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Inflation-Forecast Targeting: Applying the Principle of Transparency

by Kevin Clinton, Charles Freedman, Michel Juillard, Ondra Kamenik, Douglas Laxton, and Hou Wang

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Abstract

Many central banks in emerging and advanced economies have adopted an inflation-forecast targeting (IFT) approach to monetary policy, in order to successfully establish a stable, low-inflation environment. To support policy making, each has developed a structured system of forecasting and policy analysis appropriate to its needs. A common component is a model-based forecast with an endogenous policy interest rate path. The approach is characterized, among other things, by transparent communications—some IFT central banks go so far as to publish their policy interest rate projection. Some elements of this regime, although a work still in progress, are worthy of consideration by central banks that have not yet officially adopted full-fledged inflation targeting.

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Author's E-Mail Address: kclinton@rogers.com; Charles_Freedman@carleton.ca; michel.juillard@mjui.fr; ondra.kamenik@gmail.com; DLaxton@imf.org; HWang2@imf.org

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I. INTRODUCTION

This paper traces the development and implementation of the inflation-forecast targeting (IFT) approach to monetary policy.[1] The approach has been adopted by many central banks in advanced and emerging market economies. It has generally helped to establish an environment of low and stable inflation in these economies, most of which had previously had a poor record for monetary stability. In fact, the regime was often initiated under difficult circumstances, after a crisis, or in the midst of structural change. Many practitioners of IFT have been highly open economies, susceptible to external shocks, especially the smaller ones. Yet the regime seems to be going strong, in its third decade.

In the more recent period, after the global financial crisis took hold, much of the focus has been on the way in which monetary policy contributes to dealing with a weak economy when policy interest rates are near or at the zero lower bound (ZLB), the so-called "dark corners".[2] There has been a growing emphasis on the importance of forward guidance in recent years, as current interest rates are at the floor and conventional monetary policies are less effective. Drawing from the experiences of IFT central banks in conducting forward guidance and the lessons from the history of IFT, we argue that the IFT framework can help countries avoid dark corners.

More generally, the paper focuses on several issues that we believe are important for the successful functioning of an IFT strategy for monetary policy.[3] Many of these are related to the transparency and communications of the central bank and we examine how they can help the central bank in achieving its goals in a more efficient way. Our views are based in part on the analysis presented in this and other papers that we have published and in part on the experience with IFT to date of a number of advanced economy and developing/emerging economy central banks.

We begin in Section II with some history of Inflation Targeting (IT). We discuss some of the challenges that central banks have faced and why many of them have chosen to use the IFT framework as their approach to monetary policymaking. The background for the IFT framework, including a definition of IFT, is provided in Section III. It also describes the key role of expectations under the regime in providing a nominal anchor, the transmission

[1] The term inflation targeting or IT is commonly used to describe the approach to monetary policy discussed in this paper, which originated at the very end of the 1980s and in the early 1990s and has since spread to a large number of central banks. The term inflation-forecast targeting or IFT better describes the behavior of dual-mandate central banks that have adopted flexible inflation targeting since they typically focus their attention on their forecast of future inflation and on the actions that they propose to take to bring the future rate of inflation back to target following a shock. While IFT is slightly more technical sounding than IT, we use it throughout this paper because it better reflects the behavior of central bank in the policy framework.

[2] See Blanchard (2014).

[3] For applications to the United States and the Czech Republic, see Alichi and others (2015a, b).

mechanism of monetary policy, and the importance of having an endogenous interest rate as part of the process of preparing the forecast for output and inflation. There is also a discussion of the advantages in certain circumstances of publishing a staff forecast in the Monetary Policy Report.

In Section IV we discuss how IFT would go about eliminating differences between the current rate of inflation and the long-run target, and apply this to situations where the zero interest rate floor or zero lower bound is binding.[4] IFT central banks provide forward guidance by publishing a macro forecast with an endogenous interest rate path and then either publishing the interest rate path or simply using words to describe it.

Based on simulations with a simple model of the U.S. economy, we present in Section V examples of a policy-making strategy, and various approaches to interest rate setting (Taylor rule, inflation-forecast-based reaction function, and minimization of a loss function or optimal control policy making). It examines how the projected path of the Fed funds rate in response to the current economic situation in the United States would differ under the three approaches. The optimal policy strategy could in certain circumstances result in a planned overshoot of inflation from its long-term target. Section IV provides some concluding remarks.

The accompanying supplement provides detail and technical background on a number of subjects raised in this paper. All references to annexes in this paper refer to the accompanying supplement.

II. Some History of Inflation Targeting

The development of IT as a monetary policy regime in many countries was influenced by trends in economic theory, by pragmatic learning-by-doing, and by the experience of other IT central banks.[5] Some useful examples of how IT central banks have transitioned to full-fledged IFT are illustrated in Box 1.

[4] While some central banks have now reduced their policy rate to slightly below zero, we continue to use the term zero lower bound or ZLB to refer to situations where the policy interest rate is very near to zero in either direction.

[5] For a brief introduction to the essential ingredients of inflation targeting, see Freedman and Laxton (2009a, 2009b, 2009c).

Box 1: Some Examples of Learning from Experience

New Zealand, 1989, was the first country to embark on IT. Today it has a full-fledged IFT regime. Monetary policy credibility has risen over time. As the pioneer, the Reserve Bank of New Zealand (RBNZ) had to learn by doing. It subsequently also learned from others, in particular the Bank of Canada, on process, and from IMF advice. Inflation was quickly reduced, to less than 2 percent in 1992, but the use of the exchange rate as the main instrument of policy led to instrument instability. The RBNZ introduced the first fully structured framework for conducting policy under IFT, the so-called forecasting and policy analysis system or FPAS, in 1997, and jumped straight to IFT, with immediate full disclosure of the central bank forecast.

Canada moved to IT in 1991, after looking at the New Zealand experience. Elements of the FPAS —of which a forward-looking forecasting model is a component—were already being put in place, in consequence of the previous Bank of Canada policy of price stability, which was not defined numerically, but was understood to involve a long-run inflation objective below 2 percent. The IT program announced in early 1991 had an eventual target of 2 percent, which has not been changed since. It took several years to anchor expectations, but after fiscal policy was put on a sustainable footing in 1995, long-term inflation expectations soon stabilized at the 2 percent target rate.

The Czech Republic adopted IT in 1998. The preceding year saw the collapse of a fixed exchange rate policy and widespread bank failures. Difficulties in the transition to the post-Communist market economy were still evident, with important prices yet to be liberalized. Inflation had been running at almost 10 percent since 1993, and was accelerating at the time IT was adopted. With assistance from Bank of Canada staff and the IMF, the Czech National Bank (CNB) was using an FPAS, with a model-based forecast, by 2002. The CNB began publishing its quarterly forecast in detail, including the forecast path for the interest rate, in 2008. Surveys of inflation expectations for the past decade have shown strong public confidence in the 2 percent target. Internationally, Czech monetary policy is in the forefront for transparency. See Alichi and others (2015a) for the Czech experience.

Following the inflation of the 1970s, the theoretical contribution of Kydland and Prescott (1977), according to which discretionary monetary policy has a bias towards inflation, made a strong impression on central banks and led to a search for a more robust framework for monetary stability.[6] The solution proposed by Barro and Gordon (1983) to the predicted dilemma, that the central bank commit to a time consistent price-stability policy, required a monetary framework that would prevent policymakers from yielding to the temptation to give output a short-run boost through a surprise spurt of monetary stimulus. During the

1980s, inflation in most economies was moderate but persistent, and some central bankers saw in this situation a parallel with the chronic inflation predicted for discretionary monetary policy by the time-consistency theory. Early practitioners of IT certainly saw hitting their targets, short run as well as long run, as important in establishing their commitment to price stability. The first country to adopt IT, New Zealand, started out with a fairly rigid approach that produced a rapid decline in inflation to the long-run target, along with a case of instrument instability.[7]

During the 1990s, as inflation stabilized at low rates in line with the announced objective, it became clearer that the key to establishing confidence in IT was not rigid adherence to targets, but a transparent strategy to eliminate over time any deviations that arose or that were expected to arise. Announcing an explicit numerical target was in itself a major step to clarifying what monetary policy was aiming to achieve. Following the introduction of IT, central banks took further steps to improve their monetary policy communications, through regular Monetary Policy Reports (sometimes called Inflation Reports), speeches by senior officials on strategy, media briefings after interest rate decision meetings, and so on. By the turn of the century, one could argue that the transparent pursuit of a low-inflation objective by a politically accountable central bank provided a solution to the Kydland-Prescott time-consistency problem. That is, IT put a constraint on discretion, removing the inflation bias. Another interpretation of the evidence would be that the success of IT simply refuted the theory: central banks were showing no sign of reneging on inflation control in pursuit of short-run output goals; and in IT countries, at least, the authorities did not display the short-sighted bias at the heart of the argument. On the contrary, governments left and right of center have supported the low-inflation objective, by a formal instruction where the central bank does not have goal independence (e.g., the United Kingdom), by an endorsement where it does (e.g., the Czech Republic), or by a statement of agreement where the government and central bank jointly assume responsibility for the goal (e.g., Canada and New Zealand).

[6] A contemporary description of this search, from the trenches as it were, can be found in Bouey (1982).
[7] Bernanke and others (1999) describes the history of early IT. They conclude that given that governments and central banks do care about production, employment, exchange rates, and other variables besides inflation, treating inflation targeting as a rigid ironclad policy could lead to very poor economic outcomes.

Under these arrangements, the central bank is typically accountable for the conduct of monetary policy, to government or parliament, and implicitly to the general public. In large part because of the clear delegation of responsibility, implementation of IT has been accompanied by a vast increase in the transparency of the conduct of monetary policy. In retrospect, from the viewpoint of democratic governance, this has been a good thing in itself. Central bank independence is not an end, but a means to protect monetary stability from the risks of political interference. On these grounds, the decisions of the central bank should be subject to political scrutiny, not day-by-day, but at regular intervals. If IT is a system of constrained discretion, then accountability provides the means to ensure that discretion is used within the designated constraints, and to the specified ends. And accountability without transparency means nothing.[8]

During the 1990s, central bankers came to realize that the better their policies were understood, the more effective they were—a remarkable turnaround within one generation for a profession formerly reputed (not entirely fairly) for secrecy.[9] With respect to numerical variables, the debate has been about what to disclose above and beyond the target for the rate of inflation and the current setting of the policy interest rate policy instrument—in particular, about what elements of the quarterly macroeconomic forecast of the central bank should be released. Publishing the forecast for inflation and output has not been controversial, because policymakers had to show the public that they did have a plan for keeping inflation on target, and that the plan recognized the potential short-run implications for output. Moreover, Svensson (1997) pointed out that the central bank inflation forecast represents an ideal conditional intermediate target, since it takes into account all available information, including the preferences of the policymakers and their view of how the economy works. The flexible IT regime now in place at many central banks can be described as inflation-forecast targeting (IFT). This implies a balancing between the deviations of inflation from its target and the deviations of output from potential. It is important to emphasize that under a flexible IFT regime, the central bank has a dual mandate (either explicit or implicit) and recognizes that there is a short-run trade-off between output and inflation.

The history of IT and the transition to full-fledged IFT provides a line of openness, or accountability. Milestones along the way have been:

- Announcement of targets with a multi-year horizon—clarity of target;
- Precision on the policy interest rate setting—clarity of instrument;
- Transparent communications on policy implementation;
- Publication of a complete macro forecast (including inflation)—clarity of the intermediate target (IFT);

[8] See Freedman and Laxton (2009c).
[9] For example, compare the change in view between Acheson and Chant (1973) and Chant (2003).

- Publication of a conditional forecast path, alternative scenarios and confidence bands for the short-term interest rate (full-fledged IFT).

Newcomers to IT, unlike New Zealand, do not have to pass by each of these milestones. The road has already been tested, over a couple of decades. Depending on the available technical capacities, a central bank can take to the road at any point. As the survey of central banks by Batini and Laxton (2007) showed, numerous countries have built durable IT regimes from unpromising starting conditions. None had a reputation for stable low inflation. Many were emerging from a financial or exchange market crisis that had shaken confidence in the monetary authorities (e.g., the United Kingdom, Sweden, and the Czech Republic). Some were in the midst of economy-wide structural changes that would completely alter the transmission of monetary policy (e.g., New Zealand and the Czech Republic). Special problems enfeebled the monetary transmission mechanism in certain countries (e.g., dollarization in Peru, and severe financial fragility in the Czech Republic). Of the early adopters of IT, only the Bank of Canada had anything close to a forecasting and policy analysis system (FPAS) matched to the task—a common omission being the lack of an appropriate policy model.[10] None had the external communications program required to explain how the monetary policy objective was to be achieved and maintained. Experience denies that there is a demanding list of prerequisites—if you can do monetary policy at all, you can do IT.[11] However, it is the case that central banks that adopted IT put in place with all due speed a suitable framework for making it effective. This involved learning by doing, and the framework everywhere is still a work in progress.

The foregoing suggests that instead of *prerequisites* for IT, a potential adopter should be thinking about the same factors as *assets*. The level of development of the economy, and the technical tools available to the central bank, might well affect the appropriate form of the IT regime. For example, whereas in an emerging market economy the central bank might not yet have a model on which it wants to rely on for publishing forecasts, the U.S. Federal Reserve without doubt has the technical wherewithal to go immediately to formal full-disclosure IFT, if it decided to do so.[12]

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[10] In fact, the Bank of Canada was in the process of implementing a new model called the Quarterly Projection Model (QPM). QPM was designed explicitly to support IFT and featured an inflation-forecast-based reaction function. For documentation of the model and its properties, see Coletti and others (1996). For a discussion of the role of, and essentials of, a structured FPAS, see Annex 3.

[11] Batini, Kuttner and Laxton (2005) and Batini and Laxton (2007) discuss this issue in detail, on the basis of surveys of central banks.

[12] In practice, the Federal Reserve has recently been behaving very much like a flexible inflation-forecast targeting central bank. Nonetheless, it does not label itself as an IFT central bank, perhaps because of its long-standing emphasis on the fact that it is a dual-mandate central bank that pays attention to both inflation and output. Of course, this is also the practice of all flexible inflation targeting central banks.

III. Background on Inflation-Forecast Targeting

III.1 Defining IFT

IFT is based on the principle that, given a long-term objective for the rate of inflation, the central bank's own forecast of inflation is an optimal intermediate target (Svensson, 1997), which would allow the central bank to conduct monetary policy with the desired trade-off between deviations of inflation from target and deviations of output from potential. The reason that the inflation forecast is an optimal intermediate target is that it would embody all the relevant information available to the central bank, including knowledge of the policymakers' preferences with respect to the trade-off between deviations of inflation from target and output from potential, and the bank's view of the monetary policy transmission mechanism as summarized in its core macroeconomic forecasting model. A key aspect of IFT is that the policy interest rate is an endogenous variable: it responds to eliminate any deviations between actual inflation and its objective. In the core model, the responses derive from a policy reaction function or from a loss-minimizing function. Putting IFT into practice requires an FPAS, in which the forecast is organized around a core quarterly projection model. Making effective the strategy that emerges from the FPAS requires credibility: the better the expectations of the public align with the targets of monetary policy, the lower are the costs of achieving those targets. This involves transparent communications.

For the purposes of this paper, then, IFT means that:

- Monetary policy is based on a long-run low inflation target, and a medium-term forecast path to this target;
- The central bank has a structured FPAS, which maintains relevant data bases, and produces a model-based staff forecast, and associated economic analysis, on a regular schedule;
- Under the FPAS, the Projection Team (PT) presents the forecast shortly before a decision meeting of the Monetary Policy Committee (MPC for short—the actual name of the committee does not matter here);
- The forecast path for the short-term interest rate—the policy instrument—is endogenous within the model, with the rate varying to achieve the long-run inflation target and to eliminate any output gap;
- The staff forecast is a key input into the MPC decision, but only an input—members of the MPC need not entirely agree with the forecast and can incorporate other information into their decision-making;
- Soon after the policy decision, the associated forecast path for key macroeconomic variables is disclosed, highlighting the path for the inflation rate;
- The rationale for policy actions is explained in greater depth at regular intervals (usually quarterly) in a Monetary Policy Report (MPR—sometimes, less aptly, called an Inflation Report);
- The MPR outlines the conditional forecast path for the short-term interest rate, either

with explicit numbers or a qualitative description;

- The forecast presentations underline conditionality and uncertainty by showing confidence bands around the baseline for relevant variables, and by considering alternative scenarios with different assumptions for specific inputs.[13]

The majority of IT central banks, under this definition, would be considered inflation-forecast targeters. Examples are the Reserve Bank of New Zealand, the Bank of Canada, the Central Bank of Chile, the Czech National Bank, the Bank of Israel, the Norges Bank, and the Sveriges Riksbank. Establishing an FPAS from scratch has become easier this century because of the increased opportunities to learn from others. Indeed, as the Bank of Israel and the Norges Bank have shown, it has become possible for newer entrants to leapfrog the pack, and in some respects jump straight to the frontiers.

In practice, all IFT central banks are flexible inflation targeters. Their objective is not only to stabilize inflation around the inflation target but also to stabilize resource utilization around a long-run sustainable rate. As will be discussed in detail later, optimal control policy making is equivalent to minimizing a loss function, the principal arguments of which are the deviation of inflation from its target and the deviation of output from potential (i.e., the output gap). Flexible IFT central banks in effect choose a policy-rate path such that the forecast for inflation and output "look good" where "looking good" means finding the best policy interest rate path to stabilize inflation forecast around its target and output around its long-run sustainable path.[14]

III.2 Long-run expectations anchor to IFT

III.2.1 The anchor

The credibility of the long-run inflation target underpins IFT. Everything pivots around the anchor provided by the firm expectation of the public that monetary policy will in the long run keep inflation stable and near the target rate. This, in turn requires that policy responds systematically to the requirements of this objective.[15] A model of the process is depicted in Figure 1.

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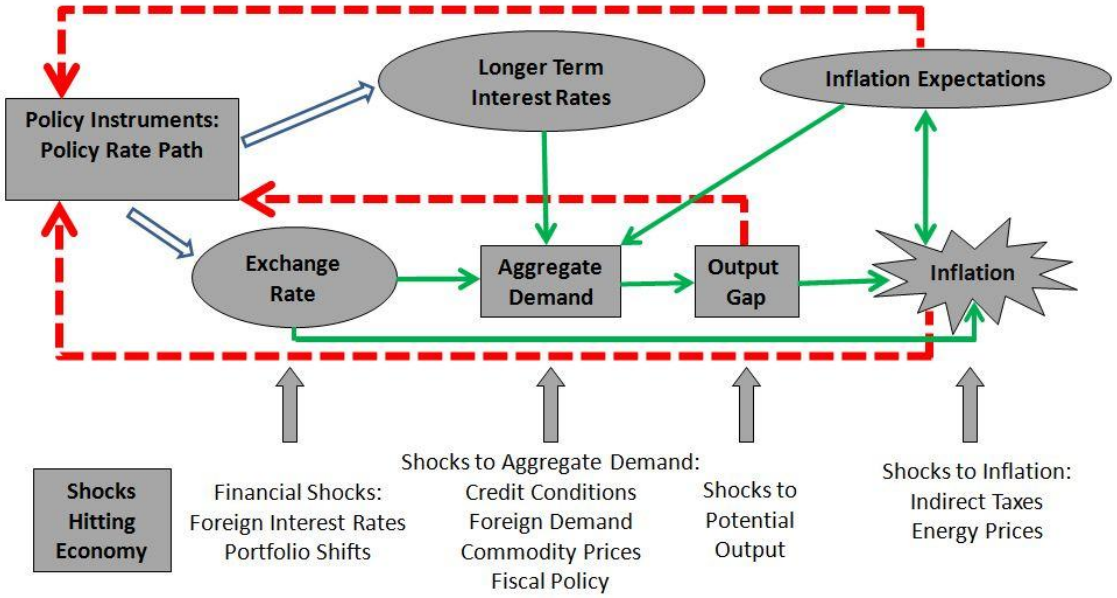
[13] These indicators of uncertainty emphasize that the central bank is not committing to blindly follow the baseline path for the policy rate, but rather to adjusting this path in response to new information. Confidence bands may be derived from an analysis of past forecasting performance. It is now possible to construct confidence intervals based on models with nonlinearities such as the zero lower bound. See Chen and others (2009).

[14] See Svensson (2010) for an extensive discussion of flexible inflation targeting.

[15] Bernanke and Woodford (1997) concludes that monetary authorities must rely on an explicit structural model of the economy to guide their policy decisions.

Figure 1. Monetary Policy Model: IFT Feedback Response and Transmission



Source: IMF staff calculations

With a forward-looking policy, the future expected path of the policy interest rate is adjusted when unanticipated disturbances hit the economy, in order to bring inflation back to the target gradually over a period of time that limits the disruptions to output. This policy feedback, via an endogenous short-term interest rate, represented by the red dashed arrows in the flowchart, ensures that the nominal anchor holds.

III.2.2 The transmission mechanism

Expectations of future policy rate movements over the short term to medium term play a crucial role in the transmission mechanism, as depicted by the blue hollow arrows pointing at the ovals with "Longer Term Interest Rates" and "Exchange Rate". The cost of borrowing of businesses and households is not the very short-term rate of interest directly controlled by the central bank. They borrow at longer terms. Policy affects the rates they pay more through the impact of the policy rates expected in the future, and hence the level of the whole yield curve, than through the current policy rate itself. This is reflected in the rectangle for the "Policy Rate Path"—the whole *path* expected for the medium-term, not just the current setting, is what counts.[16]

The difference between IFT with an endogenous, forward-looking policy reaction function, and some other approaches to IT, for example use of an exogenous forecast interest rate path

[16] The transmission effect through the exchange rate in an open economy, which also depends on expectations, is discussed in Annex 2.

(including a path derived from market forward rates), or use of a simple Taylor rule, is that the latter do not have explicit feedback from the expected future inflation rate to the policy instrument. If the figure were modified to represent an exogenous interest rate path, the red dashed feedback arrows would be erased.

III.2.3 Endogenous policy response

In situations where the actual rate of inflation differs from the long-run target, monetary policy would generally have a choice as to how to respond. The approach may be more or less rapid, depending on policymakers' preferences regarding the short-run output-inflation trade-off. It might involve an asymptotic approach or a planned overshoot. Out of the available options, the central bank will implement the one that "looks best," i.e., the one that reflects its judgment as to the best outcome.[17]

This applies to any gap between actual inflation and the long-run target. To provide a typical example, consider how the IFT would work following a sudden drop in the world price of oil. The Projection Team (PT) of the central bank would take account of the ramifications on all external variables, e.g., the level of demand in trading partners, and then, using the core model, simulate the impact on the domestic economy. The baseline forecast, using the standard policy response of the model, would imply an interest rate path that, over the medium term, returns inflation to its long-run target rate, while taking into account the trade-off between the costs of inflation being away from target and the costs of output gaps. Other policy responses might also be simulated to provide policymakers with a menu of options. In each case, there would be an entire time profile of short-term interest rates, of which the next MPC rate setting would be the first step. The PT might also provide forecasts based on a couple of scenarios in which very different assumptions are used for the oil price, or, for that matter, other exogenous variables. Associated with each simulation would be confidence bands for the key variables, reflecting the normal range of random factors that may affect the forecast. In making their decision, policymakers would decide on one of the alternative endogenous paths for the interest rate. A full description of the central bank's policy decision would therefore entail the entire future path of the interest rate, not just the immediately effective rate. This would be a theme for the subsequent round of external communications, via post-decision-meeting media briefings and press conferences, the MPR, and so on. In the most transparent case, the central bank would publish the endogenous path for the short-term interest rate, with the confidence band.

III.2.4 Publication of endogenous interest rate forecasts

[17] For a discussion for the theory and practice of flexible inflation targeting, see Svensson (2010). In part, the judgment is equivalent to choosing among outcomes that impose a different weight on the relative importance of the deviation of output from potential relative to the deviation of inflation from its target along the path back to equilibrium.

In our view, the model or models used by central banks in conducting policy under IFT logically should incorporate an endogenous interest rate. A model in which the interest rate is exogenous has no nominal anchor—the inflation rate drifts indeterminately following disturbances. Under IT, the nominal anchor for the economy is provided by the expectation that the rate of inflation will converge to the announced long-run objective. This implies an expectation that in response to any shock, monetary policy will react in such a way as to return inflation to the long-run target.[18] For the policy to be logically consistent, the interest rate must adjust to the requirements of the target. Many central banks incorporate this principle into their forecasting models and thus produce an endogenous path for the interest rate. However, most of these institutions have, so far, decided not to publish the path, their view being that the policy rate has to be free to respond at any decision meeting to all possible contingencies, and that they do not want to confuse the public by appearing to have a commitment of some kind towards the interest rate.[19]

There are, however, counterarguments in favor of publishing the interest rate forecast, and several central banks currently publish the policy interest rate path and associated confidence intervals. Why are they doing so? Given the transmission channels, any policy interest rate decision by the central bank must involve more than a one-period setting. Changes in the very short-run interest rate controlled by the central bank confined to a 6-week period (i.e., a typical period) between decision meetings would have negligible macroeconomic effects. Firms and households borrow and invest at much longer terms. To affect spending, monetary policy has to influence interest rates at these longer terms, and this requires an influence over people's expectations for the future policy interest rate, not just its current level.[20] This means that at any time the policymakers must have in mind a path for the future policy rate—a conditional path, to be sure, which will change as new data arrive.

In view of the lagged effects of monetary policy, a variety of such paths is possible; and the path chosen by policymakers would reflect their preferences regarding the short-run trade-off between inflation and output. For example, in general, a higher weight on output stability would imply smoother adjustments of the interest rate in response to price-level shocks and a

[18] There are a number of references in this paper to returning inflation to its target over time following a shock. Typically, a number of interest rate paths can result in such an outcome. For example, policy interest rates can be adjusted in such a way as to bring inflation back to target more or less rapidly. The particular path chosen will have implications for output over time. In practice, the central bank will choose a forecast interest rate path that provides a reasonable compromise between limiting deviations of inflation from its target and output from its long-run sustainable path. We use the term "returning inflation to its target over time" as a shorthand way of describing the process of choosing the best path under flexible inflation targeting for both inflation and output to return to their desired outcomes. In this context, it is worth noting that shocks that affect the forecasts of inflation and output for a given policy rate path would result in a change in that path by policymakers. But shocks that do not affect forecasts of inflation and output for a given policy rate path would not result in a change in that path.

[19] Freedman and Laxton (2009c) discusses this issue in more depth.

[20] Thus, Woodford (2005) highlights management of expectations as a key task in the practice of central banking.

slower return to the target by the inflation rate. Thus, this line of reasoning also leads to the conclusion that the interest rate decision, at any point in time, envisages a time profile for the future policy rate.

Full disclosure of the central bank forecast could reinforce the effectiveness of monetary policy in two ways. First, by showing a coherent view of the future, with inflation returning over the medium term to the desired long-run target rate, confidence in the goal, a reliable value of money, would be strengthened. Second, the published path for the short-term interest rate would help move the term structure of interest rates in a way that would assist the transmission mechanism. In terms of objectives, the payoff from this reinforcement of policy effectiveness would be a reduced cost of eliminating deviations of actual inflation from the long-run target rate, or equivalently, an improved short-run inflation-output trade-off.[21] A connected, but somewhat distinct, argument in favor of publication of the forecast interest rate path is that the information so provided further improves the accountability of the central bank. For these reasons, a leading group of central banks has gone to full disclosure.[22]

The technical complexities—deriving model-based baseline forecasts, confidence intervals, and alternative scenarios—inevitably involve the input of highly specialized staff resources of the central bank. The senior management of the institution would be expected to make sure that these resources are adequate to the job, and to have confidence in the technical quality of the forecast and associated analysis. They should also make sure that the forecasting team takes account of the major issues for the outlook as they see them. However, it would generally be a good idea for MPC members to focus on broad, strategic questions, and not to be closely connected to the production process. For this reason alone, it seems to us better to regard the forecast as belonging to the staff rather than the institution. There are, in addition, advantages in publishing the forecast as a staff forecast which are discussed in Box 2.

[21] See Blanchard and Galí (2007) and Laxton and N'Diaye (2002).

[22] Central banks that publish endogenous interest rate path forecasts include the Reserve Bank of New Zealand, the Czech National Bank, the Bank of Israel, the Norges Bank, and the Sveriges Riksbank.

Box 2: Whose Forecast Should Be Published?

In our view, in many cases it would be better for the staff to have ownership of the projection. This view is not based on any theoretical argument but, rather, it is a practical judgment that would apply to many central banks, although not necessarily to all. This judgment is particularly relevant for central banks with relatively large policymaking bodies and those in which policymakers are likely to have particularly divergent views about future economic outcomes.

Constructing a consistent and coherent projection that reflects both good economic reasoning and the circumstances of a specific economy is a challenge at the best of times. In situations of considerable uncertainty about both real and financial external and domestic developments, it is even more challenging. Maintaining the ownership of the projection by the staff creates an efficient mechanism for producing a coherent projection, which is crucial to ensuring the credibility of the central bank among expert observers of monetary policy developments, such as the specialist media and economists in financial institutions (whose opinions are solicited by the mass media).

The production of the Monetary Policy Report is also simplified when the forecast is presented as an important staff input to decision making, albeit one among a number of inputs. While the Report would underline that the staff forecast plays a key role in this regard, the policymakers would not be required to defend any particular forecast, beyond stating their confidence in the process that produced it. The alternative approach, in which the Monetary Policy Committee takes ownership of the projection, would be much more difficult at a central bank where decisions are made by vote, rather than by consensus (or by the Governor alone). Voting MPC members may have divergent views about the forecast.

Moreover, in emerging-market economies there is greater likelihood than in advanced economies that MPC members will have different views on how the economy functions. Where there is no consensus, a central bank with 7 voting members might have to publish up to 7 projections in the MPR. And how would all this be accommodated in the write-up explaining policy? Such an approach could be inefficient internally and confusing externally.

continued …

Box continued …

Ownership of the projection by the staff would avoid the problem of trying to adjust the projection to a mixture of views of MPC members. But noting that the projection is the key, but not the only, input into the MPC's decision-making gives the MPC the scope to choose a different interest rate decision or path from that advocated by the staff in its projection. And the views of the members of the MPC, whether unanimous or not, with a properly functioning FPAS, would be reflected in alternative scenarios prepared by the staff, if not in the baseline, and in the discussion of uncertainties in the first chapter of the MPR.

However, it is important that members of the MPC do have solid economic arguments for their views in circumstances when they differ from those of the staff. For example, at times it may be uncertain whether recent inflation pressures are persistent or transitory. In the former case, central bank action may well be required to counter the pressures, while in the latter case, the problem unwinds itself without any central bank action. Another example would be where the baseline projection sees a slowdown, and hence a reduction in the rate of inflation, but the projected slowdown is not yet reflected in the data. Whether the central bank should ease now, or wait-and-see, can be the subject of legitimate disagreement.

Clear and transparent explanations of such differences in the Monetary Policy Report would help financial-market participants understand the action (or absence of action) by the central bank. It might even increase the credibility of the central bank, since the debate would shed light on how the central bank would react when future data reveal which of the opposing views was more valid.

As a real-world example, the following statement is taken from the Czech National Bank's Inflation Report.

"*The forecast for the Czech economy is drawn up by the CNB's Monetary Department. ... The forecast is the key, but not the only, input to the Bank Board's decision-making. At its meetings during the quarter, the Bank Board discusses the current forecast and the balance of risks and uncertainties surrounding it. The Bank Board's final decision may not correspond to the message of the forecast due to the arrival of new information since the forecast was drawn up and to the possibility of asymmetric assessment of the risks of the forecast and divergent views of some board members on the development of the external environment or the linkages between the various indicators within the Czech economy.*"

IV. USING IFT TO HELP AVOID DARK CORNERS

IV.1 Implied forward guidance in IFT

Forward guidance (FG) for the policy interest rate, and quantitative easing (QE) via large-scale purchases of assets, have been prominently used in recent years by the major central banks to reduce medium-term and long-term interest rates, and to ease credit conditions. They adopted these measures to stimulate the economy after cutting the policy rate almost to zero, and hence having no room to cut it further. To judge from the extremely low levels to which bond yields fell after the announcements, FG and QE may in fact have provided monetary policy with an additional instrument to reduce borrowing costs. Moreover the positive macroeconomic outcomes—increased output, a decline in unemployment, suggest that the measures had some effect.

Under IFT, one can look at FG as taking place in an ongoing process, in which the central bank provides a continuous flow of information on its current policy actions, and on its view of what actions may be appropriate over the medium term ahead. During a period in which the ZLB is binding, and where the main danger facing policy is on the deflation side, an IFT central bank would publish a forecast, with an endogenous interest rate near the floor long enough to get inflation back on track. To the extent that this forecast affects market expectations, it will result in medium- and long-term rates that are lower than their long-run equilibrium values.

In this sense, publication of the forecast becomes an additional instrument, helping policy achieve its objectives, in a similar way as the Fed's FG was formulated and communicated since 2008.[23] However, the strategy of IFT central banks differs from the Fed's, in that the IFT strategy emerges from a framework that applies at all times, not just during periods of ZLB, or of other exceptional developments. The principle that underlies the effectiveness of FG with a ZLB applies more generally: if the markets understand where monetary policy is heading, they are likely to move interest rates in the direction that supports policy. Publishing the path for the endogenous policy rate underlines that an MPC decision at any point in time involves more than setting an interest rate until the next meeting. In making any particular decision, the policymakers must have in mind some view of the rates that will be necessary for the efficient achievement of the target over the medium term. A priori, releasing that path would be the single most obvious way of clarifying for the public the central bank's view of the policy implications of the economic outlook.

Under IFT, the central bank communicates to the public not just a possible path for the future policy rate, but also a sense of how this path might change in response to a variety of

[23] Bernanke (2013) provides a more precise description of the evolution of forward guidance at the Fed.

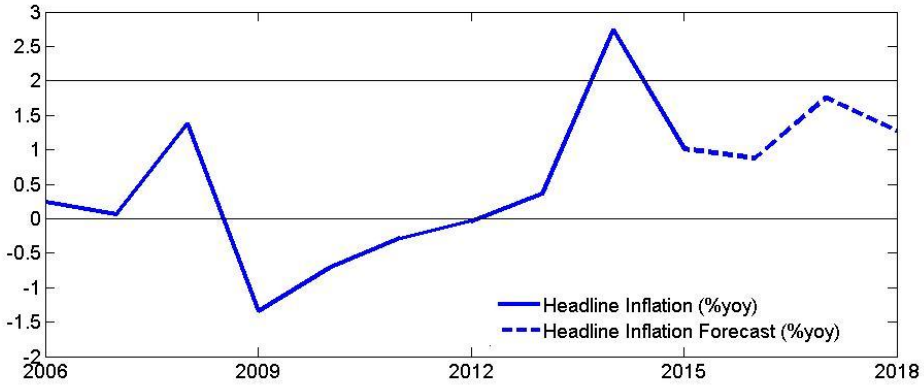
developments, and a rationale for policy actions. Thus, there is an aspect of improved accountability, as well as improved policy effectiveness, with an IFT strategy.

Another advantage of the systematic approach to policy formulation and communication under IFT, is that the central bank does not have to give special guidance as to when any particular policy approach will switch on and off, or as to trigger values of inflation and unemployment (or the output gap). In contrast, the fact that the Fed has changed its FG policy several times in these respects since 2008 might give the impression of improvisation.[24] This might be magnified if, as is conceivable under an effective counter-deflation policy (see the simulation results in Section V), the central bank deliberately plans a temporary overshoot of the long-run inflation target. Under FG, without IFT, it might look as though the switch has been left on too long by mistake.

IV.2 Deflation risk in Japan and the euro area

Expectations may act as a shock absorber or amplifier, depending on whether the policy regime is credible, and active in resisting shocks, or perceived to be passive (Box 3). The experiences of Japan and the euro area, which have been dealing with recession and a risk of deflation since the global financial crisis, illustrate the issues. In Japan, the short-term interest rate was already near the zero floor when the Lehman event hit in September 2008. With the drop in demand, and oil prices dropping sharply from their peak, 2009 saw a marked deflation (Figure 2).

Figure 2. Inflation and Inflation Forecast for Japan



Source: WEO April 2015

Since the nominal short-term interest rate could go no lower, the real rate went up. The yen rose strongly against the U.S. dollar, appreciating 25 percent between 2007 and 2009 (Table 1).

[24] For a discussion of the U.S. experience with related reference see Alichi and others (2015b).

Table 1. Selected Economic Indicators for Japan and Canada After the Financial Crisis

	Real GDP Growth	Real Export Growth	Output Gap	CPI Inflation	Long-term Interest Rate	Short-term Interest Rate	Bilateral USD Exchange Rate
Japan							
2007	2.2	8.7	0.4	0.1	1.7	0.6	100.0
2008	-1.0	1.4	-1.4	1.4	1.5	0.4	113.9
2009	-5.5	-24.2	-7.1	-1.3	1.4	0.1	125.8
Canada							
2007	2.0	1.1	1.9	2.1	4.3	4.2	100.0
2008	1.2	-4.5	0.9	2.4	3.6	2.4	100.7
2009	-2.7	-13.1	-3.5	0.3	3.2	0.4	94.0

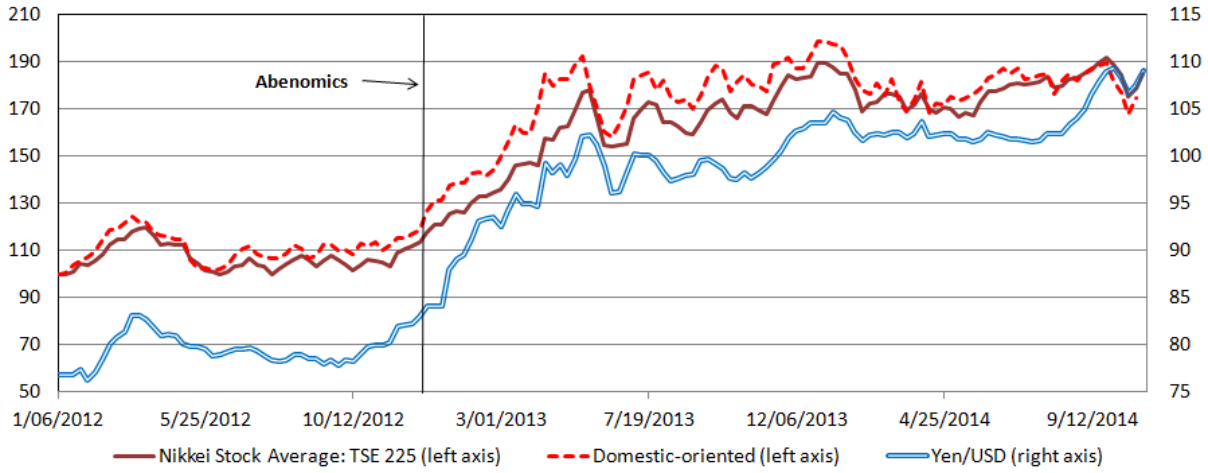
Note: Numbers in the table are in percent. Bilateral USD exchange rate is normalized to 100 in 2007.
Source: WEO October 2014

Deflationary pressures intensified in Japan (resulting in part from a sharp drop in exports). It was as if the public had the self-reinforcing belief that policy would not be able to offset the contractionary shock. That is, expectations might well have amplified the contractionary shock. A very different experience over the same period is evident for Canada. The rate of inflation when the crisis broke was about 2 percent, and the Bank of Canada's policy rate was above 4 percent. Over the next 2 years, the ample room for action was exploited by the Bank, which cut the policy rate to near zero. The Canadian dollar depreciated. Exports fell, but not as precipitously as in Japan, and the decline in GDP in 2009 was half as large. Inflation fell to a low level, but remained positive. In the Canadian post-crisis case policy actions, in combination with expectations that remained quite robust, considering the proximity of Canada to the U.S. epicenter of the crisis, acted as a shock absorber.

In 2012, the announcement of a policy change and subsequent actions by the new Japanese government, which introduced a much more vigorous policy to combat the recession, led to a substantial depreciation of the yen.[25] This was accompanied by a strong rise in the Nikkei Index, which almost doubled between mid-2012 and end-2014 (Figure 3). These movements suggest that the more active policy effectively raised longer-term inflation expectations, in support of the expansionary policy objective, even though the Bank of Japan still had no room to reduce the policy interest rate.

[25] For a discussion of Abenomics, see Botman, Danninger and Schiff (2015).

Figure 3. Japan Sectoral Stock Market Indices versus Exchange Rate



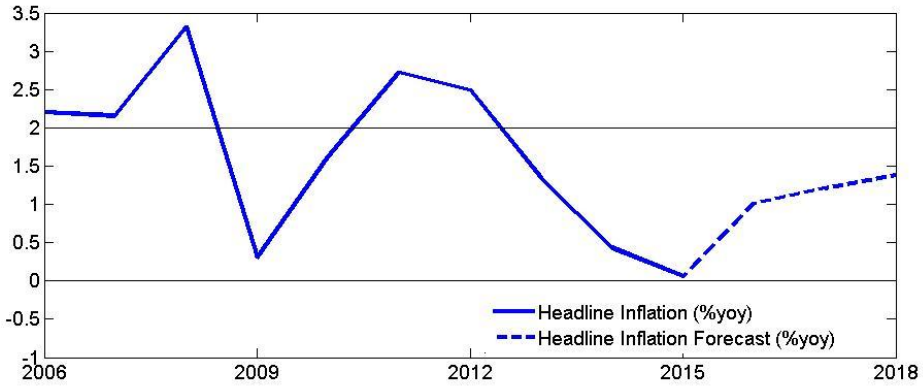
Note: Domestic-oriented stock market index is the average of real estate, wholesale trade, retail trade, banks, insurance and services. Jan 6, 2012=100.
Source: Haver Analytics and IMF staff calculations

In the euro area, since 2003 monetary policy has had a price stability objective defined as "price increases below but close to 2 percent." The European Central Bank (ECB) mandate also calls for the pursuit of full employment and balanced economic growth, in so far as these objectives do not conflict with price stability. One possible change that the ECB might consider would be to emphasize that the price stability policy is *symmetric* towards errors above and below the "close to 2 percent" inflation objective.[26] Such a shift could also be accompanied by a movement to an endogenous short-term interest rate in the published ECB forecast, from the current exogenous rate (taken from market forward rates).

Shortly before the global crisis hit, the ECB raised the policy rate from 5 to 5 ¼ percent, as inflation, driven by oil prices, rose above 2 percent. The years following the crisis saw severe weakness in output and employment in the euro area, and a rate of inflation well below 2 percent—except for years when oil prices rose strongly (Figure 4).

[26] Blanchard and Galí (2010) argues that the best monetary policy for the euro area would involve placing more emphasis on unemployment and less on inflation stability than in countries that have more flexible labor markets.

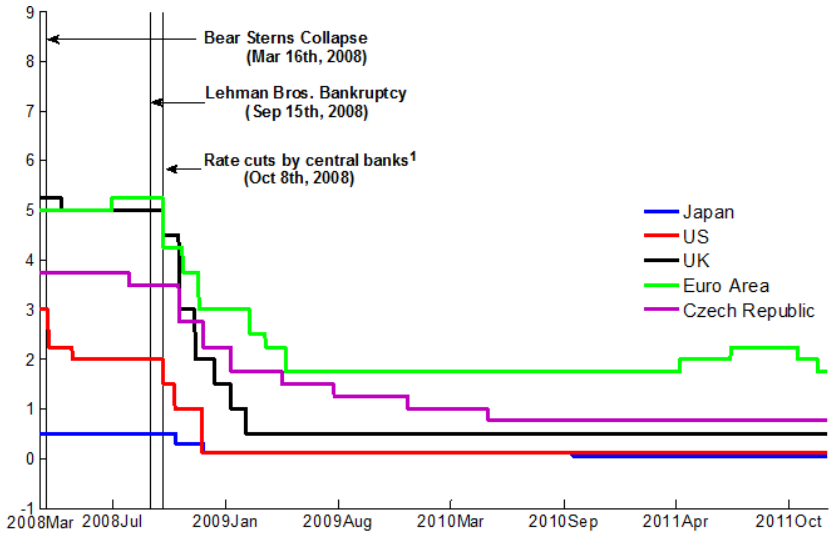
Figure 4. Inflation and Inflation Forecast for the Euro Area



Source: WEO April 2015

The ECB interest rate was raised in 2011, following an increase in oil prices (Figure 5). In 2012, inflation began to fall, to less than 1 percent by end-2013, and to about zero by end-2014. In 2012 a more expansionary policy was launched. Since then, the measures have included interest rate cuts (effectively to zero in 2014), outright asset purchases, FG on future rates, and large-scale QE. Given the transmission lags, the results of the switch are not yet in. However early 2015 data on output, employment, and credit do show a pick-up.[27] These early indications would indicate that a credible expansionary policy is now at work.

Figure 5. Evolution of Policy Rates in the US, Euro Area, Japan, UK and the Czech Republic



1. The Fed, ECB, and central banks in U.K., Canada, Sweden, Switzerland, and China cut rates in a coordinated effort.
Source: Haver Analytics and IMF staff calculations

[27] See Cœuré (2015).

Consensus forecasts for the years 2015 and 2016, surveyed from January 2014 until April 2015, nevertheless suggest that the cross-region policy differences have had a lasting effect (Figure 6). Thus, expected growth of wages and real consumption has remained substantially higher in the 3 IFT-like economies (United States, Canada, and the Czech Republic) than in the euro area (despite the recent pick-up) and in Japan. This would reflect, among other things, the impact of better-anchored inflation expectations, in spite of actual inflation being lower than the target, and their effects on longer-term real interest rates.[28] In the IFT economies, medium-term inflation expectations have been acting as a shock absorber, creating a positive effect on output and hiring by firms, and hence on expected incomes and consumption demand (see Box 3). Such an outcome is in line with the data on inflation expectations in Table 2, which show that the announced target has been providing a much firmer anchor to inflation expectations in the IFT economies than in both the euro area and Japan.[29]

Table 2. Consensus CPI Inflation Expectations

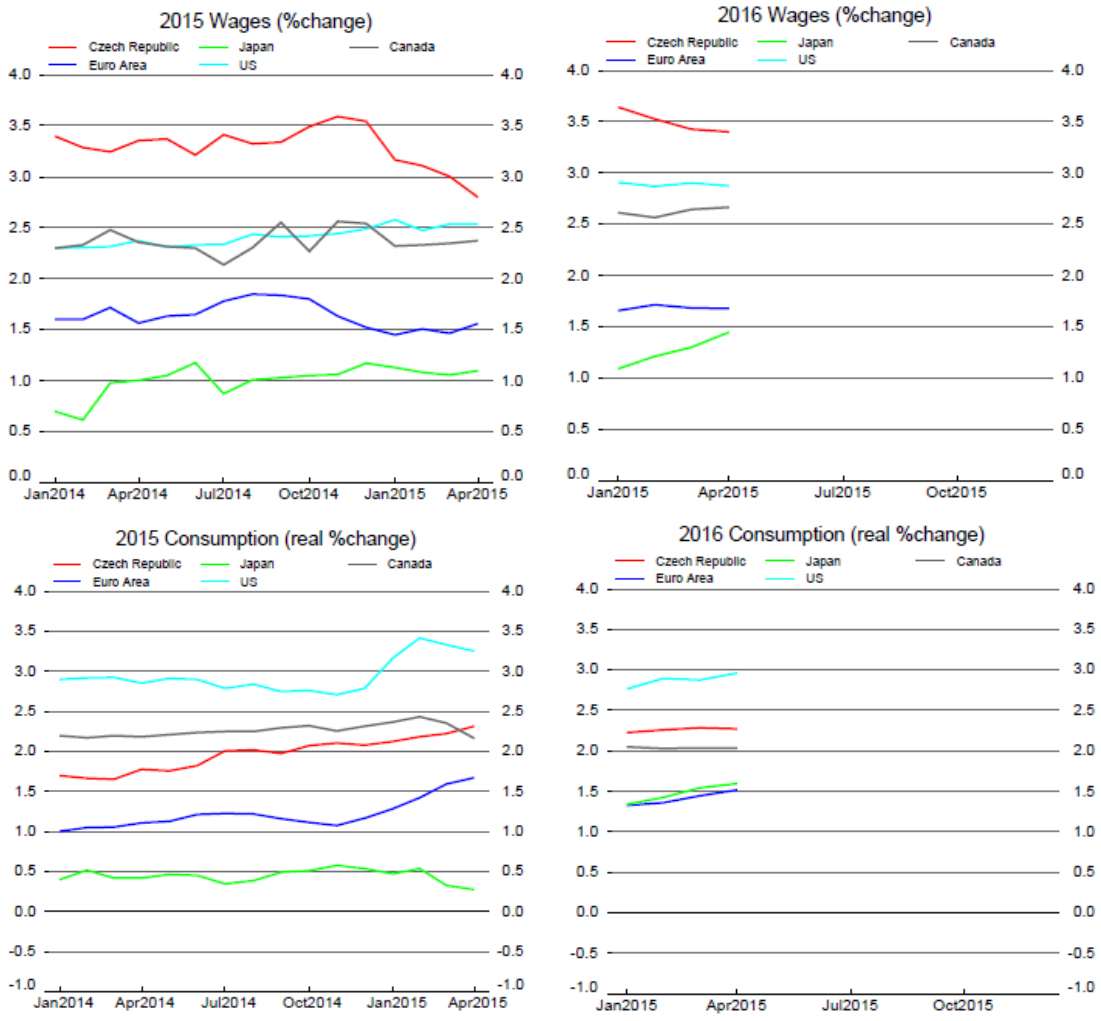
CPI Inflation Expectations and Deviations from Objectives in Parenthesis						
	Objective	2016	2017	2018	Cumulative Deviations from Inflation Objectives	IFT CB /1
Canada	**2.0**	2.1 (0.1)	2.1 (0.1)	2.0 (0.0)	**0.2**	Yes (1994)
Czech Republic	**2.0**	1.7 (-0.3)	1.9 (-0.1)	1.9 (-0.1)	**-0.5**	Yes (2002)
United States /2	**2.3**	2.2 (-0.1)	2.3 (0.0)	2.3 (0.0)	**-0.1**	Yes (2012)
Euro Area	**2.0**	1.2 (-0.8)	1.5 (-0.5)	1.7 (-0.3)	**-1.6**	No
Japan /3	**2.0**	1.0 (-1.0)	2.0 (0.0)	1.4 (-0.6)	**-1.6**	No

Source: Consensus Economics Quarterly Survey (April 2015).
1/ IFT CBs use consistent macro forecasts to explain how they are adjusting their instruments to achieve their output-inflation objectives.
2/ The implicit CPI inflation objective for the U.S. is estimated by the authors at about 0.3 percentage points above the Fed's official PCE inflation objective of 2.0 percent. This is based on the difference

[28] The empirical evidence suggests long-term inflation expectations are better anchored in IT countries than in non-IT countries. See Levin, Natulucci and Piger (2004), Goretti and Laxton (2005), Gurkaynak and others (2006), Gurkaynak, Levin and Swanson (2010).
[29] Recent Japanese data on inflation and expectations, however, have to be interpreted carefully, because of the large effect of recent and planned increases in the sales tax.

in long-term CPI and PCE inflation forecasts from Philadelphia Fed's Survey of Professional Forecasters.
3/ Annual CPI expectations for Japan are heavily affected by the VAT.

Figure 6. Consensus Forecasts for Wage and Consumption in Major Economies



Source: Consensus Economics Survey

Box 3: Medium-Term Inflation Expectations as Shock Absorber or Amplifier

In normal times, following a contractionary shock, policy would react with a rate cut which has its effects on inflation and output via the usual transmission mechanism. At the ZLB, the story is more complicated as the nominal interest rate cannot decline, but a somewhat weakened version of the mechanism could still apply, through real market interest rates and the real exchange rate. That is, expected inflation provides a channel via which FG can stimulate the economy. If monetary policy is active, and credible, it could persuade the public that it will eventually get inflation back up to the long-run target. With the promise of a sufficiently vigorous policy, which commits to holding the interest rate near zero for an extended future period, the public would expect increased inflation in the future. This would reduce longer-term real interest rates even though the nominal rate is at the ZLB. These movements serve as a buffer to the shock. Under such circumstances, in order to respond strongly to the initially very weak economy, the central bank might show a stimulative forecast in which, over the medium term, inflation overshoots before returning to the long-run target.

Moreover, in this case, the real exchange rate would depreciate, and asset prices would rise (see Annex 2). That is, the real price of foreign exchange also responds in an equilibrating way, a normal aspect of the transmission mechanism. Thus, the real interest rate channel would be amplified in the open-economy case by the real exchange rate channel. A very similar argument to that for the real exchange rate applies to asset prices. An increase in the expected medium-term rate of inflation that reduces real interest rates would boost asset prices through the lower real discount rate, and through the positive impact of exchange rate depreciation on profits. Increased asset prices would stimulate spending.

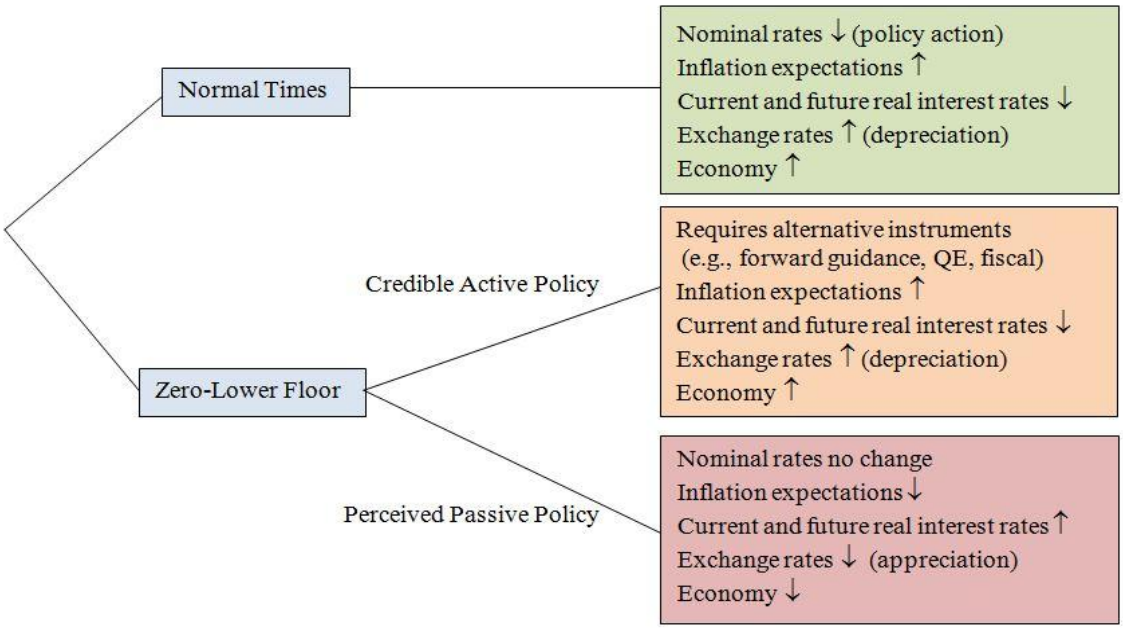
To achieve this result, the central bank has to persuade people that the nominal interest rate will remain at the floor for an extended period and that the rate of inflation will rise over the medium term, possibly above the long-run target, but that the rate of inflation will eventually return to target. Is this a realistic prospect? The exchange rate policy used by the Czech National Bank since 2013, which has relied heavily on influencing expectations, suggests that, under a transparent IFT framework, it can be (see Annex 1).

Continued …

Box continued …

If, however, monetary policy were passive, and not credible, the real exchange rate and asset prices would amplify a contractionary shock, because the expected rate of inflation would fall (equivalently, the expected rate of deflation would rise). At the ZLB, real interest rates would rise, the real exchange would appreciate, and asset prices would fall. This is the classic deflation trap. The flowchart illustrates the difference between the 2 policy regimes.

Box Figure 3.1. Expectations as Absorber or Amplifier Following a Contractionary Shock



V. Illustrative Examples of Policy-making Strategy Based on a Simple Model

V.1 Introduction

This section of the paper has two main objectives. The first is to show with a very simple model of the U.S. economy how policymakers might develop a projected path of the Fed funds rate that would deliver an appropriate response to the current economic situation. In practice, of course, any forecast by the staff is a much more complex undertaking than a simple model projection—it will combine model insights with the professional judgments of the highly-trained economists at the central bank. Hence, the discussion below is not meant to be taken literally.

The procedure described would allow the central bank to undertake a policy-making strategy that takes into account not only the baseline forecast but also the risks surrounding the baseline, including the policy response.[30] Model-derived confidence bands and alternative scenarios can help enrich the analysis and make clear to the public and financial-market participants the nature of the relevant uncertainties. In particular, they can help the central bank communicate the principal risks to the baseline projection. Indeed, it can be argued that it would be more important to show the confidence bands than the central baseline result.

The second main objective of this section is to provide some insights into the implications of various possible policy reaction functions. We use the model to compare the results of projections using: a simple Taylor rule; an inflation-forecast-based (IFB) reaction function; and optimal control policy that reflects the dual-mandate preferences of the policymakers. Comparison of the results, and discussion of the advantages and disadvantages of the various approaches that they reveal, might help policymakers to decide which approach would be most useful. An interesting result is that such a policy-making strategy could, in a situation with a negative output gap and undesired disinflationary pressure, result in a planned overshoot of the inflation target.[31] We also investigate what the different approaches indicate would be an appropriate response to positive versus negative demand shocks, and to an adverse supply shock.

V.2 Outline of the model

We use a stripped-down, closed-economy, model. It is based on the standard gap model, with equations for output (IS curve), an inflation formation equation (based on an expectations-

[30] For discussion of those issues, see Dudley (2012) and Yellen (2012).

[31] Other circumstances might also involve overshooting. For example, undershooting and overshooting could also reflect optimal monetary policy under uncertainty or simply concerns about persistent deviations on either side of the target. See Kamenik and others (2013).

augmented Phillips curve), and the short-term interest rate (policy reaction function).[32] The model is forward looking, in that expectations, and the policy rule, are driven in part by the model's own future solved values (in the long run, both expectations and outcomes converge on steady-state paths). The output gap equation contains a bank-lending-tightening variable, which captures exogenous changes in credit conditions.[33] Demand shocks are represented by the stochastic term in the output gap equation, and supply shocks by that in the inflation equation.

For present purposes, the only aspect that needs discussion in any depth is the form of the policy reaction function for the federal funds rate. We experiment with the following 3 alternatives.

Taylor rule. The variant used in this paper, as shown below, is similar to the rule proposed in Taylor (1993):

$$i_t = \bar{r}_t + \pi 4_t + 0.5*(\pi 4_t - \pi^*) + 0.5*y_t + \varepsilon_t^i,$$
$$\bar{r}_t = 0.95*\bar{r}_{t-1} + 0.05*\bar{r}^{ss} + \varepsilon_t^{\bar{r}},$$

where i_t is the federal funds rate, $\bar{r}_t$ is the equilibrium real interest rate, $\pi 4_t$ is the year-on-year inflation, π^* is the inflation objective, assumed to be 2 percent, y_t is the output gap, and ε_t^i is a policy deviation, $\bar{r}^{ss}$ is the equilibrium real interest rate in the steady-state, and $\varepsilon_t^{\bar{r}}$ is a shock to the equilibrium real interest rate.

The nominal federal funds rate is a function of: the equilibrium real interest rate; the inflation rate; the deviation of inflation from target with a coefficient of 0.5; and the output gap, also with a coefficient of 0.5. The exogenous increase over time in the equilibrium real interest rate in this study is based on the assumption that the current high level of desired saving vis-à-vis desired investment is related to the contractionary forces and heightened uncertainties in the economy over the past few years, which will gradually dissipate over time. While there is considerable uncertainty about estimates of the neutral rate, which is unobservable, estimates in Pescatori and Turunen (2015) suggest that it is currently likely to be close to zero and to increase only gradually over time (see also Dudley, 2012, and Yellen, 2015). The

[32] The model is based on a closed-economy version of the Global Projection Model (GPM). Different versions of this model have been used in a number of papers. For example, Carabenciov and others (2008) contains a version for the United States alone, while Carabenciov and others (2013) uses an open-economy version, within the multi-country Global Projection Model. The main equations of the model are presented in Annex 4.

[33] Annex 4 describes how the bank lending shock is derived. It filters out the normal cyclical component of credit tightening. The lack of an explicit financial sector is, however, an acknowledged weakness of this class of macro models. Non-linearities such as credit cut-offs and banking crises can create the potential of dark corners. The MAPMOD model embodies such aspects of financial vulnerability (Benes, Kumhof and Laxton, 2014a, b).

Taylor rule results in an increase in the real interest rate following an increase in the rate of inflation – the appropriate monetary policy response.

Inflation-forecast-based reaction function. The IFB reaction function used in this study focuses on the forecast of year-on-year rate of inflation three quarters in the future.

$$i_t = 0.71 * i_{t-1} + (1-0.71) * [\bar{r}_t + \pi 4_{t+3} + 0.91 * (\pi 4_{t+3} - \pi^*) + 0.21 y_t] + \varepsilon_t^i$$

Here the nominal federal funds rate is a function of its lagged value (a way of smoothing the reactions to changes in inflation and output), the equilibrium nominal interest rate (as measured by the sum of the equilibrium real interest rate and the projected year-on-year core PCE rate of inflation), the forecast deviation of projected inflation from its target value, and the output gap. This formulation also has the appropriate response over time of the real policy interest rate to off-target forecasts of inflation. However, in contrast to the Taylor rule, the IFB formulation ignores inflation shocks that are expected to reverse within the three-quarter policy horizon. It also allows the central bank to take account of known developments that might affect inflation over this horizon, including lagged effects of policy itself that are still in the pipeline.

Optimal control policy making **or minimizing a loss function.** The loss function incorporates the principal objectives of the central bank in policy making.

$$L_t = \sum_{i=0}^{\infty} [\alpha * (\pi 4_{t+i} - \pi^*)^2 + \beta * y_{t+i}^2 + \gamma * (i_{t+i} - i_{t+i-1})^2]$$

The quadratic formulation implies that large deviations from desired levels are disproportionately more important than small deviations—i.e., that there is a rising marginal cost of inflation-targeting errors, output gaps, and interest rate volatility. This is reasonable since policymakers should not even try to avoid small errors (i.e., fine tune), because policy actions are subject to imprecision and uncertainty. The central bank would, however, very much like to avoid recessions, or destabilized inflation expectations (and especially, under current circumstances, deflationary expectations). In particular, policymakers would want to keep their economies well away from dark corners where recovery from shocks becomes much more difficult, because of nonlinearities (Blanchard, 2014). A contractionary shock combined with the ZLB would be the main concern at the moment. In other circumstances—high inflation and unstable expectations—an inflation shock and a collapse of monetary policy credibility would be the main danger.[34]

[34] A lesson from endogenous credibility models is that an episode of excessive inflation can result in a costly loss of the nominal anchor (e.g., Argov and others, 2007).

The squared change of the federal funds rate in the equation represents aversion to interest rate volatility. This term smooths the policy response of the federal funds rate, reflecting the behavior of central banks.[35] By taking account of both current and expected future values of output and inflation, this formulation incorporates currently available information about likely future developments into the policy response.

For optimal control policy making, we use two calibrations of the optimal control loss function, both reflecting a dual-mandate central bank or, equivalently, an IFT central bank. The first variant (DM1) puts equal weight (1.0) on inflation and output gaps. The second (DM2) has half the weight on the output gap (0.5) as that on the inflation gap (1.0). The coefficient for the change in the nominal interest rate remains the same, 0.5, in both versions. The latter acts to smooth the interest rate path and to prevent the type of abrupt interest rate movements that are rarely seen in reality.

It is worth briefly summarizing the transmission mechanism in the model, from central bank policy rate actions to output and inflation. An exogenous increase in the policy interest rate leads to an increase in the short-term real interest rate, which feeds into the long-term real rate. The latter, with lags, leads to a decrease in aggregate demand and output via the output gap equation. The more negative output gap (i.e., increased excess capacity) gradually puts downward pressure on inflation. Exogenous shocks in the aggregate demand and inflation equations also have direct and lagged effects on both output and inflation. The feedback loops are also worth underlining. Any shock of material size and duration, in any equation, reverberates through the whole system, and brings into play the IFT policy response, which eventually, through the transmission mechanism just described, will stabilize inflation at the long-run target rate, and output at its long-run equilibrium, or potential level, as befits a flexible IT or dual-mandate regime.

V.3 Illustrative simulation results

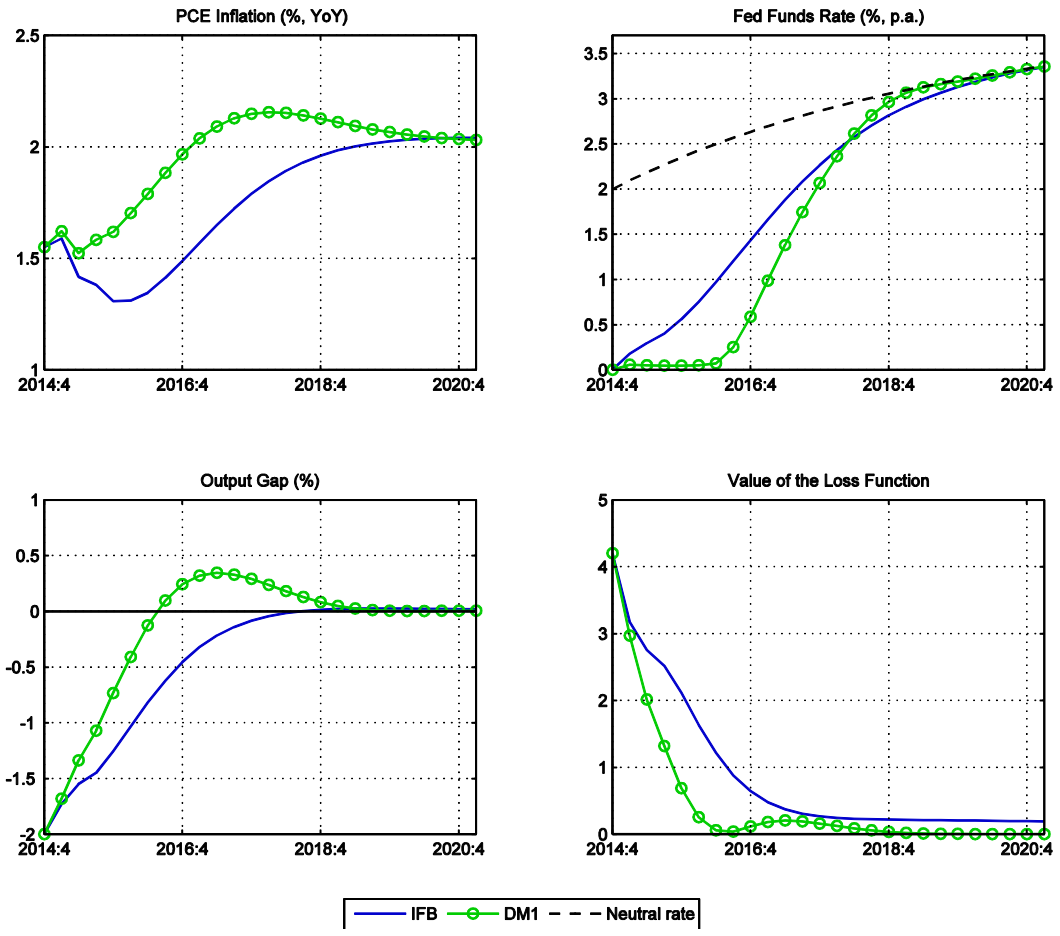
V.3.1 Policy response to current economic situation

The first set of illustrative simulations are based on assumed initial conditions in the U.S. economy as of 2014Q4, with an output gap of -2 percent (i.e., excess capacity), a rate of PCE

[35] Woodford (2003) presents a theoretical argument that some policy rate smoothing is optimal for clear signals to the market about the intent of policy. High variance of the rate might cause people to disregard its movements as noise. Rudebusch (2002) argues that what looks like interest-rate smoothing in estimations of a reaction function is probably due to slow-moving omitted variables that the central bank is taking into account in its interest rate setting. Another way of thinking about gradual responses by central banks to shocks is the uncertainty of whether unexpected shocks are likely to be transitory or longer-lasting. While there may be no reason for the central bank to respond to the former, it should respond to the latter. The uncertainty about the nature of the shock in the data might well lead central banks to respond slowly and wait to see whether subsequent data confirm that the shock is likely to be long-lasting and hence requires a stronger response.

inflation of about 1.5 percent, and a federal funds rate of about zero. In Figure 7, we compare the policy implications of the IFB reaction function (the blue line) and optimal control policy making DM1 (green circles). The value of the loss function for the IFB reaction function is calculated using the same weights as in the optimal control policy making DM1. The figure reports the contemporaneous value of the loss function, not the expected sum of all future losses.

Figure 7. Illustrative Example of the Current Situation: IFB Reaction Function versus a Dual Mandate CB Optimal Control



Source: IMF staff calculations

The *real* equilibrium funds rate (the so-called neutral rate) rises, by assumption, from 0 in 2014Q4 to about 1.3 percent in 2020Q4. We posit the rising trend to depict the return of the equilibrium rate to a more normal value after the damaging effects on investment and

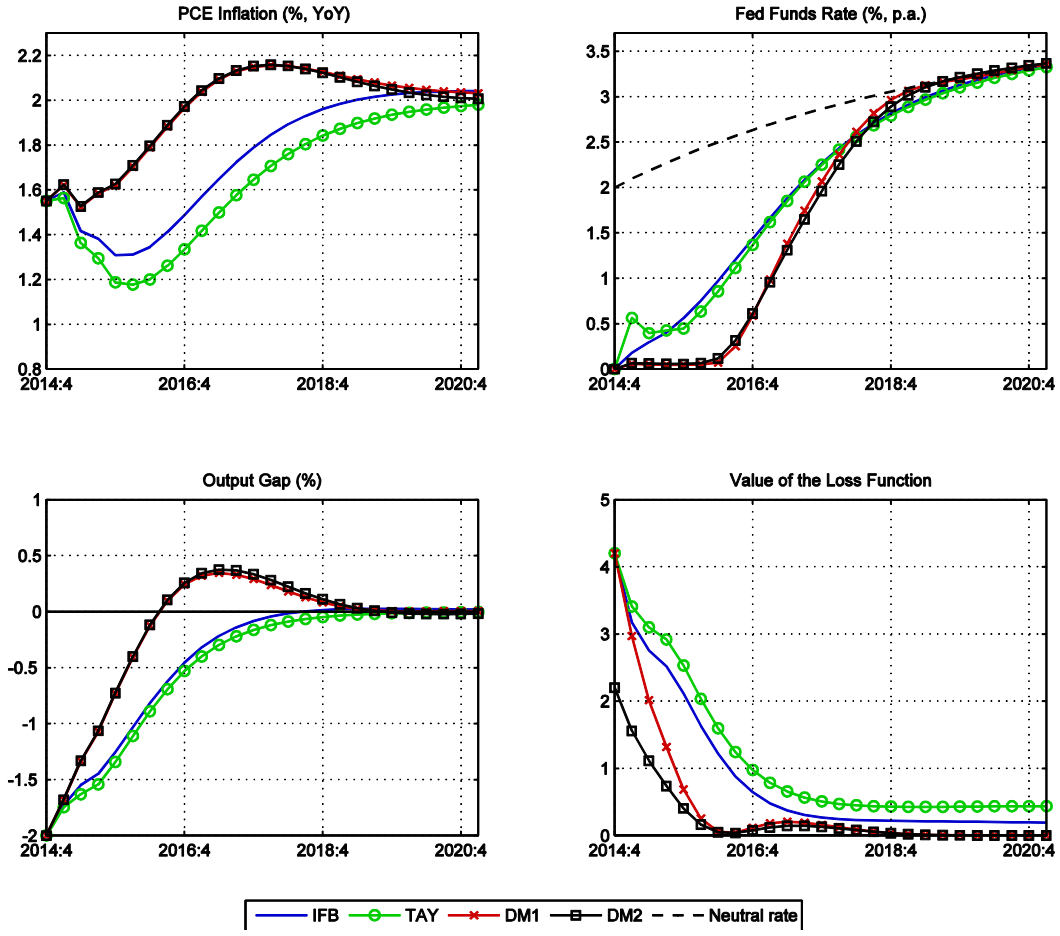
confidence of the Great Recession.[36] Equivalently, with a 2 percent inflation target, the equilibrium nominal rate rises from 2 percent in 2014Q4 to 3.3 percent in 2020Q4 (the dashed line).

The federal funds rate gradually rises starting almost immediately under the IFB reaction function relative to its path under DM1 optimal control where it remains at the zero lower bound until mid-2016 before beginning to rise. The immediate increase under the IFB reaction function is related to the increase in the equilibrium real interest rate in the IFB function specification. The IFB policy tightening means a slower closing of the output gap, and inflation below target for a longer period of time, with the output gap and the rate of inflation moving gradually to the long-run equilibrium. In contrast, the output gap and the inflation rate overshoot somewhat under the DM1 policy, with the output gap moving to a positive 0.3 percent (i.e., modest excess demand) at the maximum and the rate of inflation to 2.2 percent at the maximum. That is, equilibrium is reached via a modest cycle.

Figures 8 and 9 present all 4 policy approaches (Taylor, IFB, DM1, and DM2). Here, DM1 is represented by a red line with crosses, and DM2 by a black line with squares.

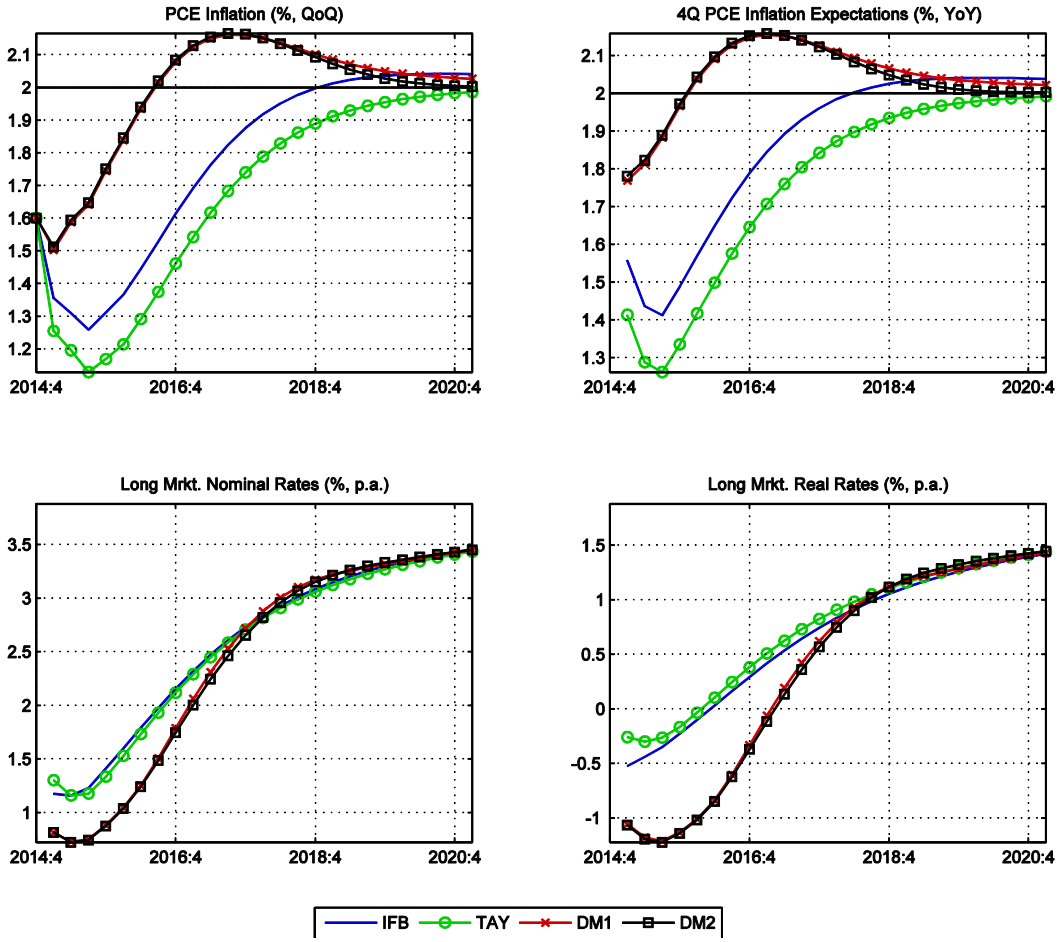
[36] Taylor (1993) assumes a constant 2 percent equilibrium real rate.

Figure 8. Comparison of 4 Reaction Functions for the Current Situation (Part 1)



Source: IMF staff calculations

Figure 9. Comparison of 4 Reaction Functions for the Current Situation (Part 2)



Source: IMF staff calculations

The two DM lines sit almost on top of each other—the halving of the weight on the output gap in DM2 makes hardly any economic difference. The two reaction functions (blue line for the IFB reaction function, green line with circles for the Taylor rule) show a small difference. Thus the major difference is seen in the pair of loss-function minimizations versus the pair of policy rules. To repeat, the much lower market real rate for the loss-function minimization approach has a significant effect on the movements of output and inflation. The higher medium-term inflation in the loss-function cases, with forward-looking expectations, means that the difference is even larger for real long-term rates than for nominal short-term rates—compare the bottom pair of panels of Figure 9. The higher inflation expectations largely result from market participants' understanding of the policy frameworks under the loss-function arrangements and how they lead to lower interest rates and a stronger economy over time. This, of course, drives stronger growth (as shown in the output gap) and a higher inflation rate, as compared to the reaction functions, since it is the real long-term interest rate

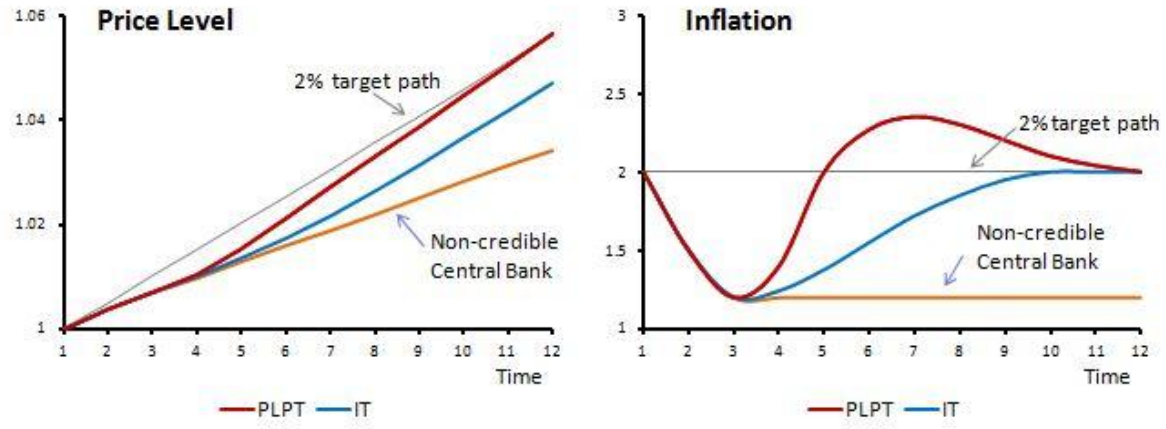
that enters into the aggregate demand function. The predicted overshooting of inflation and output under DM1 or DM2 is the deliberate result of the very stimulative policy stance. From the viewpoint of optimal control policy making, the starting point for the economy (with output well below potential and inflation below the target rate) is very inefficient. The central bank takes a minor upside risk to insure against a much more costly downside risk, given the rising marginal cost of the negative output and inflation gaps, and given the ZLB, which deprives policy of a stimulative tool, in the event of a negative demand shock. Box 4 expands on the argument for a planned overshoot.

But here we would emphasize the word *planned*. Given the certainty of subsequent random shocks, it is not at all certain that the overshoot would occur. More important, if the forecast path were to aim at an asymptotic approach to the desired equilibrium, monetary policy actions would have to be less stimulative (as in the IFB outcome), and both output and inflation would be below their desired levels for a much longer period of time. Furthermore, as will be seen later in the paper, the bands of uncertainty are much wider than the size of the predicted overshoot. In statistical terms, the probability of overshooting the 2 percent target is slightly greater than 50 percent, and the overshoot is not very large.

Box 4: Price-Level-Path Stability and Inflation Overshooting

If the economy has been mired in an undesired disinflation, an overshooting of the long-run inflation target in the medium term is harmless, in that it would help restore the average medium-term rate of inflation to target. That is, the overshoot would help hold the price level closer to a stable long-run growth path, as shown in the red line in the figure below. This is in contrast to the non-overshooting IT policy represented by the blue line in the figure. Thus, a strongly stabilizing IFT policy would have an outcome similar to that of a price-level targeting policy—Canada provides an example (Kamenik and others, 2013). In contrast, if inflation returns asymptotically to target, after a deflationary period, the path of the price level would be permanently lower, as for the blue line. A contractionary shock with a non-credible passive policy at the ZLB is illustrated by the yellow line: expectations amplify the shock.

Box Figure 4.1: Price Level and Inflation under Price-Level-Path-Targeting (PLPT) Policy, Inflation-Targeting (IT) Policy, and Non-Credible Policy

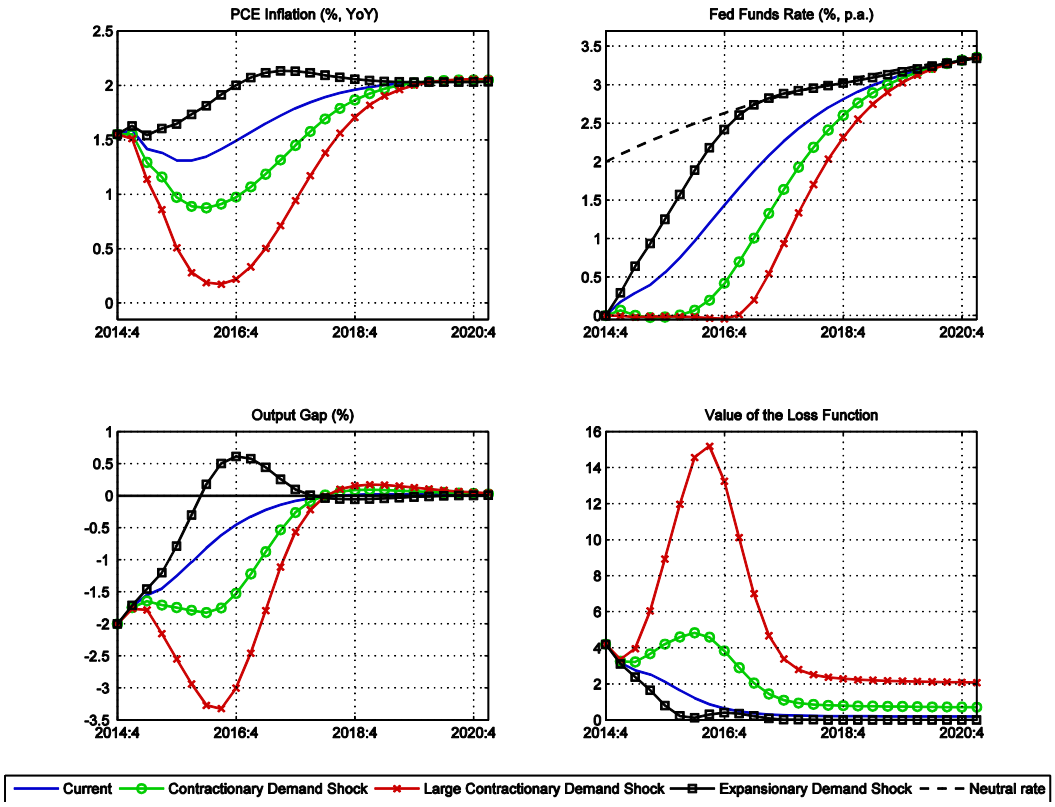


Some central bankers might nevertheless be concerned that a plan to inflate beyond the target would lead to unanchored expectations. There is the possibility that the economy might turn out to be stronger than expected, and overheat. However, as soon as such a development became visible, the central bank would raise the policy interest to counter any inflationary effects—and there is unlimited potential for monetary policy to tighten, since there is no equivalent to the ZLB to constrain interest rate increases. Credibility means that people give policymakers more scope to be flexible in the way they approach their objectives. Moreover, the inflation objective is symmetric. Even ignoring the ZLB, there is no reason why people would be more concerned by overshoots than undershoots, especially in the context where an overshoot follows a series of undershoots.

V.3.2 Demand shocks

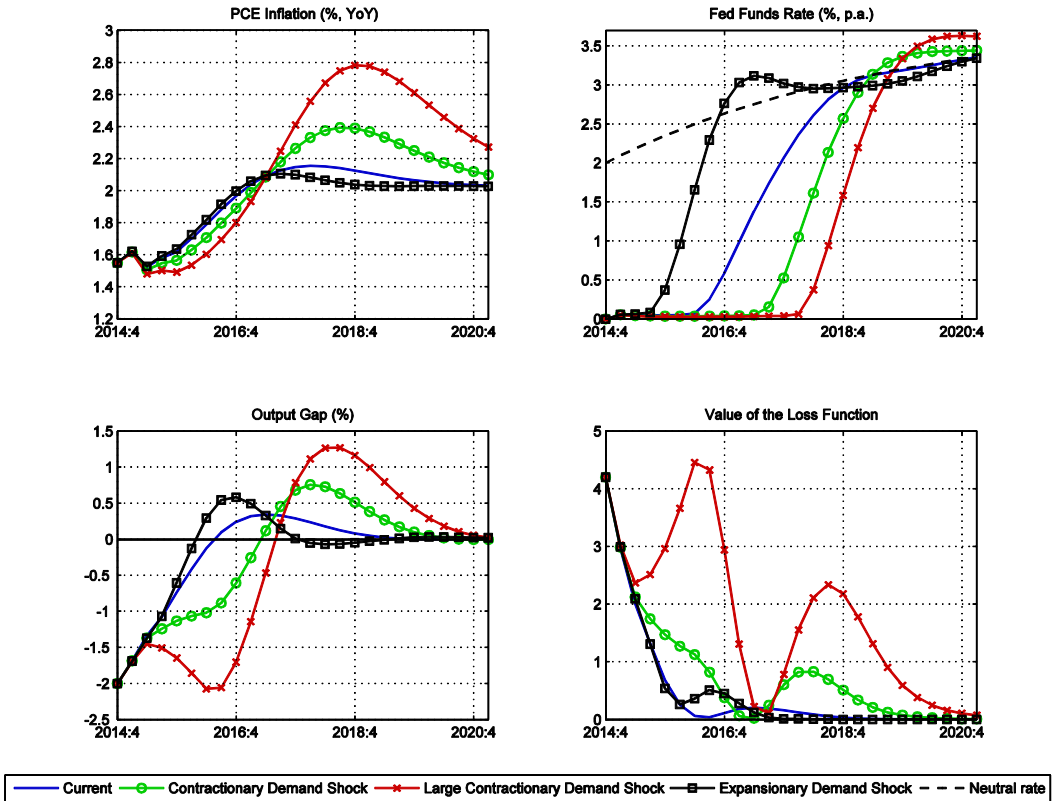
Figure 10 (IFB reaction function) and Figure 11 (DM1 optimal control) show the effects of various kinds of demand shocks (mild contractionary–green line, large contractionary–red line, and expansionary–black line) relative to the baseline repeated from Figure 7 (blue line).

Figure 10. Vulnerabilities Related to the ZLB under IFB Reaction Function



Source: IMF staff calculations

Figure 11. Vulnerabilities Related to the ZLB under Dual Mandate CB Optimal Control (DM1)



Source: IMF staff calculations

In comparing the two figures, we see that the loss minimization approach cushions the real economy much better against contractionary demand shocks, with some overshoot in inflation in the case of contractionary demand shocks under DM1. Again, the increase in federal funds rate is more delayed under the DM1 optimal control than under the IFB reaction function. As before, the loss-function approach puts a high marginal cost on further widening of the negative output gap of the initial conditions. With the policy instrument readily able to prevent inflation from getting out of hand, the central bank optimal control is more concerned about the actual disinflationary pressures, and the deflationary risks of the contractionary shock, than about a possible future inflation overshoot.

The reactions to a positive demand shock show considerable similarity across the IFB and DM1 options. In each case, the central bank raises the policy rate to 3 percent, the output gap goes through a mild cycle on its way to zero, and inflation has a modest overshoot. The

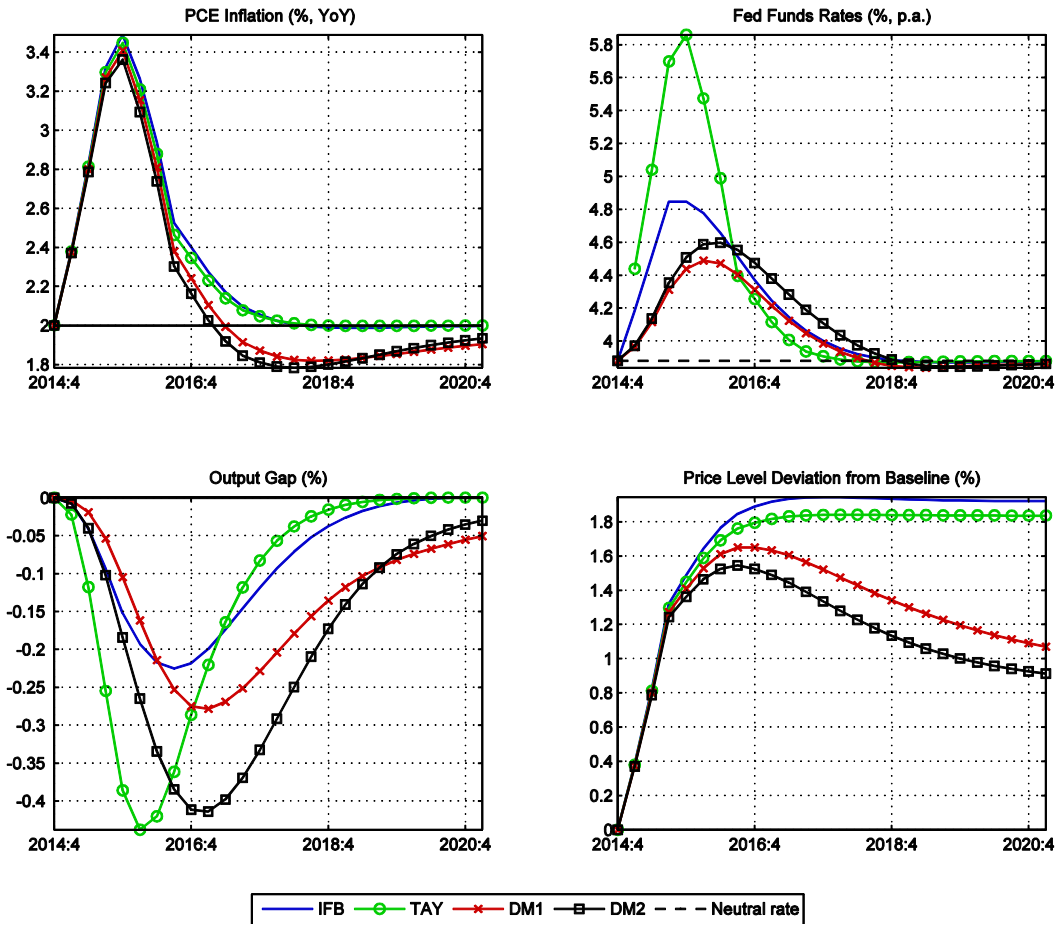
similarity reflects that the expansionary shock is an easy one to manage. Given the starting point, this shock pushes the economy towards equilibrium. Policy under either option does not have to offer resistance, it just has to raise the interest rate to its equilibrium level.

V.3.3 Supply shocks

Figures 12 and 13 show the effect on the economy of a nasty supply shock under the reaction functions and optimal control.[37] The starting point for this shock is a full equilibrium: zero output gap; 2 percent inflation; and a stable equilibrium real interest rate.

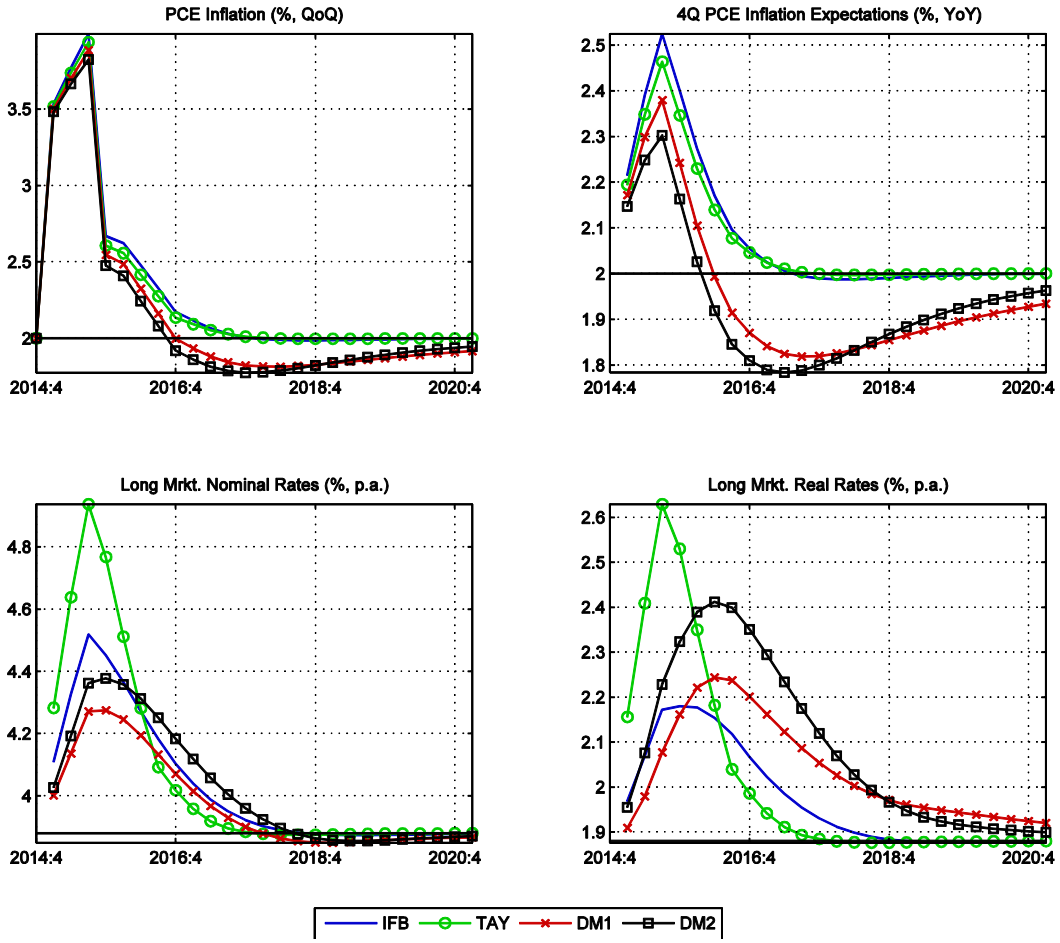
[37] Nasty here means a 1-standard-deviation shock to the stochastic term in the Phillips curve, equivalent on impact to a 1.38 percent jump in quarter-on-quarter inflation. The duration of the shock is 2015Q1-2015Q3.

Figure 12. Comparison of 4 Reaction Functions for Illustrative Nasty Supply Shock (Part 1)



Source: IMF staff calculations

Figure 13. Comparison of 4 Reaction Functions for Illustrative Nasty Supply Shock (Part 2)



Source: IMF staff calculations

Adverse supply shocks are generally difficult for monetary policy. The short-run policy trade-off is very problematic, with rising inflation and a drop in output. The latter would normally require an interest rate reduction, while the former would normally require an interest rate increase. All four of the policy options show a considerable policy rate hike, up to 4 ½ percent for the optimal control loss functions, and 5 ½ percent for the Taylor rule. Not surprisingly, the Taylor rule opens a wide negative output gap, and quickly gets inflation back to 2 percent without any undershoot. The IFB reaction function outperforms the Taylor rule. It produces a relatively small but still sharp policy rate increase, to about 4.8 percent for a couple of quarters. The cumulative output gap is smaller, and inflation returns to target as quickly as for the Taylor rule. The reason for the dominance of IFB over the Taylor rule for

this shock is that IFB sees that the inflation impact is one-off, whereas the Taylor rule does not look forward, and responds with a heavier hand.

The optimal control loss functions bring inflation back to the target faster than the reaction functions, and with an undershoot. Under optimal control, the interest rate hikes are smaller and more gradual. Output gaps are more negative because an overshoot implies lower inflation later on, and this results in higher real rates compared to the reaction function. The DM2 optimal control with its low weight on the output gap, implies a bigger output gap compared to DM1. The pair of optimal control loss functions has the additional benefit of bringing the price level back to its pre-shock levels whereas under the policy rules the price level can permanently change because of the shock—over time, with a long sequence of shocks, the price level would behave like a random walk under the policy rules. The slightly more negative output gap under the loss minimizing strategies is outweighed by smaller inflation gaps. Since the disutility from higher inflation increases disproportionately with the level of inflation, the larger peak errors of the IFB policy, relative to the loss minimizing policies, are heavily penalized. This said, the comparative advantage of the loss-function approach is not large for this particular shock. A better idea of the potential gain under a variety of different shocks is apparent from the confidence intervals in Figures 14 and 15 (discussed in more detail below). These capture the impact of the whole set of random disturbances over the sample period. The overall superiority of the loss-minimizing approach is reflected in the much narrower output and inflation confidence bands than those for IFB.

V.3.4 A summing up

While the reaction functions may give reasonable results in normal times, they have difficulty in abnormal times. When policy interest rates are at or very near the zero lower bound, the quadratic loss-function approach appears to give better results because its response to disinflationary conditions involves an extended commitment to keep the rate at the floor. As the ZLB approaches, the quadratic optimal control loss function provides ever stronger policy reactions to contractionary shocks, to keep the economy away from the deflation dark corner. At the ZLB, this is reflected in a commitment to hold the short-term interest rate to zero for long enough that inflation will rise, perhaps for a while above the long-run target rate. The boost to inflation expectations reduces the real medium-term interest rate, even though the nominal short rate can go no lower. Under the circumstances, where there is very little risk of sustained inflationary pressure, but a high risk of getting stuck in the deflation trap, such a policy reaction represents prudent policy-making.[38]

[38] Isard, Laxton and Eliasson (1999) makes a more general argument for stronger policy reactions to avoid bad outcomes in the presence of model uncertainty, especially where non-linearities may be involved.

The desire for continuity in policy would argue that more attention should therefore be paid to the loss-minimization approach, in both normal and abnormal circumstances. Nonetheless, this does not imply that information from Taylor rule and IFB approaches should be ignored. Indeed, they can serve as crosschecks to the results from the loss-minimization approach, especially when there is concern that the model specification may be less than satisfactory.

V.4 Confidence intervals and alternative simulations

Every forecast is fraught with risk and it is important that the most relevant risks be communicated to financial markets and the public. Two techniques that are very helpful in such communications are computation of confidence intervals and the simulation of alternative scenarios.

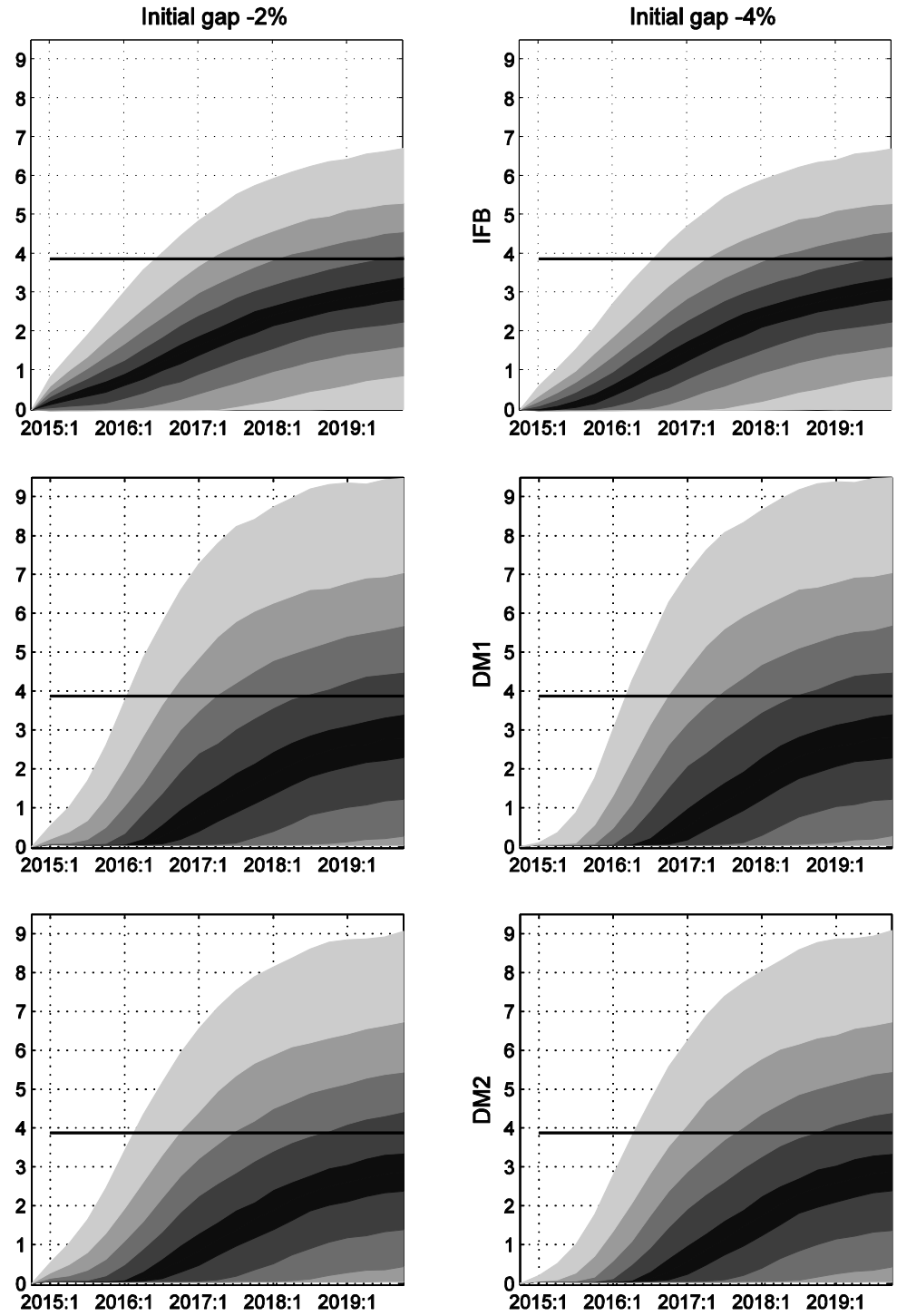
The left hand panels of Figures 14, 15, and 16 show confidence intervals for the forecast federal funds rate, output gap, and year-on-year inflation rate for the monetary policy responses to the current economic situation under IFB, and for the two calibrations of optimal control policymaking.[39] The right hand panels show the results for the current economic situation if the initial output gap were believed to be -4 percent rather than -2 percent. The shaded bands show the confidence intervals from 10 to 90 percent in 10 percentage-point increments. These confidence intervals show a wide range of uncertainty in the projections. In particular, the overshoots discussed in the preceding subsections are very small relative to, say, the 30 to 70 percent confidence bands. This gives one a better perspective on the challenges facing policymakers in the current economic circumstances.

Since the loss-function approach implies more aggressive interest rate responses to negative demand shocks, given the initial conditions, it results in wider confidence bands for the interest rate, and much narrower bands for output and inflation, than the IFB reaction function. Moreover, under the latter, there is a 15 to 20 percent probability of deflation one year into the future. Confidence bands for the policy rate under the loss-function approach are skewed because of the zero lower bound. And the volatility of the economy is somewhat greater under the -4 percent output gap case versus the -2 percent case, because of the higher likelihood that the floor will impede an effective stabilizing policy response.

Figures 17, 18 and 19 compare the loss-function responses to small and large supply shocks with the response of the forward-looking policy rule IFB. The large supply shock scenario doubles the shocks in the small supply shock scenario.

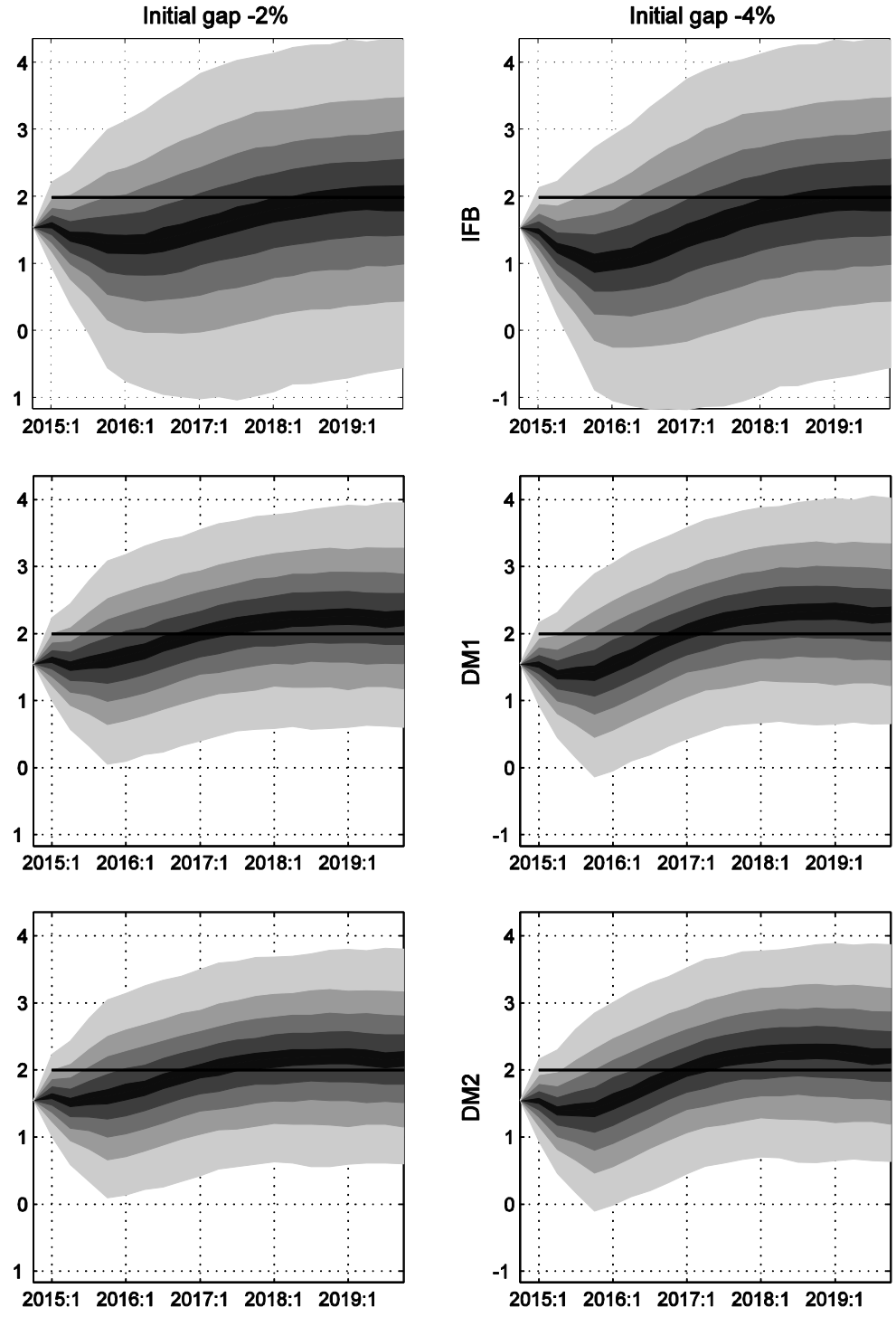
[39] The optimization under the loss function is done for a deterministic baseline simulation, following which we draw shocks around the baseline to compute confidence intervals.

Figure 14. Illustrative Examples of the Current Situation with Confidence Bands (Fed Funds Rate, Percentage, p.a.)



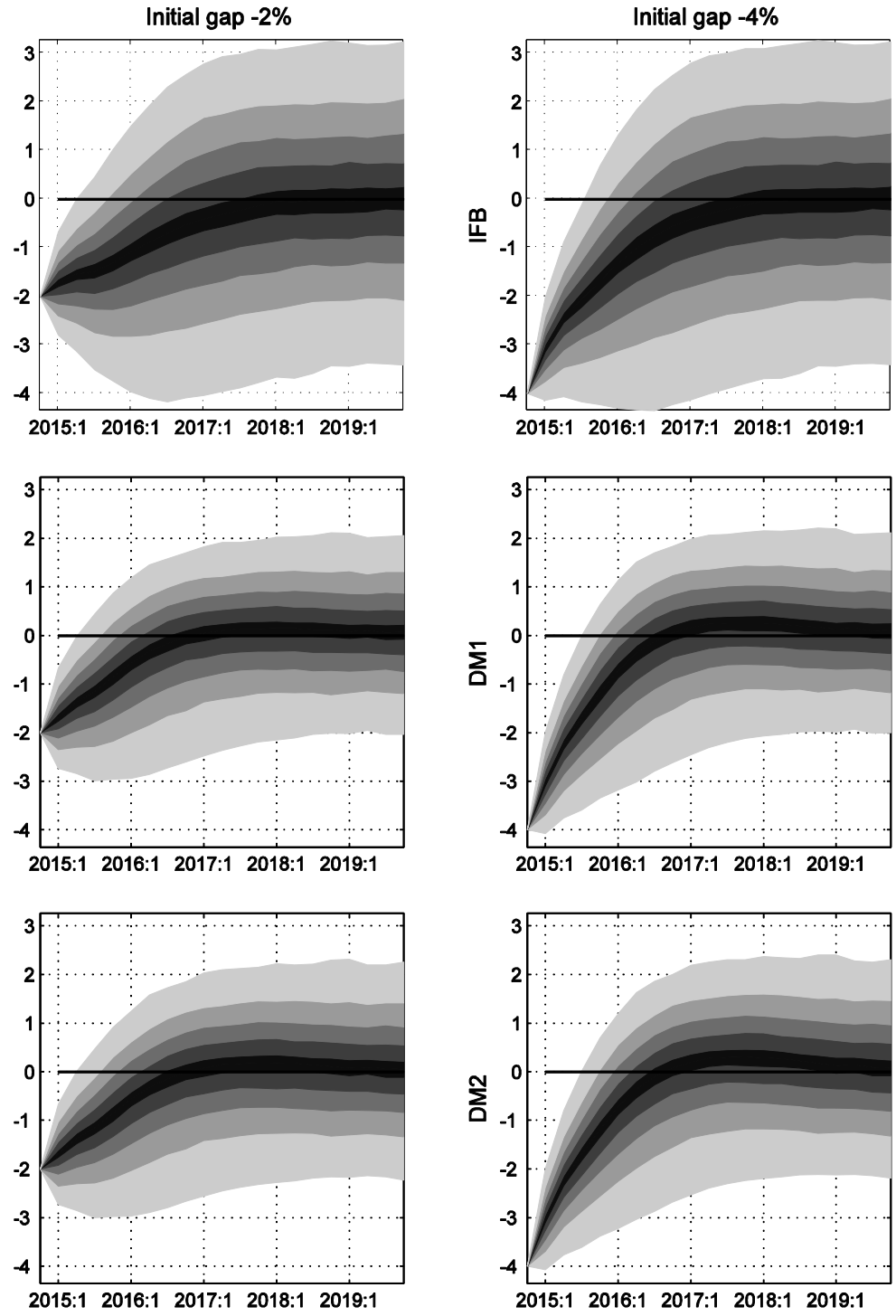
Source: IMF staff calculations

Figure 15. Illustrative Examples of the Current Situation with Confidence Bands (YoY PCE Inflation, Percentage)



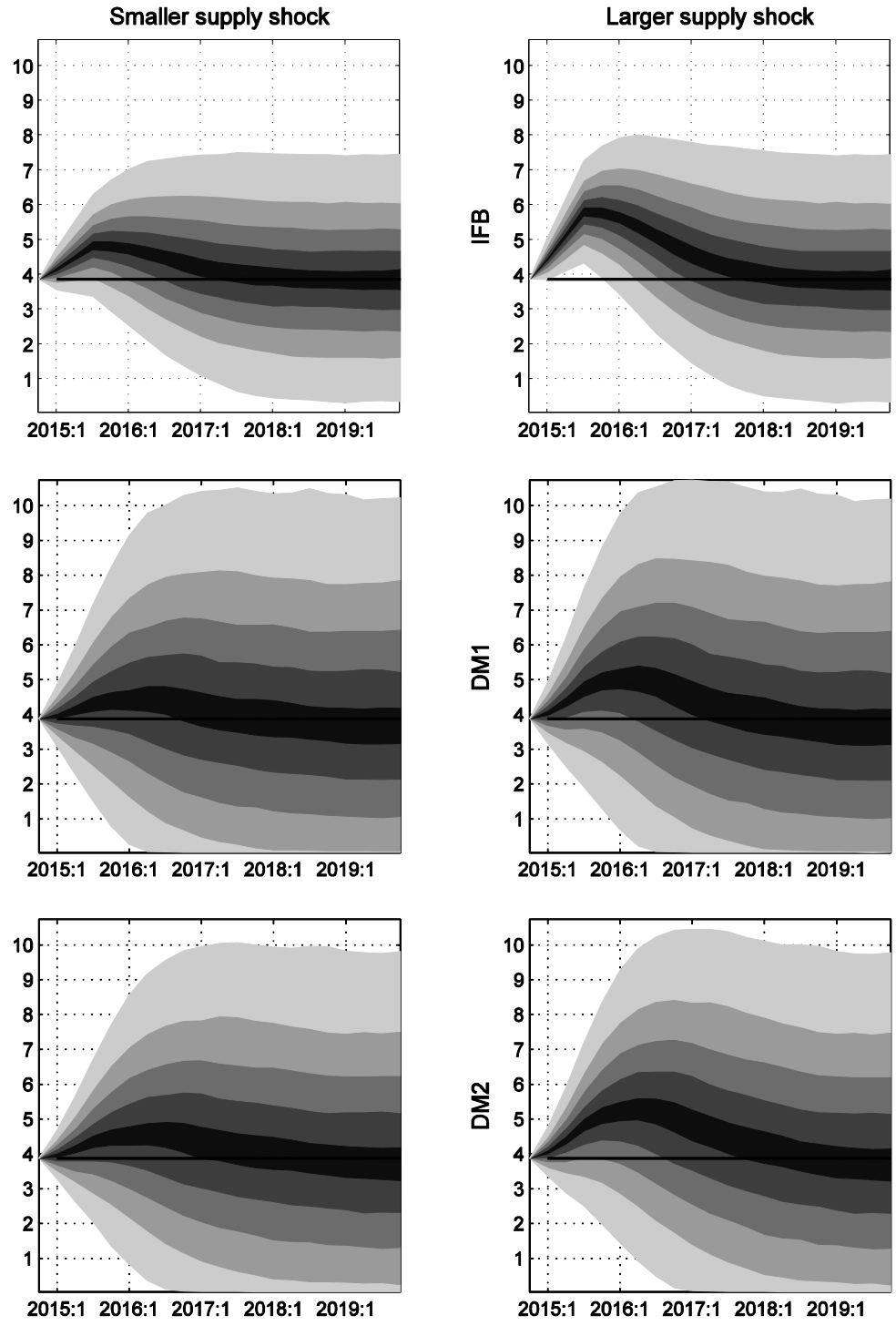
Source: IMF staff calculations

Figure 16. Illustrative Examples of the Current Situation with Confidence Bands (Output Gap, Percentage)



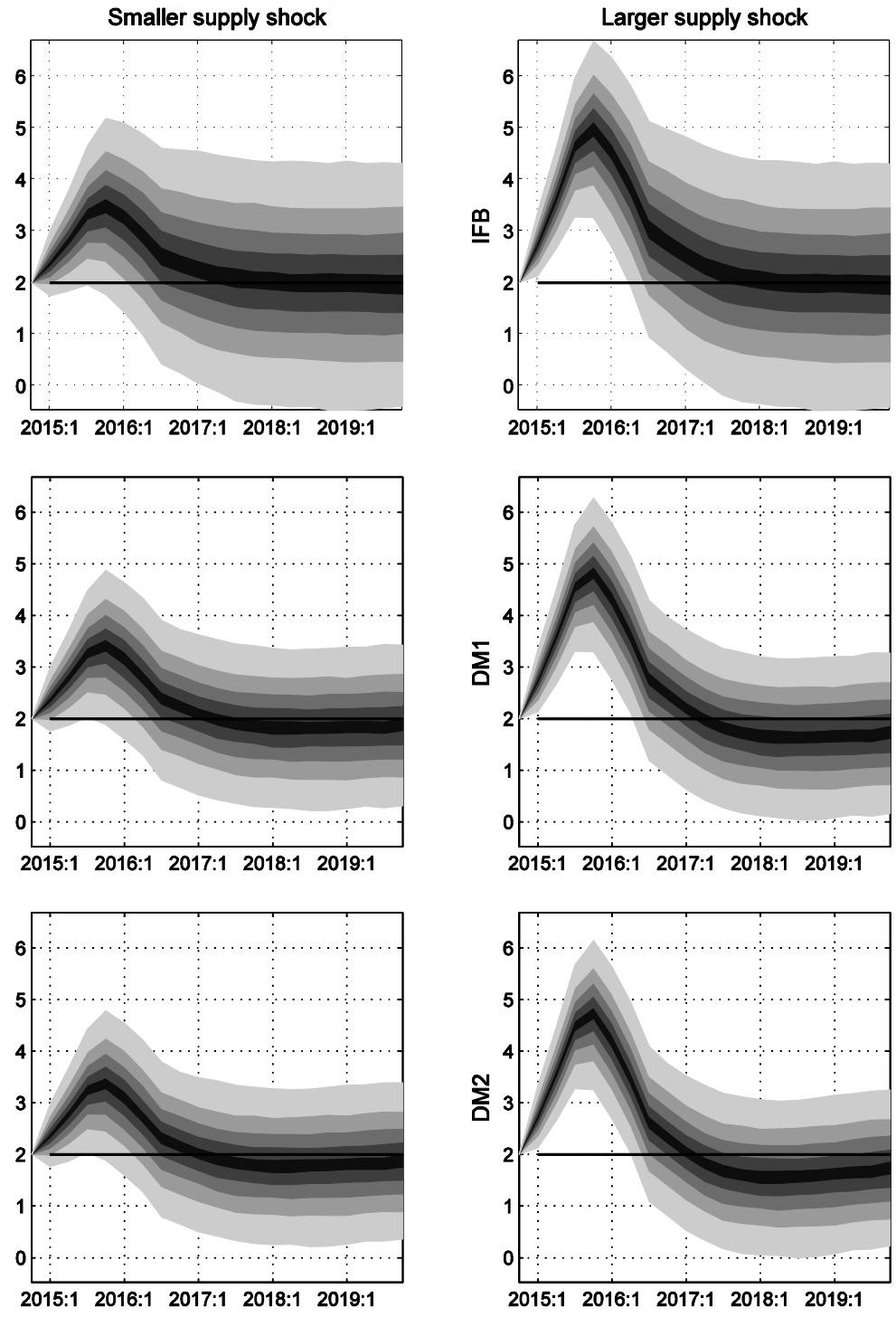
Source: IMF staff calculations

Figure 17. Illustrative Examples of Nasty Supply Shock with Confidence Bands (Fed Funds Rate, percentage, p.a.)



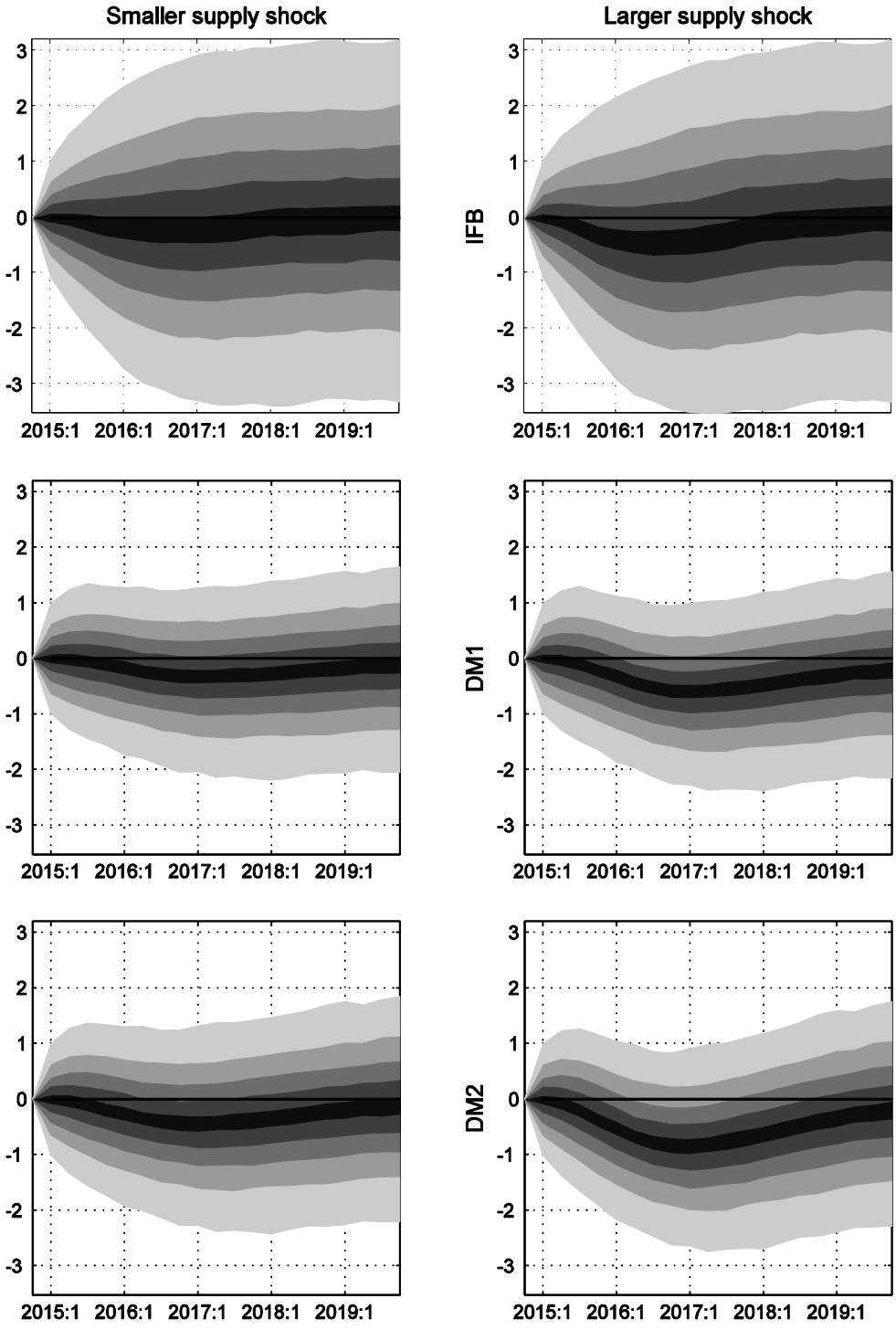
Source: IMF staff calculations

Figure 18: Illustrative Examples of Nasty Supply Shock with Confidence Bands (YoY PCE Inflation, Percentage)



Source: IMF staff calculations

Figure 19: Illustrative Examples of Nasty Supply Shock with Confidence Bands (Output Gap, Percentage)



Source: IMF staff calculations

As one would expect, the output gap confidence band is narrower for DM1 than DM2—reflecting the lower DM2 weight on the output gap—but the difference is not large. And there is hardly any difference between the two with respect to deviations of inflation. Both DM1 and DM2 provide narrower bands for these goal variables than IFB, at the cost of greater interest rate variance.

A complementary way of communicating risks is to present a few alternative scenarios to the baseline for specified contingencies, e.g., large durable shocks to the oil price. Central banks have used these in Monetary Policy Reports to address the two or three risks that they feel are most important (because they are likely to occur and/or have a major economic impact if they do).

VI. CONCLUSION

Inflation targeting was introduced almost 25 years ago, and this approach to policy has become increasingly widespread in both advanced and developing and emerging economies in recent years. This suggests that this framework is robust.

We argue that a source of robustness is the framework of principles. Important among these is transparency. At a minimum, the approach requires that the central bank publish an explicit path for the inflation rate forecast. This shows how quickly, in the event of a deviation of the current rate of inflation from the long-run target, the central bank aims to get inflation back on track over the medium term. In addition, the policymakers have to indicate what this will likely imply for the interest rate policy instrument. Most IFT central banks provide a verbal, qualitative description. Others go so far as to publish the explicit forecast path for the short-term interest rate, along with all other material details of their forecast. In either case, the transparency strengthens monetary policy in two respects. First, by influencing medium-term expectations of nominal interest rates and inflation, it helps move real interest rates, at all terms, in a direction that assists policy. In addition, the induced reactions of the exchange rate and asset prices then become buffers against the shocks that policy tries to mitigate. In sum, transparency makes the transmission mechanism more effective. Second, providing a coherent macroeconomic explanation of how policy intends to hold inflation near target in the long run is likely to encourage confidence in this objective, and thereby to solidify the nominal anchor of the system. The framework relies heavily on the credibility of policy.

A credible IFT framework provides for a wide range of flexibility in the implementation of policy. For example, QE, or intervention to influence the exchange rate, or other extraordinary short-term measures, can be placed in a longer-term context. FG, under IFT, is a continuous process, in that following every interest rate decision meeting the central bank would be disclosing the path it expects for the future interest rate. Moreover, the process under IFT does not involve speculation about the time horizon for FG, or when it will switch

off. If at any point policymakers need to underline the guidance implicit in a forecast, this can be done through the regular communications strategy.

An aspect of inflation-targeting strategy when monetary policy is constrained by the ZLB is of relevance here. In this situation policy effectiveness is more than usually dependent on the ability of the central bank to influence medium-term inflation expectations, because raising these expectations is the only way to reduce real interest rates. An aggressive, counter-deflation policy might well involve overshooting the long-run target for inflation in the medium term. The explicit publication and discussion of such an outlook would deliberately draw attention to it, to get the maximum effect. Moreover, properly explained, the projected overshooting need not weaken confidence in the long-run objective.

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