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The analysis in this paper was presented to the Federal Open Market Committee as background for its discussion of the Federal Reserve's review of monetary policy strategy, tools, and communication practices. The Committee discussed issues related to the review at five consecutive meetings from July 2019 to January 2020. References to the FOMC's current framework for monetary policy refer to the framework articulated in the Statement on Longer-Run Goals and Monetary Policy Strategy first issued in January 2012 and reaffirmed each January, most recently in January 2019.

Abstract

We consider three ways that a monetary policy framework may employ a range for inflation outcomes: (1) ranges that acknowledge uncertainty about inflation outcomes (uncertainty ranges), (2) ranges that define the scope for intentional deviations of inflation from its target (operational ranges), and (3) ranges over which monetary policy will not react to inflation deviations (indifference ranges). After defining these three ranges, we highlight a number of costs and benefits associated with each. Our discussion of the indifference range is accompanied by simulations from the FRB/US model, illustrating the potential for long-term inflation expectations to drift within the range.

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I. Introduction

Over the eight years since the Federal Open Market Committee (FOMC or the Committee) adopted its 2 percent inflation objective, deviations of inflation from this objective have been frequent, and they will be unavoidable in the future. These deviations reflect both technical limitations on the ability of monetary policy to control inflation (such as imperfect knowledge about the state of the economy) and tradeoffs between inflation stabilization and the Committee's objective of maximum employment. Moreover, control of inflation may be particularly difficult in the current economic environment in which deviations of inflation below the Committee's objective have proven to be highly persistent and monetary policy faces a heightened risk of being hampered by the effective lower bound (ELB).[1]

Because inflation will not always be at its objective, conveying some information about an appropriate range of inflation variability may help the public better understand some key features of the Committee's monetary policy framework. This paper describes several different ways in which an inflation range *around* a target might be employed and identifies channels through which these approaches might help or hinder the Committee's efforts to achieve its objectives. We will focus particularly on the ways in which inflation ranges can support or interfere with monetary policy strategies designed to cope with the challenges of the current environment.

While we do not provide a complete quantitative assessment of the efficacy of these various approaches, several key conceptual points emerge from our discussion. First, because there are several ways in which an inflation range might be employed, a key risk is that the intent of a range could be misinterpreted. In particular, ranges intended to communicate uncertainty or allow for flexibility could be interpreted as signaling indifference across inflation outcomes within the range. Second, ranges and other components of the Committee's broader monetary policy framework—including the strategy that the central bank will employ to guide inflation toward and within the range—should support each other and, thus, would benefit from being clarified in tandem. Third, the use of a range focuses public attention on the magnitude of inflation

[1] A voluminous literature going back to Reifschneider and Williams (2000) quantifies the effect of the ELB on economic outcomes, including inflation.

deviations, thus possibly diminishing attention to other important aspects of inflation dynamics, such as the persistence and source of those deviations. The Committee may want to clarify that these aspects also play important roles in monetary policy deliberations. Finally, the appropriateness of a range is contingent on structural factors that may not be constant over time, such as the volatility of supply shocks or changes in the structure of the labor market. Accordingly, if a range is specified, the public should be made aware that the band may need to be revised depending on the evolution of these factors.

The paper is organized as follows. In section II, we distinguish three ways in which inflation ranges might be employed. In section III, we summarize the international experience with ranges for inflation. In section IV, we discuss advantages and disadvantages of each inflation range concept, focusing on challenges to communications related to the use of a range. In section V, we discuss practical issues pertaining to the choice of an inflation measure. Section VI concludes.

II. A Taxonomy of Inflation Range Concepts

We begin by laying out three different concepts of an inflation range: an uncertainty range, an operational range, and a range of indifference.[2] In each case, monetary policy frameworks using such a range may or may not emphasize a point inflation objective. Throughout our discussion, we take as given that the Committee will continue to pursue a 2 percent inflation objective and accordingly discusses the use of ranges in this context.

Uncertainty Range

An uncertainty range informs the public about the Committee's assessment of the magnitude of inflation variations under appropriate policy. Complete inflation stabilization may not be possible or appropriate for a number of reasons, including imperfect information about the current state of the economy or the occurrence of shocks that require monetary policy to balance its inflation objective against its maximum-

[2] While we focus largely on ranges defined in terms of commonly reported inflation series, ranges that refer to transient or persistent components of inflation, as well as inflation forecasts, could also play a role. We will discuss considerations bearing on the choice of inflation measure to use in the range in section V.

employment objective. An uncertainty range can help clarify for the public the extent to which the Committee views its pursuit of the inflation objective as constrained by these factors. Moreover, as we will discuss, central banks in a number of advanced foreign economies use an uncertainty range in communication and accountability.

The specification of an uncertainty range may reflect short- to medium-term uncertainty or may refer to average uncertainty over the long term, and this specification choice may be communicated with varying degrees of precision to the public.[3] For example, the range may characterize the uncertainty of inflation over the next one to two years or, less precisely, over the "medium term." Alternatively, the range could be defined in terms of the behavior of inflation over the business cycle such that, with high probability, inflation does not exceed the top of the range in expansions and, similarly, is unlikely to fall below the bottom of the range in recessions (or when the ELB binds).

Operational Range

An operational range signals to the public that the Committee might, under some conditions, prefer inflation to be away from its long-run objective for a time, such as a temporary overshoot of inflation following persistent undershooting. The operational range could define the scope of such intentional deviations. Operational ranges are conceptually distinct from uncertainty ranges in several ways.[4] First, an operational range expresses the Committee's intent to move inflation temporarily away from its objective, not just its recognition of imperfect control or of a tradeoff between inflation and employment stabilization. Second, the operational range need not be tied to a specific statistical measure of dispersion in inflation outcomes. To clarify this concept, we present the following two examples to demonstrate the use of such a range:

1. *An operational range for generic "lower for longer" policy.* An extensive literature has shown that the adverse effects of a binding ELB can be offset, to some extent, by lower-for-longer policies, including threshold-based policies for

[3] Formally, that is, the range may reflect either conditional uncertainty around a forecast for inflation at some finite future horizon or the unconditional uncertainty of inflation.

[4] Logically speaking, an operational range could be introduced via a suitably specified (conditional) uncertainty range. Nothing in our discussion is affected by this possibility.

exit from the ELB and various makeup strategies.[5] An operational range could be used to convey to the public that the Committee will consider lower-for-longer strategies in a recession subject to a maximum tolerance for above-target inflation but without pre-commitment to any specific quantitative reaction function. (Particular details could, of course, be communicated as more information becomes available and the Committee's views about appropriate policy become more determinate.)

More concretely, the Committee could convey to the public that in the event that a binding ELB is accompanied by inflation meaningfully and persistently below its objective, it would prefer for inflation to vary in a range of 2 to 2½ percent, but no higher, during some period over the recovery.[6] From the asymmetric inflation range, the public might infer the Committee's appetite for exceptionally accommodative policy during the expansion, and this expectation alone should lower expected real interest rates.

2. *An operational range to implement average inflation targeting.* In the previous example, the operational range specification is vague about matters such as how protracted an overshoot within the range would be permitted or how soon the Committee would prefer to see overshooting and might, indeed, be consistent with very little exceptional accommodation. In the absence of further communication, private forecasters would have to put at least some weight on only modest or transient overshooting, diminishing the effectiveness of the range as a support for lower-for-longer strategies.

The specification of an operational range would be strengthened if clarified in tandem with the Committee's overall monetary policy strategy. In this

[5] Simple, but effective, strategies for offsetting the ELB though forward guidance were described by Reifschneider and Williams (2000). Optimal strategies in the presence of the ELB, which typically involve a commitment to keep interest rates lower for longer, were described by Eggertson and Woodford (2003) and Adam and Billi (2006).

[6] Note that in this example, conveying a preference for inflation in the 2 to 2½ percent range, but no higher, relates to a similar "escape clause" concept under a lower-for-longer policy that was discussed in Chung and others (2019). The implications of inflation outside the range could be communicated jointly with the announcement of the range itself, in particular, conditions under which excessive inflation would trigger monetary tightening.

example, the Committee would make explicit that the range is intended to serve as a placeholder for an incompletely determined average inflation-targeting strategy. In this case, the Committee could convey to the public that inflation persistently above or below its 2 percent objective is a matter of concern if the credibility of the Committee's symmetric inflation objective is threatened. The Committee could then state that, accordingly, in situations where inflation has run well below 2 percent for an extended period, it would prefer for inflation to rise to between 2 and 2½ percent until average inflation over several years is roughly 2 percent.[7] Because this policy does not specify the length of the averaging window (or even whether there is a time- and data-invariant horizon), the Committee retains considerably more flexibility than with the announcement of a completely determined average inflation-targeting rule. However, the public can now infer that inflation toward the lower end of the range will imply a longer duration for the overshoot. Along with corresponding inferences about the degree of monetary accommodation necessary to achieve these inflation outcomes, public understanding along these lines should provide additional support for aggregate demand in the face of deflationary shocks.

Indifference Range

An indifference range indicates to the public that monetary policy will not respond to deviations from the inflation objective within the indifference region. As we define the term, an indifference range is compatible with responding to movements in economic activity at all times. For example, appending an indifference range to a standard Taylor-type rule could yield

$$R_t = \gamma\, R_{t-1} + (1-\gamma)(R^* + 2 + \alpha_Y GAP_t + \alpha_\pi\, d_t),$$

where R_t is the federal funds rate, R^* is the natural rate of interest, and GAP_t is the output gap, with $d_t = \pi_t - 2$ when π_t (the four-quarter change in core personal consumption expenditures (PCE) inflation) is outside the range and $d_t = 0$ otherwise. Unlike the

[7] Used in this way, the limits of the range will affect public expectations about the duration of the intentional deviation from the inflation objective. For example, all else being equal, the public may infer that a higher limit would allow the Committee to more rapidly stabilize whatever measure of average inflation the Committee chooses to actually guide its policy setting.

previous two range concepts, which described a range for outcomes but did not directly characterize policy, this concept prescribes, by definition, specific behavior of monetary policy within the range.

An indifference range might appear appropriate under the assumption that even very small changes in policy could generate nonnegligible costs for the public, such as costs of interpreting and acting on such changes.[8] We note that adopting an indifference range need not imply that the Committee regards all inflation paths within the range as equally desirable, just that, given the costs associated with changes to the policy instrument, the Committee chooses not to react directly to those deviations.

III. Foreign Experience with Inflation Ranges

Most advanced-economy central banks arguably use some form of an inflation range, with ranges being seen as having "soft edges" where inflation rates just inside and just outside the range are not treated as sharply different (table 1, located after the appendixes).[9] Some central banks, including the Swedish Riksbank, the Reserve Bank of New Zealand (RBNZ), and the Bank of Canada, have symmetric ranges but emphasize the midpoint of their ranges. A few central banks have ranges without a clear point target. The Reserve Bank of Australia (RBA) has a "thick point" of 2 to 3 percent without a point target or midpoint. The target of the Swiss National Bank (SNB) is below 2 percent but positive. The European Central Bank (ECB) aims for inflation that is below, but close to, 2 percent, without precisely indicating what that number is. A couple of central banks—the Bank of England and Norges Bank—have point targets but with additional communications linked to a range, which we will discuss.

In terms of our taxonomy, what most central banks say they do can be best described as an uncertainty range—both because inflation is volatile and because central banks cannot control it precisely. For instance, the Riksbank notes that its "variation

[8] A formal, albeit stylized, example of an environment in which an indifference range is optimal is provided by Lei and Tseng (2019), who consider optimal policy in the presence of a fixed cost incurred when the federal funds rate is changed.

[9] See appendix 1 for a listing of the remits of the central banks studied here.

band" is intended to signify "that monetary policy is not able to steer inflation in detail . . . [and] that inflation varies around the target and will not be exactly 2 per cent every single month."[10] Ranges were generally adopted when inflation targeting was introduced in the 1990s at a number of these central banks. At that point, the experience with high and volatile inflation in the 1970s and 1980s and the difficulty in controlling inflation were likely fresh in the minds of the designers of many of these frameworks. In addition, many of the central banks considered in this paper are in small open economies, where inflation is more sensitive to foreign factors.

By contrast, no central bank publicly describes its range as a "range of indifference," as defined earlier, though two cases are questionable. The RBA argues that its target of 2 to 3 percent is not "a zone of policy inaction," although the notion of a "thick point" suggests that policy responses could be muted as long as inflation is within the range.[11] Similarly, the SNB has said that its 0 to 2 percent range is meant to take "into consideration the fact that inflation cannot be steered with pinpoint accuracy, or measured precisely," which suggests an uncertainty range.[12] However, the SNB's communications stress the need for adjustment when inflation is outside the range, and Swiss inflation has persistently been slightly negative or close to zero for several years now, suggesting that in practice the SNB may be closer to a range of indifference.

In general, central banks are trying to filter which shocks to inflation are transitory and which are more persistent, and they may not react as strongly to shocks that are perceived as transitory, whether inflation is in the range or not. For instance, the Bank of Canada, noting that inflation is volatile, has said that it would not always take action to bring inflation back to the midpoint because reacting to transitory shocks would

[10] The passage continues: "However, the objective of monetary policy is still that inflation shall be 2 per cent, the variation band of 1–3 per cent is not what is known as a target interval"; see the Riksbank's website at https://www.riksbank.se/en-gb/monetary-policy/the-inflation-target.

[11] According to Guy Debelle (2018), "The inflation target can be thought of as a 'thick point.' This doesn't mean that inflation with a 2 in front of it implies a zone of policy inaction. It simply acknowledges that inflation will obviously vary through time and that there is probably not much to be gained from being too precise about the appropriate inflation rate, whilst also recognising that the specification of the inflation target plays an important role in anchoring inflation expectations."

[12] See the SNB's website at https://www.snb.ch/en/iabout/monpol/id/monpol_strat#t3.

lead to instrument instability.[13] Moreover, most central banks are "flexible" inflation targeters or, in a few cases, have mandates for employment like the Federal Reserve, and they are likely trading off reacting to inflation with reacting to an unemployment gap.

As for the remaining concept in our taxonomy, no advanced-economy central bank describes its range as an "operational range," where the central bank might be following a makeup strategy. A couple of central banks—the RBA and the RBNZ—describe themselves as trying to meet their inflation targets "on average," but they note that their framework allows "bygones to be bygones."[14] In addition to how central banks describe what they are doing, some empirical work suggests that they have not been following price-level targeting.[15]

One possible exception, as noted by Duarte and others (2020), is the Czech National Bank (CNB), an emerging market central bank that communicated its intention to maintain a ceiling on the exchange rate until inflation exceeded its 2 percent objective. The CNB's inflation range of 1 percentage point on either side of its objective was one element among several that may have raised the credibility of this commitment. However, the CNB's range does not seem intended to signal that it would actively prefer inflation to deviate from 2 percent under certain circumstances. Thus, in terms of our taxonomy, the CNB's experience seems closer to an uncertainty range.[16]

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[13] According to Timothy Lane (2015), "Total inflation can be 'noisy' because many temporary sector-specific factors impinge on inflation in the short run and, in many cases, are quickly reversed. . . . In this setting, we can't hit our inflation target precisely or continuously—and we don't try to. . . . And because our policies work with long lags, we would have to overreact, making huge adjustments in our policy rate to have any effect, followed by huge corrections to compensate for the lagged effects of our own policies. This would lead to what has been called 'instrument instability.' "

[14] See Debelle (2018). Also, discussing monetary policy accountability and monitoring on its website, the RBNZ states, "The Board noted that the inflation target was something which the Bank was to be 'constantly aiming' for, and that deviations from the target range neither could nor should be instantly corrected. . . . In conducting monetary policy, then, the Governor is expected to be constantly forward looking, focusing on the horizons where monetary policy can work most efficiently and effectively. Bygones (recent inflation outcomes) matter to current policy only to the extent that they affect likely future inflation outcomes"; see https://www.rbnz.govt.nz/monetary-policy/about-monetary-policy/monetary-policy-accountability-and-monitoring.

[15] See Ruge-Murcia (2014).

[16] According to the CNB's website, "Despite the fact that the CNB strives to keep future inflation at the 2% target all the time, actual inflation deviates from this value due to unexpected shocks. Although

One way that central banks handle deviations from their inflation target is by stipulating a horizon by which they generally try to meet their inflation targets. As noted in row 6 of table 1, these can be phrased as "over the medium term," as several central banks do, such as the ECB and Norges Bank, or suggest a more specific date range, like six to eight quarters, as at the Bank of Canada.

While it is not clear that ranges affect a central bank's setting of its policy instruments, they do play a role in accountability at many central banks. Several central banks release additional communications if inflation moves away from the target by 1 percentage point or more. For example, the Bank of England has a point target, but if inflation deviates by more than 1 percentage point from the objective, the Monetary Policy Committee (MPC) must write an open explanatory letter to the Chancellor of the Exchequer that includes the MPC's "strategy towards returning inflation to the target . . . in a timely fashion" (Hammond, 2018). Norges Bank, the Bank of Canada, and the Riksbank also have requirements for additional communications if inflation falls outside of their ranges, including public letters and more detailed explanations in monetary policy and annual reports.

IV. Implications of Employing an Inflation Range

In this section, we discuss some benefits and challenges of employing one of the inflation range concepts defined in section II. We begin by emphasizing a few common concerns that arise to various degrees across all of the inflation range concepts and then discuss pros and cons pertaining to each. We summarize our discussion of the concept-specific pros and cons in table 2 (shown on the final page of this paper). We conclude the section with simulation results for the case of an indifference range.

Common Concerns

First, each of the inflation range concepts focuses attention on the magnitude of inflation deviations. However, when responding to shocks to inflation, monetary policymakers will also consider a number of other features, such as the nature of the

monetary policy reacts to these shocks and aims to ensure that the point target is achieved in the future, it is unable to return inflation to 2% immediately. This uncertainty is illustrated by a tolerance band of one percentage point in either direction"; see https://www.cnb.cz/en/monetary-policy/inflation-targeting.

shock (for example, supply or demand) and the likely persistence of the resulting deviation in inflation under appropriate policy. For example, offsetting very transient fluctuations would require volatile interest rate settings, and policymakers may accordingly not be inclined to react forcefully to such fluctuations, even if they are possibly large. Similarly, given the attenuated relationship between inflation and economic slack, policymakers may not wish to completely offset certain structural shocks to costs, such as technology shocks, even if this stance implies appreciable deviations of inflation from its objective. However, a drift in long-term inflation expectations may require vigorous policy action to preserve the credibility of the inflation objective.

Second, context may matter importantly for the introduction of an inflation range. Introducing an inflation range at a time when inflation has been running persistently below 2 percent may reduce the credibility of the commitment to a symmetric inflation objective strongly centered at 2 percent, possibly causing inflation expectations to become less well anchored or even anchored below the objective. In the case of most other central banks using inflation ranges, these ranges were established close to the introduction of inflation-targeting regimes, when the central banks' ability to control inflation was less clear. More recently, proposals by a couple of ECB Governing Council members to introduce an inflation range have been interpreted by some as suggesting that they may wish to slow down or remove monetary policy actions to achieve their inflation objective.

Finally, any range concept risks confusing the public's understanding of the point inflation objective, possibly weakening its credibility.

Range-Specific Concerns

Uncertainty range

Uncertainty ranges might bring several benefits.[17] First, specifying an uncertainty range acknowledges the challenges of measuring inflation as well as unavoidable

[17] A number of papers, going back to Stein (1989) and including Mishkin and Westelius (2008), have noted that imprecise central bank commitments and communications can be helpful for addressing certain time-inconsistency problems. In Stein (1989), time-inconsistency issues create an obstacle for central bank disclosure of private information even where revealing that information would be welfare improving;

variation from transient shocks, possibly enhancing the central bank's credibility. Positive effects on central bank credibility could be increased if inflation outside the range triggers extra communications about the central bank's strategy for returning inflation to the range, as with several of the foreign central banks previously mentioned. Second, as a number of other central banks already employ something like an uncertainty range, previous foreign experience with such a tool might facilitate the public's understanding of the Committee's communications and intentions if the Committee adopted a similar framework. We show the specific language used by central banks to describe their range in appendix 1.

Employing an uncertainty range, however, creates several challenges, in addition to the general issues with ranges previously noted. First, uncertainty ranges assert statistically testable statements about the behavior of inflation under appropriate policy, and realized outcomes may fall persistently outside the range, potentially damaging the central bank's credibility. This problem could be exacerbated in ELB episodes, which limit the ability of monetary policy to control inflation. Further, if the uncertainty range is introduced at a time when inflation has rarely been in the upper portion of the range, the public may not initially perceive the range as credible. These additional credibility issues might be mitigated by pairing the announcement of the range with a description of strategies designed to ensure that the range is adequately covered or by introducing the range at a time when realized inflation has been recently at or above its objective. Moreover, the range associated with appropriate policy may change, as the size and nature of the shocks hitting the economy vary. For example, a broader range may be more appropriate for an economy experiencing more volatile supply shocks than for an economy in which most inflationary pressure is driven by demand shocks. Finally, a last,

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announcing that its desired policy action lies within one of a discrete set of ranges allows the central bank to partially reveal this private information. By contrast, Mishkin and Westelius (2008) assume that in a model in which the central bank would otherwise bias inflation away from the social optimum, the central bank can be punished in cases where inflation falls outside of a certain range. They show that with suitable choices for the range, such a mechanism can be welfare improving. In both papers, however, the value of employing a range is linked to institutional features external to the central bank, such as an external punishment mechanism in Mishkin and Westelius (2008) and a constraint that communications regarding policy settings are restricted to be discrete in Stein (1989). Accordingly, we do not discuss in detail these range concepts here.

but important, caveat is that some observers could misinterpret the uncertainty range as a range of indifference, posing additional communication challenges.

Operational range

The main benefit of an operational range is that it might prepare the public for an intentional temporary overshooting of inflation, as described in the examples previously discussed, while also diffusing concerns about the degree of inflation deviation that may eventually be tolerated and without the necessity of committing to a completely specified rule.[18] Moreover, in addition to characterizing the Committee's preferences over inflation outcomes, the public may also be able to infer an unusually accommodative stance for monetary policy over the period of overshooting, further lowering expected real interest rates and stimulating economic activity. These benefits seem particularly likely to be realized if the range is introduced along with other guidance that enables the public to understand better which inflation paths within the range are most preferred. This guidance could be similar in form to communications meant to support explicit makeup or threshold strategies, as in our second operational range example.

An operational range raises a number of concerns. First, the benefits mentioned in the previous paragraph could be limited by any factors that might diminish the effect of the range on inflation expectations, such as a lack of experience with inflation in the range or uncertainty about whether the central bank can or will deliver inflation in that range. Relatedly, while the operational range preserves flexibility, in the absence of more precise forward guidance, the public's beliefs about the funds rate may remain diffuse, limiting the positive effect of the operational range, as compared with more explicit, but more restrictive, guidance, such as the introduction of numerical thresholds. Second, while the operational range does not necessarily make an assertion about the behavior of inflation as readily testable as an uncertainty range does, operational ranges do involve a similar risk that central bank credibility may suffer if, for whatever reason, the desired overshooting in inflation fails to materialize. Third, ranges that are adequate for typical

[18] Because we focus on the use of operational ranges to support lower-for-longer strategies, for expositional simplicity, the main text focuses on an operational range for inflation overshooting. In principle, however, an operational range could also be employed in the context of intentional undershooting of the objective.

recessions may be constraining to policymakers faced with extraordinarily adverse shocks, while ranges that would be sufficient even for those cases may not be very informative for outcomes in all but extremely rare instances. Finally, as with the uncertainty range, there is also a risk that an operational range might be taken as defining an indifference range.

Indifference range

An indifference range has at least two benefits. First, in theory, the optimal monetary policy response to modest fluctuations in inflation may be muted if these fluctuations are not associated with expectations of persistent movements in inflation or resource utilization, especially if it is difficult for the public to understand and react to frequent changes in the policy rate. A range of indifference would spare the public these difficulties as well as limit the possibility of inadvertent miscommunication. Second, as argued by Bianchi, Melosi, and Rottner (2019 [rev. 2020]), an asymmetric indifference range above the inflation objective would have a tendency to raise average inflation, as inflation fluctuations within the band (and, thus, above the objective) would tend to be more persistent, given the reduced pressure on inflation from monetary policy.

A range of indifference, however, raises several concerns. First, because fluctuations within the indifference range would be more persistent, the indifference range may imply more dispersion in inflation outcomes. The additional persistence and dispersion may make it harder for the public to identify the long-term average level of inflation and, as we will illustrate in simulation results, may cause long-term inflation expectations to drift. Another disadvantage is that the absence of monetary feedback on inflation may allow self-confirming fluctuations in expectations to arise, potentially also increasing the variability of inflation. In addition, if inflation is often in the indifference region, the absence of any reaction by monetary policy will inhibit private-sector learning about the Committee's reaction function outside the range. Lastly, because an indifference range implies a stronger response to inflation outside the range, the Committee would have to convey to the public how the adoption of a range of indifference aligns with the balanced approach.

Simulation Results

Of the three range concepts, indifference range policies are the most amenable to formal modeling, as they have direct implications for the setting of the federal funds rate.[19] In this section, we illustrate some implications of an indifference range policy using simulations of the FRB/US model.[20] Specifically, in these simulations, monetary policy follows a standard inertial Taylor-type rule for inflation outcomes that are outside a certain range; for inflation outcomes within the range, by contrast, the policy rule no longer responds to the inflation gap. We assume that policy always responds to the output gap.[21]

Finally, in these simulations, we assume that long-term inflation expectations are formed exclusively based on the behavior of actual inflation and not with reference to the Committee's stated objective. In such an environment, even under a standard Taylor rule, inflation can deviate from its objective for many years. Under an indifference policy, the absence of active monetary stabilization of inflation may lead inflation to diverge persistently enough that long-term inflation expectations become unanchored from the objective.

We begin by illustrating this possibility in two scenarios: first, as a consequence of a negative demand shock and, second, as a result of starting the simulation with long-term inflation expectations initially below 2 percent. These simulations assume that the indifference range is sufficiently broad that the inflation outcomes always remain within the range during the simulation, implying a range of at least 20 to 30 basis points below the 2 percent objective. We show these long-horizon results only to illustrate the underlying unanchoring of inflation expectations and will revisit the issue of outcomes given stochastic shocks.

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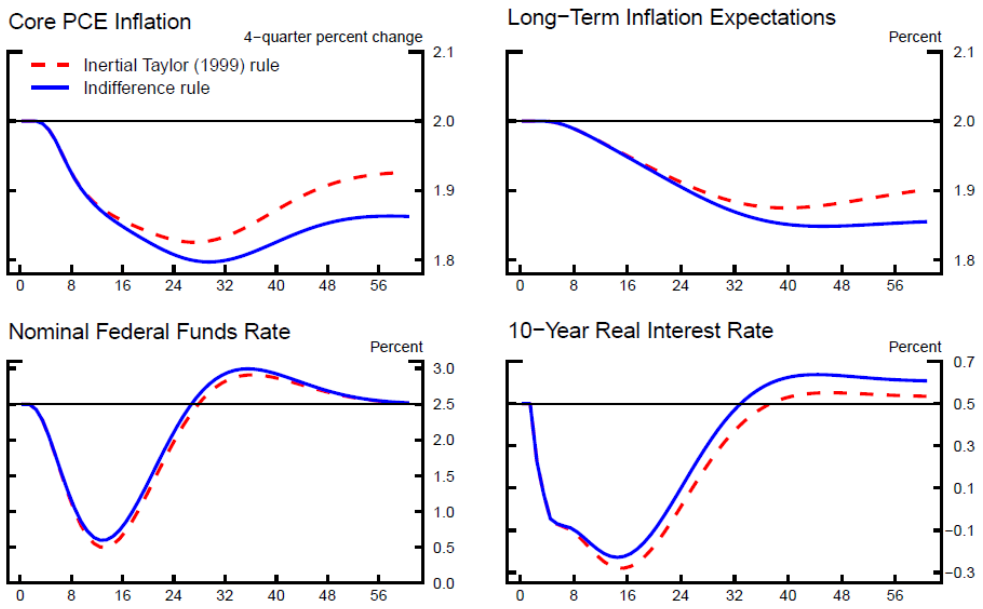
[19] By contrast, simulating the other range concepts would require modeling the effects of incomplete central bank communication, in particular, how the public would update its views about the conduct of monetary policy, given only partial information about the Committee's intentions—a considerably less tractable task.

[20] See appendix 2 for details of the simulation.

[21] Because monetary policy cannot affect the long-run neutral rate of interest, maintaining the Committee's 2 percent inflation objective requires that the federal funds rate converge to the neutral rate of interest plus 2 percent in the long run. We assume that if the output gap were closed and inflation were within the indifference band, this convergence would proceed at a predetermined rate with a half-life of around four quarters.

As shown by the red dashed line in the upper-left panel of figure 1, following a negative demand shock, under a Taylor rule, while inflation is below its objective for a number of years, inflation converges appreciably by the end of the first decade of the simulation. By contrast, as shown by the [blue solid line, under the indifference range policy, inflation eventually diverges away from the inflation objective. As suggested by the upper-right panel of the figure, this difference in outcomes is attributable to the unanchoring of long-term inflation expectations under the indifference policy, which remain close to its lowest realization in the simulation.

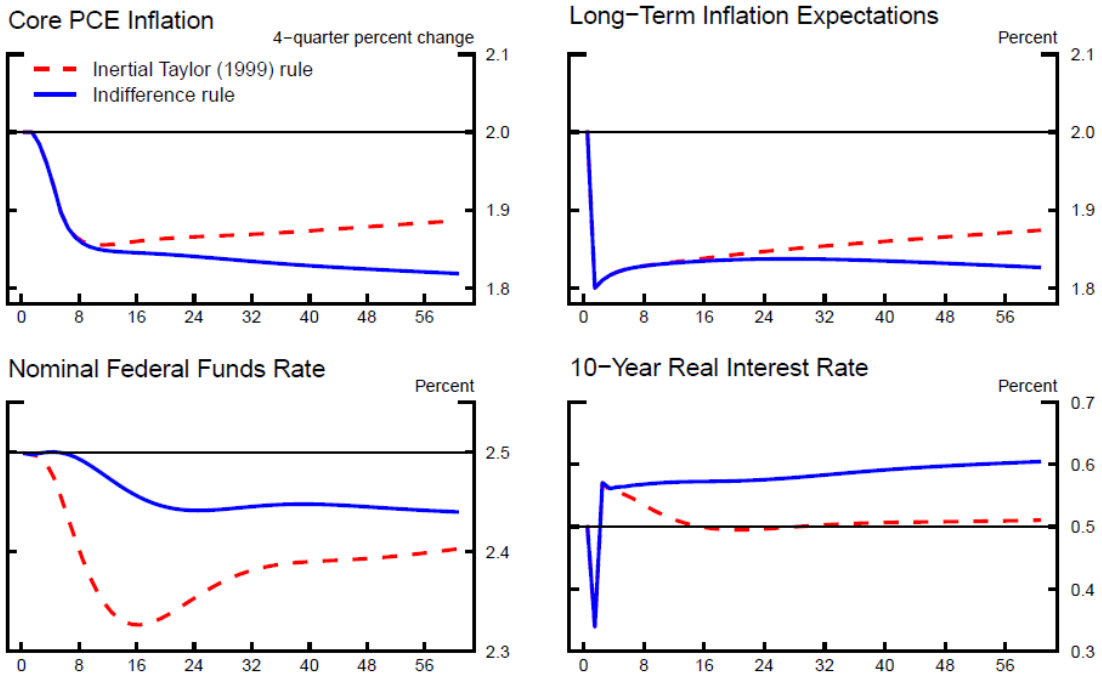
Figure 1: Outcomes Following a Negative Demand Shock under a Standard Taylor Rule and an Indifference Policy



Note: X-axes denote quarters since the onset of the shock. PCE is personal consumption expenditures.
Source: Authors' calculations.

We now consider how this same logic plays out if long-term inflation expectations are initially anchored 20 basis points below 2 percent but inflation is within the indifference range. Just as in the case of a demand shock, the absence of monetary stabilization leaves inflation permanently below its objective. As illustrated by figure 2,

Figure 2: Outcomes Following a Negative Shock to Inflation Expectations under a Standard Taylor Rule and an Indifference Policy



Note: X-axes denote quarters since the onset of the shock. PCE is personal consumption expenditures.

Source: Authors' calculations.

neither long-term inflation expectations nor, as a result, actual inflation converge back to the 2 percent objective.

We turn now to a stochastic environment, in which outcomes under the indifference policy depend on the volatility of inflation. In particular, if inflation is variable enough, the indifference region may not be visited often or persistently enough to materially affect the distribution of inflation outcomes except, perhaps, at the tails. For our stochastic simulations, we consider two bands: a symmetric band of 1 percentage point on either side of the objective and an asymmetric band from 1½ to 3 percent. Simulations are run around a baseline scenario featuring stable paths for inflation, the output gap, and the federal funds rate. In order to examine the effects of the indifference policy on the anchoring of long-term inflation expectations, we further subject this economy to a negative 20 basis point shock to long-term expectations in the initial quarter of the simulation, as in figure 2.

As shown in table A.1 in appendix 2, the mean duration of a spell within the indifference region is around 33 quarters for the symmetric band and 16 quarters for the asymmetric band. Although inflation is thus very often within the indifference zone, the mean and standard deviation under the indifference policy are similar to corresponding outcomes under the Taylor rule. By the same token, in our simulations, the asymmetric range creates only a modest upward inflation bias, around 4 basis points. The small upward bias in our simulations is a consequence of the FRB/US model's low sensitivity to monetary policy, a feature that also implies that the ELB has only a small effect on average inflation. In models that are more interest elastic, such as many DSGE models, both effects would be larger, as in Bianchi, Melosi, and Rottner (2019 [rev. 2020]). The adversity of outcomes under an indifference policy is quite sensitive to a number of specific modeling choices. In particular, the assumption that long-term inflation expectations are dependent only on the history of actual inflation plays an essential role in generating the permanent deviation of inflation from its objective shown in the simulations; more sophisticated learning frameworks on the part of the public might have different implications, especially in the very long run.

V. Practical Issues Regarding the Choice of Inflation Measure for the Range

Overview of Inflation Measures

The specification of an inflation range requires a choice of inflation measure and, even if the inflation objective is defined in terms of PCE price inflation, the inflation range's intended use may imply that another inflation measure is best suited for the specification of the range. For example, a range used to define a ceiling on allowed inflation deviations, defined in terms of headline PCE inflation, would be more likely to be breached by transient shocks with little implication for future inflation than one defined in terms of a more stable and persistent price index, such as core inflation. Table 3 presents summary statistics regarding the variability of several inflation measures for the United States.

Table 3: Inflation Measures Summary Statistics

	Mean	Median	Std Dev	Iqr
Panel A: 1978–2018				
PCE inflation	2.92	2.18	2.19	1.68–3.57
Core PCE inflation	2.90	2.12	1.94	1.68–3.61
Trimmed mean inflation	2.99	2.38	1.77	1.85–3.63
Panel B: 1992–2018				
PCE inflation	1.84	1.93	.75	1.34–2.33
Core PCE inflation	1.78	1.71	.42	1.44–2.12
Trimmed mean inflation	2.03	2.08	.42	1.66–2.38

Note: Staff calculations using annual data from 1978. Inflation is computed as the 12-month annualized percent change. "Std Dev" is the standard deviation of inflation. "Iqr" is the interquartile range. PCE is personal consumption expenditures.
Source: Authors' calculations.

We note that, for all range concepts, the associated inflation measure need not be a measure of realized inflation but could refer to inflation forecasts or to other statistical constructs related to inflation, such as a common component among disaggregated inflation series, or the components of inflation estimated to be particularly transient or persistent. Such ranges, while possibly more difficult to communicate to the public, might help address some of the concerns raised earlier regarding an overly restrictive focus on the magnitude of inflation deviations alone. For example, an uncertainty range for inflation forecasts would look through some of the transitory movements in realized inflation.

Foreign Experience with Underlying Measures of Inflation

In practice, while central banks abroad with an inflation target nearly universally target a consumer price index (CPI) inflation rate—most often an all-items CPI—such a measure can be volatile, especially in small open economies.[22] As noted earlier, one way of communicating that volatility is through the use of an uncertainty range. But another is central banks' heavy use of underlying measures of inflation when formulating and communicating policy to suggest where inflation will be over the near term. As noted in row 4 of table 1, central banks refer to a suite of such measures, including a core or "exclusion" measure such as the CPI excluding food and energy, a trimmed mean, a median, a common factor estimate, and a volatility-weighted measure. Some small open economies, such as Australia and New Zealand, also report tradable and nontradable inflation.

In communications such as their monetary policy reports, central banks generally discuss this suite of underlying inflation measures. Historically, an exclusion measure, such as inflation excluding food and energy, has been the primary measure of underlying inflation, but over time central banks have added underlying measures to the set that they discuss in reports. However, while central banks generally refer to a suite of measures in monetary policy reports, in monetary policy statements and in central bank projections, they still limit their communications to either just total inflation or total inflation along with one underlying measure, usually a core measure.

VI. Conclusion

In this paper, we have explored the implications of the use of three different inflation range concepts and identified a number of ways that these ranges can help the Committee respond to the challenges inherent in the current economic environment. We highlight several main points that have emerged from our discussion. First, clear

[22] The rationale that central banks give for targeting the overall CPI is that it is broad, familiar to the public, and the most relevant index for consumers' cost of living. Furthermore, the CPI generally has the practical advantages of being available monthly, having a short lag, and essentially never being revised.

One minor exception to the inclusion of all items is the removal of mortgage interest payments, as they are strongly positively correlated with the policy rate. The Riksbank targets the CPIF, which excludes such payments, and several other central banks, including the ECB, RBA, BOE, and RBNZ, target an overall inflation rate that is defined to exclude interest payments.

communication about the nature of the range and its role in the monetary policy framework would be essential for the proper functioning of the range. Second, ranges and the Committee's broader monetary policy strategy should be mutually supportive and their relationship clearly described to the public. Third, with the introduction of a range, the persistence and the source of inflation deviations will likely continue to play important roles in monetary policy, and the public should understand the relation between these factors and the range. Finally, the public should be made aware that the band may be contingent on certain structural factors that may evolve over time.

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Appendix 1: Remits of Central Banks in Advanced Foreign Economies

Reserve Bank of New Zealand

From the Government of New Zealand's "Remit for the Monetary Policy Committee":

a) For the purpose of this remit the MPC's operational objectives shall be to:
   i. keep future annual inflation between 1 and 3 percent over the medium term, with a focus on keeping future inflation near the 2 percent mid-point. This target will be defined in terms of the All Groups Consumers Price Index, as published by Statistics New Zealand; and
   ii. support maximum sustainable employment. The MPC should consider a broad range of labour market indicators to form a view of where employment is relative to its maximum sustainable level, taking into account that the level of maximum sustainable employment is largely determined by non-monetary factors that affect the structure and dynamics of the labour market and is not directly measurable.

b) In pursuing the operational objectives, the MPC shall:
   i. have regard to the efficiency and soundness of the financial system;
   ii. seek to avoid unnecessary instability in output, interest rates, and the exchange rate; and
   iii. discount events that have only transitory effects on inflation, setting policy with a medium-term orientation. (Reserve Bank of New Zealand, 2019)

From the Reserve Bank of New Zealand's website at https://www.rbnz.govt.nz/monetary-policy:

> The Reserve Bank uses monetary policy to maintain price stability and support maximum sustainable employment as defined in the Remit to the Monetary Policy Committee (MPC). The current Remit requires the Bank to keep inflation

between 1 and 3 percent on average over the medium term, with a focus on keeping future average inflation near the 2 percent target midpoint. There is no numerical target for employment, as the Bank uses a range of different indicators to assess the maximum sustainable level. The Bank implements monetary policy by setting the Official Cash Rate (OCR), which is reviewed seven times a year.

Bank of Canada

From the Government of Canada and Bank of Canada's "Joint Statement of the Government of Canada and the Bank of Canada on the Renewal of the Inflation-Control Target":

> [T]he Government of Canada and the Bank of Canada agree to renew the inflation target on the following basis:
>
> - The target will continue to be defined in terms of the 12-month rate of change in the total CPI.
> - The inflation target will continue to be the 2 per cent mid-point of the 1 to 3 per cent inflation-control range. (Government of Canada and Bank of Canada, 2016)

From the Bank of Canada's website at https://www.bankofcanada.ca/rates/indicators/key-variables/inflation-control-target:

> The [inflation-control] target aims to keep total CPI inflation at the 2 per cent midpoint of a target range of 1 to 3 per cent over the medium term. The Bank raises or lowers its policy interest rate, as appropriate, in order to achieve the target typically within a horizon of six to eight quarters—the time that it usually takes for policy actions to work their way through the economy and have their full effect on inflation.

Bank of England

From "Letter from Chancellor Phillip Hammond to the Monetary Policy Committee":

> I hereby re-confirm the inflation target as 2 per cent as measured by the 12-month increase in the Consumer Prices Index (CPI). The inflation target of 2 per cent is

symmetric and applies at all times. This reflects the primacy of price stability and the forward-looking inflation target in the UK monetary policy framework. The government's commitment to price stability remains absolute. . . .

The framework is based on the recognition that the actual inflation rate will on occasion depart from its target as a result of shocks and disturbances. Such factors will typically move inflation away from the target temporarily. Attempts to keep inflation at the inflation target in these circumstance may cause undesirable volatility in output . . . and the Monetary Policy Committee may therefore wish to allow inflation to deviate from the target temporarily. . . .

In exceptional circumstances, shocks to the economy may be particularly large of the effects of shocks may persist over an extended period, or both. . . .

[The Committee] should set out in its communication . . . the horizon over which [it] judges it is appropriate to return to the inflation target. . . .

The open letter process is a key element of the Committee's transparency and accountability in communicating its strategy at times when inflation deviates from target. Following changes to the Committee's schedule in recent years, and the potential lags that can now emerge between the publication of the inflation data and an open letter, I am revising the remit. In circumstances where the data is published after a meeting of the Committee has commenced but before the minutes of that meeting are published, I will expect an open letter within seven days of the publication of the inflation data. This will continue to allow the Committee time to form and communicate its strategy towards returning inflation to the target after consideration of the trade-offs, and in a timely fashion. (Hammond, 2018)

Sveriges Riksbank

From "CPIF Target Variable for Monetary Policy":

The Executive Board of the Riksbank has decided to adopt inflation measured in terms of the CPIF (the consumer price index with a fixed interest rate) as a formal target variable for monetary policy. The target for monetary policy is that the annual change in the CPIF shall be 2 per cent, that is, the same level previously

> applied to the CPI. The Riksbank will also use a variation band of 1–3 per cent for outcomes for CPIF inflation to illustrate that monetary policy is not able to steer inflation in detail, but that inflation normally varies around the target. . . . The variation band is intended to illustrate, in a simple way, that inflation varies and will not be exactly 2 per cent every single month. The target for monetary policy is, however, still 2 per cent. Consequently, this is not a so-called target range.
>
> "2 per cent still applies. The Riksbank will always aim for this, regardless of whether inflation is inside or outside the variation band to start with," says Governor Stefan Ingves. (Sveriges Riksbank, 2017)

From *Monetary Policy Report:*

> There is no general answer to the question of how quickly the Riksbank aims to bring the inflation rate back to 2 per cent if it deviates from the target. A rapid return may in some situations have undesirable effects on production and employment, while a slow return may weaken confidence in the inflation target. The Riksbank's general ambition has been to adjust monetary policy so that inflation is expected to be fairly close to the target in two years' time. (Sveriges Riksbank, 2019)

Reserve Bank of Australia

From the "Statement on the Conduct of Monetary Policy":

> Both the Reserve Bank and the Government agree that . . . an appropriate goal is to keep consumer price inflation between 2 and 3 per cent, on average, over time. This formulation allows for the natural short-run variation in inflation over the economic cycle and the medium-term focus provides the flexibility for the Reserve Bank to set its policy so as best to achieve its broad objectives, including financial stability. The 2–3 per cent medium-term goal provides a clearly identifiable performance benchmark over time. (Reserve Bank of Australia, 2016)

Norges Bank

From "Modernisation of the Monetary Policy Regulation," letter from the Ministry of Finance to the Norges Bank:

> The operational target of monetary policy shall be annual consumer price inflation of close to 2 percent over time. Inflation targeting shall be forward-looking and flexible so that it can contribute to high and stable output and employment and to counteracting the build-up of financial imbalances. (Government of Norway, 2018)

The response from Norges Bank is available at https://www.norges-bank.no/en/news-events/news-publications/Submissions/2018/18-02-28-submission.

From the Norges Bank's website at https://www.norges-bank.no/en/topics/Monetary-policy/Mandate-monetary-policy:

> The policy rate is set with a view to stabilising inflation at the target in the medium term. The time horizon will depend on the disturbances to which the economy is exposed and the effects on the outlook for inflation and for output and employment.

European Central Bank

From the ECB's website at https://www.ecb.europa.eu/mopo/strategy/pricestab/html/index.en.html:

> The ECB's Governing Council adopted a quantitative definition of price stability in 1998:
>
> "Price stability is defined as a year-on-year increase in the Harmonised Index of Consumer Prices (HICP) for the euro area of below 2%."
>
> The Governing Council clarified in 2003 that in the pursuit of price stability it aims to maintain inflation rates below, but close to, 2% over the medium term."

Press seminar and slides from the evaluation of the ECB's monetary policy strategy on May 8, 2003, are available at https://www.ecb.europa.eu/press/pressconf/2003/html/is030508_1.en.html.

Swiss National Bank

From the Swiss National Bank's website at https://www.snb.ch/en/iabout/monpol/id/monpol_strat#:

> The SNB equates price stability with a rise in the Swiss consumer price index (CPI) of less than 2% per annum. Deflation, i.e. a protracted decline in the price level, is also regarded as a breach of the objective of price stability. With this definition, the SNB takes into consideration the fact that inflation cannot be steered with pinpoint accuracy, or measured precisely. Measurement problems arise, for example, when the quality of goods and services improves. Such changes are not fully taken into account in the CPI calculation; as a result, measured inflation tends to be slightly overstated.
>
> The SNB reviews its monetary policy on a regular basis to ensure that it is appropriate for maintaining price stability. It publishes its conditional forecast for inflation over the next three years on a quarterly basis. The period of three years corresponds roughly to the time required for monetary policy stimuli to be transmitted to the economy.

Bank of Japan

From "The 'Price Stability Target' under the Framework for the Conduct of Monetary Policy":

> The newly-introduced "price stability target" is the inflation rate that the Bank judges to be consistent with price stability on a sustainable basis. The Bank recognizes that the inflation rate consistent with price stability on a sustainable basis will rise as efforts by a wide range of entities toward strengthening competitiveness and growth potential of Japan's economy make progress. Based on this recognition, the Bank sets the "price stability target" at 2 percent in terms

of the year-on-year rate of change in the consumer price index (CPI)—a main price index. . . .

The Bank will continue to conduct monetary policy, based on its assessment of economic activity and prices from two perspectives, in the context of the "price stability target." The first perspective is examining, as regards economic activity and prices over the next two years or so, whether the outlook deemed most likely by the Bank of Japan follows a path of sustainable growth under price stability. (Bank of Japan, 2013)

Appendix 2: Description of FRB/US Simulation Protocols

The simulations in section IV are conducted using a linearized version of the FRB/US model, similar to versions previously employed in Chung and others (2019). Briefly summarized, the key features of this model are as follows:

- As in Chung and others (2019, we exogenize term premiums and adjust trend government spending in response to the output gap so as to reduce the propensity of the economy to collapse into liquidity trap states at the ELB. In stochastic simulations, we also downweight shocks to the Phillips curve to yield a standard deviation for inflation similar to that seen in the past few decades.
- In contrast to the earlier paper, we draw shocks from a normal distribution rather than the modified bootstrap procedure. We do so in order to abstract from the short-term bias induced by conditioning on the current Markov state for the recession indicator.
- Also in contrast to Chung and others (2019, we assume that long-term inflation expectations evolve without reference to the Committee's inflation target, according to the equation

$$\bar{\pi}_t = 0.95\bar{\pi}_{t-1} + 0.05inflation_{t-1}.$$

- We have simulated the model under the assumption that expectations are VAR-based.

The indifference rule is built on an inertial Taylor rule specified as follows:

$$R_t = 0.85\ R_{t-1} + 0.15(R^* + 2 + GAP_t + 1.5\ d_t),$$

where $d_t = (\pi_t - 2)$ when π_t (the four-quarter change in core PCE inflation) is outside the range and $d_t = 0.8\ d_{t-1}$ otherwise.

Table A.1: Summary Statistics from Stochastic Simulations at T = 60 Quarters

Inertial Taylor (1999)	Indifference Range (IR)	Mean $\boldsymbol{\pi_T}$	Std Dev $\boldsymbol{\pi_T}$	Mean $\boldsymbol{\bar{\pi}_T}$	$\boldsymbol{P(\pi_T \in IR)}$	Mean Duration
ELB	-	1.87	.63	1.86	-	-
No ELB	-	1.89	.61	1.87	-	-
ELB	[1.5 3.0]	1.91	.65	1.89	.69	15.61
ELB	[1.0 3.0]	1.84	.67	1.84	.86	33.29

Note: Each row reports results for a set of 5,000 stochastic simulations. "$\boldsymbol{P(\pi_T \in IR)}$" refers to the probability of being within the indifference range in quarter 60 of the simulations. "Mean Duration" is the average duration of a spell within the indifference range. ELB is effective lower bound.

Source: Authors' calculations.

Table 1: Features of Inflation Objectives at Central Banks in the Advanced Foreign Economies

	New Zealand	Canada	United Kingdom	Sweden	Australia	Norway	European Central Bank	Switzerland	Japan
Date target first issued	March 1990	February 1991	October 1992	January 1993	April 1993	March 2001	October 1998	January 2000	March 2006
Current target	1–3% with focus on 2%	2% as a midpoint between 1-3%	2%	2% with "variation range" of 1–3%	2–3%	2%	Below but close to 2%	Below 2% but positive	2%
Inflation target measure	CPI	CPI; operational objective is three measures of underlying CPI	CPI (HICP)	CPIF (CPI with fixed interest rate)	CPI	CPI	Euro-area CPI (HICP)	CPI	CPI
Other inflation measures discussed	Trimmed mean; weighted median; common factor; GDP deflator; tradables	Trimmed mean; median; common component	CPI ex. food, energy, alcohol, and tobacco	CPIF ex. energy; trimmed mean; volatility weighted	Core ex. volatile items; trimmed mean; weighted median; tradables	CPI excluding energy and real taxes	CPI ex. food and energy; ex. food, energy, alcohol, and tobacco	CPI ex. fresh and seasonal products, energy, and fuel; trimmed mean	CPI ex. fresh food; CPI ex. fresh food and energy
Inflation measures projected	Headline and tradables	Headline only	Headline and core	Headline and ex. energy	Headline and trimmed mean	Headline and core	Headline and core	Headline only	CPI ex. fresh food
Horizon for reaching target	On average over the medium term	Over the medium term, typically 6 to 8 quarters	Informal 2 years but longer in exceptional circumstances	Generally 2 years	On average, over time	In the medium term	Medium term	Medium term (12 quarters)	About 2 years
Other features	Governor could be dismissed if inflation performance inadequate	Persistent deviations outside range require additional discussion in Monetary Policy Report	Deviations of more than 1 percentage point lead to open letter to Chancellor	If outside range, additional communication required		Deviations of more than 1 percentage point to be explained in Bank's annual report			
Current target duration	2012 onward	To December 2021	2003 onward	1995 onward	Indefinite	2001 onward	October 1998 onward	January 2000 onward	January 2013 onward
Average time period between review/renewal	Must be reviewed when new Governor of Bank is appointed	Formal, every 5 years	Every year		Informal, around 3 years				Formal, reviewed "in principle" every year
Target set by	Minister of Finance & Governor of the Reserve Bank	Minister of Finance & Governor of Bank of Canada	Chancellor of the Exchequer	Riksbank	Treasurer & Governor of the Reserve Bank	Government of Norway & Norges Bank	European Central Bank	Swiss National Bank	Bank of Japan
Mandate	Price stability and maximum sustainable employment	To regulate credit and currency in the best interests of the economic life of the nation	Price stability and, subject to that, growth and employment	Price stability and financial stability	Stability of the currency, maintenance of full employment, economic prosperity and welfare	Maintain the domestic and exchange value of the krone, low and stable inflation, stable output and employment	Price stability, secondary objectives of full employment and economic growth	Price stability, while taking into account the economic situation	Price stability

Note: CPI is consumer price index. GDP is gross domestic product.
Source: European Central Bank and central banks of Australia, Canada, Japan, New Zealand, Norway, Sweden, Switzerland, and the United Kingdom.

Table 2: Key Advantages and Disadvantages of Inflation Ranges

	Uncertainty Range	Operational Range	Indifference Range
Advantages	• Acknowledges the challenges of measuring and stabilizing inflation → may increase central bank's credibility • Widely used among central banks	• Might prepare the public for an intentional temporary deviation from inflation objective • Alleviates concerns about the degree of acceptable inflation deviation	• Avoids public having to adjust to small fluctuations • Asymmetric indifference range above the objective may raise average inflation
Disadvantages	• May damage central bank's credibility if inflation outside the range • Appropriate range may change over time • May be confused with indifference range	• Public beliefs about the funds rate may remain diffuse • Range adequate for typical recession may be constraining central bank in very adverse conditions • May be confused with indifference range	• May increase dispersion and persistence of inflation outcomes • Long-term inflation expectations could become unanchored • May allow self-confirming expectations

Source: Authors' analysis.