Central Banking Post Crises

by

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Abstract

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1 Introduction

Central banks are experiencing the apocryphal curse that they are living through interesting times.[1] In the last twenty years, they have faced the global financial crisis of 2007-2009, the Covid pandemic of 2020, and a surge in inflation in 2022-2023. This chapter examines the challenges that central banks face in the wake of these crises. Here we focus on how central bank governance, monetary policy and financial stability policy at central banks has evolved in recent years. We start by discussing the core economics of central banking, and then discuss how this analysis impacts the tools and design of monetary policy. Then we discuss challenges created by the low interest rates in the aftermath of the global financial crisis and the Covid pandemic, and the inflation surge in 2021-22. Finally, we conclude with a summary of the lessons we have learned for central bank strategies and tactics.

2 The Core Economics of Central Banking

Over the last six decades, economists have derived from theory and empirical evidence a core of economic analysis that guides central bank policy. We discuss this economic analysis, which is often referred to as the "science of central banking" (Clarida, Gali and Gertler, 1999) by discussing the following core economic principles:

- Price stability has important benefits and is primarily the responsibility of a central bank.

- There is no long-run tradeoff between unemployment and inflation, but a short-run tradeoff exists.

- Expectations play a crucial role in the macro economy and the role of expectations can create time-inconsistency problems that impair achievement of price stability.

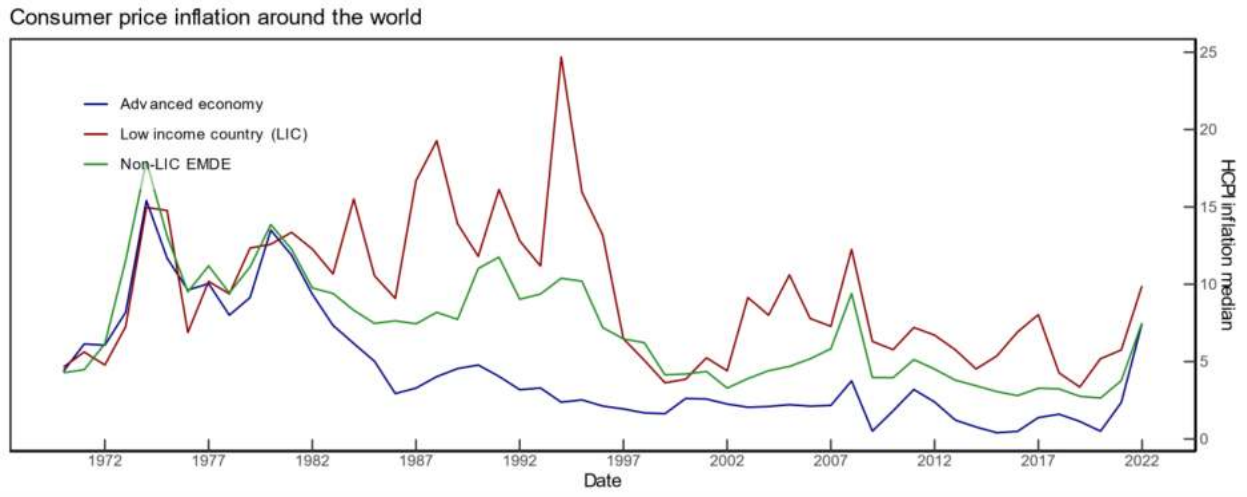
[1] The curse, "May you live in interesting times" has often been attributed to ancient China, but this is incorrect.

- Central bank independence promotes price stability and economic performance, in part by addressing time-inconsistency challenges.

- A transparent policy framework for monetary policy can constrain discretionary behavior and alleviate some of the time-inconsistency problems. Such constrained discretion may be informed by instrument rules, but is a better approach for the conduct of monetary policy than strict adherence to rules.

2.1 Price Stability has Important Benefits and is the Responsibility of a Central Bank

The science of monetary policy has coalesced around a set of core principles since around the time of the Volcker disinflation in the United States and especially over the late 1980s through the early 2000s. The history of inflation over the past 50 years, from 1970 to 2022, sets the stage for this evolution. Figure x presents the median level of inflation across advanced economies, low-income emerging market and developing economies (LIC-EMDEs) and non-LIC EMDEs over this period from Ha, Kose, and Ohnsorge (2021). The median level of inflation across all countries was in the neighborhood of 10 percent in the 1970s. In advanced economies, inflation fell below 5 percent by the mid-1980s. In non-LIC countries, the median level of inflation remained near 10 percent through the mid-1990s and then settled near 5 percent. In LIC countries, the median level of inflation rose above 10 percent through the 1980s and fell below 10 percent by the 2000s.



With the rise of inflation in the 1960s and 1970s, economists, and also the public and politicians, began to discuss the high costs of inflation (for example, see the surveys in Fischer, 1993; Anderson and Gruen, 1995; and Kiley, Mauskopf, and Wilcox, 2007). High inflation undermines the role of money as a medium of exchange by acting as a tax on cash holdings. On top of this, a high-inflation environment leads to overinvestment in the financial sector, which expands to help individuals and businesses escape some of the costs of inflation (English, 1996). The interaction of the tax system and inflation also increases distortions that adversely affect economic activity (Feldstein, 1997). Unanticipated inflation causes redistributions of wealth that harm some households or sectors and benefit others, potentially causing economic or political spillovers (for example, Doepke and Schneider, 2006a and 2006 b).

Inflation also leads to uncertainty about relative prices and the future price level, making it harder for firms and individuals to make appropriate decisions, thereby decreasing economic efficiency (e.g., Lucas, 1972, Briault, 1995). Economists have observed a correlation between the *level* and the *volatility* of inflation, with the latter serving as a proxy for uncertainty (for example, Okun, 1971; Taylor, 1981; Kiley, 2007; and Cecchetti et al, 2023). Theoretical analysis shows that increases in trend inflation lead to greater volatility in standard macro models (see Kiley, 2007; and Coibion et. al., 2012). To the extent that high inflation tends to be associated with volatile inflation, these distortions may boost the costs of borrowing. In addition, nominal rigidities and staggered wage and price setting imply that inflation creates dispersion in relative prices which is inefficient, lowering activity and harming welfare; while

this channel is central in New-Keynesian models (for example, Woodford, 2003), empirical analysis does not clearly suggest this channel is large (for example, Nakamura et al, 2018).

Finally, there are behavioral cost associated with high inflation. Former Federal Reserve Chair Alan Greenspan famously provided a "rational inattention" definition of price stability describing it as the "state in which expected changes in the general price level do not effectively alter business or household decisions."[2] Some households undoubtedly do not fully understand the implications of a general trend in prices—that is, they may suffer from nominal illusion—making financial planning more difficult. In addition, both theory and evidence suggest that as inflation rises above the Greenspan definition, people will respond with increased sensitivity (Bracha and Tang, 2022; and Korenok, Munro, and Chen, 2022). This is consistent with survey evidence showing that the public strongly dislikes inflation (for example, Shiller, 1997).

The total effect of these distortions became more fully appreciated over the course of the 1970s, and the recognition of the high costs of inflation led to the view that low and stable inflation can increase the level of resources productively employed in the economy.[3] The deleterious effects of inflation on economic efficiency implies that the level of sustainable employment is probably lower at higher rates of inflation. Thus, the goals of price stability and high employment are likely to be complementary, rather than competing, over the medium and long run.

At the same time, the high level of inflation in the 1970s led economists and policymakers to examine the policies most appropriate for controlling inflation. In the 1970s, the role of supply factors in driving up inflation and uncertainty about the relationship between inflation and economic activity contributed to a sense, in some analyses, that inflation was not a monetary problem. As a result, alternative approaches, such as price or wage controls, were considered. For example, the Nixon Administration imposed price controls in the early 1970s. These efforts temporarily lowered inflation, but inflation returned after their removal. Tobin (1980) argued that lowering inflation through monetary policy would be excessively costly and that wage and

[2] See page 53 of Federal Open Market Committee (1996).
[3] A further possibility is that low inflation may even help increase the rate of economic growth. While time-series studies of individual countries and cross-national comparisons of growth rates are not in total agreement (Anderson and Gruen, 1995), the consensus is that inflation is detrimental to economic growth, particularly when inflation rates are high.

price controls were an appropriate tool. Wage and price controls were prevalent in the approach to inflation control among emerging market economies through the 1980s (Kiguel and Livatan, 1992). However, over time, a consensus emerged that monetary policy was the key factor in inflation over medium-term horizons. Among other factors, the rapidity of the Volcker disinflation in the early 1980s, a growing appreciation for the role of expectations (discussed below), and additional cross-country evidence which supports a nominal-anchor-cemented monetary policy as the key medium-term factor in inflation and thereby emphasized that inflation control is primarily the responsibility of a central bank.

2.2 No Long-Run Tradeoff Between Unemployment and Inflation

A influential paper published in 1960 by Paul Samuelson and Robert Solow (1960) argued that work by A.W. Phillips (1958), which became known as the Phillips curve, suggested that there was a long-run tradeoff between unemployment and inflation and that this tradeoff could be exploited. Under this view, the policymaker would have to choose between two competing goals--inflation and unemployment--and decide how high an inflation rate he or she would be willing to accept to attain a lower unemployment rate.

The tradeoff suggested by Samuelson and Solow was hotly contested by Milton Friedman (1968) and Edmund Phelps (1968), who independently argued that there was no long-run tradeoff between unemployment and the inflation rate: Rather, the economy would gravitate to a natural rate of unemployment in the long run no matter what the rate of inflation was. In other words, the long-run Phillips curve would be vertical, and attempts to lower unemployment below the natural rate would result only in higher inflation. The Friedman-Phelps natural rate hypothesis was immediately influential and was quickly incorporated in formal econometric models.

The benefits of price stability suggest a long-run tradeoff--but not of the Phillips curve type: low inflation likely contributes to improved efficiency and higher employment in the long run.

2.3 Importance of Expectations and the Time-Inconsistency Problem

2.3.1 Expectations are Important Determinants of Inflation and Economic Activity

A key aspect of the Friedman-Phelps natural rate hypothesis was that sustained inflation may initially confuse firms and households, but in the long run sustained inflation would not boost employment because *expectations* of inflation would adjust to any sustained rate of increase in prices. Starting in the early 1970s, the rational expectations revolution, launched in a series of papers by Robert Lucas (1972, 1973, and 1976), took this reasoning a step further and demonstrated that the public and the markets' expectations of policy actions have important effects on almost every sector of the economy.[4]

A fundamental insight of the rational expectations revolution is that expectations about future monetary policy have an important impact on the evolution of economic activity. As a result, the systematic component of policymakers' actions--i.e., the component that can be anticipated--plays a crucial role in the conduct of monetary policy.[5] Indeed, the management of expectations about future policy has become a central element of monetary theory, as emphasized in the synthesis of Michael Woodford (2003). And this insight has far-reaching implications, for example, regarding the types of systematic behaviour by policymakers that are likely to be conducive to macroeconomic stability and growth.

2.3.2 The Time Inconsistency Problem

The Friedman (1968) and Phelps (1968) modification of the traditional Phillips (1960) curve analysis demonstrated that there is no long run tradeoff between unemployment and inflation. However, there is a short-run tradeoff between unemployment and inflation that can lead to the time-inconsistency problem (Kydland and Prescott, 1977, Calvo, 1978, and Barro and Gordon, 1983). The time-inconsistency problem arises when monetary policy is conducted on a discretionary, day-by-day basis. In particular, policymakers may find it tempting to exploit a

[4] Note that although Muth (1961) introduced the idea of rational expectations more than ten years earlier, his work went largely unnoticed until resurrected by Lucas.

[5] Indeed, one implication of rational expectations in a world of flexible wages and prices was the policy ineffectiveness proposition, which indicated that if monetary policy was anticipated, it would have no real effect on output; only unanticipated monetary policy could have a significant impact. Although evidence for the policy ineffectiveness proposition turned out to be weak (Barro, 1977; Mishkin, 1982a,b, 1983), the rational expectation revolution's point that monetary policy's impact on the economy is substantially influenced by whether it is anticipated or not has become widely accepted.

short-run Phillips curve tradeoff between inflation and unemployment by seeking lower unemployment through a surprise inflation. Private agents, cognizant of this temptation, will adjust expectations to anticipate the expansionary policy, resulting only in higher inflation with no short-run increase in employment In other words, without a commitment mechanism, monetary policy makers are unable to manage expectations for low inflation because private agents will understand that low inflation is not *consistent* with the temptation of policymakers to engender a surprise inflation*;* that is, policy intentions to pursue low inflation can be *time-inconsistent* and so will soon be abandoned. The time-inconsistency problem of discretionary monetary policy can be a serious impediment to the achievement of price stability, and it has led to important insights regarding central bank governance and behaviour.

2.3.3 Rules versus Discretion Debate

The time-inconsistency problem brought to the for the role of rules versus discretion in the setting of monetary policy. This debate has been a long standing one.[6] A *rule* requires that monetary policy is essentially automatic: it involves a precise prescription for how monetary policy reacts to a set of economic circumstances. One example of a monetary policy rule is the constant-money-growth rule advocated by Milton Friedman, in which the money supply is set by the central bank to grow at a constant rate. A more recent alternative is the classic Taylor (1993) rule in which the policy interest rate, the federal funds rate, is set to be a weighted average of an output gap (actual output minus potential output) and an inflation gap (actual inflation minus the target inflation rate). The opposite of a monetary policy rule, according to the traditional classification of policy regimes, is *discretion*. Discretion, in its purist form, involves monetary policymakers setting their policy instruments on a day-to-day basis as economic events unfold, with no public commitments about their objectives or actions.

2.3.3.1 The Case for Rules

There are two basic arguments for monetary policy rules. The first argument is that discretionary decisions about monetary policy can lead to poor economic performance because of mistakes in judgment; essentially, this argument is that discretionary monetary policymakers cannot be trusted

[6] See Mishkin (2018) for a more detailed discussion on the rules versus discretion debate discussed here.

to deliver good economic performance. In their classic study of monetary policy history, Friedman and Schwartz (1963) document many instances of Federal Reserve mistakes, as does Meltzer (2004, 2014). Policy mistakes that followed the period discussed by Friedman and Schwartz and Meltzer led to the Great Inflation that lasted from the late 1960s to 1979, until actions by the Federal Reserve under the chairmanship of Paul Volcker led to a low-inflation period since the early 1980s. Monetarists such as Friedman, Schwartz, and Meltzer have argued that these mistakes would have been avoided if the Federal Reserve had pursued a constant-money-growth rule. In addition, Taylor (2007) and Nikolsko-Rzhevskyy, Papell, and Prodan (2014) argue that periods in which Taylor-type rules more accurately describe Federal Reserve policy actions experience better outcomes than periods in which the Fed deviated from these rules.

The second, and more powerful, argument for monetary policy rules results from the time-inconsistency problem discussed above. A commitment to an instrument monetary-policy rule that embeds a nominal anchor is one way of mitigating the time-inconsistency problem. Once a monetary policy rule such as a Taylor rule is adopted, monetary policy no longer can try to exploit the short-run tradeoff between unemployment and inflation through discretionary actions.

2.3.3.2 The Case for Discretion

There are three main arguments against adoption of a monetary-policy instrument rule that argue in favor of the conduct of monetary policy with some discretion. They include: 1) a rule requires a reliable and stable structure and model of the macroeconomy, 3) a rule cannot foresee every contingency and does not allow for judgement when developments outside the realm of the established framework occur, and 5) monetary policymakers are not less trustworthy than rules.

A Rule Requires a Reliable and Stable Structure and Model of the Macroeconomy. For an instrument rule to produce good economic outcomes, policymakers must have a reliable model of the macroeconomy so that they can have confidence that the instrument rule they choose is close to the optimal policy rule. For example, deriving a reliable Taylor rule requires that the central bank has confidence in its estimates of 1) the long-run, or natural (equilibrium), rate of interest that is the intercept of the policy rule; 2) the natural rate of unemployment and hence the deviation

of employment and economic activity from potential; and 3) the nature and stability of Phillips-curve relationship between inflation and activity and of the monetary transmission mechanism.

As we have seen recently, there have been major reassessments of the value of the natural (equilibrium) rate of interest (e.g., Barsky, et. al., 2014, Curdia, et. al., 2014 and Hamilton, et. al., 2015, Harris, Hatzius and West, 2015, Holston, Laubach, and Williams, 2017; and Kiley, 2020a.b). Research also indicates that estimates of the natural rate of unemployment are highly uncertain (Staiger, Stock, and Watson (1997)). Indeed, Orphanides (2003) has argued that the very high inflation outcomes in the United States in the 1970s were due to an underestimate of the natural rate of unemployment on the part of Federal Reserve policymakers.

A successful instrument rule requires that the structure of the economy does not undergo substantial changes so the instrument rule remains valid. The failure of monetary targeting in many countries in the 1980s indicates the dangers of adopting instrument rules.[7]

A rule cannot foresee every contingency and does not allow judgment. The state of the economy depends on a vast number of variables, many of which cannot be foreseen. Thus any conceivable instrument rule cannot respond to all states of the economy. For example, almost no one could have predicted that problems in one small part of the financial system, subprime mortgage lending, would lead to the worst financial crisis since the Great Depression. The unprecedented steps that the Federal Reserve took during the crisis to prevent it from escalating into an even deeper crisis (Mishkin and White, 2016) could not have been written into a policy rule ahead of time. More generally, an instrument rule does not easily incorporate the use of judgement. Monetary policy is as much an art as a science. Monetary policymakers look at a wide range of information in order to decide on the best course for monetary policy, and some of this information is not easily quantifiable. Incorporating judgment into the outlook for economic and price stability can be critical and is one of the arguments for a forecast-targeting approach to inflation targeting (for example, Svensson, 2005 and 2020, discussed below).

[7] See Bernanke, Laubach, Mishkin, and Posen (1999).

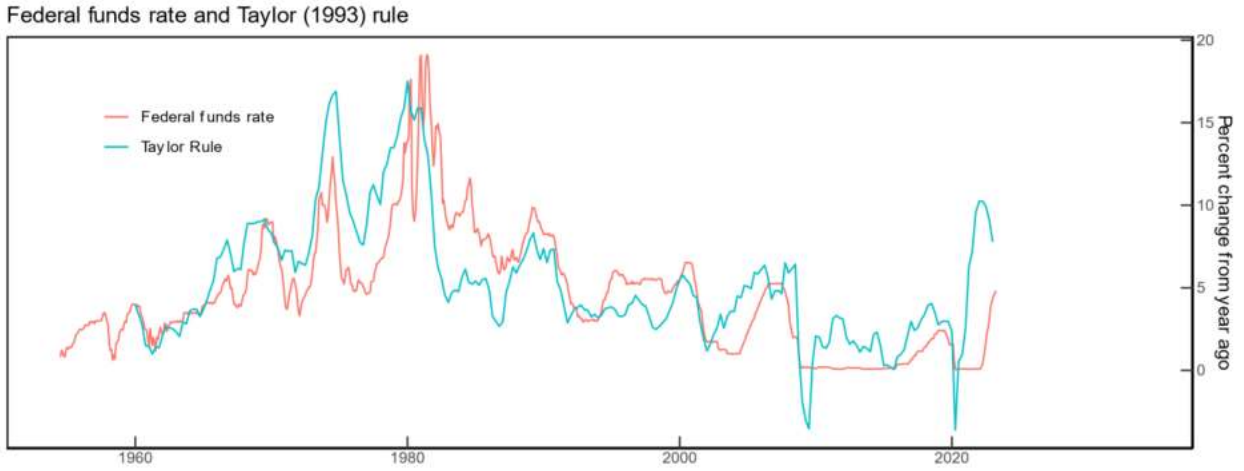
Monetary Policymakers are Not Obviously Less Trustworthy than Rules. One argument for adoption of rules is that they are more trustworthy than policymakers, who could either be incompetent or opportunistic. Friedman and Schwartz (1963) and Meltzer (2004, 2014) have documented serious policy mistakes made by the Federal Reserve. However, beginning in the 1980s, monetary policymakers in the United States and around the world learned from their past mistakes, producing more stable inflation and output. As shown in figure 1, inflation has been low in the 2000s across countries, although inflation above 5 percent returned to advanced economies in the 2020s (see section 6).

As an illustration of the debate and challenges associated with rules, the early 2000s experience in the United States and other countries is instructive. Taylor (2007, 2009) argues that excessively loose monetary policy contributed to a global housing bubble and the global financial crisis of 2008. Dokko et al (2011) look across a wide number of countries and find little evidence of that discretionary monetary policy contributed significantly to the housing bubble. Mishkin (2018) conducts an exercise which evaluates how well a traditional Taylor (1993) rule would have performed during the global financial crisis and its aftermath. To illustrate these points, figure x presents the prescriptions from the original Taylor (1993) rule (equation x, in which the nominal short-term interest rate, i_t, is a function of inflation π_t, and the output gap, y_t..

$$i_t = 2 + \pi_t + 0.5(\pi_t - 2) + 0.5y_t$$

The federal funds rate was somewhat below the prescriptions of the Taylor rule in the early 2000s, but the gap was not large by historical standards. And over the course of the 2010s the rule consistently prescribed a funds rate above the actual funds rate; however, inflation and economic activity were arguably below target and full employment for much of this period (Clarida, 2022), highlighting how strict adherence to a rule may have led to policy mistakes. Furthermore, the Taylor rule did not prescribe the Fed's preemptive lowering of the funds rate in the early stages of the global financial crisis and the Covid pandemic. These exercises suggests that a Taylor rule would have performed suboptimally, by not lowering interest rates sufficiently at the outset of

these crises and then raising interest rates far too quickly in the aftermath of the global financial crisis. The Taylor rule did not take account of the financial disruptions that were an important factor in the evolution of the economy at that time and that were largely absent from the core models used at central banks (see Mishkin, 2011). Despite the limitations of the Taylor rule, the rule does capture the broad contours of historical policy, which suggests that periods of large deviations be evaluated and that reference to policy rules may inform policy discussions. For example, the deviations were very large in 2021.



2.3.3.3 Constrained Discretion

The arguments above argue against adoption of an instrument rule for monetary policy. However, we have also seen that pure discretion also has undesirable properties.

Bernanke and Mishkin (1997) argues that the rules-versus-discretion debate has been miscast because the dichotomy between rules and discretion is too simple. Advocates of rules argue against *pure* discretion which is subject to the time-inconsistency problem, while advocates of discretion argue against *rigid* rules. Bernanke and Mishkin (1997) argued that by imposing a structure that imposes discipline on monetary policy, but does not eliminate flexibility, what they called *constrained discretion,* monetary policy could avoid some of the disadvantages of either rigid rules or pure discretion. Another way of thinking about constrained discretion is that it is an attempt to achieve the best of both rules and discretion by making discretion have rule-like properties, mitigating the time-inconsistency problem.

An approach of constrained discretion considers the prescriptions of simple policy rules and augments those prescriptions with judgment. This approach appears to capture well the behavior of central bankers in advanced economies. For example, the Federal Open Market Committee of the Federal Reserve routinely considers the prescriptions of simple rules in the materials it receives during its meetings, and the Federal Reserve System routinely publishes the prescriptions of simple rules. Under constrained discretion, such rules can inform policy debates and large discrepancies between the prescriptions of policy rules and the contemplated setting of monetary policy are judged as driven by factors that simple rules cannot adequately capture. In this sense, policy rules can be a part of the set of constraints within a constrained-discretion approach.

2.4 Central Bank Independence

2.4.1 Independence in Monetary Policy: Instrument versus Goal Independence

The potential problem of time-inconsistency has led to a great deal of research that examines the importance of institutional features that can give central bankers the commitment mechanisms to pursue low inflation. Perhaps the most significant has been research showing that central bank independence, at least along some dimensions, is likely very important to maintaining low inflation. However, it is important to distinguish between two types of independence made by Debelle and Fischer (1994) and Fischer (1994). *Goal independence* is the ability of the central bank to set its own goals for monetary policy, while *instrument independence* is the ability of the central bank to independently set the instruments of monetary policy to achieve its goals.

Central bank instrument independence can help insulate central banks from short-run pressures to exploit the Phillips-curve tradeoff between employment and inflation and thus avoid the time-inconsistency problem.[8] Evidence supports the conjecture that macroeconomic performance is improved when central banks are instrument independent. When central banks in industrialized countries were ranked from least legally independent to most legally independent, the inflation

[8] For an example of how the time-inconsistency problem can be modeled as resulting from political pressure, see Mishkin and Westelius (2008).

performance was found to be the best for countries with the most independent central banks (Alesina and Summers, 1993; Cukierman, 1993; Fischer, 1994; and the surveys in Forder, 2000, and Cukierman, 2006).[9]

Although there is a strong case for instrument independence, which is more common, the same is not true for goal independence. If the goals of monetary policy are set by the elected government, then the democratic principles that the public exercises control over government actions and holds policymakers accountable has been satisfied. Although basic democratic principles argue for the government setting the goals of monetary policy, the question of whether it should set goals for the short-run or intermediate-run is more controversial. For example, an arrangement in which the government set a short-run inflation or exchange rate target that was changed every month or every quarter could easily lead to a time-inconsistency problem in which short-run objectives would dominate. In practice, however, this problem does not appear to be severe: for example, in many countries in which the government sets the annual inflation target, the target is rarely changed.

Instrument independence generally calls for processes to hold the central bank accountable for achieving its objectives. The most straightforward approach to such accountability is transparency in the setting of its instruments in order to achieve its objectives. As a result, it is common for independent central banks to publish monetary policy or inflation reports. The trend toward greater central bank independence has been accompanied by greater transparency on the part of central banks (for example, Dincer and Eichengreen, 2014).

2.4.2 Monetary/Fiscal Policy Interactions

[9] A case study that provides a striking example of the benefits of instrument independence occurred with the granting of instrument independence to the Bank of England in May of 1997 (Mishkin and Posen, 1997; Bernanke, Laubach, Mishkin and Posen, 1999); before that date, the Chancellor of the Exchequer (the finance minister) set the monetary policy instrument, not the Bank of England. During 1995-96 the U.K. retail inflation rate (RPIX) was fairly close to 3 percent, but the spread between nominal and indexed bond yields--referred to as 10-year breakeven inflation--was substantially higher, in the range of 4 percent to 5 percent, reflecting investors' inflation expectations as well as compensation for perceived inflation risk at a 10-year horizon. Notably, breakeven inflation declined markedly on the day that the government announced the Bank of England's independence and has remained substantially lower ever since.

The strong case for central bank instrument independence in the pursuit of price stability does not lower the importance of interactions between central bank actions and those of the fiscal authority. Fiscal and monetary policy interact in many ways. The effects of fiscal actions on price stability and on stabilization policy overall affect the tools and design of monetary policy. In addition, central bank actions may affect the fiscal position.

2.4.2.1 Fiscal Discipline and Price Stability

Fiscal discipline is a requirement for price stability (Canzoneri, Cumby, and Diba, 2010; Bassetto and Sargent, 2020). Sargent and Wallace (1985) provide a classic theoretical example. As they note, central bank liabilities—currency and reserves, for example—are a liability of the consolidated government, and the revenue (seignorage revenue) that a central bank accrues through the issuance of these liabilities (which provide liquidity services and hence can be issued at low (or zero) interest rates) is part of the general government's revenue. If the fiscal policy of the government does not generate sufficient revenue to repay government bonds, a central bank can be forced to close the whole in the government's budget constraint through seignorage (that is, "monetize the debt"), leading to inflation. As Fischer and Easterly (1993) note, extremely rapid inflation is almost always a fiscal phenomenon. Bassetto and Sargent (2020) also discuss historical examples demonstrating the importance of fiscal discipline for price stability. The role of fiscal discipline in stabilizing inflation from high levels is a core element of macroeconomic analysis in of developing economies (Agenor and Montiel, 1999).

A more controversial line of recent research, denoted the fiscal theory of the price level, has examined whether fiscal policy may directly affect price stability even in the absence of explicitly action on the part of the central bank to bring about inflation to deliver seignorage revenue.[10] In these models, a fiscal authority that does not commit to revenue that matches expenditures generates inflation—a higher price level—because a higher price level is necessary for the government's nominal obligations—the money supply and nominal bonds—to match the

[10] Important references include Leeper 1991; Sims 1994; Woodford 1994, 1995, 2001; Cochrane 1998, 2001. The recent book by Cochrane (2023) contains a thorough treatment.

present discounted value of its nominal surplus. Empirical modeling has developed to try to assess these channels empirically (for example, Bianchi, Faccini, and Melosi, 2022).

While much of the modeling behind the fiscal theory of the price level reflects offers new insights that empirical work must evaluate more closely, many of the principles presented in Cochrane (2023) are familiar. The fiscal theory emphasizes that fiscal and monetary policy jointly influence inflation. Successful inflation targets have usually come with fiscal and microeconomic reforms. Money and government bonds are government liabilities (and interest-bearing reserves are very similar to short-term bills). Central bank independence can act as an important fiscal commitment, precommitting the government against inflationary finance.

2.4.2.2 Fiscal Policy and Economic Stabilization

Over the decades prior to the global financial crisis, macroeconomic stabilization policy was primarily the job of monetary policy. Blanchard and Summers (2020) ascribe the primacy of monetary policy in stabilization policy to several factors. The central role of nominal rigidities in theories of business cycles implies that price stability is a core element of stabilization, and consequently monetary policy is right tool. In addition, monetary policy is straightforward to adjust as conditions change. Central bank instrument independence also implies that monetary policy is largely protected from political pressure. Moreover, the stability in economic activity and inflation in the years prior to the global financial crisis—the Great Moderation—seemed to confirm that monetary policy could achieve stabilization.

Against this backdrop, fiscal policy was largely confined to the automatic stabilizers or infrequent stimulus packages. However, the effective lower bound and the trend decline in neutral real interest rates constrained monetary policy across advanced economies in the 2010s. This development led to nonconventional monetary policy tools, as we discuss below. It also has led economists to suggest that fiscal policy may need to play a larger role in stabilization policy (Blanchard and Summers, 2020; Furman, 2020). Indeed, fiscal policy is generally viewed as more powerful when the effective lower bound binds, as an impetus to aggregate demand from fiscal policy does not generate a response from monetary policy and hence the crowding out associated

with higher interest rates is limited.[11] According to Blanchard (2023), low interest rates decrease the room to maneuver in monetary policy—and thus increase the benefits of using fiscal policy, including deficits and debt, for macroeconomic stabilization.

While there may be important benefits to the active use of fiscal policy in stabilization, additional research is needed. Rules-based approaches to fiscal stabilization are limited and need more research (Blanchard and Summers, 2020). Fiscal stimulus was substantial in 2020 and 2021 in the United States and elsewhere, and the subsequent macroeconomic effects may not have been well anticipated. For example, we show in section 4 that there were persistent errors in forecasting inflation during this period, which may have owed to an incomplete understanding of the inflationary effects. Bianchi, Faccini, and Melosi (2022) is one example of empirical work ascribing some of the unusual behavior of inflation to fiscal channels. Putting these observations together supports central banks analyzing carefully the possible implications of fiscal policy for price and economic stability, which may prove different in the future if low interest rates persist and/or if fiscal authorities take a more active approach to stabilization policy.

2.4.2.2 Fiscal Effects of Central Bank Actions and Fiscal Dominance

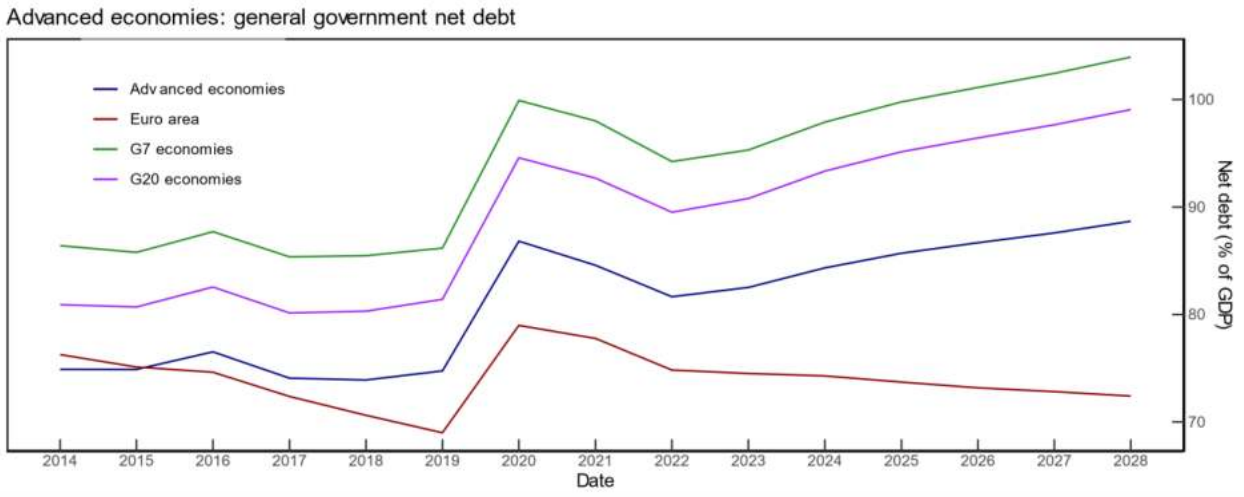
In addition to interactions of fiscal policy with the stabilization objectives of central banks, there are important potential effects of monetary policy actions on fiscal authorities. Seignorage is an element of the consolidated government's revenues and central bank liabilities are an element of the consolidated government's liabilities. These factors have generally been of limited public interest in advanced economies in the decades before the global financial crisis, as seignorage revenues were small and interest-paying liabilities of the central bank were small. Indeed, the primary focus of institutional arrangements prior to the global financial crisis was on central bank independence to limit pressures on central banks to monetize the debt.

Central bank balance sheets grew substantially during the 2010s owing to nonconventional policy actions. For a time, this increased the remittances from central banks to the fiscal agent, but the increase in interest rates in the 2020s has led to large mark-to-market losses on the asset holdings

[11] This holds across a wide range of models. Kiley (2016) discusses related literature and presents related stylized models.

of advanced economy central banks (Bell et al, 2023). Such losses have little direct bearing on a central bank's ability to conduct monetary policy, but they may create communication challenges and undermine public or political support for independence; Rajan (2022, 2023) and Brunnermeier (2023), among others, have highlighted this concern and suggested that it be factored into discussions of institutional arrangements and of the costs and benefits of expanding central bank balance sheets.

Rajan (2022, 2023) and Brunnermeier (2023) highlight an additional challenge that central banks could face should interest rates remain high or rise further than has already been the case since 2021. Government debt levels across advanced economies are high and projected to remain high or rise, as show in figure x from IMF (2023).



High levels of debt imply that higher interest rates could create pressure on the fiscal position in advanced economies. As a result, central banks may face political pressure not to raise interest rates, or may find the adverse effects of interest rate increases to be too large to tolerate. Such dynamics could undermine the pursuit of price stability, a situation called fiscal dominance. Recent experience does not suggest this concern is material, but the historical experience of fiscal effects on inflation highlights the importance of central banks' understanding the effects of their actions on the fiscal position and, if any such effects are non-negligible, communicating clearly why the policy stance is appropriate to achieve desirable outcomes.

3 The Design and Tools of Monetary Policy

Here we look at the implications of the science of monetary policy for the design and tools of monetary policy. First we discuss central bank mandates. In particular, the price stability and economic stability mandates common to central banks derive from the science of monetary policy. At the same time, the important role of financial stability in promoting price and economic stability highlight how financial stability factors are important for the achievement of central bank mandates; this has led to a greater focus on the role of financial stability in central bank mandates, implicitly of explicitly. We then discuss the role of a nominal anchor and different approaches to the implementation of a nominal anchor. We then turn to the properties of monetary policy that enable central banks to achieve price and economic stability, focusing primarily on approaches to implementing flexible inflation targeting. This focus leads to a discussion of the properties of approaches to adjusting short-term policy interest rates to achieve price and economic stability, which has been the primary tool used by inflation targeting central banks. We conclude with the role of forward guidance and quantitative easing (nonconventional monetary policy tools) that have been used extensively since 2008.

3.1 Central Bank Mandates

The core objective of central banks is price stability. Around the world, this mandate for monetary policy is governed by different arrangements with a different degree of focus on the complementary goals of economic stability and price stability. Our review of monetary policy mandates focuses on these structures. In addition, financial stability factors are important for price and economic stability, and we devote considerable space to these considerations. We conclude with recent research on other mandates that have been discussed recently.

3.1.1 Monetary Policy Mandates

Two types of monetary-policy mandates for central banks are common: hierarchical and dual mandates. Because monetary policy is the primary determinant of inflation over the long run, many countries have decided that the mandate for a central bank focus on price stability. For example, the Maastricht Treaty, which created the European Central Bank, states, "The primary objective of the European System of Central Banks [ESCB} shall be to maintain price stability. Without prejudice to the objective of price stability, the ESCB shall support the general economic policies in the Community," which include objectives such as "a high level of employment" and "sustainable and non-inflationary growth." Mandates of this type, which put the goal of price stability first and then state that other goals can be pursued if price stability is achieved, are known as *hierarchical mandates.* Other central banks with hierarchical mandates include the Bank of England, the Bank of Canada, and the Reserve Bank of New Zealand.

In contrast, the legislation that defines the mission of the Federal Reserve states, "The Board of Governors of the Federal Reserve System and the Federal Open Market Committee shall maintain long-run growth of the monetary and credit aggregates commensurate with the economy's long-run potential to increase production, so as to promote effectively the goals of maximum employment, stable prices and moderate long-term interest rates." Because moderate long-term interest rates require that inflation be kept low, the statement in practice is a *dual mandate* to achieve two coequal objectives: price stability and maximum employment (output stability).

Because no inconsistency exists between achieving price stability in the long run and the natural rate of unemployment, these two types of mandates are not very different *if maximum employment is defined as the natural rate of employment*. In practice, however, substantial differences between these two mandates might exist. For example, a hierarchical mandate could lead a central bank to put too much emphasis on inflation control and not enough on stabilizing output.[12] Indeed, the ECB's hierarchical mandate may have led it to focus too much on controlling inflation and not

[12] Hierarchical mandates can be even more problematic if they lead to an extreme focus on price stability in which a central bank is, as described by the former Governor of the Bank of England, Mervyn King, as an "inflation nutter"—that is, a central bank that focuses solely on inflation control, even in the short run, and so undertakes policies that lead to large output fluctuations.

enough on stabilizing output and unemployment.[13] This might be one reason for the ECB's tighter monetary policy than the Federal Reserve's during the recovery from the global financial crisis.

On the other hand, a dual mandate might lead to pressure on a central bank to focus too much on stabilizing output and unemployment rather than stabilizing inflation. In this case, the dual mandate could lead a central bank to pursue short-run expansionary policies that increase output and employment without worrying about the long-run consequences for inflation, The time-inconsistency problem would then recur. However, as long as a central bank with a dual mandate makes it clear that price stability is a long-run, but not short-run, goal, it can reduce output and unemployment fluctuations by allowing inflation to deviate from the long-run goal for short periods, without compromising the long-run goal of price stability.

Deciding which type of monetary policy mandate is better for a central bank ultimately depends on the subtleties of how the mandate is communicated and how politicians and the public react to it. The two types of mandates might lead to similar outcomes as long as they make it clear that price stability the primary goal in the long run, but not necessarily in the short run.

3.1.1 Financial Stability

Financial stability supports the ability of central banks to stabilize both price and economic stability, and so is subsumed under the goals of price and economic stability.[14] The promotion of financial stability has a long history in central banking. When a sector of the financial system, especially the banking system, suffers a disruption that renders it unable to perform its normal function, the central bank can provide liquidity to this sector to keep it operating. This function of the central bank has become known as the *lender of last resort*, because the central bank is the

[13] See the discussion of Hartmann and Smets (2018).

[14] While our focus is not on the link between financial instability, economic activity, and price stability, the related literature is large. Research outlines how asymmetric information could impede the efficient functioning of the financial system (Akerlof, 1970; Myers and Majluf, 1984; and Greenwald, Stiglitz, and Weiss, 1984). When financial instability results, the economy can experience a severe economic downturn (Mishkin, 1997). Financial instability played a central role in the collapse of economic activity during the Great Depression (Mishkin, 1978; Bernanke, 1983; and the survey in Calomiris, 1993), and it spawned a large literature on the role of financial frictions in business cycle fluctuations (e.g., Bernanke and Gertler, 1999, 2001; Bernanke, Gertler, and Gilchrist, 1999; Kashyap and Stein, 1994). Empirical evidence strongly supports the proposition that the most severe business cycle downturns are always associated with financial instability (Mishkin, 1991, 1996).

only entity in an economy that can create unlimited amounts of liquidity. Historically, this function dates from at least Bagehot (187?) onward. The lender-of-last resort role involves addressing financial-sector strains after they have emerged. Because such actions may encourage risk-taking (i.e., lead to moral hazard), central banks often have responsibility for the supervision of banks.[15]

These principles are apparent in practice around the world. For example, Liang and Edge (2017) review the financial stability and supervisory responsibilities of central banks across 58 countries. In their sample, all but two of the central banks are involved in policies related to financial stability. Regarding supervision, 36 of the 58 central banks have a direct supervisory role. However, these responsibilities are recent: A formal financial stability role for central banks was less common prior to the global financial crisis (BIS SG-CBGG, 2011). For example, that study found a relatively minor role for financial stability factors at the ECB prior to the GFC; a significant but incomplete role for the Federal Reserve, and a very significant role in the emerging markets reviewed (for example, Thailand, Malaysia, and the Philippines).[16] These findings suggest that the prominence of financial stability considerations in central bank (implicit or explicit) mandates in Laing and Edge (2017) stems partly from GFC experience.

Central banks have two types of financial stability policies: 1) reactive, which involve the provision of liquidity to sectors of the financial system to restore their functioning once a disruption to the financial system results in financial instability, and 2) proactive, which involves supervision of the financial system to prevent financial instability.

3.1.1.1 Reactive Policy: Liquidity Provision

When a sector of the financial system, especially the banking system, suffers a disruption that renders it unable to perform its normal function, the central bank can provide liquidity to this sector

[15] Domanski, Moessner, and Nelson (2014) discuss the role of central banks In the provision of emergency liquidity assistance and review related literature. While it is common for central banks to have a regulatory and supervisory role related to banks for the reasons discussed, this role has not been without debate; for example, Goodhart (2000) and Nier et al (2011).

[16] This pattern was like the pattern observed for deployment of supervisory tools for financial stability purposes prior to the GFC in Committee on the Global Financial System (CGFS) (2010), which found that emerging markets had been more likely to use regulatory or supervisory powers to promote financial stability.

to keep it operating. This function of the central bank has become known as the *lender of last resort*, because the central bank is the only entity in an economy that can create unlimited amounts of liquidity. During the recent global financial crisis, central banks throughout the world not only performed this lender of last resort role by providing liquidity to banking institutions, but also undertook extraordinary actions, especially in the United States, to provide liquidity to non-bank sectors of the financial system, such as investment banks, money market mutual funds that make up the so-called shadow banking system (Mishkin and White, 2016). This liquidity provision was taken even further during the Covid pandemic, when the Fed extended its liquidity facilities to additional entities.

Although the lender-of-last-resort function of central banks can mitigate and sometimes even stop a financial disruption in its tracks (e.g., as in 1987, see Mishkin, 1991), it does lead to a moral hazard problem: financial institutions, knowing that the central bank will provide them with liquidity when they get into trouble, take on more risk that can make financial instability more likely in the future. One solution to this problem was proposed by Bagehot (1873) who recommended that central bank lender-of-last-resort lending be done only for solvent institutions and at a penalty rate. However, in practice, his recommendation can be difficult to implement. First, determining which institutions are solvent is extremely difficult. An institution may be solvent when there is no financial disruption, but insolvent if there is a financial disruption. Should a central bank lend to the institution in this case? Not doing so can worsen the financial disruption, while doing so does lead to some moral hazard because they have less incentive to make sure that they are solvent during financial disruptions. Furthermore, determining what a penalty rate should be during a financial disruption is far from clear cut. If the rate is set too high, then solvent, but liquidity-deficient institutions may still fail, while if the rate is set too low, then it encourages risk-taking by financial institutions because they recognize that they will get loans at subsidized rates when they get in trouble. Domanski, Moessner, and Nelson (2014) note that another way to limit moral hazard is via "constructive ambiguity", in which ambiguity about whether liquidity provision will be provided incentivizes banks to act prudently. In addition, supervision by a central bank can help it understand the distinction between solvency and liquidity (through better information) as well as limit moral hazard through prudential regulation.

3.1.1.2 Proactive Policy: Financial Supervision

Before the global financial crisis, financial supervision was focused on *microprudential supervision*, that is, supervision which focuses on the safety and soundness of *individual* financial institutions.[17] As we learned during the global financial and Covid crises, a focus on microprudential supervision is not enough to prevent financial crises. As argued in Mishkin (2009) and French et al. (2010)), the global financial crisis provides strong support for a systemic regulator and central banks are the natural choice for this role. The global financial crisis has therefore increased the focus of central banks to *macroprudential supervision*, which promotes the safety and soundness of the financial system *in the aggregate*. Rather than focusing on the safety and soundness of individual institutions, macroprudential supervision seeks to mitigate systemwide fire sales and deleveraging by assessing the overall capacity of the financial system to avoid them

A macroprudential policy approach requires four elements: 1) a governance framework, including the role of the central bank and other parts of the government and coordination with microprudential supervision; 2) a definition of financial stability/resilience and associated macroprudential surveillance; 3) macroprudential regulation and tools; and (4) the role of proactive macroprudential policies relative to reactive crisis-management tools.[18]

Regarding governance, two interrelated considerations stand out. First, governance structures differ across economies and it is common for responsibility related to financial stability to be shared across parts of the government, including both central banks and finance ministries through committee structures (Liang and Edge, 2017). Central banks have a natural role because they can provide emergency liquidity and have a systemwide perspective through their monetary policy and macroeconomic mandates, while the finance ministry may have a natural role because of the fiscal implications of emergency actions (e.g., providing credit support). Second, the complicated nature of governance and the potential for policy actions related to financial stability to have fiscal or distributional consequences can subject a central bank to questions regarding its independence in monetary policy decisions (Tucket, 2018; Rajan, 2022 and 2023; Brunnermeier, 2023).

[17] See, for example, BIS Study Group of the Central Bank Governance Group (BIS SG-CBGG, 2011).
[18] The elements are similar to those discussed in Tucker (2016) and Lombardi and Schembri (2016).

Defining stability has led to a measurement agenda to provide tools to assess stability and has led to growth in the use of financial stability reports. A substantial literature has found that rapid credit growth leads to financial instability and/or poor macroeconomic outcomes, although other factors including asset price booms and external borrowing are important; these findings have been incorporated in monitoring frameworks.[19] Measurement has led to greater communication on financial stability assessments. According to Correa et al (2021), the Bank of England was the first central bank to have published an FSR (in 1996), while thirty-five institutions were publishing versions of their FSRs in English by 2005 and sixty-six by the mid-2010s. However, resilience and financial stability are not simple metrics: while the level of inflation provides a simple metric to define price stability, no such metric exists for financial stability.

Macroprudential policy tools aim to limit vulnerabilities to financial stability. Frameworks and quantitative measures of vulnerabilities focus on three broad classes of vulnerability: leverage in the financial sector; funding and liquidity risks in the financial sector; and borrowing by households and businesses. The IMF regularly surveys its members on the tools they have to address these imbalances.[20] With regard to leverage in the financial sector, capital requirements for banks, including the countercyclical capital buffer, are a prominent tool. The idea behind the countercyclical capital buffer derives from the so-called *leverage cycle*, in which a feedback loop resulted from a boom in issuing credit, which led to higher asset prices, which resulted in higher capital buffers at financial institutions, which supported further lending in the context of unchanging capital requirements, which then raised asset prices further, and so on; in the bust, the opposite occurs, with the value of the capital dropping precipitously, leading to a cut in lending. To short-circuit this leverage cycle, macroprudential policies make capital requirements countercyclical; that is, they are adjusted upward during a boom and downward during a bust. In addition, to ensure that financial institutions have enough liquidity, macroprudential policies can require that banks have a sufficiently large share of funding from stable sources (the net stable funding ratio (NSFR)) and sufficient liquid assets to cover potential funding outflows (the liquidity

[19] Jorda, Schularick, an Taylor (2012) is a classic reference. Related work includes Kiley (2018, 2021), Adrian et al (2020), and the review in Boyarchenko, Favara, and Schularick (2022). Adrian, Covitz, and Liang (2016) provides aan example of how to incorporate risk factors for financial stability into a monitoring framework. Aikmn et al (2017) provides a quantitative implementation of such a framework.
[20] IMF Macroprudential Policy Survey, https://www.elibrary-areaer.imf.org/Macroprudential/Pages/Home.aspx.

coverage ratio). It is common in emerging markets for there to be restrictions linking the currency composition of funding and lending to prevent instability owing to currency mismatch. Finally, tools that limit borrowing by households and businesses include limits on loan-to-value ratios in real estate lending and limits related to debt service coverage ratios. Adjustments in these tools in response to changes in vulnerabilities related to financial stability can lean against the leverage cycle in a manner similar to that of tools like the countercyclical capital buffer.

While this list of potential tools is long, two limitations are important. First, many of the tools focus on the banking sector (even those addressing households and businesses, as such tools may act through banking regulation). Progress on tools to address vulnerabilities arising in the nonbank financial sector has been more limited (FSB, 2022). Second, empirical evidence suggests that macroprudential policies can be effective at slowing credit growth or reducing over vulnerabilities, but the empirical evidence remains limited and suggests leakage and spillovers (Forbes, 2021). For example, restrictions on banks slow bank credit but the impact on broader credit growth is more muted, as lending increases through nonbanks (Akinci and Olmstead-Rumsey 2018). Bergant et al. (2020) suggest that macroprudential regulations limit the vulnerability of emerging markets to global financial shocks, but tighter regulations push some financial activities outside the regulated sector. As a result, of these limitations, there remains an active debate over the role of monetary policy as a tool to address financial stability.

3.1.1.3 Financial Stability, Monetary Policy, and Financial Dominance

Before the global financial crisis, the standard view in central banks was that there was a dichotomy between financial stability policy and monetary policy. Monetary policy would focus on stabilizing output and inflation, while financial supervision would separately focus on promoting financial stability. The global financial crisis suggests that this dichotomy is a false one. There is now a strong argument that there is an interaction between monetary policy and financial stability.

Some economists have suggested that monetary policy has contributed to financial instability, in a manner echoing issues from the classic rules versus discretion debate discussed earlier. The fact that the low interest rate policies of the Federal Reserve from 2002 to 2005 and 2020 to 2022 were

followed by excessive risk-taking leads Taylor (2007) to argue that excessively low policy rates led to the housing bubble, while Bernanke (2010), Bean, Paustian, Penalver and Taylor (2010), Turner (2010) and Posen (2009) have argued otherwise. Dokko et al (2011) examine experience in the United States, United Kingdom, Europe, Australia, Canada and others during this period and find little role for monetary policy in the global housing bubble.

Nonetheless, monetary policy has broad effects on the economy—it "gets in all the cracks" (Stein, 2013)—and hence influences factors relevant for financial stability. Ajello et al (2022) review the related literature and suggest several broad channels through which monetary policy affects vulnerabilities related to financial stability including interest rate and asset price channels interacting with balance sheet channels and reach-for-yield channels.

Expansionary monetary policy compresses risk premiums and boosts asset prices through financial accelerator channels. These effects additionally operate through balance sheet channels, increasing borrowing through higher collateral values (Bernanke, Gertler and Gilchrist, 1999; Kiyotaki and Moore, 1997), and allowing leverage investors to take on more risk (Adrian and Shin 2009, 2010; Adrian, Moench and Shin, 2010; and Allen and Gale, 2010). Moreover, in models with irrational beliefs, higher asset prices may lead to overborrowing and instability (Krisnamurthy and Li, 2020).

The literature provides several reasons why low interest rates might promote excessive risk-taking through reach-for-yield. First, as Rajan (2005, 2006) points out, low interest rates can increase the incentives for asset managers in financial institutions to search for yield and hence increase risk-taking. These incentives could come from contractual arrangements that compensate asset managers for returns above a minimum level, often zero, and with low nominal interest rates only high-credit risk or high-interest-rate-risk, long-duration investments will lead to high compensation. They could also come from fixed-rate commitments, such as those provided by insurance companies, forcing the firm to seek out higher-yielding, riskier investments. Or they could arise from behavioural tendencies such as money illusion, because of which the managers believe that low nominal rates indicate that real returns are low, encouraging them to purchase

riskier assets to obtain a higher target return. Models exploring these risks include Campbell and Sigalov (2021), Lian et al. (2019), and Martinez-Miera and Repullo (2017).

Micro-empirical analysis provides a fair amount of support for various risk-taking channel of monetary policy. For example, Jimenez, Ongena, Peydro and Saurina (2009), using Spanish credit registry data, find that low nominal interest rates, despite decreasing the probability of defaults in the short term, lead to riskier lending and more defaults in the medium term. Moreover, the empirical support for broad financial channels of monetary policy through financial imperfections are strong.

Nonetheless, empirical research does not suggest that monetary policy has been an important driver of financial vulnerabilities leading to financial instability (Boyarchenko, Favara, and Schularick, 2022). At least two factors contribute to this assessment. Quantifying the link between monetary policy and financial vulnerabilities is hard because financial vulnerabilities (like excessive borrowing) move slowly. And the literature does not often separate the implications of changes in monetary policy from those due to changes in the long-run neutral interest rate.

Given this evidence, the case for using monetary policy to lean against credit bubbles is not strong. In addition, using monetary policy to address credit bubbles is a violation of the Tinbergen (1939) principle, because one instrument is being asked to do two jobs: 1) stabilize the financial sector; and 2) stabilize the economy. Macroprudential tools are better able to address financial stability, leaving monetary policy to focus on price and output stability. But macro-prudential tools are limited and may be subject to political pressure (Tucker, 2018). The possibility that macro-prudential policies may not be implemented sufficiently well to constrain credit bubbles provides a reason why central banks might want to use monetary policy to limit them in rare circumstances.

Financial vulnerabilities may also create constraints on the ability of monetary policy to pursue price and economic stability. When financial vulnerabilities are high, a central bank may be unable to tighten monetary policy to restrain inflation. Because banking institutions often engage in the traditional business of borrowing short and lending long, a rise in interest rates lowers the value of assets more than the value of liabilities fall. The result is a deterioration in bank balance sheets

that can lead to a bank failures, with the result that a banking or financial crisis can erupt. More generally, overborrowing by households and businesses may lead them vulnerable to an increase in interest rates. In such situations, raising interest rates to contain inflation may thus no longer be an option for a central bank, a situation that is referred to as *financial dominance* (e.g., Brunnermeier, 2020).

Recent events have led some to reexamine these issues. For example, financial markets experienced heightened volatility in September 2022 as pension funds with leveraged positions (in liability-driven investments) had trouble meeting margin calls, leading the Bank of England to intervene. In March 2023, the failure of two banks in the United States owing to excessive interest rate risk exposures, among other weaknesses, led to similar observations from some; Rajan (2023) and Brunnermeier (2023) are two examples highlighting concern over financial dominance.

Boissy et al (2023) examine the interaction of monetary policy, financial stress, inflation, and macroprudential policies to shed light on policy strategies that may limit the risk of financial dominance. They present evidence that monetary policy tightening raises the likelihood of financial stress down the road if the hikes take place when the initial level of private sector debt is high and inflationary pressures call for a strong policy reaction; this combination suggests a risk of financial dominance. However, they also show that macroprudential measures help to reduce the likelihood of financial stress. They conclude that macroprudential policy can allow monetary policy to focus more freely on its fight against inflation, by mitigating the risk of financial dominance. This provides further support for an effective macroprudential toolkit and the complementary role for central banks between monetary and macroprudential policies as part of a economic and financial stability framework of the type outlined herein and in Brunnermeier (2020) and Borio et al (2022).

3.1.3 Additional Mandates

Adding more goals for central banks beyond price and economic (output) stability (and financial stability within those goals) is highly problematic. A key reason for limiting central bank goals to price and economic stability is that these goals are difficult enough to achieve. A focus on additional goals may lead to central banks taking their eye off the ball on achieving price and

economic stability and thus could lead to poorer central bank performance on achieving these goals. In addition, additional goals may not be achievable with monetary tools: achievement of a set of goals requires a set of policy tools sufficient to jointly meet all of the goals; the absence of sufficient policy instruments implies that a central bank may not be able to achieve multiple goals (Tinbergen, 1939). It may not be desirable to expand the goals of a central bank by assigning it more policy instruments, as this may overburden a central bank or lead to challenges in prioritizing goals and policy actions. If central banks pursue additional goals, the risk of disagreements over goals and policies is higher, potentially affecting support for central bank independence in monetary policy.

While debates regarding additional mandates for central banks are ongoing, it is common for experienced central bankers to voice significant the potential downsides outlined above.[21] Recent debates on additional goals for central banks have also included how central banks account for climate change or inequality, and policymakers and researchers have also highlighted the challenges noted above. [22] [23] [24] Their observations highlight how discussions regarding new

[21] Paul Tucker, a former senior official at the Bank of England, summarized his views in 2018 as follows: "I worry that too much is now expected of central banks. We hope they'll solve all of the macroeconomic and financial problems that we have. I worry that some central banks have powers that make it possible for them to enter territory which really belongs to the politicians. The slogan is, "Central banks are the only game in town," and I don't think that's sustainable." In In English and Tucker (2018See also Tucker (2018).

[22] For example, with regard to climate change, Lars Hansen (Nobel Laureate in Economics) writes the following: "I see three potential dangers: i) hastily devised policy rules unsupported by empirically grounded quantitative modeling could backfire if or when climate policy targets are missed, harming reputations of central banks and weakening their ability to act in the future on a variety of fronts; ii) attempts to take on a broader mission without formal and well-defined mandates could compromise central bank independence in the longer run; iii) climate change mitigation targets added to currently well-defined mandates may generate excessive expectations and unwarranted confidence in the abilities of central banks to address this important social and economic problem while diverting the attention away from fiscal policy." Hansen (2022). Brunnermeier and Landau (2020) discuss similar issues.

[23] With regard to income inequality, Augustin Carstens, general manager of the Bank for International Settlements, writes "inequality is not a monetary phenomenon over the long run. Yet central banks are fully aware of the consequences of their actions on income and wealth distribution over shorter horizons. While they do not have the necessary tools to achieve targeted distributional outcomes on top of their mandated objectives, they can go a long way in contributing to an equitable society by fulfilling their mandates. This means seeking to keep the economy on an even keel, so that price, financial and macroeconomic stability prevail. High inflation and recessions can be extremely costly for inequality." Carstens (2021).

[24] Tying these threads together, Raghuram Rajan, former Governor of the Bank of India, observes the following: "So when all settles back down, what should central bank mandates look like? Central banks are not the obvious institutions to combat climate change or promote inclusion. Often they have no mandate to tackle these issues. Instead of usurping mandates in politically charged areas, it is best that central banks wait for a mandate from the elected representatives of the people. But is it wise to give central banks mandates in these areas? First, central bank

mandates for central banks appears to suggest caution, reflecting the challenges an organization faces when executing to achieve multiple goals, a lack of policy levers relevant for addressing new mandates, and concerns over an expansion in responsibilities that may lower independence and hence undermine price stability.

3.2 The Role of a Nominal Anchor

3.2.1 Commitment to a Nominal Anchor

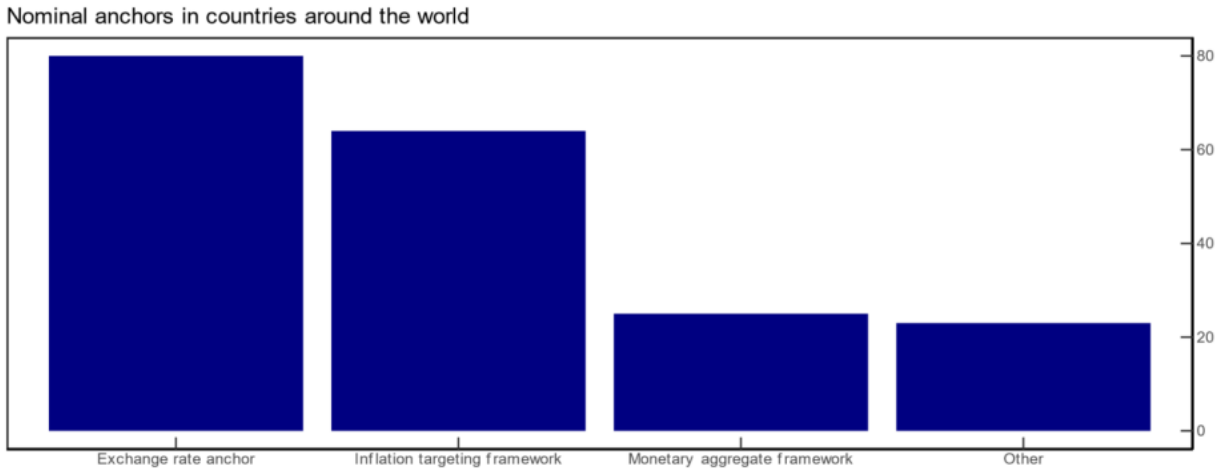
Commitment to a nominal anchor – i.e., stabilization of a nominal variable such as the inflation rate, the money supply, or an exchange rate—provides a counterbalance to the time-inconsistency problem. It makes it clear that the central bank is focusing on the long-run and is thus able to resist the temptation to pursue short-run expansionary policies that are inconsistent with the nominal anchor. Commitment to a nominal anchor can also encourage the government to be more fiscally responsible, an issue we discuss below, which also supports price stability. For example, persistent fiscal imbalances have, in the absence of a strong nominal anchor, led some governments, particularly in less-developed economies, to resort to the so-called inflation tax--the issuing/printing of money to pay for goods and services that leads to more inflation and is thus inconsistent with price stability.

Commitment to a nominal anchor also leads to monetary policy actions that promote price stability A credible commitment to a nominal anchor helps stabilize inflation expectations, which reduce the likelihood of "inflation scares," in which expected inflation and interest rates shoot up and monetary policy tightening to get inflation back under control results in large declines in economic activity (Goodfriend, 1993). Commitment to a nominal anchor can also help stabilize output and employment, as a long-run nominal anchor contributes to stability in long-run inflation expectations which provides scope for a central bank to act forcefully to stabilize demand. As a

tools have limited effectiveness in areas like combating climate change or inequality. Second, could new responsibilities influence their effectiveness in achieving their primary mandate(s)? For instance, could the new Fed framework requiring it to pay attention to inclusion have held back rate increases—since disadvantaged minorities are usually, and unfortunately, the last to be hired in an expansion? Finally, could these new mandates expose the central bank to a whole new set of political pressures and prompt new forms of central bank adventurism?." Rajan (2023).

result, a credible commitment to a nominal anchor is therefore a crucial element in the successful management of expectations; and it is a key feature of the new-neoclassical synthesis (Goodfriend and King, 1997; Clarida, Gali, and Gertler, 1999; Woodford, 2003). A successful commitment to a nominal anchor has been found to produce not only more-stable inflation but lower volatility of output fluctuations (Fatás, Mihov, and Rose, 2007; Mishkin and Schmidt-Hebbel, 2002, 2007).

What nominal anchor should be chosen and how should it be implemented? Figure x presents information on the nominal anchors used by central banks around the world, as reported in IMF (2022). The most prominent nominal anchor is an exchange rate anchor; however, this anchor is most common in less developed economies, often reflecting the limited degree of financial development. An inflation targeting framework is the second most common, and is used across major advanced economies (for example, the United States, the euro area, Japan, the United Kingdom, Canada, Australia, and Sweden) and large emerging market economies (for example, Brazil, Chile, India, Korea, and South Africa).[25] We discuss in some detail the most prominent choices for a nominal anchor: 1) an exchange rate peg, 2) or an inflation target.



Source: IMF (2022). Note that we classify the United States and the Euro area as inflation targeting frameworks.

3.2.2 Exchange Rate Pegs

[25] Note that we classify the United States and euro area countries as inflation targeting regimes, whereas the IMF (2022) refers to the regimes as "other".

A commitment to a fixed exchange rate is often referred to as an exchange rate peg. Some countries and their central banks just announce that they will fix their exchange rate to an anchor currency, such as the euro or the dollar, and this is often referred to as a conventional peg. For example, Denmark and many African countries have pegged their currencies to the euro, while Saudi Arabia, and many Caribbean countries have pegged to the U.S. dollar. Other countries adopt two forms of a harder peg: 1) adopting a foreign currency like the U.S. dollar or the euro as legal tender (e.g., Panama, El Salvador, Ecuador, and Zimbabwe, adopting the dollar, or Monaco or Kosovo adopting the euro), or 2) establishing a currency board as Argentina did in 1991, where by law, the central bank must exchange the domestic currency for the foreign currency, such as the dollar, at a fixed rate.

Adoption of an exchange rate peg as the nominal anchor results in a central bank giving up the ability to conduct its own independent monetary policy. In effect, its monetary policy is now conducted for it by the central bank of the currency to which it has pegged, say the Federal Reserve or the European Central Bank. Adopting a fixed exchange rate regime not only can provide a nominal anchor and stabilize both inflation and inflation expectations, but it also can help integrate a country's economy with the economy of the country whose currency it is pegged to. However, when there is only weak integration of the economy afforded by the exchange rate peg, fixed exchange rate regimes can blow up in spectacular fashion. Strong shocks can force abandonment of the exchange rate peg, which leads not only to devaluation but also to a major financial crisis: This occurs because much of the country's debt is denominated in the anchor currency and when the devaluation occurs the foreign currency value of liabilities skyrockets, which blows up balance sheets and produces a major financial crisis (Mishkin, 2006).

As noted above, the exchange rate serves as the nominal anchor in a large number of countries. These are primarily emerging market and less developed economies. The role of the exchange rate as the nominal anchor increased following the 1980s. In particular, the experience in the 1980s included a fair number of attempts to control high inflation through monetary targeting, but the most successful disinflations were achieved when the exchange rate was the nominal anchor (as discussed in Frankel, 2010).

3.2.3 Inflation Targeting

Problems with exchange rate pegs and instrument rules have led most of the major central banks in the world—including the Federal Reserve, European Central Bank, Bank of Japan, Bank of Canada, Bank of England, the Reserve Bank of New Zealand, the Reserve Bank of Australia, the Riksbank and the Central Banks of Chile and Brazil)—to adopt an inflation target as the nominal anchor. Inflation targeting is also increasingly common among smaller economies, reflecting its success as a nominal anchor (Frankel, 2010; IMF, 2022).

Inflation targeting includes an announcement of an inflation objective, typically close to 2 percent. The framework involves an institutional commitment to achieve this target over the medium term and accountability via central bank communication and transparency about how the target is to be achieved and how past policy actions were consistent with achieving the inflation target. As described above, inflation targeting is a form of constrained discretion in which central banks have the flexibility (discretion) to avoid some of the problems with instrument rules described above, but accountability to meet the inflation target prevents the central bank from reneging on the optimal, long-run monetary policy plan to keep inflation low and stable, and so inflation targeting avoids the time-inconsistency problem.

Advocates of instrument rules criticize inflation targeting for being too discretionary. However, the evidence suggests that countries that have adopted inflation targeting have been able to anchor inflation expectations well (Gürkaynak, et. al, 2010), which only occurs if inflation target is able to overcome the time-inconsistency problem. Furthermore, countries that have adopted inflation targeting have had better inflation performance, that is, low and stable inflation, without bearing the cost of larger fluctuations of output (Mishkin and Schmidt-Hebbel, 2002, 2007).

3.3 Properties of Monetary Policy to Achieve Price and Economic Stability

3.3.1 Implementing Flexible Inflation Targeting

An inflation targeting regime involves a commitment to a numerical inflation target and communications regarding how to achieve the target. Implementation requires a policy strategy, which links the setting of policy instruments to the achievement of the policy goals.

A policy strategy within a constrained discretion framework involves a specification of the policy instrument(s) and how they are set to achieve objectives, including a description of the factors at a given time that lead to the choice for the policy instrument. A particularly clear articulation of a strategy is the forecast targeting approach of Svensson (2020). Under this approach, a central bank would communicate their setting of the policy instrument and plans for future settings of the instrument and would describe the paths expected for their goal variables under this policy setting. In addition, the central bank would describe, qualitatively or quantitatively through alternative scenarios, how the setting of the policy instrument would adjust if economic conditions changed the outlook for the goal variables.

In concrete terms, consider a central bank whose primary policy instrument is the short-term nominal interest rate and whose goal variables are inflation, with a target of 2 percent, and full employment. Based on the available information, the central bank would describe its outlook for the economy under appropriate settings for the short-term nominal interest rate: for example, in a situation in which inflation is below 2 percent and employment is below full employment, the central bank would set the nominal interest rate below is neutral level—that is, set the interest rate to an accommodative level—and outline its expectation for the future path of interest rates, inflation, and employment that achieve the 2 percent inflation target and full employment within an appropriate time period. Loosely speaking, this is the approach taken by major central banks (such as the Federal Reserve in the Federal Open Market Committee's Summary of Economic Projections or the Bank of England in the Monetary Policy Committee's Inflation Report).

3.3.2 Adjusting Short-term Interest Rates to Achieve Price and Economic Stability

While the forecast targeting approach has benefits and aligns, in some ways, with practice, it is nonetheless critical that any approach—whether based on forecast targeting, an instrument rule, or a combination of information consistent with forecast targeting, guidance from instrument rules, and judgment—is consistent with principles that ensure price stability and stability in economic

activity. Focusing on the baseline case in which the primary policy instrument is the short-term interest rate, a central principle for the achievement of price stability is that the nominal interest rate increase more that one-for-one with inflation—a condition known as the Taylor principle. (The term "Taylor Principle" is widely used and was popularized in the work of Woodford (2001 and 2003) and derives from the rule in Taylor (1993) and related works.) This condition ensures achievement of an inflation target over the medium term in a broad class of models, and can be illustrated most simply through a simple (flexible-price) model in which the relationship between inflation, expected inflation, and the nominal interest rate are given by 1) the Fisher equation, in which the nominal interest rate (i_t) equals the real interest rate (r_t) plus expected inflation (π^e_{t+1}) and 2) a policy rule linking the nominal interest rate to its long-run equilibrium value r^* and the deviation of inflation from its target ($\pi_t - \pi^T$) as in the following equation[26]:

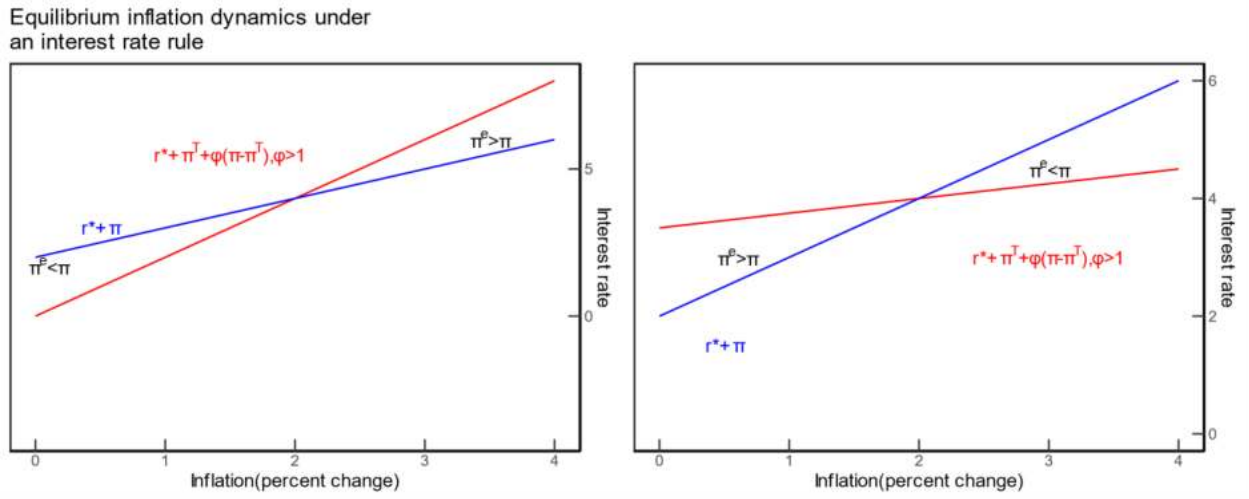
$$i_t = r_t^* + \pi^T + \varphi(\pi_t - \pi^T)$$

Assuming the real interest rate is constant, inserting the Fisher equation, and rearranging yields the relationship between expected inflation and realized inflation

$$\pi^e_{t+1} - \pi_t = (\varphi - 1)(\pi_t - \pi^T)$$

This difference equation has a unique ("saddlepath") equilibrium if $\varphi > 1$. This is illustrated in the left panel of figure x (in which $r^* = 2$ and $\pi^T = 2$.

[26] This illustration follows that in, among others, Benhabib, Schmitt-Grohe, and Uribe (2001).



While this simple model is stylized, the principle that inflation is stabilized when the nominal interest rate rises more than one-for-one with inflation holds across a range of models and assumptions regarding expectations formation (including rational expectations, adaptive expectations, and various models of learning). Experience suggests that failure to follow the Taylor principle has contributed to historical examples of instability in inflation (Taylor, 1993).

In addition to inflation stabilization, a policy strategy outlines how stability in economic activity and other factors affect the policy stance and the outlook. While the pursuit of price stability is a core function of monetary policy, our discussion of mandates emphasized how both hierarchical and dual mandate approaches to monetary policy include an objective for economic stability and full employment. A policy strategy that focused only on inflation and in an aggressive manner—that is, an "inflation nutter" as described by Mervyn King and consistent with a large value of φ in equation x—would lead to excessive volatility in economic activity. In other words, there is not a "divine coincidence" between price and economic stability at all times, as supply shocks induce a short-run tradeoff between inflation and employment as discussed above.

As a result, effective policy strategies account for inflation, economic activity, and the other factors important for the economic outlook. These ideas can be illustrated through an expanded instrument rule for the nominal interest rate that includes a measure of the output gap (which captures deviations from full employment) and a time-varying measure of the neutral, or equilibrium, real interest rate:

$$i_t = r_t^* + \pi^T + \varphi(\pi_t - \pi^T) + \theta y_t$$

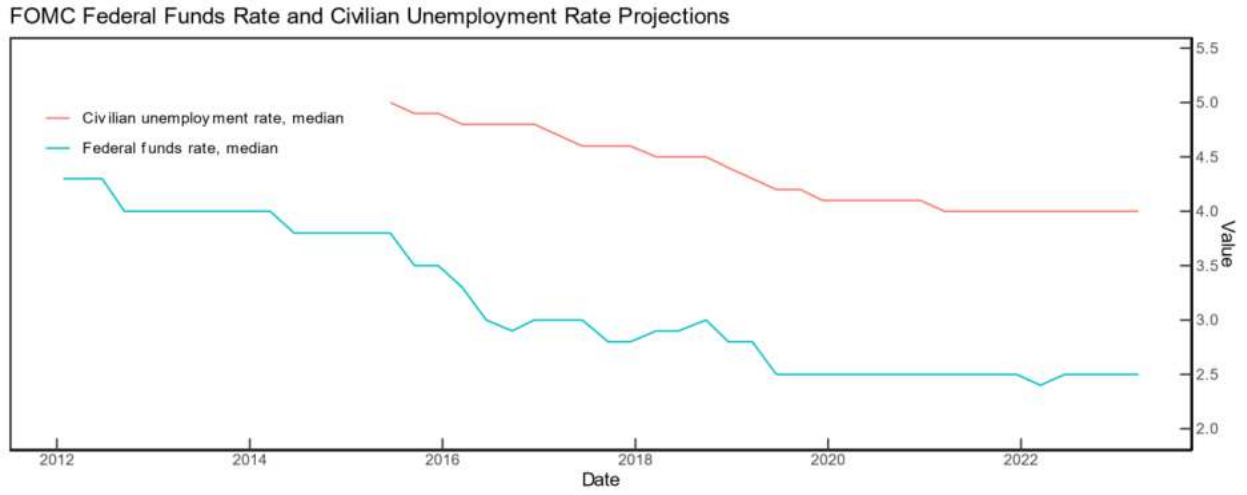
This augmented instrument rule highlights three issues that are important for policy strategy and will arise in out discussion of experience since 2008, especially experience in the early 2020s.

The first issue is the responsiveness to output or full employment deviations (θ). Research has generally suggested that θ is nontrivial. The original Taylor rule set θ at 0.5, and Yellen (2017) suggests that a larger value of 1.0 provides a more balanced approach. The discussion of the robustness of strategies in Orphanides and Williams (2006) and Taylor and Williams (2010) suggests that a moderate response to output, as well as a moderate response to inflation, performs reasonably well across a range of macroeconomic models, including models with different assumptions regarding expectations formation. In contrast, extreme settings for the responsiveness to output or inflation can perform poorly.

The augmented policy rule also includes a time-varying estimate of the neutral real interest rate. This concept can capture two issues. First, factors beyond inflation and the output gap—and potentially outside of the factors captured in macroeconomic models—can prove important for the setting of monetary policy. A constrained discretion approach allows for such considerations, and communication of such factors through their implications for the neutral real interest rate and the outlook can be an important component of a policy strategy. Second, there has been a trend decline in the long-run neutral real interest rate. Accounting for this decline is important to setting an appropriate stance for monetary policy, especially as it may call for nonconventional policy instruments as we discuss below.

Importantly, both the output gap and the neutral real interest rate are unobservable. While accounting for these factors is important when setting monetary policy, the challenges associated with measuring these concepts implies that excessive reliance on such measures can lead to policy errors (for example, Orphanides, 1998; Orphanides and Williams, 2002). This issue was important in the 1970s (Orphanides, 1998). The challenges in measuring the neutral real interest rate and long-run level of potential output or employment are always present. For example, the FOMC lowered both its estimate of the long-run neutral interest rate and of the long-run unemployment

rate over the 2010s, as show in the Summary of Economic Projections (figure x). The slow recognition of these changes may have contributed to the speed of the recover in the 2010s and provided impetus to the Federal Reserve's review of its policy framework according to Clarida (2022). The challenges in measuring the output gap, or the balance between aggregate demand and supply, may have been important in the early 2020s, as we discuss in section 6.



3.4 The Effective Lower Bound and Nonconventional Monetary Policy Tools

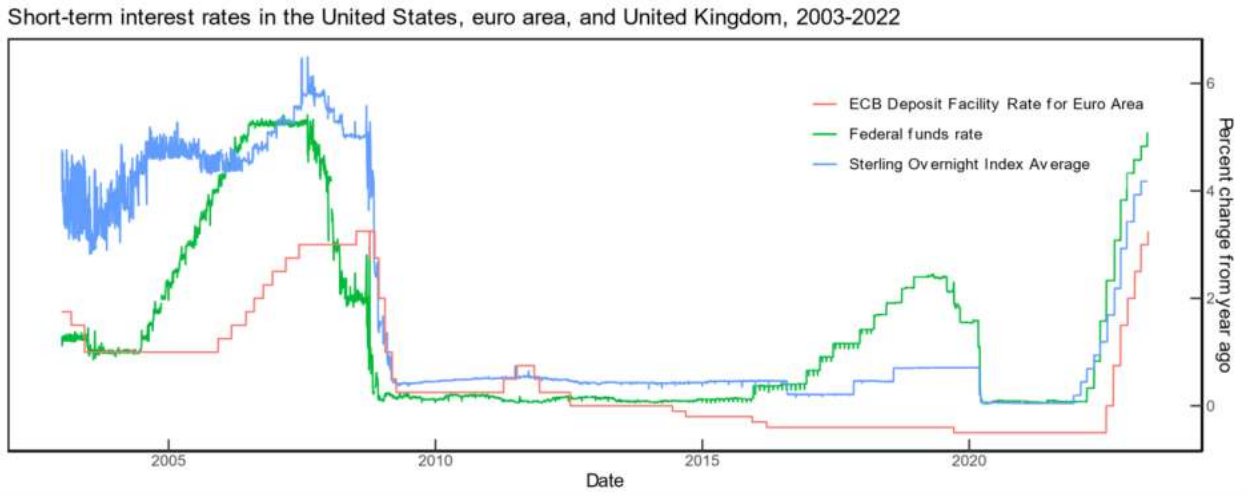
Conventional monetary policy manipulates a policy rate that is typically a very short-term, interbank lending rate. However, this is not the interest rate that is the most relevant to household and business spending decisions, which is both longer term and has some credit risk. Nonetheless, a short-term interest rate is the standard policy instrument across advanced economy central banks because adjustments in a short-term, risk-free rate broadly affect financial conditions and the economy: the current and expected short-term interest rate influences long-term safe interest rates on government bonds through the expectations component of the term structure of interest rates; these long-term rates affect the rates facing households and businesses—on mortgages, bank loans, corporate bonds, or other similar instruments—as investors react to the shifts in yields on safer assets; and similar adjustments propagate through to equity prices and other financial instruments. The behavior of the spectrum of financial conditions—interest rates across the yield curve and lending and investment products, wealth as influenced by equity, house, and the prices of other financial assets, and the exchange value of the currency—are the determinants of household and

business spending, and monetary policy's influence over economic activity and inflation operates through these transmission channels.[27]

The role of financial conditions in general and especially that of interest rates across the term structure rose to the fore of monetary policy discussions in the 2000s and especially around the Global Financial Crisis (GFC) of 2008. On the eve of GFC, short term policy interest rates in the United States, euro area, and the United Kingdom ranged from 3 percent to just below 6 percent (figure x). These levels were low by historical standards, but much of this decline owed to the stabilization of inflation in the neighborhood of the 2 percent targets that were either explicitly or implicitly the objective of central banks that had adopted an inflation targeting framework. As a result, real short-term interest rates across these economies ranged from a level somewhat below 1 percent to about 3 percent. These levels of real short-term interest rates were below the levels that prevailed in earlier decades, especially in the 1980s as fiscal policy placed upward pressures on interest rates and efforts to lower inflation from the elevated levels of the earlier 1980s required somewhat restrictive monetary policy. Nonetheless, real short-term interest rates remained in the 2 percent area that had been viewed as a reasonable benchmark, at least in the United States, since the work on the real interest rate appropriate for a balanced economy embedded in simple rules such as Taylor (1993).

As the GFC caused a sharp weakening in economic activity, central banks lowered their policy interest rates rapidly. The weakening activity and decline in short-term policy interest rates occurred first in the United States, with the Federal Reserve reducing the federal funds rate to effectively zero by the end of 2008. The ECB and the Bank of England following suite and had reduced policy rates to levels at or near their effective lower bound in 2009. As figure x shows clearly, the reduction in the policy rate were rapid, an approach consistent with our earlier discussion of how downturns can be rapid, exhibiting nonlinear dynamics relative to typical business cycle fluctuations, and thus demand a policy approach that responds rapidly, in contrast to the gradual adjustments that may be appropriate to manage expectations as in the linear New-Keynesian model of Woodford (2003).

[27] For example, Boivin, Kiley, and Mishkin (2010) review aspects of the monetary transmission mechanism.



More significantly, the decline in short-term interest rates brought them to levels in the neighborhood of zero, which serves as an effective lower bound on the nominal interest rates. Short-term nominal interest rates cannot fall (much) below zero because currency holdings offer a nominal interest rate of zero and short-term nominal interest rates below zero would simply lead households and businesses to turn to currency for their short-term nominal safe assets.

Once the effective zero-lower-bound constraint binds, central banks have resorted to stimulating spending by affecting the long-term rates and broader financial conditions that influence household and business spending with nonconventional monetary policies: forward guidance, including enhanced efforts to manage inflation expectations and, more prominently, the announcement of a future path for the policy interest rate; and large-scale asset purchases or quantitative easing.

3.4.1 Forward Guidance through Management of Inflation Expectations

Forward guidance is one form of management of expectations that provides a nonconventional monetary policy tool. In theory, management of inflation expectations provides a possible nonconventional monetary policy tool: a central bank can promise to deliver higher inflation. If inflation expectations rise because a central bank commits to do "whatever it takes" to raise

inflation in the future, then the even if the policy rate is constrained by the effective lower bound, the real rate of interest will decline, thus stimulating the economy.[28]

One problem with this monetary policy tool is that the public must understand and believe that the central bank will be able to achieve this higher rate of inflation. Two challenges arise. First, efforts to raise inflation expectations may succeed in generating inflation without easing financial conditions, for example because they induce an unanchoring of inflation expectations that increases real long-term interest rates; some discussions have highlighted this concern (for example, the concern of unanchoring expressed in Kohn, 2019). Second, efforts to raise inflation expectations may not succeed. Indeed, this policy was tried by the then new Governor of the Bank of Japan, Huruhiko Kuroda, who in 2013 made a strong commitment to raise the inflation rate to a 2% target level within two years. The success of this policy was mixed because neither inflation nor inflation expectations rose in the aftermath of the inflation target announcement. Research by Candia, Coibion and Gorodnichenko (2022) casts doubt on the ability of central banks to affect inflation expectations.

These factors have led to a greater focus on forward guidance for the path of short-term interest rates, as the communication and execution of such guidance seems more straightforward than that associated with direct management of inflation expectations.

3.3.3 Forward Guidance on the Future Path of the Policy Interest Rate

Forward guidance is another form of central bank transparency. The most common form of forward guidance involves a central bank announcement of a future path for the policy interest rate. Even with the policy rate at the effective (zero) lower bound, by committing or signaling that the policy interest rate will be lower in the future, a central bank can lower long-term interest rates because a major factor driving long-term rates are expectations about future short-term rates. The increased emphasis on forward guidance during the effective-lower bound periods following 2008 represented an evolution. Central banks had been increasingly relying on communications and

[28] For an illustration of how this mechanism could work, see Eggertsson (2008). He argues that the Roosevelt Administration's commitment to raise inflation was a key factor that promoted the receovery from the Great Depression.

forward guidance as part of expectations management in a manner consistent with the emphasis on expectations management in New-Keynesian models (e.g., Woodford, 2003). For example, the FOMC used forward guidance in its statement in the early 2000s (Meade et al, 2015): the August 2003 statement stated that policy accommodation could be maintained "for a considerable period;" in January 2004, that forward guidance was changed to indicate that the Committee thought it could be "patient in removing" monetary policy accommodation.

However, the use of forward guidance during the effective lower-bound represented a shift to using guidance as a tool to communicate a commitment to a lower-for-longer interest rate strategy. As discussed in Fisher et al (2017), the FOMC first used loose and then specific calendar-based guidance. In December 2008, the FOMC indicated that the funds rate would remain exceptionally low for "some time." In March 2009, the FOMC replaced "some time" with "extended period." In August 2011, the FOMC indicated that exceptionally low levels of the funds rate would remain in place "at least through mid-2013." The calendar-based language was replaced in the December 2012 with the state-contingent guidance that "this exceptionally low range for the federal funds rate will be appropriate at least as long as the unemployment rate remains above 6-1/2 percent, inflation between one and two years ahead is projected to be no more than a half percentage point above the Committee's 2 percent longer-run goal, and longer-term inflation expectations continue to be well anchored."

This evolution highlights how forward guidance has two types. The first type is *time-based* forward guidance in there is an *unconditional* commitment by a central bank to set the policy rate at specific levels at specific calendar dates. An extreme version of time-based forward guidance would be a central bank committing not to raise interest rates from their current level for several years. Such a commitment would ignore incoming information, which is why the forward guidance is *unconditional* and *time-based*.

The second type of forward guidance is *data-based* forward guidance, in which the central bank provides information about the monetary policy reaction function by indicating future path of the policy rate *conditional* on the data that is expected over the policy horizon. This means not only

providing information on the policy path given the central bank's forecast, but also to indicate how that path changes if and when the central bank's forecast changes.

Feroli et. al. (2017) argue that data-based forward guidance has substantial advantages over time-based forward guidance, except in the following unusual circumstances: when the zero lower bound is binding and the central bank wants to pursue very expansionary monetary policy and yet the central bank is finding it very difficult to communicate data-based forward guidance. To see the advantages of data-based forward guidance, consider a negative shock to aggregate demand when both the inflation gap and output gap are at zero. The result would be that both the inflation and output gaps would turn negative in the future and an optimal monetary policy reaction function would indicate that the federal funds rate path would be lowered. If the central bank's reaction function is well understood by the public, then without the central bank's taking any actions, expectations of the future policy rate would decline, which would result in lower longer-term interest rates and stimulate the economy. The result would then be an immediate offset to the negative aggregate demand shock which would help stabilize the economy. Another way of stating this result is that successful central bank communication about the monetary policy reaction function would enable the markets to do a lot of the work for the central bank. If the monetary policy reaction to shocks is predictable, expectations work to tighten or loosen financial conditions appropriately when there are shocks to the economy.

If instead, the forward guidance is *time*-dependent--the central bank says that the policy rate will be set to particular values at particular date-- then when the inflation and output forecasts rises, there is no change in the policy path. Now the inflation shock does not lead to an automatic effective tightening of monetary policy. Indeed, time-dependent forward guidance can lead to expectation dynamics that make things even worse. Again consider the situation in which the positive employment report leads to expectations that inflation will be higher than previously expected. With time-dependent forward guidance, the projected policy path does not change, but expected inflation rises. This means that the expected path of future *real* interest rates, policy interest rates minus expected inflation, now declines. The effect of the positive employment report shock is then an effective easing of monetary policy, the opposite to what would be an optimal effective monetary policy response.

Another way of stating the above argument is that data-dependent forward guidance leads to beneficial expectation dynamics, while time-dependent forward guidance leads to perverse expectation dynamics of the type emphasized by Eggertsson and Woodford (2003). Feroli et. al. (2016) provide empirical evidence to support the theory that time-based forward guidance leads to bad expectation dynamics because it leads to interest rates becoming insensitive to macroeconomic news.

Research has generally found forward guidance to be effective (e.g., Fisher et al, 2017). Cecchetti et al (2020) present evidence that calendar- or date-based guidance was relatively less effective than state-contingent guidance. This could be because date-based guidance can lack credibility, as it commits to ignore the state of the economy when setting policy—an approach that the public may doubt. In contrast, data- or state-based guidance commits to accommodation until certain economic conditions are met. While this type of guidance is also subject to the time-consistency problem, it may be less subject to this problem than date-based guidance, as it does not commit to ignore economic conditions. Cecchetti et al (2020) find this type of guidance was generally somewhat effective.

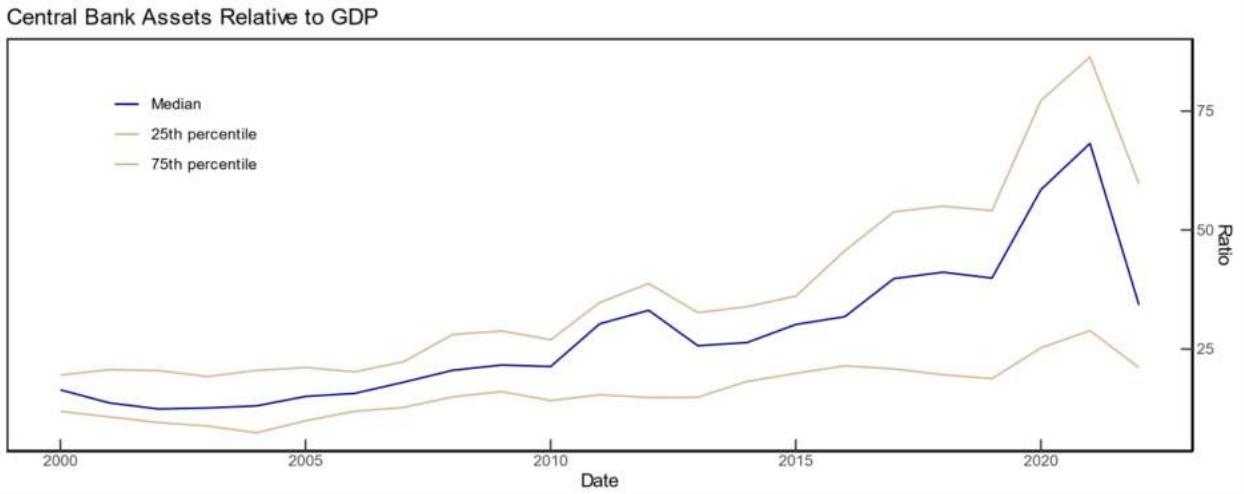
3.3.3 Large-Scale Asset Purchases, or Quantitative Easing

While enhanced forward guidance was extensively deployed, the post-2008 monetary toolkit was arguably equally as reliant on a more novel tool—asset purchases by the central bank in which the central bank purchases long-term government debt through the issuance of short-term (usually overnight) central bank liabilities (reserves) (Joyce et al, 2012). Because these purchases of assets lead to an expansion of the central bank balance sheet and the monetary base, they have become referred to as *quantitative easing (QE)*. This name is something of a misnomer. Large-scale asset purchases of short-term government bonds, although they do lead to an expansion of the central bank balance sheet and the monetary base, are unlikely to be effective in stimulating household and business spending: they cannot drive short-term bond government bond rates down further. Indeed, this is the experience of the Bank of Japan which engaged in large-scale purchase of short-term government bonds that led to a huge increase in the Bank of Japan's balance sheet in the 1990s, but which was unable to prevent deflation and a weak economy (see Kuttner, 2004, Curdia and Woodford, 2009). While quantitative easing has become the more popular term, it is critical

to remember that expansion of a central banks balance sheet to stimulate activity requires purchases of long-duration assets, or other assets that are not near perfect substitutes for short-term liabilities issued by a central bank to finance the purchases, to alter the assets held by the private sector and potentially broadly affect financial conditions. Purchases directed at lowering longer-term rates stimulate demand thereby raising the price and lowering the interest rates on purchased assets and close substitutes.

While the Bank of Japan had been conducting asset purchases and expanding its balance sheet for some time prior to 2008, the approach and prevalence of QE expanded notably when short-term nominal interest rates fell to near their effective lower bound in the United States and Europe. In November 2008, the FOMC announced its first large-scale asset purchase (LSAP) program, involving purchases "up to" $200 billion in agency debt, $300 billion in Treasury securities, and $1.25 trillion in agency MBS. Over the next four years, six additional versions of such programs, involving either asset purchases or changes in reinvestment policies, were announced (Ihrig et al, 2018). As a result of these policies (and, early in the period, emergency liquidity programs), the assets of the Federal Reserve rose from just above 5 percent of GDP to 25 percent in 2014 (figure x). When COVID19 struck, the FOMC again engaged in QE and the Federal Reserve's balance sheet was just below 35 percent of GDP at the end of 2022. The Bank of England similarly announced a substantial asset program when its policy rate fell to the effective lower bound in 2009. The ECB would only turn to quantitative easing later, with its asset purchase program in 2015; however, the ECB did substantially expand its balance sheet through liquidity programs in the years prior to 2015.

Quantitative easing was also deployed following the onset of covid. In 2020 and 2021, quantitative easing was used by both advanced economies and emerging market economies (Adrian et al, 2021). In many cases, the use of QE among emerging markets was focused more on market functioning than on aggregate demand management. However, the widening of the set of economies using quantitative easing highlights how it has grown to be a more integral part of central banks' toolkit. This can be seen in the general trend toward larger central bank balance sheets relative to GDP shown in figure x.



Source: Bell et al, 2023. Based on 27 AEs including euro area national central banks.

QE provides economic stimulus through two channels. The first channel is a signaling channel: by demonstrating actions to provide stimulus and communicating intentions (e.g., the amount and time period of purchases), QE can reinforce the central bank's communications on forward guidance and signal accommodation (Christensen and Rudebusch, 2012). The second channel is more direct and lowers long-term interest rate and raises asset prices through portfolio balance/imperfect substitution of financial assets (e.g., Vayanos and Vila, 2021). For example, some investors may have a strong preference for long-duration assets. QE, by reducing the supply of long-duration assets held by the public, may increase the price on such assets and lower their yields, with spillovers to the yields on other assets.

However, there is debate over the degree of spillovers to broader asset prices. Much of the literature from, for example, researchers employing macroeconomic models to assess QE assume broad spillovers to asset prices, which implies that QE is a good substitute for adjustments in the short-term policy interest rate (e.g., Reifschneider, 201x; Kiley, 2018; Chung et al, 2023). This is consistent with some of the literature on event studies of financial market reactions (e.g., Rogers et al, 201x). However, there is a literature suggesting that the spillovers to broader financial conditions are narrow, with only modest additional stimulus to the broader economy from QE (e.g., Krishnamurthy and Vissing-Jorgensen, 2012; D'Amico and King, 2013, Cahill et al., 2013, Joyce et al., 2020; Di Maggio et al., 2020; and Lucca and Wright, 2022).

All told, the relative efficacy of QE remains contentious. For example, Borio and Zabai (2016) Kuttner (2018), Kiley (2018), and Bernanke (2020) suggest that the empirical evidence and macroeconomic model simulations point to QE as a good substitute for conventional short-term interest rate adjustments. Others, including Greenlaw, Hamilton, Harris and West (2018), Cecchetti et al (2020) and Krishnamurthy (2022) see the evidence as more mixed.

In addition, central banks have modest experience in unwinding QE, as is apparent from the experience across advanced economies in figure x: the balance sheets of central banks that engaged in QE since 2008 have risen relative to GDP with only limited subsequent declines. A portion of this may owe to the slow recovery and modest pace of inflation over the 2010s prior to COVID19, which called for only moderate removal of monetary accommodation. Some other fraction of the persistent increase in central bank balance sheets relative to GDP likely owes to changes in regulation and preferences regarding liquid and safe assets. For example, central bank reserves are the most liquid asset that a bank can hold, even relative to Treasury securities. Efforts by banks to increase their holdings of liquid assets after 2008—in part owing to regulation—may have increased the demand for central bank reserves to avoid market pressures during periods of high liquidity needs (Bush et al., 2019). Greater demand for reserves leads to a larger central bank balance sheet. Beyond these channels, research has suggested that the upward "ratchet" in the size of central bank balance sheets may reflect other factors, with QE leading banks to persistently increase demand for reserves in a manner that makes reducing the central bank balance sheet difficult (Acharya et al, 2022).

The potential challenges associated with reducing a large central bank balance sheet may merit additional analysis in order to factor the implications of such challenges into policy strategies. Several factors seem relevant. First, the effects of balance sheet reductions—quantitative tightening (QT)—may not mirror those of QE for a variety of reasons. Wright (2022) summarizes the potential asymmetries. Identifying the effects of QT is challenging. QT has largely been anticipated and hence empirical work has not been able to exploit "announcement effects" to identify the impact of QT on asset prices (with limited exceptions, such as in D'Amico and Seida (2020) and Smith and Valcarel (2020)). More generally, QT occurs during stable recoveries, whereas QE has been initiated during periods or market dysfunction (e.g., 2008 and 2020).

Policymakers have gone to pains to avoid signaling channels when conducting QT, as exemplified by the "watching paint dry" description of Yellen (2017). Finally, QE was undertaken when the effective lower bound was binding, whereas QT has not, which may alter financial market reactions.

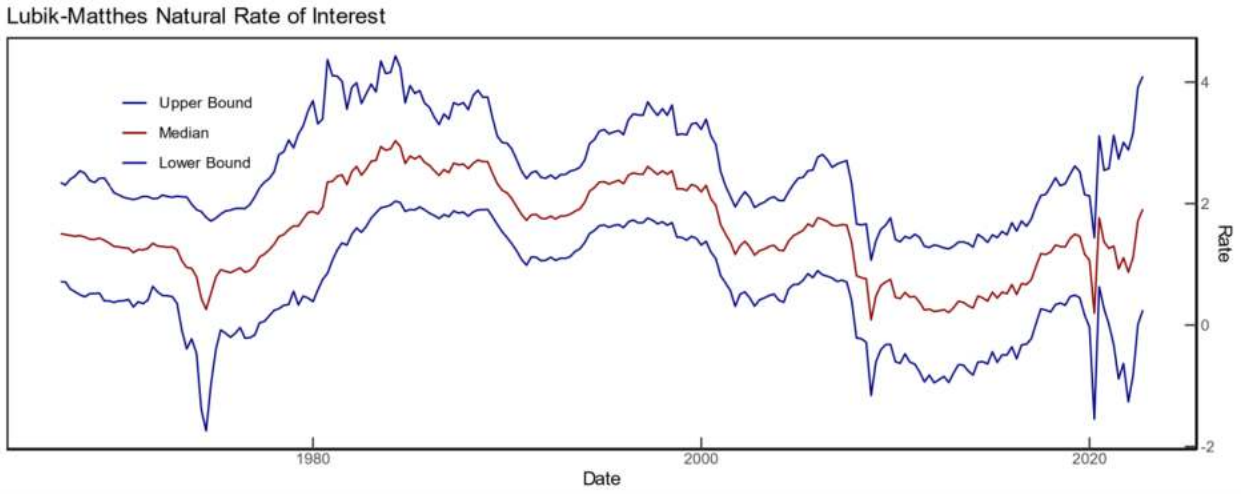
In addition to uncertainties associated with the financial market effect of QT, the ratcheting up of central bank balance sheets may create other challenges for central banks. Large central bank balance sheets may imply a greater actual or perceived role for central banks in financial activity, which may lead to questions regarding their mandates and independence (Rajan, 2022). Similarly, a large central bank balance sheet with sizable long-term assets and short-term liabilities creates substantial interest rate risk on the central bank's balance sheet. This can lead to sizable fluctuations in the income and/or equity associated with a central bank balance sheet. In general, these effects do not affect the ability of central banks in advanced economies, with a stable demand for central bank liabilities (currency and reserves), to conduct monetary policy. However, interest rate risk on the central bank's balance sheet will affect the timing and volatility of its income and hence in the consolidated budget of the government. These effects may create pressure on the central bank or affect its public support, potentially impacting central bank independence (Bell et al, 2023; Honohan, 2023). Our discussions of financial and fiscal dominance in sections x and y highlighted these issues.

4 Challenges From Low Interest Rates Post Crises and the Inflation Spike of 2021-22

4.1 Low Inflation and the Inflation Target

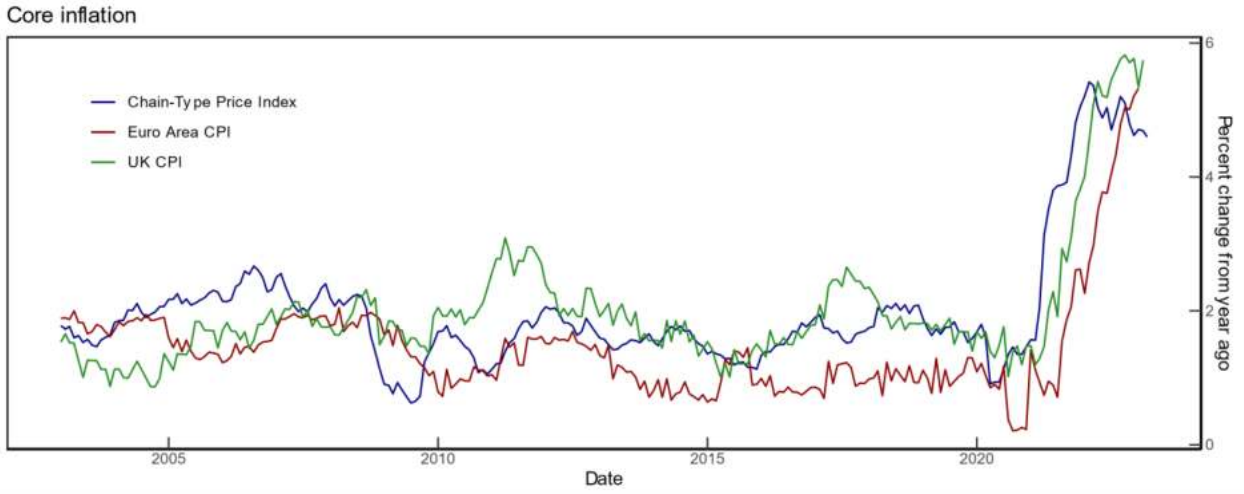
The reliance on forward guidance and QE over the 2010s raised questions regarding the implementation of inflation targeting frameworks. Two sets of developments loomed large in related academic research and policy discussions. First, real interest rates remained extremely low from an historical perspective in the 2010s, suggesting that the real interest rate consistent with

price stability and full employment over the medium run—the equilibrium real interest rate r*—had fallen to low levels. Model-based estimates of r*, typically based on a framework like that of Laubach and Williams (2003), supported this conclusion. Prominent examples of research reaching this conclusion include Holston, Laubach, and Williams (2016) and Kiley (2020a,b). Figure x presents one such model-based measure that is regularly updated on the website of the Federal Reserve Bank of Richmond (from Lubik and Matthes, 2015). According to this estimate, r* in the United States fell below 1 percent for much of the 2010s. By the end of 2022, the estimate of r* had risen to near 2 percent, with a wide confidence interval. These model-based approaches imply substantial uncertainty about the level of r* (Hamilton et al, 2015; Kiley, 2020a,b), and some researchers highlighted concerns that the equilibrium real interest rate may be notably higher than suggested by 2010s experience (Hamilton et al, 2015).



A low level of the equilibrium real interest rate implies that the effective lower bound will bind more frequently (Summers, 1991). The decline in the apparent level of r*--perhaps to levels below 1 percent—suggested that the effective lower bound may bind very frequently; for example, Kiley and Roberts (2017) suggested that standard Taylor-rule approaches to policy could imply the effective lower bound binding well more than 25 percent of the time. Other researchers, such as Andrade et al (2019), reach similar conclusions. These findings, combined with the long period during which interest rates were at the effective lower bound across advanced economies in the 2010s, suggested that the effective lower bound was a more significant constraint than appreciated just a few years earlier (e.g., Williams, 2009).

These concerns were amplified by the low level of inflation during the 2010s, despite extensive use of forward guidance and QE. In the 2010s, headline inflation in the United States, United Kingdom, and euro area inflation was below levels that prevailed in the 2000s and was notably below inflation targets in the mid-2010s. Some of the low level of inflation across these economies reflected volatile food and energy prices. Figure x presents the evolution of core inflation. In both the United States and the euro area, core inflation was persistently below the 2 percent objective for overall inflation: In the United States, core inflation only touched the 2 percent level briefly over this period, and core inflation fell short of 2 percent in the euro area for the entire period. Inflation in Japan (not shown) ran at levels below objective consistently over the first two decades of the 21st century.



Research during the 2010s attributed the muted pace of inflation to changes in the Phillips curve, as reviewed in Kiley (2015) and Blanchard (2016). At the same time, some research noted the risk that Phillips curve relationships could re-emerge in a high-pressure economy and lead to higher-than-expected inflation ((e.g., Erceg et al, 2019; Hooper, Mishkin, and Sufi, 2019; McLeay and Tenroyo (2020) and Carpenter et al, 2022). When monetary policy is oriented to stabilizing inflation, as it was starting in the 1980s, then the endogenous response of monetary policy to inflation shocks will induce a correlation of the error term of the Phillips curve with the unemployment variable, thus biasing its coefficient towards zero. If a central bank weakens its response to inflation in the pursuit of high employment, then the bias to the unemployment coefficient will disappear and the Phillips curve relationship would emerge.

The realization that the effective zero-lower-bound on nominal interest rates can be a significant constraint on monetary policy and persistently low inflation in the 2010s led to some rethinking of inflation target. Prominent economists, such as Olivier Blanchard, Paul Krugman and Lawrence Ball, suggested that the inflation target be raised from the 2% to the 4% level.[29] A higher inflation target makes the zero-lower-bound less binding: a 4% inflation target would mean that the zero lower bound would bind only when the central bank wants to set the real interest rate at -4%, while the zero lower bound would be binding when the central bank wants to set the real interest rate at only -2% with a 2% inflation target.

These challenges can be seen more clearly through the lens of a simple instrument rule, as illustrated in Cecchetti et al (2023). Consider a modified Taylor rule which responds one-for-one to the unemployment gap: [30]

$$(9)\quad i = (r^* + \pi^e) + 0.5(\pi - \pi^*) - (u - u^*).$$

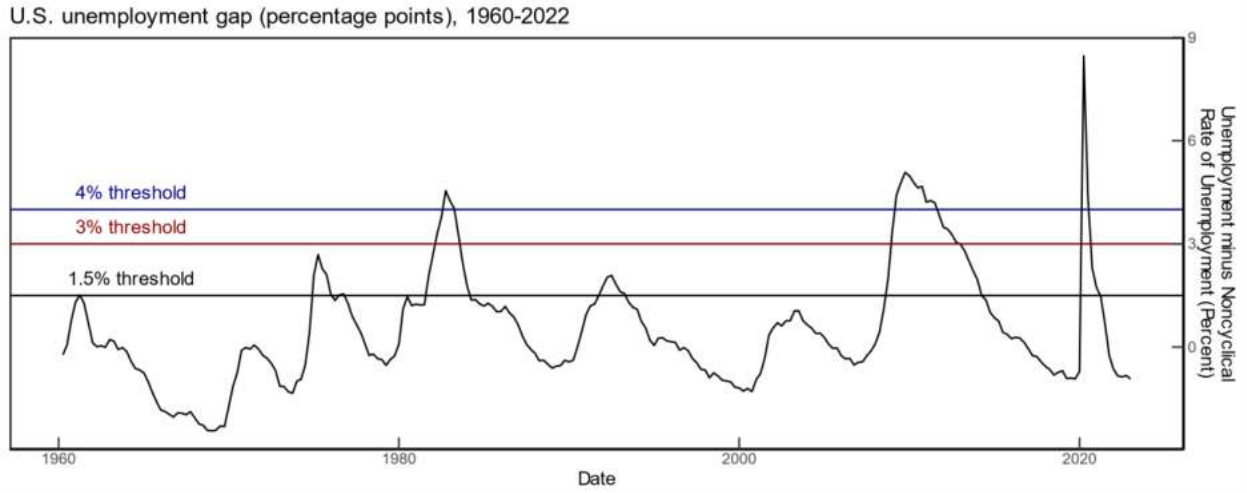
When r^* falls from 2 percent to 1 percent, the *nominal* equilibrium rate of interest $(r^* + \pi^*)$ falls by 1 percentage point from 4 percent to 3 percent and there is less room for monetary policy to cut rates to stimulate demand. Figure x highlights the importance of both r^* and the Taylor rule specification. With r^* and π^* both equal to 2 percent, when the unemployment rate is 4 percentage points higher than the natural rate of unemployment (u-u^*=4), the modified Taylor rule (equation 9) indicates that the policy rate is lowered to zero, so the ZLB binds. Figure x shows that, since 1960, the unemployment gap exceeded this 4 percent threshold (the horizontal blue line) 6 percent of the time. If r^* falls from 2 percent to 1 percent, the unemployment gap threshold declines to 3 percent (the horizontal red line), a level that was surpassed nearly 10 percent of the time.

If instead we use the Fed's balanced approach rule, in which the policy rate moves two-for-one with the unemployment gap, the coefficient on (u-u^*) in equation (9) is two instead of one. In this circumstance, an r^* of 1 percent implies a threshold for the unemployment gap of a mere 1½

[29] E.g., see Blanchard, Dll'Ariccia and Mauro (2010), Krugman (2014), and Ball (2014),

[30] For a discussion of the modified Taylor rule see Cecchetti and Schoenholtz (2018). This modified Taylor rule differs from the one in equation 2 both because the coefficient on the unemployment gap is 1, rather than 2, and because it lacks policy rate smoothing.

percent (the horizontal brown line). Since 1960, the unemployment gap exceeded this level nearly 20 percent of the time.[31]



Although the logic of this argument for a higher inflation target is correct, there are two major reasons why central banks have not decided to raise their inflation targets. Central banks are concerned that significantly higher inflation targets do not accord with the Greenspan definition of price stability,[32] i.e., "the state in which expected changes in the price level do not effectively alter business or household decisions, which seems to be below the 3% level, they cannot be kept stable". Once inflation start to rise above this level, the public is likely to believe that price stability is no longer a credible goal of the central bank and then the question arises, "if a 4% level of inflation is OK, then why not 6%, or 8%, and so on". This problem is more than a theoretical possibility: Korenok, Munro and Chen (2022) provide empirical evidence that households pay increasing attention to inflation has it rises to levels above 2 percent. A second argument against raising the long-run inflation target is that although raising the target might have benefits in the short-run, the costs of higher inflation in terms of the distortions it produces in the economy are ongoing. Thus, although they may not be large in any given year, these costs add up, and in present

[31] Using the FRB/US model and the Fed's balanced approach Taylor rule, Kiley and Roberts (2017) estimate that the U.S. economy would hit the ZLB nearly 40 percent of the time. See their Table 3.

[32] Greenspan apparently first expressed this definition in the July 1996 FOMC meeting (page 51 of the transcript, which can be found at http://www.federalreserve.gov/monetarypolicy/files/FOMC19960703meeting.pdf). This definition was later made public in numerous speeches.

value terms might outweigh the intermittent benefits obtained from the zero lower bound not being binding in periods such as those we have recently experienced.

4.2 Price-level or Average Inflation Targets and Revisions to Policy Frameworks

While central banks have not raised their inflation targets, the combination of low interest rates, pervasive use of QE, and inflation generally below target levels led central banks to assess their policy frameworks in the late 2010s and early 2020s. The frameworks in the United Kingdom and Canada were reviewed periodically as part of the renewal of their inflation target, either implicitly through analysis and communication of the inflation target from the government to the Bank of England in the United Kingdom or through regular periodic (five-year) reviews of the inflation targeting framework in Canada. In the euro area, the policy framework was not formally reconsidered following its establishment in 2003 until a review over 2020 and 2021. In the United States, the FOMC adopted an explicit numerical price objective for its inflation target in 2012 and conducted a review of its policy framework over 2019 and 2020.

As central banks considered revisions to their frameworks, the related research literature was influential. An important literature on ways to make the zero lower bound less binding focused on adopting variants of inflation targeting that are, as Woodford (2003) describes, *history-dependent*: if the inflation target has been undershot in the recent past, monetary policy strives to overshoot it in the near future. Price level targets are one variant of inflation targeting that displays this history dependence, while other similar variants are nominal GDP targeting.[33] These history-dependent targets result in a temporary rise expected inflation when there have been undershoots in the past, thereby allowing the real interest rate to fall below what would have occurred when the nominal rate hits the zero lower bound under a conventional inflation target. In addition, research such as Svensson (1999), Ditmar, Gavin and Prescott (1999, 2000), Vestin (2000, 2006) and Woodford (2003) have shown that a price-level target, which displays this type of history-dependence, produces less output variance than an inflation target in some models, most notably models with rational expectations. The reasoning is straightforward. A negative demand shock

[33]Another, even more complicated variant is using a target criterion, as in Woodford (2003) that involves a tradeoff between output gaps and inflation gaps.

that results in say the price level falling below its target path, say a 2% growth path, leads monetary policy to try to raise the price level back to its 2% target growth path, so that inflation will temporarily rise above 2%. The rise in expected inflation then lowers the real interest rate, thereby stimulating aggregate demand and economic activity. Hence a history-dependent price-level target is an automatic stabilizer: a negative demand shock leads to stabilizing expectations, which stabilize the economy. The mechanism is even more effective when the negative demand shock is so large that the zero lower bound on interest rates becomes binding, as Eggertsson and Woodford (2003) point out.

In practice, price-level or nominal-GDP targets may be less effective than suggested by rational expectations models. There are formidable communication challenges to adoption of either a price-level or a nominal- GDP target. First it is more difficult to explain to the public and financial market participants that the central bank is aiming to hit a price-level or nominal GDP path where the actual level of the price level or nominal GDP is changing over time. Targeting a level of inflation such as 2% is much more straightforward because this 2% number is kept constant. Second, when inflation temporarily rises above 2%, as the central bank intends, the central bank wants the public to understand that it is not weakening its commitment to the long-run 2% inflation target. In addition, price-level or nominal-income targets may be less effective if expectations are not perfectly rationale. Kiley and Roberts (2017) and Bernanke, Kiley, and Roberts (2019) provide simulations demonstrating this possibility and discuss related research. These challenges help explain why central banks have not yet adopted either a price-level or a nominal-GDP target, although central banks continue to study these variants of inflation targeting. For example, the Bank of Canada has explicitly considered price-level targeting in its reviews of its inflation targeting framework.

At the same time, the basic idea that an overshooting strategy involving lower-for-longer interest rates may improve performance near the effective lower bound has proven influential. These ideas have been studied for a long time, most notably beginning with Reifschneider and Williams (2000). Kiley and Roberts (2017) suggested that allowing inflation to rise to between 2½ and 3 percent following an ELB episode may be effective; Bernanke, Kiley and Roberts (2019) considered a range of similar temporarily higher inflation targets, in which policy was

accommodative until a one or three-year moving average of inflation reached the inflation target. Williams and Mertens (2019) considered average inflation target approaches with similar features.

These ideas appear to have influenced discussions at central banks, with discussions of the policy frameworks focused on elements of overshooting and/or (temporary) average inflation targeting. Table x summarizes some of the key elements of the policy frameworks recently adopted (or reconfirmed) in the United States, euro area, United Kingdom, and Canada. Both Canada and the United Kingdom renew their inflation targeting frameworks regularly. In the most recent remit letter to the Bank of England from HM Treasury, the inflation targeting framework was little changed by the 2010s experience. The framework acknowledges that forward guidance and unconventional policies—QE—have a role to play in the conduct of policy but also emphasizes that the inflation target always applies. This reference excludes targeting temporarily higher inflation as part of a strategy to address problems associated with the effective lower bound. Similar, the Bank of Canada acknowledges the impact of the effective lower bound on the choice of policy tools; at the same time, the Bank noted that it considered average inflation targeting but concluded it was not superior to the preexisting inflation targeting framework. In contrast, both the ECB and the FOMC noted that it may be appropriate to aim for inflation above the 2 percent objective following periods over which the effective lower bound was binding and inflation fell short of objective. These statements appear to have been a response to the below-target levels of inflation over the 2010s and the research that suggested that policies that attempt to overshoot target inflation following inflation shortfalls, like average inflation targeting, may address challenges posed by the effective lower bound (e.g., Kiley and Roberts, 2017; Bernanke, Kiley and Roberts, 2019; Mertens and Williams, 2019).

Table x: Reviews of Inflation Targeting Frameworks in the early 2020s

	UNITED STATES	EURO AREA	UNITED KINGDOM	CANADA
INFLATION OBJECTIVE	2 percent, symmetric (unchanged)	2 percent, symmetric (changed from below, but close to, 2 percent)	2 percent, symmetric (unchanged)	2 percent, symmetric (unchanged)
ELEMENTS OF AVERAGE INFLATION TARGETING OR OVERSHOOTING	"following periods when inflation has been… persistently below 2 percent… policy will likely aim to achieve inflation moderately above 2 percent for some time"	"when the economy is close to the lower bound…" "may also imply a transitory period in which inflation is moderately above target."	"The inflation target of 2 percent applies at all times."	Considered average inflation targeting but "In the end, no alternative was better than flexible inflation targeting."
EXPLICIT CONSIDERATIONS RELATED TO THE EFFECTIVE LOWER BOUND	"the proximity of… the effective lower bound" suggests "downward risks to employment and inflation have increased."	Factors "have driven down equilibrium real interest rates. This has reduced the scope… to achieve their objectives by exclusively relying on changes in policy interest rates."	"In the event of… *(the)* effective lower bound, , the Committee may judge it necessary to deploy unconventional policy instruments" and "may also judge it to be appropriate to deploy forward guidance"	"central banks will have less room to lower the policy rate in response to negative shocks. As a result, the Bank will likely have to use other monetary policy tools more often"
ROLE OF ACTIVITY/EMPLOYMENT	"policy decisions must be informed by assessments of the shortfalls of employment" (asymmetric)	"support the… economic policies in the EU…" "includ*(ing)* ... a highly competitive social market economy aiming at full employment"	"support the economic policy of Her Majesty's Government, including its objectives for growth and employment"	"actively seek the level of maximum employment needed to sustainably achieve the inflation target."

The Federal Reserve's revised policy framework differed from its previous framework along two key dimensions. The first was the link to average inflation targeting associated with the idea that inflation above the 2 percent target may be appropriate following a period when the effective lower bound was binding and inflation fell short of objective. This statement introduced aspects of asymmetric average inflation targeting. The second revision was an emphasis on shortfalls of

employment from full employment, rather than two-sided deviations in which employment may fall short or, or may exceed, full employment. This revision suggested that the FOMC would not act preemptively to tighten policy when employment was viewed as high relative to full employment in the absence of higher inflation. As emphasized by Clarida (2022), this approach may have been adopted because estimates of full employment were too pessimistic in the 2010s, potentially leading to a premature removal of policy accommodation, and because of research on the potential benefits of a "hot" economy (Aaronson et al, 2019). Notably, this change set aside the concerns in Erceg et al (2019), Hooper, Mishkin, and Sufi (2020) and McLeay and Tenroyo (2020) regarding the potential for a hot economy to lead to a reemergence of adverse inflation dynamics.

4.3 The inflation spike of 2021-22: Causes and lessons for monetary policy

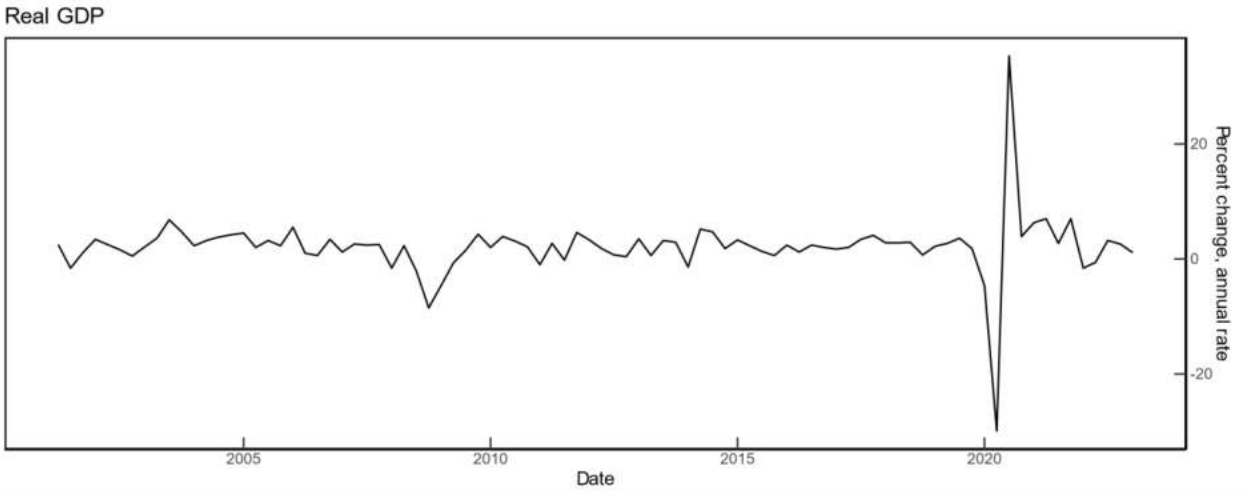
Almost immediately after the shift in policy frameworks by the FOMC and ECB to consider the possibility of inflation overshooting objective following a period of low inflation, advanced economies witnessed the highest levels of inflation in a generation. As shown earlier in figure x, inflation rose above 2 percent across the euro area, United States, and United Kingdom in 2021 and rose to levels between 5 and 10 percent in 2022; moreover, as show in figure x, these increases were broad based in 2022, with core inflation above 5 percent.

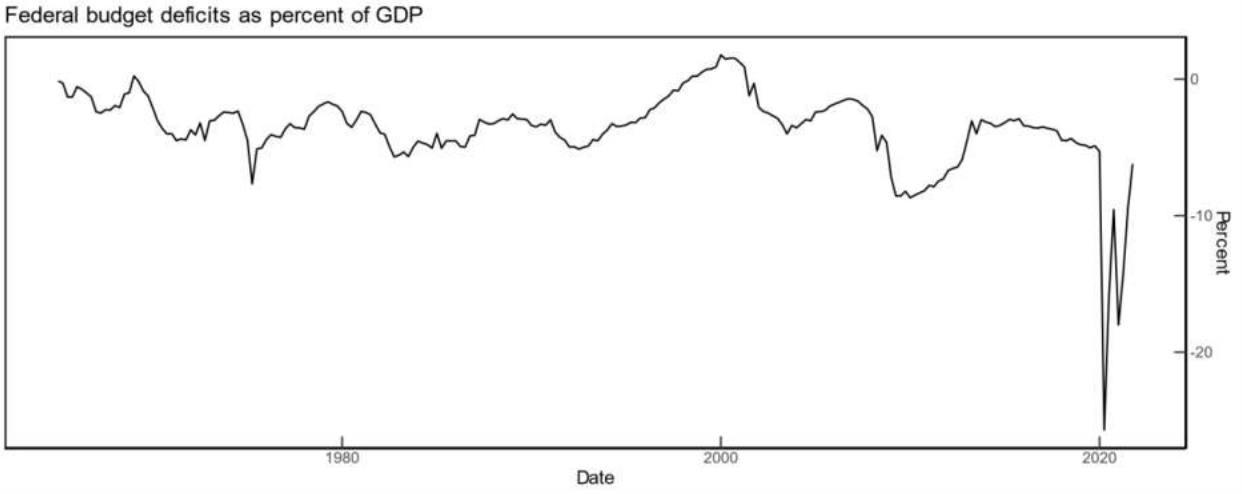
The causes of high inflation were multiple and differed somewhat, especially in timing, across advanced economies. In particular, supply chain disruptions associated with COVID-19 were important and manifested first in the United States when the economy recovered strongly in 2021. Over time, price pressures broadened and appeared to increasingly reflect both excess aggregate demand pressures and momentum in price inflation. Moreover, the euro area and United Kingdom experienced acute price pressures from energy following Russia's invasion of Ukraine in early 2022. Disentangling the relative importance of supply and demand factors on the inflation outlook has been the subject of recent research, with two broad conclusions emerging.

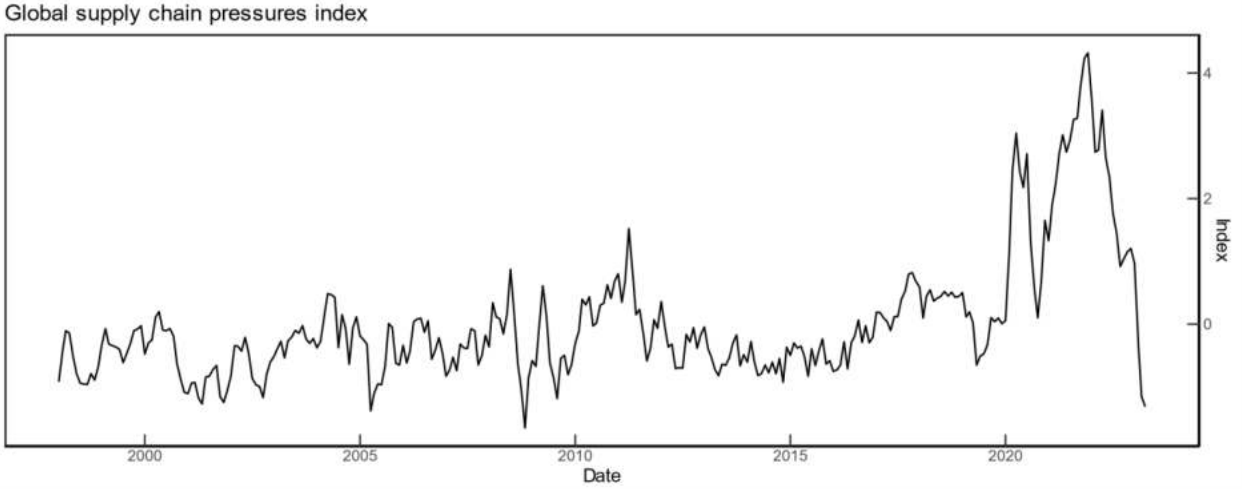
First, both supply and demand factors are important. For example, Giovanni et al (2022) present a macroeconomic model decomposition with a role for supply and demand factors; Shapiro (2022) presents a decomposition of prices into categories more or less influenced by supply and demand factors and similarly finds a role for both in U.S. inflation; and Eickmeier and Hofmann (2022) present an econometric analysis finding a role for both supply and demand factors, with supply factors more important in the euro area in 2022. Given that it is the balance between aggregate demand and aggregate supply that determines inflationary pressures and the large shocks to both supply (e.g., COVID-19 disruptions and Russia's war on Ukraine) and demand (e.g., fiscal stimulus and pent-up demand from lockdowns), it is not surprising both supply and demand factors contributed to the high levels of inflation in 2021 and 2022.

While supply and demand factors were both important, separating supply and demand factors is always challenging. Moreover, the impetus to aggregate demand, especially in the United States but also in other economies, was extraordinary. In response to covid, the federal government initiated substantial stimulus programs as real GDP collapsed. Figure x presents the evolution of real GDP, the federal budget deficit as a percent of GDP, and the supply chain pressures index from the Federal Reserve Bank of New York. The decline in real GDP in the first half of 2020 was unprecedented. The fiscal response was equally unprecedented. In addition, the federal government provided additional stimulus payments to households and initiated a set of other spending programs in 2021, again widening the federal budget deficit to levels well outside historical norms. Even at the onset of the 2021 stimulus, analysis using standard measures of fiscal impact pointed to a large effect on real GDP that would push economic activity above potential (for example, Edelberg and Sheiner, 2021; Blanchard, 2021). Even so, many forecasts did not expect inflation to rise, as the Phillips curve had appeared dormant in the 2000s; we will see this pattern in the discussion of forecasts below. In addition, discussions did not appear to delineate clearly that it is the balance between demand and supply that governs both measures of supply chain pressures and inflation. For example, the measure of supply chain pressures in figure x deteriorated sharply in early 2020, when demand was weakening; this suggests a decline in supply, which would likely prove temporary when covid was controlled. However, supply chain pressures worsened substantially again in 2021 as GDP recovered strongly owing to pent up demand from covid and fiscal stimulus. While a portion of these supply constraints plausibly owed to continued

interruptions owing to covid, it is likely that rapidly expanding demand was a contributor to supply constraints and to inflation. This narrative is consistent with the research above.







The challenges posed by assessments of the balance between aggregate supply and demand can be viewed through the lens of the instrument rules for short-term interest rates that we have used throughout our analysis. In particular, the conduct of monetary policy involves the assessment of the neutral, or equilibrium, real interest rate and the output gap (or deviation from full employment). These concepts are not observable, and they are subject to both movements in trend and changes that may affect their short-run values. It is challenging to assess these factors when economic conditions behave in unusual ways: this was true in the 1970s, when productivity slowed and oil price shocks introduced a new inflationary factor; this was true following the GFC, when severe dislocations in the financial sector weighed on activity in persistent ways that contributed to a slow recover; and it was true following the unprecedented covid shock. While these shifts are hard to identify quickly, an enduring lesson is that policy approaches that are insufficiently cognizant of the possibility that these factors are shifting may lead to poor economic performance.

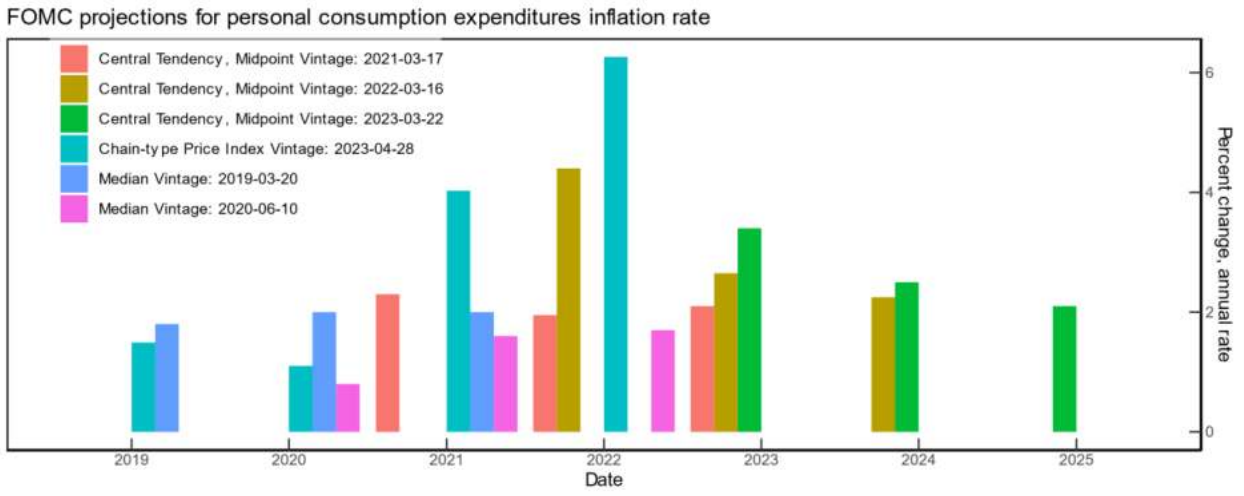
A second conclusion emerging from research is that the persistence of inflation beyond the initial impulses appears to be more in line with macroeconomic relationships that existed many decades ago, rather than during the period of low and stable inflation that prevailed over the 2000s (Kiley, 2022). This is exactly what the analysis of McLeay and Tenroyo (2020); and Hooper, Mishkin and Sufi (2020) predicted, as pointed out Cecchetti et al 2023). It also emerges in flexible time series models, which show an increase in the persistent component of inflation in recent years—a pattern that had not been seen in recent decades but was common in earlier decades (e.g., Almuzara and Sbordone, 2022; Kiley, 2023).

With these observations, we turn our focus to how views on the causes of inflation over 2021 and 2022 shaped the monetary policy reaction and lessons for policy strategies. Two factors are salient: the challenges associated with disentangling the role and persistence of supply and demand factors and associated forecasting errors; and the interaction of these forecast errors with the reduced role for preemptive policy tightening and tolerance for inflation overshooting associated with the revised policy frameworks.

The challenges associated with forecasting economic activity and inflation were important factors. This is straightforward to document for the United States, given the projections from the FOMC

and many outside groups. Figure x summarizes the projections for PCE inflation in the FOMC's Summary of Economic Projections for the years 2019-2023 (which includes forecast until 2025, and using the first available projections in each year); the figure also includes the realization of inflation in 2019-2022). At the end of 2020, inflation remained subdued, and FOMC participants expected inflation to remain below 2 percent. Moreover, the unemployment rate (not shown) remained relatively high. This set of factors was consistent with FOMC communications at the time, which anticipated a prolonged period of policy accommodation.

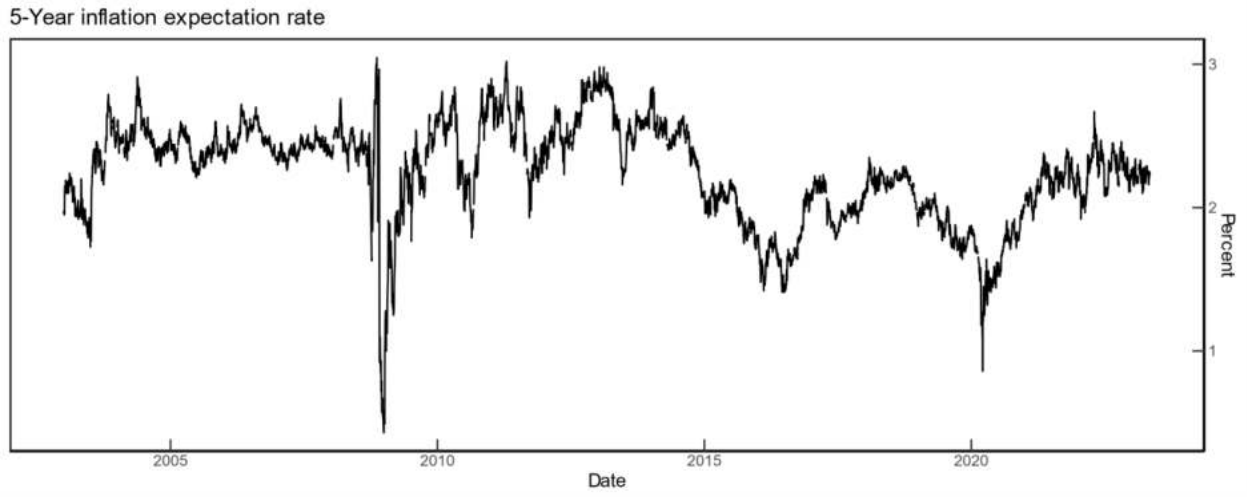
However, headline inflation was 6 percent in 2021 (while core inflation was nearly 5 percent) and the unemployment rate dropped to near 4 percent. Despite this, the federal funds rate remained near zero. Moreover, the FOMC projections in early 2022 showed inflation dropping quickly. The FOMC began to raise the federal funds rate in early 2022 and accelerated the pace of increases over the year as inflation surprised to the upside. The projections from the FOMC suggest that forecast errors, with inflation expected to prove transitory, were an important factor in delaying increases in the federal funds rate. This is consistent with the discussion by Federal Reserve Chair Powell (2021) and Powell (2022) at the Federal Reserve Bank of Kansas City's Jackson Hole Symposium.



The projections from the FOMC on inflation and other macroeconomic variables were similar to those of professional forecasters; for example, Kiley (2022) reports projections from professional forecasters and various Phillips curve models. These forecasts indicate that professional

forecasters were too optimistic regarding the inflation outlook and failed to project the recovery in employment relative to actual realizations. As a result, FOMC and private-sector expectations were for settings of the federal funds rate below levels realized. In addition, the federal funds rate fell below prescriptions from the Taylor 1999 rule over the course of 2021 and 2022 (e.g., Papell, 2022). This likely reflected several factors. First, inflation was not expected to be persistent, as indicated by forecasts, and hence forward-looking prescriptions from interest rate rules suggested less need for a removal of accommodation. Second, the FOMC's 2020 framework did not emphasize preemption in response to low levels of the unemployment rate—that is, it focused on shortfalls. Asymmetric rules that ignored low unemployment suggested less need for a removal of accommodation (e.g., Papell, 2022). Finally, albeit more speculatively, many policy rules in the literature included a role for gradualism and the FOMC had adjusted the federal funds rate in a gradual manner since the early 2000s. This practice may have contributed to a period over which communications and decisions regarding the removal of accommodation needed to adjust to enable a more rapid removal of accommodation. Over the course of 2022, the FOMC shifted in that direction and responded with large adjustments in the federal funds rate.

One factor that may have made monetary policy communications in the United States challenging in 2021 and 2022, beyond forecast errors and a lack of response to rapidly falling unemployment, was the role of temporary average inflation targeting. The FOMC's 2020 framework was not transparent with respect to a time period over which inflation shortfalls would be computed and used in the determination of overshooting. This lack of clarity may have made it difficult to assess the degree of overshooting that would be tolerated, which could have led to a deanchoring of inflation expectations. While this risk was present in principle, longer-term inflation expectations remained well contained throughout this episode, as indicated by the five-year/five-year forward breakeven inflation rate from TIPS (figure xx). However, an important factor in preventing the deanchoring of inflation expectations was the rapid reversal of the Fed's easy monetary policy when it reestablished its commitment to stabilize inflation by raising the federal funds rate target at a very rapid clip: with a 50 basis point increase at the May, 2022, FOMC meeting and then unprecedented 75 basis point increases at the June, July, September and November FOMC meetings, with a further 50 basis point increase at the December FOMC meeting, with several 25 basis point increases at subsequent meetings.



Despite the challenges associated with learning to execute a new framework, the elements of average inflation targeting adopted by the FOMC in 2020 were arguably not the most important factors shaping the response of the federal funds rate in 2021 and 2022. For example, research on policy strategies that suggested a degree of inflation overshooting would enhance the efficacy of policy generally called for modest overshooting. Kiley and Roberts (2017) suggested that an inflation overshoot to levels of 2½ to 3 percent my enhance the stabilization properties of standard policy strategies. Bernanke, Kiley, and Roberts (2019) and Bernanke (2020) suggested that overshoots of inflation that recouped the shortfall of inflation relative to 2 percent over the previous year or three years may enhance stabilization. The inflation rates in 2021 far overshot these levels, and hence these types of overshooting strategies would have called for the removal of accommodation before the end of 2021.

Putting these results together, the asymmetric average inflation targeting elements likely were not central to the slow adjustment of monetary policy to high inflation in 2021. The lack of preemption in the face of low and falling unemployment, the gradualism of the policy approach since the early 2000s, and the persistent forecast errors were likely more central.

The post-covid role of persistent forecast errors and the challenges associated with measuring the neutral real interest rate and the balance between aggregate demand and supply have not been limited to the United States. For example, the euro area has been struck by many of the same factors as the United States, and the euro area was more directly affected by the adverse supply

and demand effects of the Russian invasion of Ukraine in 2022. As shown earlier, inflation in the euro area has been high, including in core inflation. The persistence of inflation and the rise in core inflation in the euro area was unanticipated by the ECB (and private forecasters) well after the supply shocks of 2022 materialized.

5 Conclusions: Lessons for Central Bank Strategy and Tactics

Our review of central bank activities and economic performance points to several lessons for central banks. These lessons include relearning, or reemphasizing, earlier lessons as well as lessons on how to adapt central bank practices to accommodate new challenges and tools.

Lesson 1: Price stability has important benefits and is the responsibility of a central bank

Our first lesson, perhaps relearned or at least reemphasized, is that price stability has important benefits and is the primary responsibility of the central bank. Recent experience suggests this lesson, while not forgotten, may have been underappreciated over the past decade. Central banks and economic research in general were concerned about persistently low inflation among advanced economies in the 2010s. Inflation remained low even after economic activity had substantially recovered and the economy approached levels of employment. Inflation expectations appeared well anchored, even following large shocks to the economy including the Global Financial Crisis and Covid. This combination suggested the Phillips curve was sufficiently flat (or nonexistent) to lead to an increased emphasis on the benefits of a high-pressure economy.

Inflation returned to high levels in 2021 and 2022. While a very large share of the increase, especially initially, reflected supply shocks, excess aggregate demand has played a role. The Phillips curve has returned, as would be expected when monetary policy became less preemptive. High inflation has imposed costs on households and businesses, as is clear from surveys. Bringing inflation down has become the central factor—at least in 2022—in the determination of the monetary policy stance.

In broad terms, this pattern echoes that of the 1970s, although the echo is very faint. A view that supply shocks were driving inflation and monetary action was not needed led to a slow response. As inflation appeared more intractable, central banks pivoted to reassert price stability in recognition of the centrality of price stability to their remit. The echo of the 1970s is nonetheless very faint, as the pivot by central banks occurred quickly and inflation expectations at longer horizons remained anchored. Nonetheless, inflation remained well above central banks' objectives, highlighting how the adjustment process and ultimate outcome remains to be seen. To the extent inflation returns near objective levels soon, the early 2020s inflation episode will be remembered as an important reminder of the costs of price instability, which had not been a significant factor across advanced economies since the 1990s.

Lesson 2: Achieving price stability in a complex and uncertain environment involves a credible commitment to a nominal anchor with a strong response to inflation and preemptive leaning against an overheating economy.

A credible commitment to a nominal anchor provides a counterbalance to the time-inconsistency problem, helps anchor inflation expectations, and can promote fiscal responsibility, all of which help a central bank to achieve price stability. However, even with a credible nominal anchor, containing inflationary pressures, once they emerge, requires a monetary stance sufficiently tight to reverse inflationary pressures. Judging whether a monetary stance is appropriately tight is not simple for several reasons. The neutral real interest rate is not observable. Tighter monetary policy will also lead to a weakening in economic activity. Central banks mandates call for a balancing of inflation and activity, but the level of full employment or potential output is similarly unobservable. As a result, gauging the appropriate level of interest rates to achieve a desirable balance between price and economic stability is challenging. In addition, the monetary stance in the neighborhood of the effective lower bound has involved quantitative easing, which affects long-term interest rates and financial conditions in general. QE implies that the stance of monetary policy is multidimensional, which further complicates the setting of monetary policy and the achievement of price stability.

All of these factors have been important since the Global Financial Crisis. The level of the neutral real interest rate in the 2010s was lower than in earlier decades, but this was difficult to assess in

real time. The level of full employment in the United States appears to have been higher (a lower equilibrium real interest rate) in the 2010s than appreciated in real time. The appropriate level of the central bank's balance sheet was also hard to gauge in real time, as illustrated by the challenges in the United States in gauging a sufficiently ample level of reserves. Moreover, all of these uncertainties were arguably amplified by Covid, which caused significant impediments to aggregate supply and was met with a large fiscal expansion and QE in the United States and elsewhere. The uncertainties associated with this complex environment contributed to the high and persistent inflation over 2021 and 2022.

Nonetheless, experience and the literature emphasize several principles that can guide monetary policy. Real interest rates must rise with inflation more than one-for-one to cut short inflationary pressures. Economic models and forecasts are subject to significant errors and excessive reliance on forecasts can lead to policy mistakes. Similarly, excessive reliance on measures of the neutral interest rate, potential output or full employment, or changes in the Phillips curve relationship have contributed to policy mistakes—in both directions. Research suggests that these uncertainties can be addressed by a balanced approach with systematic responses to inflation, a degree of preemption in which policy responds to sizable changes in labor market conditions or economic activity, and flexibility. For example, strict adherence to policy rules relies heavily on measures of the neutral rate and full employment and hence is subject to a range of policy errors. At the same time, research suggests wide gaps between policy rules and policy settings can signal a policy stance inconsistent with price stability. A flexible inflation targeting framework, informed by rules, can incorporate these policy lessons.

Lesson 3: Central bank communication and transparency are key elements of monetary policy strategies and tactics.

A credible commitment to a nominal anchor, such as an inflation target, can only be achieved if a central bank communicates in a transparent manner its target and how it plans to achieve it. Central bank practice has incorporated this lesson, as inflation targeting has become among the most common frameworks and has been accompanied by enhanced communications. However, as central banks have adopted elements of average inflation targeting schemes, communications regarding the new elements (such as the degree or time period for overshooting inflation) have not

been well developed. This underdevelopment may have contributed to some of the challenges that followed the Federal Reserve's framework adopted in 2020.

Furthermore, transparency and communication is what enables a central bank to constrain discretion, thereby alleviating the time-inconsistency problem. Central-bank instrument independence, which has many benefits, is only sustainable if the central bank is accountable to the public, and accountability only occurs if the central bank communicates clearly about its objectives and how it sets its policy instruments. In addition, nonconventional monetary policy such as forward guidance has its intended effects directly through transparent communication about the future path of policy instruments. Indeed, increased central bank communication and transparency have been key features of the evolution of central banks over the last 30 years.

Lesson 4: The equilibrium interest rate may remain low and call for forward guidance and QE, but the roles of QE and new strategies require more research and experience.

A substantial share of the new issues confronting central banks since the 2000s stem from low levels of nominal and, especially, real interest rates. Low interest rates imply that the effective lower bound is more likely to bind. As a result, central banks turn to forward guidance and quantitative easing to provide monetary accommodation.

While higher inflation in 2021 and 2022 has led to somewhat higher nominal and real interest rates, real interest rates and measures of the equilibrium real interest rate remain low relative to the levels that prevailed prior to the Global Financial Crisis. While uncertainty is considerable, low real neutral interest rates may persist. If this occurs, central banks will likely continue to deploy forward guidance and QE.

However, the use of forward guidance and QE remains a work in progress. With regard to forward guidance, both the ECB and the Federal Reserve communicated in their framework reviews around 2020 a tolerance of a modest inflation overshoot following periods when the nominal rate was constrained by its effective lower bound. The Federal Reserve's approach suggested elements of asymmetric average inflation targeting. The efficacy of these approaches has not been tested, as

the large shocks following Covid quickly raised inflation beyond levels consistent with even an average inflation targeting framework. Nonetheless, the communication and implementation challenges of new frameworks remain to be addressed. Similarly, research suggests that QE is effective, both the degree of efficacy found across studies is sizable and generally points to the idea that QE is an imperfect substitute to lowering the short-term nominal interest rates. Moreover, central banks have had limited experience substantially reducing their balance sheets following expansionary QE. All told, QE remains an important research area.

Lesson 5: The role of central banks in promoting financial stability is appropriate to achieve price and economic stability but increases risks to independence.

The Global Financial Crisis, low interest rates and the potential for reach-for-yield behavior, and the use of central bank balance sheets to promote financial stability (in addition to the use for QE) have highlighted the importance of financial stability and the associated role for central banks. Financial stability is important for price and economic stability. Central banks have a macroeconomic perspective and a role in payments and financial supervision. This combination implies a role for central banks in financial stability.

At the same time, financial stability typically involves extensive coordination with other parts of the government, including with fiscal authorities in cases where credit risk or other quasi-fiscal actions are involved. The role for coordination is apparent in the use of committees to set financial stability policies across many countries. Such coordination brings the potential for political conflict which could affect independence in the setting of monetary policy. Frameworks with clear delineation of the roles and responsibilities of different parts of the government are important for avoiding such risks to monetary policy independence. As the development of financial stability committees is somewhat recent, research and experience will help identify organizational principles and macroprudential policies that most effectively promote financial stability.

Lesson 6: Goals for central banks other than price and economic stability can be problematic, as promoting stability and implementing new strategies are sufficiently challenging and other goals may risk independence in monetary policy.

Even with mandates focused primarily on price and economic stability, with a complementary mandate for financial stability, the task before central banks has become increasingly complex over the past twenty years. Low interest rates have required nonconventional policies such as forward guidance and QE, and the combination of low interest rates and inflation in the 2010s led to consideration of variants of average inflation targeting. These tools and strategies remain works in progress.

Financial stability concerns have been important factors for central banks through their role in macroprudential policy and through the impact of developments in the financial sector on economic activity and inflation. The possibility that low interest rates has contributed to a build up in risks in the financial sector has led to renewed focus in research and policy commentary on the possibility that financial dominance could constrain monetary policy.

Large central bank balance sheets and the substantial increase in government debt relative to GDP in many countries have led to increased focus on central bank's income on government finances. This focus has increased further as interest rates have risen in recent years, as persistently higher interest rates would increase government debt expense. (Despite this, high inflation in recent years typically helped the fiscal position, as it was a surprise and led to more rapid increases in nominal GDP than in debt). These developments have contributed to increased focus on the role of fiscal-monetary interactions in the determination of inflation and on the possibility of fiscal dominance constraining monetary policy.

Given this complex landscape, central banks have a difficult job. Despite this, there has been some call for central banks to take on additional mandates, including issues such as inequality and climate change. These issues have important macroeconomic and financial implications, and as a result central bank analysis to understand these issues is part of promoting price, economic, and financial stability. However, the central banks have limited tools and additional mandates for central banks may not be achievable given their tools. Such additional mandates may also affect

monetary policy independence in ways that affect the achievement of price, economic, and financial stability.

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