CHAPTER 2

THE GREAT TIGHTENING: INSIGHTS FROM THE RECENT INFLATION EPISODE

The recent global inflationary experience was characterized by a complex set of events. During COVID-19 lockdowns, demand shifted toward goods and then pivoted toward services as economies reopened. These demand shifts occurred in the context of supply disruptions and unprecedented fiscal and monetary stimulus. Subsequently, the war in Ukraine led to spikes in commodity prices. Evidence suggests that the pass-through of sectoral price pressures to core inflation and the steepening of the inflation-slack relationship—that is, the Phillips curve—are essential to understanding the global surge in inflation. This evidence is consistent with key sectors hitting their supply bottlenecks as demand rotated across sectors and was boosted over time by a drawdown of savings. This chapter offers a new lesson and confirms an old one for monetary policy. In extreme cases when sectoral supply bottlenecks are widespread across an economy and interact with strong demand, inflation can surge, but tighter policy can bring it down quickly with limited output costs. Outside of such cases, when supply bottlenecks are confined to specific sectors, conventional policy rules, such as those that target measures of core inflation, perform well.

Introduction

The past three years have witnessed an extraordinary set of inflationary events. Initially, the COVID-19 pandemic triggered widespread economic shutdowns, causing many businesses to cut back on production. As the recovery began with pandemic restrictions still in place, consumer demand for goods surged. However, producers struggled to ramp up supply quickly enough amid ongoing supply-chain disruptions, leading to price pressures in the goods sector. When economies reopened, price pressures shifted as pent-up demand for services was released. While instrumental in containing the economic fallout from the pandemic, the unprecedented fiscal and monetary stimulus[1] deployed by advanced economies and some emerging markets initially increased savings. Over time, however, a drawdown of those savings boosted demand, widening supply-demand imbalances and spurring inflation as capacity remained constrained. The situation was exacerbated by the war in Ukraine, which led to a global food and energy crisis. By mid-2022, global inflation had tripled relative to its prepandemic level (Figure 2.1, panel 1).

These inflationary pressures tested monetary policy frameworks and resulted in a global tightening cycle, or "Great Tightening." The sectoral nature of the shocks, the accompanying relative price shifts, and the uncertainty about their ultimate inflationary effects, as well as the desire to prevent scarring from the pandemic, made it a challenge for central banks to calibrate the timing and pace of monetary responses. Central banks had to rely on tools and frameworks that did not fully account for the features of the new economic landscape. The simultaneous use of multiple policy levers by many countries, including balance sheet policies, price-suppressing measures, and fiscal policy, required assessment of their joint effects in real time. Despite the global nature of the tightening cycle, central banks did not start their rate hikes at the same time, with some (for example, Brazil and Chile) moving earlier than others, depending on country-specific circumstances and the timing and asymmetric effects of shocks.

Taking stock of the experience since late 2020, this chapter aims to disentangle the contribution of shocks and policy responses in accounting for the inflation surge and the subsequent disinflation, with the goal of drawing lessons for monetary policymakers. The chapter's findings can be informative as rising geopolitical tensions and extreme weather events are likely to trigger further sectoral shocks, and as central banks review their monetary policy strategies and

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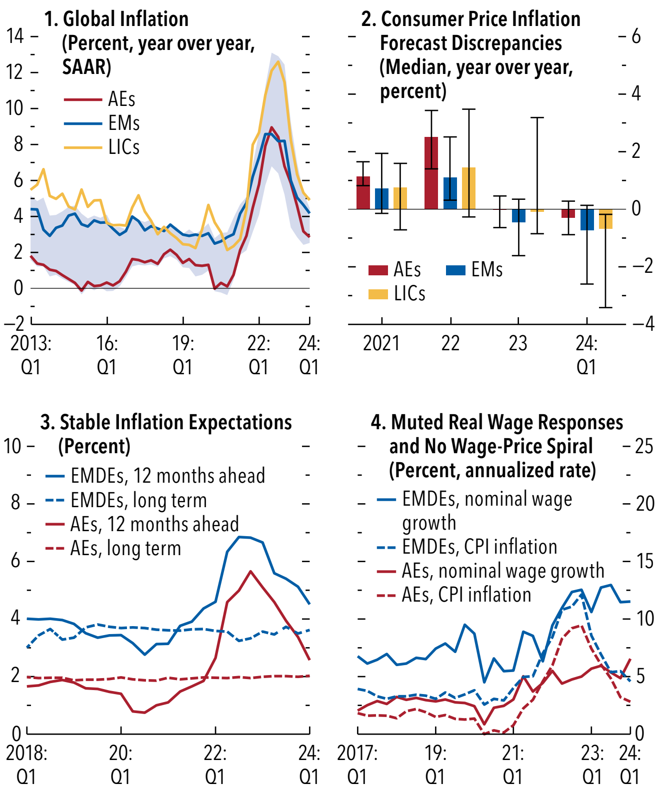
[1]Fiscal stimulus amounted to an average of about 12 percent of GDP in advanced economies and to an average of 4 percent of GDP in emerging markets (Deb and others 2024); quantitative easing policies amounted to about 20 percent of GDP in several advanced economies (Erceg and others 2024a).

Figure 2.1. Cross-Country Inflation Dynamics



Sources: Consensus Economics; Haver Analytics; International Labour Organization; Organisation for Economic Co-operation and Development; and IMF staff calculations.

Note: In panel 1, lines are the median of consumer price index (CPI) inflation within each analytical group. The band depicts the 25th to 75th percentiles of data across economies. In panel 2, forecast discrepancies are derived by comparing one-year-ahead inflation forecasts with actual figures in the April *World Economic Outlook*. The bars represent median inflation rates, and the whiskers extend from the 25th to the 75th percentiles of data across economies. The data for the first quarter of 2024 are annualized year-over-year percent changes. Panel 3 reports quarterly 12-month- and five-year-ahead inflation expectations. Panel 4 reports real wages computed as nominal wages (defined on a per worker basis) divided by the CPI and then indexed to 100 in each country in the first quarter of 2017. Each line reports the group median. AEs = advanced economies; EMs = emerging markets; EMDEs = emerging market and developing economies; LICs = low-income countries; SAAR = seasonally adjusted annual rate.

frameworks. The chapter's analysis is structured around the following questions:

- What accounts for the recent inflation dynamics in advanced economies and in emerging market and developing economies? What role did sectoral shocks and capacity constraints play, and how did they interact with monetary and fiscal policy?
- Was the monetary policy response or its transmission unusual relative to the past?
- What lessons can be drawn for monetary policy? Did the global nature of tightening make a difference?

The chapter tackles these questions in three parts. It first lays out stylized facts, both using raw data and through the lens of empirical Phillips curves. The second part documents the monetary policy response and transmission across countries and time. Third, findings from the empirical section motivate the development of a new multisector network model. The model is used to construct counterfactual scenarios to assess the importance of sectoral capacity constraints, the global nature of monetary tightening, and other fundamental factors in driving both the recent inflation surge and the ensuing disinflation. This part also compares the performance of alternative simple policy rules under different scenarios.

The chapter's main findings are as follows:

- *Price surges in specific sectors and their broadening over time were a defining feature of the recent inflation episode.* Price pressures emerged sooner and were more pronounced in the goods sector and in sectors with higher energy dependence and flexible prices. The spillovers from higher prices in the energy and other sectors to core inflation played an important role. Overall, there is little evidence in most economies—with the possible exception of the US—to suggest that inflation was driven by labor market strength, at least during peak inflation.
- *Price Phillips curves steepened, but wage Phillips curves did not.* The relationship between economic slack and inflation in the data—that is, price Phillips curves—shifted upward and steepened. In other words, inflation accelerated faster than expected when unemployment declined, and in the same vein, disinflation took place with fewer job losses than expected. This was not the case for wage Phillips curves, as wages did not spike in the same way as prices did.
- *Interaction of supply bottlenecks with demand pressures can rationalize the steepening of price Phillips curves.* The decline in capacity in sectors that were in high demand—for example, in durable goods early in the pandemic and in transportation during reopening—contributed significantly to inflationary pressures.
- *Tightening on a global scale can be more effective than that by individual countries, as it can lower the price of tradable goods, especially commodities.*
- *The prevalence of supply bottlenecks and their interaction with demand are key for policy responses.* A diagnosis of the drivers of inflation, though challenging in real time, remains vital.

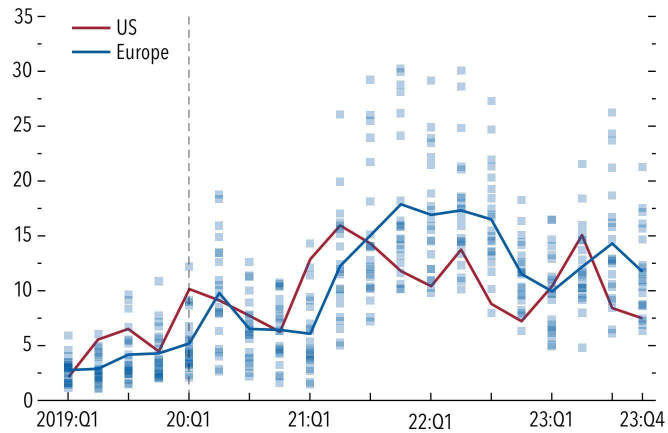
- When the Phillips curve is steep for an economy overall, the benefits of monetary tightening are amplified. In other words, counteracting the inflationary effects of demand in the presence of prevalent supply bottlenecks—as experienced recently—presents a favorable sacrifice ratio.
- However, when supply constraints are confined to the commodity sector, conventional policy rules, such as those targeting measures of core inflation, remain appropriate. Reacting strongly to flexible commodity prices, when supply constraints are present only in those sectors, brings down inflation fast but risks a recession later. In contrast, targeting sticky prices results in more gradual disinflation with a smoother output path.

The chapter focuses mainly on the role of policy interest rates through conventional demand channels. As such, it is complementary to other work focusing on the role of central bank communications in inflation expectations (see Chapter 3 of the October 2023 *World Economic Outlook*), financial market risks, balance sheet policies (Box 2.1), price-suppressing measures (Box 2.2), liquidity measures, and other policy instruments beyond policy rates. Although lessons in these areas can be drawn from recent experience, the stability of long-term inflation expectations and the lack of broad-based financial distress motivate the chapter's focus on interest rates, economic slack, and sectoral activity.

What Happened? Dissecting Inflation Dynamics

Starting in late 2020, inflation rose simultaneously and unexpectedly across the world to levels not seen since the 1970s (Figure 2.1, panel 1). Annual inflation peaked in 2022 at about 8 percent in the median advanced economy and emerging market and extended beyond that in the median low-income country, before receding over the course of 2023. The inflation surge was largely unexpected. Starting in 2021, *World Economic Outlook* forecasts, like many others, *underestimated* inflation for many countries, as evidenced by positive forecast errors in panel 2 of Figure 2.1.[2] The positive forecast errors were even larger in 2022, particularly for advanced economies, in which the median forecast error reached 2.5 percentage points (1.1 percentage points for emerging markets and 1.5 percentage points for low-income countries). The disinflation of 2023–24 also progressed faster than expected, with negative forecast errors this time, especially for forecasts made in 2023 regarding 2024 inflation.

Figure 2.2. Movements in Sectoral Price Dispersion
(Percent)



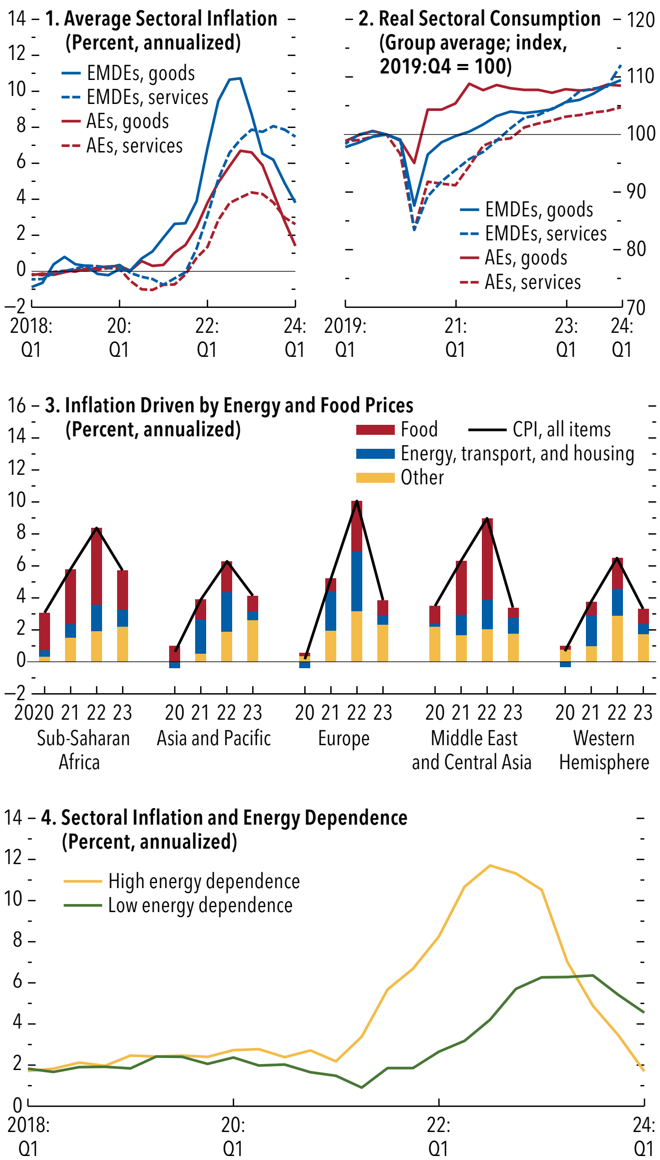
Sources: Eurostat; US Bureau of Labor Statistics; and IMF staff calculations.
Note: Figure shows average sectoral price dispersion measured using the cross-sectoral standard deviation of producer price index (PPI) inflation for European countries (Norway, UK, EU countries) and the United States. The red line is quarterly standard deviation across US PPI sectors. Each blue square represents one European country's cross-sectoral standard deviation, and the blue line represents the median of European countries in each given quarter.

Even though global inflation reached unprecedented levels in recent history, the feared de-anchoring of inflation expectations reminiscent of the 1970s (Carvalho and others 2023) did not materialize, although short-term expectations and nominal wages went up (Figure 2.1, panels 3 and 4). Crucially, real wage growth remained contained in most economies and wage-price spirals—simultaneous accelerations of nominal wages and prices—did not occur in line with most historical experience (Alvarez and others 2024).

A defining feature of this inflationary episode was the prevalence of large sectoral shifts driven by both supply and demand. As a result of these shifts, relative prices changed and the variation in inflation across sectors spiked (Figure 2.2). Two main forces were at play. First, demand initially rotated toward goods amid lockdowns and supply-chain disruptions (Figure 2.3, panels 1 and 2). This caused goods inflation to take off, before a rebalancing of demand as the lockdowns eased. Because of this, inflation peaked earlier and higher in goods than in services. Second, the war

[2]Koch and Noureldin (2024) provide an in-depth analysis of inflation forecast errors.

Figure 2.3. Sectoral Characteristics and Inflation Dynamics



Sources: Haver Analytics; IMF, Consumer Price Index (CPI) data portal; Organisation for Economic Co-operation and Development; US Bureau of Economic Analysis; and IMF staff calculations.

Note: Panel 1 displays the average inflation rates for goods (excluding food and energy) and services across a sample of 30 AEs and 13 EMDEs over time. Data are reported as deviations from 2018–19 average. Panel 2 shows the purchasing-power-parity GDP-weighted average of real sectoral consumption across AEs and EMDEs, normalized to the fourth quarter of 2019. Panel 3 shows the median contributions and aggregate inflation rate for each region. For panel 4, energy dependence is computed as the total share of oil, gas, and utilities in sectoral inputs. Sectors are defined as energy dependent if their energy dependence is above the median. Remaining sectors have low energy dependence. Sectoral inflation rates (measured as sectoral value-added deflators) are collapsed by median within each group. AEs = advanced economies; EMDEs = emerging market and developing economies.

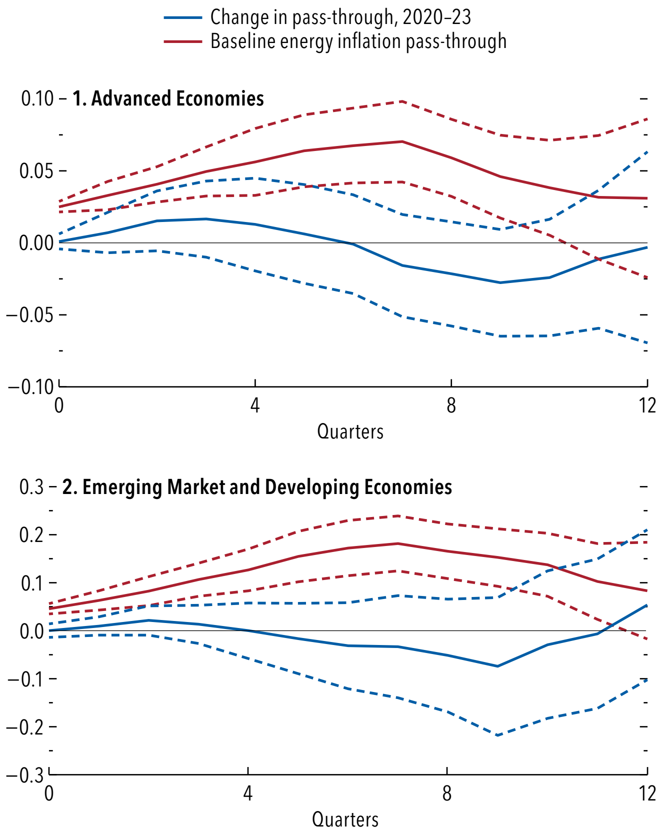
in Ukraine placed substantial pressure on noncore components of headline inflation. These drove the lion's share of both the increase and the subsequent decrease in overall inflation (Figure 2.3, panel 3), with a major role for food price inflation, particularly in sub-Saharan Africa, the Middle East, and Central Asia, whereas energy prices were the primary driver of inflation dynamics in Europe.

The increases in commodity prices had substantial downstream effects, because commodities are an input for many other sectors. Using international input-output tables, the chapter computes the direct and indirect energy dependence of sectors through their supply chains. Inflation initially surged in energy-dependent sectors in 2021, even before the war in Ukraine began. During 2022, inflation in energy-dependent sectors peaked; inflation broadened and started rising in sectors with low energy dependence. Whereas inflation came down markedly in the energy-dependent sectors, it was just plateauing in less energy-dependent industries at the end of 2023 (Figure 2.3, panel 4), and these industries then became the primary drivers of overall inflation.

This is broadly consistent with past patterns in transmission of energy shocks across sectoral networks: energy shocks spread according to sectoral price flexibility and energy dependence (Online Annex Figure 2.2.6), with stronger pass-through in more energy-dependent sectors and in sectors with more flexible prices (Minton and Wheaton 2022; Afrouzi, Bhattarai, and Wu 2024). Even though the energy price shocks were extraordinarily large this time around (Online Annex Figure 2.2.2), the pass-through was not necessarily out of line. Historically, the peak pass-through from a 1 percentage point increase in energy prices into consumer price index (CPI) inflation at the country level was about 0.06 percentage point in advanced economies and 0.17 percentage point in emerging market and developing economies.[3]

[3]These estimated magnitudes are in the ballpark of those in Task Force of the Monetary Policy Committee of the ESCB (2010); Choi and others (2018); Minton and Wheaton (2022); and Afrouzi, Bhattarai, and Wu (2024). The larger impact on emerging market and developing economies partly reflects the greater share of energy-intensive sectors (for example, mining and manufacturing) in those countries (see also the October 2023 Asia and Pacific *Regional Economic Outlook*). Online Annex Figure 2.2.4 additionally tests for nonlinearities in pass-through, which are a feature of some structural models, such as that of Cavallo, Lippi, and Miyahara (2023). Although there is some evidence for nonlinearities in energy price pass-through, there is no evidence for a broad-based postpandemic strengthening of these nonlinearities. All online annexes are available at www.imf.org/en/Publications/WEO.

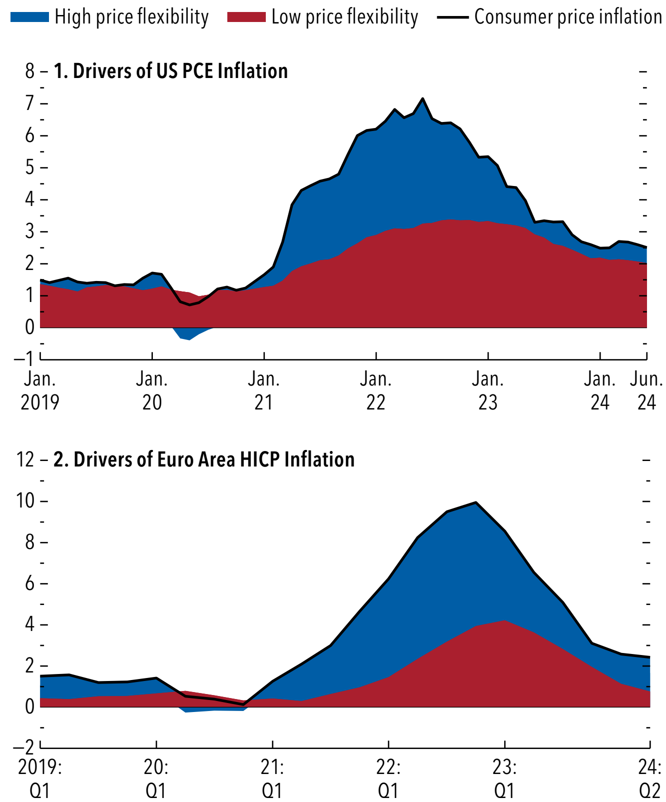
Figure 2.4. Energy Price Pass-Through into CPI Inflation
(Percentage points)



Sources: Haver Analytics; IMF, Consumer Price Index (CPI) data portal; and IMF staff calculations.

Note: Figure reports results of local projections of country-level consumer price index (CPI) inflation on energy prices for a 100 basis point energy price shock. The sample covers 2010–24 data for 26 advanced economies (AEs) and 9 emerging market and developing economies (EMDEs). COVID period is defined as the third quarter of 2020 onward. The first two quarters of 2020 are excluded. Controls include two lags of output gap, CPI inflation, policy rate, and change in nominal effective exchange rate. Regressions also include country fixed effects. Standard errors are double-clustered by country and time. Lines report local-projection coefficients for up to 12 quarters ahead alongside 95 percent confidence bands (dashed lines).

Figure 2.5. Sectoral Inflation and Price Flexibility
(Percent, annualized rate)



Sources: Organisation for Economic Co-operation and Development; and IMF staff calculations.

Note: Inflation is measured as HICP inflation across euro area sectors. Sectoral price flexibility is computed using data from Rubbo (2023). Sectoral data feature 12 HICP sectors. Sectors are split along median of price flexibility, and then inflation is aggregated across countries using PPP country weights and within-country HICP weights. PCE = personal consumption expenditures; HICP = harmonised index of consumer prices; PPP = purchasing power parity.

The values were comparable this time around, because the pass-through from energy prices into CPI inflation did not strengthen materially across a wide range of countries (Figure 2.4; Online Annex Figures 2.2.4 and 2.2.5).[4] Moreover, countries with lower energy price inflation, notably Asian emerging market and developing economies (Online Annex Figure 2.2.2, panel 4), had lower overall CPI inflation, suggesting that energy prices may have played a prominent role in inflation dynamics—a theme that is revisited in this chapter using statistical inflation decompositions and in Box 2.2, in which the role of price-suppressing measures in containing (energy) inflation is explored.

Partly because of the role of energy and commodity price shocks, headline inflation was initially led by more price-flexible goods sectors such as energy, vehicles, and household equipment and followed by flexible-price services sectors such as restaurants, hotels, and recreation. These flexible-price sectors explain the bulk of the rise and fall in inflation observed in the United States and the euro area. Sectors with more rigid prices did not experience substantial price increases until late 2022 and early 2023. By the end of 2023, however, inflation was driven primarily by inflexible-price sectors such as clothing, communications, and health (Figure 2.5, panels 1 and 2). The chapter's structural model captures different degrees of

[4]The strength of oil price pass-through across countries may be affected by the level of fuel excise taxes (Ahn 2024), with stronger pass-through in countries with lower rates for these taxes.

price stickiness across sectors and the pass-through of inflation from flexible to sticky prices over time.

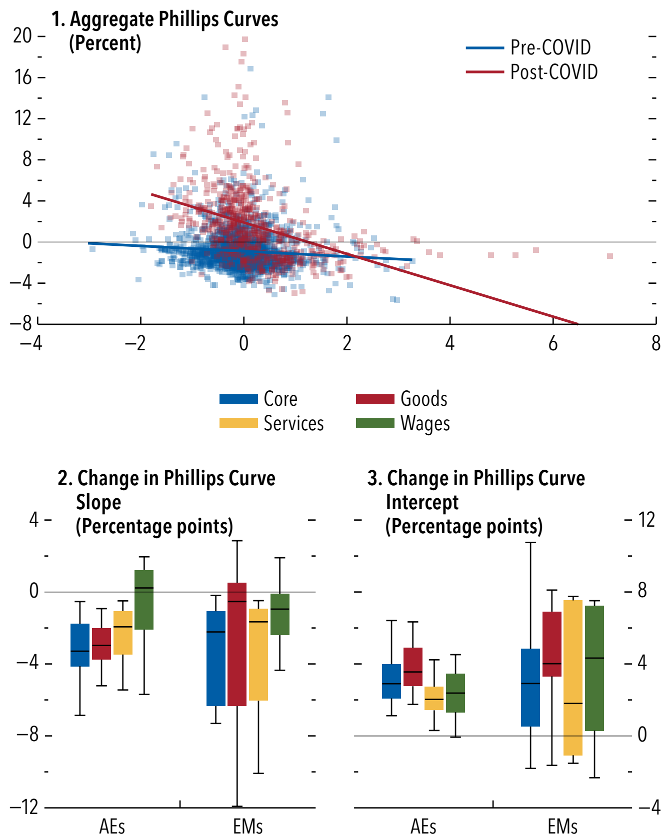
Before turning to the implications of these patterns for monetary policy, this section further dissects these inflation dynamics through the lens of aggregate and sectoral Phillips curves.

Shifting and Steepening of the Phillips Curve

Monetary policymakers pay particular attention to the relationship between economic slack and inflation, or the Phillips curve, because this relationship provides a measure of forgone employment and output as a cost of lowering inflation. Prior to the pandemic, the relationship was relatively flat, suggesting a weak trade-off between output and inflation (Blanchard 2016; Del Negro and others 2020; Hazell and others 2022; Rubbo 2023).[5] In other words, before 2020, even when the economy was close to full employment, inflationary pressures were weak. However, during the pandemic, the empirical Phillips curve notably steepened and shifted upward (Figure 2.6; Ari and others 2023; Benigno and Eggertsson 2023; Gudmundsson, Jackson, and Portillo 2024; Inoue, Rossi, and Wang 2024). These patterns were particularly pronounced in advanced economies, and when comparisons are made across sectors, the shifting and steepening of empirical Phillips curves were somewhat more pronounced for goods than for services inflation (Figure 2.6, panels 2 and 3; Online Annex Figure 2.2.7). The steeper slope of the empirical Phillips curve implies that for a given *decrease* in economic slack, a larger increase in inflation was observed; conversely, a given *increase* in economic slack was associated with a larger decline in inflation. This pattern is consistent with the finding in the previous section that forecasts, presumably based on flatter prepandemic Phillips curves, underestimated inflation when it was surging and overestimated it when it was declining.

To test these relationships at the country level, the chapter estimates empirical Phillips curve relationships country by country and compares coefficients before and after the pandemic. The results confirm that the patterns were nearly universal across advanced economies and most emerging markets (Figure 2.6, panels 2 and 3). This holds true as well in a richer version of the model, which controls for other factors, including lagged inflation (to control in turn for potential mean reversion), inflation expectations, and energy and import prices (Online Annex Figure 2.2.7, panels 1 and 2).[6]

Figure 2.6. Evolution of Phillips Curves



Sources: Haver Analytics; and IMF staff calculations.

Note: Throughout the figure, the first two quarters of 2020 are excluded. In panel 1, *x*-axis shows unemployment gap and *y*-axis denotes core inflation deviation. Inflation measures are residualized on a country fixed effect within each country. Blue and red lines are linear fits with a sample of 29 advanced economies and 15 emerging markets during the period from the first quarter of 2010 to the first quarter of 2024. "Post-COVID" is defined as the first quarter of 2020 onward. The unemployment gap is estimated using a univariate Hodrick-Prescott filter. Outliers with deviations of inflation from country average by more than 20 percentage points are excluded. Panels 2 and 3 report distribution of Phillips curve slope changes and intercept changes across countries from country-level estimations of pre-2020 and post-2020 raw Phillips curves. Outside values (more than 1.5 interquartile ranges below first quartile or above third quartile) are excluded from boxplots. AEs = advanced economies; EMs = emerging markets.

[5]As discussed in McLeay and Tenreyro (2020), the flat prepandemic Phillips curve may also partly be the result of monetary policy that accommodated cost-push shocks and successfully stabilized economies in the wake of demand shocks.

[6]Hooper, Mishkin, and Sufi (2020); McLeay and Tenreyro (2020); and Hazell and others (2022) argue for identifying Phillips curves from regional data to mitigate concerns about cost-push shocks biasing Phillips curves estimates from aggregate data. A regional estimation within the euro area with time fixed effects (Online Annex Figure 2.2.7, panels 5 and 6) confirms results presented earlier in the chapter.

However, the patterns were less pronounced for the empirical wage Phillips curve, which did not steepen much in either advanced economies or emerging markets, but shifted upward as short-term inflation expectations increased (green boxplots in Figure 2.6, panel 3). Because wages were less responsive, recent inflation dynamics likely did not reflect, at least not solely, excessive tightness in the labor market. The chapter's structural model rationalizes the steepening of the Phillips curve with shocks and constraints that originate outside of the labor market.

Pass-Through of Commodity Price Shocks

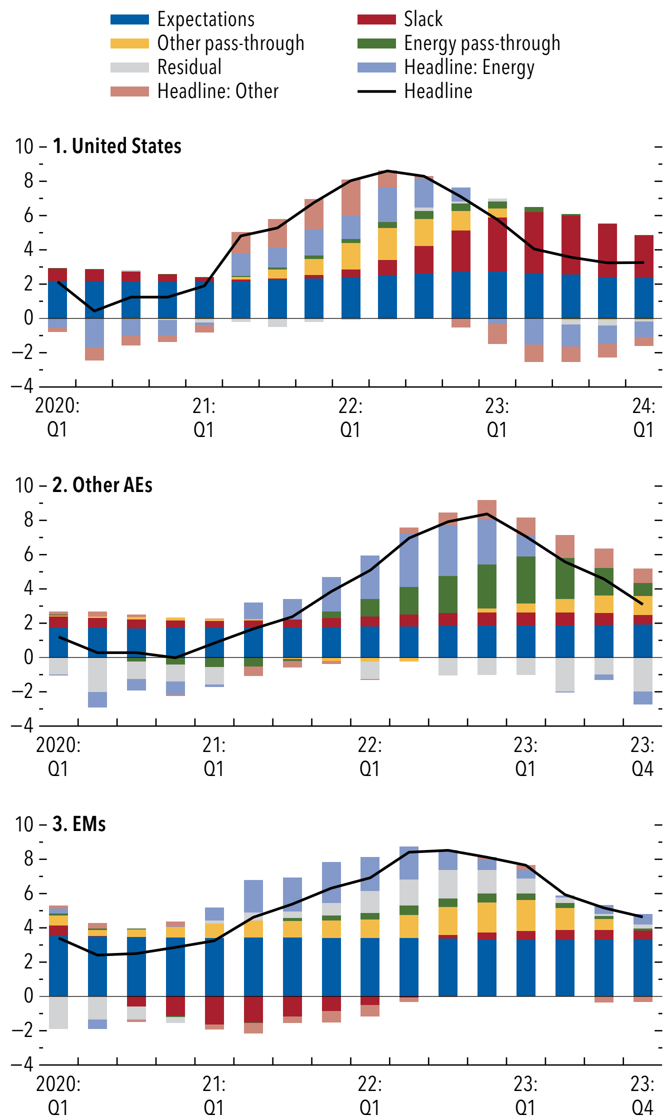
If a richer estimated Phillips curve is employed (Online Annex Figure 2.2.7), inflation in different countries can be decomposed through use of a methodology similar to that of Ball, Leigh, and Mishra (2022) and Dao and others (2024). Such a statistical decomposition does not break down the contribution of structural shocks to inflation but instead provides a correlational analysis of key factors contributing to inflation dynamics.[7]

Across the board, with the possible exception of the United States during the later period, since mid-2022, tight labor markets (a proxy for the amount of slack in the economy) play a moderate role in explaining inflation dynamics (Figure 2.7). This result is consistent with findings noted earlier in the chapter of a muted real wage response and limited changes to the wage Phillips curve. Instead, energy shocks and other shocks to headline inflation played an outsized role. These shocks were subsequently passed on to broader inflation, with import prices accounting for a sizable part of the pass-through in emerging markets. Finally, long-term inflation expectations remained anchored across countries and did not directly contribute to inflation dynamics.

More specifically, US inflation (Figure 2.7, panel 1) was initially driven by energy price shocks and other sector-specific shocks as shortages and the pandemic disrupted supply chains. These headline shocks subsequently passed through into broader

[7]The impact of economic slack also captures the aggregate demand effects of fiscal stimulus or monetary policy. The impact through short-term inflation expectations is captured under pass-through, and the impact of food prices is captured under other headline shocks. The specification employed in the chapter allows labor market tightness to affect core inflation directly, rather than only indirectly through wage inflation, consistent with the evidence of Dao and others (2024).

Figure 2.7. Inflation Drivers in the United States, Other Advanced Economies, and Emerging Markets
(Percent, year-over-year rate)



Sources: Consensus Economics; Haver Analytics; and IMF staff calculations.
Note: US inflation drivers are estimated on monthly data (following Dao and others 2024) and then converted to quarterly; for other countries, estimation is conducted on quarterly data. "Slack" is measured using the vacancy-to-unemployment ratio for AEs and using the unemployment gap (estimated using a univariate Hodrick-Prescott filter) for EMs. Country-level contributions for AEs and EMs are aggregated across country groups using purchasing-power-parity GDP weights. Fitted values for inflation gap are converted into 12-month rates. AEs = advanced economies; EMs = emerging markets.

inflation in 2021 and early 2022. Since mid-2022, however, the main driver of US inflation has been a tight labor market.[8] By the first quarter of 2024, labor market tightness was still contributing 2.5 percentage points to US CPI inflation, which was partly offset by a modest deflation in energy costs.

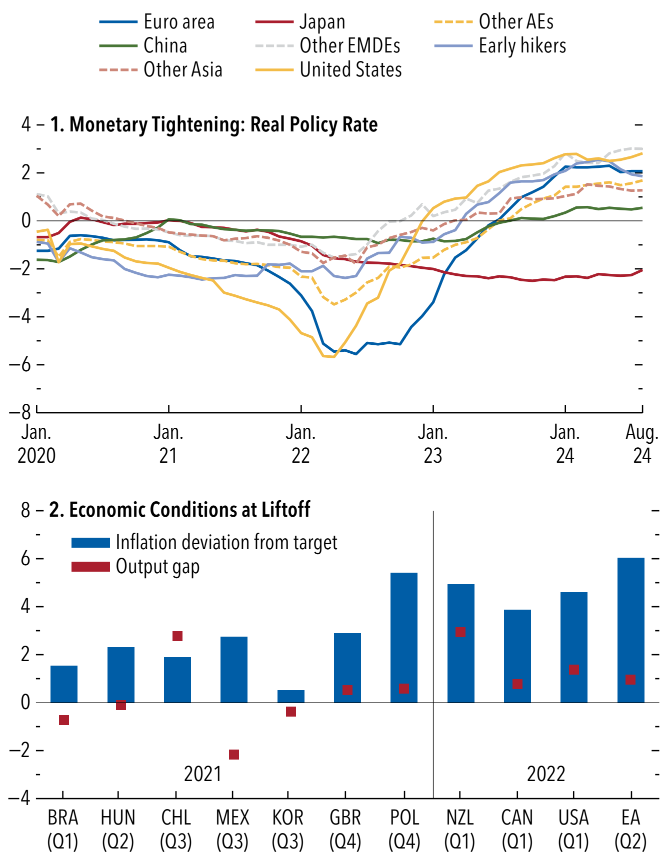
In contrast, the contribution of labor market slack to inflation in other advanced economies and emerging markets was small. Inflation in other advanced economies, particularly those in Europe (Figure 2.7, panel 2), was initially driven by large energy price shocks that passed through into broad inflation, with the pass-through of energy price shocks alone contributing more than 2.5 percentage points to CPI inflation at its peak. For emerging markets (Figure 2.7, panel 3), import price pass-through was a significant driver of inflation pass-through, which would include any exchange rate effects, because import prices in local currency were used.[9]

Understanding the recent inflation dynamics requires understanding how sectoral shocks, including those in the energy and commodity sectors, led to broad-based inflationary pressures. Going beyond traditional models with one sector, the multisector structural model employed here sheds further light on the pass-through of sectoral shocks across the production network.

The Monetary Policy Reaction

Faced with the pandemic, central banks worldwide initially adopted expansionary monetary policies aimed at stimulating economies and maintaining financial stability (Figure 2.8, panel 1). As broader inflationary pressures emerged, central banks transitioned to tightening policy. Although the tightening was broadly synchronized, its exact timing and pace varied across countries, depending on the impact of the shocks on individual economies, the timing of lockdowns and reopening, and initial conditions and institutional features. For example, commodity price increases after the start of the war in Ukraine led to terms-of-trade improvements for exporters, but to terms-of-trade deteriorations for importers. Central banks with a history of low and stable inflation had built policy credibility and could afford to "look through" seemingly transitory supply shocks for longer. In contrast, the presence of wage and price indexation mechanisms

Figure 2.8. Monetary Policy Tightening
(Percent)



Sources: Bank for International Settlements; Consensus Economics; Haver Analytics; and IMF staff calculations.

Note: Sample comprises 16 AEs and 65 EMDEs. "Other" aggregates are medians. "Early hikers" are Brazil, Chile, Hungary, Korea, New Zealand, Norway, Peru, and Poland, which hiked much earlier than major central banks. In panel 1, real rates are constructed as nominal rates minus one-year-ahead inflation expectations. Panel 2 reports economic conditions at first interest rate hike during current tightening cycle for early hikers other than Peru, Canada, the euro area, the United Kingdom, and the United States. Countries are sorted by the timing of their first interest rate hike. Inflation is reported as deviation of central bank's targeted inflation rate from central bank target in quarter of first tightening. The output gap data are annual. Data labels in the figure use International Organization for Standardization (ISO) country codes. AEs = advanced economies; EA = euro area; EMDEs = emerging market and developing economies.

[8]As argued by Ball, Leigh, and Mishra (2022); Barnichon and Shapiro (2024); and Bernanke and Blanchard (2024), labor market tightness in the United States is measured using the vacancy-to-unemployment ratio. Elsewhere, labor market tightness plays a much smaller role, regardless of the measure of tightness (vacancy-to-unemployment ratio or unemployment gap). Again, except in the case of the United States, using the output gap as the measure of economic slack results in similar findings (Online Annex Figure 2.2.7, panels 3 and 4), as does using country-by-country estimates for countries for which monthly data are available.

[9]Online Annex Figure 2.2.8 provides a detailed breakdown, highlighting, among other features, the importance of energy and headline shocks in eastern European emerging market and developing economies. Residuals across emerging markets overall could be explained partly by the cross-border transmission of global liquidity (Choi and others 2017).

limited room to maneuver in many countries. Finally, variation in other policy settings, such as the size of fiscal stimulus or price-suppressing measures, motivated different monetary responses. These differences resulted in some emerging market and developing economies, such as Brazil, Chile, and Mexico, starting their rate hikes earlier than others. Conversely, Asia exhibited a more tempered response, and the United States adjusted its policies relatively later (Figure 2.8, panel 2).

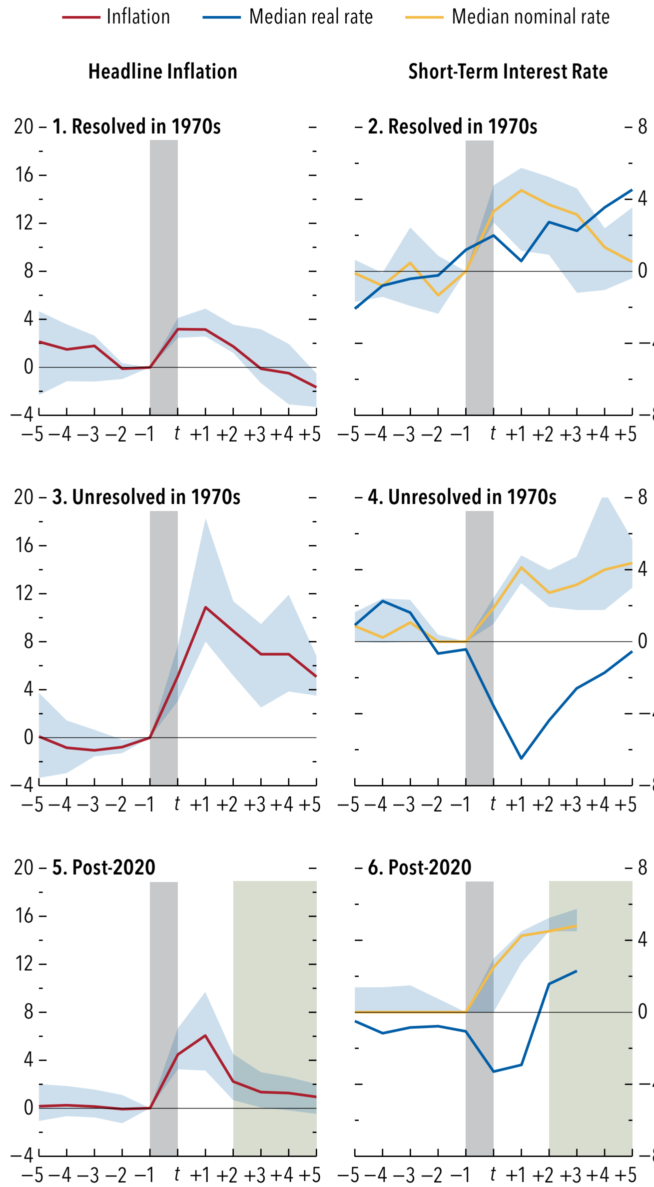
Policy Responses Compared with Those in the 1970s

The energy price shocks of the 1970s, which also had global repercussions, offer a natural, though imperfect, benchmark for comparing policy responses during the recent inflation surge. The benchmarking is imperfect because of the transformative changes in monetary policy frameworks and policy credibility since the 1970s and the fact that the recent experience coincided with a pandemic.

Such comparisons are facilitated by identifying inflationary episodes in a global sample. Following Ari and others (2023), this section defines an inflation episode as a period with an increase in inflation of more than 2 percentage points in a year. Such episodes are then grouped as "resolved" or "unresolved," in which an episode is considered resolved if inflation declines in the neighborhood of 1 percentage point of its pre-episode level within a five-year window. Comparison of the post-2020 and 1970s episodes yields the following observations (Figure 2.9):

- Post-2020 inflation episodes have been more pronounced and persistent compared with the *resolved* episodes of the 1970s, with inflationary pressures building sharply during the episodes (shaded gray areas in the figure) and continuing to rise in the subsequent year.
- Nominal interest rate hikes during *resolved* episodes of the 1970s were larger, as real rates swiftly transitioned to contractionary territory (Figure 2.9, panel 2). In contrast, post-2020 episodes involved a milder nominal rate adjustment and a more prolonged expansionary policy stance, indicated by sustained negative real interest rates.
- During *unresolved* episodes, the median policy stance remained consistently expansionary, characterized by more prolonged and more negative real interest rates than observed after 2020.

Figure 2.9. Comparison of Inflation Episodes
(Percent)



Sources: Ari and others 2023; Haver Analytics; and IMF staff calculations.
Note: "Median" refers to median outcome across inflation episodes. Inflation and short-term nominal interest rates are normalized to the preceding year ($t - 1$) as zero, with deviations shown thereafter. Real interest rates are shown in levels rather than normalized deviations. Blue-shaded areas indicate the 25th to 75th percentiles of data across inflation episodes. Gray-shaded areas denote identified inflation episodes, and green-shaded areas indicate projections.

Overall, the recent episode lies between the resolved and unresolved episodes of the 1970s in terms of inflation dynamics and the speed of the policy response. This conclusion for the policy response is corroborated when comparing the deviations from policy rates that would be implied by a simple policy rule targeting inflation and the output gap (Online Annex Figure 2.2.9). Although inflation expectations data for the 1970s are limited, proxying the degree of inflation expectations anchoring using past inflation volatility reveals that inflation expectations were more strongly anchored this time around (Online Annex Figure 2.2.10).

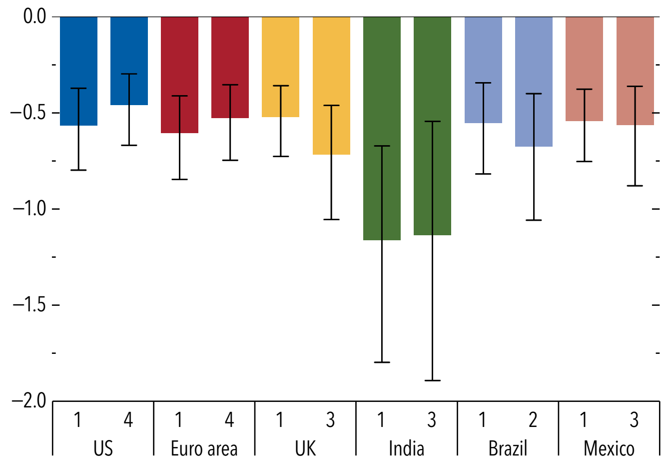
Transmission of Monetary Policy Tightening: Continuities and Changes

As has been documented in this chapter, monetary policy tightening kick-started after the initial extraordinary pandemic effects subsided, with most of the tightening occurring later in the episode.

But did the extraordinary shocks result in monetary transmission that was very different from historical experience? The answer is not obvious because some forces at play point to weaker transmission, whereas others point to a stronger transmission. For example, the policy transmission through housing markets may have weakened in some countries, given that the growing popularity of fixed rate mortgages may have reduced the sensitivity of households' payments to rising interest rates (see Chapter 2 of the April 2024 *World Economic Outlook*). Similarly, excess household savings have buffered household finances in many countries and may have resulted in resilience in consumption even as policy tightened. The globally synchronized nature of the tightening may have weakened the exchange rate channel of monetary policy, whereas it may have strengthened other channels, for example, through the world price of commodities (Bernanke, Gertler, and Watson 1997; Blanchard and Galí 2007b; Auclert and others 2023). Moreover, a steeper Phillips curve, as documented in the previous section, may imply that tightening could have a small effect on output but a strong disinflationary impact. Given these different forces, this section measures overall transmission.

The preliminary evidence suggests some variation but not a broad-based and significant change in

Figure 2.10. Monetary Policy Transmission to CPI during Tightening Episodes



Source: IMF staff calculations.

Note: The bars denote the country median peak response, and the whiskers represent the upper and lower bounds of the 68 percent HPD set of responses. 1 = 1990s to 2019, 2 = 2021 to 2022, 3 = 2021 to 2023, 4 = 2022 to 2023. CPI = consumer price index; HPD = highest posterior density set.

transmission over time. The comparison focuses on the transmission of a standardized monetary policy tightening shock, as estimated by a vector autoregression model with time-varying coefficients, across selected countries during tightening cycles since the 1990s.[10] Estimates from the model suggest that the peak effects of consumer prices vary somewhat in response to the tightening shock (Figure 2.10; Online Annex Figure 2.3.2). However, the analysis does not detect a systematic and statistically significant difference in the magnitude of the responses when the post-2022 price responses are compared with the average transmission observed during the tightening cycles in the 1990s through 2019. This conclusion also holds when the full path of impulse responses over time, as opposed to only the peak effects, are compared (Online Annex Figure 2.3.1).

Several caveats are in order. The methodology employed in this section is designed to detect, using data available, significant changes in the overall transmission of policy tightening so far in countries' tightening cycles. It therefore does not rule out moderate

[10]The chapter focuses on the post-1990 period after countries adopted inflation-targeting regimes. Methodological details and further results are provided in Online Annex 2.3.

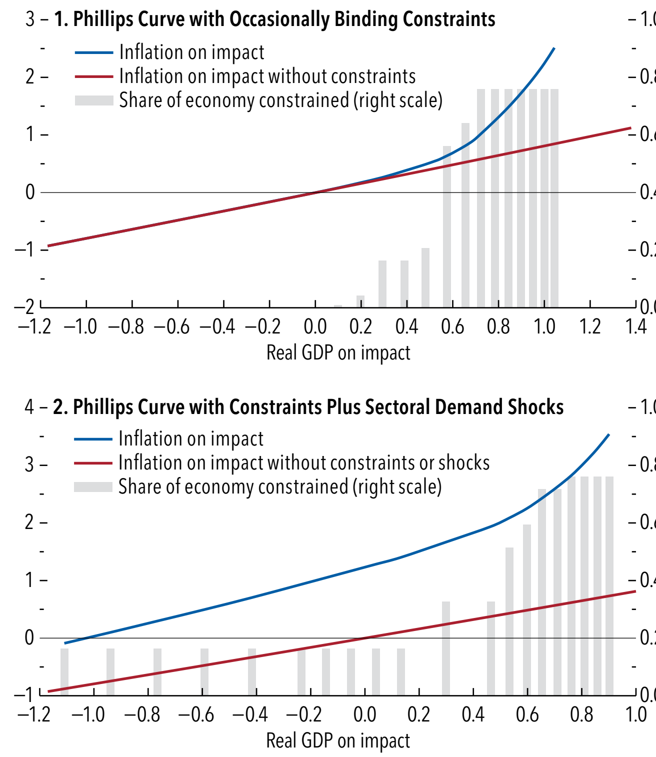
changes, given uncertainty surrounding the estimates, or the possibility that its conclusions will change once more data become available.

Lessons for Monetary Policy: A Model-Based Analysis

Guided by the chapter's findings so far, this section develops a new global model with input-output linkages, the Global Dynamic Network Model, to derive further policy insights. Crucially, the model includes these features:

- *Rich input-output linkages across sectors and countries.* To replicate the transmission of price pressures in individual sectors to core inflation, as in the empirical section, the model considers multiple sectors that are connected through input-output linkages. Relative demand for each sector can change both as a response to prices rising more in some sectors and if households' tastes change, as happened, for example, when demand for goods relative to services rose during the pandemic lockdowns. Because it features two countries with trade linkages, the model can assess the role of synchronized global tightening.
- *Occasionally binding supply constraints.* The model features sectoral constraints, in the form of limits on the maximum employment level of firms, that bind occasionally. These constraints mimic supply bottlenecks, and as will be shown, they are a key ingredient for rationalizing the recent steepening of the aggregate Phillips curve documented in the empirical section and observed in many countries (Gudmundsson, Jackson, and Portillo 2024; Comin, Johnson, and Jones 2023). In normal times, employment is rarely near these limits. However, in extreme cases such as lockdowns, in which the maximum employment in a sector may fall, or demand may surge in certain sectors (durable goods is an example), then these constraints can limit production. Such dynamics would result in higher prices in sectors with binding supply constraints and would also trickle down to the rest of the economy, especially if constrained sectors are major providers of inputs to other sectors and those inputs are not easily substitutable.
- *Aggregate and sectoral shocks.* Given the potential role of monetary and fiscal stimulus during an episode, the model allows for monetary policy shocks as well as shocks to aggregate demand, in addition to a rich set of sectoral demand and supply shifts.

Figure 2.11. Phillips Curve under Different Constraints
(Percent)



Source: IMF staff calculations.
Note: The blue line shows combination of the impact effect of real GDP (*x*-axis) and inflation (left scale) on monetary policy shocks of various sizes, with panel 2 also including a relative demand shock. The gray bars (right scale) show the share of the economy constrained. The red line shows the same combination without any supply bottlenecks imposed. The Phillips curve shape will depend on choice of constraints.

Widespread Bottlenecks and Rationalization of Steep Phillips Curves

To illustrate how the model can account for the steepening of Phillips curves, both panels in Figure 2.11 present the relationship between peak effects of inflation and output in a scenario in which monetary policy starts out contractionary (on the left) and gradually becomes more expansionary (on the right). In both panels, the supply constraints are set such that they become binding in more sectors as demand strengthens.

- *Steepening.* When monetary policy is contractionary and demand is low, sectors operate below their labor constraints, and increases in demand lead to both higher employment and higher inflation. However, as policy becomes more expansionary, more sectors hit their supply constraints, as shown by the gray bars in panel 1 of Figure 2.11 (see also Online Annex Figure 2.4.1). In turn, firms in these sectors cannot increase employment and output, and instead, prices must rise to equalize supply and demand. When such constraints are widespread, adding up across sectors for the entire macroeconomy reveals a nonlinear relationship between inflation and output; that is, a nonlinear aggregate Phillips curve (blue line). In the absence of supply bottlenecks, the analysis would have resulted in a linear aggregate Phillips curve (red line), underscoring the importance of the bottlenecks as a key mechanism in the model to account for the findings of the empirical section.[11]

- *Shifting.* Panel 2 of Figure 2.11 illustrates how the Phillips curve can shift when relative demand shocks are also added. In that case, high-demand sectors hit their supply constraints and face upward price pressures. At the same time, other sectors produce less because of weak demand. The combination of higher prices (in constrained sectors) and weak output (in unconstrained sectors) leads to an upward shift in the aggregate Phillips curve.

Because the model allows for both a steepening and a shift of the Phillips curve, the relative strength of the two alternatives is then determined by the data.

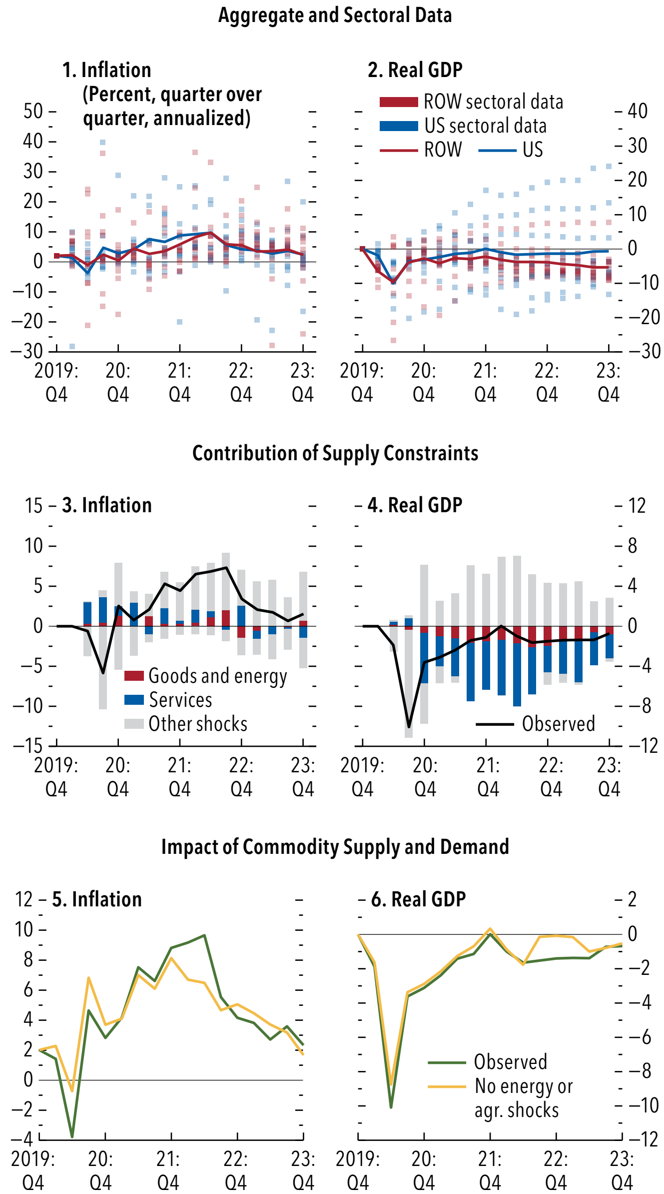
Role of Constraints and Commodity-Specific Shocks

To unpack the role of supply constraints and commodity-sector-specific shocks through the lens of the model, this section takes the model to the data and presents counterfactual scenarios.

With the United States and the rest of the world set as the two countries or regions in the model, sectoral and aggregate shocks are quantified to match the data. Because the matched data include inflation and output, the model matches the sectoral dispersion shown in panels 1 and 2 of Figure 2.12 (similar to the empirical section). In the same figure, panel 4 shows that supply constraints were an important persistent drag on real GDP during this period. In addition,

[11]Other mechanisms can also result in a steepening of the Phillips curve, such as asymmetries in wage setting, quasi-kinked demand for goods or informational frictions, and state-dependent pricing (Ilut, Valchev, and Vincent 2020; Harding, Lindé, and Trabandt 2022, 2023; Benigno and Eggertsson 2023; Dupraz 2024; Karadi and others 2024).

Figure 2.12. Impacts of Supply Constraints and Commodity Sector Shocks
(Percent deviation, unless noted otherwise)



Sources: Eurostat; Federal Reserve Economic Data; Organisation for Economic Co-operation and Development; and IMF staff calculations.

Note: The line in panel 3 shows inflation, and the line in panel 4 shows real GDP. The bars in panels 3 and 4 show the contributions from different groups of shocks. Note that the sum of all bars will equal the black line in each period. In panels 5 and 6 the "No energy or agriculture shocks" scenario assumes that monetary policy shocks remain as in the observed data, but monetary policy responds to changes in inflation, and that identified supply constraints in noncommodity sectors remain. agr. = agriculture; ROW = rest of the world.

they led to significant upward price pressures early in the pandemic, contributing 2–3 percentage points to US inflation during 2020–22 and playing a role in the subsequent disinflation, with a negative net contribution after 2023 (Figure 2.12, panel 3).[12] The inflation impacts appear to be less significant than GDP effects, largely because the supply bottlenecks—even if they may last for an extended period—raise prices persistently, leading to one-off rather than persistent increases in inflation.[13]

Because the empirical decompositions attribute an important role to "headline shocks," which include shocks to food and energy prices, a scenario with a similar spirit can be considered. Specifically, panels 5 and 6 in Figure 2.12 turn off the shocks specific to the agriculture and raw energy sectors. The exercise reveals that inflation would have been lower when these shocks are turned off, especially around the beginning of the war in Ukraine, when supply constraints in these sectors were tightest. Turning off shocks specific to commodity sectors makes a smaller difference for GDP.

Although the important role of the agriculture and raw energy sectors in regard to inflation broadly aligns with the empirical analysis (if findings for the US are used to compare the two, given the model's calibration), the two exercises are not identical. One important difference arises because shocks specific to agriculture and raw energy, which are turned off in this exercise, are not the only drivers of prices in their corresponding sectors. That's why turning off shocks to these sectors does not mean that their prices remain constant throughout the exercise. In fact, the analysis suggests that aggregate demand shocks (especially because agriculture and energy have relatively flexible prices) and constraints in other sectors (which raise input prices) play a role, too. In contrast, empirical decompositions take these sectoral prices as exogenous and measure their contributions to core inflation relative to a case in which they are unchanged, remaining agnostic about their drivers.

[12]The blue and red bars in panels 3 and 4 include supply constraints and their interactions with other shocks. "Other shocks," shown by the gray bars, include everything else. Because all shocks interact with supply constraints in complex ways, producing more detailed bars implying mutually exclusive contributions of shocks would be misleading.

[13]Supply bottlenecks can arise from tightening supply constraints for a given level of demand and their interaction with demand. The reported contributions measure the *total* impact of supply constraints, capturing the effects of supply constraints both in isolation and in combination with demand.

Policy Experiments

To draw policy lessons, this section undertakes two sets of analyses. The first comprises counterfactual scenarios with policies set differently from what central banks actually did. Because the data are first matched to the recent period featuring the effects of the pandemic and the war in Ukraine, the resulting policy lessons are more relevant for such tail event situations. The second set of analyses considers a hypothetical run-of-the-mill scenario. It features a supply constraint binding only for food and energy and a positive aggregate demand shock. For example, it could capture a situation in which a drought or a geopolitical shock constrains supply in agriculture and energy and is accompanied by fiscal support to contain its effects. In comparison with the experience since the pandemic, the share of sectors subject to supply bottlenecks would be much smaller in this scenario.

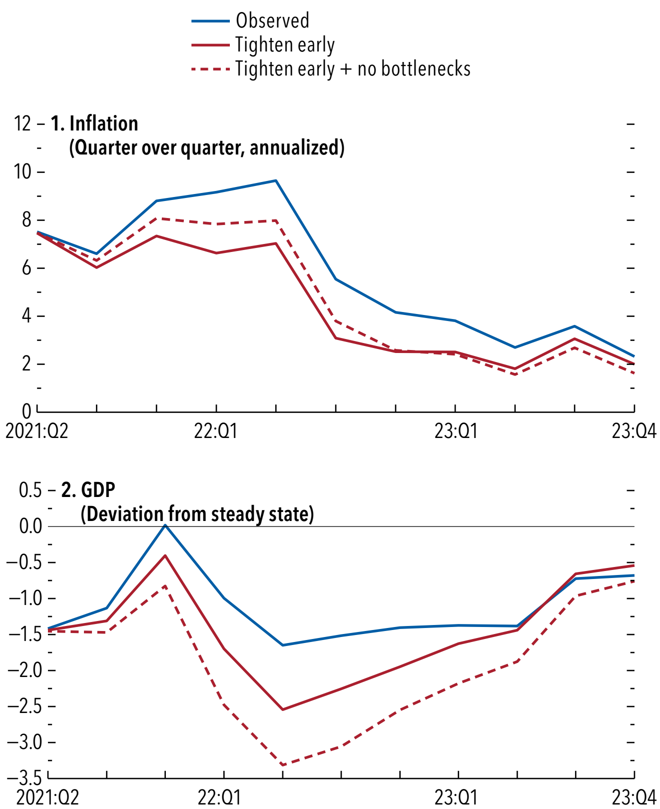
Counterfactual Scenarios

The counterfactual scenarios first ask, Would different policy choices by central banks have made a difference during the inflation surge? And how would they have interacted with bottlenecks? To answer these questions, Figure 2.13 presents cases in which policy tightens three quarters earlier than observed, combined with different assumptions about the presence of bottlenecks.

- Tightening earlier, shown by the solid red lines, lowers peak inflation by about 2 percentage points relative to the data (Figure 2.13, panel 1) but results in a 0.8 percentage point reduction in real GDP (Figure 2.13, panel 2) for 2022.
- Comparing two versions of the "earlier tightening" counterfactual further reveals the role of supply bottlenecks. When capacity constraints are imposed at levels estimated from fitting the model to the data (solid red lines), tighter policy has greater potency in lowering inflation, with low output cost relative to the case in which the constraints are assumed away (dashed red lines). This is because the constraints steepen the Phillips curve, as shown earlier, making expansionary policies more inflationary but also making it less costly to bring down inflation through monetary tightening. This comparison highlights how supply bottlenecks can steepen the Phillips curve and affect the cost of disinflation.

Would different policy choices by *other* central banks have made a difference? In the counterfactual scenario, the rest of the world tightens monetary

Figure 2.13. Counterfactual Monetary Policy
(Percent)



Sources: Federal Reserve Economic Data; Organisation for Economic Co-operation and Development; and IMF staff calculations.

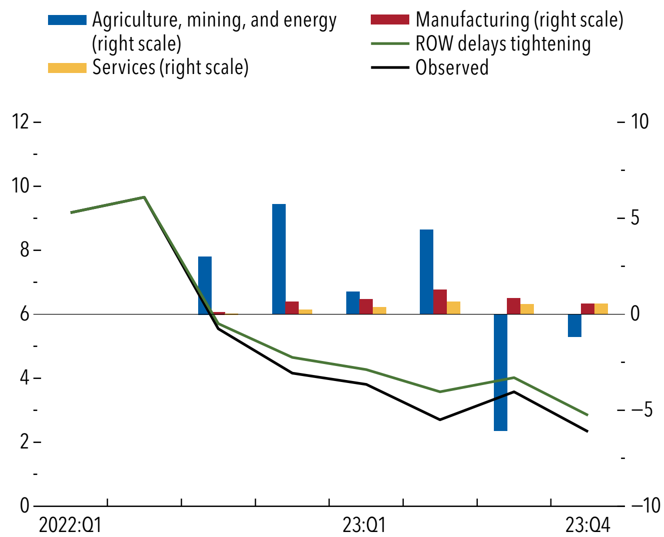
Note: "Tighten early" scenario assumes rates rise three quarters earlier. Standard monetary policy counterfactuals assume identified labor constraints remain. "No bottlenecks" assumes the wedge between the marginal product of labor and wages (shadow price of constraint) is kept consistent with the data, but the constraint does not bind.

policy later than the United States (Figure 2.14).[14] This delayed synchronization in tightening slows the domestic disinflation process. The difference between observed inflation and the counterfactual scenario is displayed by the bars in Figure 2.14 for each sector.[15] Agriculture, mining, and energy—sectors with highly flexible prices—experience stronger inflation than the other sectors, and although inflation diminishes in these sectors over time, they generate further waves of price increases in manufacturing and services through input-output linkages.

[14]Even though this simulation considers the United States, a similar mechanism would be applicable for other economies.

[15]The figure reports both the direct and indirect effects, for example, including the impact that food and energy prices likely have on the prices of other goods and services.

Figure 2.14. Role of Coordinated Monetary Policy
(Percent, quarter over quarter, annualized)



Sources: Federal Reserve Economic Data; Organisation for Economic Co-operation and Development; and IMF staff calculations.

Note: "The rest of the world (ROW) delays tightening" scenario assumes ROW hiking is delayed three quarters and US rates remain as observed. Identified labor constraints are assumed to remain. The right-hand *y*-axis shows percentage point difference in sectoral inflation between the observed data and "ROW delays tightening" scenario.

Hypothetical Scenario

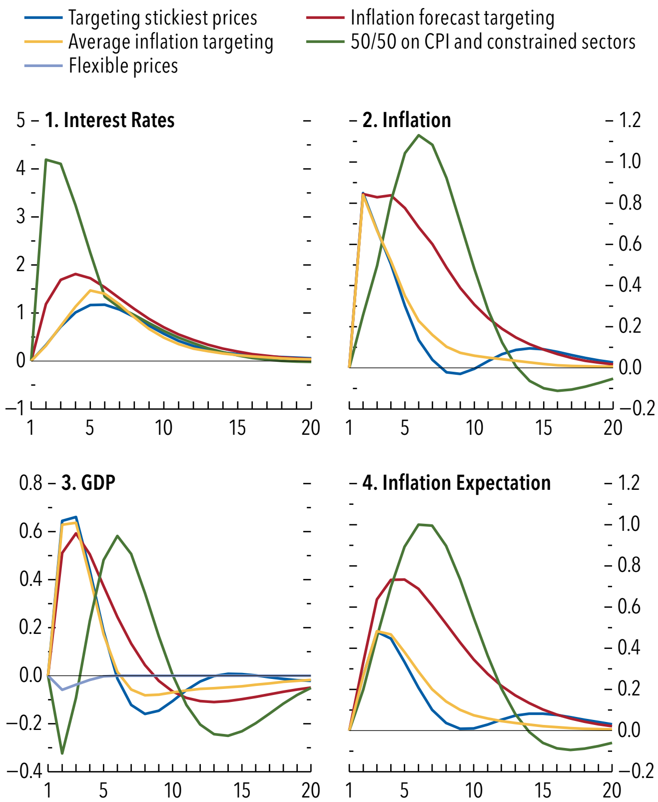
The analysis next turns to a hypothetical scenario with positive aggregate demand shocks combined with negative capacity constraint shocks in the agriculture, mining, and energy sectors for both countries or regions in the model. As explained in this chapter, this would correspond to a milder set of shocks than those considered so far.

Figure 2.15 compares four simple monetary policy rules in this scenario: (1) targeting inflation in sectors with the stickiest prices;[16] (2) "inflation forecast targeting," which aims to stabilize the four-quarter moving average of future CPI inflation; and (3) "average inflation targeting," in which the central bank targets the average of the preceding four quarters of inflation, as well as (4) a sectoral Taylor rule that targets equally CPI inflation and sectoral inflation in agriculture, mining, and energy, which are the sectors subject to supply constraints but also those with the most flexible prices. The first three rules tend to be widely used or discussed, and the last one helps assess whether

[16]These sectors are information technology and telecommunications; finance and insurance; professional, scientific, and technical; education, health, and government services; and arts, entertainment, and recreation.

Figure 2.15. Alternative Policy Rules

(Percent deviation from steady state, quarter over quarter, annualized, y-axis; quarters, x-axis)



Source: IMF staff calculations.

Note: The Taylor rules are identical except for the inflation measure targeted. "Targeting stickiest prices" targets the five sectors with the steepest Phillips curves. "Inflation forecast targeting" targets the four-quarter moving average of future CPI inflation. "Average inflation targeting" represents average inflation targeting in which the central bank targets the average of the previous four quarters of inflation. "50/50 on CPI and constrained sectors" targets CPI inflation and sectoral inflation in agriculture, mining, and energy. "Flexible prices" shows relative prices in a scenario without nominal rigidities in any sector market. In each case the Taylor parameter is 3, the persistence parameter is 0.5, and neither GDP nor the output gap is targeted. CPI = consumer price index.

front-loading the policy adjustments in response to price increases in constrained sectors is appropriate. Because monetary policy can only alleviate the effect of nominal frictions on an economy's response to shocks, a benchmark "efficient" economy output for the case in which prices and wages are assumed to be perfectly flexible is also shown, in panel 3 of the figure.

Comparing the alternative policy rules yields the following insights (Figure 2.15):

- Targeting inflation in the stickiest-price sectors delivers relatively fast disinflation. By contrast, the inflation forecast targeting rule ends up "running the economy hot" by responding to medium-term inflation, which is lower than inflation on impact, and leads to a surge in inflation and inflation expectations. Despite higher nominal rates, this rule delivers lower real rates than the other policy rules. This leads to higher output initially but requires a prolonged medium-term reduction in real GDP to bring inflation to target.[17]
- The policy rule with the higher weight on food and energy tightens markedly more on impact, because food and energy prices are more flexible and sensitive to the demand shock, and these sectors themselves are supply constrained. The imposition of supply constraints, even if binding persistently, has transitory effects on inflation (Online Annex Figure 2.4.5).[18] When policy focuses on these sectors, it overreacts to transitory inflation, delivering a sharp recession. As shocks dissipate, food and energy prices fall faster than the overall CPI, because they are more flexible, leading to a rapid fall in policy rates, and in turn, inflation and GDP surge. Although this policy rule delivers relative prices closer to the flexible-price benchmark in the short term, in the longer term, relative price movements are more persistent, distorting resource allocation for longer (Online Annex Figure 2.4.6).
- "Average inflation targeting" features inflation and GDP responses that are most like those arising from the rule targeting inflation in the sectors with the stickiest prices. The main difference is that the delayed response of average inflation targeting to inflation delivers a more gradual return of inflation to target, which leads real GDP to remain below the steady state in the medium term for longer.

Summary and Policy Implications

A defining characteristic of the recent inflationary episode was the prominence of sectoral shifts amid policy stimulus and capacity constraints, partly arising from

[17]These downsides from forecast-based policy rules relative to targeting realization-based inflation are similar to the results from Erceg, Lindé, and Trabandt (2024). Despite the broad similarities in their conclusions, the frameworks in the two studies are different in terms of specific scenarios considered and the underlying mechanisms. For example, Erceg, Lindé, and Trabandt (2024) allow price and wage setters to index more intensively after prolonged periods of high inflation, amplifying the costs of delayed policy tightening.

[18]Supply constraints require higher *prices* to realign demand in a sector to be consistent with the constrained production available. Once *prices* have risen, no further price increases are required to keep sectoral demand low. This leads to a transitory effect on inflation.

supply-chain disruptions. Statistical decompositions attribute an important role to price pressures arising from individual sectors and their spillovers to core inflation. Evidence also suggests that the relationship between inflation and economic slack shifted and steepened. In line with the empirical findings, a newly developed structural model can account for the transmission of sector-specific price pressures to the rest of an economy, as well as the shifting and steepening of Phillips curves, with a mechanism running through binding supply constraints combined with demand shocks.

Even though the episode was unique, central banks can still draw lessons from the experience, especially as they review their monetary policy frameworks. In this vein, the chapter offers the following insights.

Sectoral supply constraints tend to have large but short-lived effects on inflation as they start to bind. Steeper Phillips curves stem from the *interaction* of these constraints with demand shocks. Hence, policymakers should aim to differentiate between the immediate and transitory effects of sectoral constraints and their more persistent impact when combined with demand pressures.

The chapter draws an important distinction between the steepening of *aggregate* Phillips curves and that of *sectoral* Phillips curves. In doing so, it offers a new policy insight and reaffirms an old one.

- *New lesson.* When supply bottlenecks are prevalent and combined with strong demand, the aggregate Phillips curve steepens, as it did in the recent episode. In such cases, policy tightening is effective because it can ease demand pressures and bring down inflation quickly with limited output costs; in other words, the sacrifice ratio is low. Monitoring whether key sectors bump against their supply bottlenecks in an overheated economy is crucial.
- *Old lesson.* When supply bottlenecks are confined to specific sectors, such as commodities, standard rules, such as those focusing on inflation in sectors with the stickiest prices, remain appropriate (Blanchard and Galí 2007a; Natal 2012). Although sectoral Phillips curves steepen in constrained sectors, their effects may not spread widely enough to cause a steepening of the aggregate Phillips curve. In that case, monetary tightening can achieve a sharp decline in commodities' flexible prices, but at the expense of lower output, and over time, inflation will undershoot as flexible commodity prices decline and other prices also react to tighter policy.
- *Putting them together.* Central banks should consider including well-defined escape clauses in their policy frameworks to tackle inflationary pressures when aggregate Phillips curves steepen. Forward guidance should internalize those escape clauses and allow for front-loading of tightening in such situations.

This distinction aligns with earlier IMF work that suggests refining the traditional prescription to "look through" temporary supply shocks. In this context, Gopinath (2022, 2024) underscores that second-round effects can be significant if supply shocks are large and far reaching, particularly when the economy is already overheated with high inflation. The chapter's differentiation between widespread bottlenecks and those confined to specific sectors mirrors the earlier work's focus on the size and scope of shocks. In addition, the chapter's emphasis on the interaction of these bottlenecks with demand pressures relates to the earlier work's observation about the importance of recognizing an already overheated economy.

While "running the economy hot" may have benefits—for example, facilitating relative price adjustment when shocks are permanent and the economy needs to adjust accordingly (Guerrieri and others 2021; Guerrieri and others 2023), those benefits need to be weighed against the risk of a potential de-anchoring of inflation expectations and wage-price spirals. When balancing these risks, central banks should consider not only the most likely outcomes but also the distribution of risks, and they should keep inflation from drifting too far from target for an extended period, especially when inflation expectations are less anchored and policy credibility is weaker (Gopinath 2024).

A better understanding of sectoral dynamics can help central banks calibrate their policy responses more effectively. Therefore, investing in improved models and data collection over time would be a valuable endeavor.

- Developing models that capture sectoral linkages and heterogeneity—as exemplified by the model in this chapter—can be a step in the right direction, which should be considered as central banks plan to revamp their modeling approaches in the context of their framework reviews (for example, Bank of England 2024).
- The collection of more granular sectoral data would allow sectoral networks to be mapped out and models to be refined. How much and how fast sectoral price pressures propagate across an economy, for example, depending on the centrality or criticality

of sectors or the degree of price stickiness, could be quantified through such data.

- High-frequency sectoral indicators of supply constraints and demand pressures can support policymaking in real time. Disruptions in supply chains can arise both upstream (such as component shortages) and downstream (such as congested ports), and surveys of producers could help identify them early. Constraints may also emerge from the labor market: although many central banks monitor labor market indicators, analyzing them at the sectoral level could provide a more detailed understanding of shortages. In addition, measures of overall supply-demand mismatches (such as back orders) could highlight the interacted effects of supply and demand shocks.

Open economies can benefit from positive spillovers of other central banks' policy tightening through lower tradable goods prices. Such spillovers can be particularly important for countries that have high exposure to those prices—for example, those for food and energy, and limited policy levers to respond to them—for example, low-income countries with fixed exchange rate regimes. Exchange rate depreciations and their pass-through into inflation can exert upward price pressures in countries with flexible exchange rate regimes if they are not hiking interest rates at the same time.[19] However, the exchange rate channel would be muted relative to the lower tradable goods prices channel to the extent that the policy tightening is synchronized.

Credible policy frameworks remain a valuable asset for central banks. The recent experience is a case in point: inflation expectations remained anchored and wage-price spirals did not materialize even as policymakers navigated difficult policy trade-offs under immense uncertainty in countries with credible frameworks. Better understanding of inflation expectations formation across different horizons and economic agents would help inform policymaking (Adrian 2023; Alvarez and Dizioli 2023; Brandão-Marques and others 2023; October 2023 *World Economic Outlook*).

It is important to emphasize that providing a precise quantification of the drivers of inflation in the context of simultaneous shocks during a once-in-a-century pandemic is an inherently difficult task. Reduced-form empirical analyses provide suggestive correlations. Using aggregate data or single-sector models leads to difficulties in the identification of demand and supply shocks, given input-output linkages: supply constraints in one sector can cause lower demand in complementary sectors that produce their intermediate inputs. The chapter's multisector model can capture such interlinkages and emphasizes supply constraints but also finds that their interaction with demand shocks must have played an important role in generating the size and persistence of inflation observed in the data.

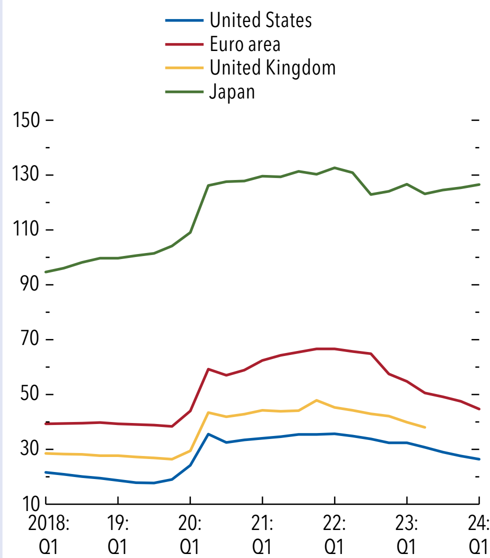
[19]Although such currency movements can facilitate expenditure switching, financial frictions or weakly anchored inflation expectations can hamper macroeconomic stability.

Box 2.1. The Role of Central Bank Balance Sheet Policies

Since the global financial crisis, central banks have expanded their toolkits by using balance sheet policies to achieve their objectives at the effective lower bound (ELB). This box documents that the unwinding of such policies, specifically quantitative tightening (QT), has had minimal effects so far, partly because of its slow and predictable implementation, facilitated by timely and extensive communication.

Central banks engaged in quantitative easing (QE) during the pandemic. QE was initially aimed at mitigating acute pandemic-related financial distress in spring 2020 and was used by many emerging markets as well as advanced economies. However, advanced economy central banks continued to expand their balance sheets even after the easing of financial distress in order to provide macroeconomic stimulus, although their policy rates were constrained by the ELB. Overall, during 2020–22, central bank balance sheets grew by more than 20 percent of GDP in Japan, the United Kingdom, and the euro area, and by about 18 percent of GDP in the United States (Figure 2.1.1). QE undertaken in this period is estimated to have had sizable effects in containing financial distress and supporting economic activity.

Figure 2.1.1. Central Bank Balance Sheets
(Percent of GDP)



Sources: Haver Analytics; and IMF staff calculations.
Note: Figure reports stock of central bank asset holdings as a percentage of GDP at monthly frequency. United Kingdom data ends in the second quarter of 2023 due to five-quarter reporting lag.

Once inflation surged, central banks began hiking policy rates and unwinding balance sheet policies, but QT is not merely QE in reverse.[1] First, central banks generally resort to QE when short-term policy rates are constrained by the ELB. This is not the case with QT, which has been used alongside policy tightening. Second, if QT and rate hikes are at least partially substitutable, greater QT can be partly offset by a slower tightening of policy rates—its effects, therefore, are more muted.[2] Third, QT may take place against a steeper Phillips curve (Erceg and others 2024a).

Evidence suggests that the effects of QT have so far been modest. Erceg and others (2024a), drawing on large-scale asset purchase shocks since the late 1990s, find that a one-standard-deviation QT shock has had a small, possibly slightly negative, effect on short-term rates while raising term premiums by about 12 basis points (Figure 2.1.2). Du, Forbes, and Luzzetti (2024) find that active QT tended to have a stronger impact on long-term rates than passive QT during the recent episode. They also find that the cumulative impact of QT announcements since 2021 has equaled at most two or three rate hikes in some countries, thus contributing moderately to a tighter policy stance.[3]

However, QT may have larger effects, especially if conducted more rapidly or on a larger scale. When reducing its balance sheet size, a central bank withdraws reserves from the banking system.

The author of this box is Thomas Kroen.

[1]QT can occur passively when a central bank does not reinvest assets that mature or when it actively sells assets (Du, Forbes, and Luzzetti 2024).

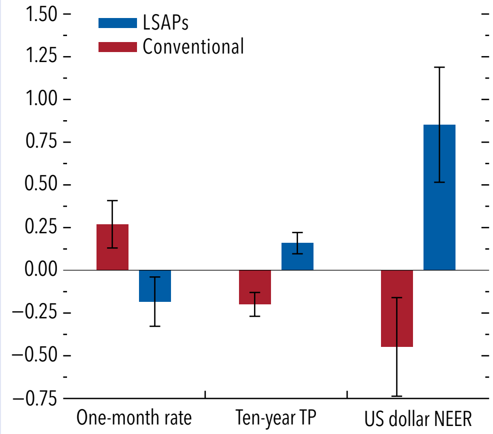
[2]The peak impact on inflation from a one-standard-deviation QT and a similar-sized policy rate shocks is estimated to be comparable in Erceg and others (2024a).

[3]Overall, QT has not been used as an explicit tool to tighten policy, instead largely working in the background. Moreover, because experience with QT started only in 2021, the external validity of these estimates in a macroeconomic environment very different from the postpandemic recovery remains an open empirical question (Du, Forbes, and Luzzetti 2024).

Box 2.1 *(continued)*

Although there was excess liquidity during the pandemic, QT may have stronger effects once reserves become scarce, as witnessed in the United States in 2019 (Du, Forbes, and Luzzetti 2024). Financial stability risks could also come to the fore: US commercial banks became more liquidity dependent through higher issuance of credit lines and increased financing via uninsured deposits, which raised the risk of sudden deposit withdrawals, as took place in March 2023 (Acharya and others 2023). Finally, advanced economies' QT strengthens their currencies (through higher term premiums) more than conventional tightening (through the short-term policy rate). Hence, there is more pressure on the currencies of emerging market and developing economies (Figure 2.1.2). This worsens inflation-output trade-offs in those economies, especially in those with a fixed exchange rate that must raise rates sharply to maintain their pegs (Erceg and others 2024a). In contrast, conventional tightening can achieve similar macroeconomic outcomes with smaller adverse international spillovers (Erceg and others 2024a).

Figure 2.1.2. Estimated Impact of Monetary Policy and LSAP Tightening
(Percent)



Sources: Erceg and others 2024a; and IMF staff calculations.
Note: Monetary policy shocks are from Lewis (2023). The figure reports median quarterly impulse responses from estimation as in Erceg and others (2024a), along with 68 percent error bands for the United States. Shocks are scaled to a one-standard-deviation shock. LSAPs = large-scale asset purchases; NEER = nominal effective exchange rate; TP = term premium.

Box 2.2. The Role of Price-Suppressing Policies

Countries have frequently resorted to tools other than monetary policy to combat inflation. The recent inflationary episode was no exception. This box takes stock of inflation stabilization policies implemented historically and in the postpandemic recovery and discusses their rationale and limitations.

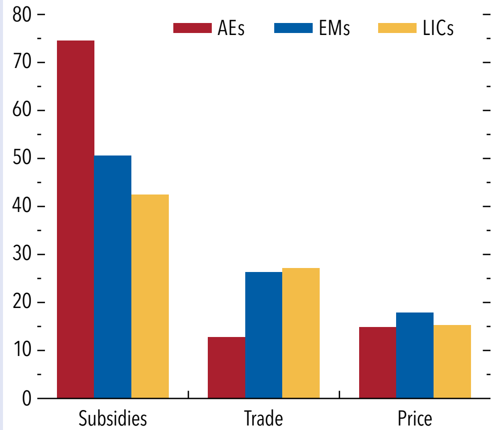
Energy and consumption subsidies. Subsidies have historically been used to maintain lower prices, especially for energy (Black and others 2023). During the pandemic, most governments subsidized fuel and electricity and reduced value-added taxes, sales taxes, and excises on essential goods (Figure 2.2.1). Subsidies work by absorbing increases in costs, thus limiting the pass-through to prices. They can tame inflation driven by temporary cost-push shocks. Dao and others (2023) find that energy subsidies played a significant role in stabilizing inflation in the euro area (Figure 2.2.2) in the recent episode. However, subsidies have substantial fiscal costs, do not align with climate-change-related goals, and often fail to target the vulnerable. They also distort relative prices, leading to overconsumption of subsidized goods, which fuels further price rises (Erceg and others 2024b).

Import tax reductions and export restrictions. Following the pandemic, many countries resorted to reducing import taxes and imposing export restrictions to stabilize domestic prices, especially in emerging markets and low-income countries (Figure 2.2.1). Import tax cuts lower imported goods prices and increase domestic supply, whereas export restrictions can ease domestic inflationary pressures. However, tax cuts have fiscal costs, and both policies induce adverse international spillovers by reducing global supply or increasing global demand, thereby contributing to further price increases (Giordani, Rocha, and Ruta 2016).

Price and wage controls. Historically, price and wage freezes have been used to curb inflation, in the United States and Europe in the 1960s and 1970s, among other instances. They have been used again to some degree since the pandemic, particularly in emerging markets and low-income countries, primarily on essential food items (Figure 2.2.1). In specific contexts, such as when dealing with monopsony (for example, minimum wage) or monopoly (for example, electricity pricing) power, these controls can be justified. However, they often lead to adverse outcomes, such as the emergence of black markets and shortages, and prevent adjustment in relative prices.

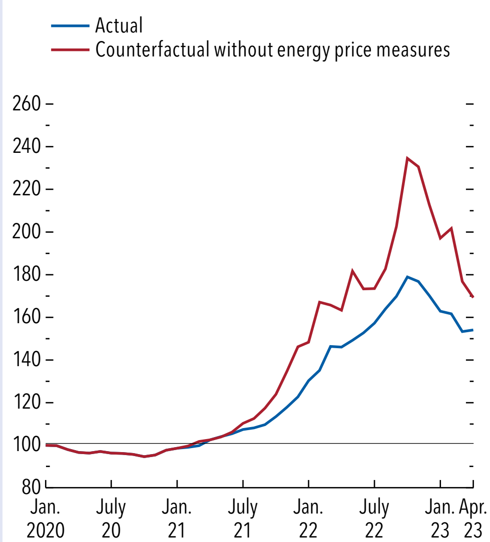
The author of this box is Damien Capelle.

Figure 2.2.1. Discretionary Inflation Stabilization Policies during the Pandemic
(Percent of countries)



Sources: Amaglobeli and others 2023; IMF, Database of Energy and Food Price Actions.
Note: Based on surveys of 174 countries conducted from March to July 2022. AEs = advanced economies; EMs = emerging markets; LICs = low-income countries.

Figure 2.2.2. Euro Area Actual and Counterfactual Energy Price Levels
(Index; January 2020 = 100)



Sources: Dao and others 2023; and IMF staff calculations.
Note: "Actual" indicates the electricity, gas, and other fuels series of the harmonised index of consumer prices.

Box 2.2 *(continued)*

Other policies. Government-led negotiations have been historically employed in many countries to coordinate wage and price setting, during the pandemic as well as at other times. Although they can be instrumental in managing wage-price spirals and anchoring expectations, they can also distort relative prices. Finally, tax on inflation policies, which involve taxes proportional to a firm's increase in prices, was widely discussed and implemented in several advanced and emerging market economies in the 1970s and 1990s. Capelle and Liu (2023) show that by providing firms with incentives to moderate their price increases, tax on inflation policies can offer substantial stabilization gains under certain conditions. Although these policies are useful for addressing inflation coming from cost-push shocks and shifts in inflation expectations, their practical implementation needs to be clarified, and monetary policy is a better instrument for bringing down inflation arising from excessive aggregate demand.

To conclude, countries have employed additional tools to stabilize inflation when monetary policy is limited, such as during cost-push shocks or under an exchange rate peg. However, monetary policy remains the primary tool for managing demand-driven inflation. The use of alternative tools requires careful assessment of their effectiveness and trade-offs to minimize potential adverse side effects.

References

Acharya, Viral, Rahul Chauhan, Rajan Raghuram, and Sascha Steffen. 2023. "Liquidity Dependence and the Waxing and Waning of Central Bank Balance Sheets." NBER Working Paper 31050, National Bureau of Economic Research, Cambridge, MA. https://www.nber.org/papers/w31050.

Adrian, Tobias. 2023. "The Role of Inflation Expectations in Monetary Policy." Remarks delivered at the Institut für Bank and Finanzgschichte/Deutsche Bundesbank Symposium, May 15. https://www.imf.org/en/News/Articles/2023/05/15/sp-role-inflation-expectations-monetary-policy-tobias-adrian.

Afrouzi, Hassan, Saroj Bhattarai, and Edson Wu. 2024. "Relative-Price Changes as Aggregate Supply Shocks Revisited: Theory and Evidence." *Journal of Monetary Economics,* ahead of print, August 8, 2024. https://doi.org/10.1016/j.jmoneco.2024.103650.

Ahn, JaeBin. 2024. "Greenflation or Greensulation? The Case of Fuel Excise Taxes and Oil Price Passthrough." IMF Working Paper 24/153, International Monetary Fund, Washington, DC.

Alvarez, Jorge, John Bluedorn, Niels-Jakob Hansen, Youyou Huang, Evgenia Pugacheva, and Alexandre Sollaci. 2024. "Wage-Price Spirals: What Is the Historical Evidence?." *Economica* 91 (364).

Alvarez, Jorge, and Allan Dizioli. 2023. "How Costly Will Reining in Inflation Be? It Depends on How Rational We Are." IMF Working Paper 23/021, International Monetary Fund, Washington, DC. https://www.imf.org/en/Publications/WP/Issues/2023/03/24/Policy-Responses-to-High-Energy-and-Food-Prices-531343.

Amaglobeli, David, Mengfei Gu, Emine Hanedar, Gee Hee Hong, and Céline Thévenot. 2023. "Policy Responses to High Energy and Food Prices." IMF Working Paper 23/074, International Monetary Fund, Washington, DC. https://www.imf.org/en/Publications/WP/Issues/2023/03/24/Policy-Responses-to-High-Energy-and-Food-Prices-531343.

Ari, Anil, Daniel Garcia-Macia, and Shruti Mishra. 2023. "Has the Phillips Curve Become Steeper?." IMF Working Paper 23/100, International Monetary Fund, Washington, DC. https://www.imf.org/en/Publications/WP/Issues/2023/05/12/Has-the-Phillips-Curve-Become-Steeper-533315.

Ari, Anil, Carlos Mulas-Granados, Victor Mylonas, Lev Ratnovski, and Wei Zhao. 2023. "100 Inflation Shocks: Seven Stylized Facts." IMF Working Paper 23/190, International Monetary Fund, Washington, DC.

Auclert, Adrien, Hugo Monnery, Matthew Rognlie, and Ludwig Straub. 2023. "Managing an Energy Shock: Fiscal and Monetary Policy." Unpublished, Stanford University, Stanford, CA.

Ball, Laurence M., Daniel Leigh, and Prachi Mishra. 2022. "Understanding US Inflation during the Covid Era." NBER Working Paper 30613, National Bureau of Economic Research, Cambridge, MA.

Bank of England. 2024. "Response of the Bank of England to the Bernanke Review of Forecasting for Monetary Policy Making and Communication at the Bank of England." London. https://www.bankofengland.co.uk/independent-evaluation-office/forecasting-for-monetary-policy-making-and-communication-at-the-bank-of-england-a-review/response-forecasting-for-monetary-policy-making-and-communication-at-the-bank-of-england-a-review.

Barnichon, Regis, and Adam Hale Shapiro. 2024. "Phillips Meets Beveridge." Working Paper 2024-22, Federal Reserve Bank of San Francisco. https://doi.org/10.24148/wp2024-22.

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. https://www.nber.org/papers/w31197.

Bernanke, Ben S., and Olivier Blanchard. 2024. "An Analysis of Pandemic-Era Inflation in 11 Economies." Peterson Institute for International Economics Working Paper 24-11, Washington, DC. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4834622#.

Bernanke, Ben S., Mark Gertler, and Mark W. Watson. 1997. "Systematic Monetary Policy and the Effects of Oil Price Shocks." *Brookings Papers on Economic Activity* 1997 (1): 91–157.

Black, Simon, Antung A. Liu, Ian Parry, and Nate Vernon. 2023. "IMF Fossil Fuel Subsidies Data: 2023 Update." IMF Working Paper 23/169, International Monetary Fund, Washington, DC. https://www.imf.org/en/Publications/WP/Issues/2023/08/22/IMF-Fossil-Fuel-Subsidies-Data-2023-Update-537281.

Blanchard, Olivier. 2016. "The Phillips Curve: Back to the '60s?." *American Economic Review* 106 (5): 31–34.

Blanchard, Olivier, and Jordi Galí. 2007a. "Real Wage Rigidities and the New Keynesian Model." *Journal of Money, Credit and Banking* 39 (S1): 35–65.

Blanchard, Olivier, and Jordi Galí. 2007b. "The Macroeconomic Effects of Oil Price Shocks: Why Are the 2000s So Different from the 1970s?." In *International Dimensions of Monetary Policy,* edited by Jordi Galí and Mark Gertler, 373–421. Chicago, IL: University of Chicago Press.

Brandão-Marques, Luis, Gaston Gelos, David J. Hofman, Julia Otten, Gurnain Kaur Pasricha, and Zoe Strauss. 2023. "Do Household Expectations Help Predict Inflation?." IMF Working Paper 23/224, International Monetary Fund, Washington, DC.

Capelle, Damien, and Yang Liu. 2023. "Optimal Taxation of Inflation." IMF Working Paper 23/254, International Monetary Fund, Washington, DC. https://www.imf.org/en/Publications/WP/Issues/2023/12/08/Optimal-Taxation-of-Inflation-542215.

Carvalho, Carlos, Stefano Eusepi, Emanuel Moench, and Bruce Preston. 2023. "Anchored Inflation Expectations." *American Economic Journal: Macroeconomics* 15 (1): 1–47. https://www.doi.org/10.1257/mac.20200080.

Cavallo, Alberto, Francesco Lippi, and Ken Miyahara. 2023. "Large Shocks Travel Fast." NBER Working Paper 31659, National Bureau of Economic Research, Cambridge, MA. https://www.nber.org/papers/w31659.

Choi, Sangyup, Davide Furceri, Prakash Loungani, Saurabh Mishra, and Marcos Poplawski-Ribeiro. 2018. "Oil Prices and Inflation Dynamics: Evidence from Advanced and Developing Economies." *Journal of International Money and Finance* 82 (April): 71–96. https://doi.org/10.1016/j.jimonfin.2017.12.004.

Choi, Woon Gyu, Taesu Kang, Geun-Young Kim, and Byongju Lee. 2017. "Global Liquidity Transmission to Emerging Market Economies, and Their Policy Responses." *Journal of International Economics* 109 (November): 153–66. https://doi.org/10.1016/j.jinteco.2017.08.001.

Comin, Diego A., Robert C. Johnson, and Callum J. Jones. 2023. "Supply Chain Constraints and Inflation." NBER Working Paper 31179, National Bureau of Economic Research, Cambridge, MA. https://www.nber.org/papers/w31179.

Dao, Mai Chi, Alan 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. https://www.imf.org/en/Publications/WP/Issues/2023/08/31/Unconventional-Fiscal-Policy-in-Times-of-High-Inflation-537454.

Dao, Mai Chi, Pierre-Olivier Gourinchas, Daniel Leigh, and Prachi Mishra. 2024. "Understanding the International Rise and Fall of Inflation since 2020." *Journal of Monetary Economics,* ahead of print, August 13, 2024. https://doi.org/10.1016/j.jmoneco.2024.103658.

Deb, Pragyan, Davide Furceri, Jonathan D. Ostry, Nour Tawk, and Naihan Yang. 2024. "The Effects of Fiscal Measures during COVID-19." *Journal of Money, Credit and Banking,* ahead of print, April 25, 2024. https://doi.org/10.1111/jmcb.13154.

Del Negro, Marco, Michele Lenza, Giorgia E. Primiceri, and Andrea Tambalotti. 2020. "What's Up with the Phillips Curve?" NBER Working Paper 27003, National Bureau of Economic Research, Cambridge, MA. https://www.nber.org/papers/w27003.

Du, Wenxin, Kristin Forbes, and Matthew Luzzetti. 2024. "Quantitative Tightening around the Globe: What Have We Learned?" NBER Working Paper 32321, National Bureau of Economic Research, Cambridge, MA. https://www.nber.org/papers/w32321.

Dupraz, Stephane. 2024. "A Kinked-Demand Theory of Price Rigidity." *Journal of Money, Credit and Banking* 56 (2–3): 325–63.

Erceg, Chris, Marcin Kolasa, Jesper Lindé, Haroon Mumtaz, and Pawel Zabczyk. 2024a. "Central Bank Exit Strategies: Domestic Transmission and International Spillovers." IMF Working Paper 24/73, International Monetary Fund, Washington, DC. https://www.imf.org/en/Publications/WP/Issues/2024/03/29/Central-Bank-Exit-Strategies-Domestic-Transmission-and-International-Spillovers-546938.

Erceg, Chris, Marcin Kolasa, Jesper Lindé, and Andrea Pescatori. 2024b. "Can Energy Subsidies Help Slay Inflation?." IMF Working Paper 24/81, International Monetary Fund, Washington, DC. https://www.imf.org/en/Publications/WP/Issues/2024/04/05/Can-Energy-Subsidies-Help-Slay-Inflation-547366.

Erceg, Chris, Jesper Lindé, and Mathias Trabandt. 2024. "Monetary Policy and Inflation Scares." Unpublished, International Monetary Fund, Washington, DC.

Giordani, Paolo, Nadia Rocha, and Michele Ruta. 2016. "Food Prices and the Multiplier Effect of Trade Policy." *Journal of International Economics* 101: 102–22.

Gopinath, Gita. 2022. "How Will the Pandemic and War Shape Future Monetary Policy?." Presentation, Jackson Hole Economic Policy Symposium, Jackson Hole, WY, August 25.

Gopinath, Gita. 2024. "Navigating Fragmentation, Conflict, and Large Shocks." Remarks, Eighth Joint NBU [National Bank of Ukraine]–NBP [Narodowy Bank Polski] Annual Research Conference, Kyiv, June 20–21.

Gudmundsson, Tryggvi, Chris Jackson, and Rafael Portillo. 2024. "The Shifting and Steepening of Phillips Curves during the Pandemic Recovery: International Evidence and Some Theory." IMF Working Paper 24/007, International Monetary Fund, Washington, DC.

Guerrieri, Veronica, Guido Lorenzoni, Ludwig Straub, and Iván Werning. 2021. "Monetary Policy in Times of Structural Reallocation." Working Paper 2021-111, Becker Friedman Institute for Economics, University of Chicago, Chicago, IL.

Guerrieri, Veronica, Michala Marcussen, Lucrezia Reichlin, and Silvana Tenreyro. 2023. *The Art and Science of Patience. Relative Prices and Inflation*. Geneva Report on the World Economy 26. Paris: CEPR Press.

Harding, Martín, Jesper Lindé, and Mathias Trabandt. 2022. "Resolving the Missing Deflation Puzzle." *Journal of Monetary Economics* 126: 15–34. https://doi.org/10.1016/j.jmoneco.2021.09.003.

Harding, Martín, Jesper Lindé, and Mathias Trabandt. 2023. "Understanding Post-Covid Inflation Dynamics." *Journal of Monetary Economics* 140: 101–18. https://doi.org/10.1016/j.jmoneco.2023.05.012.

Hazell, Jonathon, Juan Herreño, Emi Nakamura, and Jón Steinsson. 2022. "The Slope of the Phillips Curve: Evidence from US States." *Quarterly Journal of Economics* 137 (3): 1299–344. https://doi.org/10.1093/qje/qjac010.

Hooper, Peter, Frederic S. Mishkin, and Amir Sufi. 2020. "Prospects for Inflation in a High Pressure Economy: Is the Phillips Curve Dead or Is It Just Hibernating?." *Research in Economics* 74 (1): 26–62. https://doi.org/10.1016/j.rie.2019.11.00.

Ilut, Cosmin, Rosen Valchev, and Nicolas Vincent. 2020. "Paralyzed by Fear: Rigid and Discrete Pricing under Demand Uncertainty." *Econometrica* 88 (5): 1899–938. https://www.jstor.org/stable/48597206.

Inoue, Atsushi, Barbara Rossi, and Yiru Wang. 2024. "Has the Phillips Curve Flattened?." Discussion Paper 18846, Centre for Economic Policy Research, London. https://cepr.org/publications/dp18846.

Karadi, Peter, Anton Nakov, Galo Nuño, Ernesto Pasten, and Dominik Thaler. 2024. "Strike while the Iron Is Hot: Optimal Monetary Policy with a Nonlinear Phillips Curve." Discussion Paper 19339, Centre for Economic Policy Research, London. https://cepr.org/publications/dp19339.

Koch, Christoffer, and Diaa Noureldin. 2024. "How We Missed the Inflation Surge: An Anatomy of Post-2020 Inflation Forecast Errors." *Journal of Forecasting* 43 (4): 852–70.

Lewis, Daniel J. 2023. "Announcement-Specific Decompositions of Unconventional Monetary Policy Shocks and Their Effects." *Review of Economics and Statistics* 1–46. https://doi.org/10.1162/rest_a_01315.

McLeay, Michael, and Silvana Tenreyro. 2020. "Optimal Inflation and the Identification of the Phillips Curve." *NBER Macroeconomics Annual* 34 (1): 199–255. https://doi.org/10.1086/707181.

Minton, Robert, and Brian Wheaton. 2022. "Hidden Inflation in Supply Chains: Theory and Evidence." Unpublished, Harvard University, Cambridge, MA, and University of California at Los Angeles.

Natal, Jean-Marc. 2012. "Monetary Policy Response to Oil Price Shocks." *Journal of Money, Credit and Banking* 44 (1): 53–101. https://doi.org/10.1111/j.1538-4616.2011.00469.

Rubbo, Elisa. 2023. "Networks, Phillips Curves, and Monetary Policy." *Econometrica* 91 (4): 1417–55.

Task Force of the Monetary Policy Committee of the ESCB. 2010. "Energy Markets and the Euro Area Macroeconomy." Occasional Paper 113, European Central Bank, Frankfurt am Main.