The Opportunistic Approach to Disinflation*

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Abstract

This paper explores the theoretical foundations of a new approach to monetary policy. Proponents of this approach hold that when inflation is moderate but still above the long-run objective, the Fed should not take deliberate anti-inflation action, but rather should wait for external circumstances—such as favorable supply shocks and unforeseen recessions—to deliver the desired reduction in inflation. While waiting for such circumstances to arise, the Fed should aggressively resist incipient increases in inflation. This strategy has come to be known as "the opportunistic approach to disinflation."

We deduce policymaker preferences that rationalize the opportunistic approach as the optimal strategy for disinflation in the context of a model that is standard in other respects. The policymaker who is endowed with these preferences tends to focus on stabilizing output when inflation is low, but on fighting inflation when inflation is high. We contrast the opportunistic approach to a more conventional strategy derived from strictly quadratic preferences.

KEYWORDS: Inflation, monetary policy, interest rates, policy rules.

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1 Introduction

In the last several years, a number of current and former members of the Federal Open Market Committee (FOMC) have developed a new view as to how the Federal Reserve should close the gap between the current rate of inflation and the long-run objective of price stability. Proponents of this new view hold that when inflation is moderate but still above the long-run objective—as is the case currently—the Federal Reserve should not take deliberate action to reduce inflation. Instead, it should wait for external circumstances—e.g., favorable supply shocks and unforeseen recessions—to deliver the desired additional reduction in inflation. Until such disinflationary shocks occur, the Fed should move aggressively to counteract incipient increases in inflation.

President Boehne of the Federal Reserve Bank of Philadelphia gave one early statement of this approach during the FOMC meeting in December 1989:

> Now, sooner or later, we will have a recession. I don't think anybody around the table wants a recession or is seeking one, but sooner or later we will have one. If in that recession we took advantage of the anti-inflation [impetus] and we got inflation down from 4-1/2 percent to 3 percent, and then in the next expansion we were able to keep inflation from accelerating, sooner or later there will be another recession out there. And so, if we could bring inflation down from cycle to cycle just as we let it build up from cycle to cycle, that would be considerable progress over what we've done in other periods in history. [FRB, 1989, p.19]

In testimony before the Senate committee that was meeting to consider his nomination to the Federal Reserve Board, former Vice Chairman Blinder summarized his views on this issue as follows:

> If monetary policy is used to cut our losses on the inflation front when luck runs against us, and pocket the gains when good fortune runs our way, we can continue to chip away at the already-low inflation rate. [Blinder, 1994, p.4]

This approach to the conduct of monetary policy has come to be known as "the opportunistic approach to disinflation."

If the Phillips curve is linear and the policymaker's loss function is quadratic in inflation and the deviation of output from potential, the opportunistic approach is not the optimal policy. On the contrary, the policymaker should in that circumstance pursue the objective of price stability period by period, regardless of external economic circumstances, so long as inflation remains above its long-run target. If, in a conventional model, disinflation is desirable in the long run, then at least partial disinflation is desirable in the short run as well.

This paper relaxes some of the assumptions that are implicit in the simplest linear-quadratic model of the macroeconomy, and in so doing provides a partial rationale for the opportunistic approach. In essence, we undertake an exercise in "reverse engineering." That is, we search for a specification of the policymaker's loss function that would lead her to pursue an opportunistic approach to disinflation. The rationale is partial in the sense that we provide only some preliminary comments on the theoretical motivation for the loss function that we propose, and defer a more thorough justification to future research.[1]

Despite the anti-inflationary resolve of the opportunistic policymaker in our model, inflation can creep up, within limits, for two reasons: First, the policymaker will sometimes choose to allow inflationary shocks to feed through into higher actual inflation even when those shocks can be forecasted; this choice will sometimes be the optimal one because the sacrifice of output that would be required to prevent any increase in inflation would be too great. Second, the policymaker will not be able to anticipate all inflationary shocks, and the ones that are not anticipated will become embedded in actual inflation before the policymaker can do anything about them.

To the best of our knowledge, none of the advocates of opportunism has addressed the issue of how the opportunistic policymaker should behave once inflation has reached a high level. The model we present in this paper predicts that the opportunistic policymaker will act deliberately to bring inflation down whenever inflation exceeds a certain threshold level. (As we show later in the paper, this threshold is a function of the policymaker's

[1] In conducting our exercise in reverse engineering, we constrain ourselves by maintaining the assumption of a linear Phillips curve. Also, we do not claim to have discovered the *only* loss function that might rationalize the opportunistic approach.

preferences.) Once inflation is back at least as low as the threshold level, the policymaker in our model will revert to the opportunistic approach, and wait for favorable shocks to deliver any further disinflation.

The loss function that results from our process of reverse engineering has two key attributes: path dependence, and differential valuation of deviations from the inflation and output targets. Path dependence allows the policymaker to react differently to a given level of inflation depending on the prior history of inflation itself. For example, the policymaker in our model views an inflation rate of 3 percent more favorably if inflation in the previous period was 4 percent than if inflation was 2 percent. An evolving perspective of this type is essential if the policymaker is to display determination to "hold the line" on inflation at the current level, and fight to prevent an earlier and higher level from recurring even though that earlier level was acceptable by previous standards. The differential valuation of inflation and output deviations causes the policymaker to focus on different policy objectives under different circumstances. In particular, the opportunistic policymaker in our model concentrates on output stabilization when inflation is low and inflation reduction when inflation is high.

In the course of our exercise in reverse engineering, we investigated whether we might be able to generate opportunistic behavior by assuming that the central bank is penalized for either high or rising interest rates. We concluded that we could not unless we also introduced some mechanism like the one we referred to above involving asymmetric valuation of output and inflation deviations from target. In the absence of such a mechanism, a penalty on either high or rising interest rates only induces an inflationary bias in the economy and does not alter the *timing* of policymaker actions. In light of this finding, we do not pursue this alternative avenue further in this paper.

The rest of this paper is organized as follows. Section II attempts to provide a more rigorous definition of the opportunistic approach. Section III builds on this definition, and sketches the simplest possible model that rationalizes the behavior described in Section II.

Section IV rectifies a gross simplification in the model of Section III by introducing aggregate demand shocks into the analysis. Section V considers in greater detail the optimal response to supply shocks of various descriptions. In Section VI, we provide a more rigorous discussion of the implications of uncertainty for the policy prescriptions of our model. Finally, Section VII concludes with, among other things, some preliminary speculation on the critical issue of what might motivate a policymaker to adopt the loss function that generates opportunistic behavior.

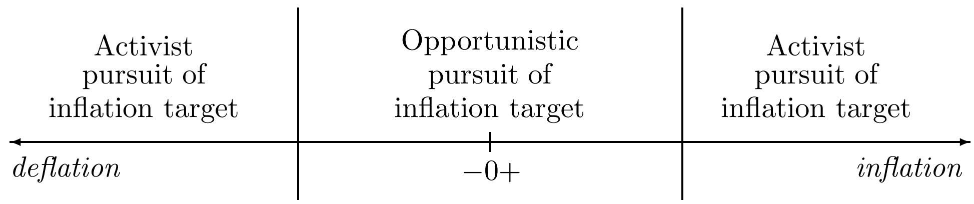
2 Defining opportunism

This section provides a more complete description of the opportunistic approach to disinflation. In drawing this more complete portrait of the strategy, we necessarily are filling in some of the details in the sketches provided earlier by Boehne and Blinder. While we believe the spirit of our efforts to be consistent with their views, we make no claim that they would subscribe to our characterization.

One way to describe the behavior of an opportunistic policymaker is to contrast it with the behavior of a conventional policymaker. The conventional policymaker we have in mind takes price stability as the long-run objective of monetary policy, and attempts to minimize a loss function that is additively separable and quadratic in inflation and the deviation of output from potential.[2] When confronted with a linear Phillips curve, this policymaker pursues the goal of price stability gradually, but persistently. The pursuit is gradual because the policymaker suffers increasing marginal costs from deviations of output from potential. The pursuit is persistent because the conventional policymaker always views the benefit of at least a little progress on inflation as worth the cost; therefore, the policymaker pursues the long-run inflation objective every period.

[2] We finesse a number of important issues related to the definition of price stability and simply stipulate that price stability obtains when the policymaker sets the inflation rate equal to zero on average. Technically, the price level that results from a policy of this type will drift over time. We do not enforce the more stringent requirement that the policymaker render the price level stationary. We also ignore the issue of measurement error in the relevant index of inflation.

Like the conventional policymaker, the opportunistic policymaker we have in mind recognizes price stability as the long-run objective of monetary policy. Unlike the conventional policymaker, however, the opportunistic policymaker adopts a different mode of behavior depending on the level of inflation. The following diagram depicts this relationship between the opportunistic policymaker's behavior and the level of inflation.



In the diagram, inflation is shown on the horizontal axis. The three regions in the diagram correspond to different modes of behavior on the part of the policymaker.

When prices are rising rapidly (as is the case in the right-most region) the opportunistic policymaker deliberately pursues a policy of disinflation. As we shall describe in greater detail later in the paper, the policymaker continues in this mode of deliberate disinflation until the rate of inflation has been brought down to a certain threshold, which is depicted in the diagram by the boundary between the right-most and middle regions. (As we show later, the location of this boundary is a function of the policymaker's preferences and the slope of the Phillips curve.) Symmetrically, when prices are falling rapidly (as is the case in the left-most region), the policymaker deliberately pursues an expansionary policy, and continues doing so until the rate of inflation has been brought up to the boundary between the left-most and middle regions. Thus, in these two regions (i.e., when prices are either rising rapidly or falling rapidly), the opportunistic policymaker behaves very much like a conventional policymaker.

The interesting differences between the opportunistic and conventional strategies occur in the middle region—when inflation is neither too high nor too low. Consider first the case in which the rate of inflation is positive but not so high as to provoke the opportunistic policymaker into deliberate action. In this circumstance, the opportunistic policymaker does not seek to open up a gap between actual and potential output for the sake of bringing inflation down, even though inflation remains above the long-run target. Instead, she adopts a more reactive stance, moving to limit the influence of shocks that would drive the inflation rate up, but accommodating shocks that drive inflation down. Importantly, the opportunistic policymaker allows the full impact of favorable supply shocks to show through in the form of lower inflation in this middle region, and does not attempt to reap a dividend in the form of a transitory blip in output above potential.

For now, we posit symmetric policymaker behavior for rates of inflation *below* the long-run objective. Thus, there exists a maximally negative inflation rate which the opportunistic policymaker tolerates without taking deliberate countervailing action. So long as the rate of deflation is less extreme than that maximally negative rate, the policymaker waits for inflationary supply shocks and unforeseen economic expansions to bring inflation back toward the long-run objective. And while waiting for those inflationary shocks, the policymaker moves to limit the influence of deflationary shocks, which would drive the rate of inflation away from the long-run objective.

As we noted in the introduction, a monetary policy conducted in the opportunistic manner has a path-dependent character when inflation is in the moderate range. That is, the policymaker's reaction to a given rate of inflation (so long as it falls in this middle region) depends on the inherited level of inflation and thus on the prior history of shocks. For example, an opportunistic policymaker evaluates a 3 percent rate of inflation today less favorably if inflation yesterday was 2 percent than if inflation yesterday was 4 percent. In the former case, an opportunistic policymaker might well aim to drive output below potential, whereas in the latter case she would aim simply to hold output at potential. Of course, a policymaker following a conventional strategy would adopt the same policy stance regardless of the prior history of inflation.

3 A simple one-period model

For certain parameter settings, the following model rationalizes an opportunistic approach to disinflation. We begin with a stylized Phillips curve:

$$\pi = \pi^e + \alpha y + e \tag{1}$$

where π is current inflation, π^e is expected inflation, α is a parameter (greater than zero), y is the deviation of output from potential (measured as the logarithm of actual output less the logarithm of potential output), and e is a shock. For simplicity, we assume initially that the monetary authority controls y directly and without error; in a later section of the paper we relax this assumption.[3] We also assume for now that the policymaker can observe e before choosing y.

The policymaker's loss function is given by:

$$\mathcal{L}_{\mathcal{A}} = (\pi - \tilde{\pi})^2 + \gamma y^2 + \psi |y| \tag{2}$$

where $\gamma \geq 0, \psi \geq 0$, and $\tilde{\pi}$ is an intermediate target for inflation (zero being the long-run target). Importantly, the central bank's loss function depends on the deviation of inflation from the intermediate target, not the long-run target.[4] The model also includes an equation describing the determination of the intermediate target as a function of the inherited inflation rate:

$$\tilde{\pi} = \lambda \pi_0. \tag{3}$$

where $0 \leq \lambda < 1$. Thus, the intermediate target always lies between the inherited rate and

[3]We realize that the resulting model is therefore incapable of addressing the circumstance highlighted by Boehne in the passage we quoted in the introduction—namely, an unforeseen recession. We make the assumption here nonetheless in light of the greater clarity it affords, and consider the case later in the paper in which the monetary authority controls the output gap only imperfectly.

[4]The device of the intermediate inflation target allows us to write the loss function in a form that more closely resembles conventional policy rules. However, we show later in this section that equivalent behavior can be derived from a loss function that penalizes both the level of and changes in the rate of inflation, and that dispenses with the notion of an intermediate target for inflation.

the long-run target of zero.

The loss function given in equation (2) nests both the conventional and the opportunistic specifications. If ψ equals 0 (so the loss function is quadratic in both inflation and the output gap) and λ equals 0 (so the intermediate target equals the long-run target), a conventional strategy for monetary policy is optimal. On the other hand, if both ψ and λ are greater than 0, the opportunistic strategy will be optimal regardless of whether γ equals 0 or is positive.

In words, the objective function can be written as:

$$Loss \quad = \quad \begin{array}{c} loss\ from \\ inflation \end{array} + \begin{array}{c} loss\ from \\ output\ gap \end{array}$$

We solve the model by calculating the derivative of the objective function with respect to the choice variable—the output gap—and setting the result equal to zero:

$$marginal\ loss \quad = \quad \begin{array}{c} marginal\ loss \\ from\ inflation \end{array} + \begin{array}{c} marginal\ loss \\ from\ output\ gap \end{array} = 0$$

or, after trivial rearrangement,

$$\begin{array}{c} marginal\ loss \\ from\ inflation \end{array} \quad = \quad - \quad \begin{array}{c} marginal\ loss \\ from\ output\ gap \end{array} \tag{4}$$

Figure 1 displays the building blocks of the opportunistic loss function for the benchmark case in which γ equals 0. The upper left panel shows the loss inflicted on the policymaker by a deviation of output from potential, while the lower left panel shows the derivative of this component of the loss function with respect to output. The key feature of this element of the loss function is that it is *linearly* increasing in the output gap for positive values of the gap, and *linearly* decreasing in the output gap for negative values of the gap. Correspondingly, as shown in the lower left panel, the marginal loss is constant at $-\psi$ for negative values of the gap, and constant at ψ for positive values of the gap. The fact that the marginal loss is everywhere bounded away from 0 implies that deviations of output from potential impose first-order losses on the policymaker. It is also worth noting that the loss function is nondifferentiable at 0, and that this nondifferentiability shows up in the marginal loss function as a discontinuity at 0.

The upper right panel in Figure 1 shows the loss to the policymaker inflicted by deviations of inflation from the intermediate target. This portion of the loss function takes the conventional quadratic shape. Note that we plot this element of the policymaker's total loss as a function of the level of inflation rather than the deviation of inflation from the intermediate target; as a result, the quadratic function is centered around $\tilde{\pi}$ rather than 0. The lower right panel shows the derivative of this element of the loss function with respect to inflation. Of course, this schedule is linear, and cuts the horizontal axis at the intermediate target.

Figure 2 follows the algorithm suggested by equation (4), and solves the model (again for the case in which γ equals 0) by superimposing the marginal loss from inflation deviations on top of *minus* the marginal loss from output gaps. In order to draw Figure 2, we first had to rewrite the marginal loss from inflation as a function of the output gap. This we accomplished with a simple application of the chain rule:

$$\begin{aligned} \frac{d}{dy}\begin{pmatrix} loss\ from \\ inflation \end{pmatrix} &= \frac{d}{d\pi}\begin{pmatrix} loss\ from \\ inflation \end{pmatrix}\frac{d\pi}{dy} \\ &= 2(\pi - \tilde{\pi})\ \alpha \\ &= 2\alpha(\pi^e + \alpha y + e - \tilde{\pi}) \end{aligned}$$

The last expression is the upward-sloping line plotted in Figure 2.

If the upward-sloping line portraying the inflation schedule passes between the two branches of the output schedule without intersecting either one of them, the optimal policy action involves setting y equal to 0. On the other hand, if the inflation schedule intersects one of the two branches of the output schedule, the optimal policy action is given by the value of y at the intersection. We can summarize this condition algebraically by stating that the optimal policy will involve setting output equal to potential if:

$$\psi \quad \geq \quad |2\alpha(\pi^e + e - \tilde{\pi})|, \tag{5}$$

where the left-hand side of this condition gives the height of the output schedule in Figure 2 at y=0, and the right-hand side gives the height of the inflation schedule at the same location. Equation (5) implies that the optimal action more likely will involve setting output at potential

- the more the policymaker cares about output deviations from potential (i.e., the larger is ψ);
- the smaller the reward to the policymaker (in terms of inflation reduction) in return for enduring an output gap of any given size (i.e., the smaller is α); and
- the closer inflation would be to the intermediate target if the central bank set output at potential (i.e., the closer is $\pi^e + e - \tilde{\pi}$ to 0).

In the case shown in Figure 2, expected inflation plus the new impetus to inflation (π^e+e) exceeds the intermediate target ($\tilde{\pi}$) by enough to cause the policymaker to set output below potential. A still larger value of $\pi^e + e$ relative to $\tilde{\pi}$ would cause the policymaker to set output even further below potential; this would be reflected in the figure as a leftward shift of the upward-sloping line, and therefore a leftward-shift of the intersection between the inflation schedule and the output schedule.

If no inflation is inherited from the previous period, so the intermediate target coincides with the long-run target of 0, and economic agents expect no inflation in the current period, the upward-sloping line will intersect one of the two branches of the output schedule in Figure 2 only if the inflation shock is large enough in absolute value—that is, only if

$$|e| > \frac{\psi}{2\alpha} \tag{6}$$

Thus, an opportunistic central bank starting from a position of price stability will give priority to the task of output stabilization—even at the expense of some upward or downward drift in the inflation rate—unless the inflation shock is large in absolute value, where large is defined by equation (6).

The only role of the parameter γ in the model is to determine the aggressiveness with which the policymaker pursues the inflation target when operating outside the opportunistic middle region shown in the diagram on page 5. If γ equals 0, the policymaker concentrates exclusively on the inflation objective when she is actively combating inflation. Thus, if $2\alpha(\pi^e + e - \tilde{\pi}) > \psi$ and $\gamma = 0$, the policymaker attempts to bring inflation to the boundary of the inaction region immediately. If γ is greater than 0, on the other hand, the central bank pursues a gradual strategy for bringing inflation down to the inaction boundary.

Equation (7) provides the solution to the opportunistic policymaker's optimization problem for the general case in which γ may be non-zero:

$$y = \begin{cases} -\frac{2\alpha(\pi^e+e-\tilde{\pi})-\psi}{2(\alpha^2+\gamma)} & \text{if } 2\alpha(\pi^e + e - \tilde{\pi}) > \psi \\ 0 & \text{if } \psi \geq 2\alpha(\pi^e + e - \tilde{\pi}) \geq -\psi \\ -\frac{2\alpha(\pi^e+e-\tilde{\pi})-\psi}{2(\alpha^2+\gamma)} & \text{if } -\psi > 2\alpha(\pi^e + e - \tilde{\pi}) \end{cases} \tag{7}$$

All the elements of this solution other than the role of γ can be deduced from the information presented in Figure 2.

Figure 3 presents this decision rule in graphical form. We plot $\pi^e + e$ on the horizontal axis; this variable can be interpreted as the rate of inflation that would occur if the policymaker held output at potential. We plot y, the optimal choice of the output gap, on the vertical axis. The downward-sloping line segments in the figure come in pairs, the two members of which are depicted with like linetypes. (That is, one pair is shown as solid segments, another pair is shown with dotted segments, etc.) Each pair of segments pertains to a different intermediate target for inflation, and each has one member above the horizontal axis and one member below. In addition, each pair of downward-sloping segments is connnected by a third segment which is not visible in the figure because it runs along the horizontal axis. Together, these three segments define an "iso-intermediate-target" schedule. The optimal policy choice is determined by locating the appropriate point on the relevant intermediate-target schedule.

Suppose, for the sake of seeing how the diagram works, that workers and firms are not expecting any inflation, but that the supply shock is putting 1 percentage point's worth of upward pressure on the inflation rate. In this case, as is shown by point A in the figure, the model predicts that the central bank will hold output at potential.

Point A thus provides an illustration of the most notable aspect of the opportunistic strategy—namely, that the opportunistic central bank, under certain circumstances, will hold output at potential even when inflation is above its long-run target and the inflation shock is not pushing inflation downward. Indeed, as is shown by the distance between the downward-sloping segments of the schedule labelled "$\tilde{\pi} = 0$," the policymaker operating under an intermediate target of 0 inflation will hold output at potential whenever $\pi^e + e$ is between -2 percent and 2 percent. As can be seen in the diagram, similar "inaction regions" obtain when the intermediate target is not equal to 0.

The zone of inaction also extends to some circumstances in which the inherited rate of inflation is nonzero and the inflation shock is actually driving the level of inflation further away from the long-run objective. For example, when inflation expectations and inherited inflation are both at 2 percent, and λ equals 0.5 so the intermediate target is 1 percent, the central bank whose behavior is depicted in Figure 3 will tolerate a positive inflation shock of as much as 1 percentage point before taking any anti-inflationary action (see point B). It is important to note that in this case—as in most—the policy reaction function is asymmetric in the inflation shock, because the central bank would tolerate a *negative* inflation shock of as much as 3 percentage points before taking countervailing measures. The only case in which the policy function is symmetric is when inherited inflation is 0 percent.

There are limits to even the opportunistic central bank's tolerance of inflation. To see that this is so, assume that inflation expectations and inherited inflation are both running at 4 percent (so the intermediate target is 2 percent), and there is no inflation shock. In this case, the opportunistic policymaker will just tolerate the prevailing inflation rate and refrain from taking deliberate anti-inflationary action. This situation is depicted by point C in Figure 3. However, 4 percent is the limit given this calibration, and if either inherited inflation is higher than 4 percent, or there is any upward impetus to inflation from the supply shock, the policymaker will take deliberate anti-inflationary action.

As another illustration of the limits on the central bank's tolerance of inflation, assume once again that inflation expectations and inherited inflation are both equal to 0 (and so, likewise, the intermediate target), but now assume that the supply shock puts 3 percentage points' worth of upward pressure on the inflation rate. In this case, as is shown by point D in the figure, the central bank will set output 4 percent below potential, given our calibration of the model.

The contrast between points B and D in Figure 3 highlights the role of inherited inflation in determining the behavior of the opportunistic policymaker: In both situations, π^e and e sum to 3 percent. However, in the circumstance depicted by point B, inherited inflation came in at 2 percent, so the intermediate target was established at 1 percent. In contrast, in the circumstance depicted by point D, inherited inflation came in at 0, so the intermediate target was established at 0. In the first case, the policymaker evaluated the 3 percentage points in the pipeline as (barely) acceptable, whereas in the second case she evaluated that same incipient rate of inflation as unacceptable and worth fighting with a recession. In other words, the policy stance of the opportunistic central bank depends on the history of inflation.

The contrast between the opportunistic and conventional policies can be drawn particularly easily and sharply in the special case in which there are no inflation shocks ($e = 0$), and inflation expectations are formed adaptively ($\pi^e = \pi_0$). In this case, the opportunistic policymaker's decision rule can be written as follows:

$$y = \begin{cases} -\frac{\alpha(1-\lambda)}{\alpha^2+\gamma}(\pi_0 - \underline{\pi}_0) & \text{if } \pi_0 < \underline{\pi}_0 \\ 0 & \text{if } \underline{\pi}_0 \leq \pi_0 \leq \overline{\pi}_0 \\ -\frac{\alpha(1-\lambda)}{\alpha^2+\gamma}(\pi_0 - \overline{\pi}_0) & \text{if } \overline{\pi}_0 < \pi_0 \end{cases} \tag{8}$$

where $\underline{\pi}_0 = -\frac{\psi}{2\alpha(1-\lambda)}$ and $\overline{\pi}_0 = +\frac{\psi}{2\alpha(1-\lambda)}$. Thus, when inherited inflation exceeds some upper threshold, the policymaker sets output below potential. Likewise, when inflation falls below some lower threshold, the policymaker boosts output above potential. And when inherited inflation is between these two thresholds, the policymaker sets output at potential.

Figure 4 provides a graphical description of these choices. The straight line through the origin corresponds to conventional preferences with $\psi = \lambda = 0$. In this case, $\underline{\pi}_0 = \overline{\pi}_0 = 0$ and the policymaker simply chooses an output gap proportional to inherited inflation

$$y = -\frac{\alpha}{\alpha^2 + \gamma}\pi_0 \tag{9}$$

The dotted line represents our benchmark example of opportunistic preferences with $\psi, \lambda > 0$ and $\gamma = 0$.

We close this section by noting that introducing an intermediate target for inflation is not the only way to induce the type of path-dependent behavior we require of the opportunistic policymaker. Specifically, we can specify that the loss depends on both the level of and change in inflation:

$$\mathcal{L}_{\mathcal{B}} = b_1\pi^2 + b_2(\pi - \pi_0)^2 + \gamma y^2 + \psi|y| \tag{10}$$

Exactly the same behavior will result from loss function $\mathcal{B}$ as from loss function $\mathcal{A}$ provided that b_1 and b_2 satisfy a pair of constraints. The form of these constraints can be derived by using equation (3) to eliminate $\tilde{\pi}$ from the inflation component of equation (2)):

$$(\pi - \lambda\pi_0)^2 = (1-\lambda)\pi^2 + \lambda(\pi - \pi_0)^2 + (\lambda^2 - \lambda)\pi_0^2.$$

If $b_1 = (1-\lambda)$ and $b_2 = \lambda$, then $\mathcal{L}_{\mathcal{A}} = \mathcal{L}_{\mathcal{B}}$ up to a term in π_0 that does not affect the optimal choice of the output gap, and the two problems yield identical policies.

4 Aggregate Demand

In the basic model, we assumed that the monetary authority could control the level of output directly. Here we relax that assumption and assume instead that the central bank controls an interest rate which is only one of the factors determining aggregate demand. This alternative setup has the important benefit of allowing us to link the model more closely to the thoughts of Boehne and Blinder as represented by the quotes we gave in the introduction. We also assume that output follows an autoregressive process; as we shall show, this specification gives rise to Taylor's rule as the optimal policy rule if the policymaker has a conventional loss function.

Specifically, we now assume that aggregate demand is given by:

$$y = \rho y_0 - \sigma(r - r^*) + u, \tag{11}$$

where y_0 denotes the lagged deviation of output from potential, ρ is a parameter between 0 and 1 describing the persistence of output deviations, $r - r^*$ is the deviation of the real interest rate from its "natural" long-run level, σ is a parameter greater than 0, and u is a shock. The central bank can be thought of as controlling the variable r indirectly by setting the nominal interest rate, i, which is linked to r by the Fisher relation

$$i = \pi^e + r. \tag{12}$$

If the central bank can observe shocks to aggregate demand contemporaneously, it will use the interest rate to fully neutralize the influence of those shocks on output. Consider, for the sake of building intuition, the case in which output in the previous period was at potential, inflation in the previous period was at its long-run target, there is no supply shock, and there is a positive demand shock. Both the opportunistic and conventional policymakers will offset this shock completely if they are capable of doing so, because if they did not, they would suffer loss directly in the current period from the excess of actual output over potential, and indirectly in future periods from the resulting inflation. Because there is no penalty in either objective function directly related to interest rates, the policymaker suffers no loss if she opts for full neutralization. Thus, in this case, aggregate demand shocks are an uninteresting complication in the model, and our earlier assumption that the central bank could control output directly involved no loss of generality.[5]

Even if the central bank cannot observe aggregate demand shocks contemporaneously (but the other assumptions of our model continue to hold), those shocks do not drastically alter the analysis we presented earlier. Unanticipated aggregate demand shocks feed through into inflation contemporaneously, and accordingly affect the inherited rate of inflation in the following period. But once we know how to analyze the implications of different rates of inherited inflation, we also know how to analyze the implications of unanticipated shocks.[6]

For example, if the economy has been operating at potential ($y_0 = 0$), no shocks are currently anticipated, and inherited inflation, π_0, is positive but below the upper limit of the inaction region in equation (14), $\overline{\pi}_0$, the policymaker will set the nominal interest rate at $i = \pi_0 + r^*$, expecting this action to result in unchanged inflation during the period and no deviation of output from potential. A negative shock to aggregate demand would drive output below potential and bring inflation down from its inherited level. In the following period, the policymaker will reduce the nominal interest rates for two reasons: first to match the new lower level of inflation, and second to bring output back to potential more quickly than would occur if the policymaker kept the real interest rate at its natural level. This policy will consolidate the gain in the inflation front. We view this scenario as corresponding directly to the intuition from Boehne and Blinder that we quoted in the introduction.

If neither the demand nor supply shock can be anticipated, and inflation expectations are set adaptively ($\pi^e = \pi_0$), the optimal rule for the conventional policymaker takes the

[5]Of course, this result depends importantly on the other assumptions maintained here that there are no lags in the transmission of monetary policy to the real economy, and that there are no problems associated with instrument instability.

[6]A key aspect of our ongoing research is an effort to assess the relationship between the variance of the shocks hitting the economy and the speed with which the economy approaches price stability.

general form of John Taylor's rule:

$$i = \pi_0 + r^* + \frac{\rho}{\sigma} y_0 + \frac{\alpha}{\sigma(\alpha^2 + \gamma)} \pi_0 \tag{13}$$

The optimal rule for the opportunistic policymaker is identical except for the form of the response to inflation:

$$i = \begin{cases} \pi_0 + r^* + \frac{\rho}{\sigma} y_0 + \frac{\alpha(1-\lambda)}{\sigma(\alpha^2+\gamma)}(\pi_0 - \underline{\pi}_0) & \text{if } \pi_0 < \underline{\pi}_0 \\ \pi_0 + r^* + \frac{\rho}{\sigma} y_0 & \text{if } \underline{\pi}_0 \leq \pi_0 \leq \overline{\pi}_0 \\ \pi_0 + r^* + \frac{\rho}{\sigma} y_0 + \frac{\alpha(1-\lambda)}{\sigma(\alpha^2+\gamma)}(\pi_0 - \overline{\pi}_0) & \text{if } \overline{\pi}_0 < \pi_0 \end{cases} \tag{14}$$

where, as before, $\underline{\pi}_0 = -\frac{\psi}{2\alpha(1-\lambda)}$ and $\overline{\pi}_0 = +\frac{\psi}{2\alpha(1-\lambda)}$. In Orphanides et al. (1996), we compare the performance of equations (13) and (14) in stochastic simulations of the U.S. economy.

5 Aggregate supply

Thus far, we have interpreted e, the shock to the Phillips curve, as a "supply shock." The rationale for this interpretation is that the shock affects the inflation rate through a non-demand-related channel. However, this shock differs from the supply shocks studied by many other authors. In particular, it affects only the rate of inflation in our model and not either potential or actual output.[7] A common view is that an adverse supply shock not only boosts the rate of inflation but also depresses the level and possibly the rate of growth of potential output; in addition, it may depress actual output.

If the central bank controls the output gap directly, then the fact that a supply shock may affect either actual or potential output (in addition to influencing inflation) is immaterial; the policymaker still sets the output *gap* in light of the same considerations as before, taking

[7] Furthermore, it is worth noting that e affects the level of the inflation rate *permanently* absent any offsetting action by the monetary authority because inherited inflation enters the Phillips Curve with a unit coefficient.

into account the impact of the supply shock on the inflation rate.

If the central bank controls output only imperfectly (i.e., equation (11) is relevant and the central bank takes either the nominal or real interest rate as its instrument), then the exact nature of the supply shock is important for determining the stance of policy. One way to organize the analysis of the various possibilities is around the question of whether the supply shock affects r^*, the natural real rate of interest. If a supply shock does not affect the natural real rate (i.e., the direct effect of the shock on actual output is the same as the direct effect on potential), the analysis given above remains valid: An adverse supply shock has no direct effect on the output gap, and the higher level of inflation is the only problem the policymaker can address. If the inherited rate of inflation was above the long-run inflation objective, the policymaker will tend to respond aggressively to the threat that inflation may be moved further from its long-run objective.

If an adverse supply shock *boosts* the natural real rate of interest because it depresses potential output by more than it depresses actual output, the above analysis needs some modification. The optimal policy decision is most easily determined in two steps. In the first step, the policymaker increases the real rate by just enough to match the increase in the natural real rate. In the second step, the policymaker adjusts the real rate from its new level according to the same analysis of inflation outlined above.

If an adverse supply shock *reduces* the natural real rate because it affects demand by more than it affects supply (possibly an anomalous definition of a supply shock), then the central bank is faced with a dilemma: fight the shortfall of activity relative even to the new lower level of potential, or fight inflation. If inflation was at its long-run target level, the opportunistic central bank might choose to ignore much or all of the increase in inflation and move instead to boost real activity back to potential. However, if inherited inflation was far enough above the long-run target level, then even an opportunistic central bank would tighten its policy stance in order to prevent inflation from increasing too much.

6 Uncertainty

Thus far, we have ignored the influence of uncertainty on the optimal setting of the policy instrument. Although this approach is useful as a starting point, it does not yield a complete analysis except under very restrictive circumstances, including the one on which we have concentrated the bulk of our attention to this point in the paper—namely, a one-period model in which the policymaker can react contemporaneously to the shocks hitting the economy. This section provides an analysis of the influence of uncertainty under more general assumptions.[8]

In these more general circumstances, the policymaker must be treated as minimizing the expected value of the loss function:

$$\mathcal{L}_{\mathcal{C}} = E[(\pi - \tilde{\pi})^2 + \gamma y^2 + \psi |y|] \tag{15}$$

where the expectation is taken with respect to the probability distribution governing the inflation shocks, e, aggregate demand shocks, u, or both.

As is well known, the linear-quadratic framework that gives rise to the conventional strategy has the special property that the optimal policy depends only on the expectation of the shocks and not on their variances. The loss function we use to characterize the preferences of opportunistic policymakers is not quadratic. Nonetheless, the associated decision rule does display certainty equivalence in one special circumstance—namely in a one-period model in which the monetary authority controls the output gap perfectly. In this case, no modification of the earlier analysis is required even when the monetary authority cannot observe the inflation shock before it sets the level of output: The fact that the monetary authority picks the output gap effectively renders that variable non-stochastic in a one-period model, and inflation enters the loss function via a quadratic function.

This convenient result does not obtain when either the model is extended to more than

[8] To be clear, the source of the uncertainty we are concerned with in this section is the shocks in the model, not the parameters.

one period, or the central bank cannot control output perfectly. Specifically, it does not obtain when the central bank controls aggregate demand imperfectly (i.e., when equation (11) comes into play, and the central bank controls the real interest rate). In that case, it is convenient to decompose the resulting output gap, y, into two components—the expected output gap corresponding to the policymaker's choice, $\bar{y}$, and the unexpected additional influence from the aggregate demand shock, u. Assuming with no loss of generality that u is drawn from a zero mean distribution this yields:

$$y = \bar{y} + u$$

Controlling the interest rate in this setting is equivalent to controlling the expected or *intended* output gap, $\bar{y}$. The failure of certainty equivalence in the opportunistic case implies that, in general, the choice of $\bar{y}$ will depend on whether u is stochastic or always equal to its zero mean. Fortunately, in our model it is easy to show qualitatively the influence of uncertainty on the policymaker's choice.

Figure 5 reproduces the graphical derivation of the policymaker's choice in the absence of uncertainty (from Figure 2), and shows how uncertainty alters the analysis. On the horizontal axis we now show the *intended* output gap, $\bar{y}$, as opposed to the actual output gap shown in Figure 2. Since in the absence of uncertainty the two are always equal, the marginal loss curves for the deterministic case are identical to those in Figure 2. (As before, we restrict attention to the benchmark case in which γ equals 0 for the figure). Since the marginal loss from inflation is linear in output, uncertainty does not influence its expectation. Consequently, it is identical with and without uncertainty. Uncertainty operates exclusively through the marginal loss from the output gap which is non-linear in intended output. In the case of certainty this component of marginal loss is given by:

$$g^C(\bar{y}) \equiv \frac{d}{d\bar{y}}\psi|\bar{y}|.$$

As in Figure 2, we plot the negative of $g^C(\bar{y})$ here. The intersection with the marginal-loss-from-inflation schedule at point C indicates the policymaker's intended output choice in the absence of uncertainty. When u is stochastic, the marginal expected loss from output becomes

$$g^U(\bar{y}) \equiv \frac{d}{d\bar{y}} \int_{-\infty}^{+\infty} \psi|\bar{y}+u|dF(u).$$

where F denotes the distribution of u. The intersection of $-g^U(\bar{y})$ with the marginal-loss-from-inflation schedule at point U indicates the policymaker's intended output choice with uncertainty.

As is clear from the figure, to understand the influence of uncertainty on the policymaker's choice, we need only compare the two marginal-loss-from-output functions, g^C and g^U. The characteristics of the distribution function $F(u)$ have an important role in this comparison. Some implications, however, obtain without placing unduly restrictive assumptions on the distribution function. For instance, for any continuous distribution, g^U will be continuous in the intended output gap. Consequently, the policymaker's choice of intended output gap will not exhibit the region of absolute inaction characterizing the opportunistic pursuit of the inflation target when there is no uncertainty regarding aggregate demand. If the distribution is symmetric and has positive support over the entire real line, $g^U(\bar{y})$ simplifies to:

$$g^U(\bar{y}) = \psi \int_{-\bar{y}}^{+\bar{y}} dF(u)$$

This is the case we show in Figure 5. The schedule under uncertainty lies everywhere (except the origin) between the horizontal axis and the schedule under certainty. As a result, the policymaker will always pursue the inflation target more aggressively in the presence of uncertainty than in its absence. For example, as we show in Figure 5, an opportunistic policymaker facing positive inherited inflation will tilt toward a somewhat more restrictive policy in the face of aggregate demand uncertainty (point U) than she would have done in the absence of any uncertainty (point C). As a result, some progress toward price stability will be achieved even when inherited inflation falls within the region characterized by inaction in the absence of uncertainty and even if no shocks actually materialize.

7 Conclusion

The model we outline in this paper rationalizes the pursuit of an opportunistic approach to disinflation. When inflation is rapid, the strategy we describe calls for aggressive anti-inflationary action on the part of the monetary authority. When inflation is moderate, however, the strategy involves waiting for external circumstances to deliver reductions in inflation, and in the meantime merely attempting to hold the line against upticks in inflation.

As we have highlighted, the key feature of the model we present is the policymaker's objective function. By our lights, the most important unresolved issue related to opportunism concerns the economic rationale for the objective function. What considerations could motivate the policymaker to adopt an objective function with these characteristics? What evidence exists to support the view that the costs of inflation and deflation are more convex than are the costs of deviations of output from potential? In one respect, the specification of the opportunistic loss function is relatively easy to justify: As we noted earlier, the device of the intermediate target is not essential, and its function can be replicated by introducing a penalty in the *change* in inflation. Such a penalty has some appeal to us because our presumption is that continuity and absence of dislocation are positive attributes in the macroeconomy, and that large changes in the rate of inflation may be inconsistent with those attributes.

The more challenging problem is to justify the difference we posit between the penalties on inflation deviations from target and output deviations from potential. In words, this difference amounts to an assertion on our part that the policymaker may be thought of as incurring a first-order loss from output deviations even when output is close to potential, and yet only a second-order loss from inflation deviations when inflation is close to its target. The possible microeconomic foundations for this assertion are far from clear to us, but at this stage we (perhaps imprudently) offer the following highly speculative remarks. The deleterious effects of inflation are mainly allocative in nature: Investment decisions are distorted, borrowing, saving, and spending decisions become inefficient, and wealth may be transferred in possibly unpredictable ways. At least within some relatively narrow range, it may be reasonable to think of these costs as convex in the level of inflation.[9] In contrast, an interesting recent strand of literature takes seriously the fact that for much of the workforce, employment is an all-or-nothing proposition: Either you're employed full-time, or you're unemployed, and when the unemployment rate moves up slightly from the natural rate, it is more accurate to think of a few individuals becoming completely unemployed, rather than thinking of everyone becoming slightly underemployed. It may be that this concentration of unemployment provides the basis for treating deviations of output from potential as imposing first-order costs on the policymaker.

Perhaps the most striking implication of the opportunistic approach concerns the timing of the attainment of price stability. Under a conventional policy (and assuming that the Phillips curve is linear), the expected time to attainment of price stability can be computed even in the absence of information about the distribution of shocks hitting the economy. This is not the case if the monetary authority is pursuing the opportunistic approach. Indeed, this is the feature of the opportunistic approach that has led former Vice Chairman Blinder on many occasions to remark that the U.S. economy is "one recession away from price stability." In Orphanides et al. (1996), we explore the contrast between the conventional and opportunistic strategies in this dimension, using stochastic simulations of a small-scale macroeconomic model of the U.S. economy.

[9] It may not be reasonable to hold this view over too large a range of inflation, because there is ample anecdotal evidence that institutions and agents adapt in cost-reducing ways when inflation becomes very high.

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Figure 1

Building blocks of the opportunistic loss function

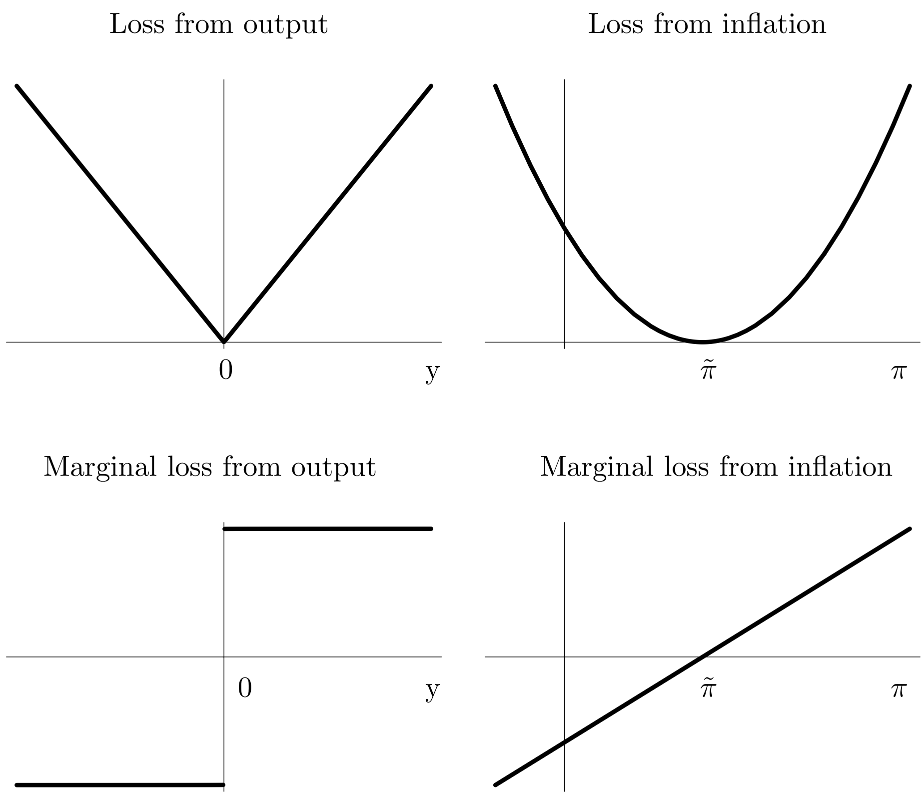
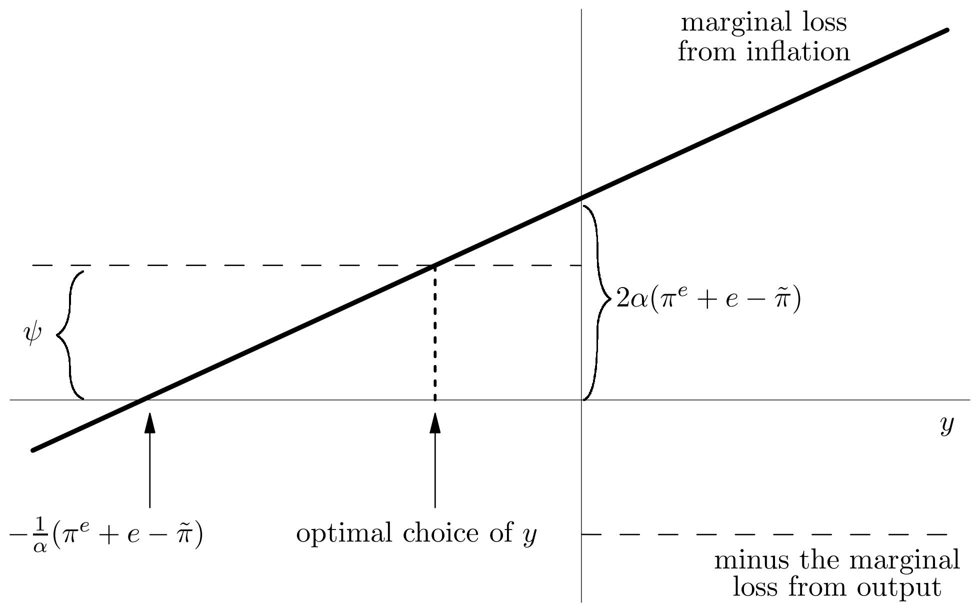


Figure 2

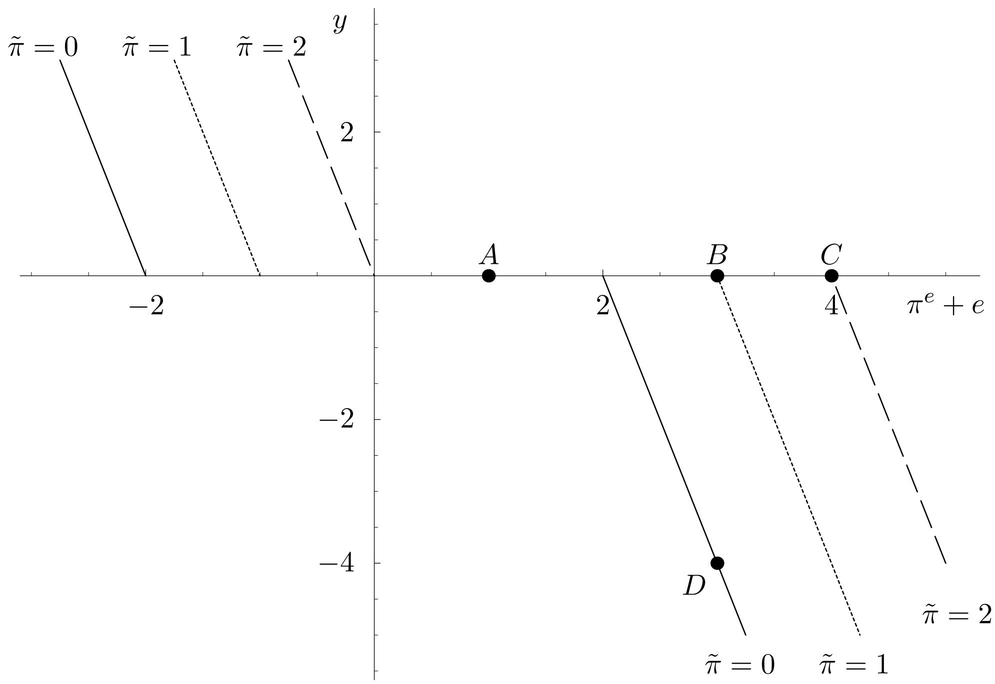
Graphical derivation of the opportunistic policy



Notes: This diagram presents a graphical solution to the optimization problem with the opportunistic loss function specification $\mathcal{L} = (\pi - \pi_0/2)^2 + |y|$, subject to the linear Phillips curve, $\pi = \pi_0 + y/4$. The horizontal axis measures the output gap,y, while the vertical axis measures marginal loss. The upward-sloping line gives the marginal loss from inflation as a function of the output gap, while the piecewise-linear schedule gives *minus* the marginal loss from the output gap, also as a function of the output gap. The optimal choice of the output gap is given by the horizontal location of these two schedules at their point of intersection.

Figure 3

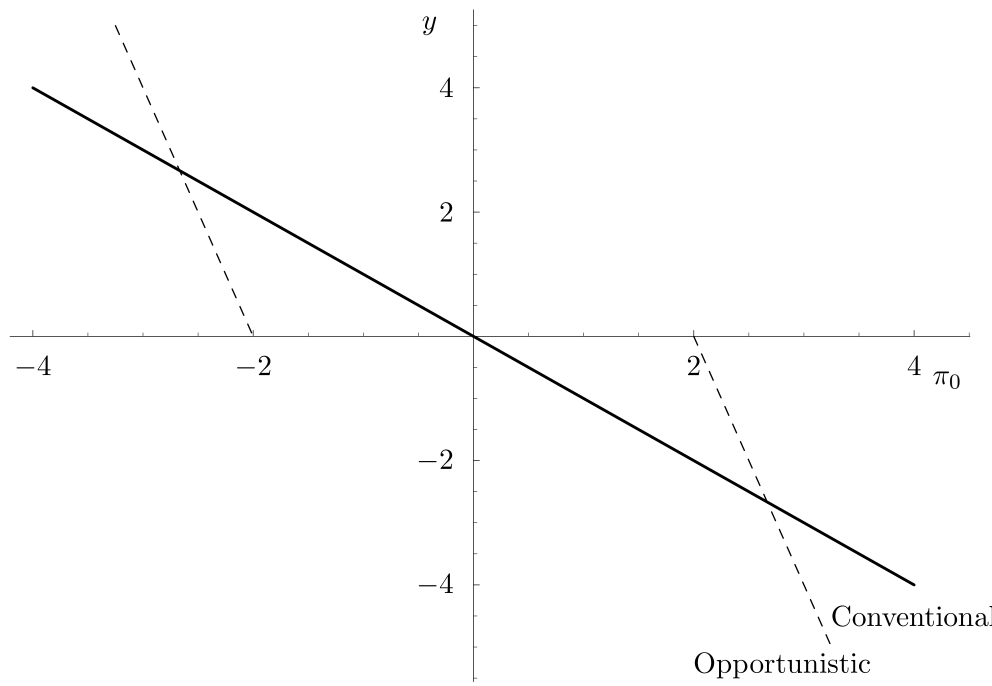
The opportunistic decision rule



Notes: This diagram shows the optimal choice of output gap (measured on the vertical axis) as a function of two variables: the rate of inflation if the central bank sets output at potential ($\pi^e + e$, measured on the horizontal axis), and the intermediate inflation target, $\tilde{\pi}$. The optimal choice of output gap for the opportunistic policymaker can be determined by locating the appropriate point on the relevant intermediate-target schedule.

Figure 4

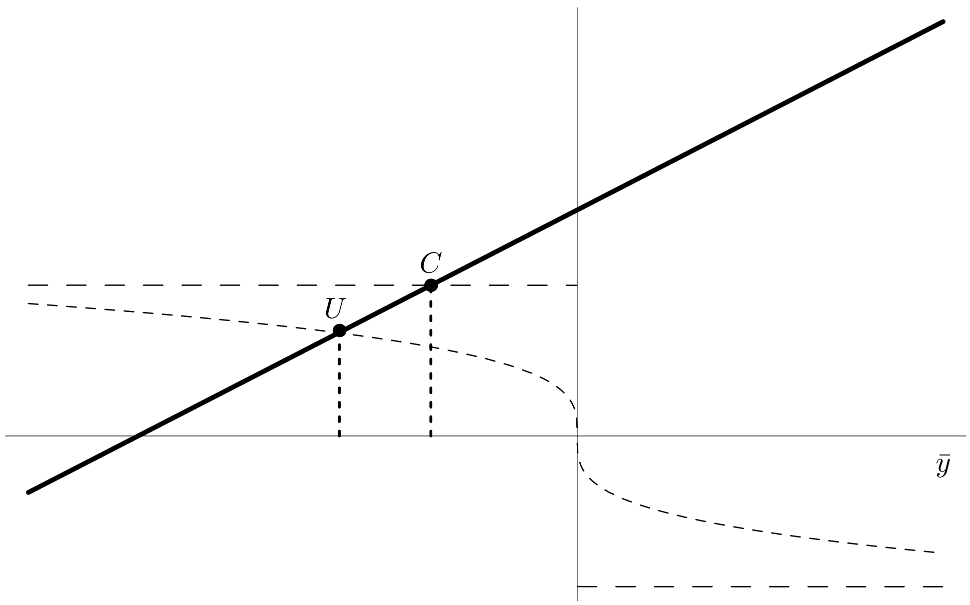
Conventional versus opportunistic policy: A special case



Notes: This diagram compares the conventional and opportunistic policies under the assumptions that inflation expectations are formed adaptively, and neither the supply nor demand shock can be anticipated. The conventional policy rule always attempts to make some progress toward the long-run inflation objective, and so sets the output gap to some non-zero value whenever inherited inflation is non-zero. By contrast, the opportunistic policy sets output at potential whenever inherited inflation close enough to zero, even if not literally zero.

Figure 5

The impact of uncertainty on the opportunistic policy



Notes: This diagram shows that the opportunistic policymaker will more aggressively pursue the long-run inflation target whenever there is uncertainty about aggregate demand. The logistic-shaped curve shows minus the *intended* value of the marginal loss from output when there is uncertainty, while the piecewise linear schedule shows minus the actual value of the marginal loss from output when there is no uncertainty. The curve under uncertainty lies everywhere between the horiontal axis and the curve under certainty; as a result, its intersection with the inflation schedule always occurs at a larger value of the output gap, in absolute value.