Tradeoffs and Sacrifice over Rate Cycles: Activity, Inflation and the Price Level*

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Paper prepared for the NBER Macroeconomics Annual

March 20, 2025

Abstract: Central banks often face tradeoffs in how their monetary policy decisions impact economic activity (including employment), inflation and the price level. This paper assesses how these tradeoffs have evolved over time and varied across countries, with a focus on understanding the post-pandemic adjustment. To make these comparisons, we first compile a cross-country, historical database of "rate cycles" (i.e., easing and tightening phases for monetary policy), which allows us to quantify the characteristics of interest rate adjustments and corresponding tradeoffs around activity, inflation, and the price level. We also calculate Sacrifice Ratios (output losses per inflation reduction) and document a historically low "sacrifice" during the post-pandemic tightening. This popular measure, however, ignores adjustments in the price level—which increased by more after the pandemic than in over the past four decades. Our results suggest a significant role for central banks' monetary policy strategy (and particularly the timing and aggressiveness of rate hikes) in explaining these tradeoffs and how adjustments occur during tightening phases. For example, in response to the post-pandemic inflation surge, the slow start to tightening appears to have reduced Sacrifice Ratios, but at the cost of larger increases in the price level. Central bank credibility is the one institutional feature that corresponds to positive outcomes and no tradeoffs across the measures we assess.

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* Paper prepared for the NBER Macroeconomics Annual held in Cambridge, MA in April 2025. Author contact information: kjforbes@mit.edu, jongrimha@worldbank.org, akose@worldbank.org. The findings, interpretations, and conclusions expressed in this paper are those of the authors and should not be attributed to the institutions with which they are affiliated. Thanks to Mirco Balatti, Stephen Cecchetti, Steven Kamin, Dohan Kim, Donald Kohn, and Robert Tetlow for feedback on early versions of this work. We are grateful to Nikita Perevalov for his help with model simulations and Rafaela Henriques for excellent research support. Further thanks to participants at the ECB's Forum on Central Banking in Sintra, Portugal in July 2024 for feedback on this research agenda, and especially Philip Lane who motivated this paper based on his question on tradeoffs.

I. Introduction

When central banks adjust monetary policy, they can choose between a number of different strategies, such as when, how quickly, and by how much to adjust the policy interest rate, as well as whether to combine these adjustments with other policy tools. These decisions often involve weighing difficult tradeoffs—such as whether to tighten policy more aggressively in order to bring inflation down to target more quickly, but at the cost of a larger output loss and increase in unemployment. This paper attempts to better understand these tradeoffs and corresponding sacrifices,[1] including how they have evolved over time and varied across economies, and with a focus on understanding the post-pandemic tightening. During this period, advanced economy central banks followed an unusual strategy for adjusting policy rates: a delayed start followed by aggressive tightening. When combined with an initial high level of credibility, this strategy contributed to a historically small "sacrifice" by some traditional measures, but an unusually large cost in terms of the increase in the price level.

An extensive body of literature analyzes monetary policy tradeoffs using various modeling frameworks and approaches (Clarida, Gali, and Gertler 1999; Adolfson, Laseén, Lindé, and Svenson 2008). A central theme in this literature is the short-run tradeoff between activity and inflation, encapsulated in the Phillips curve and at the core of most central bank DSGE models.[2] Another theme is the relative weight central banks should put on the output (or employment) gap and deviations of inflation from target when setting interest rates, as originally captured in the Taylor rule (Taylor 1993). One simple approach to describing these types of tradeoffs that has captured the attention of the broader public is the "Sacrifice Ratio"—the output losses required per inflation reduction (Ball 1994; Cecchetti et al. 2023; Tetlow 2024). These issues became particularly poignant when inflation spiked around the world in 2021-22, causing central banks to weigh these tradeoffs as they evaluated the appropriate strategy for tightening monetary policy (Tenreyro 2023; Maechler 2024).

Recent research provides various explanations why the tradeoff between activity and inflation can change over time and vary across countries (well summarized in Tetlow 2024). For example, an extensive series of papers focuses on the role of inflation expectations (Beaudry, Hou and Portier 2024; Reis 2022) and how the actions taken by central banks can stabilize inflation expectations and the related wage- and price- setting process (Bandera et al. 2023) and reinforce central bank commitment to meeting inflation targets (Afrouzi et al. 2024 ; Romer and Romer 2024).[3] Another line of research emphasizes how the shocks affecting the economy determine the corresponding

[1] We use the term "tradeoff" to capture when a central bank balances two outcomes (such as how much adjustment occurs through above-target inflation versus output losses) and the term "sacrifice" to capture a narrower set of situations when a central bank balances a negative outcome in one measure to achieve a positive outcome in another (such as the magnitude of output losses to reduce above-target inflation).
[2] This original framework developed in Phillips (1958) focused on tradeoff between wages and unemployment, but it is now used more broadly to capture the relationship between various measures of activity (including GDP and employment) with different measures of inflation. See McLeay and Tenreyro (2021) for a recent discussion at the NBER Macro Annual.
[3] This links to an extensive body of work on inflation expectations in monetary policy models that depart from full-information rational expectations, as well as to the literature on the responses of inflation and other macro variables to policy shocks, such as Christiano, Eichenbaum, and Evans (2005) and Ramey (2016).

tradeoffs (Adolfson et al. 2008; Bandera et al. 2023). Other literature discusses how slower-moving variables, such as globalization and changes in the labor market, reduce the slope of the Phillips curve and therefore affect the relationship between activity and inflation (Forbes 2020; Ha, Kose and Ohnsorge 2019; Jasová, Moessner and Takáts 2018).

One important concept that has received much less attention in this discussion, however, is the aggregate impact of different monetary policy strategies on the price level. This is obviously related to the inflation rate, but also takes into consideration the length of time inflation deviates from target combined with the cumulated size of the deviation. Although many central banks viewed the combination of sharp disinflation with fairly robust activity after the pandemic as a success (a view supported by historically low Sacrifice Ratios), recent polls suggest high levels of dissatisfaction with the macroeconomy during this period, partly because of high prices. The period of elevated inflation and impact on the level of prices appears to have also played a role in recent elections.[4]

A body of research uses survey data on individual preferences to provide further evidence that households care about this increase in the price level, and not just the rate of inflation (Cournède and Moccero 2009; Honkapohja and Mitra 2020). For example, Stantcheva (2024) finds that the "predominant reason for people's aversion to inflation is the widespread belief that it diminishes their buying power" rather than due to an association with unemployment or activity. Other papers document that individuals believe inflation has a negative impact on their personal financial situation and erodes their purchasing power (Coibion, Georgarakos, Gorodnichenko, and Van Rooij 2023; Binetti, Nuzzi, and Stantcheva 2024). This belief that inflation is "unfair" seems to persist even if central banks accomplish their goal of returning inflation to target.

Moreover, other research and the post-pandemic experience highlights the nonlinear effects of price shocks. Larger shocks cause firms to adjust prices more frequently (Khalil and Lewis 2024), reflecting the non-linear effects on workers bargaining for wages that can lead to broader wage-price spirals (Alvarez et al. 2024). Similarly, consumers and businesses pay more attention to inflation after large and longer lasting price shocks, such that inflation expectations may become less firmly anchored (Bums et al. 2021; Beaudry, Hou, and Portier 2024). For all of these reasons, even if inflation returns to target after a price shock, larger increases in the price level could correspond to more persistent changes in price setting behavior, wage negotiations, and a greater sensitivity to future inflation shocks, all of which could affect the transmission of monetary policy.

These different strands of research, as well as the post-pandemic experience examined in this paper, suggest that any assessment of the tradeoffs and sacrifices during a disinflation episode should incorporate the duration and cumulative amount by which inflation deviates from target (i.e., the impact on the price level), as well as the traditional focus on activity and returning inflation to target. This does *not* imply that central banks should shift to targeting the price level, which has its own serious shortcomings—including the difficulty in communication (Ambler 2009; Kahn

[4] New research suggests that inflation surprises "are regularly followed by a substantial increase in vote shares of extremist, anti-system, and populist parties" (Federle, Mohr, and Schularick 2024). This topic has also been covered in media, such as "Voter frustration with rising prices has a major impact on the election, 11/09/24, National Public Radio, https://www.npr.org/2024/11/09/nx-s1-5184401/voter-frustration-with-rising-prices-had-a-major-impact-on-the-election.

2009). Such a shift would also imply a major change in strategy away from one that has been largely successful in anchoring inflation expectations over recent decades.

Moreover, in many cases the optimal adjustment to shocks (particularly supply shocks and sectoral shocks) should primarily occur through prices (Afrouzi, Bhattarai, and Wu 2024). Instead, our analysis suggests that central banks should supplement their existing focus on inflation targets (and employment or other measures of activity) with a more explicit assessment of what different strategies imply for the extent and duration of any deviations of inflation from target. This richer discussion of the tradeoffs for monetary policy that includes the impact on the price level could involve a range of approaches (discussed in more detail in the conclusions).

In order to better understand the tradeoffs in activity, inflation, and the price level facing central banks, Section II draws on the business cycle literature to identify a series of "rate cycles" based on changes in policy interest rates and new balance sheet programs across a sample of 24 advanced economies from 1970 through 2024. This yields a monthly database of tightening and easing phases—together which constitute a "rate cycle"—comparable to how the expansion and recession phases of output together constitute a business cycle. To the best of our knowledge, this is the first cross-country, historical database of rate cycles.

Section III analyzes the characteristics of these cycles on several dimensions, building on statistics that are often used to describe business cycles: amplitude (total rate hikes); length of phase; pace (average size of rate adjustments); and initial velocity (rate adjustments over the first six months). We also include characteristics that are unique to rate cycles—such as the duration for which rates are "on hold" at peak/trough levels before the end of the phase and use of balance sheet policies. This allows us to compare the characteristics of easing and tightening phases across economies and over time, as well as how they correlate to key macroeconomic variables. These statistics on monetary policy strategies will also be central to the analysis of tradeoffs in Section V.

This analysis suggests the post-pandemic tightening phase stands out by several metrics: a very slow start to tightening policy (based on the evolution of macroeconomic variables), followed by aggressive increases in the policy interest rate (measured by the initial velocity, number, pace and amplitude of rate hikes). This was followed by a much longer period holding rates constant at elevated levels and the start of quantitative tightening in many economies (in most cases much earlier and faster than expected). We also assess the evolution of activity (GDP and industrial production), the labor market (employment and unemployment), and prices (headline and core inflation) over tightening phases. This analysis highlights the historically large movements in each variable around the pandemic.

Section IV then focuses on the measurement of key tradeoffs and the corresponding sacrifices for central banks over tightening phases. It begins by calculating relevant statistics for inflation (such as the disinflation accomplished over each phase) and output gaps (using a range of measures). For many of these statistics, the post-pandemic adjustment continues to stand out. For example, the median accumulated output loss during the post-pandemic tightening was only -0.4% of

annual GDP, while the median reduction in CPI inflation from its post-pandemic peak was 8.5pp (the largest of any of our long historical sub-periods since 1970). [5]

Next, we combine these measures to calculate Sacrifice Ratios (the absolute value of the accumulated negative output gaps relative to the reduction in inflation) across economies and tightening phases. The results suggest that the median "sacrifice" during the post-pandemic tightening was lower than any historical period based on a range of measures. This reflects the combination of historically low output losses combined with historically large disinflations. In fact, these Sacrifice Ratios are near zero in several major economies during the post-pandemic tightening phase.

These statistics, however, and the focus on whether inflation returns to targets, miss an important consideration: the impact on the price level. During the post-pandemic tightening, price levels increased sharply and remained at elevated levels even as inflation fell. Across our sample, the median increase in the price level (based on the CPI or PCE) was more than 4 pp per year above that which would occur if inflation had remained at 2%. This is the largest annual "excess" increase in the price level since 1970-1984, and particularly challenging for households and businesses for which inflation expectations were anchored around 2% (or even lower after negative "excess" inflation in the period before the pandemic). A comparison of these accumulated changes in the price level to those for output losses (roughly captured in a simple "Price-Output Tradeoff Ratio") suggests that more of the post-pandemic adjustment occurred through price (level) increases relative to through output or employment losses than has historically occurred.

To better understand these tradeoffs for monetary policy, Section V explores why they have changed over time and can vary meaningfully across economies. We begin with regression analysis to assess how a central bank's strategy corresponds to the subsequent macroeconomic adjustments and tradeoffs around inflation, activity and the price level. In order to capture a central bank's strategy, we use the rate cycle characteristics developed in Section II to measure the aggressiveness of tightening phases and timing of the first rate hike. We also control for central bank credibility, labor market flexibility, and the role of oil shocks (as well as a large set of additional variables in sensitivity tests).

Our results suggest that the unusual tradeoffs during the post-pandemic period (e.g., the collapse in Sacrifice Ratios, large excess increase in the price level, and bulk of the adjustment occurring through prices rather than output) reflect a combination of: the slow start to tightening monetary policy; the subsequent aggressive path of rate hikes; and the strong prior credibility of the central banks in our sample. A delayed start to raising interest rates corresponds to lower Sacrifice Ratios, but primarily due to significantly larger disinflations after substantially larger increases in the price level. A delayed start does not appear to provide any benefit in terms of reducing output losses (possibly reflecting the more aggressive tightening needed to stabilize inflation) and therefore generates less attractive tradeoffs for monetary policy. A more aggressive path of rate hikes corresponds to significantly larger output losses, only partially balanced by significantly larger disinflations, and thereby higher Sacrifice Ratios and another clear tradeoff for monetary policy.

[5] As explained in Section III, we analyze rate cycles across five sub-periods: 1970-84, 1985-98, 1999-2007, 2008-19, and 2020-24. Each window includes some type of recession/crisis and recovery period, with the demarcations marking major global events that might have changed the nature of monetary policy cycles.

Greater pre-existing central bank credibility is the one institutional feature that does not appear to involve tradeoffs (at least for the measures we consider), as it is associated with better outcomes for each variable (significantly lower Sacrifice Ratios, significantly lower output losses, larger disinflations, and smaller increases in the price level.

These empirical results are simple associations and should only be interpreted as suggestive, however, as they do not control for the full set of variables and interactions that could affect macroeconomic outcomes. Therefore, to better understand these results in the context of a more fully developed framework, we also use the Federal Reserve Board's FRB/US model to simulate the impact of the different central bank strategies analyzed above. More specifically, we simulate how the timing of the first rate hike and subsequent aggressiveness of rate hikes affect inflation, output, and the price level, as well as the Sacrifice Ratio and the share of the adjustment through prices relative to output losses. The results from these illustrative simulations largely support the key findings of our regressions on how different central bank strategies affect macroeconomic variables and the corresponding tradeoffs.

Section VI concludes with several broad lessons from placing the post-pandemic tightening in a historical context. Central banks cannot avoid painful adjustments in response to certain types of shocks. Monetary policy decisions often involve weighing difficult tradeoffs between activity and inflation, and how to assess and balance these tradeoffs will depend on the specific situation and priorities of the central bank. Our analysis of the cross-country and historical evidence, however, suggests that central banks should also consider the price level when weighing these tradeoffs. The results also provide insights on which strategies can mitigate adjustment costs and thereby lead to more attractive tradeoffs during tightening phases.

II. Defining Rate Cycles: Methodology, Data and Dates

This section adapts the methodology used in the extensive business cycle literature to identify cycles in policy interest rates. We also incorporate information on central banks' balance sheet programs involving large-scale asset purchases (QE, quantitative easing) and subsequent asset sales (QT, quantitative tightening). This section begins by introducing the methodology and then describes the data on policy interest rates and asset purchase programs used to identify the rate cycles. It concludes with the resulting dates for easing and tightening phases used in the remainder of the paper.

II.1. Dating Methodology

Our goal is to identify the turning points of rate cycles using a methodology that links to the long-standing literature on business cycles and can be applied consistently over a long period and across countries. Because of the substantial volatility in interest rates early in our sample period and differences in monetary policy frameworks across countries and time, we cannot use an off-the-shelf approach, rely on country-specific analyses, or employ simple rules of thumb as sometimes done for business cycles (such as the two quarters of negative GDP growth popularly used as a shorthand to identify recessions).

Instead, we modify the BBQ algorithm proposed by Bry and Boschan (1971) and then developed in Harding and Pagan (2002).[6] This algorithm evaluates increases and decreases in a series to locate local maxima and minima over specified windows. If an adjacent local peak and trough of policy interest rates meets the censoring criteria set in the algorithm, they define the start of the two phases (easing and tightening) that together constitute a cycle. More specifically, the algorithm identifies a local maxima in the monthly series for interest rates i_t at time *t* if the interest rate increases and does not immediately fall back per the following criteria:

$$\{[(i_t - i_{t-2}) > 0, (i_t - i_{t-1}) > 0] \; and \; [(i_{t+2} - i_t) < 0, (i_{t+1} - i_t) < 0]\}. \quad (1)$$

Similarly, a local minima occurs in month *t* if:

$$\{[(i_t - i_{t-2}) < 0, (i_t - i_{t-1}) < 0] \; and \; [(i_{t+2} - i_t) > 0, (i_{t+1} - i_t) > 0]\}. \quad (2)$$

A local maxima is the peak of the interest rate series and can be the start of an easing phase (if it meets the requirements above), while a local minima is the trough of the interest rate series and can be the start of a tightening phase. A full "rate cycle" comprises an easing and a tightening phase, just as a business cycle comprises an expansion and contraction phase. For these local maxima and minima to qualify as the start of an easing or tightening phase, respectively, we set three parameters: (i) a window of at least 18 months on each side of a local maxima and minima; (ii) a window of at least 36 months for a full cycle (including both tightening and easing phases); and (iii) a window of at least 7 months for any individual phase of a cycle (either a tightening or easing phase).

The first two criteria require relatively long windows on each side of a turning point and for the full cycle in order to capture changes in interest rates that are not reversed soon afterward; this allows us to identify and study periods of "premature adjustment", i.e., when a central bank shifts from raising to lowering interest rates (or vice versa) and then needs to reverse course.[7] These longer windows also avoid classifying changes in interest rates that largely reflect market-driven movements as turning points, an issue earlier in the sample when interest rate data is more volatile and policy rates may not be directly set by central banks. In contrast, the third criterion allows for individual phases in a cycle to be short-lived; brief periods of rate hikes or cuts can potentially qualify as an easing or tightening phase—albeit within the longer parameters for a full cycle. This is useful in several cases when a central bank adjusts rates quickly by a large amount, and then does not adjust rates again (such as lowering rates to zero in one meeting).

After applying the algorithm, we make several adjustments to the dates identified in order for a month *t* to qualify as a turning point. These adjustments are mainly to address issues when interest rates are constant for an extended period around the lower bound. First, a month can qualify as the start of an easing (tightening) phase if there is no change in the policy rate but the central bank starts a new QE (QT) program (defined below). Second, if there is not a new balance sheet program, there must be an increase (decrease) in the policy interest rate to qualify as the start of a tightening (easing) phase. Third, any such increase (decrease) in the policy rate must be meaningful and

[6] The BBQ algorithm was first proposed by Bry and Boschan (1971), building on the work of Burns and Mitchell (1946) that lays the foundation for identifying US business cycles. See Claessens, Kose, and Terrones (2009, 2012) for details and applications to identifying business and financial cycles.

[7] See Forbes, Ha and Kose (2024) for the identification of and analysis of "premature adjustments".

lasting, defined as $|\Delta i_t| \geq 0.50$pp over one month, or at least two rate changes (of any size) occurring over a year, such that the policy rate is at least 30 basis points higher/lower one year after the first rate change.

Finally, if a central bank is in a tightening (easing) phase at the start of 2024, but shifts to easing (tightening) the policy rate in 2024, we classify this change as a turning point indicating the start of the next phase (as long as the rate change was not subsequently reversed). This is required as not enough time has passed for some of these shifts in monetary policy to be identified as turning points according to the mechanical application of the Harding and Pagan (2002) algorithm.[8] Appendix 1 provides more information on the details of the criteria used to identify the cycle dates, the application of each of the additional criteria, and the specific countries and dates affected by each of these criteria.

II. 2. Data: Policy Rates and Balance Sheet Programs

To define rate cycles, we focus on the policy interest rate for several reasons. First, policy interest rates are currently the primary tool used by central banks to affect the monetary policy stance. Since our goal is to inform central bank decisions today, this is an obvious measure to focus on. Employing market-determined measures of interest rates would incorporate fluctuations in rates that are not directly under the control of central banks. Second, data for policy interest rates are widely available over a long period, allowing us to analyze their evolution over the past 55 years (1970-2024) for 24 advanced economies. A long panel is particularly important for our empirical decomposition of the factors driving rate cycles and for the identification of precedents comparable to the ongoing rate cycle.

Finally, we focus on nominal policy rates, instead of attempting to estimate more complex measures of the overall stance of monetary policy.[9] Measuring the overall policy stance would require finding a comparable way to measure the impact of adjusting other policy tools (such as the money supply in certain periods) and modelling variables such as the neutral interest rate (which could be subject to substantial measurement error). Both of these tasks are extremely challenging for an individual country, and even more so for a cross-section of diverse economies over a long period when economic and financial structures have shifted and the relationships between variables have changed meaningfully. Measuring variables such as the neutral interest rate is also particularly difficult in real-time—especially today—which would limit our ability to analyze the current situation and compare it to historical precedents.[10]

While there are multiple reasons to focus on policy interest rates as our main guide to identify cycles in monetary policy, they have several limitations. Although policy interest rates are currently the key tool for adjusting monetary policy, there are periods when other instruments have also been important (including for different goals)—such as adjusting reserve requirements, the money

[8] In practice, this corresponds to the Bank of Japan being defined as shifting from an easing to tightening phase in March 2024 and the other central banks in the sample shifting from tightening to easing phases during 2024 (with the exceptions of Australia and Norway, which had not lowered rates by the end of 2024).
[9] A series of papers (such as Woodford 2003) have used alternative approaches to measure the overall stance of monetary policy.
[10] See Kiley (2020) for discussions of the challenges associated with using the neutral interest rate to measure the monetary policy stance

supply, and the size and composition of the central bank's balance sheet. Given our focus on monetary policy today, we incorporate information on the adoption of new QE and QT programs in our measure of rate cycles. Finally, we do not take into account changes in monetary policy goals, frameworks and targets that occurred over the sample period (such as whether a central bank targets inflation, employment, the money supply, or the exchange rate), although we discuss the likely impact of some of these changes on rate cycles over time.[11]

Our sample includes 24 advanced economies (including the euro area as a single entity for some parts of the analysis). We select these economies based on several criteria: (i) they are defined as advanced economies in the World Bank's *Global Economic Prospects* report, January 2024 (World Bank 2024); (ii) they are independent countries with GDP of at least $100bn in 2023; (iii) they have data for GDP, inflation and interest rates from at least 1980; and (iv) they have not primarily set interest rates in order to target the exchange rate since 1999.[12] Depending on the analysis, we include individual countries that are currently in the euro area, or consider the euro area as an economic entity.

We collect monthly data on the nominal interest rate defined as the policy rate by the central bank from January 1970 through December 2024.[13] Our main source is the BIS, but when data are unavailable or there are gaps, we augment it with information from Haver Analytics, FRED and the OECD. For members of the euro area, we use the policy rate for individual member countries through the end of 1998 and then use the European Central Bank (ECB) policy rate starting in January 1999. Also, in many economies the policy rate was substantially more volatile in earlier periods when it was not the central bank's operating target (e.g., in the 1970s and 1980s some central banks allowed their policy rates to adjust frequently as they aimed to meet operating targets for the money supply). This volatility is an important consideration in choosing the appropriate criterion for the identification of the turning points in rate cycles.

Next, we augment this monthly data on policy interest rates with dummy variables indicating if the country announces a new QE or QT program and when such program ends. Incorporating these programs is important to capture changes in the evolution of monetary policy in several parts of the subsequent analysis, particularly when policy rates in several economies were at the lower bound and central banks relied on asset purchase programs to adjust policy. These dummy variables equal one on the announcement date of a new program (even if the program is not implemented until later) and only include programs involving government bonds (i.e., not programs involving only corporate, territory, municipality or agency bonds). The dummy variables only capture the announcement of a new balance sheet program (and not later adjustments to the speed, size or

[11] Countries have adjusted their frameworks and targets meaningfully during the sample, but classifying different regimes is not straightforward, especially as some economies had multiple targets and others had substantial discretion in how they adjusted policy (Ball 2011; Bernanke and Mishkin 1992). Section III discusses how these regime changes can explain some of the differences in rate cycles over time.
[12] We include countries in the ERM in the earlier half of our sample, as well as Switzerland when it had a one-sided band on its exchange rate from 2011-2015.
[13] The interest rate that the central bank identifies as the policy rate has changed over time in most countries. For details, see the database "Long Series on Central Bank Policy Rates" compiled by the BIS and available at: https://www.bis.org/statistics/cbpol/cbpol_doc.pdf.

scope of the program). These QE and QT dummies only include programs related to monetary policy, i.e., not programs primarily aimed at providing liquidity or addressing market dysfunction.[14]

II.3. The Dates of the Rate Cycles

Application of our algorithm to the data on nominal policy rates and balance sheet programs yields 223 distinct rate phases (112 of tightening and 111 of easing) from January 1970 through December 2024 for our sample of 24 advanced economies. This includes the phase that each economy is in as of December 2024—even if that phase is not complete. Table 1 lists the identified turning points at the start of tightening and easing phases.

The 24 economies in our sample averaged 5 tightening and 5 easing phases, but some countries have had substantially more rate cycles than others. For example, the United States has had 18 distinct easing and tightening phases, and Canada and Sweden 16, while Ireland and Portugal had only 3 and 4, respectively. The smaller number of cycles for the individual euro area countries, however, reflects their shorter time series—as any cycles after 1998 are included as the euro area and not for the individual countries. Of the countries with data on nominal policy rates from 1970 through the end of the sample, Japan has the fewest turning points, with only 5 tightening and 4 easing phases—half of the United States.

More interesting than this list of turning points, however, is seeing these cycles in the context of the evolution of the policy rate and any QE or QT announcements for each economy. Figure 1 shows these graphs of policy rates for three major economies: the euro area, Japan, and the United States. Appendix Figures 1a and 1b show the resulting cycles for other economies and the individual euro area countries, respectively. The start of tightening phases is denoted by dashed purple lines, and easing phases by dashed red lines. The start of QT and QE programs are in dashed blue and orange lines, respectively.

A closer look at the turning points for these three major economies in Figure 1 is useful to better understand how these rate cycles are defined—and what can be learned from them. For example, consider the patterns for the euro area after the ECB started setting policy rates in January 1999. The methodology described above identifies: a tightening phase starting in November 1999; followed by an easing phase from May 2001; then another tightening phase starting in December 2005; and an easing phase starting in October 2008 (during the Global Financial Crisis), which subsequently involved several rounds of asset purchases. This later easing phase ended in July 2022, when policy rates began to be raised sharply, before the current easing phase began in June 2024. The period in 2011 when the ECB raised interest rates twice by 25bps does not count as the start of a tightening phase, as the ECB unwound these rate hikes within a year, followed by further rate cuts and asset purchase programs.[15] In March 2020 when the ECB announced a new asset

[14] The data used to compile these balance sheet variables are: CGFS (2019) and BIS (2019) for programs before the pandemic, English et al. (2021) and Fratto et al. (2021) for QE programs in response to the pandemic, and Du, Forbes, and Luzzetti (2024) and English et al. (2024) for QT programs since the pandemic.
[15] Specifically, the ECB increased rates by 25bps in April 2011 and July 2011, and then lowered them by the same amount in November and December 2011, such that the policy rate in January 2012 was the same as in March 2011. Forbes, Ha, and Kose (2024) defines this as a "preliminary adjustment" in an analysis of why some attempts to transition to a new phase are unwound.

purchase program, but did not reduce interest rates, this would have qualified as the start of an easing phase if the ECB was not already in an easing phase.[16]

A useful contrast to these patterns for the ECB is the turning points for Japan (middle of Figure 1). Japan has very few full rate cycles (only four), with policy interest rates hugging zero from the mid-1990s and extended periods when asset purchase programs are the primary tool for monetary policy. Also, in contrast to the above example for the ECB in 2011, Japan's increase in interest rates in July 2006 is identified as the start of a tightening phase—even though (as with the ECB) the Bank of Japan (BoJ) raised rates only twice in 25 bps increments and these hikes were later reversed. This qualifies as a turning point for Japan because the interest rate increases were sustained for over a year; the subsequent easing phase did not begin until over two years after the initial rate hike.

The cycle dates for the US are also a useful contrast to those for the euro area and Japan. The more frequent turning points in the United States, and corresponding larger number of easing and tightening phases, are more typical of other countries in the sample. The dates of the turning points for the US correspond to well-known shifts in monetary policy, as well as to the obvious peaks and troughs in the policy rate data. This is noteworthy given the greater volatility of policy rates earlier in the sample when the Federal Reserve relied on different tools and monetary frameworks (e.g., including more focus on the control of monetary aggregates). Despite these changes in how monetary policy is conducted, the dating algorithm, together with the additional criteria discussed above (and in Appendix 1), appears to have been successful in identifying the major turning points in policy interest rates that generally correspond to shifts in monetary policy.

While these differences in rate cycles across the euro area, Japan, and the United States are useful to understand the dating algorithm, there are also several fairly consistent patterns across most economies. Policy interest rates tended to be higher and substantially more volatile in the first half of the sample—reflecting higher neutral rates and inflation combined with monetary policy regimes that generally focused less on the level of the policy rate and more on other variables (such as the money supply). In the latter half of the sample, interest rates tend to be lower and much more stable (often flat around the lower bound in the 2010s), with a corresponding shift to more frequent use of balance sheet policy. There are also substantially fewer turning points after 2010, with several countries in a single, lengthy easing phase from 2008 through 2021/2022. When most countries shifted to a tightening phase after the pandemic, many combined sharp increases in interest rates with the start of QT.

III. Rate Cycles, Activity, and Inflation

This section analyzes key characteristics of these rate cycles across economies and over time. It begins by calculating a series of statistics for each economy across all the tightening and easing phases from 1970-2024 identified in Section II, and then evaluates how these characteristics have changed across shorter windows. The second half of the section then evaluates how

[16] The Swedish Riksbank also did not lower its policy interest rate and started a new asset purchase program after the pandemic, but this is considered as the start of an easing phase as monetary policy was previously defined as being in a tightening phase.

macroeconomic variables capturing activity, the labor market, and inflation evolve over rate cycles, once again starting with statistics across the full sample period and then examining changes over time. Throughout this section, we evaluate how the tightening episode that began after the COVID-19 pandemic compares to historical episode. This set of statistics characterizing rate cycles is central to the analysis in Section VI (which assesses the tradeoffs for monetary policy), as it provides more detailed information than previously available on the cross-country and time-series variation in central bank strategies during easing and tightening phases.

III.1. Rate Cycles

In order to understand the characteristics of rate cycles and how they have evolved over time, we compute a set of descriptive statistics inspired by the extensive literature analyzing business cycles, but adjusted in some cases to better apply to the tightening and easing phases for monetary policy. We focus on six statistics:

- *Duration*: The length of the phase (in months), defined from the turning point marking the start of one phase to the turning point marking the start of the subsequent phase, and including any periods when rates are constant at the end of the phase.
- *Amplitude*: The total change in the policy interest rate (in pp) over the entire phase.
- *Number of in-sync rate changes*: The number of times the policy rate is adjusted by more than 0.1 pp in-sync with the phase (i.e., the number of rate increases >0.1 pp during a tightening phase and the number of rate decreases <-0.1pp during an easing phase).[17]
- *Pace*: The average size of policy rate adjustments in-sync with the phase (as described above); this does not include months with no change in rates.
- *Initial Velocity*: The total change in the policy rate (in pp) over the first six months of the phase.
- *Hold Duration*: the number of months when policy is "on hold" at the end of a phase, defined as (i) after the last increase in the policy rate during a tightening phase, or (ii) after the last decrease in the policy rate and after any QE program has ended (defined in Section II) during an easing phase.[18]

III.1.1. Rate Cycles: 1970 –2024

To begin, we calculate each of the six statistics above using monthly data over the full sample period from January 1970 through December 2024 for the tightening and easing phases defined in Section II. Figure 2 summarizes these key statistics and shows large ranges for many of the variables, including substantial skews in some cases (such as for the average pace of rate hikes

[17] We use the threshold of 0.1pp so that minor movements in market-determined rates are not counted as rate increases or decreases.

[18] We continue to define a "change" in the policy interest rate as greater than or equal to 0.1pp. We also consider policy "on hold" even if the central bank is continuing QT as these programs are considered "in the background" and not the active tool of monetary policy for our sample. We have also computed the *Hold Share of the Phase,* i.e., the number of months that policy is "on hold" relative to the total duration of the relevant tightening or easing phase. Results are not reported as they are similar to those for the *Hold Duration*, but available in Forbes, Ha, and Kose (2024).

during tightening phases). Despite this asymmetry, however, the means are fairly similar to the medians for most statistics (although the means are usually slightly greater in absolute value for the summary statistics), suggesting that the skews represent a few outliers and thin tails.

For a better understanding of the differences across easing and tightening phases across economies, especially given the large variation in each variable, Appendix Table 1 reports the corresponding statistics for the full sample as well as for individual economies.[19] Several patterns are noteworthy. Tightening phases last an average of 47 months, much shorter than the average 79-month duration of easing phases. During tightening phases policy rates are also adjusted less often and initially more gradually (i.e., lower velocity), but are changed by larger increments on average (i.e., pace). These differences in the duration, initial velocity, number and pace of rate changes over the phases largely balance out over the full cycle, however, in the sense that the mean amplitude of rate changes is identical (with the sign reversed) across the two phases.

A closer look at the statistics other than the means and medians, as well as individual economy information in Appendix Table 1, provide additional insights on these patterns. Although the durations of the shortest tightening and easing phase are similar (at 24 and 26 months, respectively), the longest easing phase (at 154 months for Japan) is much longer than the longest tightening phase (at 98 months for Spain). There is also substantial heterogeneity across the sample by some measures. For example, in some countries, the pace of rate adjustments is substantially greater—whether measured by amplitude, velocity, or the average size of rate changes—although this often reflects a larger share of the respective sample occurring during earlier periods when inflation (and corresponding nominal policy interest rates) was higher.

Some of these differences across easing and tightening phases and across economies can be explained by different shocks triggering the start of certain phases, as well as constraints around the lower bound. Specifically, some easing phases (such as around the 2008 Global Financial Crisis and 2020 COVID-19 pandemic) were triggered by severe shocks that quickly affected many economies, causing central banks to lower interest rates aggressively and contributing to the higher initial velocity of rate adjustments during easing phases.[20] These aggressive rate adjustments during easing phases, however, may not necessarily correspond to similar velocity and pace for tightening phases, as recoveries tend to occur more gradually. The longer average duration of easing phases, however, particularly for some countries with rates around zero, may also partly reflect a limited ability to provide monetary stimulus around the lower bound.

III.1.2. Rate Cycles Over Time

To analyze how rate cycles have changed over time, we calculate the same statistics as above for five sub-periods:

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[19] Summary statistics are calculated by first averaging across all relevant phases for each economy, and then calculating the sample statistic (e.g., median) across all the economies with data in the relevant period. This approach gives equal weight to each country—instead of each easing or tightening phase. This implies that a country (such as Japan) with a smaller number of long cycles receives more weight than if simply calculating sample statistics across all phases (and not by country first).

[20] See Forbes, Ha and Kose (2025) for an analysis of the synchronization of rate cycles across economies and detailed analysis of the role of global shocks in explaining rate cycles over time.

- *1970-84*: the first half of the "pre-ECB" period, including the global recessions of 1975 and 1982, and the first and second oil price shocks of the 1970s.
- *1985-98*: the latter half of the "pre-ECB" period, including the 1991 global recession, the global downturn in 1997-98 associated with the Asian and Russian financial crises, and a series of debt defaults and emerging market crises.
- *1999-2007*: the start of the ECB setting rates for the euro area, the bursting of the tech bubble, the 2001 global downturn, and the lead up to the 2008 Global Financial Crisis.
- *2008-19*: the Global Financial Crisis and the 2009 global recession, the 2012 global downturn associated with the euro area debt crisis, but ending before the COVID-19 pandemic.
- *2020-24*: the 2020 global recession associated with the COVID-19 pandemic, the post-pandemic spike in inflation, and the Russian invasion of Ukraine in 2022.

Each of these sub-periods includes some type of recession/crisis and recovery period, with the dividing lines between them marking major global events that might have changed the nature of monetary policy cycles. The first two periods (from 1970-1998) also include individual cycles for countries that are currently members of the euro area, but then the later periods (from 1999) include one euro area cycle as the ECB began setting monetary policy for the group. The periods before 1999 are also when central banks used a wider range of monetary policy tools, frameworks, and strategies than in the subsequent periods—with some central banks putting more weight on monetary targets (and interest rates determined partly by markets as well as central bank operations). Over the 1990s and 2000s, however, most central banks transitioned to some form of inflation targeting, albeit this also involved its own evolution of tools and frameworks (such as the greater use of balance sheet policies and forward guidance).

Figure 3 shows median policy interest rates over tightening and easing phases for each of the five periods listed above. It highlights the higher level of policy rates during the pre-1998 cycles, and unusually low level of rates during the 2008-19 cycles. What is most striking, however, are the patterns around the 2020 cycles (in red); rates started the post-pandemic tightening phase at the low levels of the 2008-19 period, but were raised aggressively to reach levels typical of the 1999-2007 tightening phases in about a year. The increases in interest rates during the 2020 easing phase were also unusual—with rates increasing quickly from two years after the start of the easing phase, a much faster shift to tightening than occurred during any of the other windows.

Figure 4 presents median statistics characterizing these rate cycles for the five periods, with the corresponding data in Appendix Table 2. In tightening phases, there is a striking pattern from the earlier period starting in 1970 up until the last period (the pandemic tightening in red): most of the statistics suggest a steady "dampening" of tightening phases from the 1970s through the pandemic. Tightening phases had become shorter, involved a slower pace of rate increases, and slower initial velocity at the start of the phases.

Not surprisingly, all of this contributes to a sharp fall in the overall amplitude of tightening phases over time—with the total change in rates falling by about 80% from 10.3pp in the tightening phases over 1970-84 to 2.2pp over 2008-19. Granted, some of this "dampening" reflects lower levels of inflation that reduce the nominal statistics above, but these patterns also hold for the duration of

tightening phases. This moderation of tightening phases does not happen in any one period, but for each of these statistics over each subsequent period. These results are consistent with arguments that more strongly anchored inflation expectations have allowed central banks to stabilize inflation with smaller increases in policy rates (Forbes 2019; Ha, Kose, and Ohnsorge 2019) and lower Sacrifice Ratios (as analysed below).

Equally striking, the post-pandemic tightening breaks this pattern of more moderate cycles over time; it is more aggressive by most measures than tightening phases since 1999. More specifically, in the post-pandemic tightening phase, the sample medians indicate larger rate hikes, a much faster velocity of initial rate hikes, and a larger amplitude in terms of the total increase in interest rates (all relative to the preceding tightening phases over 1999-2007 and 2008-19). For many statistics, the most recent tightening phase is closest to the 1985-98 windows. Also striking, rates are on hold at the end of the post-pandemic tightening for longer than any historical period; this extended period with rates at elevated levels and before shifting to easing policy further adds to the overall aggressiveness of this recent tightening phase.

In contrast to these patterns for tightening phases, easing phases show less consistent evidence of moderating over time, and less of a break in the characteristics for the most recent pandemic cycle. The median duration of easing phases has more than doubled, however, from 47 months (over 1970-84) to 126 months (over 2008-19). Changes in the patterns of rate adjustments during easing phases also reflect constraints in central banks' ability to lower rates further due to the lower bound—which limits the number of rate reductions, pace, and amplitude of the phase, potentially leading to longer easing phases as the ability to provide stimulus is more limited.

Noteworthy, however, is the abbreviated holding period during the post-pandemic easing of a median of only 3 months; this was the fastest pivot from actively easing policy to tightening policy of any historical period—and particularly striking when compared to medians for the previous period (from 2008-2019). In most cases, a period of actively easing or tightening policy is followed by a period with policy on hold in order to let the lags from the policy changes to take effect. In contrast, tightening phases after the pandemic were started even before the full impact of previous easing would have filtered through the economy.

These patterns on how rate cycles—and particularly tightening phases—have changed over time are consistent with results in the business cycle literature (Ha, Kose, and Ohnsorge 2019) and will form the basis of the discussion of tradeoffs below.

III.2. Activity and Inflation over Rate Cycles

This section examines how the economy typically evolves during rate cycles, analyzing tightening phases as they are the focus of the analysis in the rest of this paper.[21] It follows the standard approach in the business cycle literature of evaluating the evolution of key macroeconomic variables around the cycle's turning points, continuing to use the turning points defined in Section II and listed in Table 1.

In order to assess how the economy evolves in response to increases in policy rates, we study the evolution of six macroeconomic variables that are central to the analysis of monetary policy and

[21] Comparable statistics for easing phases are available in Forbes, Ha and Kose (2024).

which have decent country coverage for the long period on which we focus: GDP growth, industrial production (IP) growth, employment growth, the unemployment rate, headline CPI inflation, and core CPI inflation. The first two variables focus on real economic activity, the middle two on the labour market (which we often refer to as activity for simplicity), and the final two on inflation. Each variable is measured as the percent change relative to a year earlier (to eliminate seasonality).[22] Details on sources and definitions are in Appendix Table 4.[23] We focus on the evolution of each of these variables from 1-year before the turning point of the rate cycle through 3-years after, with the start of each tightening phase denoted as t=0. For countries in the euro area, we include each member country individually throughout the full sample period (even for any phases beginning before 1999 when the euro area came into existence).[24]

III.2.1. Activity and Inflation over Rate Cycles: 1970–2024

Figure 5 shows the evolution of these macroeconomic variables during tightening phases. The graphs include the mean, median and quartile distribution for the country-phases identified over the full period from January 1970 through December 2024 (or the latest available for most countries). The patterns for economic activity and the labour market closely mirror results from the business cycle literature. Activity is accelerating and the labour market tightening (based on unemployment falling or employment increasing) before the start of tightening phases. After interest rates begin rising, activity and the labour market continue to have positive momentum for roughly 6 months, but then activity begins to slow and the labour market softens, presumably reflecting in part the lagged effects of tightening monetary policy.

These results are broadly consistent with the forward-looking and counter-cyclical nature of monetary policy, as well as with estimates of the length of transmission lags.[25] The means and medians follow very similar patterns—suggesting any skews in the distribution are roughly balanced between positive and negative outcomes.

The evolution of inflation (both headline and core) displays notably different patterns. The pickup in inflation before the start of tightening phases is more muted than occurs for the other macroeconomic variables. After interest rates are increased at the start of tightening phases, mean inflation continues to pick up and only declines very gradually; median inflation barely moves. This weak relationship between starting a tightening phase and inflation is consistent with the "price puzzle" in the monetary VAR literature, as well as because inflation is influenced by factors other

[22] Macroeconomic data was collected on February 1, 2025 and covers the period from January 1970 through late 2024 for most countries.

[23] All variables are measured as the % change relative to a year earlier, except the unemployment rate, which is measured as the change. Data for some variables is more limited early in the sample. We only include economies if the relevant data is available for at least 6-months before t=0.

[24] We have also repeated the analysis with the euro area as one economy starting in 1999 (and excluded individual member countries), with only modest changes in some of the graphs and no impact on the key results discussed below.

[25] See Clarida, Gali, and Gertler (1999), Woodford (2003), and Lane (2022), among many others, for a discussion of these topics. Havranek and Rusnak (2013), using a meta-analysis based on 67 studies, reports that the average transmission lag of monetary policy to inflation is 29 months (ranging from 18 to 49 months).

than monetary policy.[26] These findings are also consistent with a flat Phillips curve, or a non-linear Phillips curve with the median cycle on the flat section of the curve. For example, when activity is weak and interest rates are low (as typically occur at the start of tightening phases), changes in activity and interest rates may have minimal impact on inflation, but when there is less slack in the economy, changes in activity and interest rates would have a greater impact on inflation.[27]

Also, for both headline and core CPI inflation, the mean is substantially higher than the median, indicating an asymmetric skew in the distribution. The dashed lines showing the distribution of inflation outcomes also reflect this skew—with much higher inflation in a small number of economies. As discussed below, these phases with higher inflation largely occur early in the sample when inflation was much higher in most economies—as well as during the post-pandemic period. This highlights the importance of understanding how the rate cycles, and their relationship to economic variables, have evolved over time.

III.2.2. Activity and Inflation across Rate Cycles over Time

To assess how the relationships between tightening phases and macroeconomic variables change over time, we repeat this analysis for the five sub-periods used in the last section, with the results in Figure 6.[28]

Beginning with measures of activity, and the labor market during tightening phases, the series of graphs shows a fairly similar evolution of GDP, industrial production, employment and unemployment during most tightening phases until 2020. In contrast, the strength in activity before rate increases, as well as the deterioration in activity after rate increases, was more pronounced during the post-pandemic tightening phase. These patterns are consistent with the post-pandemic tightening starting later in the expansion than has historically occurred based on the macroeconomic variables considered here (and which we show more formally in Section V), but then becoming more aggressive in terms of rate hikes than earlier periods—a pattern consistent with the statistics on how cycle characteristics have changed over time (Figure 4).

Three years after the start of the post-pandemic tightening, however, the median changes in most measures of activity and labor markets were comparable to this stage during historical cycles (with IP growth on the stronger end, and employment growth on the softer end—but all near at least one previous cycle). Granted, these graphs only show the medians for the sample and there are important differences for individual economies (and some do not yet have data for the full three years after they started raising interest rates). Overall, however, this implies that even if central banks were slower to start tightening monetary policy after the pandemic given macroeconomic developments (and with the benefit of hindsight), the subsequent aggressive response (including

[26] More specifically, this muted correlation between the turning points in rate cycles and inflation may reflect forward-looking monetary policy, i.e., that reacts to, and prevents, future expected inflation, based partly on central banks' information on future inflation developments (Castelnuovo and Surico 2010; Jarocinsky and Karadi 2020; Ha et al. 2025). In order to assess the direct effects of monetary policy, it would be necessary to use a different analytic approach that controls for the reaction functions of central banks.
[27] See Benigno and Eggertsson (2023) and Forbes, Gagnon, and Collins (2022) for evidence of this nonlinearity in the Phillips curve.
[28] We have also repeated the analysis below to adjust for countries at the effective lower bound for policy interest rates, with no meaningful impact on the results.

the unusually long period holding rates constant at elevated levels) seems to have caught them up, on average, by these macroeconomic measures for this point in a tightening phase.

The comparable graphs for headline and core CPI inflation during tightening phases (bottom of Figure 6) also suggest that this cycle involved larger movements than have historically occurred, and an unusually slow start to tightening monetary policy, but a recent normalization relative to a comparable stage in historical cycles. Inflation during the post-pandemic period started around the lows typical of historical episodes one year before the start of the tightening phase (excluding the earliest phases when inflation was meaningfully higher), but then picked up much faster than the medians of all earlier tightening phases—such that headline inflation reached the much higher levels typical of the earliest 1970-1984 period before central banks began increasing interest rates.

Both measures of inflation have fallen since, such that at the end of the sample, headline inflation is around levels typical at this point in the 1999-2007 tightening phases, although core inflation is still elevated around levels of the 1985-1998 phases. Headline inflation peaks at higher levels (as would be expected given the large shocks to food and oil prices), but core inflation was slower to decline (as would be expected given the greater persistence in core inflation). The steep increase and subsequent decline in inflation is a sharp contrast to the flatter inflation paths during earlier episodes, and the most recent data suggests inflation has not fallen back to the low levels typical before the pandemic.

These patterns are consistent with the previous discussion of the unusual patterns for rate adjustments and holding periods during the pandemic easing and post-pandemic tightening. After easing monetary policy in response to the pandemic, unusually rapid recoveries and the sharp acceleration in inflation prompted central banks to transition more quickly than usual from actively easing to tightening policy, with a shorter "hold" at the end of the easing phase than historically occurs. Central banks then tightened monetary policy more aggressively on average than during historical cycles since 1998, followed by a "higher for longer" period during which monetary policy was on "hold" in order to allow the lags for this aggressive tightening to affect the economy and better assess when it was time to transition to an easing phase.

Moreover, although the shift from easing to tightening monetary policy occurred later than during historic cycles, the subsequent aggressive tightening has allowed economies to largely catch up—at least to pre-2008 levels. Noteworthy, however, this "normalization" has occurred with a large increase in the price level (which is analyzed below) as well as policy rates at much higher levels than since the Global Financial Crisis and closer to levels typical of pre-2008 tightening cycles.

IV. Tradeoffs and Sacrifice: Activity, Inflation and the Price Level

This section shifts from analyzing how key macroeconomic variables evolve over tightening phases to measuring key tradeoffs for central banks over the entire phase. It begins by calculating relevant statistics for inflation, output gaps, and the corresponding Sacrifice Ratio. Then it focuses on a set of statistics that receive less attention—related to changes in the price level—and explains why these measures should be part of the discussion of tradeoffs around tightening phases.

Throughout these comparisons, the post-pandemic adjustment stands out—with historically low Sacrifice Ratios (on average for the sample) combined with unusually large increases in the price level. The analysis in this section uses the data presented in Section III (with details in Appendix Table 3) for the period from January 1970 through 2024. We continue to exclude any tightening phases that begin in 2024 (i.e., for Japan) as there has not yet been sufficient time to evaluate the impact on macroeconomic variables.

IV.1. Inflation and Output Gaps

In order to evaluate the tradeoffs facing central banks during tightening phases, we begin by focusing on two macroeconomic variables at the core of monetary policy decisions: inflation and output gaps. For each of the statistics reported below, we begin with the dates for the tightening phases defined in Section II, but also include an additional 12-months after the end of each phase in order to capture any lagged effects of monetary policy (with this extended period referred to as the "tightening window" below).[29] We also calculate each of the statistics reported below for each member of the euro area individually, as well as for the euro area as a whole, in order to be able to understand dynamics and compare tradeoffs across these different entities.[30]

To calculate key statistics for inflation, we use monthly data on the headline or core consumer price index (CPI) for each of the 24 advanced economies in our sample (except for the United States, for which we use the PCE index). We calculate year-over year inflation (π_t) over each month *t* of the window lasting *y* months for the country-phase (*cp*) and then use these statistics to calculate:

Inflation Reduction= $IR_{cp} = \pi_{cp}^{IP} - \pi_{cp}^{IT}$,
with *Inflation Peak* = $\pi_{cp}^{IP} = max(\pi_{cp})$,
and *Inflation Trough* = $\pi_{cp}^{IT} = min(\pi_{cp})$ during any month in the window *y* <u>after</u> the π_{cp}^{IP}

The IR_{cp} captures the disinflation that occurs from the inflation peak (π_{cp}^{IP}) to its <u>subsequent</u> trough (π_{cp}^{IT}) over each country tightening phase (*cp*) and is a key focus of the analysis on tradeoffs below.

Table 2 reports medians for each of these statistics over the five historical windows used throughout the paper. The median disinflation during the post-pandemic window was larger than during any of the historical periods—at 8.5pp for headline and 3.7pp for core inflation. This is noteworthy as peak inflation was meaningfully higher during the 1970-84 window, but did not fall as

[29] We focus on a 12-month lag as this is standard in previous work on sacrifice ratios (e.g., Ball 1994). We still capture longer lags during many cycles when rates are "on hold" before the phase ends. We exclude any lagged effects during the two major global crises in our sample, in order to avoid interpreting the sharp collapses in activity as resulting from changes in domestic monetary policy. These two exclusion windows are: the Global Financial Crisis (defined as starting in October 2008) and the COVID-19 pandemic (defined as starting in March 2020). Also, we do not include information on phases with less than 6 months of data.
[30] None of the statistics reported below change meaningfully if we exclude the euro area as an individual entity, or if we exclude individual countries and only include the euro area. For the regression analysis below, however, we exclude the euro area as a single entity in order to avoid double-counting.

much, with a trough of only 5.5% for headline inflation over 1970-84 (as compared to a trough of 1.5% over 2020-24).[31]

In addition to closely monitoring inflation, another key set of indicators tracked by central banks is deviations in activity (including the labor market) from "potential". We use several measures of the output gap (OG_t) for each month *t* and then accumulate these measures to calculate the following statistics over each country-phase (*cp*) as defined above (and continuing to include 12-month lag after the end of each tightening phase):

$$\textit{Accumulated Output Gap} = AOG_{cp} = (\sum_{t=0}^{y} OG_t)/12$$

$$\textit{Accumulated Negative Output Gap} = ANOG_{cp} = (\sum_{t=0}^{y} OG_t)/12 \quad if\ OG_t < 0.$$

Each measure is divided by 12 so that the accumulated monthly output gaps (AOG_t) are relative to annual GDP; this makes the measure easier to compare to standard output gap calculations, but smooths sharp but short-lived deviations of output from potential.

Measuring potential output (and the corresponding output gap) is not straightforward, and there are a range of approaches used in the literature.[32] Each approach has its advantages and disadvantages, and there is often substantial variation in the estimates at any point in time. To simplify discussion, we will focus on monthly estimates of the output gap based on the Hodrick-Prescott (HP) filter, but we also report key statistics based on measures of the output gap using alternate filters (Baxter-King and Hamilton), using alternate measures (an OECD measure based on the production method and country-specific sources), and focusing on employment or unemployment rate gaps. We write each measure so that a positive value indicates a strong economy, i.e., output (or employment) above potential and unemployment below its natural rate. The key patterns highlighted below are highly consistent across these alternate measures of the output gap, although there are often meaningful differences in the point estimates for any economy at any point in time based on the metric.

Table 3 reports median statistics for several measures of these gaps over tightening phases for the five historical periods defined earlier in the paper, documenting the Accumulated Negative Output Gaps (ANOGs) that will be a focus in the analysis below. The post-pandemic period continues to stand out, with the lowest median trough during tightening phases of any of the historical windows (at -0.4% of GDP based on the HP filter measures). In fact, the ANOGs are the lowest of any historical window when measured using the Baxter-King filter or employment gap, albeit closer to other historical windows based on other measures. These relatively low output losses by most

[31] The higher trough for inflation during this earlier period reflected a combination of related factors: (1) inflation expectations were not as well anchored; (2) central banks had different monetary policy frameworks that did not involve a 2% inflation target; (3) in some cases the disinflation process continued over an extended period and is therefore included in subsequent phases.

[32] Estimating output gaps is challenging, particularly as estimates of potential GDP are often substantially revised as more data is available (Orphanides and Norden 2002). This should be less of a concern for our historical comparisons, but may impact estimates of potential GDP over the past few years, and particularly during the post-pandemic period given the large shocks which could affect potential output (Coibion, Gorodnichenko, and Ulate 2018; Ramey 2018). See Hamilton (2018) and Schüler (2024) for information on various filtering methods for time-series data.

measures are despite the relatively large number of months with negative output gaps (12 based on the HP filter), further suggesting that even if output was below potential for much of the post-pandemic tightening, any shortfalls tended to be smaller than during other tightening windows.

It is also worth noting that economies typically "overheat" on average during tightening phases as a whole. Even though activity slows later in the phase as the impact of higher interest rates is transmitted through the economy, the median accumulated output gap is positive over each historical tightening phase. During the post-pandemic tightening, this "overheating" was at the median of the five historical windows.

IV.2. Sacrifice Ratios

Next, to better understand the tradeoffs around inflation and output deviations facing central banks—as well as how the decisions made by central banks affect macroeconomic outcomes—it is useful to compare the relative adjustments in these measures over different tightening episodes. To make these comparisons, we draw on an extensive literature to calculate a "Sacrifice Ratio"—the output that is "sacrificed" per unit of inflation reduction. This "ratio" has been defined and calculated in more ways than can be summarized here.[33] We build on one of the most popular approaches, which uses event studies of disinflation episodes to calculate the Sacrifice Ratio as the accumulated output loss per inflation reduction during each episode (see Ball 1994 and Cecchetti et al. 2023 for prominent examples).

More specifically, we calculate the *Sacrifice Ratio* for each country-phase (*cp*) as:

$$\textit{Sacrifice Ratio} = SR_{cp} = -\left({ANOG_{cp}}/{IR_{cp}}\right),$$

where the Accumulated Negative Output Gap ($ANOG_{cp}$) and peak-to-trough Inflation Reduction (IR_{cp}) over each tightening window are defined above.[34] Our calculation differs from the *Sacrifice Ratio* used in previous literature by focusing on disinflations over the windows when a central bank is tightening monetary policy (in order to better link to the tradeoffs facing central banks) rather than over windows determined by inflation peaks and troughs (which often do not correspond to monetary policy cycles).[35] Our estimates—and those across different papers—can also vary due to

[33] Different approaches to measuring the sacrifice ratio include: extracting it from estimates of a Phillips curve (Blanco et al. 2024; Benigno and Lopez-Salido 2006), aggregate supply curve (Andersen and Wascher 1999), or time series model (Cecchetti et al. 2023). See Tetlow (2024) for a survey of estimates using different approaches for the United States. We focus on the event study approach as it is the most common method in the literature and therefore easier to compare estimates with previous work. This approach also avoids the need to make assumptions about the underlying model and parameters, instead simply letting the data speak.

[34] Since the ANOG is negative (i.e., output is below potential), we follow the literature by inverting the sign so that the Sacrifice Ratio is a positive number.

[35] In some cases, inflation peaks at or near the end of the tightening window, such that *Inflation Reduction* is at or close to zero. In these cases, defined as when the *Inflation Peak* is within 3 months of the end of the window, we do not calculate a Sacrifice Ratio. There are 22 of these country-phases when headline inflation peaks within 3 months of the end of the tightening window, of which 18 occur during tightening phases that ended around the 2008 Global Financial Crisis (and inflation picked up globally through 2007 and early 2008).

a number of differences in how the individual components of the ratio are measured and calculated.[36]

Figure 7 shows the median Sacrifice Ratios for tightening phases across the five periods used throughout this paper for headline inflation based on the six different gap measures. In each case, the median Sacrifice Ratio is lower during the post-pandemic tightening than during any historical period (except when calculated based on the Hamilton filter, when it is only marginally above the ratio over the 1999-2007 period). Over the 2020-24 period, the median Sacrifice Ratio declines to close to zero by most measures (to 0.01 based on the Baxter-King filter and employment gap, to 0.03 based on the unemployment gap, and 0.06 based on the HP filter). Results are very similar when the Sacrifice Ratio is calculated based on core inflation.[37] The consistent message across all statistics is noteworthy—especially given the substantial variation in the point estimates for different measures of output and employment gaps. For the median advanced economy in our sample, the post-pandemic tightening required a much lower "sacrifice" than during historical tightening phases in terms of the output losses corresponding to the sharp disinflation.

To better understand this decline in the median Sacrifice Ratio and the underlying tradeoffs, Figure 8 graphs the components of the Sacrifice Ratio for each tightening phase in each economy since 1970 for our baseline measure (using headline inflation and the output gap based on the HP filter). Each data point, and the corresponding fitted lines, are colored to identify the five historical periods—with the post-pandemic tightening in red. The figure highlights how the tradeoffs facing central banks have changed meaningfully over time—and particularly over the most recent tightening phase. The dots for the post-pandemic period are scattered across the top right of the graph—reflecting high levels of disinflation combined with minimal output losses. Some periods with large disinflations (largely over 1970-84) corresponded to large output losses, while other periods with less disinflation (such as over 1999-2007) corresponded to a range of accumulated negative output gaps. Reflecting these patterns, the slope of the fitted line for the post-pandemic period is much flatter than historical periods—and basically horizontal—indicating no apparent tradeoff between the amount of disinflation and output losses across economies. On average, economies appeared to no longer have to "sacrifice" output in order to accomplish a meaningful reduction in inflation.

Figure 8, however, also highlights the substantial variation in these variables across individual economies. To better understand these cross-country differences, Appendix Table 4 reports the Sacrifice Ratio and corresponding components for each of the advanced economies in our sample during the post-pandemic tightening phase (for both headline and core inflation, with the output gap calculated using the HP filter). There is some variation in Sacrifice Ratios across individual economies—ranging from 0.02 or less in several economies (such as Belgium, Canada, Greece, Italy, Portugal, the UK and the US) to highs of 0.70 and 0.87 in Ireland and Israel, respectively. The

[36] To provide a few examples: (1) we use monthly data, while much of the earlier work uses quarterly data; (2) we scale the ANOG relative to annual GDP, while some earlier work (such as Ball 1994) scales relative to quarterly GDP (which would require multiplying our ratios by roughly four to be comparable); (3) we use direct measures of the output gap, rather than estimating it based on an interpolation of "trend" GDP.

[37] When these Sacrifice Ratios are calculated based on core inflation, they are also lower during the post-pandemic period than during any historical periods based on all gap measures except the OECD statistic, for which the median Sacrifice Ratio is lower during the 1999-2007 window than the 2020-2024 window.

large values for Ireland and Israel reflect unusual characteristics of these economies (most notably the war in Israel and sharp adjustment in multinational-denominated sectors in Ireland), with the next highest Sacrifice Ratio of 0.16 in Switzerland. Overall, however, these Sacrifice Ratios are much lower across all the economies (except Israel and Ireland) than historical medians.

As a final comparison, and to better understand these patterns over time, Figure 9 shows the evolution of the Sacrifice Ratio and its underlying components for the United States over each of its nine historical tightening phases (identified in Table 1). The top panel shows that the Sacrifice Ratio is sharply lower during the post pandemic period than during any historical tightening phase since our sample begins in 1970. Moreover, the breakdown of the components of the ratio shows that this reflects a combination of low accumulated output gaps (in the numerator) as well as large inflation reductions (in the denominator). In fact, for the United States the accumulated output loses during the post-pandemic tightening were lower and the inflation reduction larger (based on PCE inflation) than during any historical tightening phases in our sample.[38]

These results—across advanced economies since 1970, as well as focusing just on the United States—present a consistent message: the post-pandemic tightening involved an unusually low cost when assessed as output losses per inflation reduction. By this traditional measure, central banks faced very little "sacrifice" in reducing inflation sharply from multi-decade highs (combined with achieving maximum employment in some economies).

IV.3. The Price Level

The Sacrifice Ratio and its focus on the amount of disinflation, however, misses an important factor when assessing the tradeoffs around monetary policy: the impact on the price level. Even if central banks were able to return inflation to target with minimal output losses during the post-pandemic tightening, this ratio does not incorporate the duration or extent of any deviation of inflation from target. In fact, the Sacrifice Ratio could even be lower for a central bank which allows a larger pickup in inflation above its target, creating the opportunity for a larger disinflation when returning inflation to target than a central bank which attempted to minimize this initial overshoot.

A closer look at the evolution of the price level over historical US tightening phases shows how this adjustment can vary meaningfully across periods. Figure 10 graphs the PCE price index, set at zero one year before the start of each US tightening phase, with tightening phases since 1990 on the left and those from 1970-1990 on the right. In each graph, the adjustment in the price level that occurred over the post-pandemic period is in red, and that if inflation was at 2% in yellow. The graphs show the surge in the price level since 2021 in the United States—well above any historical comparison since 1990—and even above that which occurred in the 1980s. The gap relative to what would have occurred if inflation was steady at 2%, which is what households and businesses had grown to expect and become accustomed to, is massive.

[38] These patterns generally apply to measures of the Sacrifice Ratio using other combinations of gaps and inflation measures. The notable exception is when the gap is measured by the unemployment gap, which deteriorated more during the post-pandemic period than tightening phases over 1987-2015. When combined with the large inflation reduction, however, the Sacrifice Ratio based on the unemployment gap is still very close (within 0.004) to the historical low set during one other tightening phase.

More specifically, at the end of 2024 and less than 3 years after the start of the post-pandemic tightening, the PCE index was about 13% higher than if inflation was 2% over this period. This is a large adjustment for an economy in which inflation expectations were well anchored around 2% (or even below) before the pandemic. The only tightening phases during which the price level increased by more than after the pandemic were in the 1970s—a period which required an aggressive tightening in monetary policy under Chair Volcker that corresponded to large output losses and Sacrifice Ratios (Figure 9).

While the mandates of many central banks do not explicitly mention the price level, it is still implicitly incorporated in several ways. For example, the mandates of the US Federal Reserve and Swiss National Bank include a goal of "stable prices". Other central banks include a time by which they are expected to return inflation to target, e.g. two years for the Bank of England in normal circumstances and three years in "exceptional" circumstances.

Moreover, recent research highlights that large price shocks can have non-linear effects and impact the transmission of monetary policy—issues which should be central to a discussion of optimal monetary policy. On the one hand, the transmission of price shocks (such as energy supply shocks) into economic conditions is stronger and more persistent following larger shocks and during high-inflation regimes (De Santis and Tornese 2024; Bachmeiera and Keen 2023). On the other hand, in high inflation regimes, the response of the price level to monetary policy shocks tends to be larger and thus the real effects can be smaller (Ascari and Haber 2022). These results build on the literature documenting that households and businesses care not just about the level of inflation, but also the level of prices (Bernanke 2019; Honkapohja and Mita 2020; Coibion et al. 2023).

In order to analyze this additional consideration for monetary policy, we use the same monthly data on the headline and core price index used above to calculate inflation, except now focus on annualized changes in the level of prices over each country-phase:

Accumulated Excess Price Level Change $= EPLC_{cp} = (PLC_{cp} - PLC_{cp}^{2\%})$,
Annualized Accumulated Excess Price Level Change $= EPLC_{cp} * ({}^{12}/_{months_{cp}})$,
with Price Level Change $= PLC_{cp} = \left({}^{CPI_z}/_{CPI_0} - 1\right) * 100$,
and *PLC if inflation at 2%* $= PLC_{cp}^{2\%} = \left(\left(1.02^{\frac{1}{12}}\right)^z - 1\right) * 100$

The *Annualized Accumulated Excess Price Level Change*—referred to below as the excess increase in the price level for simplicity—captures the accumulated change in the price level per year in excess of what would have occurred if inflation had been 2% over the tightening window; this is a similar concept to the accumulated output gap in the sense that it focuses on the aggregate impact relative to a trend (or target).[39] We annualize this measure in order to capture the amount of time

[39] Most economies did not target 2% inflation earlier in the sample, and many have had different targets and frameworks at different points in time (as discussed above). This 2% is still a useful baseline, however, particularly for the inflation targeting period. An alternative approach would be to measure the change in the price level that was a surprise, e.g., relative to inflation expectations, but cross-country data is not available to do this for much of the sample period.

over which the adjustment in the price level occurs, and over which households and business must adjust; a 5pp increase spread over one year would be more challenging than the same increase spread over five years. Also, we measure the change in the price level over a window lasting *z* months, which includes a 12-month lead before the start of the tightening phase as well as a 12-month lag after the phase ends (excluding the periods around the 2008 Global Financial Crisis and 2020 Pandemic). Measuring the change in the price level with a lead and lag around the tightening phase allows us to capture any changes in the price level that occur just before the first rate hike (which can be large if the central bank is slow to tighten policy and inflation accelerates before the phase starts) as well as that occur after the phase ends while the effects of the prior rate hikes are still being transmitted to prices.[40]

Figure 11 shows the resulting median excess increase in the price level over tightening phases for our sample of 24 economies over the five historical windows used throughout this paper. The median excess increase in the price level was 4.0pp for the headline CPI (or PCE) index and 2.9pp for the core index. This is meaningfully larger than any historical tightening phases since 1999—and a particularly large adjustment after the median increase in the price level was negative (i.e. inflation rates were less than 2% over 2008-2019). The post-pandemic increase in the price level is comparable to that over 1985-1998 tightening phases, although it was smaller than over the 1970-1984 window.

The medians shown in Figure 11, however, mask important differences across individual economies. The right side of Appendix Table 4 reports the corresponding excess price level changes for each of the economies in our sample during the post-pandemic tightening phases. This shows the substantial variation across the sample; with excess increases in the consumer price index of over 5pp per year in Austria, the Netherlands, Sweden and the UK, and a modest decline (relative to 2% inflation) in Switzerland. The corresponding 3.1pp increase for the US PCE index is smaller than the sample mean and median. The excess price level increases tend to be larger in Europe (albeit with some exceptions, such as Switzerland), likely reflecting the larger role of energy, commodity and other trade shocks to this region after the Russian invasion of Ukraine.

As a final comparison, and in order to succinctly capture how central banks can face a tradeoff in some circumstances between allowing an adjustment to occur through the price level or output losses, we also calculate a new Price-Output Tradeoff Ratio:

$$\text{Price-Output Tradeoff Ratio} = {EPLC_{cp}}\Big/{-ANOG_{cp}}$$

where $EPLC_{cp}$ is the accumulated excess price level change and $ANOG_{cp}$ is the accumulated negative output gap (both defined above) over each country phase (*cp*) during the tightening windows. The $EPLC_{cp}$ is still measured as the "excess" increase in prices resulting from inflation above 2%, but is not annualized in order to be comparable to the denominator (which is over the entire phase). The closest precedent to this ratio that we have been able to find is the "Phillips multiplier" introduced in Barnichon and Mesters (2021) and defined as the expected cumulative

[40] Allowing for this lead before the first rate hike is important for windows when the central bank is slow to begin tightening policy. For example, the Federal Reserve started its post-pandemic tightening phase in March 2022, at which time PCE inflation was already 7%.

change in inflation caused by a monetary shock that lowers expected unemployment by 1pp. Instead of focusing on cumulative output losses in the numerator (as done for the Sacrifice Ratio), our goal (as for Barnichon and Mesters 2021) is to focus on cumulative changes in the price level.[41]

This simple ratio is intended to capture how the macroeconomic adjustment is split between cumulative changes in prices and the cumulative losses in output during tightening phases. For example (and as shown in more detail in the simulations in Section V), assume an economy is overheating and the central bank can choose a path for rate hikes that is more "gradual" or more "aggressive". In the "gradual" strategy, cumulative output losses are smaller, but inflation is higher so that the price level increases by more. As a result, the Price-Output Tradeoff Ratio would be higher in the "gradual" scenario, reflecting the central bank's strategy causing more of the adjustment to occur through price level increases and less through output losses. Of course, a number of factors other than the central bank's strategy will affect how much adjustment occurs through prices versus activity (such as the nature of the shocks affecting the economy[42] and whether the shocks are transitory), just as many other factors affect the relationship between disinflation and output gaps in the Sacrifice Ratio. The central bank's reaction to such shocks over the tightening phase, however, including how much weight it places on stabilizing output versus inflation, could also affect how much of the relative adjustment occurs through inflation/prices and output/growth.

Figure 12 shows the resulting median Price-Output Tradeoff Ratios over tightening phases for our sample of 24 economies over the five historical windows on the left, and then for each of the US tightening phases on the right. For the sample as a whole, this ratio was falling over time (until the pandemic), suggesting that less macroeconomic adjustment was occurring through the price level relative to through output losses. The decline corresponds to the widespread shift to inflation targeting and is consistent with greater attention to maintaining inflation around 2%, even if this strategy involved larger output losses. This Price-Output Tradeoff Ratio jumped during the post-pandemic tightening, however, reflecting the large share of the adjustment that occurred through the price level during this episode. This jump is particularly striking for the United States, where almost all of the adjustment during the post-pandemic tightening occurred through prices rather than through output losses. Although the spike in the ratio overstates the adjustment due to the unusually low cumulative output losses (near zero) in the denominator, it reflects a sharp change in how the adjustment occurred relative to in earlier tightening phases. Appendix Table 4 provides more detail on the components of this ratio.

To summarize, this section highlights the unusual tradeoffs during the post-pandemic period. Inflation spiked to reach levels not seen since the 1970s and early 1980s in many economies, but then fell quickly towards target levels. This disinflation occurred with fairly small output losses in most economies, but large increases in price levels. The Sacrifice Ratios suggest there was historically little "sacrifice" when measured as the output losses per unit of inflation reduction, but

[41] This approach also has analogies to the fiscal literature which evaluates the cumulative multipliers of different policies, often measured as the ratio of integrals to impulse responses, as introduced by Mountford and Uhlig (2009). For a more detailed discussion of the benefits of this approach, see Ramey (2019).
[42] For example, after a demand shock, prices and output generally move in the same direction, while after a supply shock, these two measures generally move in opposite directions and involve a tradeoff. In the empirical analysis, we control for the extent of supply shocks or oil shocks.

this measure misses an important part of this adjustment process: the sharp increase in prices. Even if the surge in inflation proves to be temporary and inflation settles back at 2%, the price level has increased meaningfully. In other words, and as captured in the Price-Output Tradeoff Ratio, many economies (including the United States) chose to adjust to the post-pandemic shocks largely through adjustments in the price level and with minimal adjustment in output and employment. There were sharp differences across economies, however, with others choosing a more balanced adjustment.

V. Explaining Tradeoffs

This section explores why these sacrifices and tradeoffs for monetary policy vary across economies and over time during tightening phases. It focuses on the role of the central bank's strategy (using the characteristics of rate cycles defined in Section III) during tightening phases (as defined in Section II). It also considers the role of slow-moving country characteristics that have been highlighted in prior work (such as the central bank's credibility and flexibility of the labor market) and the shocks affecting the economy (e.g., the role of oil shocks).

The section begins with a simple regression analysis, focusing on the impact of the central bank's decisions on when to start raising rates and then how aggressively to subsequently tighten policy. The section ends with simulation results from the FRB/US model used by the US Federal Reserve Board to better understand the empirical findings. Although our regressions and illustrative simulations only focus on a small set of the possible variables and relationships affecting inflation, activity, and the price level, the two approaches provide similar insights for how central bank strategies can impact macroeconomic tradeoffs and how they contributed to the unusual macroeconomic developments during the post-pandemic recovery (shown in Sections III and IV).

V.1. Empirical Assessment

V.1.1. Methodology and Variables

When central banks adjust monetary policy through their primary tool of interest rates (and ignoring decisions around guidance, the balance sheet, etc.), they must make a number of strategic choices. An extensive literature documents how these decisions can affect different macroeconomic variables, the transmission of monetary policy, and corresponding tradeoffs.[43] Much of this literature focuses on how central bank credibility impacts inflation expectations and finds that the cost of disinflation can be reduced when monetary authorities have the reputation of implementing credible policies, including a commitment to price stability and a transparent decision-making process (Huang et al. 2019; Magkonis and Zekente 2020; Romer and Romer 2024).

While there is general agreement on the benefits of greater central bank credibility (which includes characteristics such as independence, transparency and turnover), there are different views and conflicting evidence on the benefits of more aggressive (or "cold turkey") versus "gradual" approaches to adjusting monetary policy (Ball 1994; Mazumder 2014; Tetlow 2024). Some papers

[43] For details on these strategies and tradeoffs, see Bandera et al. (2023); Reis (2022); Afrouzi, Halac, Rogoff and Yared (2024).

find that more aggressive actions by central banks can improve macroeconomic tradeoffs by generating a regime shift that enhances credibility. For example, strategies that reinforce the commitment to an inflation target can better stabilize inflation expectations and reduce second-round effects on wage and price setting so that disinflation is less costly (Kugler 2024). Mann (2022) models how this type of more "activist" approach could even support an earlier shift to easing monetary policy and therefore smaller aggregate output losses than would occur from a prolonged tightening phase.

In contrast, other work argues that more cautious rate adjustments by central banks could lead to more attractive tradeoffs, primarily by minimizing output losses. This could occur if wages and prices exhibit inertia and require time to adjust to monetary tightening. Tenreyro (2023) models how more aggressive rate increase by the Bank of England in response to the post-pandemic inflation would have generated much larger output losses and only moderately lower peak inflation. Other work shows that in the presence of certain types of uncertainty (as initially argued in the seminal work by Brainard 1967) and in order to maintain financial stability (Stein and Sunderam 2018), a slower path of monetary policy tightening could reduce output losses—and in the extreme avoid a financial crisis (and corresponding large output losses).

To test formally if different strategies for monetary policy correspond to different outcomes and tradeoffs, we estimate the simple model below:

$$Tradeoff_{cp} = \alpha + \beta * CB_Strategy_{cp} + \delta * Country_Characs_{cp} + \gamma * OilShocks_{cp} + \varepsilon_{cp}, \qquad (3)$$

where *Tradeoff* is one of: (1) the Sacrifice Ratio; (2) Accumulate Negative Output Gap (ANOG); (3) Inflation Reduction (IR); (4) Accumulated Excess Price Level Change (EPLC); or (5) the Price-Output Tradeoff Ratio (all defined in Section IV). We focus on the role of the central bank's strategy (*CB_Strategy*), but also control for slower-moving country characteristics (*Country_Characs*) and the role of oil shocks on inflation rates (*OilShocks*).[44] All variables are measured over 1970-2024 for each country-phase (*cp*) identified as a tightening phase in Section II.[45] Standard errors are clustered by country and over the five long periods defined in Section III.

There are many variables that could affect the macroeconomic outcomes in this regression, with an extensive literature providing theoretical and empirical evidence for and against a large number of possible controls. Summarizing this literature and analyzing all of the potential explanatory variables is beyond the scope of this paper; it is also not possible to control for many variables simultaneously in our framework given the limited observations available. Although our sample benefits from having a panel of observations for 23 countries over a long period from 1970-2024, the number of observations is still limited by the number of tightening phases and limited availability for some of the macroeconomic variables early in the sample. Therefore, in the analysis below we focus on the role of central banks—as this draws on our new analysis of rate cycles and

[44] As discussed below, in sensitivity tests, we also control for a broader range of shocks (including the contribution of all supply shocks or all global shocks or demand shocks to the variation in inflation).
[45] We include each member of the euro area as an individual country (and not the euro area as a separate entity). The countries in the sample are listed in Table 1. For the baseline analysis, we also exclude four extreme outliers (the tightening phases that begin in Spain in 1973, New Zealand in 1976, and Greece in 1987 and 1997). These generally do not impact the empirical results, but distort the scale of the graphs.

the corresponding characteristics—and as this has received less attention in the literature than some other variables (such as labor market flexibility). In our baseline analysis, we focus on two characteristics of the central bank's strategy: the timing of the first rate hike ("liftoff") and the "aggressiveness" of the subsequent rate hikes.

Timing of the first rate hike. To measure the timing of liftoff in each tightening phase relative to the state of the economy, we use the phase definitions and corresponding macroeconomic variables from Sections II and III to estimate a principal component of four variables that are central to setting monetary policy and also widely available across our sample: headline inflation, core inflation, the output gap and unemployment rate gap (both based on the HP filter).[46] We will refer to this variable as *Delayed Start*, as a larger number indicates a later timing of liftoff based on the evolution of the underlying macroeconomic variables.

To better understand this new variable, Figure 13 graphs this measure during the post pandemic tightening (in dark blue) relative to the average over the 1970-2019 period (in light blue) for a subset of the sample. The large positive values for the post-pandemic period, especially when compared to the slightly negative values for the pre-pandemic window, indicate that all countries were slower to start raising rates based on these macroeconomic developments than has occurred on average during historical tightening phases. As discussed above, this slow start to tightening likely reflected a number of factors: forecasts that missed the inflation surge; caution tightening policy after the prolonged recovery and subpar inflation over the previous decade; uncertainty about the strength of the recovery; belief the Phillips curve was flat; a misunderstanding of the sources and transitory nature of inflation; and constraints switching from easing to tightening policy due to commitments through forward guidance and ongoing asset purchase programs. It is also noteworthy that the United States was the slowest (along with Canada) to start tightening based on its macroeconomic variables, possibly due to the new flexible average inflation targeting (FAIT) framework.[47]

Aggressiveness of rate hikes. As a second measure capturing central bank strategy, we control for the "aggressiveness" of the tightening phase. Section III presents a range of rate cycle characteristics that could each contribute to the aggressiveness of the subsequent rate path in different ways. Rather than taking a stance on which measure better captures aggressiveness, we calculate a principal component of these different cycle characteristics that reflect a form of aggressiveness: (1) the number of rate hikes; (2) the pace of rate hikes (i.e., average size); (3) the amplitude of rate hikes (i.e., total increase); (4) the initial velocity of rate hikes (over the first six months); and (5) the largest rate hike divided by the average rate hike (to capture the use of

[46] In order to maintain as large a sample as possible, if all of these variables are not available, we estimate the principal component with substitute measures. More specifically, if the output gap based on the HP filter is not available, we measure the gap using the OECD measure, Hamilton or Baxter-King filter. If GDP growth is not available, we use the growth in industrial production. If the four variables are not available after these substitutions, we estimate the principal component using a smaller set of available measures.
[47] See English et al. (2024) for more details on why central banks were slow to start tightening.

"supersized" hikes).[48] In the sensitivity tests, we also discuss a subset of results using the individual measures of aggressiveness used to calculate this principal component.

Country characteristics. In addition to these two controls for the central bank's strategy, we also include controls for slower moving country characteristics. In our baseline specification, we focus on two variables that have received the most attention in the literature: central bank credibility (e.g., Goodfriend and King 2005) and labor market flexibility (e.g., Bowdler and Nunziata 2008). In sensitivity tests, we also control for trade openness, financial openness, exchange rate flexibility, and the level of inflation just before the start of the tightening phase. Capturing any effect of these country characteristics is more challenging than for the other factors analyzed above as they tend to be slow moving, so that any relationships are primarily identified through the more limited cross-country variation in the data (and not the additional time dimension incorporated in the phases). Many of these variables are also highly correlated (such as central bank credibility and financial openness) and some have little variation across the sample (such as exchange rate flexibility).

Contributions of shocks. As a final set of variables, we control for the contributions of shocks to the variation in inflation rates during each tightening phase. To measure the underlying shocks, we use estimates from the factor-augmented VAR (FAVAR) model developed in Forbes, Ha and Kose (2024) of the contributions of seven types of shocks to the variation in inflation.[49] In our baseline analysis. we focus on the contribution of oil price shocks (which also includes other commodity shocks, such as gas price shocks, that move similarly to oil prices). In the sensitivity analysis we also control for the role of all supply shocks, of all global shocks, and other combinations of shocks. These are not consistently significant, and do not affect the headline results reported below.

The sources and definitions for each of the control variables are provided in Appendix Table 3b. Both *CB_Strategy* and *OilShocks* are measured over each country-phase, while *Country_Characs* is measured in the year before the start of the phase.

V.1.2. Regression Results

To begin, we estimate the regression defined in equation 3 to explain the Sacrifice Ratio, its components, price level increases, and the Price-Output Tradeoff Ratio for tightening phases. Results are shown in Table 4. Starting with the measures capturing the central bank's strategy, the first row of each results shows that a delayed start to tightening corresponds to lower Sacrifice Ratios (with mixed significance), primarily due to significantly larger inflation reduction. This seemingly positive result of a late start, however, masks that this disinflation corresponds to an even larger and significant increase in the price level over the tightening phase. This suggests that the tradeoff from delaying liftoff may not be as attractive as suggested by simply focusing on the Sacrifice Ratio; delaying the first rate hike only appears to lead to a lower "sacrifice" because it allows inflation to surge more before bringing it back down—with a long lasting impact on the price

[48] Some of these variables are highly correlated, especially nominal variables (such as the pace of rate hikes and total amplitude of rate hikes). Many are also endogenous; for example, if inflation picks up faster than expected midway through the tightening phase, then the central bank is more likely to raise rates more times and for longer (i.e., the phase would involve more rate hikes or a longer duration of the phase).

[49] This framework estimates the contribution of four global shocks (oil prices, supply, demand and monetary policy) and three domestic shocks (supply, demand, and monetary policy) behind the variation in domestic inflation (and other macroeconomic variables).

level and no apparent improvement in output gaps. In fact, a delayed start to tightening corresponds to worse output gaps (albeit with mixed significance), likely reflecting additional rate hikes required to disinflate after the larger inflation surge. Also, the positive and significant coefficient on the Price-Output Tradeoff Ratio suggests tightening phases which start late correspond to a relatively larger share of the subsequent adjustment occurring through prices rather than output losses.

Shifting to the other key component of the central bank's strategy, the second row of each set of results suggests that more aggressive tightening strategies correspond to higher Sacrifice Ratios, driven by significantly worse ANOGs, albeit partly balanced by significantly larger inflation reductions. There is no significant impact on the price level (or Price-Output Tradeoff Ratio) from more aggressive tightening strategies—although this may reflect endogeneity as central banks are likely to tighten more aggressively (and subsequently suffer larger output losses) in the face of larger price increases.

The coefficient estimates for central bank credibility in the third rows also indicate an important role for central banks other than their phase-specific tightening strategy—consistent with results in the literature. Greater central bank credibility is correlated with significantly lower Sacrifice Ratios, and this effect may be more powerful than the phase-specific strategy (as the central bank strategy variables become insignificant in some specifications, including the baseline, when the control for credibility is included). Central bank credibility is also correlated with smaller output losses, larger disinflations, and smaller price level increases—all in the direction expected—albeit the coefficient estimates have mixed significance based on specification and other variables included. This fluctuating significance may also reflect the challenges measuring central bank credibility across countries over this long time period. With these caveats, stronger central bank credibility appears to be the one institutional feature with no tradeoff (by our measures)—and only positive outcomes.

Finally, the other explanatory variables are usually insignificant, and many of the signs fluctuate across specifications. More flexible labor markets are usually correlated with lower Sacrifice Ratios, smaller output losses, larger disinflations, and smaller price level increases, but the relationships are usually not significant, at least partly reflecting its correlation with the measure of central bank credibility. Oil shocks correspond to larger price level increases and larger disinflations (relationships which are sometimes significant at the 10% level), as would be expected if oil price shocks are transitory.

In addition to the main results highlighted above, we have also implemented an extensive set of sensitivity tests. More specifically, we have repeated the baseline analysis with the following changes: (1) added additional controls for the country's characteristics (including inflation before the start of the tightening phase, trade openness, financial openness, and exchange rate flexibility); (2) included country fixed effects and/or period fixed effects (for the five long windows introduced in Section II); (3) used the different measures of output gaps discussed in Section IV.1 (including unemployment rate and employment rate gaps and output gaps measured by the OECD (using the production method) or using Baxter-King or Hamilton filters instead of the HP filter; (4) used core (instead of headline) inflation; (5) included each of individual measures of aggressiveness and central bank credibility used in calculating the corresponding principal component (instead of using the aggregated measure); and (6) included different measures of shocks affecting inflation

(including all types of supply shocks, all global shocks, or all demand shocks). Appendix Table 5 shows a subset of these results.

The empirical results based on these extensive robustness tests are consistent with the key findings highlighted above—albeit the significance of some variables (particularly those only significant at the 10% level in the baseline) can fluctuate. The coefficients for most of the additional control variables included, however, are not statistically significant. More specifically, throughout this series of extensions, central bank credibility is consistently and significantly corelated with lower Sacrifice Ratios and positively correlated with smaller output losses (albeit with mixed significance). A delayed start to tightening is consistently and significantly corelated with larger disinflations, but this results from significantly larger price level increases; there is also no evidence that a delayed start reduces output losses (with some evidence it aggravates output losses), such that more of the overall adjustment occurs through prices than output. A more aggressive tightening strategy is consistently and significantly correlated with larger output losses and larger disinflations. Most of the country-specific characteristics are insignificant, which is not surprising as many are correlated with measures included in the baseline (such as central bank credibility), but there is some evidence that more openness to trade and capital flows is correlated with smaller price level increases (consistent with Razin and Loungani 2005).[50]

V.2. Illustrative Simulations

To better understand these regression results and assess if they correspond to the predictions of a standard model for how different monetary policy strategies affect the tradeoffs facing central banks, we conduct two illustrative simulations using the FRB/US model, the workhorse model used by the U.S. Federal Reserve. We simulate the impact on the US economy of the choices that are the focus of the empirical analysis above: the timing of the first rate hike and the aggressiveness of the subsequent tightening path.[51] In each simulation, we assume that the economy begins from a position of overheating—similar to the position of the United States before the start of its post-pandemic tightening—with output above potential by 3.0%, unemployment 2.0pp below NAIRU and inflation above target by around 6pp (similar to the tightening episode starting 2021).

First, we simulate the impact of a "late" or "early" start to tightening. In each case, we assume the central bank raises the policy interest rate from 0 to 4.5% over a period of 2 years. In the "early" case, the central bank begins raising rates at t=1, but in the "late" case, the central bank waits and begins raising rates one year later. Appendix Figure 2a shows the resulting paths for the policy rate, inflation, price level, output gap, GDP and unemployment rate. A late start corresponds to a longer overshoot of output above potential, but higher inflation and a larger increase in the price level.

Figure 13 shows the corresponding impact on the key macroeconomic variables and tradeoffs that are the focus of this paper: the Sacrifice Ratio and its components, the Excess Price Level Change (above that which would have occurred if inflation was 2%); and the Price-Output Tradeoff Ratio. The central bank's decision on when to start raising rates has clear implications for the corresponding tradeoffs for the economy; a late start corresponds to a lower Sacrifice Ratio (due

[50] Razin and Loungani (2005) models how globalization causes monetary policy to put greater emphasis on reducing inflation than narrowing the output gap.

[51] See Brayton, Laubach, and Reifschneider (2014) and Laforte (2018) for background on the FRB/US model.

primarily to meaningfully smaller output losses), but at the cost of a larger increase in the price level. Finally, the "late" strategy also corresponds to a meaningfully larger Price-Output Tradeoff Ratio, as a relatively greater share of the adjustment to the initial situation of overheating occurs through the price level than output losses. These simulations correspond to the results from the regressions analysis in Section V.1 in terms of indicating a later liftoff corresponds to a lower Sacrifice Ratio, larger increase in the price level, and greater share of the adjustment occurred through prices than output gaps. The mechanisms are somewhat different, however, as the regression results indicate that a delayed start corresponds to larger output losses (instead of the smaller losses predicted in the simulations) and more disinflation. The regression results may also capture a secondary effect of a late start on output—that the central bank needs to tighten policy for longer in response to the longer inflation overshoot and higher price level —which is not captured in the simulation.

For a second simulation, we assess the impact of an "aggressive" versus "gradual" path for rate hikes. We begin from the same starting point as above (with the economy overheating) and assume lift off occurs at the same time in each case. In the aggressive case, the policy rate is quickly hiked by 4.75pp in one year and then reduced by 25bp and held steady at 4.5%, while in the "gradual" case, the rate is hiked more slowly by 4.5pp over 2 years and then held constant at 4.5%. Appendix Figure 2b shows the resulting paths for the same set of macroeconomic variables. As expected, a more aggressive adjustment corresponds to lower inflation at the end of the window and a smaller increase in the price level, but at the cost of slower GDP growth, larger output losses and a larger increase in unemployment (relative to neutral).

Figure 13 shows that this choice between interest rate paths has clear implications for the corresponding tradeoffs facing the economy; a more aggressive path corresponds to a much larger Sacrifice Ratio (mainly due to much larger output losses) combined with a smaller increase in the price level. The "aggressive" strategy also implies more adjustment through output losses than prices (and therefore a lower Price-Output Tradeoff Ratio), while the cautious strategy implies more adjustment through prices than activity.

It is important to highlight that these illustrative simulations do not answer which strategy is optimal. The optimal choice for monetary policy involves the relative weights given to output losses, unemployment increases, inflation overshoots, and changes in the price level. The simulations do, however, provide more insight on how different central bank strategies affect different macroeconomic variables and the related tradeoffs.

To summarize, these illustrative simulations of the impact of different monetary policy strategies based on the FRB/US model are largely consistent with the regression results in Section V.1., as well as existing literature on Sacrifice Ratios. They also clarify the tradeoffs facing central banks when they choose their strategy for tightening monetary policy. Delaying liftoff corresponds to lower Sacrifice Ratios, but at the cost of a larger increase in the price level, with mixed evidence of the impact on output gaps. A more aggressive tightening path corresponds to smaller increases in the price level, but at the cost of larger output losses and higher Sacrifice Ratios. Interpreting large disinflations as a successful policy is difficult, as this can (at least partially) reflect prior policy choices supporting a larger inflation overshoot. The results also suggest how different monetary policy strategies can affect the channels by which an economy adjusts to overheating; delaying

liftoff and raising rates more gradually causes more of the adjustment to occur through prices (instead of output), while starting to tighten earlier and/or raising rates more aggressively causes more of the adjustment to occur through output losses.

VI. Conclusions

When central banks adjust monetary policy, they often balance difficult tradeoffs, including how much weight to put on various goals and on different costs, benefits and risks. Balancing these tradeoffs determines the direction, magnitude, speed and overall strategy for adjusting interest rates and monetary policy more broadly. This paper explores how these adjustments and the corresponding tradeoffs have changed for 24 advanced economies from 1970 to 2024. We first develop a new historical database of rates cycles to explore how strategies for adjusting policy interest rates and corresponding macroeconomic variables have evolved. We then focus on tightening phases—when the tradeoffs tend to be more challenging—and assess how output losses have corresponded to disinflations and the corresponding Sacrifice Ratio. We also evaluate measures which generally receive less attention: the excess change in the price level (i.e., difference from that assuming 2% inflation) and how much of the adjustment occurs through prices relative to output losses.

These historical and cross-country comparisons highlight the unprecedented tradeoffs in response to the inflation spike after the COVID-19 pandemic. Central banks were relatively slow to start raising interest rates (compared to the evolution of macroeconomic variables), but then raised policy rates more aggressively than during recent tightening phases. Inflation spiked by an amount not experienced since the early 1980s, but the spike was largely reversed within three years (on average across our sample). This disinflation corresponded to fairly small output losses and generated historically low Sacrifice Ratios, but also the largest annual increase in the price level (in excess of what would have occurred with inflation at 2%) in over 40 years. A larger share of the macroeconomic adjustment during this period occurred through prices (instead of output losses) than has historically occurred.

Our empirical results (supported by simulations based on the FRB/US model) show how these monetary policy decisions, combined with the pre-existing credibility of the central banks in our sample, contributed to the unusual evolution of macroeconomic variables during the post-pandemic period. Our results suggest that the initial delay in starting to hike interest rates would have lowered the Sacrifice Ratio, but at the cost of a larger increase in the price level. The subsequent more aggressive tightening path would have reduced inflation more quickly (and mitigated the effects on the price level), but would normally generate larger output losses and a higher Sacrifice Ratio. Stronger central bank credibility, however, could have mitigated these negative effects of more aggressive rate increases on the Sacrifice Ratio and output losses. These patterns are broadly consistent with the unusually low Sacrifice Ratios, large disinflations, and large price level increases during the post-pandemic period. The results also highlight that interpreting large disinflations (and the corresponding reduction in the Sacrifice Ratio) as a successful policy is challenging, as this often reflects (at least partly) a prior policy choice contributing to the inflation overshoot.

The one aspect of the post-pandemic recovery that is less well explained by the simple regressions and simulations in this paper is the modest output losses that occurred despite the aggressive rate hikes (even after accounting for the mitigating effect of strong pre-existing central bank credibility). There are two potential explanations not incorporated in our analysis. First, the path of rate hikes may not have been as "aggressive" as generally perceived. The analysis of historical rates cycles provides some support for this argument; although the recent rate hiking cycle was more aggressive than tightening phases since 1999 by most measures, it was not as aggressive as tightening phases over 1970-1998 by most of the same metrics—periods when inflation was also much higher than over 1999-2019. The path of real interest rates (not just the nominal rates examined in this paper) may be more important, especially during periods of high inflation, when assessing the aggressiveness of policy and corresponding impact on activity.

Second, and potentially even more important than monetary policy, is the impact of other policies in explaining the relative stability of output during the post-pandemic inflation surge. This includes the substantial fiscal stimulus, policies to limit the impact of energy price increases (including price caps and subsidies), the fairly rapid easing of supply constraints, and other delayed effects of the pandemic (such as the support to consumption from accumulated savings). None of these policies are included in our analysis, but many played critical roles in supporting the economic recovery after the pandemic.

This analysis of the tradeoffs for monetary policy, however, helps explain a disconnect between the views of many central bankers and the general public on the success of this post-pandemic adjustment. From the viewpoint of many central bankers, the post-pandemic disinflation was successful; inflation fell sharply and is largely on track to return to target with minimal output loss (at least before any new shocks). From this viewpoint, very little "sacrifice" was required for central banks to meet their mandates, despite inflation spiking to levels not seen since the early 1980s. Opinion polls, however, suggest high levels of dissatisfaction with central banks and governments, and research suggests that this surge in inflation and increase in the price level have contributed meaningfully to election outcomes in recent years (e.g., Federle et al. 2024). Moreover, research discussed above shows that households care about the increase in the price level, and not just the rate of inflation. The increase in the price level is not captured in measures such as the Sacrifice Ratio, or directly in many central bank mandates.

This set of results suggests that, in the future, central banks may want to place more weight on the length of time and extent to which inflation deviates from target (i.e., changes in the price level) when considering the timing and path of rate adjustments. This does *not,* however, imply that central banks should target the price level or that they should change their formal frameworks.[52] In many cases the optimal adjustment to shocks should involve an adjustment in the price level that deviates from what would have occurred if inflation remained at 2%. In response to certain shocks,

[52] For discussion of the advantages and disadvantages of price-level targeting, see Ambler (2009) or Bernanke (2019), which discusses how price-level targeting could be an alternative framework for inflation targeting, albeit only temporarily when interest rates are around the zero-lower bound. Another approach could be nominal GDP targeting, as discussed in Woodford (2012) and Binder (2024). While this approach has the benefit of incorporating changes in activity and the price level, it has a number of disadvantages, including challenges communicating to the public and measuring potential GDP.

the adjustment in interest rates that would be required to target the price level would involve extremely large output losses that are unlikely to be optimal in any reasonable framework.

Nonetheless, there are several ways that central banks could learn from the last few years and consider placing greater weight on adjustments in the price level without constraining their ability to adjust to a range of shocks and situations. First, central banks could be more explicit in their communications about the expected path for the price level when presenting different monetary policy strategies and explain why a potentially large change in the price level is justified given the policy options. Second, when discussing "price stability" central banks could clarify that this means stabilizing inflation at target and taking into account the length and extent of deviations of inflation from target (in both directions). This could include specifying the length of time by which inflation should return to target (such as two years); this is already done in a number of central banks, but for those with no explicit "time target", this could provide an additional incentive to try to limit the duration of any inflation deviations.

Third, central banks could adopt language in their frameworks that commits to a "more forceful" response to inflation deviations from target that are larger and longer lasting; some central banks (such as the ECB) already use this language to address situations when inflation is below target and interest rates are near the lower bound, but this commitment could be made symmetric. Finally, central banks could consider removing any constraints in their frameworks that limit their ability to respond in a timely fashion when inflation is expected to deviate substantially from target (or has already deviated substantially from target), i.e., that relegates price stability to a secondary consideration in order to attain other goals. This does not mean ending dual mandates (such as in the United States), but instead ensuring that a deviation in one part of the mandate will not overly constrain the central bank's ability to respond to large deviations in the other part.[53]

Macroeconomic developments around the pandemic and post-pandemic tightening are unlikely to be repeated, and monetary policy frameworks should be designed for a range of scenarios and not overweight the most recent experience. Nonetheless, the lessons from the last few years, particularly when assessed in the longer historical and cross-country context in this paper, suggest that when central banks discuss the many tradeoffs for monetary policy, the corresponding changes in the price level from different strategies should be part of this discussion.

[53] An example of this type of constraint is the Federal Reserve's FAIT framework, which makes it more difficult to raise interest rates in response to an expected (or ongoing) overshoot of inflation until the economy reaches full employment.

References

Andersen, P. S. and W. L. Wascher. 1999. “Sacrifice Ratios and the Conduct of Monetary Policy in Conditions of Low Inflation*”* No. 82. Bank for International Settlements, Monetary and Economic Department.

Adolfson, M., S. Laseén, J. Lindé, and L. E. O. Svensson. 2008. "Monetary Policy Trade-Offs in an Estimated Open-Economy DSGE Model." *NBER Working Paper* 14510. Cambridge, MA: National Bureau of Economic Research.

Afrouzi, H., S. Bhattarai, and E. Wu. 2024. “Relative-price Changes as Aggregate Supply Shocks Revisited: Theory and Evidence. *Journal of Monetary Economics* 148: 103650.

Afrouzi, H., M. Halac, K. Rogoff, and P. Yared. 2024. "Changing Central Bank Pressures and Inflation." *Brookings Papers on Economic Activity,* March 28–29. Cambridge, MA.

Ambler, S. 2009. “Price-level Targeting and Stabilisation Policy: A Survey.” *Journal of Economic Surveys* 23 (5): 974-97.

Alvarez, J., J. C. Bluedorn, N. J. Hansen, Y. Huang, E. Pugacheva, and A. Sollaci. 2024. "Wage–Price Spirals: What Is the Historical Evidence?" *Economica* 91 (364): 1291–319.

Ascari, G. andT. Haber. 2022. “Non-linearities, State-dependent Prices and the Transmission Mechanism of Monetary Policy.” *The Economic Journal* 132 (641): 37-57.

Bachmeier, L. J., and B. D. Keen. 2023. “Modeling the Asymmetric Effects of an Oil Price Shock.” *International Journal of Central Banking* 19 (3): 1-47.

Ball, L. 1994. "What Determines the Sacrifice Ratio?" In *Monetary Policy,* 155–93. Chicago: University of Chicago Press.

Ball, L. 2011. "The Performance of Alternative Monetary Regimes." In *Handbook of Monetary Economics,* vol. 3B, 1303–43. Elsevier.

Bandera, N., L. Barnes, M. Chavaz, S. Tenreyro, and L. von dem Berge. 2023. "Monetary Policy in the Face of Supply Shocks: The Role of Inflation Expectations." *ECB Forum Working Papers*.

Barnichon, R. and G. Mesters. 2021. “The Phillips Multiplier.” *Journal of Monetary Economics* 117: 689-705.

Beaudry, P., C. Hou, and F. Portier. 2024. "Monetary Policy When the Phillips Curve Is Quite Flat." *American Economic Journal: Macroeconomics* 16 (1): 1–28.

Bems, R., F. Caselli, F. Grigoli, and B. Gruss. 2021. “Expectations' Anchoring and Inflation Persistence. *Journal of International Economics 132:* 103516.

Benigno, P., and G. Eggertsson. 2023. "It’s Baaack: The Surge in Inflation in the 2020s and the Return of the Nonlinear Phillips Curve." *NBER Working Paper* 31197. Cambridge, MA: National Bureau of Economic Research.

Benigno, P. and J. D. Lopez-Salido. 2006. “Inflation Persistence and Optimal Monetary Policy in the Euro Area.” *Journal of Money, Credit and Banking* 587-614.

Bernanke, B. 2019. "Monetary Policy in a New Era." *Brookings Papers on Economic Activity,* Spring: 1–81.

Bernanke, B., and F. Mishkin. 1992. "Central Bank Behavior and the Strategy of Monetary Policy: Observations from Six Industrialized Countries." *NBER Macroeconomics Annual 1992* 7: 183–228.

Binder, C. 2024. “Post-pandemic Inflation and Improving FAIT with Nominal GDP Level Targeting.”, Federal Reserve Framework Review December 10, 2024.

Binetti, A, N. Francesco, and S. Stantcheva. 2024. “People’s Understanding of Inflation.” *NBER Working Paper* No. 32497.

BIS (Bank for International Settlements). 2019. "Large Central Bank Balance Sheets and Market Functioning." *Markets Committee Report*. October.

Blanco, A., C. Boar, C. Jones, and V. Midrigan. 2024. “Non-linear Inflation Dynamics in Menu Cost Economies.*”* National Bureau of Economic Research, No. w32094

Bowdler, C. and L. Nunziata. 2010. “Labor Market Structures and the Sacrifice Ratio.” *Journal of Macroeconomics* 32 (3): 816-26.

Brainard, W. 1967. "Uncertainty and the Effectiveness of Policy." *American Economic Review* 57: 411–25.

Brayton, F., T. Laubach, and D. Reifschneider. 2014. “The FRB/US Model: A Tool for Macroeconomic Policy Analysis.” *FEDS Notes*, (2014-04), 03.

Bry, G., and C. Boschan. 1971. *Cyclical Analysis of Time Series: Selected Procedures and Computer Programs*. Cambridge, MA: National Bureau of Economic Research.

Burns, A. F., and W. C. Mitchell. 1946. *Measuring Business Cycles*. Cambridge, MA: National Bureau of Economic Research.

Castelnuovo, E., and P. Surico. 2010. "Monetary Policy, Inflation Expectations and the Price Puzzle." *Economic Journal* 120 (549): 1262–83.

Cecchetti, S. G., M. Feroli, P. Hooper, F. S. Mishkin, and K. L. Schoenholtz. 2023. “Managing Disinflations.” Centre for Economic Policy Research.

CGFS (Committee on the Global Financial System). 2019. "Unconventional Monetary Policy Tools: A Cross-Country Analysis." *CGFS Papers* 63. October.

Chinn, M. D., and H. Ito. 2006. “What Matters for Financial Development? Capital Controls, Institutions, and Interactions.” *Journal of Development Economics* 81(1): 163-92.

Claessens, S., M. A. Kose, and M. Terrones. 2009. "What Happens During Recessions, Crunches, and Busts?" *Economic Policy* 24: 653–700.

Claessens, S., M. A. Kose, and M. Terrones. 2012. "How Do Business and Financial Cycles Interact?" *Journal of International Economics* 87: 178–90.

Clarida, R., J. Gali, and M. Gertler. 1999. "The Science of Monetary Policy: A New Keynesian Perspective." *Journal of Economic Literature* 27: 1661–707.

Coibion, O., D. Georgarakos, Y. Gorodnichenko, and M. Van Rooij. 2023. "How Does Consumption Respond to News about Inflation? Field Evidence from a Randomized Control Trial." *American Economic Journal: Macroeconomics 15* (3): 109-52.

Coibion, O., Y. Gorodnichenko, and M. Ulate. 2018. "The Cyclical Sensitivity in Estimates of Potential Output." *Brookings Papers on Economic Activity* Fall: 343-411.

Cournède, B., and D. Moccero. 2009. "Is There a Case for Price-Level Targeting?" *OECD Publication*.

Christiano, L. J., M. Eichenbaum, and C. L. Evans. 2005. "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy. *Journal of political Economy 113* (1): 1-45.

De Santis, R. A., and T. Tornese. 2023. "Energy Supply Shocks' Nonlinearities on Output and Prices." ECB Working Paper No. 2834.

Dincer, N., and B. Eichengreen. 2014. "Central Bank Transparency and Independence: Updates and New Measures." *International Journal of Central Banking* 10 (1): 189-259.

Dreher, A., J.-E. Sturm, and J. de Haan. 2010. "When Is a Central Bank Governor Replaced? Evidence Based on a New Data Set." Journal of Macroeconomics 32 (3): 766-81.

Du, W., K. Forbes, and M. Luzzetti. 2024. "Quantitative Tightening Around the Globe: What Have We Learned?" *NBER Working Paper* 32321. Cambridge, MA: National Bureau of Economic Research.

English, W., K. Forbes, and A. Ubide. 2021. *Monetary Policy and Central Banking in the Covid Era*. CEPR, March.

English, W., K. Forbes, and A. Ubide. 2024. *Monetary Policy Responses to the Post-Pandemic Inflation*. CEPR, February.

Federle, J., C. Mohr and M. Schularick. 2024. "Inflation Surprises and Election Outcomes." CEPR Working Paper DP *19741*.

Forbes, K. 2019. "Inflation Dynamics: Dead, Dormant, or Determined Abroad?" *Brookings Papers on Economic Activity,* Fall: 257–338.

Forbes, K., J. Gagnon, and C. Collins. 2022. "Low Inflation Bends the Phillips Curve Around the World." *Economia* 45 (89): 52–72.

Forbes, K., J. Ha, and M. A. Kose. 2024. "Rate Cycles." *CEPR Discussion Paper* 19272.

Fratto, C., B. H. Vannier, B. Mircheva, D. de Padua, and H. Poirson Ward. 2021. "Unconventional Monetary Policies in Emerging Markets and Frontier Countries." *IMF Working Paper* 2021/014.

Garriga, A. C. 2016. “Central Bank Independence in the World: A New Dataset.” *International Interactions* 42 (5): 849-68.

Goodfriend, M. and R. King. 2005. “The Increased Volcker Disinflation.” *Journal of Monetary Economics* 52(5): 981-1015.

Ha, J., D. Kim, M. A. Kose, and E. S. Prasad. 2025. “Resolving Puzzles of Monetary Policy Transmission in Emerging Markets.” *European Economic Review* 104957.

Ha, J., M. A. Kose, and F. Ohnsorge, eds. 2019. *Inflation in Emerging and Developing Economies: Evolution, Drivers, and Policies*. Washington, DC: World Bank.

Ha, J., M. A. Kose, and F. Ohnsorge. 2023. "One-Stop Source: A Global Database of Inflation." *Journal of International Money and Finance* 137.

Hamilton, J. 2018. “Why You Should Never Use the Hodrick-Prescott Filter.” *The Review of Economics and Statistics* 100(5, December): 831-43.

Harding, D., and A. Pagan. 2002. "Dissecting the Cycle: A Methodological Investigation." *Journal of Monetary Economics* 49: 365–81.

Havranek, T., and M. Rusnak. 2013. "Transmission Lags of Monetary Policy: A Meta-Analysis." *International Journal of Central Banking* 9 (4): 39–76.

Honkapohja, S., and K. Mitra. 2020. "Price Level Targeting with Evolving Credibility." *Journal of Monetary Economics* 116: 88–103.

Huang, H. C., C. C. Yeh, and X. Wang. 2019. “Inflation Targeting and Output-Inflation Tradeoffs.” *Journal of International Money and Finance*, *96*, 102-120.

Ilzetzki, E., C. Reinhart, and K. S. Rogoff. 2017. “Exchange Arrangements Entering the 21st Century: Which Anchor Will Hold?” NBER Working Paper 23134, National Bureau of Economic Research, Cambridge, MA.

Jarociński, M., and P. Karadi. 2020. "Deconstructing Monetary Policy Surprises: The Role of Information Shocks." *American Economic Journal: Macroeconomics* 12 (2): 1–43.

Jasová, M., R. Moessner, and E. Takáts. 2018. “Domestic and Global Output Gaps as Inflation Drivers: What Does the Phillips Curve Tell?” BIS Working Papers No. 748.

Kahn, G. A. 2009. “Beyond Inflation Targeting: Should Central Banks Target the Price Level?. *Federal Reserve Bank of Kansas City Economic Review 94* (3): 37-66.

Khalil, M .and V. Lewis. 2024. “Product Turnover and Endogenous Price Flexibility in Uncertain Times”, CEPR Discussion Paper No. 18941.

Kiley, M. T. 2020. “The Global Equilibrium Real Interest Rate: Concepts, Estimates, and Challenges.” *Annual Review of Financial Economics* 12: 305–26.

Krippner, L. 2013. "Measuring the Stance of Monetary Policy in Zero Lower Bound Environments." *Economics Letters* 118 (1): 135–38.

Kugler, A. D. 2024. "Central Bank Independence and the Conduct of Monetary Policy," speech delivered at the Albert Hirschman Lecture, 2024 Annual Meeting of the Latin American and Caribbean Economic Association and the Latin American and Caribbean Chapter of the Econometric Society, Montevideo, Uruguay, November 14.

Lane, P. R. 2022. "Monetary Policy in the Euro Area: The Next Phase." Remarks for the High-Level Panel “High Inflation and Other Challenges for Monetary Policy,” Annual Meeting, European Central Bank.

Lane, P. R., and G. M. Milesi-Ferretti. 2007. “The External Wealth of Nations Mark II: Revised and Extended Estimates of Foreign Assets and Liabilities,1970-2004.” *Journal of International Economics* 73 (2): 223-50.

Laforte, J.-P. 2018. “Overview of the Changes to the FRB/US Model. 2018.” FEDS Notes. Washington: Board of Governors of the Federal Reserve System.

Maechler, A. 2024. “Monetary Policy in an Era of Supply Headwinds–do the Old Principles Still Stand?. Speech by Ms Andréa M Maechler, Deputy General Manager, Bank for International Settlements, at the London School of Economics, London.

Magkonis, G. and K. M. Zekente. 2020. "Inflation-Output Trade-off: Old Measures, New Determinants?” *Journal of Macroeconomics 65*: 103217.

Mann, C. 2022. “UK monetary Policy in the Context of Global Spillovers.” Bank of England speech available at: https://www.bankofengland.co.uk/speech/2022/june/catherine-l-mann-speech-at-a-market-news-international-connect-event.

Mazumder, S. 2014. “Determinants of the Sacrifice Ratio: Evidence from OECD and non-OECD Countries.” *Economic Modelling 40*: 117-135.

McLeay, M., and S. Tenreyro. 2021. "Optimal Inflation and the Identification of the Phillips Curve." *NBER Macroeconomics Annual* 34: 199–255.

Mountford, A. and H. Uhlig. 2009. “What are the Effects of Fiscal Policy Shocks.” *Journal of Applied Econometrics* 24(6): 960-992.

Orphanides, A., and S. V. Norden. 2002. "The Unreliability of Output-Gap Estimates in Real Time." *Review of Economics and Statistics* 84 (4): 569–83.

Phillips, A. W. 1958. "The Relationship Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861–1957." *Economica* 25 (100): 283–99.

Quinn, D. P., and A. M. Toyoda. 2008. “Does Capital Account Liberalization Lead to Growth?” *Review of Financial Studies* 21 (3): 1403-49.

Ramey, V. 2019. “Ten Years After the Financial Crisis: What Have We Learned from the Renaissance in Fiscal Research?” *Journal of Economic Perspectives* 33(2): 89-114.

Ramey, V. 2018. “Comment on The Cyclical Sensitivity in Estimates of Potential Output.” *Brookings Papers on Economic Activity*, Fall, 424-431.

Ramey, V. 2016. "Macroeconomic Shocks and Their Propagation." In *Handbook of Macroeconomics,* vol. 2, 71–162.

Razin, A. and P. Loungani. 2005. “Globalization and Inflation-Output Tradeoffs.” *NBER Working Paper No. 11641*.

Reis, R. 2022. "Losing the Inflation Anchor." *Brookings Papers on Economic Activity* 2021 (2): 307–79.

Romelli, D. 2024. “Trends in Central Bank Independence: a De-jure Perspective.” BAFFI CAREFIN Centre Research Paper 217.

Romer, C. D., and D. H. Romer. 2024. "Lessons from History for Successful Disinflation." *Journal of Monetary Economics* 148: 103654.

Schüler, Y. S. 2024. Filtering economic time series: On the cyclical properties of Hamilton's regression filter and the Hodrick-Prescott filter. *Review of Economic Dynamics 54*: 101237.

Shambaugh, J. C. 2004. “The Effect of Fixed Exchange Rates on Monetary Policy.” *Quarterly Journal of Economics* 119 (1): 301-52.

Stantcheva, S. 2024. "Why Do We Dislike Inflation?" *NBER Working Paper* 32300. Cambridge, MA: National Bureau of Economic Research.

Stein, J., and A. Sunderam. 2018. "The Fed, the Bond Market, and Gradualism in Monetary Policy." *Journal of Finance* 73 (3): 1015–60.

Taylor, J. B. 1993. "Discretion Versus Policy Rules in Practice." *Carnegie-Rochester Conference Series on Public Policy* 39: 195–214.

Tenreyro, S. 2023. "The Economy and Policy Trade-Offs." *LSE Research Online Documents on Economics* 117623. London School of Economics and Political Science.

Tetlow, R. J. 2024. “How large is the output cost of disinflation?” *International Finance 27* (3): 231-252.

Woodford, M. 2012. “Methods of Policy Accommodation at the interest-Rate Lower Bound.” In *The Changing Policy Landscape*, Economic Policy Symposium, Jackson Hole, August 30-Sept 1, 2012, pgs. 185-288.

Woodford, M. 2003. *Interest and Prices: Foundation of a Theory of Monetary Policy.* Princeton, NJ: Princeton University Press.

World Bank. 2024. *Global Economic Prospects,* January. Washington, DC: World Bank Publications.

Table 1: Turning Points—The Start of Monetary Policy Tightening and Easing Phases

	Start of Phase	
	Tightening	Easing
Australia	1973m2	1982m9
	1984m2	1986m1
	1988m2	1989m12
	1994m8	1996m7
	2002m5	2008m9
	2009m10	2011m11
	2022m5	
Canada	1973m4	1976m11
	1978m3	1981m9
	1987m4	1990m6
	1997m6	2001m1
	2004m9	2007m12
	2010m6	2015m1
	2017m7	2020m3
	2022m3	2024m6
Denmark	1973m7	1977m1
	1979m6	1980m9
	1990m3	1992m12
	1999m11	2000m10
	2005m12	2008m11
	2022m7	2024m6
Israel	1993m11	1996m8
	2002m2	2002m12
	2005m9	2006m10
	2009m8	2011m10
	2022m4	2024m1
Japan	1973m4	1975m4
	1979m4	1980m8
	1989m5	1991m7
	2006m7	2008m10
	2024m3	
Korea	1997m12	1993m5
	2005m10	2001m2
	2010m7	2008m10
	2021m8	2012m7
		2024m10
New Zealand	1976m2	1985m4
	1994m1	1998m4
	1999m2	2003m1
	2004m1	2008m7
	2021m10	2024m8

	Start of Phase	
	Tightening	Easing
Norway	1986m1	1982m6
	1997m7	1987m1
	2005m7	1999m1
	2009m10	2008m10
	2021m9	2011m12
Sweden	1974m4	1978m2
	1979m7	1981m10
	1987m1	1992m11
	1999m11	2002m11
	2006m1	2008m10
	2010m7	2011m12
	2019m1	2020m6
	2022m4	2024m5
Switzerland	1973m1	1975m3
	1979m11	1982m8
	1988m8	1992m9
	2000m1	2001m3
	2004m6	2008m10
	2022m6	2024m3
United Kingdom	1972m6	1976m11
	1977m11	1980m7
	1984m5	1985m3
	1988m6	1990m10
	1994m9	1998m10
	2003m11	2007m12
	2021m12	2024m8
United States	1972m1	1974m7
	1977m1	1981m1
	1983m3	1984m8
	1987m1	1989m6
	1994m2	1995m7
	1999m6	2001m1
	2004m6	2007m9
	2015m12	2019m8
	2022m3	2024m9

	Start of Phase	
EURO AREA	Tightening	Easing
Euro area	1999m11	2001m5
	2005m12	2008m10
	2022m7	2024m6
Austria	1980m1	1975m4
	1988m7	1982m9
		1992m9
Belgium	1972m11	1981m4
	1983m11	1985m5
	1988m7	1993m9
Finland	1972m11	1974m7
	1976m1	1981m10
	1988m8	1990m1
France	1972m11	1974m7
	1976m1	1981m10
	1988m8	1990m4
Germany	1972m10	1974m10
	1979m1	1980m9
	1983m9	1985m4
	1988m6	1992m9
	1997m10	
Greece		1982m10
	1984m2	1986m7
	1987m10	1994m7
	1997m6	
Ireland		1986m3
	1988m6	1992m12
Italy	1973m9	1977m6
	1979m10	1982m8
	1987m8	1990m5
	1994m8	1996m7
Netherlands	1972m11	1974m10
	1977m11	1980m6
	1983m5	1985m8
	1988m7	1992m9
	1997m3	
Portugal	1977m3	1985m8
	1989m3	1993m5
Spain	1973m7	1983m9
	1988m9	1991m2
	1995m1	1995m12

Sources: Authors' calculations, based on the identification of rate cycles described in Section II, with data from January 1970 through December 2024.

Notes: Phases for individual countries in the euro area and the euro area as a whole are in the column on the right. Members of the euro area have national cycles through 1998, after which they are reported for the euro area as a whole.

Table 2
Median Inflation and Disinflation during Tightening Phases

	Headline Inflation			Core Inflation		
	Peak (%)	Trough (%)	Disinflation (pp)	Peak (%)	Trough (%)	Disinflation (pp)
1970-84	13.9	5.5	5.2	12.0	5.6	2.9
1985-98	6.9	2.6	2.3	6.8	3.3	2.2
1999-07	4.0	1.3	1.2	2.9	1.1	0.8
2008-19	3.5	0.6	3.1	2.8	1.1	1.2
2020-24	***9.2***	***1.5***	***8.5***	***6.2***	***2.0***	***3.7***

Notes: Disinflation is calculated from the peak to subsequent trough for each economy, such that the median may not equal the difference between the median peak and median trough of the sample. Inflation is calculated based on the CPI and core CPI price indices for each country except the United States, which is based on PCE (and core PCE) index. Each statistic is calculated over the tightening phases defined in Section II plus a 12-month lag.

Table 3
Median Output and Unemployment Gaps during Tightening Phases

	Output gaps (as % of GDP) based on HP filter					ANOG based on alternate gap measures				
	Peak	Trough	AOG	# months of ANOG	ANOG	Hamilton filter	Baxter-King filter	OECD	Employ. Gap	Unemploy. Gap
1970-84	2.5	-2.1	0.6	10	-1.6	-5.7	-0.4	-3.1	-1.0	-0.3
1985-98	2.6	-0.8	3.3	8	-0.8	-2.1	-0.3	-1.3	-0.2	-0.2
1999-07	2.4	-1.0	2.5	7	-0.3	-0.4	-0.2	-0.4	-0.4	-0.1
2008-19	1.5	-1.0	0.9	15	-0.8	-1.5	-0.2	-1.1	-0.7	-0.2
2020-24	***1.8***	***-0.7***	***1.0***	***12***	***-0.4***	***-1.6***	***-0.1***	***-2.0***	***-0.1***	***-0.2***

Notes: AOG is the accumulated output gap and ANOG is the accumulated negative output gap. The # months of ANOG is the number of months of negative output gaps. All output gaps are as a % of annual GDP, and the unemployment (and employment) gap is relative to the trend unemployment (employment) rate. The window for each statistic is the tightening phase plus a 12-month lag. Gaps are positive when output is above potential or unemployment is below the trend rate.

Table 4
Regression Results: Explaining Tradeoffs

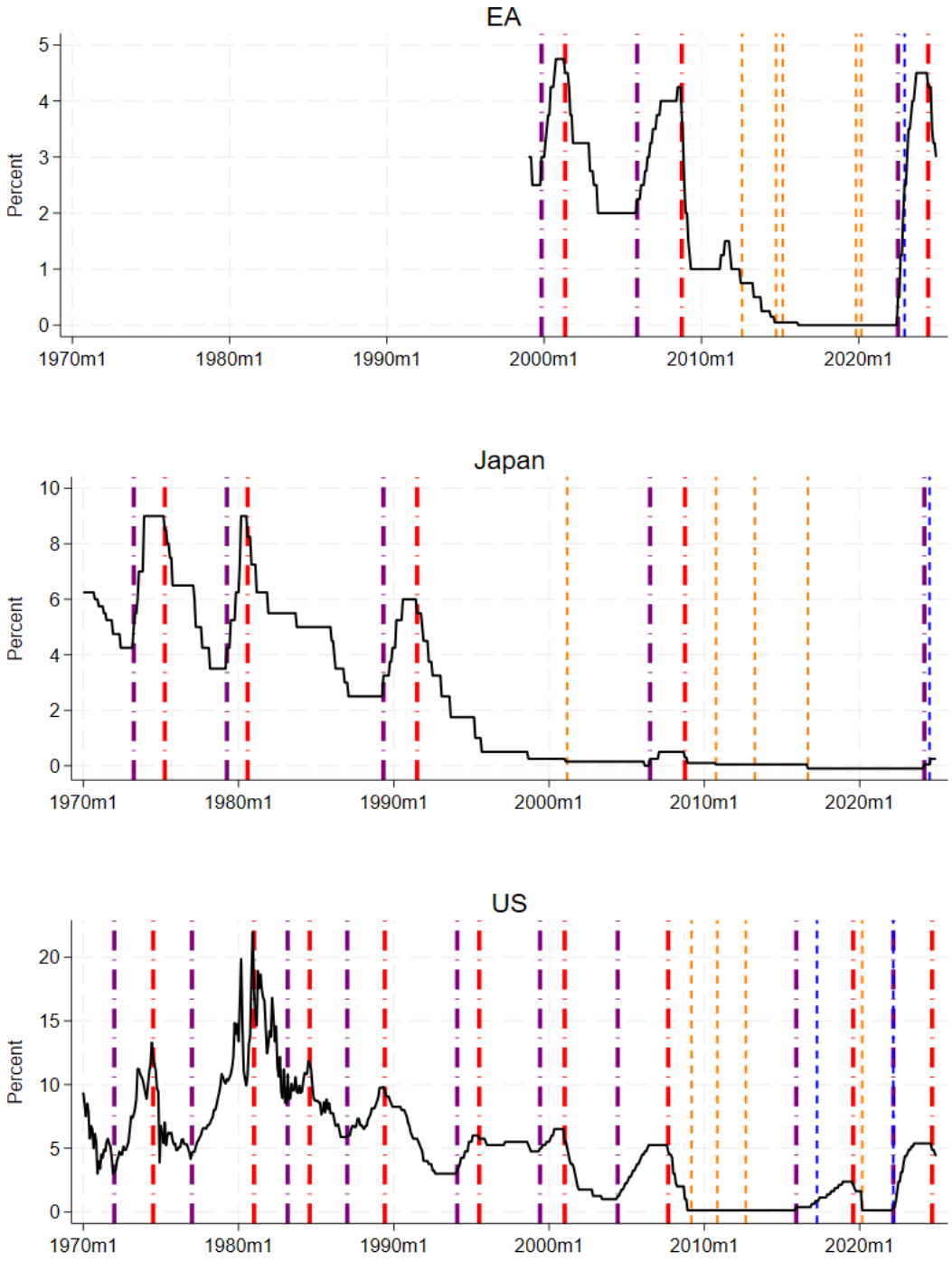
	Sacrifice Ratio (ANOG/IR)					Accumulated Negative Output Gap (ANOG)				
Delayed Start	-0.0546*		-0.0782***	-0.0527	-0.0482	-0.304*		-0.130	-0.165*	-0.186*
	(0.0211)		(0.0147)	(0.0309)	(0.0357)	(0.132)		(0.0824)	(0.0651)	(0.0852)
Aggressiveness		0.0361*	0.0788***	0.00539	0.00501		-0.607***	-0.527***	-0.373**	-0.371**
		(0.0139)	(0.0132)	(0.0248)	(0.0256)		(0.0397)	(0.00870)	(0.0957)	(0.0999)
Central Bank				-0.141**	-0.132**				0.266*	0.226*
Credibility				(0.0334)	(0.0394)				(0.115)	(0.0946)
Labor Market					-0.0273					0.121
Flexiblity					(0.0261)					(0.0993)
Oil Shocks					0.00183					-0.00514
					(0.00719)					(0.0254)
Observations	***88***	***88***	***88***	***88***	***88***	***108***	***108***	***108***	***108***	***108***
R-squared	***0.040***	***0.010***	***0.079***	***0.212***	***0.216***	***0.121***	***0.257***	***0.274***	***0.319***	***0.325***

	Inflation Reduction (IR)					Excess Price Level Change (EPLC)				
Delayed Start	1.704***		1.560***	1.565***	1.476***	2.926*		2.362*	2.328*	2.492**
	(0.136)		(0.120)	(0.0973)	(0.147)	(1.356)		(1.070)	(0.872)	(0.839)
Aggressiveness		1.195*	0.494**	0.586**	0.581**		2.917	1.932	1.372	1.398
		(0.508)	(0.141)	(0.157)	(0.160)		(1.801)	(1.228)	(1.053)	(1.024)
Central Bank				0.239	0.0697				-1.448	-1.128
Credibility				(0.279)	(0.186)				(0.983)	(0.882)
Labor Market					0.532					-0.956
Flexiblity					(0.322)					(0.466)
Oil Shocks					-0.0458					0.0937
					(0.0288)					(0.0462)
Observations	***136***	***137***	***136***	***136***	***135***	***136***	***137***	***136***	***136***	***135***
R-squared	***0.512***	***0.173***	***0.538***	***0.543***	***0.563***	***0.399***	***0.279***	***0.505***	***0.554***	***0.569***

	Price-Output Tradeoff Ratio (EPLC/ANOG)				
Delayed Start	14.30**		14.82**	14.19**	11.81**
	(4.312)		(4.237)	(3.627)	(2.938)
Aggressiveness		7.631	-1.582	1.150	1.304
		(4.229)	(2.019)	(2.230)	(2.214)
Central Bank				4.721	0.490
Credibility				(3.221)	(3.503)
Labor Market					13.89
Flexiblity					(8.344)
Oil Shocks					-1.006
					(0.570)
Observations	***108***	***108***	***108***	***108***	***108***
R-squared	***0.061***	***0.009***	***0.062***	***0.065***	***0.086***

Notes: Results from estimates of equation (3) of the *Tradeoff* variables on central bank strategies, country characteristics and shocks over tightening phases from 1970-2024 for a sample of 23 advanced economies (including individual countries in the euro area, but not the euro area as a single entity). All variables are defined in Appendix Table 3b. Regressions include a constant (not reported) and robust errors clustered by country and time period (for the five long windows defined in Section III).

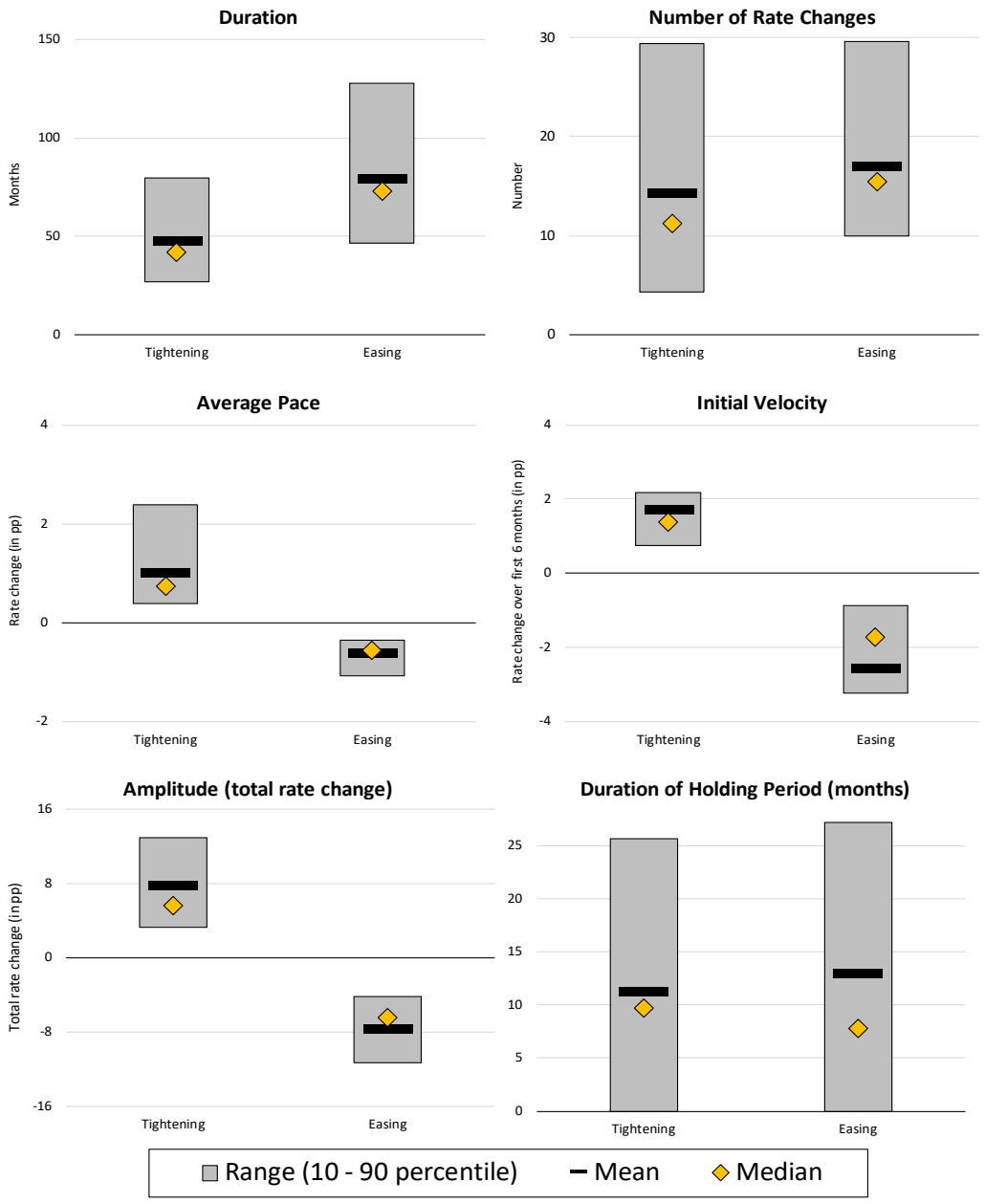
Figure 1: Rate Cycles in Euro area, Japan, and the United States



Sources: Authors' calculations based on the data and methodology identifying rate cycles described in Section II, with data from January 1970 through December 2024.

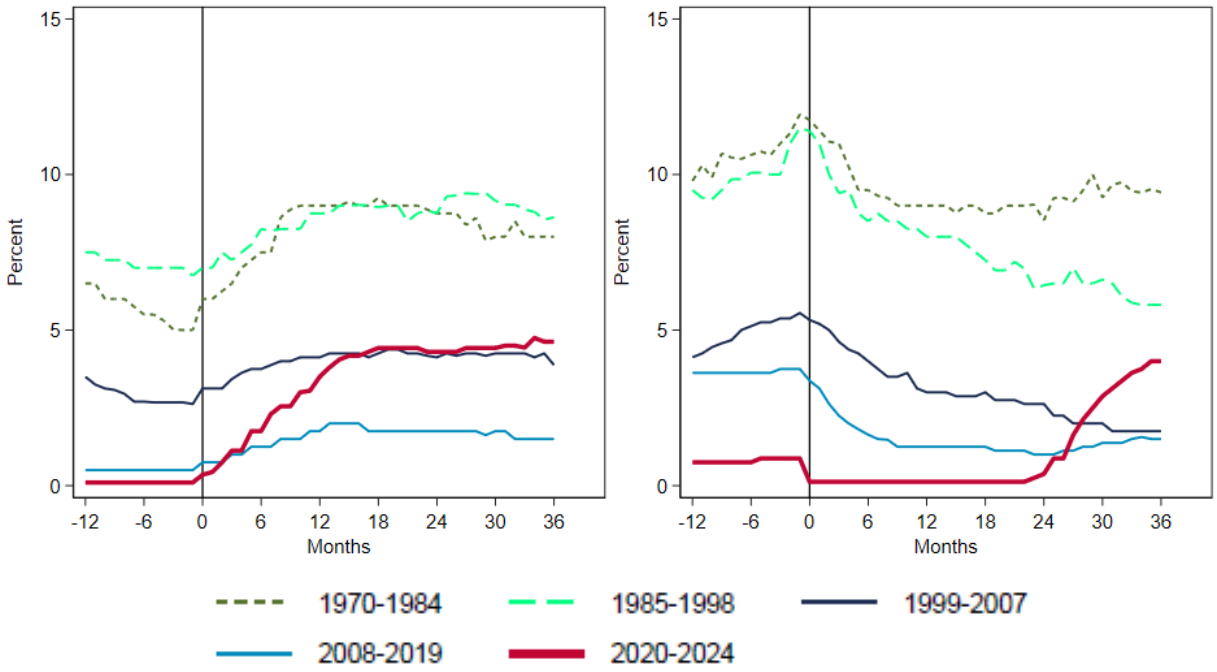
Notes: The solid black line is the policy interest rate. Dashed purple and red lines indicate the start of tightening and easing phases, respectively. Dashed blue and orange lines represent the announcement of new QT and QE programs, respectively, and only include the announcement of major new programs involving government bonds and aimed at providing monetary stimulus; we do not include announcements of changes to an ongoing QE/QT program or balance sheet programs aimed primarily at providing liquidity. These QE/QT dates are not turning points that denote the start of an easing or tightening phase unless there is also a red or purple line.

Figure 2: Characteristics of Rate Cycles: 1970 – 2024



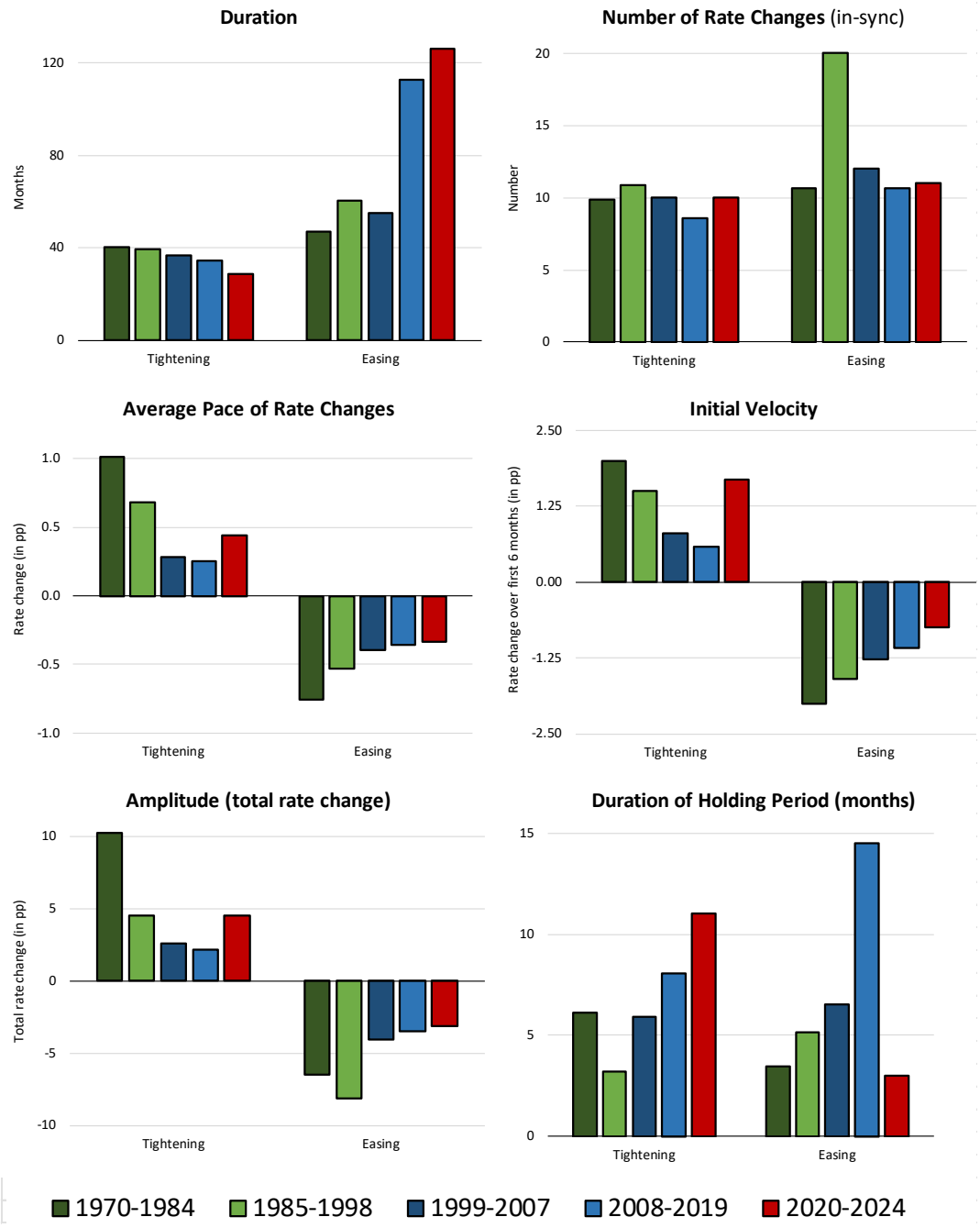
Sources: Calculated based on the rate cycles defined in the text, with data from January 1970 through December 2024.
Notes: Figure shows sample statistics across all tightening or easing phases. The number and pace of rate adjustments only includes "in-sync" rate adjustments, i.e., the rate increases for tightening phases and decreases for easing phases. Initial velocity and amplitude are the total changes in rates (in any direction) over the first six months of the phase or the entire phase, respectively. The duration of the holding period is the number of months after the last rate increase during a tightening phase or the last decrease and end of any government QE during an easing phase. Means are calculated for each economy (weighted by the months of each phase), and then the means, medians, and 10th and 90th percentiles reported above are calculated across all economies. Members of the euro area are included as individual countries through 1998, and then the euro area is included from 1999.

Figure 3: Policy Interest Rates over Tightening and Easing Phases during Different Sub-periods



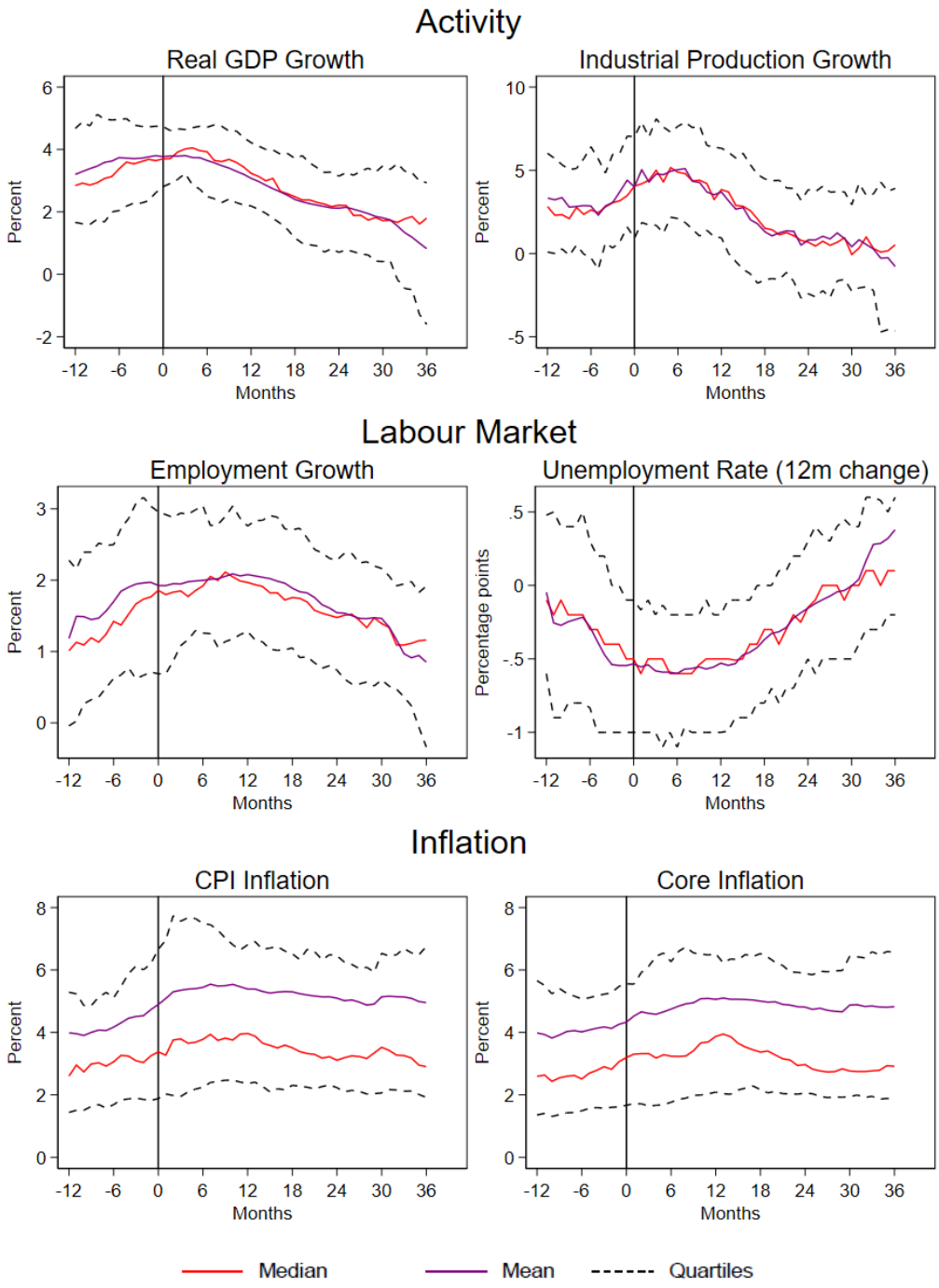
Sources: Authors' calculations using the turning points for rate cycles listed in Appendix Table 1. Data from January 1970 through December 2024.
Notes: Figure shows policy interest rates around the turning points of rate cycles during different sub-periods, with t=0 the start of each tightening or easing phase within the window listed above. Lines are the medians for all tightening (left) and easing (right) phases in the period listed at the top and for which data on the policy rate is available for at least 6 months prior to *t*=0. Phases are defined based on individual euro area countries through 1998, and then for the ECB cycle starting in 1999.

Figure 4: Characteristics of Rate Cycles over Different Sub-periods



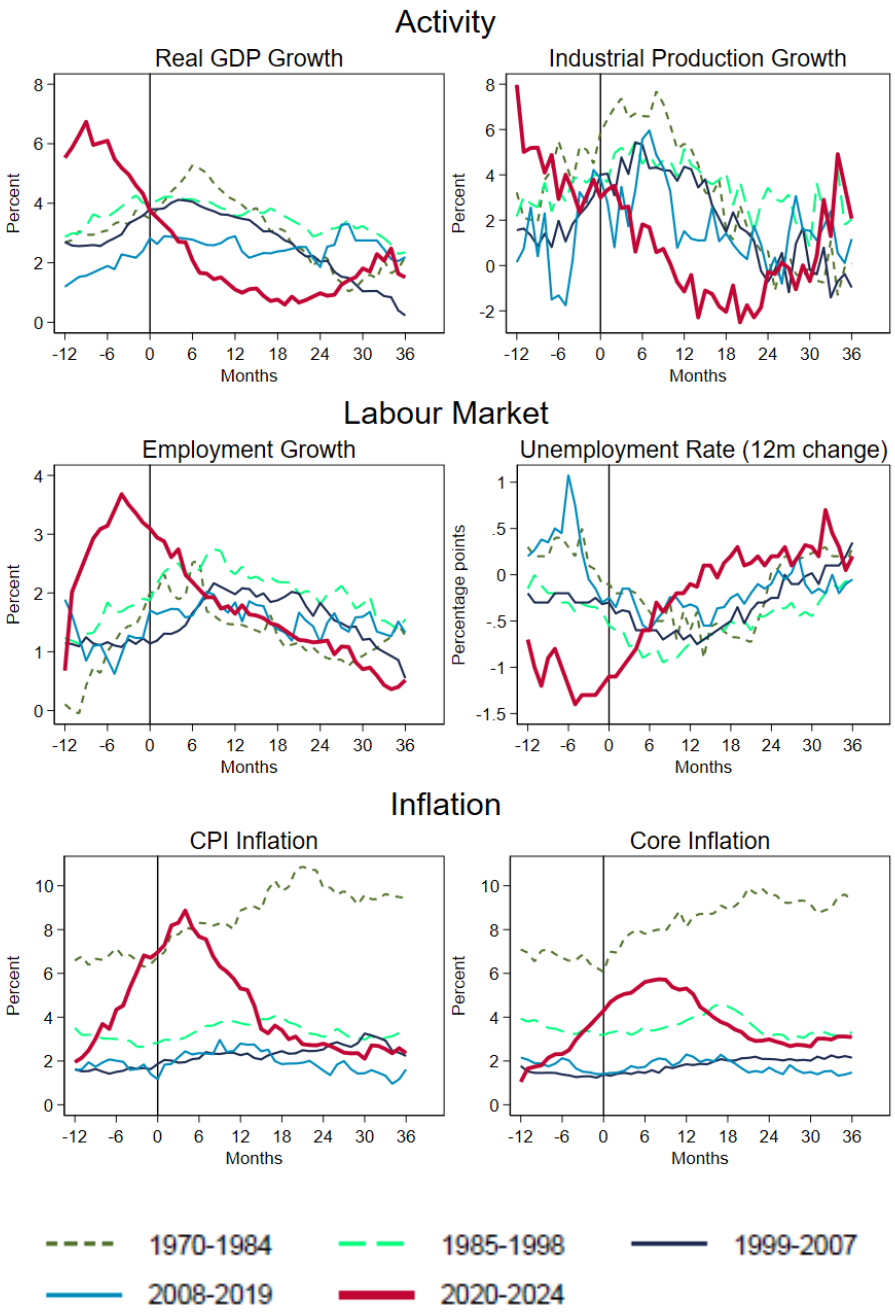
Sources: Calculated based on the rate cycles defined in the text, with data from January 1970 through December 2024.
Notes: Figure shows characteristics of tightening and easing phases within the given time period in 24 advanced economies. The number and pace of rate adjustments only include "in-sync" rate adjustments, i.e., the rate increases for tightening phases and decreases for easing phases. Velocity and amplitude are the total change in rates (in any direction) over the first six months of the phase or the entire phase, respectively. Means are calculated for each economy (weighted by the length of each phase within the relevant period) and then medians are reported across the sample. Members of the euro area are included as individual countries through 1998, and then the euro area is included from 1999.

Figure 5: Macroeconomic Variables over Tightening Phases



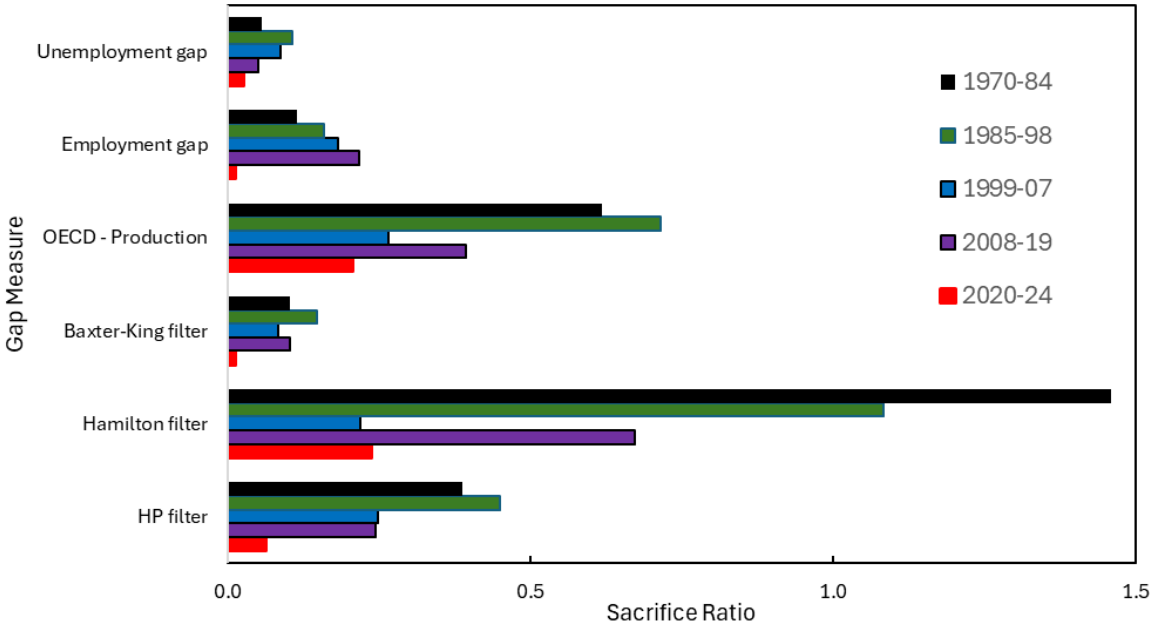
Sources: Authors' calculations using the turning points for rate cycles listed in Appendix Table 1.
Notes: Figure shows in the evolution of macroeconomic variables around the turning points of interest rate cycles, with *t*=0 the start of the tightening phase. All variables are calculated as % change relative to 12 months earlier, except for the unemployment rate, which is the change relative to 12 months earlier. All statistics calculated across all tightening phases for which the corresponding macroeconomic variable is available for at least 6 months prior to *t*=0. Phases include individual euro area countries throughout the sample plus an aggregate euro area economy starting in 1999.

Figure 6: Macroeconomic Variables over Tightening Phases during Different Subperiods



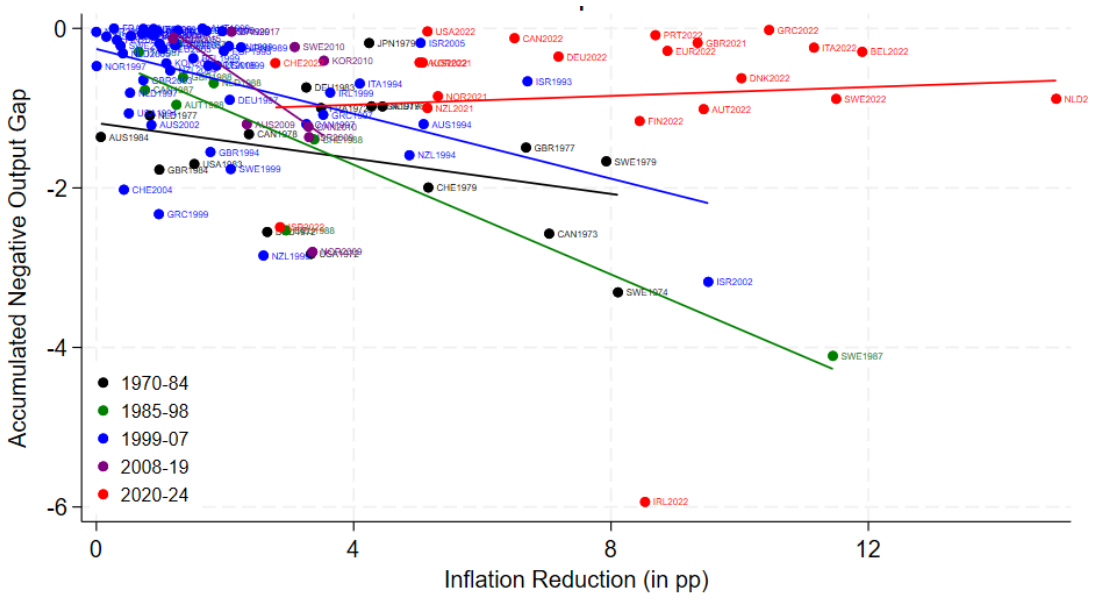
Sources: Authors' calculations using the turning points for rate cycles listed in Appendix Table 1.
Notes: Figure shows changes in macroeconomic variables around the turning points of interest rate cycles, with *t*=0 the start of the tightening phase. Lines are the medians for all tightening phases in the period listed at the top and for which the corresponding macroeconomic variable is available for at least 6 months prior to *t*=0. All variables are calculated as % change relative to 12 months earlier, except for the unemployment rate, which is the change relative to 12 months earlier. Phases include individual euro area countries throughout the sample plus an aggregate euro area economy starting in 1999.

Figure 7: Median Sacrifice Ratios during Tightening Phases



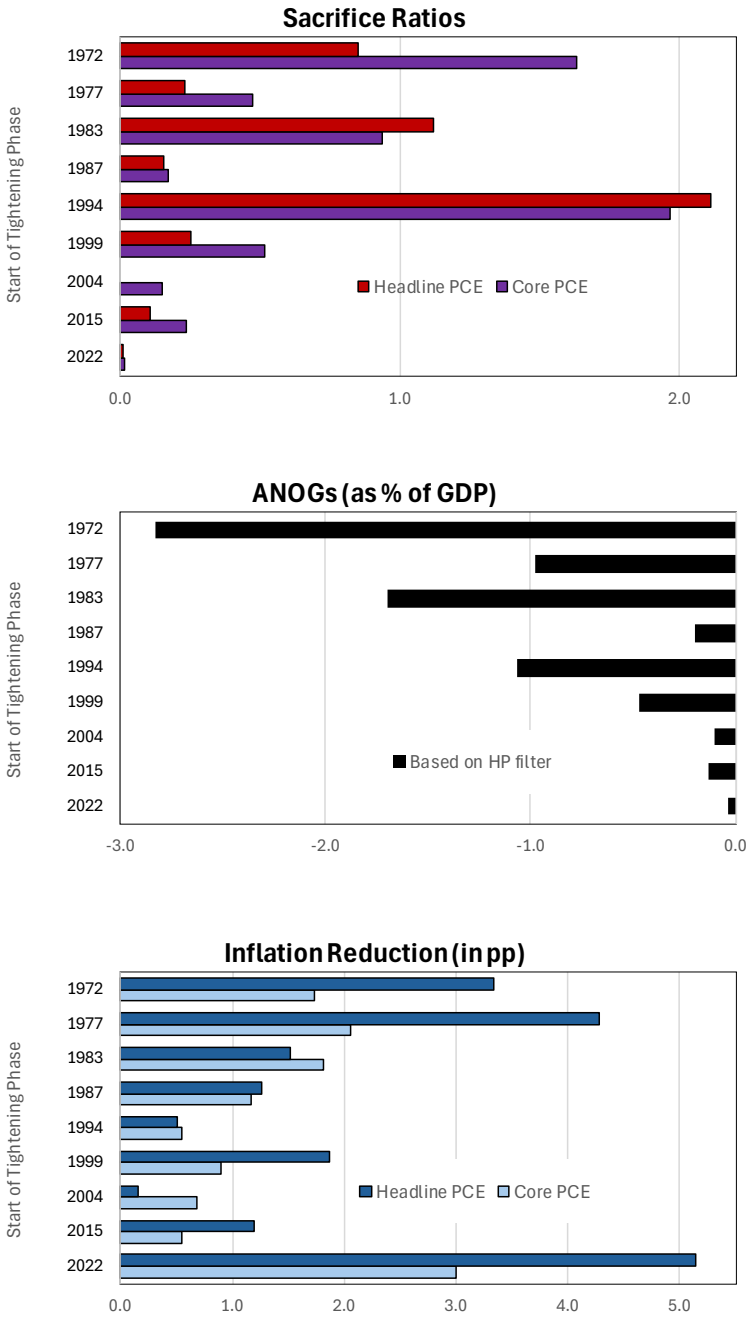
Notes: Sacrifice Ratio is the absolute value of the accumulated negative output gap relative to the reduction in headline inflation from the peak to subsequent trough for each economy over each tightening phase (including a 12-month lag after the tightening phases ends). Headline inflation is the year-over-year change in the monthly CPI price index (or PCE index for the United States). Alternate measures of the output gap are defined in Table 3. Statistics are medians for the sample of 24 advanced economies.

Figure 8: The Components of the Sacrifice Ratio over Time



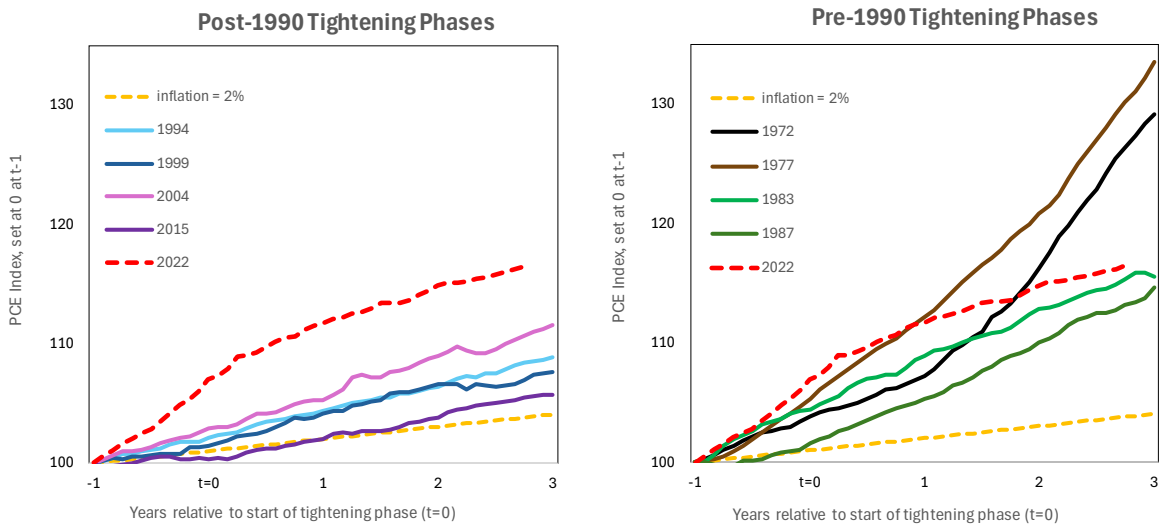
Notes: Graph shows the components of the Sacrifice Ratio for each country-phase during tightening episodes from 1970 through 2024. The accumulated negative output gap (ANOG) is based on the HP filter and the inflation reduction is based on headline year-over-year inflation of the CPI price index (or PCE for the United States). Lines are fitted based on the observations for the five historical windows defined in the legend.

Figure 9: US Sacrifice Ratios across Historical Tightening Phases



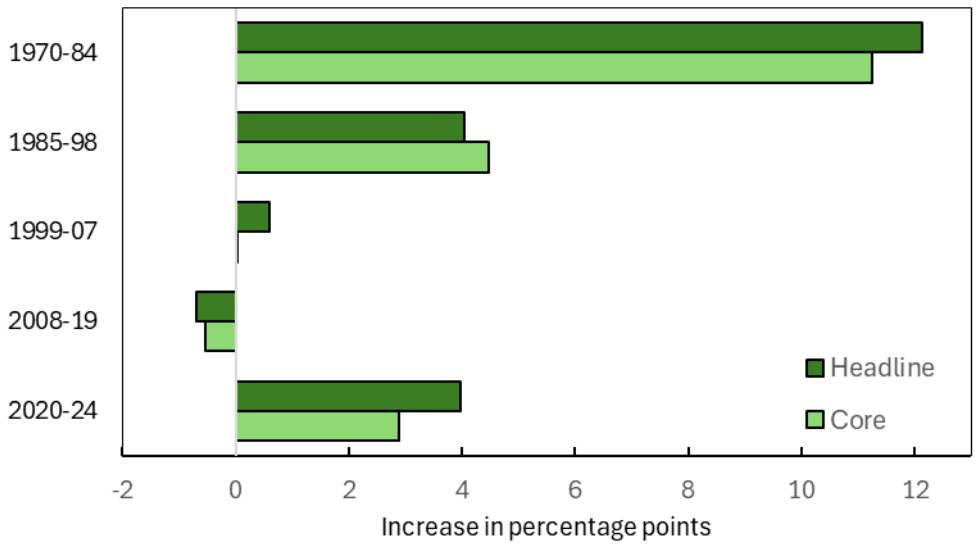
Notes: Each graph shows the relevant statistics over the nine US tightening phases identified in Section II. The Sacrifice Ratio is calculated as the absolute value of the ANOG (in the 2nd graph) relative to Inflation Reduction (in the bottom graph). The ANOG is the accumulated negative output gap based on the HP filter, and Inflation Reduction is calculated as the peak to trough in year-over-year monthly inflation based on the PCE or core PCE index. Each tightening window includes a 12-month lag after the end of the tightening phase to capture the lagged effects of monetary policy.

Figure 10: The Evolution of the Price Level in the US:
Post-Pandemic versus earlier Tightening Phases and 2% Inflation



Notes: Graphs show the evolution of the US PCE price index, which is set to 100 one year prior to the commencement of each US tightening phase. The initial year of each phase (marked as t=0) is specified in the legend. The price index is based on monthly data. The yellow line indicates the hypothetical evolution of the price level if inflation was 2% over the period.

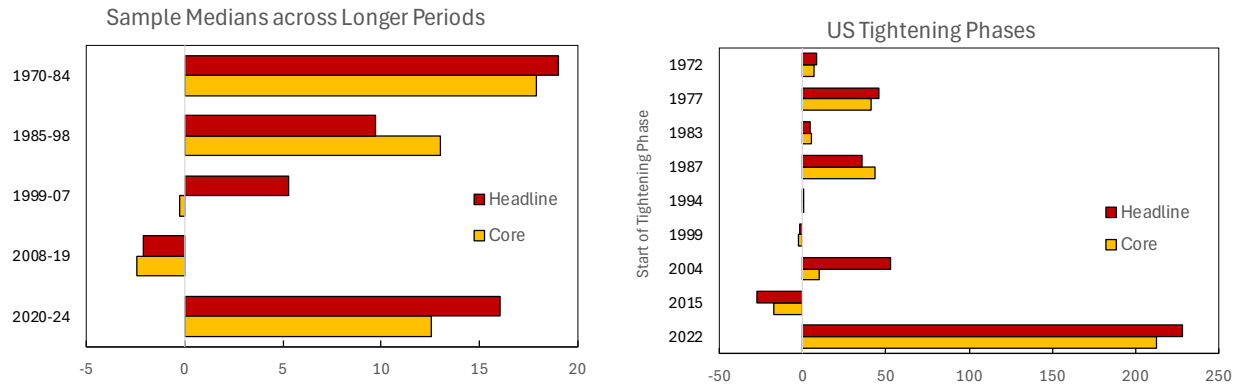
Figure 11: Excess Price Level Change during Tightening Phases
(medians, annualized)



Notes: The Excess Price Level Change is defined as the accumulated increase in the price level over tightening windows in excess of 2% and then annualized. The tightening windows include a 12-month lead before the first rate hike in the phase and a 12-month lag after the tightening phases ends. The headline and core price indices are based on the monthly CPI indices for all economies except the United States (which is based on the PCE indices). Statistics are medians over the historical windows.

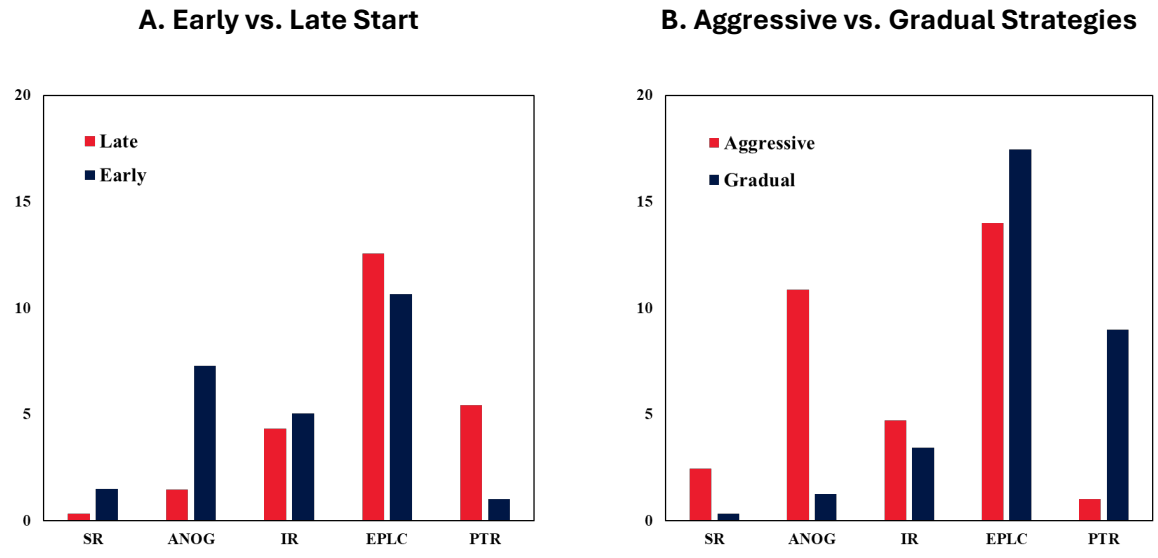
Figure 12: Price-Output Tradeoff Ratios during Tightening Phases

(Ratio of Excess Price Level Change to ANOG)



Notes: The Price-Output Tradeoff Ratio is calculated as the ratio of the Excess Price Level Change (relative to that which would occur if inflation was 2%) from Figure 11 to the Accumulated Negative Output Gap (ANOG) over each tightening phase. Output gaps are based on the HP filter. The headline and core price indices are based on the monthly CPI indices for all economies except the United States (which is based on the PCE indices). The left graph shows medians across the sample of advanced economies over each historical window, and the right graph shows the statistics for each of the US tightening phases.

Figure 13: Simulated Effects of Different Strategies on Tradeoffs

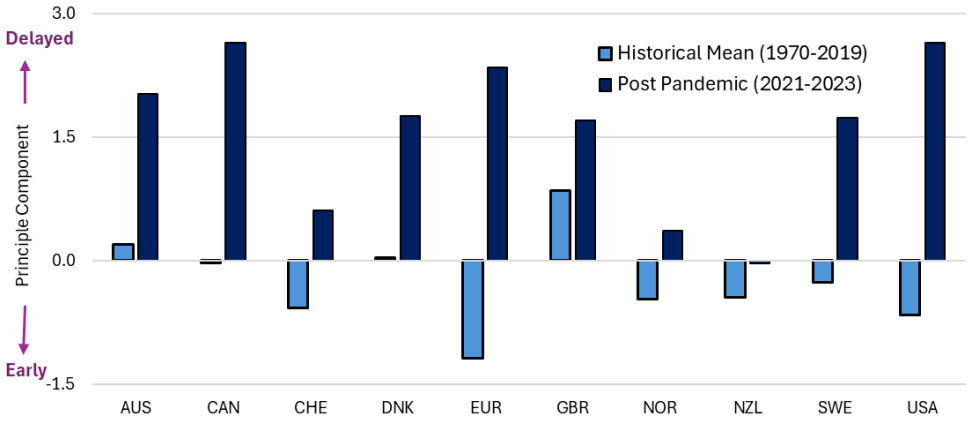


Source: Authors' calculations based on the FRB/US model as explained in Brayton, Laubach, and Reifschneider (2014) and Laforte (2018).

Notes: The estimates are based on the impulse response functions of US variables following the simulated impacts of a monetary policy tightening of 450 bps. The total increase in interest rates is the same in in both scenarios, but has different starting dates for the first rate hike for Panel A and has a different aggressiveness of tightening (i.e., path for the rate hikes) for Panel B. "IR" = Inflation Reductions (in pp), "ANOG" = Aggregated Negative Output Gaps (in % of GDP), "EPLC" = Excess Price Level Change (in % in excess of 2%), "SR" = Sacrifice Ratios (calculated as the ANOG/IR), and "PTR" = Price-Output Tradeoff Ratios (calculated as the PLI/ANOG).

Figure 14: Timing of First Rate Hike

(Relative to macroeconomic indicators)



Notes: A higher value of the index indicates a slower start to the tightening phase based on the evolution of macroeconomic variables and a negative value indicates an earlier start to tightening (relative to the full sample). This index is calculated as the principal component of five macroeconomic indicators that can influence the timing of the first rate hike: CPI (or PCE for the US) inflation, core inflation, unemployment gap, output gap and GDP growth. The output gap is measured using an HP filter; if any of these five macroeconomic variables is not available, we calculate a principal component with substitutes (such as the using OECD data for the output gap or IP growth instead of GDP growth) or with as much data as is available.

Appendix 1: Identification of Rate Cycles

Section II discusses the application of the BBQ algorithm in Harding and Pagan (2002) to identify local maxima and minima in policy interest rates and thereby define rate cycles. A simple application of this algorithm to the data on policy interest rates, however, can be problematic due to several characteristics of the interest rate data—particularly long windows when there is no change in i_t. To address this and more accurately identify the turning points of easing and tightening phases consistent with changes in central bank policy stances, we start with the dates identified in the BBQ algorithm, but then make several adjustments and add additional criteria for a month to qualify as a turning point. This appendix describes the process used to identify the easing and tightening phases in more detail.

First, we apply the BBQ algorithm in Harding and Pagan (2002) to the policy rate data, with one adjustment. Early in the sample, when the policy rate is market-determined in some countries, there are occasionally sharp spikes in the rate that appear to primarily reflect shifts in market sentiment, shifts that are quickly reversed. To avoid classifying these temporary market-based fluctuations as turning points in a cycle, we smooth across these spikes by replacing i_t with $(i_{t+1} + i_{t-1})/2$ if the policy rate changes by more than 500 basis points in one month.

Second, we set three parameters for the BBQ algorithm: (1) the window on each side of a local maxima and minima must be at least 18 months; (2) a full cycle (including both tightening and easing phases) must be at least 36 months; and (3) any individual phase of a cycle (either a tightening or easing phase) must last at least 7 months. The first two criteria require relatively long windows on each side of a turning point and for the full cycle in order to capture changes in policy which are not reversed quickly; this also avoids classifying changes in policy rates that largely reflect market movements as turning points in the policy cycle. The shorter window for individual phases in a cycle, however, still allows short periods when central banks adjust policy rates to qualify as an easing or tightening phase (such as a rapid reduction in rates over one month in response to a shock).

Third, we require i_t to increase or decrease for month *t* to qualify as the start of a tightening or easing phase, respectively. This requirement sounds obvious—but is necessary as the dating algorithm incorrectly identifies about 10 false "turning points" during long periods when there is no change in interest rates. This requirement is also needed to correctly date turning points when the exact month identified by the algorithm is slightly off due to substantial volatility in the data or the smoothing around spikes (as mentioned above). Also, if any of these adjustments causes a "false" phase to be dropped, then the subsequent phase must also be dropped as an easing phase must be followed by a tightening phase (and vice versa).[54]

[54] For example, the algorithm initially identified Switzerland as starting a tightening phase in July 2016 and starting an easing phase in December 2020—despite there being no change in Switzerland's policy rate from January 2015 (when the rate was lowered to -0.75) through May 2022. Therefore, we drop the falsely identified turning point in July 2016, as well as in December 2020, so that Switzerland remains in an easing phase from 2010 (when it started lowering rates) through May 2022 (when its first rate hike since before 2015 meets the criteria to start a tightening phase).

Fourth, we require that the change in the policy rate identified as a turning point must be "meaningful or lasting". To qualify as "meaningful or lasting", we require: (a) either a change in rates of at least 50 basis points over one month, or (b) at least one rate changes (of any size) over a year after the first change such that the policy rate is at least 30 basis points higher/lower one year after the first change in rates. This dual criteria allow for a turning point to occur if there is only one adjustment in the policy rate but the adjustment is sufficiently large.[55]

These criteria also allow for turning points to occur with more modest and gradual rate adjustments. An example is the Federal Reserve's 25bps rate increase in December 2015, which was not followed by another rate increase for a year (and then followed by a series of rate hikes). It is worth highlighting, however, that several periods when rates are adjusted and then reversed within a year will not meet these "meaningful or lasting" criteria and thereby not qualify as a turning point. For example, the ECB increased rates 25bps in April 2011 and July 2011, and then lowered rates by the same amounts in November and December of the same year, such that the policy rate in March 2012 was at the same level as in March 2011. The two, short-lived rate hikes do not qualify as a turning point that starts a tightening phase, and are instead classified as a "false start" during a longer easing phase.

Fifth, if a country adopts a new QE program but is not already in an easing phase, or starts a new QT program but is not already in a tightening phase, we allow the announcement of the new balance sheet program to count as a turning point, i.e., the start of a new easing or tightening phase, respectively, even if there is no corresponding change in the policy rate.[56] In practice, this criteria rarely binds as most central banks lower interest rates before starting QE and raise rates before starting QT, but it could be important if a country is near the lower bound and choses to use balance sheet policy to ease monetary policy instead of lowering rates further.[57]

Sixth, we make several adjustments to the start dates of cycles due to challenges using the algorithm at the start of time series or when there is a long period during which rates are not

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[55] An example is the Bank of Canada 150bps rate cut in March 2020, which was not followed by any subsequent cuts (as rates were at the lower bound).

[56] As discussed in Section II, we only include announcements of new asset purchase programs involving government bonds and primarily intended for monetary policy goals (i.e., not market dysfunction). More specifically, for the US, we include the LSAP for Treasuries (announced March 2009), but do not include the LSAP for agency debt and MBS (announced November 2008). For the Euro area, we include the OMT (announced August 2012) and PSPP (announced January 2015), but do not include the Corporate Bond Purchase Programme (announced October 2011) or Asset-backed Securities Purchase Program (announced September 2014). For the UK, we include the announcement of the start of QT (February 2022), but do not include subsequent announcements adding active bond sales to the ongoing passive QT, or the various announcements about delays and updates start dates for QT around the LDI crisis in 2022. Defining whether an asset purchase program is intended primarily to achieve price stability and support activity (i.e., monetary policy goals) or to provide liquidity and stabilize markets is not always clear, so we include any programs with joint goals in our dummy variables. We do not include programs that are intended to be short-term to provide liquidity, such as the asset purchases announced by the BoE in response to the LDI crisis in 2022.

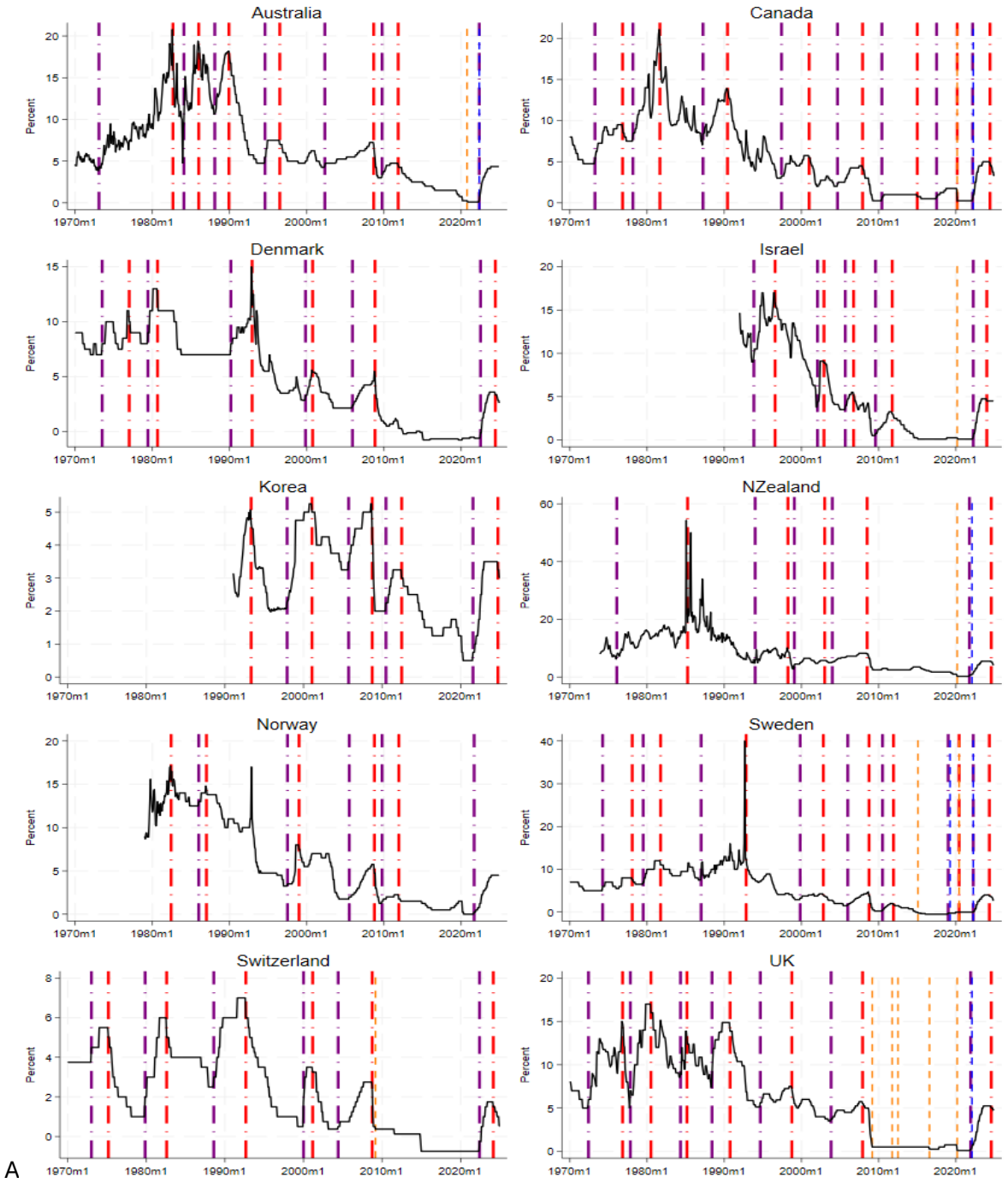
[57] In our sample, there are only two episodes when the announcement of a new balance sheet program qualifies as a turning point to identify a new phase. First is the start of an easing phase in Sweden in March 2020, when the Riksbank announced a new QE program but did not lower interest rates (which were at zero). Second is the start of a tightening phase in Sweden in April 2022, when the Riksbank announced the start of QT but did not start raising the policy rate until May.

adjusted in both directions. This requires three adjustments: (1) Identify the start of Portugal's initial tightening phase as March 1977, which is immediately after the only rate cut over an extended tightening phase—a phase which does not have a clear enough turning point for the algorithm to define the start of the tightening phase; (2) Identify the start of the ECB's initial tightening phase as November 1999, the date of the first rate increase after the April 1999 rate cut and the beginning of a series of rate hikes—a turning point which the algorithm does not capture with the time series starting in 1999;[58] and (3) identify the start of Denmark's post-pandemic tightening phase as January 2022, a turning point which is not captured in the algorithm due to the extended prior period with no meaningful change in rates.

Finally, our data set currently ends in December 2024. If a central bank adjusts its policy rate near the end of the sample in a way that is likely to become the start of a new easing or tightening phase, enough time may not have elapsed for this policy change to be identified as a turning point according to the mechanical application of the Harding and Pagan (2002) algorithm. This could lead to inaccurate statistics describing the prior phase. For example, the ECB lowered interest rates in June 2024 as the start of an easing phase, and if this does not qualify as a turning point, the second half of 2024 would still be included in statistics for the tightening phase which began in July 2022. To adjust for this, if a central bank is in a tightening (easing) phase at the start of 2024, but shifts to easing (tightening) the policy rate in 2024, we classify this change as a turning point indicating the start of the next phase (as long as the rate change has not subsequently been reversed). This corresponds to the Bank of Japan being defined as shifting from an easing to tightening phase in March 2024 and the other central banks in the sample shifting from a tightening to easing phase at some point in 2024 (with the exceptions of Australia and Norway, who did not reduce interest rates in 2024 and are therefore defined as still being in their post-pandemic tightening phase).

[58] We identify cycles for individual members of the Euro area based on their policy interest rates through end-1998, at which point their easing or tightening phase is defined as ending. Starting in 1999, the Euro area begins its first phase, and the individual member countries no longer have individual phases.

Appendix Figure 1a: Rate Cycles, Other Advanced Economies (non-euro area)

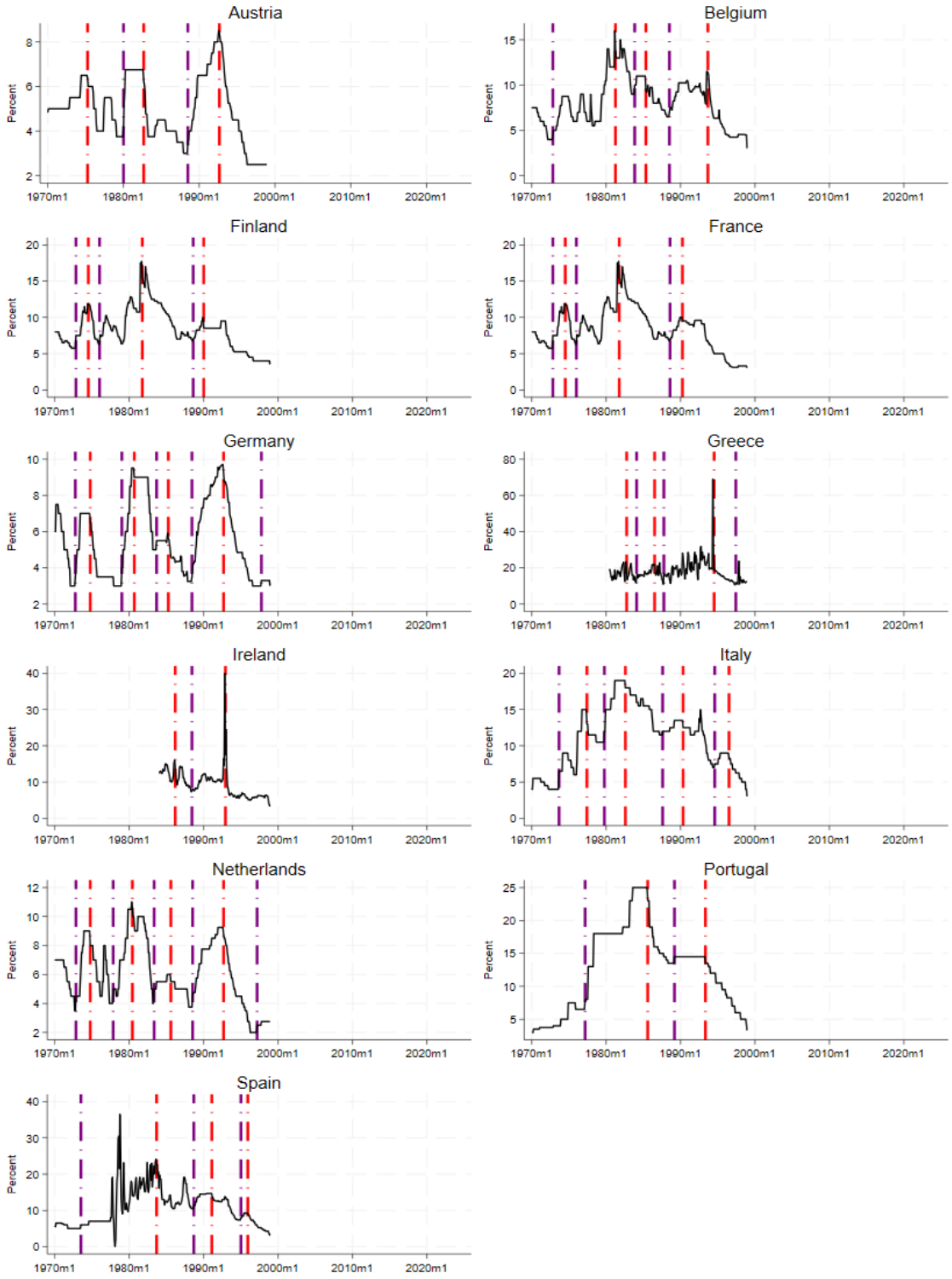


A

Sources: Authors' calculations based on the data and methodology identifying rate cycles described in Section II, with data from January 1970 through December 2024.

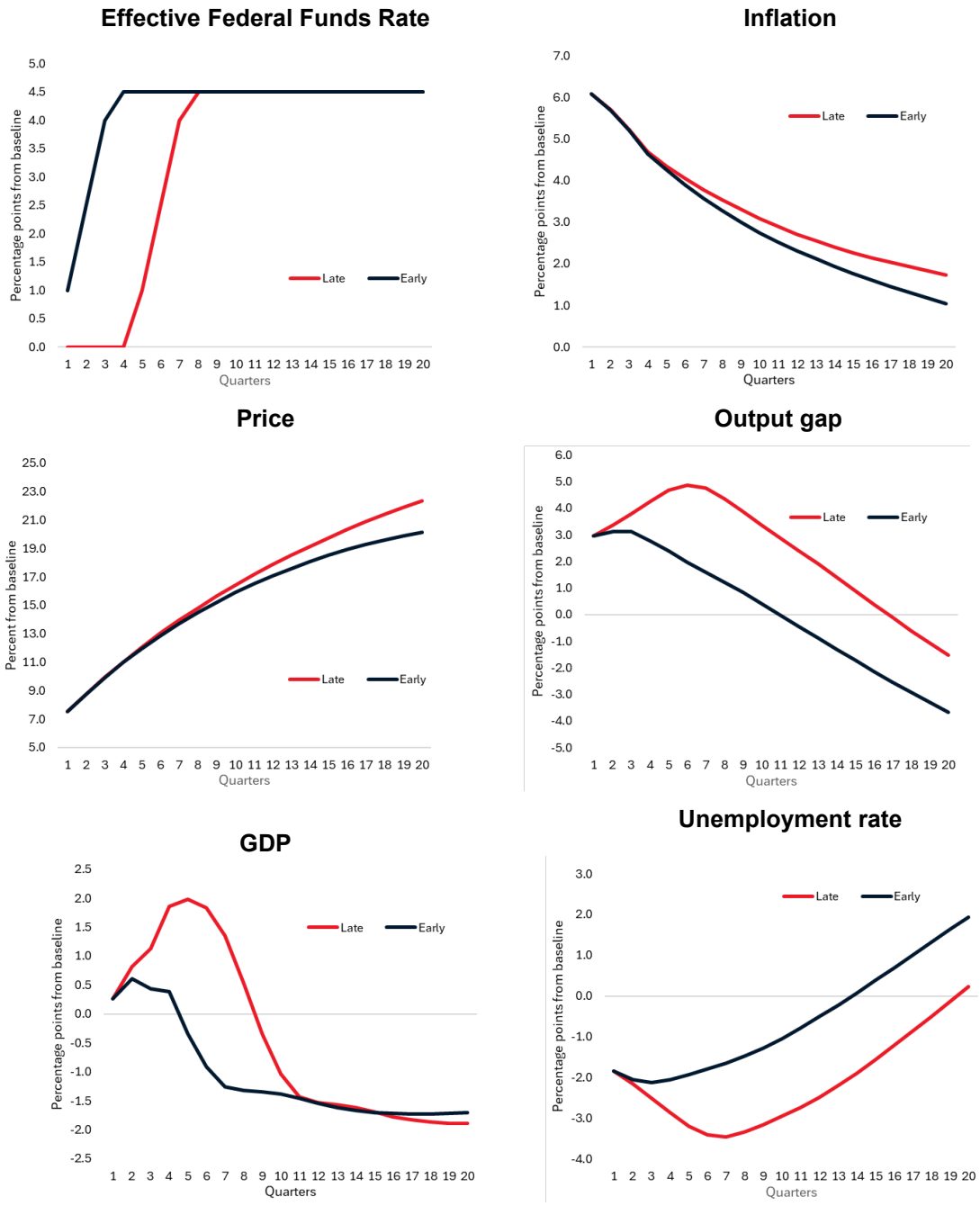
Notes: The solid black line is the policy interest rate. Dashed purple and red lines indicate the start of tightening and easing phases, respectively. Dashed blue and orange lines represent the announcement of new QT and QE programs, respectively, and only include the announcement of major new programs involving government bonds and aimed at providing monetary stimulus; we do not include announcements of changes to an ongoing QE/QT program or balance sheet programs aimed primarily at providing liquidity. These QE/QT dates are not turning points that denote the start of an easing or tightening phase unless there is also a red or purple line.

Appendix Figure 1b: Rate Cycles, euro area, pre-ECB



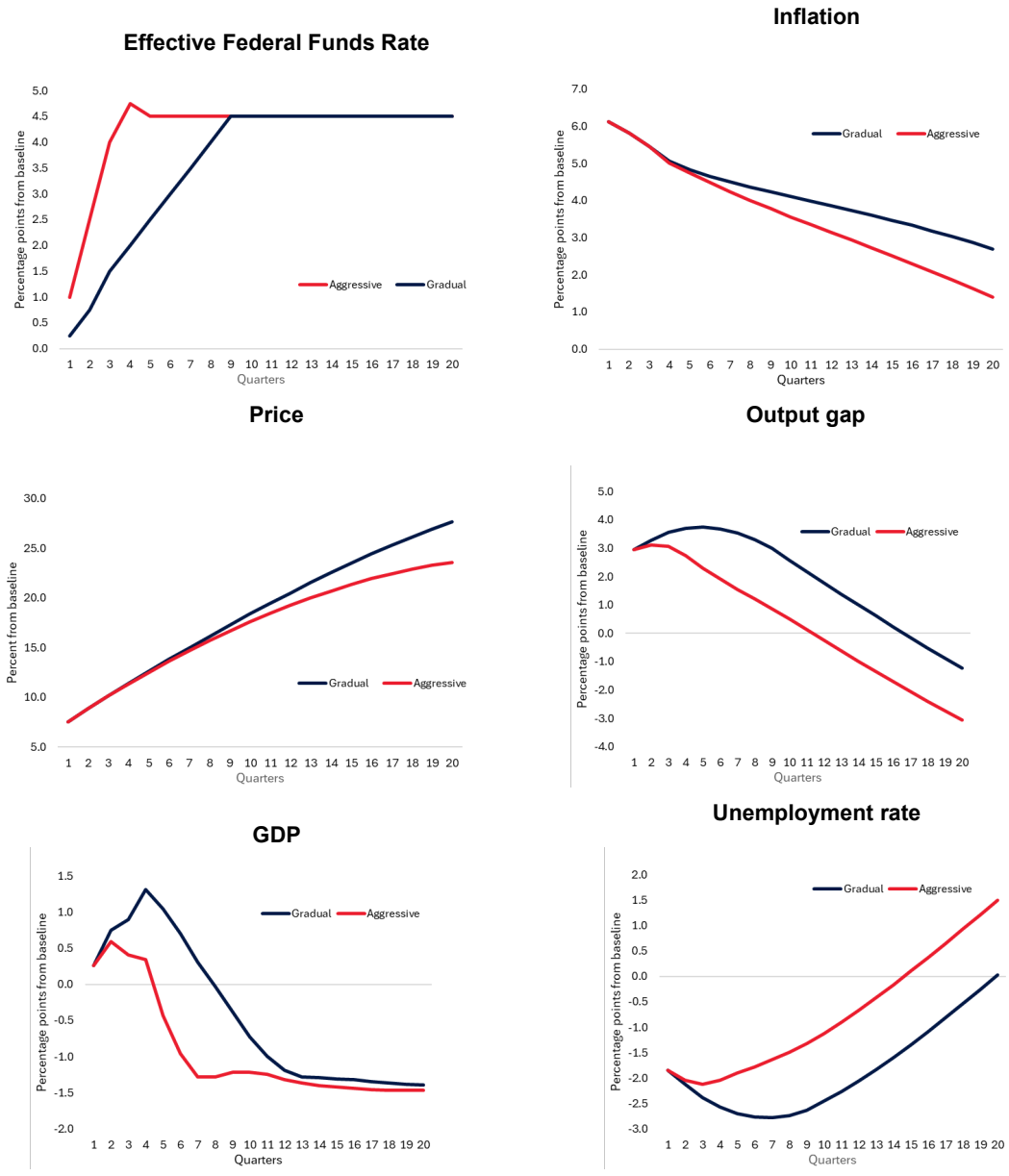
Sources: Authors' calculations based on the data and methodology identifying rate cycles described in Section II, with data from January 1970 through December 2024.
Notes: The solid black line is the policy interest rate. Dashed purple and red lines indicate the start of tightening and easing phases, respectively. There are no phases after 1998 when the ECB began setting the policy rate.

Appendix Figure 2a: FRB/US Simulations of Timing of First Rate Hike



Source: Authors' calculations based on the FRB/US model as explained in Brayton, Laubach, and Reifschneider (2014) and Laforte (2018). **Notes:** The estimates are simulated trajectory of US variables following a hypothetical monetary policy tightening that involves increasing the policy rate by 450 bps in total for both scenarios. In the "Late" scenario, this increase in rates begins 4 quarters later than in the "Early" scenario.

Appendix Figure 2b: FRB/US Simulations of Aggressiveness of Tightening Phase



Source: Authors' calculations based on the FRB/US model as explained in Brayton, Laubach, and Reifschneider (2014) and Laforte (2018). **Notes:** The estimates are simulated trajectory of US variables following a hypothetical monetary policy tightening that involves an increase in the policy rate of 450 bps by the end of the sample both scenarios. In the "Timid" or "Gradual" scenario, the policy rate is increased more gradually and there are no additional rate hikes after reaching 450bps, while in the "Aggressive" scenario rates are increase more rapidly to 475 bps before being reduced to 450bps.

Appendix Table 1: Characteristics of Rate Cycles: 1970-2024

	Duration (in months)		Amplitude (total change, pp)		Velocity (pp/first 6 months)		Rates "In Sync" with Phase # Changes		Rates "In Sync" with Phase Pace (pp)		Hold Duration (months)	
	Tightening	Easing	Tightening	Easing	Tightening	Easing	Tightening	Easing	Tightening	Easing	Tightening	Easing
Australia	70	81	8.9	-6.6	1.3	-2.0	29	15	0.6	-0.6	12.8	7.3
Austria	43	69	4.5	-4.3	1.8	-1.2	12	16	0.5	-0.3	26.1	23.3
Belgium	79	49	8.6	-7.0	1.2	-3.0	17	18	0.9	-0.5	12.3	2.8
Canada	41	55	4.6	-7.6	1.4	-2.5	11	25	0.4	-0.6	31.7	13.9
Denmark	31	114	4.7	-6.6	1.7	-3.1	8	19	0.9	-0.6	5.5	52.4
Euro area	27	138	2.9	-3.9	1.3	-2.3	9	12	0.3	-0.3	6.5	27.1
Finland	51	90	9.2	-8.2	1.4	-1.2	16	23	0.9	-0.5	0.0	0.0
France	51	88	9.0	-8.5	1.4	-0.7	15	30	0.9	-0.3	1.8	0.0
Germany	32	49	4.4	-4.7	1.3	-1.3	11	13	0.5	-0.5	12.0	10.1
Greece	60	26	12.9	-14.3	6.2	-6.5	28	19	3.4	-1.6	0.5	0.0
Ireland	54	61	32.7	-29.2	0.8	-25.1	28	30	1.5	-1.3	0.0	0.0
Israel	24	87	5.0	-6.3	1.7	-1.4	10	20	0.6	-0.4	5.0	4.7
Italy	36	47	6.6	-6.4	2.2	-1.5	4	10	1.7	-0.9	13.1	8.2
Japan	24	154	3.3	-4.1	1.4	-1.2	4	8	0.7	-0.4	14.6	19.3
Korea	35	77	2.5	-2.7	0.6	-0.9	9	10	0.3	-0.3	15.0	19.6
New Zealand	71	128	8.3	-10.9	1.6	8.4	31	30	0.8	-1.1	10.7	4.4
Netherlands	34	42	4.5	-5.6	1.1	-1.4	7	13	0.7	-0.6	9.9	6.9
Norway	32	100	3.5	-6.5	0.6	-1.3	11	17	0.4	-0.6	7.6	12.8
Portugal	84	58	12.7	-11.3	4.7	-3.2	4	11	2.4	-1.1	40.7	7.4
Spain	98	50	15.3	-9.7	1.4	-2.9	34	21	2.4	-0.8	6.4	2.3
Sweden	42	63	3.4	-4.6	1.1	-1.7	11	13	1.0	-0.4	8.8	12.0
Switzerland	38	106	3.3	-4.2	1.3	-1.7	6	8	0.6	-0.5	10.9	61.3
UK	42	102	6.2	-6.5	2.0	-1.8	10	14	0.9	-0.6	8.3	3.3
US	34	56	6.7	-5.7	1.1	-2.6	16	12	0.5	-0.6	9.6	11.1
Full Sample (Jan 1970 - Dec 2024)												
Mean	***47***	***79***	***7.7***	***-7.7***	***1.7***	***-2.6***	***14***	***17***	***1.0***	***-0.6***	***11.2***	***12.9***
Median	***42***	***73***	***5.6***	***-6.5***	***1.4***	***-1.7***	***11***	***15***	***0.7***	***-0.6***	***9.7***	***7.8***
St. Dev.	***20***	***33***	***6.3***	***5.3***	***1.2***	***5.4***	***9***	***7***	***0.8***	***0.3***	***9.7***	***15.5***
Min	***24***	***26***	***2.5***	***-2.7***	***0.6***	***8.4***	***4***	***8***	***0.3***	***-0.3***	***0.0***	***61.3***
Max	***98***	***154***	***32.7***	***-29.2***	***6.2***	***-25.1***	***34***	***30***	***3.4***	***-1.6***	***40.7***	***0.0***

Sources: Authors' calculations based on the rate cycles described in Sections II and III.
Notes: Duration is the length of the phase in months (including any period at the end of the phase when rates are on hold). Amplitude is the sum of rate changes in percentage points (pp) over the entire phase (including any rate changes in either direction). Velocity is the total change in the policy rate in pp over the first six months of the phase. Rates in-sync with phase is the mean number or mean size in pp of rate changes in "in-sync" with the phase, i.e., rate increases for a tightening phase and rate decreases for an easing phase. A holding period is the number of months after the last rate increase during a tightening phase, or after the last rate decrease and end of any government QE programs during an easing phase. Means are calculated as the average for each economy across all easing or tightening phases. EA is the euro area, with policy rate data starting in January 1999. Individual members of the euro area only include policy rate data through December 1998. Otherwise, policy rate data covers a period from January 1970 through December 2024, with a later start for some economies due to data limitations.

Appendix Table 2: Characteristics of Rate Cycles over Time

	Duration		Number of Rate Changes		Pace (pp/change)		Velocity (first 6 months)		Amplitude (in pp)		Hold Duration (in months)	
	Tightening	Easing	Tightening	Easing	Tightening	Easing	Tightening	Easing	Tightening	Easing	Tightening	Easing
Full Period	41.5	72.6	11.2	15.5	0.7	-0.6	1.4	-1.7	5.6	-6.5	9.7	7.8
Pre-ECB: 1970-98	41.4	60.6	13.0	16.1	0.9	-0.6	1.4	-2.5	7.7	-8.2	6.4	7.4
Post-ECB: 1999-2024	35.7	105.3	8.8	10.9	0.3	-0.3	1.0	-1.2	3.1	-3.9	9.7	13.1
1970-1984	40.3	46.9	9.8	10.6	1.0	-0.8	2.0	-2.0	10.3	-6.5	6.1	3.5
1985-1998	39.7	60.6	10.9	20.0	0.7	-0.5	1.5	-1.6	4.5	-8.2	3.2	5.1
1999-2007	37.0	55.0	10.0	12.0	0.3	-0.4	0.8	-1.3	2.6	-4.0	5.9	6.5
2008-2019	34.5	112.8	8.6	10.7	0.3	-0.4	0.6	-1.1	2.2	-3.5	8.1	14.5
2020-2024	28.7	126.0	10.0	11.0	0.4	-0.3	1.7	-0.8	4.5	-3.2	11.0	3.0
Change or percent change from 1970-84 period to 2008-19 period												
Change	***-5.8***	***65.9***	***-1.2***	***0.0***	***-0.8***	***0.4***	***-1.4***	***0.9***	***-8.1***	***3.0***	***1.9***	***11.0***
% Change	***-14%***	***140%***	***-13%***	***0%***	***-75%***	***-53%***	***-71%***	***-46%***	***-79%***	***-46%***	***32%***	***319%***

Sources: Authors' calculations using the turning points for rate cycles listed in Appendix Table 1 and data ending in December 2024.
Notes: This table shows medians across all tightening or easing phases within the given time period, The number and pace of rate adjustments only include "in-sync" rate adjustments. Velocity and amplitude are the total change in rates (in any direction) over the first six months of the phase or entire phase, respectively. A holding period is the number of months after the last rate increase during a tightening phase, or after the last rate decrease and end of any government QE programs during an easing phase. Averages are calculated for each economy, and then medians over the sample as a whole. Members of the euro area are included as individual countries through 1998, and then the ECB cycle is included from 1999. Any new phases which start in 2024 are not included in the statistics.

Appendix Table 3: Data Appendix

A. Variables Measuring Cycle Characteristics

Variable	Variable Description (unit)	Source
Policy rate	Nominal monetary policy interest rates by central banks (in %).	BIS, Haver Analytics, OECD
Shadow rate	Shadow policy rate point estimates (in %) as explained in Krippner (2013). Data are available for seven economies (Australia, Canada, euro area, Japan, New Zealand, United Kingdom, United States) over 1995-2024.	LJK Limited; Krippner (2013)
Headline CPI	Headline Consumer Price Index for all economies except the United States, which is based on the Headline Personal Consumption Expenditures (PCE) index. Inflation rates are calculated using monthly data as the % change in the price index relative to 12-months earlier.	OECD, Haver Analytics, Ha, Kose, Ohnsorge (2023)
Core CPI	Core Consumer Price Index, following OECD classification: Headline CPI excluding food and energy components for all economies except the United States, which is based on the core PCE index. Inflation rates are calculated using monthly data as the % change in the price index relative to 12-months earlier.	OECD, Ha, Kose, Ohnsorge (2023), Haver Analytics
Output	Real gross domestic product index based on chain-linked volume (in local currencies). The reference year is 2015.	OECD, Haver Analytics
Output gap	% deviation of real GDP from trend (potential) GDP. For our baseline measure, we use the output gap based on HP-filter. In other specifications, we also use alternative methods of calculating the output gap, including using a trend based on the Baxter-King filter and Hamilton filter, or OECD estimations of the output gap based on production function approach. We also calculate the employment gap using the long-term trends (OECD) and unemployment gap based on HP-filter.	OECD, Haver Analytics
Industrial Production	The industrial production index covers the volume of production in sectors such as mining, manufacturing, electricity, gas, steam, and air conditioning. The reference year is 2015 (OECD) unless specified otherwise. Growth rates of production are calculated on a month-over-month basis.	OECD, Haver Analytics
Unemployment rate	Unemployment rate (in %): unemployment/labour market participation	OECD
Employment	Number of persons employed with age 15 and over (in thousands)	OECD, IFS, ILO, FRED
Oil price	Nominal oil prices (average of Dubai, WTI, and Brent oil prices).	World Bank (Pink sheet database)

Notes: Sample period is from January 1970 through December 2024, albeit some data for the end of the sample period was not available when the data was collected (February 4, 2025). Economies included are: Australia, Austria, Belgium, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, the United Kingdom, Greece, Ireland, Israel, Italy, Japan, Korea, Netherlands, Norway, New Zealand, Portugal, Sweden, the United States, and the euro area.

B. Variables Used in Baseline Regression Analysis

Category	Indicator	Source	Variable Description
Tradeoffs (dependent variables)	Sacrifice Ratio (SR)	Authors' calculations	The negative of the ratio of ANOG to Inflation Reduction, with both components defined below, over the tightening window (the tightening phase plus a lag of 12 months).
	Accumulated Negative Output Gap (ANOG)	Authors' calculations	Sum of negative output gaps over the tightening window. Output gaps are % deviations of real GDP from trend (potential) GDP. For our baseline measure, we use the output gap based on HP-filter. In sensitivity tests we use the other measures of the output gap listed in Appendix Table 3A.
	Inflation Reduction (IR)	Authors' calculations	Reduction in headline inflation from peak to subsequent trough during the tightening window. For our baseline measure we use headline CPI inflation (or PCE inflation for the US), and in sensitivity tests we test core CPI inflation.
	Price Level Change (PLC)	Authors' calculations	The increase in the headline price index from 12 months before the start of the tightening phase through 12 months afterwards in excess of the increase in the price level that would have occurred if inflation stayed at 2%. In sensitivity tests we also test the price changes in core price index.
	Price-Output Tradeoff Ratio (PTR)	Authors' calculations	The ratio of the Excess Price Level Change to ANOG, with both components defined above, over the tightening window.
Central Bank Strategy	Delayed Start	Authors' calculations	A principal component calculated such that a higher value indicates a later "liftoff" (first rate hike during a tightening phase) relative to underlying macroeconomic conditions. The four macro variables used to in calculating the principal component are: headline inflation, core inflation, the output gap (based on the HP filter) and unemployment gap, all defined in Appendix Table 3A.
	Aggressiveness	Authors' calculations	A principal component calculated such that a higher value indicates a more aggressive path for interest rates during a tightening phase. The variables used to calculate the principal component are: (1) the number of rate hikes; (2) the pace of rate hikes (i.e., average size); (3) the amplitude of rate hikes (i.e., total increase); (4) the initial velocity of rate hikes (over the first six months); and (5) the largest rate hike divided by the average rate hike (to capture the use of "supersized" hikes). See Section III for more details on the calculations of each of these variables.
Country Characteristics	Central Bank Credibility	Authors' calculations	A principal component of 5 measures of central bank credibility, with a higher value indicating greater credibility. The 5 measures are: three central bank transparency indices, one from Dincer and Eichenbaum (2014) and two from Garriga (2025); a measure of central bank turnover from Dreher, Sturm, de Haan (2010) and a central bank independence index from Romelli (2024). The first measure is not available for individual euro area countries, so we calculate the principal component without these measures through 1999 and then use the value for the ECB from 1999.
	Labor Market Flexibility	Authors' calculations	A principal component of 2 measures of labor market flexibility, with a higher value indicating more flexibility. The 2 variables are: (1) An index of labor market flexibility from the Fraser Institute Economic Freedom and (2) a measure of the degree of regulation on hiring and firing practices from the OECD.
Shocks	Oil Price Shocks	Authors' calculations	The variance contribution of oil price shocks to the total variation in inflation as estimated in a factor-augmented VAR with 7 global and domestic shocks, as explained in Forbes, Ha, and Kose (2024).

C. Variables Used in Sensitivity Tests for Regression Analysis

Category	Indicator	Source	Variable Description
Country Characteristics	Initial inflation rate	OECD, Haver Analytics, Ha, Kose, Ohnsorge (2023)	Headline CPI (or PCE for the US) inflation rate one month before the start of the tightening phase.
	Exchange rate flexibility	Authors' calculations	A principal component of two measures indicating the flexibility of a country's exchange rate, with higher values indicating more flexibility. The two variables are: (1) A classification of the country's de jure regime from Ilzetzki, Reinhart, and Rogoff (2019); and (2) a classification of the country's de facto regime from Shambaugh (2019).
	Financial openness	Authors' calculations	A principal component of three measures of capital account openness, with a higher value indicating more openness. The three variables are: (1) a country's degree of capital openness from Chinn and Ito (2006); the ratio of international assets and liabilities to GDP from Lane and Milesi-Ferretti (2007); and (3) a country's degree of capital account openness from Quinn and Toyoda (2008).
	Trade openness	Authors' calculations	A principal component of three measures of trade openness, with a higher value indicating more openness. The three variables are: (1) trade to GDP from Ha, Kose and Ohnsorge (2019); (2) imports to GDP from the World Bank; (3) the average rate of effectively applied tariffs weighted by import shares for each partner from WITS.
Shocks	Global shocks	Authors' calculations	The total variance contribution of global shocks (including global demand, global supply, oil prices, and global monetary policy shocks) to the variation in inflation as estimated in a FAVAR model in Forbes, Ha and Kose (2024).
	Supply shocks	Authors' calculations	The total variance contribution of all supply shocks (including global supply, oil prices, and domestic supply shocks) to the variation in inflation as estimated in a FAVAR model in Forbes, Ha and Kose (2024).
	Demand shocks	Authors' calculations	The total variance contribution of all demand shocks (including global demand and domestic demand) to the variation in inflation as estimated in a FAVAR model in Forbes, Ha and Kose (2024).

Appendix Table 4
Sacrifice Ratios and Tradeoffs during the Post-Pandemic Tightening Phase: By Economy

	ANOG (% of GDP)	Inflation Reduction		Sacrifice Ratio		Excess Δ in Price Level		Price-Output Tradeoff
		Headline	Core	Headline	Core	Headline	Core	
Australia	-0.4	5.0	3.3	0.1	0.1	4.5	4.3	24.4
Austria	-1.0	9.4	6.1	0.1	0.2	5.9	5.1	14.6
Belgium	-0.3	11.9	4.5	0.0	0.1	4.6	3.9	39.5
Canada	-0.1	6.5	3.7	0.0	0.0	2.7	2.3	63.0
Denmark	-0.6	10.0	4.9	0.1	0.1	2.2	1.1	8.8
Euro area	-0.3	8.9	3.0	0.0	0.1	4.4	2.5	39.4
Finland	-1.2	8.4	6.1	0.1	0.2	3.5	3.1	7.6
France		5.2	2.3			2.3	0.7	
Germany	-0.4	7.2	3.4	0.0	0.1	4.0	2.5	28.1
Greece	0.0	10.5	3.9	0.0	0.0	4.8	3.5	581.9
Ireland	-5.9	8.5	4.7	0.7	1.3	4.8	3.5	2.0
Israel	-2.5	2.9	3.5	0.9	0.7	2.3	1.9	2.5
Italy	-0.2	11.2	3.3	0.0	0.1	3.4	1.0	35.4
Netherlands	-0.9	14.9	4.0	0.1	0.2	5.2	3.4	14.8
New Zealand	-1.0	5.1	3.6	0.2	0.3	4.2	3.9	13.3
Norway	-0.9	5.3	3.7	0.2	0.2	3.2	2.0	12.5
Portugal	-0.1	8.7	5.3	0.0	0.0	3.9	3.2	114.1
South Korea	-0.4	5.1	2.4	0.1	0.2	1.7	0.7	13.3
Spain		9.3	2.8			4.1	2.5	
Sweden	-0.9	11.5	10.1	0.1	0.1	5.2	5.1	16.0
Switzerland	-0.4	2.8	1.3	0.2	0.3	-0.2	-1.1	-1.3
UK	-0.2	9.3	4.0	0.0	0.0	5.2	3.9	88.6
US	0.0	5.1	3.0	0.0	0.0	3.1	2.9	228.4
Median	***-0.4***	***8.5***	***3.7***	***0.1***	***0.1***	***4.0***	***2.9***	***16.0***
Mean	***-0.8***	***7.9***	***4.0***	***0.1***	***0.2***	***3.7***	***2.7***	***64.1***
St. Dev	***1.3***	***3.1***	***1.7***	***0.2***	***0.3***	***1.4***	***1.5***	***129.7***
Min	***-5.9***	***2.8***	***1.3***	***0.0***	***0.0***	***-0.2***	***-1.1***	***-1.3***
Max	***0.0***	***14.9***	***10.1***	***0.9***	***1.3***	***5.9***	***5.1***	***581.9***

Notes: The window to calculate each statistic is the economy's post-pandemic tightening phase plus a lag of 12 months though end-2024 if data is available (and a lead of 12 months for price-level indices). ANOG is the accumulated negative output gap based on monthly output gap calculated using the HP filter. Inflation reduction is the peak to trough decline based on the monthly CPI headline or core index for all economies except the United States (which is based on the PCE indices). The Sacrifice Ratio is the absolute value of the ANOG relative to Inflation Reduction. The Excess Δ in the Price Level is the increase in the price level over 2%, annualized. The Price-Output Tradeoff is the ratio of the Excess Δ in the Price Level (not annualized) relative to ANOG. There are no statistics for Japan as its post-pandemic tightening phase only began in March 2024. Ratios based on Inflation Reduction are not calculated if inflation is not falling from its peak at the end of the tightening window.

Appendix Table 5: Explaining Tradeoffs: Sensitivity Tests

	Sacrifice Ratio (ANOG/IR)								
	Additional controls						Other measures of output gap		
	Baseline	Inflation at t= -1	Trade openness	Financial open & ER	+ period dummies	+ country + period dummies	Baxter-King filter	OECD measure	Unemp. gap
Delayed Start	-0.0482	-0.0125	-0.0486	-0.0439	-0.0657	-0.0734	-0.0211**	-0.0878	-0.0202**
	(0.0357)	(0.0773)	(0.0348)	(0.0287)	(0.0568)	(0.0365)	(0.00587)	(0.0534)	(0.00524)
Aggressiveness	0.00501	0.0114	0.00619	0.0312	0.0306	0.0537	0.00838	0.0658	0.0110
	(0.0256)	(0.0243)	(0.0276)	(0.0394)	(0.0236)	(0.0370)	(0.00502)	(0.0427)	(0.00603)
Central Bank Credibility	-0.132**	-0.136**	-0.134**	-0.191***	-0.184**	-0.267*	-0.0348**	-0.255*	-0.0161*
	(0.0394)	(0.0325)	(0.0302)	(0.0349)	(0.0624)	(0.0985)	(0.00906)	(0.119)	(0.00602)
Labor Market Flexiblity	-0.0273	-0.0250	-0.0293	-0.0648*	-0.0571*	-0.0938*	0.00147	0.0871	-0.0124
	(0.0261)	(0.0237)	(0.0305)	(0.0263)	(0.0216)	(0.0400)	(0.0132)	(0.0682)	(0.00790)
Oil Shocks	0.00183	0.00204	0.00187	0.00331	0.00249	-0.00570	0.000970	0.0239***	0.000396
	(0.00719)	(0.00738)	(0.00725)	(0.00783)	(0.00828)	(0.00916)	(0.00171)	(0.00333)	(0.00195)
Additional Controls		-0.0207	0.00428	0.101					
		(0.0274)	(0.0156)	(0.0549)					
				-0.00584					
				(0.0343)					
Observations	***88***	***88***	***88***	***88***	***88***	***88***	***96***	***87***	***89***
R-squared	***0.216***	***0.220***	***0.216***	***0.240***	***0.236***	***0.433***	***0.214***	***0.135***	***0.192***

	Accumulated Negative Output Gap (ANOG)								
	Additional controls						Other measures of output gap		
	Baseline	Inflation at t= -1	Trade openness	Financial open & ER	+ period dummies	+ country + period dummies	Baxter-King filter	OECD measure	Unemp. gap
Delayed Start	-0.186*	-0.544**	-0.193*	-0.192*	-0.261*	-0.273	-0.00806	-0.804*	-0.0118
	(0.0852)	(0.181)	(0.0855)	(0.0874)	(0.120)	(0.224)	(0.0300)	(0.333)	(0.0319)
Aggressiveness	-0.371**	-0.439***	-0.349**	-0.316***	-0.467***	-0.453**	-0.147**	-0.686**	-0.103***
	(0.0999)	(0.0693)	(0.104)	(0.0628)	(0.0786)	(0.145)	(0.0488)	(0.243)	(0.0222)
Central Bank Credibility	0.226*	0.262*	0.180	0.215	0.318*	0.328	0.0415	0.594	0.0285
	(0.0946)	(0.0963)	(0.125)	(0.143)	(0.115)	(0.173)	(0.0312)	(0.364)	(0.0325)
Labor Market Flexiblity	0.121	0.102	0.0854	0.106	0.119	0.0631	0.0145	0.0293	0.0122
	(0.0993)	(0.0671)	(0.131)	(0.134)	(0.0943)	(0.0682)	(0.0395)	(0.276)	(0.0175)
Oil Shocks	-0.00514	-0.00863	-0.00502	2.83e-05	0.00106	-0.00400	0.000530	-0.0436	-0.000863
	(0.0254)	(0.0256)	(0.0249)	(0.0215)	(0.0269)	(0.0310)	(0.00494)	(0.0275)	(0.00332)
Additional Controls		0.212*	0.0780	0.0704					
		(0.0795)	(0.130)	(0.147)					
				0.180					
				(0.179)					
Observations	***108***	***108***	***108***	***108***	***108***	***108***	***117***	***101***	***108***
R-squared	***0.325***	***0.367***	***0.327***	***0.340***	***0.370***	***0.524***	***0.342***	***0.355***	***0.281***

Appendix Table 5 (cont.): Explaining Tradeoffs: Sensitivity Tests

	Inflation Reduction (IR)						
		Additional controls					
	Baseline	Inflation at t= -1	Trade openness	Financial open & ER	+ period dummies	+ country + period dummies	Core Inflation
Delayed Start	1.476***	0.404	1.466***	1.479***	1.254**	1.197***	1.358**
	(0.147)	(0.239)	(0.170)	(0.168)	(0.298)	(0.250)	(0.445)
Aggressiveness	0.581**	0.406*	0.618**	0.490	0.646**	0.825*	0.783**
	(0.160)	(0.153)	(0.202)	(0.237)	(0.187)	(0.310)	(0.275)
Central Bank Credibility	0.0697	0.235	-0.0830	0.135	-0.173	0.0467	-0.233
	(0.186)	(0.215)	(0.130)	(0.314)	(0.0954)	(0.234)	(0.247)
Labor Market Flexiblity	0.532	0.556**	0.420	0.582	0.249	0.337	-0.278
	(0.322)	(0.183)	(0.412)	(0.323)	(0.530)	(0.549)	(0.140)
Oil Shocks	-0.0458	-0.0562*	-0.0456	-0.0584	-0.0602	-0.0374	-0.0295
	(0.0288)	(0.0263)	(0.0249)	(0.0396)	(0.0408)	(0.0360)	(0.0511)
Additional Controls		0.530***	0.239	-0.256			
		(0.0996)	(0.340)	(0.367)			
				-0.510**			
				(0.151)			
Observations	***135***	***135***	***135***	***135***	***135***	***135***	***135***
R-squared	***0.563***	***0.627***	***0.564***	***0.582***	***0.592***	***0.662***	***0.459***

	Excess Price Level Change (EPLC)						
		Additional controls					
	Baseline	Inflation at t= -1	Trade openness	Financial open & ER	+ period dummies	+ country + period dummies	Core inflation
Delayed Start	2.492**	-1.861***	2.555**	2.331**	2.679**	2.162**	2.462**
	(0.839)	(0.303)	(0.812)	(0.730)	(0.881)	(0.652)	(0.821)
Aggressiveness	1.398	0.686	1.166	1.066	1.240	1.356	1.260
	(1.024)	(0.610)	(0.940)	(0.996)	(0.979)	(1.165)	(0.899)
Central Bank Credibility	-1.128	-0.457	-0.153	0.174	0.141	0.287	-1.338
	(0.882)	(0.285)	(0.400)	(0.405)	(0.710)	(0.469)	(0.873)
Labor Market Flexiblity	-0.956	-0.858	-0.240	-0.127	-0.0210	-0.120	-1.065
	(0.466)	(0.457)	(0.476)	(0.435)	(0.297)	(0.559)	(0.508)
Oil Shocks	0.0937	0.0513	0.0923*	0.0719	0.0133	0.0594	0.0780
	(0.0462)	(0.0421)	(0.0413)	(0.0358)	(0.0377)	(0.101)	(0.0475)
Additional Controls		2.155***	-1.527*	-2.113***			
		(0.207)	(0.606)	(0.397)			
				0.0470			
				(0.337)			
Observations	***135***	***135***	***135***	***135***	***135***	***135***	***135***
R-squared	***0.569***	***0.851***	***0.589***	***0.611***	***0.656***	***0.721***	***0.607***

Notes: Results from estimates of equation (3) of the *Tradeoff* variables on central bank strategies, country characteristics and shocks over tightening phases from 1970-2024 for a sample of 23 advanced economies (including individual countries in the euro area, but not the euro area as a single entity. All variables are defined in Appendix Table 3. "Financial open & ER" indicates two additional control variables for *Financial openness* and *Exchange Rate flexibility*. Regressions include a constant (not reported) and robust errors clustered by country and time period (for the five long windows defined in Section III).