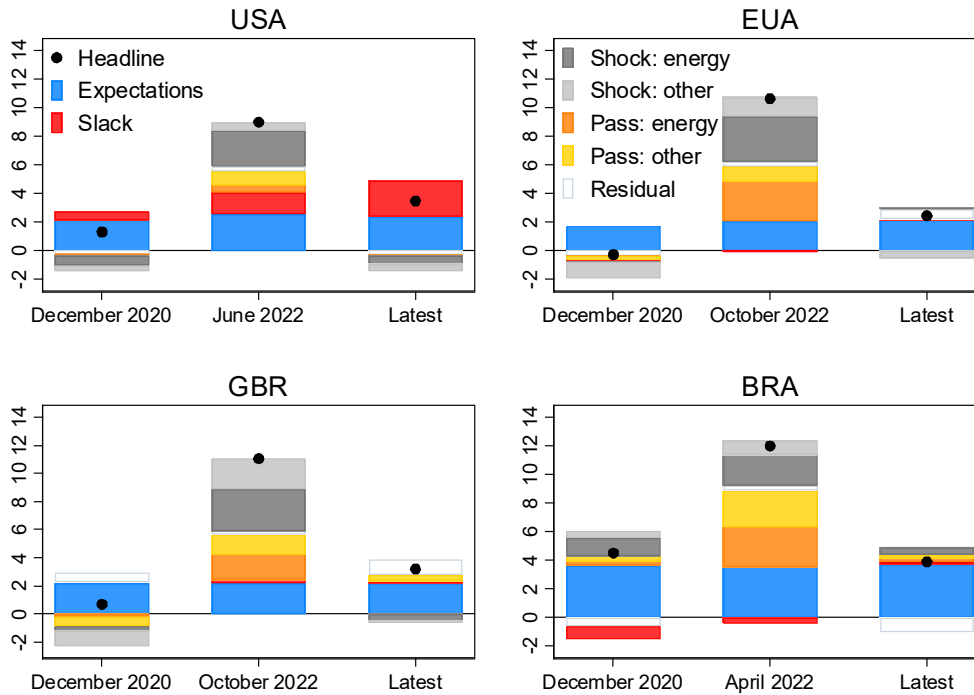
Panel B: Estimated inflation gap vs. headline inflation shock



Note: Panel A reports fitted values for economic slack terms from equation estimates reported in Annex Table 6. “V/U” denotes the ratio of vacancies to unemployment; “U gap” denotes the unemployment gap; and “Y gap” denotes the output gap. Panel B reports fitted values for headline inflation shock (H) terms. Dotted lines indicate 95 percent confidence interval. Inflation gap denotes monthly annualized median CPI inflation minus long-term inflation expectations. Data labels in the figure use International Organization for Standardization (ISO) country codes except for EUA (euro area).

Figure 6. Contributions to Headline Inflation, 2020-2024: United States, Euro Area, United Kingdom, and Brazil

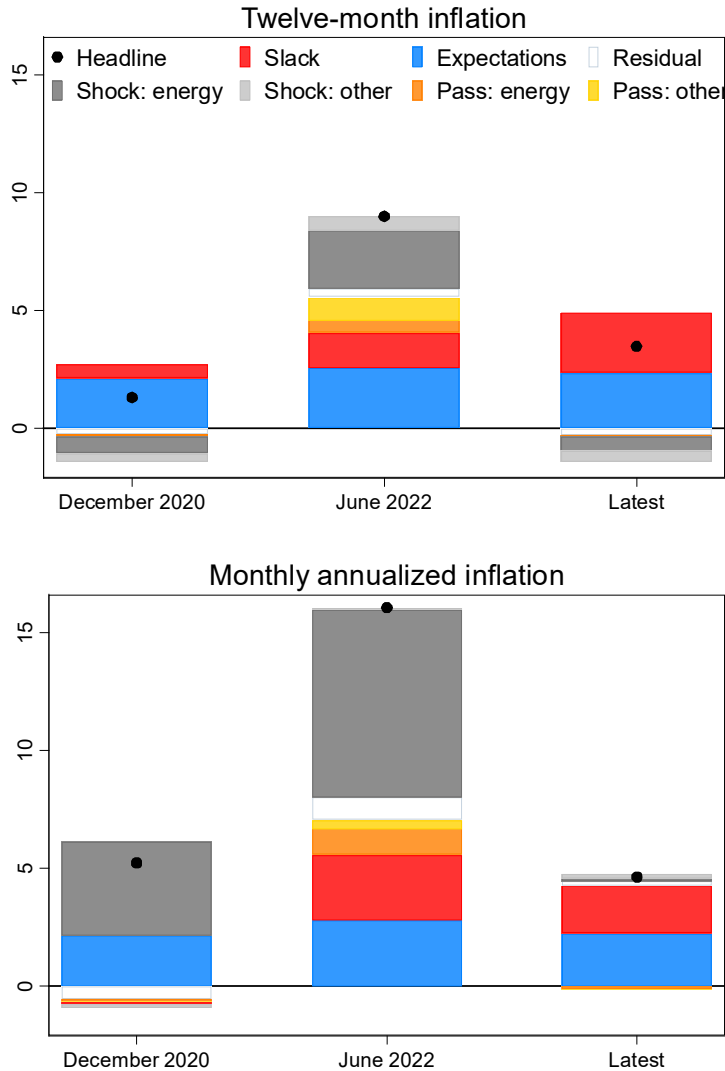
(Decomposition of twelve-month headline inflation in December 2020, month of peak, and March 2024; percentage points)



Sources: Haver analytics; Federal Reserve Bank of Cleveland; and authors' calculations.

Note: "Shock" denotes contribution of headline inflation shocks (energy or other). "Pass" denotes pass-through from headline inflation shocks (energy or other) into core inflation. "Energy" denotes contribution of relative energy prices. "Expected inflation" denotes contribution of change in long-term inflation expectations to change in headline inflation. "Slack" denotes contribution of change in economic slack (ratio of vacancies to unemployed for United States; output gap for Brazil); and unemployment gap (euro area and United Kingdom). Based on estimates in Annex Table 3 and Annex Table 6. For United Kingdom, residual includes constant term estimate. Data labels in the figure use International Organization for Standardization (ISO) country codes except for EUA (euro area).

Figure 7. United States: Contributions to Headline Inflation, 2020-2024
 (Decomposition of headline inflation; percentage points)

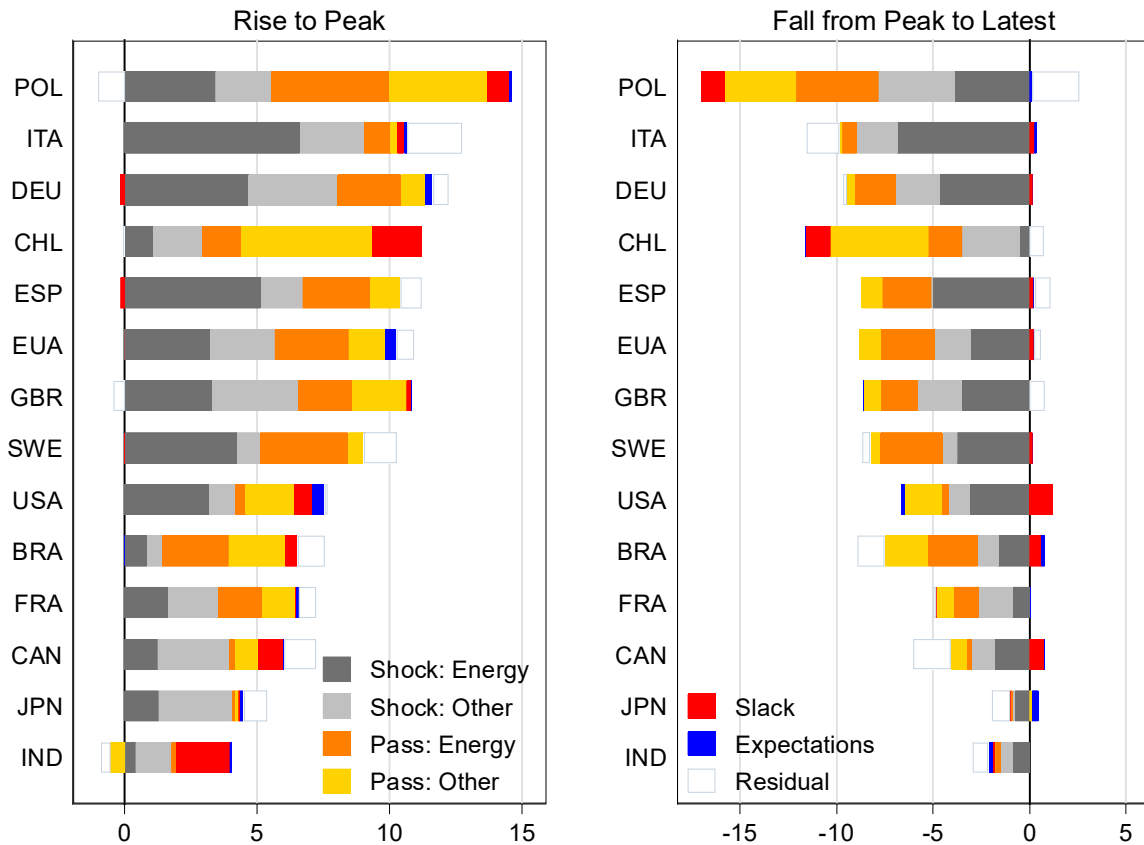


Sources: Haver analytics; Federal Reserve Bank of Cleveland; and authors' calculations.

Note: "Shock" denotes contribution of headline inflation shocks (energy or other). "Pass" denotes pass-through from headline inflation shocks (energy or other) into core inflation. "Energy" denotes contribution of relative energy prices. "Expected inflation" denotes contribution of change in long-term inflation expectations to change in headline inflation. "Slack" denotes contribution of change in economic slack (ratio of vacancies to unemployed for United States). Based on estimates in Annex Table 3 and Annex Table 6.

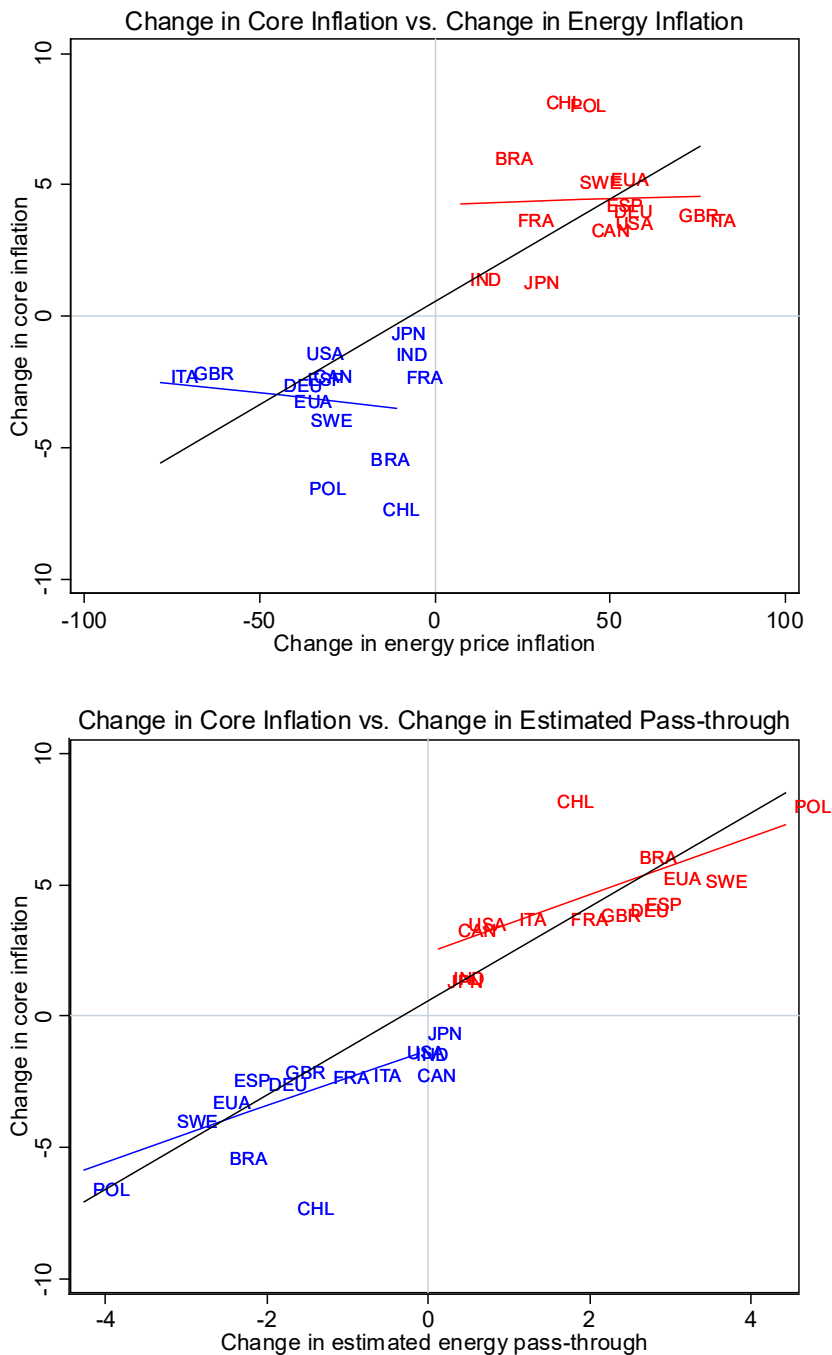
Figure 8. Accounting for the Rise and Fall in Headline Inflation, 2020-2024: Fourteen Economies

(Decomposition of change in twelve-month headline inflation from December 2020 to peak in 12-month headline inflation; and from peak to March 2024; percentage points)



Sources: Haver analytics; Federal Reserve Bank of Cleveland; Statistics Canada; and authors' calculations.
 Note: "Shock" denotes contribution of headline inflation shocks (energy or other). "Pass" denotes pass-through from headline inflation shocks (energy or other) into core inflation. "Energy" denotes contribution of relative energy prices. "Expected inflation" denotes contribution of change in long-term inflation expectations to change in headline inflation. "Slack" denotes contribution of change in economic slack (ratio of vacancies to unemployed for United States and Canada; output gap for Brazil, Chile, India, Poland); and unemployment gap (the remaining seven economies). Based on estimates in Annex Table 3 and Annex Table 6. Data labels in the figure use International Organization for Standardization (ISO) country codes except for EUA (Euro area).

Figure 9. Core Inflation vs. Energy Inflation and Estimated Pass-through, 2020-2024
 (12-month rate; percentage points)



Sources: Haver analytics; Federal Reserve Bank of Cleveland; Statistics Canada; and authors' calculations.
 Note: Change in estimated pass-through indicates estimated contribution to core inflation from energy price inflation, as reported in Figure 8. Red labels denote changes from December 2020 to month of peak in headline inflation, with red line indicating the associated regression. Blue labels denote the change from peak to March 2024, with blue line indicating the associated regression. Black line indicates cross-section regression across both time intervals. Data labels indicate International Organization for Standardization (ISO) country codes except for EUA (euro area).

Annex

Annex Table 1. Peak Dates for Headline Inflation

Country Code	Peak Month
BRA	2022m4
CAN	2022m6
CHL	2022m8
DEU	2022m10
ESP	2022m7
EUA	2022m10
FRA	2023m2
GBR	2022m10
HUN	2023m1
IND	2022m4
ITA	2022m11
JPN	2023m1
KOR	2022m7
MEX	2022m8
MYS	2021m4
NOR	2022m10
POL	2023m2
SWE	2022m12
THA	2022m8
USA	2022m6
ZAF	2022m7

Source: IMF WEO, Haver, authors' calculations.

Note: Table reports month of peak in twelve-month headline inflation. Country labels indicate International Organization for Standardization (ISO) country codes except for EUA (euro area).

Annex Table 2. Cross-Section Estimates Underlying Results Reported in Figure 2

Headline Inflation vs. Energy Inflation				Core Inflation vs. Energy Inflation			
	(1) Rise	(2) Fall	(3) Overall		(1) Rise	(2) Fall	(3) Overall
Slope	0.082* (0.039)	0.099** (0.038)	0.197*** (0.020)	Slope	0.000 (0.024)	0.003 (0.024)	0.079*** (0.013)
Constant	5.822*** (1.372)	-3.996*** (1.266)	0.298 (0.742)	Constant	4.174*** (1.142)	-2.974*** (0.977)	0.325 (0.521)
Observations	21	21	42	Observations	21	21	42
R-squared	0.122	0.149	0.751	R-squared	0.000	0.000	0.501
Near-term Expectations vs. Energy Inflation				Core Inflation vs. Unemployment			
	(1) Rise	(2) Fall	(3) Overall		(1) Rise	(2) Fall	(3) Overall
Slope	0.042 (0.026)	0.065** (0.024)	0.094*** (0.013)	Slope	-0.093 (0.296)	-0.457 (0.719)	-0.606 (0.619)
Constant	2.721*** (0.935)	-1.057 (0.739)	0.295 (0.472)	Constant	4.381*** (0.793)	-3.437*** (0.872)	0.235 (0.944)
Observations	21	21	42	Observations	19	19	38
R-squared	0.062	0.154	0.626	R-squared	0.003	0.029	0.031

Note: Four panels of table report estimation results underlying the corresponding regression lines reported in the four panels of Figure 2. In each panel; column (1) reports results for changes from December 2020 to month of the country-specific peak in headline inflation; column (2) reports results for change from peak to the latest value (March 2024); and column (3) reports results for pooled regression across both time intervals. "Core inflation" denotes weighted median inflation. "Unemployment" denotes difference between unemployment rate and estimate of natural unemployment rate. Robust standard errors in parentheses.

***p < .01, **p < .05, and *p < .10

Annex Table 3. Explaining Headline Inflation Shocks, January 2020 - March 2024
(Dependent variable: Headline-inflation shock at monthly annualized rate)

	COUNTRIES	Energy price inflation	Food price inflation	Harper charter rate	Constant	Observations	R-squared
(1)	Brazil	0.081*** (0.014)	0.122* (0.066)	-0.000 (0.001)	0.931 (0.853)	51	0.434
(2)	Canada	0.053*** (0.010)	-0.018 (0.069)	0.001** (0.000)	-1.428** (0.608)	51	0.619
(3)	Chile	0.053*** (0.017)	0.010 (0.052)	0.001* (0.000)	0.342 (0.514)	51	0.303
(4)	Euro area	0.062*** (0.012)	0.031 (0.058)	0.000 (0.000)	-0.434 (0.664)	51	0.641
(5)	France	0.067*** (0.010)	0.045 (0.051)	0.000 (0.000)	0.084 (0.725)	51	0.536
(6)	Germany	0.081*** (0.027)	0.194** (0.083)	-0.000 (0.001)	0.296 (1.109)	51	0.545
(7)	Hungary	0.062*** (0.005)	0.176*** (0.037)	0.000 (0.000)	0.880 (0.749)	51	0.820
(8)	India	0.074** (0.031)	0.438*** (0.036)	-0.000 (0.000)	0.469 (0.433)	51	0.937
(9)	Italy	0.042*** (0.003)	-0.026 (0.103)	0.001*** (0.000)	-1.655 (1.028)	51	0.760
(10)	Japan	0.060* (0.032)	0.315*** (0.064)	0.000 (0.000)	-0.341 (0.663)	51	0.475
(11)	Korea	0.014** (0.005)	0.158*** (0.033)	0.001** (0.000)	-0.468 (0.722)	51	0.339
(12)	Malaysia	0.010*** (0.002)	0.340** (0.146)	-0.000 (0.001)	-0.230 (1.726)	49	0.209
(13)	Mexico	0.083*** (0.011)	0.314*** (0.031)	-0.000 (0.000)	-0.722* (0.395)	51	0.790
(14)	Norway	0.016*** (0.005)	0.118*** (0.038)	0.001* (0.001)	-1.105 (1.047)	51	0.462
(15)	Poland	0.093*** (0.019)	0.095** (0.042)	0.001* (0.000)	-0.529 (0.713)	51	0.739
(16)	South Africa	0.028*** (0.006)	-0.023 (0.066)	0.000 (0.000)	1.092 (0.669)	51	0.452
(17)	Spain	0.070*** (0.013)	-0.074 (0.114)	0.000 (0.000)	-0.191 (0.883)	51	0.741
(18)	Sweden	0.087*** (0.009)	0.003 (0.051)	0.000 (0.000)	-0.550 (0.760)	51	0.760
(19)	Thailand	0.061*** (0.014)	0.347*** (0.101)	0.001 (0.000)	-1.971** (0.977)	51	0.746
(20)	United Kingdom	0.018*** (0.004)	0.047 (0.057)	0.001** (0.000)	-0.922 (0.764)	51	0.623
(21)	United States	0.073*** (0.012)	-0.093 (0.117)	0.000 (0.000)	-1.062* (0.538)	51	0.693

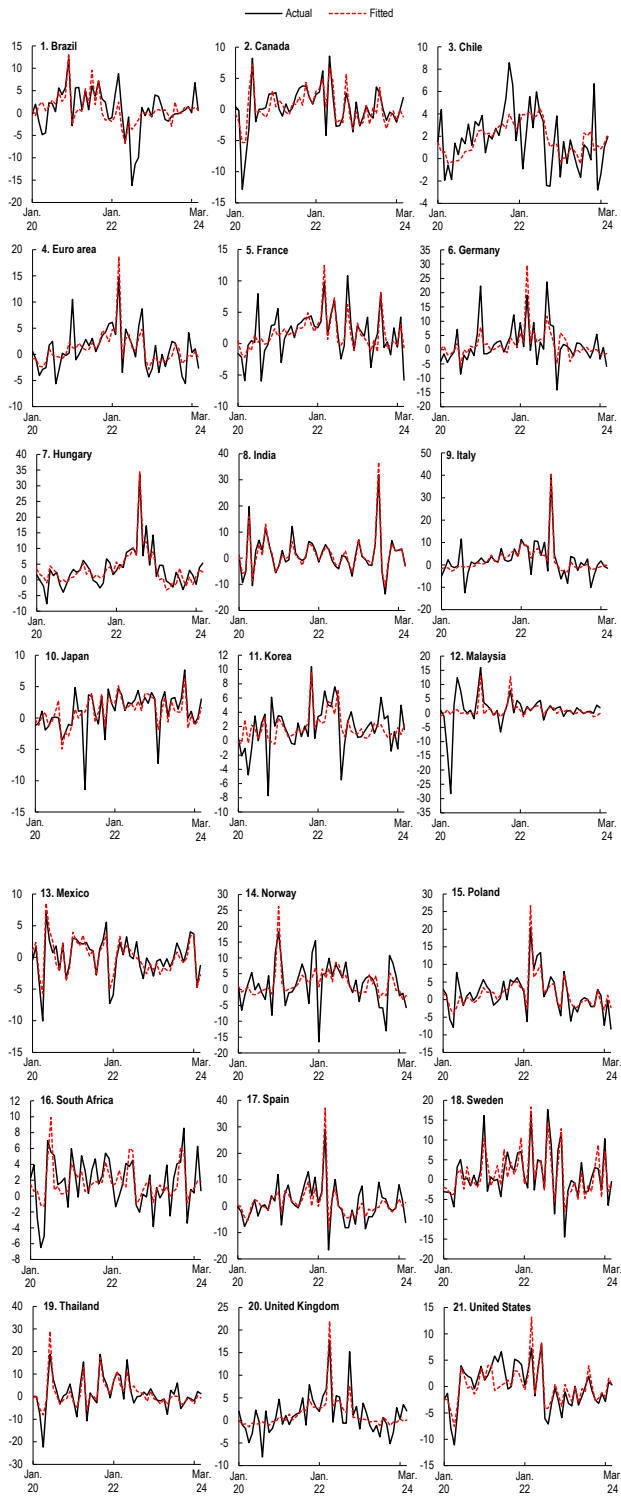
Sources: Haver analytics; Federal Reserve Bank of Cleveland; Statistics Canada; and authors' calculations.

Note: Note: Headline-inflation shock denotes deviation of headline inflation from core (weighted median) inflation.

Sample covers January 2020 – March 2024. For Malaysia, sample ends in January 2024. Relative energy and food price inflation are computed by subtracting median inflation from energy and food price inflation, respectively, in monthly annualized terms. Huber-White standard errors in parentheses.

***p < .01, **p < .05, and *p < .10

Annex Figure 1. Explaining Headline-inflation Shocks Actual vs. Fitted Values (Monthly annualized rate; percentage points)



Sources: Haver analytics; Federal Reserve Bank of Cleveland; Statistics Canada; and authors' calculations.
 Note: Figure reports actual and fitted values of headline inflation shocks based on estimation results reported in Annex Table 3.

Annex Table 4. Explaining Headline Inflation Shocks, January 2020 - March 2024: Country Specific Factors

(Dependent variable: Headline inflation shock at monthly annualized rate)

	COUNTRIES	Energy price inflation	Backlogs of work	Weighted average of car inflation	Dollar exchange rate, % change	Harper charter rate	Global supply chain pressure index	COVID-19 deaths, monthly	Food price inflation	Suppliers' delivery times	NEER, % change	Constant	Observations	R-squared
(1)	Brazil	0.073*** (0.016)	0.323** (0.154)	0.060* (0.035)								-14.414* (7.322)	51	0.472
(2)	Canada	0.047*** (0.006)	0.305*** (0.058)		-0.012 (0.014)							-14.871*** (2.762)	51	0.766
(3)	Chile	0.054*** (0.015)				0.000 (0.000)	0.347* (0.178)					0.293 (0.511)	51	0.334
(4)	Euro area	0.061*** (0.011)	0.056 (0.045)			0.000 (0.000)						-2.968 (1.932)	51	0.643
(5)	France	0.064*** (0.008)				-0.000 (0.000)		0.000** (0.000)				-0.494 (0.773)	51	0.567
(6)	Germany	0.081*** (0.027)				-0.000 (0.001)			0.194** (0.083)			0.296 (1.109)	51	0.545
(7)	Hungary	0.061*** (0.004)						0.000** (0.000)	0.143*** (0.034)			-0.049 (0.592)	51	0.838
(8)	India		0.178 (0.129)						0.427*** (0.025)	-0.223** (0.103)		2.271 (4.894)	51	0.926
(9)	Italy	0.040*** (0.004)						0.000** (0.000)	0.028 (0.117)			-1.081 (1.086)	51	0.726
(10)	Japan	0.062** (0.028)						0.000 (0.000)	0.315*** (0.073)			-0.210 (0.443)	51	0.474
(11)	Korea	0.014** (0.005)				0.001** (0.000)			0.158*** (0.033)			-0.468 (0.722)	51	0.339
(12)	Malaysia	0.009*** (0.002)			-0.104* (0.059)						-0.030 (0.083)	1.000 (0.695)	49	0.268
(13)	Mexico	0.080*** (0.010)			-0.003* (0.002)				0.309*** (0.030)			-0.902*** (0.254)	51	0.795
(14)	Norway	0.016*** (0.005)				0.001* (0.001)			0.118*** (0.038)			-1.105 (1.047)	51	0.462
(15)	Poland	0.093*** (0.019)				0.001* (0.000)			0.095** (0.042)			-0.529 (0.713)	51	0.739
(16)	South Africa	-0.045*** (0.013)		0.224*** (0.040)						0.080** (0.035)		-2.647* (1.511)	51	0.598
(17)	Spain	0.071*** (0.015)				-0.000 (0.000)				-0.020 (0.057)		0.742 (2.446)	51	0.736
(18)	Sweden	0.087*** (0.009)				0.000 (0.000)	-0.000 (0.000)					-0.550 (0.767)	51	0.760
(19)	Thailand	0.061*** (0.014)				0.001 (0.000)			0.347*** (0.101)			-1.971** (0.977)	51	0.746
(20)	United Kingdom	0.018*** (0.004)				0.001 (0.000)	0.000 (0.000)					-1.459* (0.797)	51	0.628
(21)	United States	0.062*** (0.007)	0.162*** (0.044)	0.084*** (0.011)								-9.230*** (2.222)	51	0.929

Sources: Haver analytics; Federal Reserve Bank of Cleveland; Statistics Canada; and authors' calculations.

Note: Headline-inflation shock denotes deviation of headline inflation from core (weighted median) inflation. Sample covers January 2020 – March 2024. For Malaysia, sample ends in January 2024. Relative energy, food, and auto-related price inflation variables are created by subtracting median inflation from energy, food, and auto-related price inflation respectively, in monthly annualized terms. Backlogs of work and suppliers' delivery times variables are taken from IHS Markit Economics. The Harper charter rate reflects the worldwide price evolution of the charter market for container ships, and this variable is taken from Harper Petersen Holding GmbH. Global supply chain pressure index variable is sourced from Federal Reserve Bank of New York. COVID-19 deaths variable is from Oxford Covid-19 Government Response Tracker. Huber-White standard errors in parentheses.

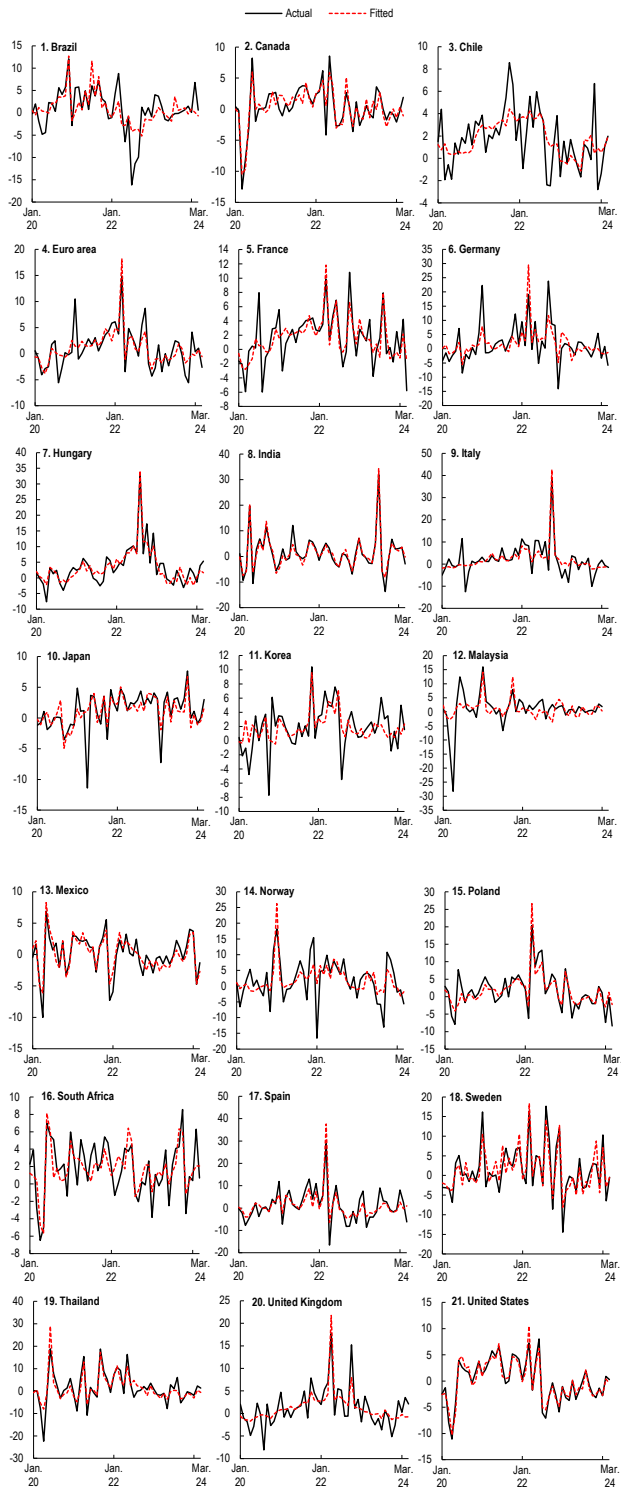
***p < .01, **p < .05, and *p < .10

Annex Table 5. Top Three Drivers of Headline Inflation Shocks

	Top1	Top2	Top3
Brazil	Energy price inflation	Backlogs of work	Weighted average of car inflation
Canada	Energy price inflation	Backlogs of work	Dollar exchange rate, % change
Chile	Harper charter rate	Energy price inflation	Global supply chain pressure index
Euro area	Energy price inflation	Harper charter rate	Backlogs of work
France	Energy price inflation	COVID-19 deaths, monthly	Harper charter rate
Germany	Energy price inflation	Food price inflation	Harper charter rate
Hungary	Energy price inflation	Food price inflation	COVID-19 deaths, monthly
India	Food price inflation	Suppliers' delivery times	Backlogs of work
Italy	Energy price inflation	Food price inflation	COVID-19 deaths, monthly
Japan	Food price inflation	Energy price inflation	COVID-19 deaths, monthly
Korea	Food price inflation	Harper charter rate	Energy price inflation
Malaysia	Energy price inflation	Dollar exchange rate, % change	NEER, % change
Mexico	Energy price inflation	Food price inflation	Dollar exchange rate, % change
Norway	Energy price inflation	Food price inflation	Harper charter rate
Poland	Energy price inflation	Harper charter rate	Food price inflation
South Africa	Weighted average of car inflation	Energy price inflation	Suppliers' delivery times
Spain	Energy price inflation	Suppliers' delivery times	Harper charter rate
Sweden	Energy price inflation	Harper charter rate	COVID-19 deaths, monthly
Thailand	Energy price inflation	Food price inflation	Harper charter rate
United Kingdom	Energy price inflation	Harper charter rate	COVID-19 deaths, monthly
United States	Energy price inflation	Backlogs of work	Weighted average of car inflation

Notes. The top three drivers reported in the table are based on the highest bivariate R-squared statistics reported in Table 1.

Annex Figure 2. Explaining Headline-inflation Shocks (country specific)
Actual vs. Fitted Values
 (Percent; monthly annualized rate)

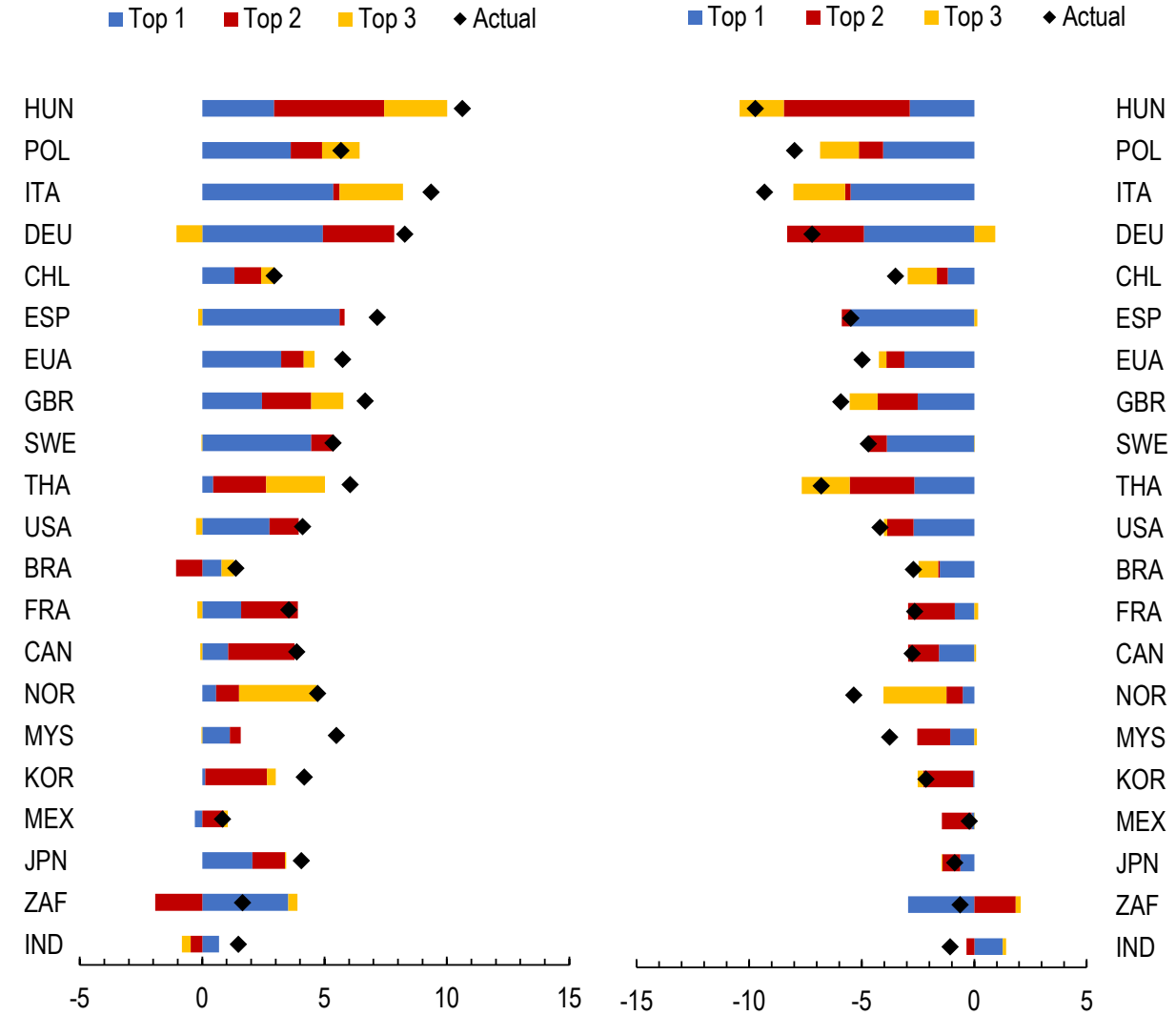


Sources: Haver analytics; Federal Reserve Bank of Cleveland; Statistics Canada; and authors' calculations.
 Note: Figure reports actual and fitted values of headline inflation shocks based on estimation results reported in Annex Table 4.

Annex Figure 3. Headline Shock Decomposition with Country-specific Components
(Twelve-month rates; percentage points)

1. Rise to Peak Inflation

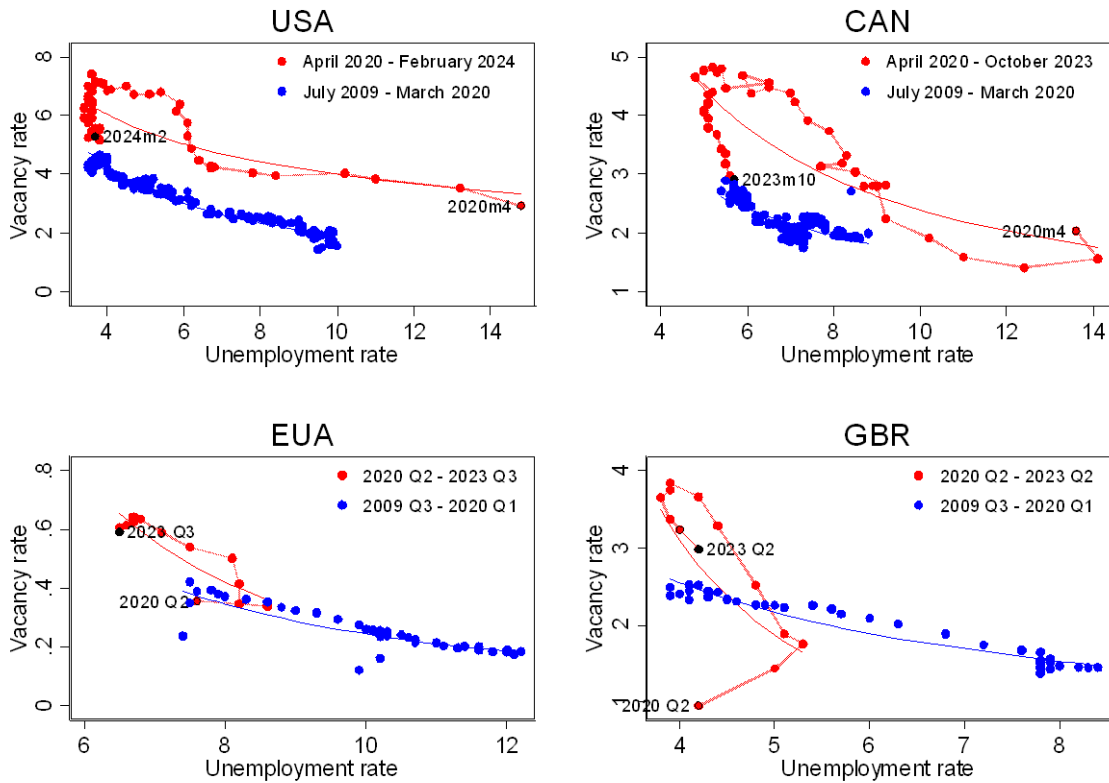
2. Fall from Peak to Latest



Notes. See notes to Figure 5. For the top three country-specific components, please refer to the list in Annex Table 5.

Annex Figure 4. The Beveridge Curve in the United States, Canada, the Euro Area, and the United Kingdom, 2009–2024

(Percent of filled and unfilled vacancies; percent of labor force)



Source: US Bureau of Labor Statistics, Statistics Canada, Eurostat, Office of National Statistics, and authors' calculations

Note: Chart reports log-linear curves fitted to each period. For the United States, July 2009 – March 2020 covers the pre-COVID-19 expansion and the first month of the COVID-19 era, based on NBER business cycle dates. For Canada, euro area, and United Kingdom, periods displayed correspondingly. Data labels in the figure use International Organization for Standardization (ISO) country codes except for EUA (euro area).

Annex Table 6. Phillips Curve Estimates: Median Inflation

	(1) DEU	(2) ESP	(3) FRA	(4) JPN	(5) SWE	(6) EUA	(7) GBR	(8) ITA	(9) BRA	(10) CHL	(11) IND	(12) POL	(13) CAN	(14) USA
Slack	-0.580*** (0.158)	-0.140*** (0.049)	-0.561*** (0.129)	0.224 (0.151)	-0.222** (0.111)	-0.501*** (0.129)	-0.716*** (0.196)	-0.241*** (0.046)	0.293*** (0.069)	0.403* (0.206)	-0.206 (0.254)	0.327** (0.126)	0.537*** (0.161)	0.433*** (0.078)
Slack-squared	0.164** (0.076)	-0.008 (0.011)	0.064 (0.168)	0.099 (0.304)	-0.059 (0.091)	0.090 (0.055)				-0.002 (0.013)	0.055 (0.042)	-0.082** (0.040)	0.059 (0.069)	-0.205** (0.217)
Slack-cubed													-0.099 (0.062)	0.113*** (0.031)
H	0.308*** (0.103)	0.159 (0.112)	0.146 (0.133)	0.150* (0.090)	0.007 (0.232)	0.587*** (0.069)	0.843*** (0.080)	0.393*** (0.046)	0.302** (0.140)	-0.073 (0.695)	0.458*** (0.158)	0.445 (0.291)	0.067 (0.146)	0.014 (0.073)
H-squared	0.072*** (0.025)	0.121*** (0.019)	0.179*** (0.044)	-0.019 (0.044)	0.267*** (0.060)	0.125*** (0.021)			0.293*** (0.061)	0.580*** (0.177)	-0.004 (0.046)	0.183*** (0.050)	0.126*** (0.045)	0.081*** (0.018)
H-cubed													0.065* (0.036)	0.042*** (0.011)
Constant	-0.793*** (0.066)	-0.680*** (0.241)	-0.925*** (0.136)	-1.150*** (0.093)	-0.637*** (0.159)		-0.301** (0.133)	-0.600*** (0.109)		-1.579** (0.645)	-0.612** (0.246)	-0.659* (0.368)	-0.243** (0.100)	0.120 (0.078)
Observations	327	255	399	279	348	267	376	327	201	171	106	207	373	460
R-squared	0.570	0.480	0.506	0.0374	0.316	0.764	0.317	0.509	0.470	0.490	0.211	0.653	0.344	0.623
Measure of slack	U gap	U gap	U gap	U gap	U gap	U gap	U gap	U gap	Y gap	Y gap	Y gap	Y gap	V/U	V/U
Sample start year	1997	2003	1991	2001	1995	2002	1992	1997	2007	2010	2015	2007	1993	1985

Note: "Slack" denotes contribution of change in economic slack. "U gap" denotes unemployment gap (twelve-month average). "Y gap" denotes output gap (four quarter average). "V/U" denotes ratio of vacancies to unemployed (twelve-month average). For comparability across economies in table, V/U variable is standardized before estimation. "H" denotes headline inflation shock (twelve-month average). Newey-West standard errors with twelve lags (monthly data) in parentheses. Data labels in the table use International Organization for Standardization (ISO) country codes except for EUA (euro area).

***p < .01, **p < .05, and *p < .10

Annex Table 7. Robustness: Excluding Outliers. Phillips Curve Estimates

	(1) DEU	(2) ESP	(3) FRA	(4) JPN	(5) SWE	(6) EUA	(7) GBR	(8) ITA	(9) BRA	(10) CHL	(11) IND	(12) POL	(13) CAN	(14) USA
Slack	-0.629*** (0.149)	-0.113*** (0.036)	-0.702*** (0.074)	0.249* (0.131)	-0.289*** (0.071)	-0.538*** (0.124)	-0.829*** (0.135)	-0.228*** (0.038)	0.305*** (0.069)	0.234 (0.150)	-0.313 (0.216)	0.377*** (0.108)	0.441*** (0.103)	0.435*** (0.072)
Slack-squared	0.189*** (0.068)	-0.008 (0.007)	0.198 (0.121)	0.186 (0.279)	0.011 (0.077)	0.101* (0.053)				-0.004 (0.012)	0.024 (0.030)	-0.096*** (0.034)	0.053 (0.061)	-0.171** (0.136)
Slack-cubed													-0.067* (0.036)	0.097*** (0.025)
H	0.214*** (0.059)	0.204*** (0.075)	0.002 (0.109)	0.080 (0.076)	-0.061 (0.133)	0.560*** (0.065)	0.820*** (0.076)	0.411*** (0.038)	0.205 (0.141)	-0.862 (0.626)	0.322** (0.141)	0.302 (0.231)	-0.064 (0.099)	0.039 (0.068)
H-squared	0.103*** (0.014)	0.116*** (0.017)	0.201*** (0.042)	0.025 (0.031)	0.214*** (0.051)	0.140*** (0.017)			0.347*** (0.028)	0.801*** (0.154)	-0.004 (0.054)	0.202*** (0.036)	0.098** (0.040)	0.114*** (0.017)
H-cubed													0.095*** (0.023)	0.039*** (0.011)
Constant	-0.834*** (0.064)	-0.890*** (0.135)	-0.857*** (0.124)	-1.212*** (0.079)	-0.713*** (0.123)		-0.360*** (0.116)	-0.753*** (0.085)		-1.012* (0.540)	-0.488** (0.220)	-0.727** (0.326)	-0.210** (0.104)	0.083 (0.078)
Observations	312	240	372	261	323	251	358	312	187	166	100	195	350	434
R-squared	0.639	0.560	0.486	0.0740	0.164	0.755	0.291	0.499	0.455	0.555	0.251	0.569	0.152	0.556
Measure of slack	U gap	U gap	U gap	U gap	U gap	U gap	U gap	U gap	Y gap	Y gap	Y gap	Y gap	V/U	V/U
Sample start year	1997	2003	1991	2001	1995	2002	1992	1997	2007	2010	2015	2007	1993	1985

Notes: Table reports estimation results based on same specifications as in Annex Table 6 but with outliers excluded based on Cook's distance. Observations where Cook's distance exceeds $4/N$, where N is the sample size, are discarded. Newey-West standard errors with twelve lags (monthly data) in parentheses. Data labels in the table use International Organization for Standardization (ISO) country codes except for EUA (euro area).

***p < .01, **p < .05, and *p < .10

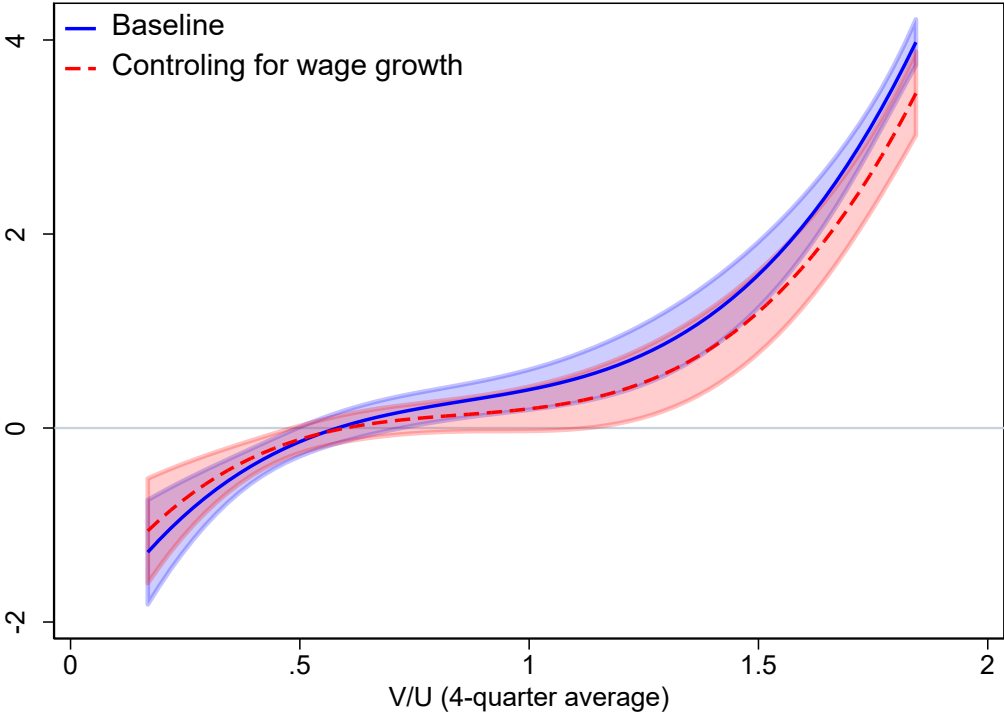
Annex Table 8. Robustness: Core Inflation based on Excluding Food and Energy. Phillips Curve Estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	DEU	ESP	FRA	JPN	SWE	EUA	GBR	ITA	BRA	CHL	IND	POL	CAN	USA
Slack	-0.097 (0.329)	-0.148*** (0.057)	-0.580*** (0.169)	-0.208 (0.309)	-0.095 (0.110)	-0.421* (0.250)	-0.615 (0.440)	-0.196** (0.093)	0.379*** (0.086)	0.473 (0.346)	-0.027 (0.329)	0.607*** (0.189)	0.291 (0.254)	0.454* (0.234)
Slack-squared	-0.022 (0.169)	-0.012 (0.013)	-0.279 (0.274)	-1.826** (0.874)	0.008 (0.124)	-0.005 (0.110)			0.008 (0.016)	0.112 (0.071)	0.006 (0.045)	0.157** (0.078)	0.437* (0.264)	-0.135 (0.159)
Slack-cubed													-0.097 (0.072)	0.059 (0.063)
H	0.034 (0.184)	0.093 (0.130)	0.282 (0.215)	0.308 (0.261)	0.120 (0.260)	0.260 (0.165)	0.677*** (0.242)	0.600*** (0.182)	0.146 (0.199)	0.046 (0.968)	0.129 (0.170)	0.699** (0.346)	0.090 (0.252)	0.205 (0.199)
H-squared	0.350*** (0.058)	0.185*** (0.023)	0.371** (0.155)	0.133 (0.116)	0.703*** (0.115)	0.270*** (0.060)			0.377*** (0.057)	0.300 (0.287)	-0.001 (0.046)	0.659*** (0.109)	-0.009 (0.180)	0.072 (0.054)
H-cubed													0.079 (0.091)	0.003 (0.031)
Constant	-0.500*** (0.161)	-0.095 (0.238)	-0.209 (0.190)	-0.977*** (0.227)	-0.906*** (0.248)		-0.261 (0.282)	0.161 (0.168)		-0.803 (0.497)	0.468 (0.404)	-0.854** (0.420)	-0.474*** (0.167)	-0.063 (0.136)
Observations	339	348	399	339	348	268	407	399	202	171	142	312	374	460
R-squared	0.149	0.172	0.134	0.0344	0.210	0.385	0.0799	0.0878	0.384	0.144	-0.0197	0.518	0.0792	0.188
Measure of slack	U gap	U gap	U gap	U gap	U gap	U gap	U gap	U gap	Y gap	Y gap	Y gap	Y gap	V/U	V/U
Sample start year	1996	1995	1991	1996	1995	2001	1990	1991	2007	2010	2012	1998	1993	1985

Notes: Table reports estimation results based on same specifications as in Annex Table 6 but with core inflation measured by monthly annualized inflation excluding food and energy (XFE) instead of with weighted median inflation. Newey-West standard errors with twelve lags (monthly data) in parentheses. Data labels in the table use International Organization for Standardization (ISO) country codes except for EUA (euro area).

***p < .01, **p < .05, and *p < .10

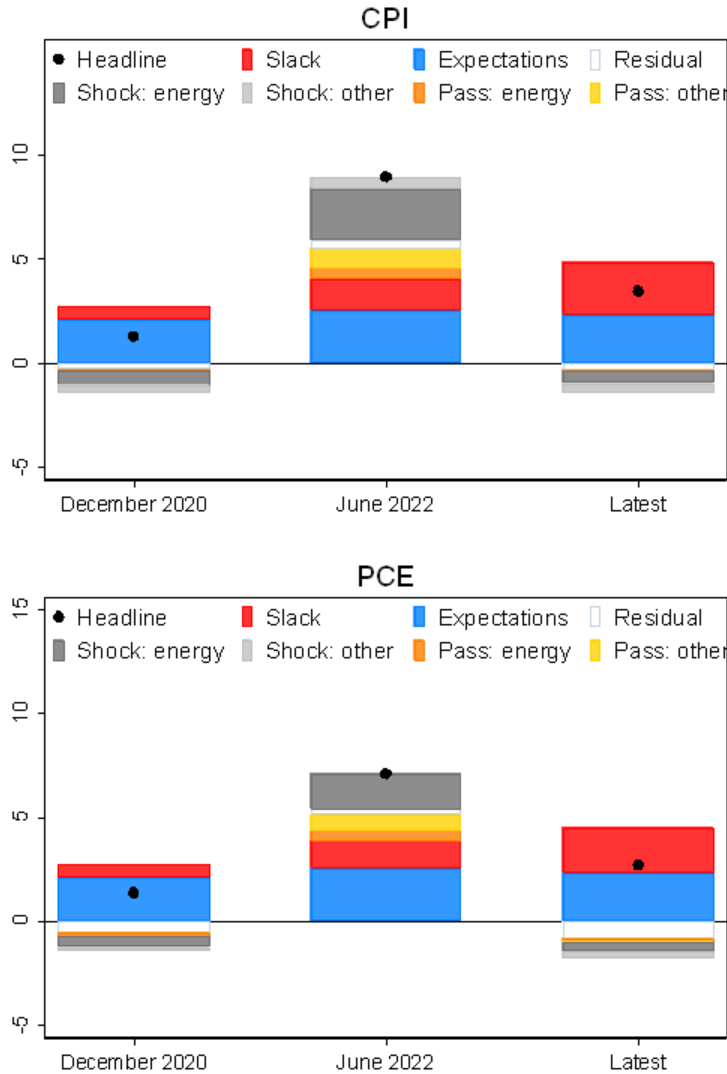
Annex Figure 5. Estimated Inflation Gap as a Function of Slack: United States
 (Percentage points; quarterly data)



Sources: Consensus Economics; authors' calculations.
 Note: "Baseline" indicates fitted values for V/U slack terms from quarterly data version of equation estimates reported in Annex Table 6 for the United States. "Controlling for wage growth" indicates fitted values after controlling for four-quarter average of wage growth based on the US Employment Cost Index for Private Industry Workers. Bands indicate 95 percent confidence interval. Inflation gap denotes quarterly annualized median CPI inflation minus long-term inflation expectations.

Annex Figure 6. United States: Contributions to Headline CPI and PCE Inflation, 2020-2024

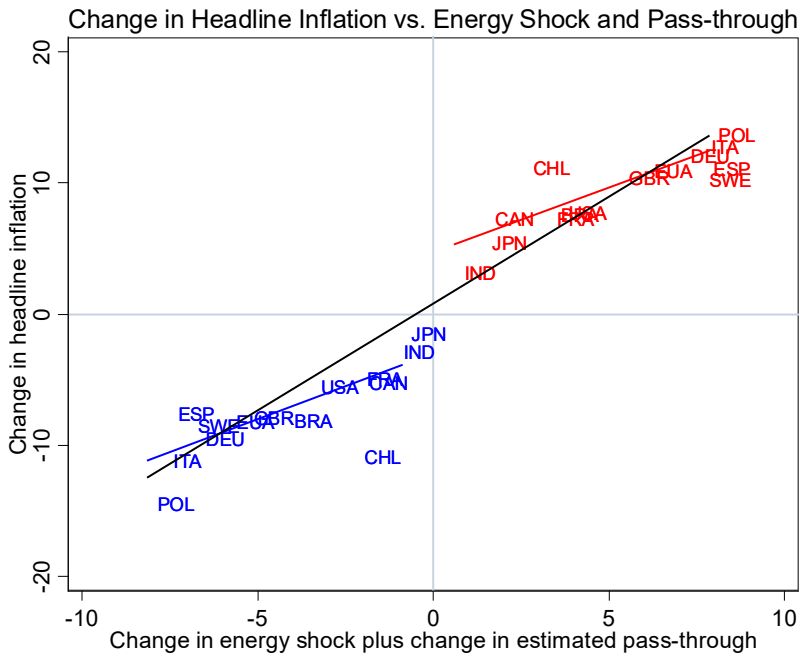
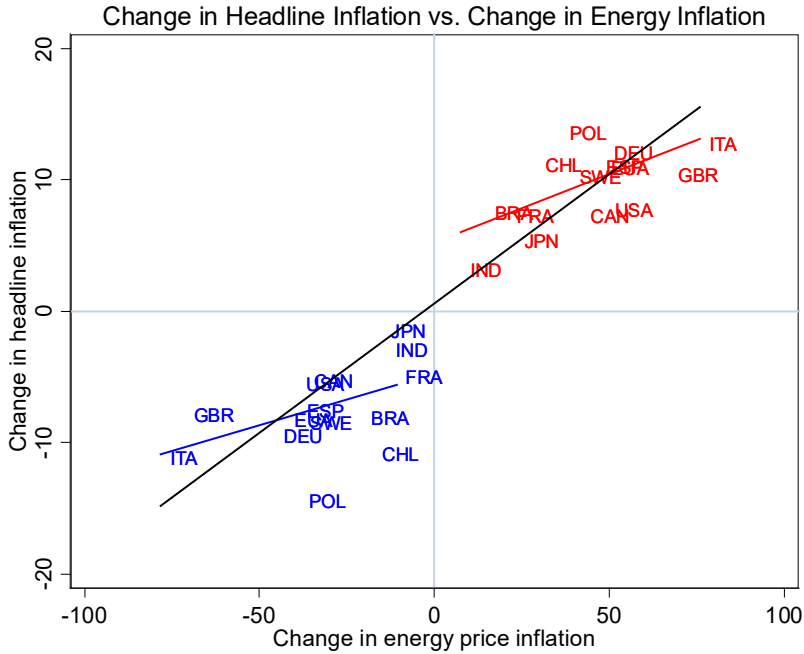
(Decomposition of headline CPI and PCE inflation; twelve-month rate; percentage points)



Sources: Haver analytics; Federal Reserve Bank of Cleveland; and authors' calculations.

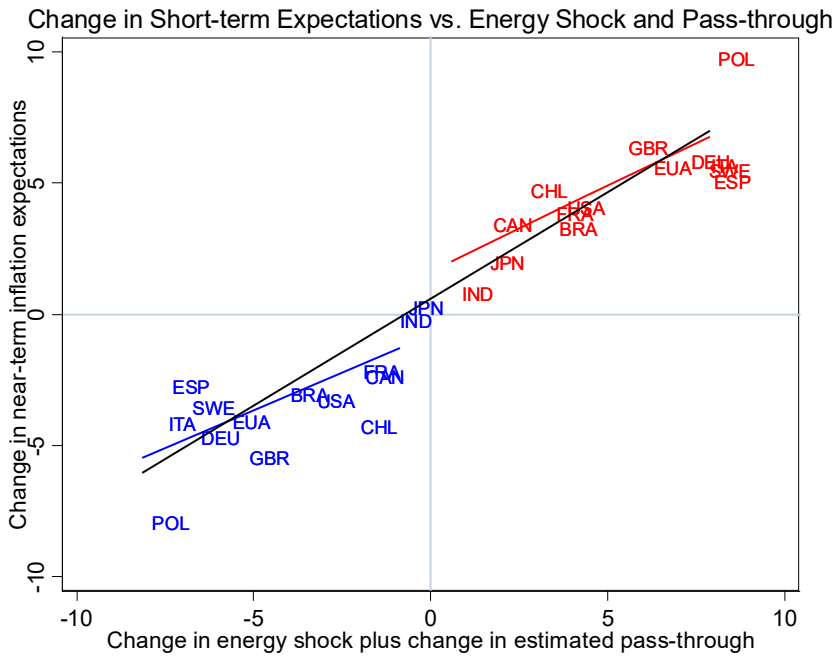
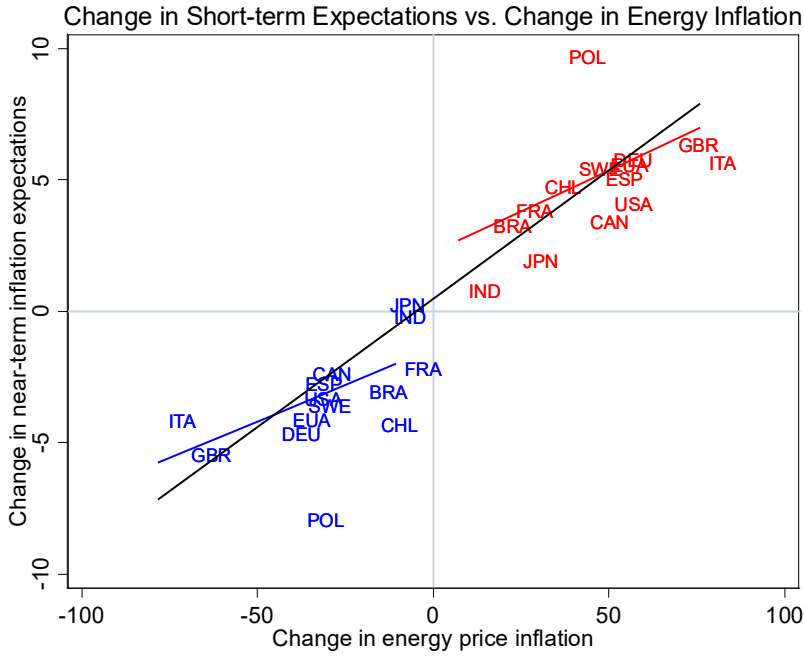
Note: "Shock" denotes contribution of headline inflation shocks (energy or other). "Pass" denotes pass-through from headline inflation shocks (energy or other) into core inflation. "Energy" denotes contribution of relative energy prices. "Expected inflation" denotes contribution of change in long-term inflation expectations to change in headline inflation. "Slack" denotes contribution of change in economic slack (ratio of vacancies to unemployed for United States).

Annex Figure 7. Headline Inflation vs. Energy Inflation and Estimated Pass-through
(12-month rate; percentage points)



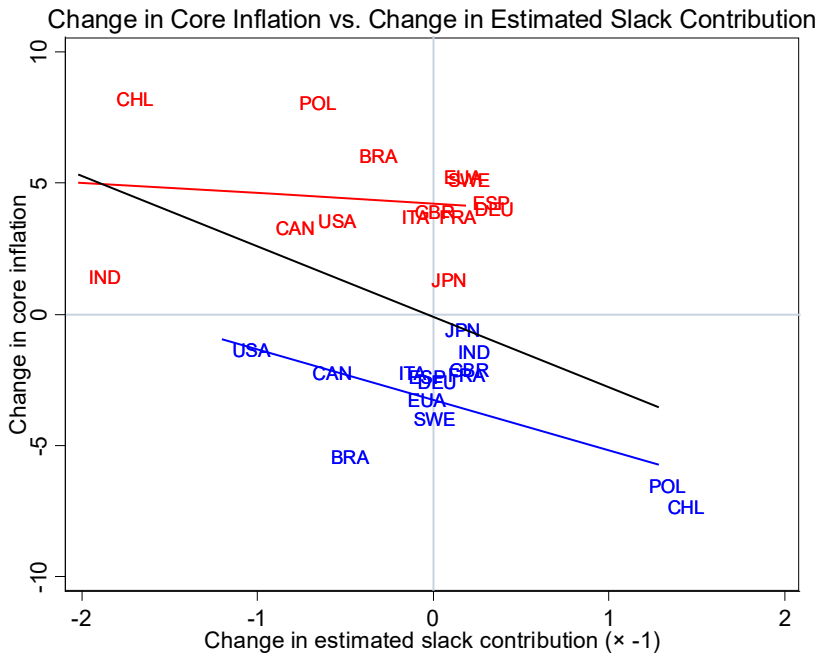
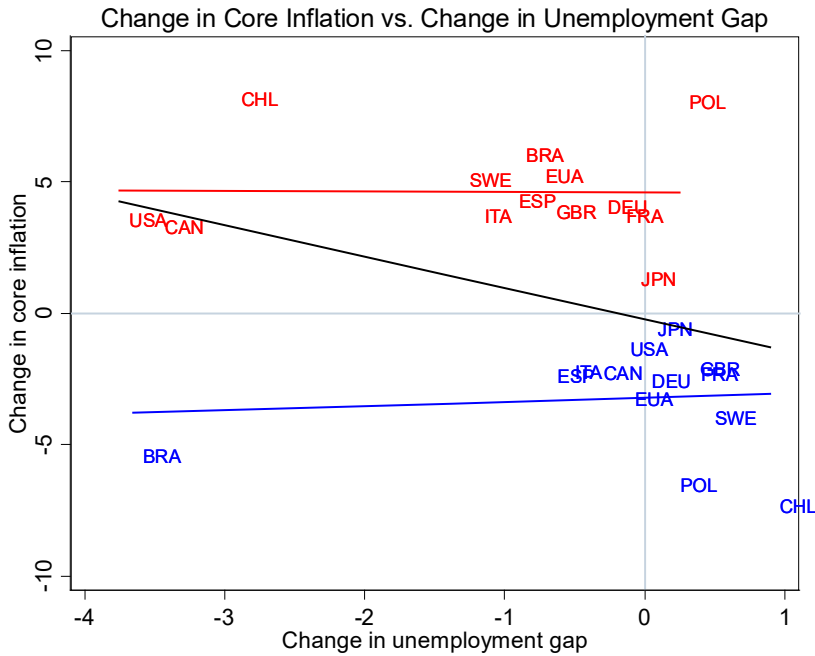
Sources: Haver analytics; Federal Reserve Bank of Cleveland; Statistics Canada; and authors' calculations. Note: Energy shock indicates headline-inflation shock explained by relative energy price inflation. Estimated pass-through indicates estimated contribution to core inflation from energy price inflation, as reported in Figure 8. Red labels denote changes from December 2020 to month of peak in headline inflation, with red line indicating the associated regression. Blue labels denote the change from peak to March 2024, with blue line indicating the associated regression. Black line indicates cross-section regression across both time intervals. Data labels indicate International Organization for Standardization (ISO) country codes except for EUA (euro area).

Annex Figure 8. Near-term Inflation Expectations vs. Energy Inflation
(12-month rate; percentage points)



Sources: Haver analytics; Federal Reserve Bank of Cleveland; Statistics Canada; and authors' calculations. Note: Energy shock indicates headline-inflation shock explained by relative energy price inflation. Estimated pass-through indicates estimated contribution to core inflation from energy price inflation, as reported in Figure 8. Red labels denote changes from December 2020 to month of peak in headline inflation, with red line indicating the associated regression. Blue labels denote the change from peak to March 2024, with blue line indicating the associated regression. Black line indicates cross-section regression across both time intervals. Data labels indicate International Organization for Standardization (ISO) country codes except for EUA (euro area).

Annex Figure 9. Core Inflation vs. Unemployment Gap
 (12-month rate; 12-month average rate; percentage points)



Sources: Haver analytics; Federal Reserve Bank of Cleveland; Statistics Canada; and authors' calculations.
 Note: "Estimated slack" indicates estimated contribution of macroeconomic conditions, as reported in Figure 8. For comparability with unemployment gap in first panel, contribution of slack multiplied by -1. Red labels denote changes from December 2020 to month of peak in headline inflation. Blue labels denote the change from peak to March 2024. Black line indicates cross-section regression across both time intervals. "Unemployment gap" denotes difference between unemployment rate and natural unemployment rate. Data labels indicate International Organization for Standardization (ISO) country codes except for EUA (euro area).