DATA REVISIONS, GRADUALISM, AND US INFLATION PRESSURE IN REAL TIME

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ABSTRACT

Uncertainties associated with the informational content of real-time data and the impact of policy initiatives on expectations have been offered as rationales for gradualism in monetary policy. Our objective is to assess these potential explanations quantitatively. Focusing on inflation as the key variable of interest to central banks, we construct indices of inflation pressure to characterize the state of the economy before and after the implementation of monetary policy. Using six vintages of US data, we analyze changes in the information content of economic data across revisions and the importance of expectations in determining the impact of monetary policy. We find that monetary policy affects inflation pressure and realized inflation primarily through its impact on expectations. We also find that while the Fed manages to influence expectations almost two thirds of the time the impact can be quantitatively small at times. One policy implication is that policy communication perhaps plays an even more crucial role for a gradualist central bank than one might think *a priori*.

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1. Introduction

Central banks generally implement interest rate changes gradually, rather than in large discrete jumps. A number of recent theoretical contributions suggest that gradualism represents a best response to the informational uncertainties that central banks face when formulating policy. It has also been suggested that gradual implementation ultimately requires smaller adjustments in interest rates because the expectational changes that accompany smaller repeated (unidirectional) changes have a greater reinforcing impact than would result from a single large adjustment.

Our objective, in this article, is to provide a quantitative assessment of the main rationales for gradualism that have been proposed in the literature. To this end, we address three related issues. The first focuses on whether informational uncertainties stemming from data revisions significantly affect the assessment of economic conditions. The second centers on the role that the expectations of forward-looking agents play in determining the effectiveness of monetary policy. The third is concerned with the extent to which using final revised data, rather than realtime data, affects the assessment of both the strength of the monetary authority's stabilization effort and effectiveness of the policies that were implemented.

In order to assess the impact of monetary policy on the economy, we need some means of quantifying the state of the economy before and after the implementation of monetary policy. We accomplish this by focusing on inflation as the key variable of interest to central banks and constructing indices of inflation pressure to characterize the state of the economy. The indices we employ are adapted from indices developed by Weymark and Shintani (2006) to examine the impact of systematic monetary policy decisions in the United States. The proposed indicators possess several desirable attributes. They provide summary measures of inflation pressure prior to the implementation of a monetary policy initiative, the degree to which monetary policy decisions change inflation pressure, and the overall effectiveness of monetary policy initiatives.

Inflation pressure can be thought of as arising from two sources, an excess demand

for goods (positive output gap) and expectations of future price increases (inflationary expectations). Interest rate increases reduce inflation pressure when they lead to reductions in the demand for goods and/or inflationary expectations. Our first measure, which we call *ex ante* inflation pressure, characterizes the inflationary environment faced by the policy authority prior to the implementation of a given policy initiative. Ex ante inflation pressure is measured as the change in the inflation rate that would have been observed if the monetary authority had held its interest rate instrument constant.[1] Our second indicator, which we refer to as *ex post* inflation pressure, measures the amount of inflation pressure that remains subsequent to the implementation of a particular policy initiative.

Our measures of ex ante and ex post inflation pressure are used to construct two indices that measure the degree to which a policy succeeded in moderating inflation pressure. We introduce two indices for this purpose. The first of these indices, the index of Effective Price Stabilization, measures the degree to which the policy that was implemented succeeded in preventing ex ante inflation pressure from being realized as observed inflation. The degree to which a monetary policy is successful in moderating realized inflation is only one aspect of policy effectiveness. A second aspect, which is of at least equal importance, is the extent to which the policy succeeded in moderating the inflationary environment. This aspect of policy effectiveness is captured by our index of Monetary Policy Effectiveness in which the magnitudes of ex post and and ante inflation pressure are compared. The index of Monetary Policy Effectiveness provides a measure of the degree to which inflationary expectations were affected by the policy that was implemented.

The measures of inflation pressure needed to calculate our indices are not directly observable. They are counterfactuals and must therefore be imputed from a theoretical model. In order to obtain estimates of inflation pressure, we apply a two-step

[1]Note that our general definition is extremely flexible in that it does not specify any particular timing between the implementation of the interest rate change and its impact on the economy. Our definition can accommodate a wide range of forward-looking and pre-emptive policy actions on the part of the central bank.

methodology that Weymark (1995, 1998) used to measure exchange market pressure. First, we propose model-independent definitions of each index. We then apply these definitions to a theoretical model and derive model-specific index formulae which provide a functional relationship between inflation pressure and economic variables that are directly observable. We then estimate our model and use the estimation results to perform specific counterfactual experiments that enable us to obtain our measures of ex ante and ex post inflation pressure.

Both the concept of inflation pressure and the methods we use to construct inflation pressure indices are new to the literature. Measures of monetary policy effectiveness, on the other hand, exist in various forms in earlier studies. Most of the earlier studies focus on impact of monetary policy shocks (i.e., non-systematic monetary policy) on output.[2] An exception is Boivin and Giannoni (2006) who use impulse response functions to assess the impact of both systematic and non-systematic monetary policy. The measure of monetary policy effectiveness that we introduce here is novel in that it captures the impact of systematic monetary policy on inflation in the form of a summary statistic that has a simple, intuitively appealing interpretation. Our indices are also more informative than their predecessors in that they allow us to characterize the inflationary environment both before and after action is taken by a central bank.[3]

[2]See, for example, Bernanke (1990), Bernanke and Blinder (1992), Bernanke and Mihov (1998), Christiano and Eichenbaum (1992), Romer and Romer (1999), and Strongin (1995), among others. Although Romer and Romer (2004) are interested in the impact of monetary policy on prices as well as output, they also employ a measure of monetary policy that is purged of all endogenous components.

[3]Many of the earlier studies of monetary policy performance are based on a vector autoregressive (VAR) models (e.g., see Christiano, Eichenbaum, and Evans (2000) for a survey). More recent research has proposed variants that allow for richer information sets to be employed without having to give up some of the advantages of restricting statistical analyses to a smaller number of time series (e.g., Bernanke, Boivin, and Eliasz 2005). However, regardless of the approach taken, existing techniques generally rely on retrospective views of monetary policy actions, and these typically resort to final revised data.

The particular era in U.S. monetary history we are interested in covers roughly the period between 1999 and 2004. This period is interesting because it contains periods of sustained interest rate increases as well as decreases. Beginning in June 1999, the Federal Reserve raised the Federal Funds rate five times in succession in increments of 25 basis points. From January 2001 to June 2003 the Federal Funds rate was reduced 550 basis points in thirteen incremental steps (nine 50 basis point increments and four 25 basis point increments). Orphanides (2001, 2003) has argued persuasively that any assessment of the conduct of monetary policy must take into account the fact that the information available to central banks at the time policy is formulated is inherently noisy.[4] Accordingly, in this paper, we use six vintages of US data, spanning the period 1998 to 2004 to conduct our analysis.

The rest of the paper is organized as follows. In section 2 we briefly review some of the hypotheses that have been put forward to explain gradualism in monetary policy. Section 3 describes the methodology that we employ to obtain our measures of ex ante and ex post inflation pressure. Formal definitions of these measures as well as our indices of effective price stabilization and monetary policy effectiveness are also given in this section. The empirical model we use to study the implications of data revisions for the conduct of monetary policy in the United States is described in Section 4. Section 5 provides a discussion of the data sources and estimation procedures employed. The empirical results are discussed in Section 6. Concluding remarks may be found in Section 7.

2. Gradualism in Monetary Policy

Although the debate about the presence of gradualism in monetary policy is an old one (e.g., see Goodhart 1999, and references therein), it is generally understood today as referring to the interest rate smoothing phenomenon. Even if central banks abide by the steady state requirement of the Taylor principle, namely that to tighten

[4]Croushore and Evans (2006) provide a survey of contributions to the real-time literature. Croushore also maintains an up to date list of the literature on real time data at http://oncampus.richmond.edu/ dcrousho/data.htm

monetary policy the interest rate response must exceed the increase in inflationary expectations, there is nothing to prevent the monetary authority from doing so in measured steps.[5] While Taylor's (1993) original rule did not contain a lagged interest rate, it is common practice to include one or more nominal interest rate lags when estimating Taylor rules empirically. Whether such a formulation of the central bank reaction function is appropriate, or simply a useful data-fitting device, has also been the subject of considerable debate (Sack 2000). Rudebusch (2002) contends that the observed gradualism in monetary policy occurs because the economy evolves slowly, with key macroeconomic variables exhibiting a high degree of serial correlation. As a consequence, the monetary response of the central bank to changes in theses variables exhibits a similar gradual, serially correlated adjustment over time.[6] English, Nelson, and Sack (2003) conclude that Rudebusch's (2002) findings are due to a co-existence of serial correlation and partial adjustment. Based on the available empirical evidence, it is not possible to definitively reject gradualism in the setting of the policy instrument.

A number of explanations have been advanced in support of the interest rate smoothing phenomenon.[7] One explanation centers on the inherent uncertainties that central banks face when formulating monetary policy. With imperfect knowledge

[5]See Walsh (2003), and Woodford (2003, p. 254), both of whom regard this long run principle as a crucial one for the conduct of good monetary policy. However, there are equally good reasons to argue that this standard cannot or indeed need not be met at all times. Circumstances may require the central bank to suspend the principle, at least in the short run. See, for example, Taylor and Williams (2010).

[6]Rudebusch (2002) focuses on the contradiction between estimated Taylor rules with a high degree of interest rate persistence (quite frequently, 0.8 or more) when many other studies report considerable difficulty in predicting policy rates. Söderlind, Söderstrom, and Vredin (2003) report that interest rate persistence is a necessary, but not sufficient, condition for predictability. If there is one omitted variable then a high degree of persistence need not imply high predictability.

[7]Siklos (2002), Goodhart (2005), Sack and Wieland (2000), and Walsh (2003) review various aspects of this literature. Bernanke (2004) also provides a useful summary of the various rationales for gradualism in monetary policy implementation.

about the structure of the economy, the timing and magnitude of any policy action becomes uncertain. The resulting model uncertainty is compounded by the fact that information about the current state of the economy changes continuously, so that policy decisions must, inevitably, be made on the basis of noisy data. In most cases, gradualism provides the most appropriate means of implementing effective monetary policy in an uncertain environment.[8] Gradualism allows the policy-maker to observe the impact of a small initial policy change and modify future policy changes as economic conditions evolve. Proceeding in small methodical steps also reduces the policy-maker's reliance on forecasts of unobservable variables such as potential output.[9]

A second justification for gradualism, originally proposed by Goodfriend (1991) and formalized by Woodford (1999, 2003a), contends that smaller, repetitive changes in the central bank's short-term interest rate target have a bigger impact on expectations, and therefore on long-term interest rates, than larger discrete changes would have. The greater is the impact on expectations and longer-term rates, the greater will be the impact of a given policy change on private expenditure and investment decisions. Furthermore, gradual interest rate adjustments make monetary policy changes easier to forecast. Central banks that change interest rates too frequently also run the risk of overreacting unnecessarily in the face of constant shocks, thereby raising the risk of a loss of credibility in the delivery of monetary policy. Finally, central banks, such as the U.S. Fed, make decisions in a committee setting, and the desire to reach a consensus can mean taking fewer risks, or implementing policy changes in smaller steps when this is deemed necessary.

The explanation most germane to this paper stems from the observation that some key data series are revised frequently or are, in any event, observed with error. In what follows, we focus on the impact that changing information about key economic variables has on the perception of the current state of the economy and on our

[8]See Brainard's (1967) seminal article on the subject of model uncertainty and Orphanides (2003) for an analysis of monetary policy formation with noisy data.

[9]See Orphanides and Williams (2002) for a detailed analysis.

assessment of the effectiveness of the central bank's policy response.

3. Measuring Inflation Pressure

Any exogenous disturbance to the economy, whether it originates in the goods market or not, has the potential to generate goods market disequilibria and so cause changes in the inflation rate. Whether or not the inflationary changes that occur represent the full impact of the disturbance on the goods market, or only a part of it, depends on the extent to which changes in other economic variables (such as the interest rate) mitigate the impact of the disturbance on the goods market before prices can respond. The concept of ex ante inflation pressure that we propose here is intended as a measure of the magnitude of the initial goods market disequilibrium in inflation equivalent units. Ex ante inflation pressure therefore is the change in the inflation rate that would have occurred in response to a given disturbance if no other variables had responded to that particular disturbance. Because we usually cannot observe exogenous disturbances in isolation and generally detect them through the changes in endogenous economic variables that are precipitated by these disturbances, a counterfactual experiment must be undertaken in order to compute ex ante inflation pressure.

The concept of ex ante inflation pressure and its computation is perhaps most easily conveyed through an illustrative example. Consider an economy with the following structural characteristics:

$$\pi_t \;=\; \alpha_0 \;+\; \alpha_1\pi_{t-1} + \alpha_2 \mathrm{E}_t\pi_{t+1} + \alpha_3 y_{t-1} + \epsilon_t \tag{1}$$

$$y_t \;=\; \beta_0 + \beta_1 y_{t-1} + \beta_2 \mathrm{E}_t y_{t+1} - \beta_3[i_{t-1} - \mathrm{E}_{t-1}\pi_t] + \eta_t \tag{2}$$

$$i_t \;=\; \rho_t i_{t-1} + (1-\rho_t)[\gamma_0 + \gamma_\pi \mathrm{E}_t\pi_{t+2} + \gamma_y \mathrm{E}_t y_{t+1} + \sigma_t] \tag{3}$$

where π_t is the inflation rate in period t, y_t is the output gap in period t, and i_t is the period t nominal interest rate. The variable $\mathrm{E}_t\pi_{t+1}$ denotes the expectation that rational agents form in period t about the level of inflation that will prevail in period $t+1$. Similarly, $\mathrm{E}_t y_{t+1}$ is the rational, one-period-ahead expectation of the output gap. The random disturbances ϵ_t, η_t, and σ_t are assumed to be independently

distributed and to have zero means. Equation (1) is a Phillips curve (PC), (2) the IS equation, and (3) is a standard version of the Taylor rule (TR).

According to the policy authority's interest rate rule (3), the current interest rate is a convex combination of the previous period's interest rate and the weighted sum of the policy authority's one-period-ahead expectations about inflation and the output gap. The (potentially) time-varying parameter ρ_t measures the relationship between the current interest rate and that of the previous period. It is assumed that the policy authority can control the interest rate perfectly. Consequently, $\rho_t = 1$ reflects the policy authority's decision to hold the period t interest rate constant at its period $t-1$ level.

The illustrative model given above is deliberately simple in order to make the derivation of model-consistent inflation pressure measures as transparent as possible. Nevertheless, the model incorporates many of the features that will be found in the more complex structure that we employ in our empirical application. The PC and IS equations are both hybrids in that they allow for persistence in inflation and the output gap and also incorporate forward-looking expectations on the left-hand side. Equations (1) and (2) also portray systematic monetary policy as having a delayed impact on inflation. Substituting (2) into (1) yields:

$$\begin{aligned} \pi_t &= \alpha_0 + \alpha_1 \pi_{t-1} + \alpha_2 \mathrm{E}_t \pi_{t+1} + \epsilon_t \\ &\quad + \alpha_3 \{\beta_0 + \beta_1 y_{t-2} + \beta_2 \mathrm{E}_{t-1} y_t - \beta_3 [i_{t-2} - \mathrm{E}_{t-2} \pi_{t-1}] + \eta_{t-1}\}. \end{aligned} \tag{4}$$

It is apparent from (4) that there is a two period control lag between the policy authority's policy tool, i_t, and the inflation rate in this economy. Batini and Nelson (2001) have shown that for both the UK and US there is, on average, at least a four quarter lag between the implementation of monetary policy and its peak impact on inflation. This suggests that in a quarterly model, one would expect a control lag of at least four periods. For the purposes of this illustration, a two period lag is sufficient; longer control lags are considered as part of the empirical application. Note that the two-period ahead inflation expectation in the policy authority's interest rate response function (3) is consistent with the control lag postulated in (4). The autoregressive

elements, forward-looking expectations, and the control lag between monetary policy and inflation that are present in the equations above ensure that this model, though simple, is rich enough to allow us to address all of the technical and methodological issues that arise in computing inflation pressure in our empirical application in later sections.

3.1 Ex Ante Inflation Pressure

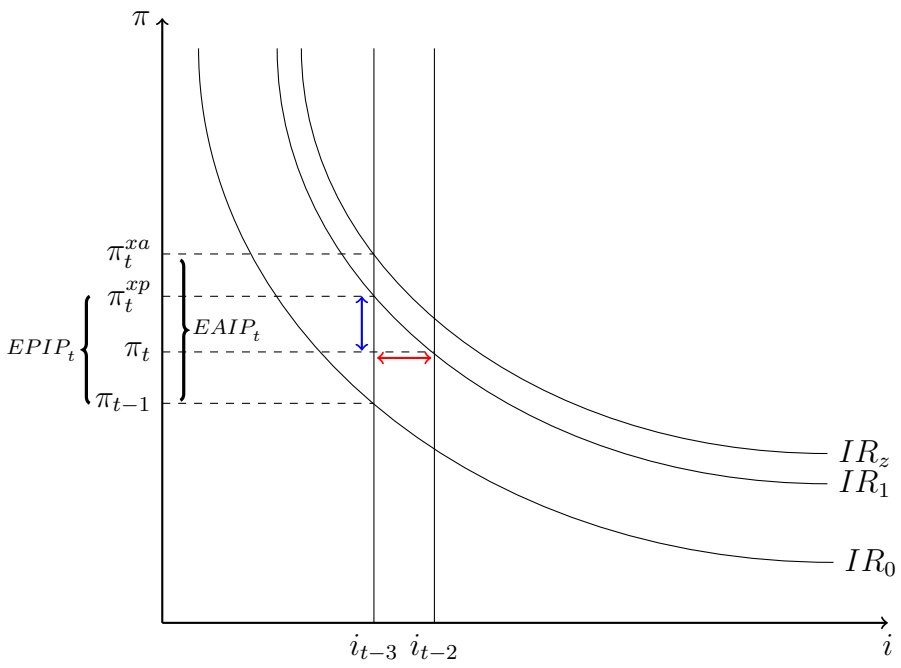
The relationship between interest rate changes and inflation reflected in (4) is represented graphically in Figure 1. In Figure 1, the trade-off between inflation and the interest rate that exists at various points in time is represented by the curves IR_0, IR_1, and IR_z. The lowest curve, IR_0, represents the trade-off that existed in period $t-3$. The difference in the position of IR_0 and highest curve, IR_z, represents the shift in the trade-off caused by changes in any of the predetermined explanatory variables on the right hand side of (4) other than i_{t-2}. In the interests of expositional simplicity, we assume for the moment that there are no exogenous expectational shocks, but our framework can handle these without difficulty as well.

In Figure 1, the inflationary environment that the policy authority faced at the beginning of period $t-2$, is given by the distance between IR_0 and IR_z. This distance can be measured horizontally (in interest rate units) or vertically (in inflation units). Because we focus on inflation outcomes as the primary indicator of monetary policy effectiveness, we choose to measure the distance between the inflation/interest rate trade-off curves vertically.

Using the past period's interest rate, i_{t-3}, as our benchmark, the impact of the disturbance that is represented by the shift in the inflation/interest rate trade-off from IR_0 and IR_z is given by the vertical distance from π_{t-1} to π_t^{xa} at i_{t-3} in Figure 1.[10] The vertical distance between IR_0 and IR_z, measured at i_{t-3} provides a quantitative

[10]Clearly, it is possible to measure the vertical distance between IR_0 and IR_z at many different points along the horizontal axis, however, in order for the measures we derive to be operational, it is advisable that we use as many directly observable variables as possible. We therefore use the observed interest rate, i_{t-3}, as our benchmark.

Figure 1: Graphical Representation of EAIP & EPIP



characterization of the inflationary environment that the policy authority faced at the beginning of period $t-2$, and to which it responded when it implemented its interest rate policy in $t-2$.

As i_{t-3} is the interest rate that prevails at the end of period 3, prior to the implementation of the policy authority's period 2 interest rate policy, we define Ex Ante Inflation Pressure as follows:

Definition: Ex ante inflation pressure is measured as the change in the inflation rate that would have been realized if the interest rate had been held constant and this policy decision had been correctly anticipated by economic agents.

Using the notation in Figure 1, the formal definition of our Ex Ante Inflation Pressure index (EAIP) for period t is given by:

$$EAIP_t \;=\; \pi_t^{xa} \;-\; \pi_{t-1} \tag{5}$$

where π_t^{xa} denotes the inflation rate that would have been observed in period t if the monetary authority had held $i_{t-2} = i_{t-3}$.

3.2 Ex Post Inflation Pressure

Ex Post Inflation Pressure (EPIP) measures the inflation pressure that remains after a policy change has been implemented. When agents form expectations rationally, their expectations about the future path of endogenous variables are affected by changes in policy variables. In Figure 1, the impact of the period $t-2$ interest rate policy on expectations is shown as an inward shift of (i.e., improvement in) the inflation/interest rate trade-off in that IR_1, which represents the trade-off between inflation and the interest rate after i_{t-2} has been implemented, lies to the left of IR_z.

In Figure 1, EPIP is represented as the vertical distance between IR_0 and IR_1. Using the notation in Figure 1, EPIP can then be characterized as the vertical distance from π_{t-1} to π_t^{xp} at i_{t-3}. Notice that when the Lucas Critique holds, and expectations change in response to changes in policy variables, this distance cannot be observed directly once i_{t-2}, which caused the shift in IR from IR_z to IR_1, has been implemented.[11] The measurement of EPIP therefore involves a measurement experiment in which the change in inflation attributable to the interest rate change is combined with the observed change in inflation, given the inflation/interest rate trade-off represented by IR_1. We therefore define Ex Post Inflation Pressure as:

Definition: Ex post inflation pressure is the change in the inflation rate that would have occurred under the monetary policy actually implemented in a given period, if the policy authority had unexpectedly maintained its policy instrument at the same level as in the previous period.[12]

Using the notation in Figure 1, the formal definition of our Ex Post Inflation

[11] Although we focus here on rational expectation formation, our method of computing ex post inflation pressure makes no a priori assumptions about the way in which expectations are formulated and is therefore equally applicable in the case of bounded rationality. This point is discussed in greater detail, in the context of measuring exchange market pressure, in Weymark (1998).

[12] The concept of ex post inflation pressure is analogous to the concept of exchange market pressure introduced in Weymark (1995, 1998).

Pressure index (EPIP) for period t is given by:

$$EPIP_t \;=\; \pi_t^{xp} \;-\; \pi_{t-1} \tag{6}$$

where π_t^{xp} denotes the inflation rate that would have been observed in period t if the monetary authority had unexpectedly held $i_{t-2} = i_{t-3}$.

Note that although we have used a particular illustrative example to motivate the concepts of ex ante and ex post inflation pressure, the verbal and formal definitions of these measures given above are not specific to this model.

3.3 Two Indices of Policy Effectiveness

The effectiveness of monetary policy is most often evaluated historically using final revised data. The monetary authority, however, must assess the effectiveness of its policy initiatives in real time. In order study the impact that data revisions have on the perceived effectiveness of monetary policy, we propose two indices. The first index, which we call the Effective Price Stabilization (EPS) index, measures the degree to which monetary policy was successful in preventing ex ante inflation pressure from being realized as observed inflation. The success of a monetary policy is most often judged on the basis of its impact on realized inflation. However, such success might prove to be of short duration if the monetary policy is not also effective in altering the inflationary environment in such a way as to improve the inflation/interest rate trade-off. Our second index, the index of Monetary Policy Effectiveness (MPE), measures the degree to which monetary policy moderated the underlying inflationary pressure.

3.3.1 Effective Price Stabilization

The IR curves shown in Figure 1 represent feasibility constraints that the monetary authority faces. When an interest rate policy is implemented, the monetary authority chooses a combination of inflation and interest rate that is a point on the relevant feasibility constraint. In an economy populated with forward-looking rational agents, changes in the monetary instrument will alter inflation expectations causing the feasibility constraint to shift. Under the assumption that there is a negative relationship between the interest rate and inflationary expectations, an interest rate increase would

cause the feasibility constraint to shift inwards. In Figure 1, we show the feasibility constraint shifting inwards, from IR_z to IR_1 when the policy authority increases the interest rate from i_{t-3} to i_{t-2}. The impact of a polity initiative on observed inflation therefore depends not only on the interest rate change, but also on the response of private expectations to this policy initiative. Our Effective Price Stabilization (EPS) index measures policy effectiveness in terms of the proportion of ex ante inflation pressure that the policy initiative successfully prevented from being realized. Formally, the EPS index is defined as

$$\text{EPS}_{t-\tau} = 1 - \frac{\Delta\pi_t}{\text{EAIP}_t} \tag{7}$$

where τ is the length of the control lag between the interest rate and inflation. In the context of our illustrative example, we set $\tau = 2$.

When $\Delta\pi_t = 0$, $\text{EPS}_{t-\tau}$ =1, indicating that monetary policy in period $t-j$ was 100% successful in preventing ex ante inflation pressure from being realized in period t. When $\text{EPS}_{t-\tau} = 0$, that is, $\Delta\pi_t = \text{EAIP}_t$, the policy initiative was unsuccessful in moderating the impact of ex ante inflation pressure on observed inflation. It is also conceivable that the policy impact on inflation can be either larger or smaller relative to EAIP, resulting in values for EPS that can be either negative or exceed 1. For example, a monetary policy that consistently under-reacts to changes in inflation expectations relative to the requirements of the Taylor principle would lead to EPS $<$ 0. An especially aggressive change in the stance of monetary policy, on the other hand, could produce a sufficiently large reduction in inflation to cause the value of EPS to exceed unity. Alternatively, one can think of monetary policy as displaying a form of overshooting as positive or negative EAIP values are offset by a change in inflation in the opposite direction. It is fairly clear that negative values of EPS are not consistent with good (i.e., effective) monetary policy practice. The interpretation of EPS values greater than unity is not quite as clear-cut. While it is true that EPS values that exceed unity indicate overshooting of the zero inflation target, which would occur if the policy authority underestimated the impact of its policy on expectations, EPS values in this range could just as easily be associated with a purposeful effort on the

part of the policy authority to alter the mean inflation level.

3.3.2 Monetary Policy Effectiveness

While it is conceivable that policy initiatives might be able to prevent temporary changes in inflation pressure from being realized, it is not very likely that this would be possible in the longer term unless the policy was also successful in moderating the underlying inflationary environment. It seems then that an important aspect of policy effectiveness is the degree to which the policy reduced inflation pressure overall. Ex post Inflation pressure, measures the inflation pressure that remains subsequent to the implementation of a particular monetary policy initiative. The difference between ex ante and ex post inflation pressure therefore reflects the impact of a particular policy on the inflationary environment. Our index of Monetary Policy Effectiveness (MPE) is therefore defined as

$$\text{MPE}_{t-\tau} = 1 - \frac{\text{EPIP}_t}{\text{EAIP}_t} \tag{8}$$

where, as before, τ reflects the length of the policy control lag. As in (7), for the illustrative example, $\tau = 2$.

Clearly, if EPIP = 0, then monetary policy is completely effective in neutralizing inflation pressure resulting in MPE =0. A monetary policy that leaves ex post and ex ante inflationary pressures the same results in MPE = 1 and is completely ineffective in the sense that there has been no discernible impact on the inflationary environment. Partial reductions in inflationary pressure result in values for MPE that range between 0 and 1. As in the case of EPS, negative values for MPE, as well as values that exceed 1, are also possible. A negative value indicates that EPIP and EAIP moved in opposite directions, clearly a sign of policy effectiveness (but possibly also evidence of overshooting the target inflation rate). A value for MPE that exceeds unity indicates that EPIP exceeds EAIP. In this case, the actual monetary policy has magnified inflation pressure and this is clearly an indication that policy is ineffective.[13]

[13]Note that our EPS and MPE indices are not defined when EAIP = 0. Situations in which EAIP is exactly equal to zero can be expected to be quite rare, so this issue is unlikely to be of much practical importance. What could be more troublesome is that as EAIP gets very small and

3.4 Operational Index Formulae

The concepts of ex ante and ex post inflation pressure that we propose, and upon which we base our indices of policy effectiveness, are counterfactuals.[14] As such, they are not directly observable. However, by applying the definitions of our counterfactual inflation pressure measures to an appropriately specified model, it is possible to derive operational measures of inflation pressure that can be computed using available macroeconomic data.[15] Although the operational formulae that we derive are necessarily model-specific, the definitions used to obtain these formulae are model-independent and can be applied to a wide variety of structural models.

The concepts of inflation pressure that we propose, and the method of obtaining their operational counterparts, are new to the literature. They are also the main tool that we employ to determine the extent to which the perception of the state of the economy is affected by data revisions. Details of the methodology we employ to derive our operational inflation pressure measures have been relegated to Appendix 1. Here, we confine ourselves to providing only the operational formulae themselves. The operational inflation pressure formulae obtained in the context of the economy

approaches zero, PIIP may approach negative infinity and MPE may approach positive infinity. This difficulty could be avoided by defining indices in terms of imputed price levels rather than changes in price levels, but doing so would make the estimation of our counterfactuals considerably more difficult because of the nonstationarity of price level data. Our preferred solution is simply to be particularly careful to interpret large (absolute) PIIP and MPE values in light of the underlying magnitude of EAIP.

[14]It has been pointed out to us that there are potentially two sets of inflation pressure indicators, depending on whether the Fed makes a single real time change in the fed funds rate or implements a series of interest rate changes. Inflation pressure can, in principle, be re-evaluated each period, conditional on the steps the Fed actually took. In practice, however, we make some simplifying assumptions to reduce the scope of the numerical approximations that must be made. This may indeed affect the accurate measurement of inflation pressure but we believe not in any significant fashion.

[15]The main requirement for a model to be appropriate for this purpose is that it contain an explicit channel of transmission between the policy instrument and inflation.

described by (1)-(3) are:

$$\text{EAIP}_t = \Delta\pi_t + \alpha_3\beta_2\Delta i_{t-2} - \Gamma_3\Delta i_{t-2}. \tag{9}$$

$$\text{EPIP}_t = \Delta\pi_t + +\alpha_3\beta_3\Delta i_{t-2}. \tag{10}$$

where Γ_3 is a complex composite of the structural and reduced-form coefficients contained in our illustrative model. It is straightforward to show, as we do in Appendix 1, that the operational formulae given in (9) and (10) are fully equivalent to their respective conceptual counterparts, (5) and (6).

Operational indices of policy effectiveness are easily obtained using the operational inflation pressure measures given above. Substituting (9) into (7) yields

$$\text{EPS}_{t-2} = 1 - \frac{\Delta\pi_t}{\Delta\pi_t + [\alpha_3\beta_3 - \Gamma_3]\Delta i_{t-2}} \tag{11}$$

where EPS_{t-2} measures the degree to which the policy implemented in $t-2$ was successful in preventing the underlying inflation pressure from being realized in period t. Substituting (9) and (10) into (8) results in the following operational monetary policy effectiveness index for period $t-2$

$$\text{MPE}_{t-2} = 1 - \frac{\Delta\pi_t + \alpha_3\beta_3\Delta i_{t-2}}{\Delta\pi_t + [\alpha_3\beta_3 - \Gamma_3]\Delta i_{t-2}}. \tag{12}$$

4. A Quarterly Model of the US Economy

In order to estimate our ex ante and ex post inflation pressure measures, it is first necessary to specify and estimate a structural model. Since its introduction, the small structural model of the US specified by Clarida, Galí, and Gertler (CGG 1999) has been employed in numerous studies. As there now exists a vast literature that relies on a fairly common structure for a small model of the U.S. economy, we follow the current consensus and estimate a variant of that model.[16]

The CGG (1999) model consists of three equations that describe aggregate demand, aggregate supply, and the U.S. Fed's reaction function. All three equations

[16]See also Fuhrer (2002), Rudebusch (2002), and Svensson (1997).

contain both forward and backward-looking elements, and are therefore consistent with Woodford's (2003) view that models ought to contain history dependent components. The following equations then describe the U.S. economy:

$$\pi_t = \alpha_0 + \alpha_1 \pi_{t-1} + \alpha_2 \mathrm{E}_t \pi_{t+2} + \alpha_3 y_{t-2} + \epsilon_t \tag{13}$$

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 \mathrm{E}_t y_{t+4} - \beta_3 [i_{t-1} - \mathrm{E}_{t-2} \pi_{t-1}] + \eta_t \tag{14}$$

$$i_t = \rho_t i_{t-1} + (1 - \rho_t)[\gamma_0 + \gamma_\pi \mathrm{E}_t \pi_{t+m} + \gamma_y \mathrm{E}_t y_{t+n} + \sigma_t] \quad m, n \geq 0 \tag{15}$$

where all variables are as previously defined for (1)-(3).[17]

Equation (13) is the aggregate supply or Phillips curve (PC), Equation (14) is an IS or aggregate demand curve. The Fed's policy response function is represented as a Taylor rule in equation (15). Both the IS and PC curves are hybrids in the sense of containing both forward and backward-looking components. The Taylor rule is written in the standard form in which interest rate smoothing, captured by the parameter ρ, together with forward-looking inflation and output gap terms jointly determine the current setting of the policy instrument.[18] Note that in our specification, ρ is potentially time-varying. Note also that, for convenience and simplicity, the forecasting horizon of the central bank, that is, m and n are not specified a priori as this can clearly change as the economic environment dictates. Furthermore, we do not impose the restriction $m = n$, which is often found in the literature (e.g., see Galí, and Gertler (2007), and references therein). This provides our model with greater flexibility in that it allows the central bank to be more or less forward-looking about inflation vis-á-vis the output gap over time. A similar argument applies, in principle, to the PC and IS curves in equations (13) and (14). However, in keeping with the

[17] In estimating (13) and (14) we found that the fit was improved when we allowed for non-zero intercept terms in both equations as well as a lagged real interest rate term in (14). The exact specifications of our estimation equations have been relegated to the Appendix.

[18] In what follows we focus on simple or standard Taylor rules. The relevant literature finds that such rules perform nearly as well as optimal rules and have the advantage of being relatively more robust to model misspecification. See Woodford (2003b).

vast majority of aggregate demand and supply specifications available in the literature, we retain the specifications as shown. The origin of the aggregate supply or PC curve in (13) can be traced to Calvo (1983) and emerges from the staggered pricing phenomenon. Equation (14) is based on the IS curve derived from a representative agent who maximizes an inter-temporal utility function with some habit persistence (Fuhrer 2000).

There are a two issues that bear mentioning at this point. First, as is apparent from (13) and (14), our empirical model specifies a three quarter control lag between the interest rate and inflation. Several recent studies indicate that, for the US, lag between the implementation of an interest rate change and the peak impact of that change on inflation lies somewhere between one and two years. In preliminary estimations we allowed for control lags of varying lengths but did not find allowing for a longer control lag significantly improved the fit of the model. Because the complexity of the derivations required to compute our counterfactual inflation pressure measures increases with the length of control lag, and we could find no compelling reason to incorporate a longer control lag, we have used a three quarter control lag for all vintages.

Another potential point of concern is the possibility of time-varying model structure, that goes beyond changes in the parameter values from vintage to vintage. Specifically, once inflation, the output gap, and the interest rate, are observed, it is conceivable that the model that best describes the environment as summarized by the IS and PC curves may have changed.[19] In what follows we re-estimate the underlying model for each vintage, and we also allow for modest changes in the model structure (particularly in the case of the Taylor Rule). However, it is beyond the scope of this article to consider alternative rational expectations solutions, variations in the lags of parameters included in the IS and PC equations, and/or time variation of parameters within each vintage.

[19]The entire structure of the model may have changed. However, under the circumstances, even a change in m or n in equation (15) is sufficient.

5. Data and Model Estimation

5.1 Data Sources and Vintages

The real time data we employ are from the Federal Reserve Bank of Philadelphia Real-Time Data Set (www.philadelphiafed.org/econ/forecast/real-time-data/index.cfm). In the estimates shown below we revised only the output gap estimates in real-time. Interest rates and consumer prices are from the Federal Reserve Bank of St. Louis FRED II database (www.research.stlouisfed.org/fred2). These two series are not generally subject to revisions considered to be quantitatively or qualitatively important.[20] Since the IS curve requires estimation of a real interest rate variable we consider several candidates as proxies for $E_t\pi_{t+m}$. They are: the mean one year ahead inflation rate ($[\pi_{t+1} + \pi_{t+2} + \pi_{t+3} + \pi_{t+4}]/ 4$), the Greenbook forecasts, forecasts from the Survey of Professional forecasters (SPF), estimates from the Livingston survey, and the University of Michigan survey. The latter three series are available from the Federal Reserve Bank of Philadelphia (www.philadelphiafed.org/econ/forecast1).[21] Greenbook forecasts, widely believed to be superior to other forecasts (e.g., Romer and Romer 2000), are available only until 2005:3, at the time of writing. Accordingly, the available data are supplemented with inflation forecasts from The Economist and Consensus forecasts (www.consensuseconomics.com). These two series are more up to date, but the time span covered by them is shorter as the available sample begins only in the early 1990s. All forecasts are one-year-ahead forecasts (e.g., four quarter ahead forecasts).[22]

[20] A caveat is in order. Croushore (2007) investigates revisions to the personal consumption expenditures index (PCE). In what follows, we rely on CPI inflation due in part to data limitations, and focus on the impact of real time revisions of the output gap which are substantial, as we shall see. However, the various proxies for the real interest rate utilized in this paper can essentially be viewed as amounting to the adoption of different views about the likely future course of inflation.

[21] An additional complication, ignored in the analysis to follow, is that Greenbook forecasts are for the chain-weighted implicit price deflator while other proxies are based on CPI inflation.

[22] Many Fed officials favor the price index for personal consumption expenditures and not the CPI. We have estimated all of the equations using the chain-weighted PCE index (not shown) but our

The output gap can also be estimated in several ways. For the most part we rely on estimates based on data for real potential Gross Domestic Product generated by the Congressional Budget Office (www.cbo.gov/Spreadsheets.shtml), as well as estimates based on quadratic and cubic detrending (also see Siklos and Wohar 2006) in addition to generating H-P filtered output gap estimates (using a smoothing parameter of 1600). Figure 2 illustrates how estimates of the output gap can change rather substantially depending on the vintage of the data. Correlations between output gaps for vintages that are temporally close to each other are, of course, very high (e.g., August 1998 versus November 1999) but the simple correlation can be as low as 0.695 as is the case between the November 1999 and May 2004 vintages, for the sample shown in Figure 2. Turning points also differ between vintages with once again, the greatest differences between output gap vintages that are least correlated with each other. For example, it not unusual for differences between August 1998 (the earliest vintage considered) and May 2004 (the most recent vintage) estimates of the output gap to be around 0.5% of GDP and for the sign of the output gap for a particular quarter to change as more recent vintages are considered.

Since least squares cannot be used to estimate (13)-(15) we resort, as have others, to GMM. The choice of instruments is a crucial, but often neglected, aspect of GMM estimation (e.g., Jondeau, Le Bihan and Galles 2004). One complication is that the list of instruments could well have changed over time as the U.S. Fed either added or dropped economic indicators that were believed to be statistically relevant or economically meaningful for setting the policy instrument. Nevertheless, in what follows, we have chosen a fixed set of instruments. We employ indicators that are not only likely to be correlated either with inflation or the output gap, but are also believed to capture a wide range of other economic phenomena that the Fed may have been concerned about in recent years (e.g., developments in asset prices). Lastly, in estimating and evaluating the inflation pressure indicators, we must be mindful of the

conclusions are unchanged. Clark (1999) argues that improvements in the CPI make it a better index for monetary policy purposes.

sample period over which (13)-(15) are estimated. In particular, it is widely believed that a structural break, or regime shift, may have taken place around the time of Paul Volcker's tenure as Fed Chairman. Therefore, estimates were generated for two samples, one that begins in 1970:1, and another one that begins in 1980:4. The former sample is generally preferred because it provides us with a sufficiently long sample to explore the evolution of monetary policy effectiveness. The possibility exists of a structural break arising from of the Monetary Control Act of 1980. Lanne (2006) is just one of several authors who reports evidence of a break in the term structure of US interest rates around 1980. Nevertheless, as we were able to generate comparable estimates for both subsamples (results not shown) we chose to rely on coefficients obtained from a longer sample in creating our indexes of inflation pressure. All the models are estimated using quarterly data.[23]

As previously noted, the choice of vintages was dictated by the desire to replicate the environment facing the U.S. Fed between 1970 and 2004. Figures 3A and 3B show that the fed funds rate rose steadily between 1999 and 2000, before the tech bubble linitiated a period of expansionary monetary policy. The Fed consistently reduced the fed funds rate beginning in 2001, at first sharply in the midst of a brief recession (identified subsequently by the NBER reference cycle), again in the aftermath of the terrorist attacks of 9/11, and then more slowly until 2003. The reference rate was then left unchanged for about a year.

We employ six vintages of data in our analysis: August 1998, February 1999, May and November 2002, May 2003, and May 2004. Table A5.1 in the appendix provides a synopsis of the contents of the minutes released shortly after the FOMC meetings that took place in the months when the vintages chosen for analysis would also have been available to policymakers. We chose vintages that match the last available dataset that FOMC officials would have seen prior to a particular FOMC meeting.

It is generally assumed that the current setting of a policy instrument reflects the

[23]We did experiment with other possible breakpoints around the early 1980s but model estimates appeared much less sensitive to sample choice once we move away from a break in 1980.

central banks outlook over the next two years. Thus the August 1998 vintage, which contains information dated approximately two years prior to the interest rate peak of 2000, provides important insights into the economic conditions that caused the Fed to initiate a period of sustained interest rate increases. The February 1999 vintage reveals that, while FOMC members unanimously decided to leave the policy rate unchanged, there was an expectation that a policy adjustment might be necessary in the near future. The May and November 2002 vintages represent the information available to the Fed approximately two years prior to the start of steady rises in the fed funds rate. The May 2003 vintage reveals concerns about the possibility of deflation or, as the Fed minutes famously put it, "a significant further decline in inflation to an unwelcome level." The May 2004 vintage is the one available roughly two years before the Fed decided to pause making further changes in the fed funds rate. Consequently, the last available data points for the various vintages are as follows with vintage dates in parenthesis: 1998Q2 (August 1998), 1998Q4 (February 1999), 2002Q1 (May 2002), 2002Q3 (November 2002), 2003Q1(May 2003), 2004Q1 (May 2004).

5.2 Model Estimates for the U.S. Economy

The objective is to produce estimates of appropriate structural equations with coefficients that are plausible, when judged on a priori grounds, and are also congruent with the data. Recent research has shown that it takes somewhere between one and two years for monetary policy to have its peak impact on inflation. We therefore estimated the PC and IS equations under a variety of lead and lag restrictions that could potentially result in a cumulative control lag of 4-9 quarters. Turning to reaction function estimates while, ideally, these should satisfy the Taylor principle Orphanides (1998) has shown that reaction functions may fail, ex post, to always produce estimates consistent with good monetary practice. Moreover, since it is also unclear what the steady state real interest rate is we did not impose any restriction except that it should be expected to be positive.

Because the variables in theoretical models of the economy may have different empirical representations, we estimated numerous alternative versions of IS, PC and

Taylor rules based on a variety of proxies for the real interest rate and expected inflation. In choosing among the many variations of PC, IS, and Taylor Rule estimations, we we imposed the following restrictions or expectations on the signs and/or magnitudes of core coefficient estimates. They are:

$$\alpha_1 < 1, \alpha_2 < \alpha_1, \alpha_3 > 0, \beta_1 > 0, \beta_2 > 0, \beta_3 > 0, \gamma_\pi > 0, \gamma_y > 0.$$

where all the expected signs were explained above. The only additional restriction requiring some comment is the one that sets the coefficient on the backward-looking portion of the Phillips curve. The practice of restricting the coefficient on the backward-looking inflation component to be larger than the coefficient on the forward-looking component (i.e., $\alpha_2 < \alpha_1$) has become quite pervasive (e.g., see CGG 1999, and Woodford 2003b).

In producing the estimates to be used in computing EAIP and EPIP, we ended up relying inflation forecasts based either on the Greenbook forecasts or the Survey of Professional Forecasters.[24] In the case of the output gap all estimates are based on the CBOs estimates. We did not find that a cumulative control lag exceeding 3 quarters yielded significant improvements for any vintage in either the reliability of the estimates or the fit of the model to the data. As the aglebraic complexity of deriving model-consistent ex ante inflation pressure measures is increasing in the control lag, we chose to use (13) and (14) as our structural PC and IS equations for all vintages. It is interesting to note that while there were a large number of PC estimates that, based on the restrictions we imposed, were empirically plausible, the same cannot be said to be true for the IS curve.[25] Details of the final estimation results for (13)-(15) are reported in Appendix 4.

Table 1 shows that the estimated PC, IS, and TR equations fulfill all of the

[24]Greenbook inflation forecasts were used for the May 2002, November 2002, May 2003, and May 2004 vintages; data from the Survey of Professional Forecasters was used for the August 1998 and February 1999 vintages.

[25]Anywhere from 56 to 119 PC estimates satisfied the properties set out in the paper while between 3 and 28 IS equations fulfilled the restrictions given above.

restrictions given above.[26] It is evident that only the February 1999 vintage satisfies the Taylor principle.[27] As we have noted above, the February 1999 vintage is the only one that precedes a run-up in the fed funds rate. All other vintages represent policy decisions made prior to either a fall in the fed funds rate or a long pause.

5.3 Model-Consistent Inflation Pressure Formulae

In order to obtain model-consistent formulae for ex ante and ex post inflation pressure, we apply the procedures described in Appendix 1 to the empirical model (13)-(15). As before, we begin by substituting the IS equation into the PC equation to obtain

$$\begin{aligned}\pi_t &= \alpha_0 + \alpha_1\pi_{t-1} + \alpha_2 \mathrm{E}_t\pi_{t+2} + \epsilon_t \\ &\quad + \alpha_3\{\beta_0 + \beta_1 y_{t-3} + \beta_2 \mathrm{E}_{t-2} y_{t+2} - \beta_3[i_{t-3} - \mathrm{E}_{t-3}\pi_{t-2}] + \eta_{t-2}\}. \qquad (16)\end{aligned}$$

In the presence of a three quarter control lag between interest rate changes and inflation, computation of our counterfactual inflation pressure measures requires that we impute the impact of a change in the interest rate from i_{t-4} to i_{t-3} on the inflationary environment. To do this, we first identify all of the variables in (16) that directly or indirectly depend on i_{t-3}. Because rational agents will alter their expectations in response to changes in policy, the computation of EAIP requires us to derive the relationship between i_{t-3} and all of the expectational variables in (16). Owing to the complexity of the model, closed-form analytical solutions cannot be obtained. We therefore use Sims' (2001) Gensys algorithm and the available parameter estimates to estimate the rational expectations solution for our empirical model. Sims' algorithm produced unique rational expectations solutions of the following form for all six vintages:

$$x_t = c_0^x + c_1^x\pi_{t-1} + c_2^x y_{t-1} + c_3^x y_{t-2} + c_4^x i_{t-1} + c_5^x\epsilon_t + c_6^x\eta_t + c_7^x\sigma_t \qquad (17)$$

where x is replaced with π, y, or i, to obtain the RE solutions for each of these

[26] A more detailed report of the estimation results is provided in the Appendix.

[27] As is well known, Fed policy during the last decade have indeed been criticized as being too lax (e.g., Taylor 2010, and references therein that relate to the Taylor principle).

endogenous variables. The coefficients in (17) that were computed using Gensys are reported in the Appendix.

It is apparent by lagging the RE solutions for π, y, or i a sufficient number of times and substituting the resulting expressions into (17), the solution for each of the endogenous variables can be written as a function of i_{t-3}. It therefore follows that $\mathrm{E}_t\pi_{t+1}$ and $\mathrm{E}_{t-2}y_{t+2}$ can also be expressed as functions of i_{t-3}. In order to identify all of the channels by which i_{t-3} affects π_t we perform a series of backward iterations in which lagged inflation variables are replaced by appropriately lagged versions of (16). In particular, because we know, from (16), that π_{t-1} is a function of $\mathrm{E}_{t-1}\pi_{t+1}$ and $\mathrm{E}_{t-3}y_{t+1}$, and from (17) that both of these expectational terms are functions of i_{t-3}, we lag (13) one period and substitute the resulting expression into (16) to obtain

$$\begin{aligned}\pi_t &= \alpha_0 + \alpha_1[\alpha_0 + \alpha_1\pi_{t-2} + \alpha_2\mathrm{E}_{t-1}\pi_{t+1} + \alpha_3 y_{t-3} + \epsilon_{t-1}] + \alpha_2\mathrm{E}_t\pi_{t+2} + \epsilon_t \\ &\quad + \alpha_3\{\beta_0 + \beta_1 y_{t-3} + \beta_2\mathrm{E}_{t-2}y_{t+2} - \beta_3[i_{t-3} - \mathrm{E}_{t-3}\pi_{t-2}] + \eta_{t-2}\}. \qquad (18)\end{aligned}$$

We continue on in this manner, lagging (13) two and three periods in order to replace first π_{t-2} in (18) and then, subsequently, π_{t-3}. We also lag (14) three periods and use the resulting expression to replace y_{t-3} in (16). After making these substitutions, we obtain the following expression for π_t:

$$\begin{aligned}\pi_t &= Z_0 + \alpha_1^4\pi_{t-4} + Z_1 y_{t-4} + \alpha_1^3\alpha_3 y_{t-5} - \alpha_3(\alpha_1+\eta_1)\beta_3 i_{t-4} - \alpha_3\beta_3 i_{t-3} + \epsilon_t + \alpha_1\epsilon_{t-1} \\ &\quad + \alpha_1^2\epsilon_{t-2} + \alpha_1^3\epsilon_{t-3} + \alpha_3\eta_{t-2} + \alpha_3(\alpha_1+\beta_1)\eta_{t-3} + \alpha_2\mathrm{E}_t\pi_{t+2} + \alpha_1\alpha_2\mathrm{E}_{t-1}\pi_{t+1} \\ &\quad + \alpha_1^2\alpha_2\mathrm{E}_{t-2}\pi_t + \alpha_1^3\alpha_2\mathrm{E}_{t-3}\pi_{t-1} + \alpha_3\beta_3\mathrm{E}_{t-3}\pi_{t-2} + \alpha_3\beta_3(\alpha_1+\beta_1)\mathrm{E}_{t-4}\pi_{t-3} \\ &\quad + \alpha_3\beta_2\mathrm{E}_{t-2}y_{t+2} + \alpha_3\beta_2(\alpha_1+\beta_1)\mathrm{E}_{t-3}y_{t-1}. \qquad (19)\end{aligned}$$

Using (17) to solve for the expectational expressions in (19) and making the relevant substitutions, in we eventually obtain:

$$\begin{aligned}\pi_t &= \Omega_0 + \Omega_1\pi_{t-3} + \alpha_1^4\pi_{t-4} + \Omega_2 y_{t-3} + \Omega_3 y_{t-4} + \alpha_1^3\alpha_3 y_{t-5} - \alpha_3\beta_3 i_{t-3} + \Omega_4 i_{t-3} \\ &\quad - \alpha_3(\alpha_1+\beta_1)\beta_3 i_{t-4} + \epsilon_t + \alpha_1\epsilon_{t-1} + \Omega_5\epsilon_{t-2} + \alpha_1^3\epsilon_{t-3} + \Omega_6\eta_{t-2} \\ &\quad + \alpha_3(\alpha_1+\beta_1)\eta_{t-3} + \Omega_7\sigma_{t-2} \qquad (20)\end{aligned}$$

where the Ω coefficients are complex composites of the structural estimates (1)-(3) and the reduced-form coefficients in (17).[28]

In (20), the component $-\alpha_3\beta_3 i_{t-3}$ reflects the impact that period $t-3$ interest rate changes have on inflation in period t via the period $t-2$ output gap. The impact of period $t-3$ interest rate changes on period t inflation through induced changes in expectations is captured by Ω_4. Applying our definitions of ex ante and ex post inflation pressure to (20) results in the following operational model-consistent inflation pressure formulae:

$$\text{EAIP}_t = \Delta\pi_t + [\alpha_3\beta_3 - \Omega_4]\Delta i_{t-3} \tag{21}$$

$$\text{EPIP}_t = \Delta\pi_t + \alpha_3\beta_3\Delta i_{t-3}. \tag{22}$$

Substituting (21) and (22) into (7) and (8) yields, respectively, operational EPS and MPE formulae that are consistent with the economy characterized by (13)-(15). Vintage-specific estimates of the coefficients in (21) and (22) may be found in Table 1. Table 1 also provides a summary of the EPS and MPE values that we obtain for each vintage. Figures 4-6 provide diagrammatic evidence of the variation in EPS and MPE index values across vintages.

6. Evaluating Policy Effectiveness

6.1 Vintage-Specific EPS and MPE Indices

In (21) the first right-hand component $\alpha_3\beta_3$ reflects the direct impact of interest rate changes on EAIP while the second component Ω_4 captures the impact that changes in interest rates have on EAIP through their impact on expectations. The results reported in Table 2 indicate that the vintage-specific estimates of $\alpha_3\beta_3$ and Ω_4 vary across vintages. It is also apparent that the estimated Ω_4 values are many times larger (in some cases as much as 50 times larger), and also considerably more variable across vintages, than the $\alpha_3\beta_3$ estimates are. These observations lead us to conclude that monetary policy primarily affects inflation outcomes through its impact

[28]Note that (20) is the counterpart of equation (A.5), which is derived in section 1 of the Appendix.

on expectations. The variability in our vintage-specific estimates of Ω_4 provides a rationale for gradualist monetary policy. In particular, the Fed may choose to act gradually because it cannot be sure of the impact that its policies will have on expectations.

The EPS index measures the degree to which monetary policy successfully prevented ex ante inflation pressure from being realized. Table 2 shows the percentage of the estimated EPS index values that fall within prescribed ranges (defined in column 1) for each of the vintages considered. It is evident that the assessment of the Fed's success in controlling realized inflation as reflected in the values of the EPS index fluctuates across vintages. It is interesting to note that these fluctuations are more dramatic for EPS values outside the [0.1] interval. This indicates that the evaluation of circumstances in which the Federal Reserve is suspected to have either reinforced (EPS <0) or over-reacted to (EPS >1) the underlying inflationary pressure is particularly sensitive to the choice of data series. Figure 6, which shows the dispersion of EPS values associated with each vintage, provides further evidence of the sensitivity of monetary policy evaluations to data revisions.

The MPE index captures the impact of monetary policy on inflation expectations. Table 2 shows that the Fed is successful in moderating inflationary expectations a majority of the time, with the proportion of values that fall in the [0, 1] interval ranging from a low of 56% of the sample for the May 2003 vintage to a high of 63% in the May 2002 vintage. It is also apparent that the actual impact of Fed policies on inflation expectations varies considerably across vintages. If we consider, for example, the February 1999, May 2002, and May 2003 vintages, the fraction of ex ante inflation pressure removed by Fed actions is rather small as shown by the relatively small values for the monetary policy effectiveness index. Estimates based on the May 2004 vintage, by contrast, show the Fed to have been considerably more successful in that the differences between ex ante and ex post inflation pressure values are, in many cases, significantly greater for this vintage. It is interesting to note that the impact of monetary policy on expectations does not appear to be sensitive to

whether or not the economy was in a recession.

In Figure 4, positive MPE index values (i.e., those obtained when EPIP < EAIP) are plotted against time. Also shown are the NBER recession dates (these are the shaded areas). MPE values that fall in the [0,1] interval are unambiguously consistent with the notion that the Fed was successful in changing expectations while maintaining stable realized inflation. Figure 4 reveals that the Fed's apparent success in influencing inflation expectations is contingent on when the evaluation takes place. For example, in the space of a mere two years of data, namely from May 2002 to May 2004, an apparent failure to influence expectations is transformed, through data revisions, into a relatively successful policy initiative. Any judgement based on the May 2002 data series would clearly have been premature. It is notable that this is the period when the Fed reduced rates in response to fears of deflation (also see Figure 2).

6.2 An Alternative Counter-Factual Exercise

Orphanides (2001, 2003) argues that any assessment of the conduct of monetary policy must take into account the fact that the information available to central banks at the time policy is formulated is inherently noisy. In this section we present the results of an additional counterfactual exercise that provides support for this view. Up to this point, we have used vintage-specific indices of monetary policy effectiveness to determine the degree to which changes in data availability affect the assessment of monetary policy. We now alter the perspective somewhat by asking how our evaluation of the conduct of monetary policy would be affected if we had used the MPE index obtained from the fully revised, May 2004 data to evaluate policy outcomes for each vintage. This provides with an alternative view of the degree to which data revisions affect the assessment of policy outcomes. The results of this exercise are reported in Table 2 (in the row labeled "0 < MPE < 1" @ 2004) and in Figure 5.

It is evident from Table 2 that the perception of overall policy success does not appear to be greatly affected by the change in metric. A comparison of Figures 4 and 5, however, tells a somewhat different story. The results presented in these figures

show that the identification of the timing and magnitude of episodes when the Fed either faced very uncertain prospects or situations which, at least ex post, were deemed undesirable, is quite sensitive to the change in metric. It is especially instructive to notice that the February 1999 and May 2003 vintages now display several values of the index that are negative. These represent instances where the Fed's actions appear, based on the May 2004 metric, to have caused inflation expectations to move in the wrong direction, thereby exacerbating inflationary pressure. Clearly, it matters a great deal whether the evaluation criteria employed in retrospective analyses of monetary policy are constructed using real-time data or the final, fully revised data.

In the case of observed variables such and prices and output, it is reasonable to assume that data revisions lead to successive reductions in measurement error. With expectational variables, this may not be the case. It is quite conceivable that expectations may actually change in response to interim data on observed variables (and any other interim data that may become available). If this is the case, then changes in expectational variables across vintages may not be entirely due to the gradual elimination of measurement errors alone. Several important implications follow from this line of reasoning. The first implication, which agrees with Orphanides' position, is that the efforts made by a central bank to control inflation should be evaluated using real-time data using vintage-specific evaluation criteria. The assessment of the *outcomes* attributable to particular monetary policy initiatives, by contrast, are properly evaluated using final, fully revised data and evaluation metrics that are consistent with that data series. Finally, the fact that data revisions, and public announcements made on the basis of these revisions, may themselves lead to expectational changes across vintages of data, suggests that what the FOMC communicates before or after a policy rate announcement potentially matters a great deal more than is commonly thought.[29]

[29]It is interesting to note that the minutes of the February 1999 meeting suggest a lack of clarity in the direction of monetary policy with the FOMC believing that the fed funds rate was just as likely to increase or decrease in upcoming settings. The minutes of the May 2003 are notable, ex post, for raising the prospect of 'unwelcome' deflation that the Committee expected would prevail.

7. Conclusion

In this article we propose measures of ex ante and ex post inflation pressure which allow us to characterize the economic environment before and after the implementation of monetary policy. We use our inflation pressure measures to construct two indices of policy effectiveness. The Effective Price Stabilization index measures the degree to which monetary policy succeeded in preventing ex ante inflation period from being realized. The Monetary Policy Effectiveness index measures the degree to which a monetary policy initiative altered the inflationary environment. In the context of the analytical framework we employ, the impact of a monetary policy on the inflationary environment is measured in terms of its impact on inflationary expectations. We therefore obtain, from our MPE index, direct quantitative information about the impact of monetary policy on expectations.

We use six vintages of real time data spanning the period 1998-2004. Throughout this period the Federal Reserve altered its target federal funds rate methodically, sometimes quite slowly and, at other times, more aggressively. Our analysis of this period results in several interesting conclusions. We find that the assessment of both the inflationary environment and perceived success of monetary policy in preventing underlying inflation from being realized varies significantly across vintages of data. Thus our results support the view that data uncertainty is, at least in part, responsible for gradualism. We also find that monetary policy has its primary impact on the economy through the changes in expectations that it generates and that estimates of these expectational changes exhibit significant variation across data vintages. This observation suggests a second, complementary, rationale for gradualism. In particular, the Fed may have acted gradually because it could not be certain of the degree to which its policy initiatives would influence expectations of future inflation.

Overall, we find that while the Fed manages to influence expectations almost

Thus there appears to be an association between the state of mind of the FOMC and the variation in the information content of the February 1999 and May 2003 vintages that results from applying the 2004 MPE formula to these earlier series.

two thirds of the time the impact can be quantitatively small at times. One policy implication is that policy communication perhaps plays an even more crucial role for a gradualist central bank than one might think *a priori*.

Table 1 Summary of Coefficient Estimates Used to Generate Measures of MP Effectiveness

	PHILLIPS CURVE						IS CURVE						TAYLOR RULE					
VINTAGE	0898	0299	0502	1102	0503	0504	0898	0299	0502	1102	0503	0504	0898	0299	0502	1102	0503	0504
CONSTANT	1.16	1.09	.55	.52	.57	-.07	1.02	1.04	.66	.60	.68	.20	.41	2.48	.66	.68	.70	.08
π_{t-1}	.68	.68	.82	.80	.80	.80	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
$E_t\pi_{t+h}$	.21(2)	.25(2)	.25(2)	.28(2)	.27(2)	.29(2)	NA	NA	NA	NA	NA	NA	1.55(3)	.31(1)	.65(3)	.72(3)	4.05(3)	1.44(0)
y_{t-2}	.06	.10	.10	.10	.09	.09	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
y_{t-1}	NA	NA	NA	NA	NA	NA	.78	.78	.78	.78	.77	.76	NA	NA	NA	NA	NA	NA
$[i_{t-1} - E_{t-2}\pi_{t-1}]$	NA	NA	NA	NA	NA	NA	-0.07	-0.07	-0.06	-0.07	-0.06	-0.06	NA	NA	NA	NA	NA	NA
$E_t y_{t+k}$	NA	NA	NA	NA	NA	NA	.27(4)	.27(4)	.28(4)	.27(4)	.30(4)	.28(4)	.17(3)	1.43(2)	.44(3)	.56(3)	3.93(3)	.86(2)
ρ_{t-1}	NA	NA	NA	NA	NA	NA	-.07	-.07	-.06	-.07	-.06	-.06	.89	.91	.90	.91	.96	.93
FORECAST TYPE	SPF	SPF	G	G	G	G	G	G	G	G	G	G	NA	NA	NA	NA	NA	NA
GAP DEF'N	CBO	CBO	CBO	CBO	CBO	CBO	CBO	CBO	CBO	CBO	CBO	CBO	CBO	CBO	CBO	CBO	CBO	CBO

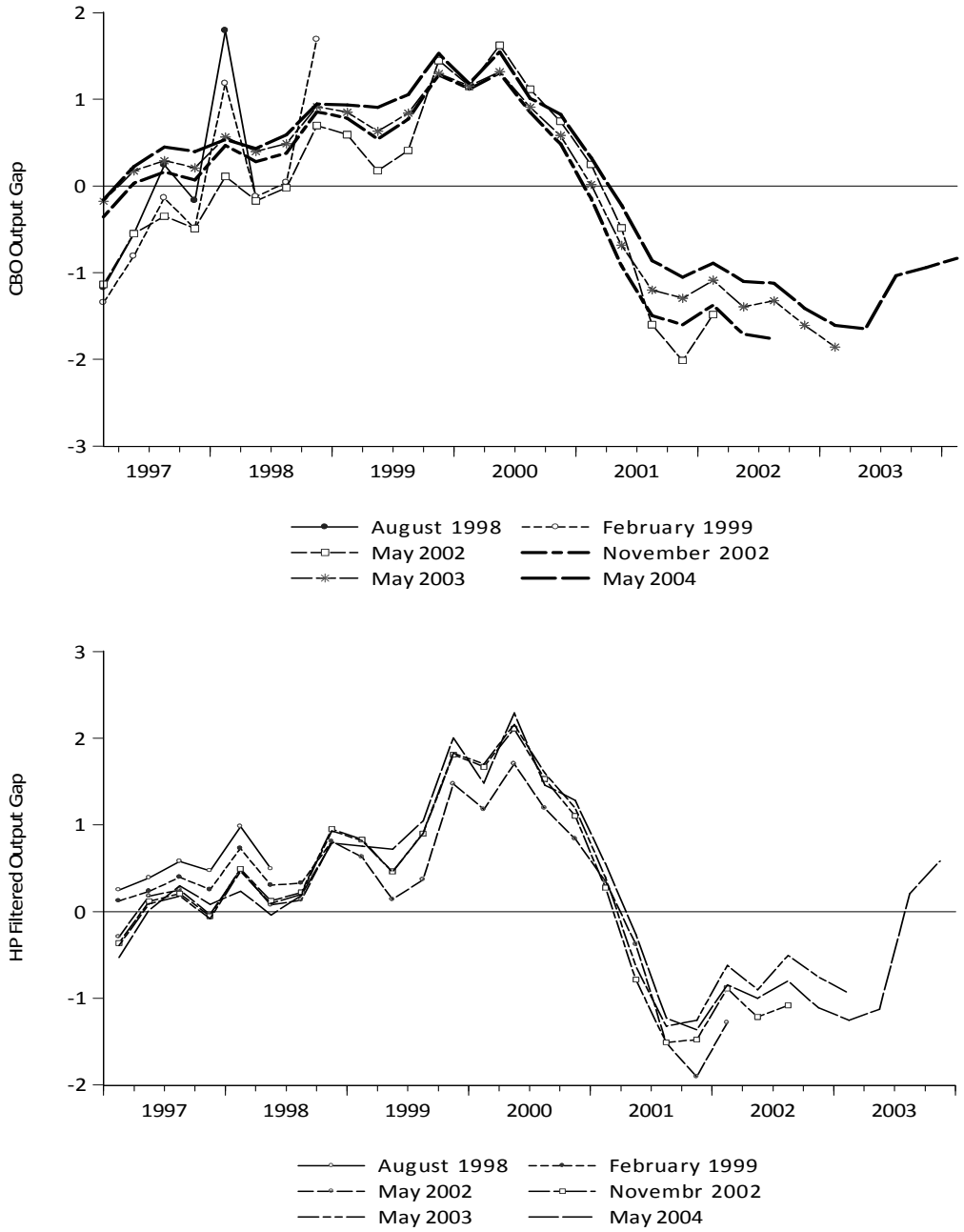
Note: The VINTAGE is the month/year. The first column indicates the number of leads/lags where appropriate. Leads/lags are shown in parenthesis and were selected because they had theoretically plausible signs and magnitudes. The appendix lists the total number of estimated equations with theoretically plausible sets of coefficient values and provides additional estimation details including standard errors. FORECAST indicates the type of inflation forecast used in each specification where G = Greenbook forecast, SPF = Survey of Professional Forecasters. GAP DEF'N indicates the type of output gap measure used where CBO = Congressional Budget Office. For the Taylor rule the estimates shown are the steady state parameter estimates for the variables in question and the constant is the estimated steady state real interest rate (i.e., $\gamma_0 / (1-\rho)$).NA means not applicable.

TABLE 2
Monetary Policy Effectiveness and Effective Price Stabilization
in the United States: 1970-2007

EAIP Coefficients	Vintages					
	Aug 1998	Feb 1999	May 2002	Nov 2002	May 2003	May 2004
$\alpha_3\beta_3$	0.0042	0.0042	0.0060	0.0070	0.0054	0.0054
Ω_4	−0.1900	−0.0234	−0.0286	−0.2803	−0.0276	−0.2514
EPS & MPE Thresholds	% of Sample					
0 <MPE< 1	58.33	58.93	62.40	62.20	55.80	60.90
0 <EPS< 1	58.33	58.04	61.60	61.40	55.00	60.20
0 <MPE< 1 @May 2004	60.19	59.82	61.60	61.42	58.65	Unchanged
MPE< 0	33.33	41.07	37.60	33.86	44.20	30.80
EPS< 0	32.41	41.07	37.60	28.35	44.19	28.57
MPE> 1	8.34	0.00	0.00	3.94	0.00	8.3
EPS> 1	9.26	0.90	0.80	10.24	0.80	11.28
Observations	108	112	125	127	129	133

Note: $\alpha_3\beta_3$ reflects the direct impact of monetary policy on inflation through the interest rate channel; Ω_4 captures the impact of monetary policy on inflation through expectational changes initiated by the policy implemented. Under the‘ % of sample’ heading, the columns show, for each vintage, the fraction, in percent, of the sample over which the Fed partially succeeded in preventing ex ante inflation pressure from being realized as observed inflation (i.e., $0 < EPS < 1$), the fraction over which the Fed's policy caused observed changes in inflation to exceed ex ante inflation pressure (i.e., EPS< 0), and the fraction of the sample over which monetary policy caused observed inflation to move in the opposite direction to ex ante inflation pressure (i.e., EPS> 1). Also shown are the fractions of the sample over which the Fed succeeded in partially reducing inflation pressure ((i.e., $0 < MPE < 1$), the fraction over which inflation pressure was magnified by policy actions (i.e., MPE< 0), and the fraction of the sample over which monetary policy caused EPIP and EAIP to move in opposite directions (i.e., MPE>1).

Figure 2 Output Gaps By Vintage of Data



Source: See text for data source. H-P filer applied to the logarithm of real GDP with a smoothing parameter of 1600. Data for output gap are in %.

Figure 3A Target Federal Funds Rate: 1970-2007

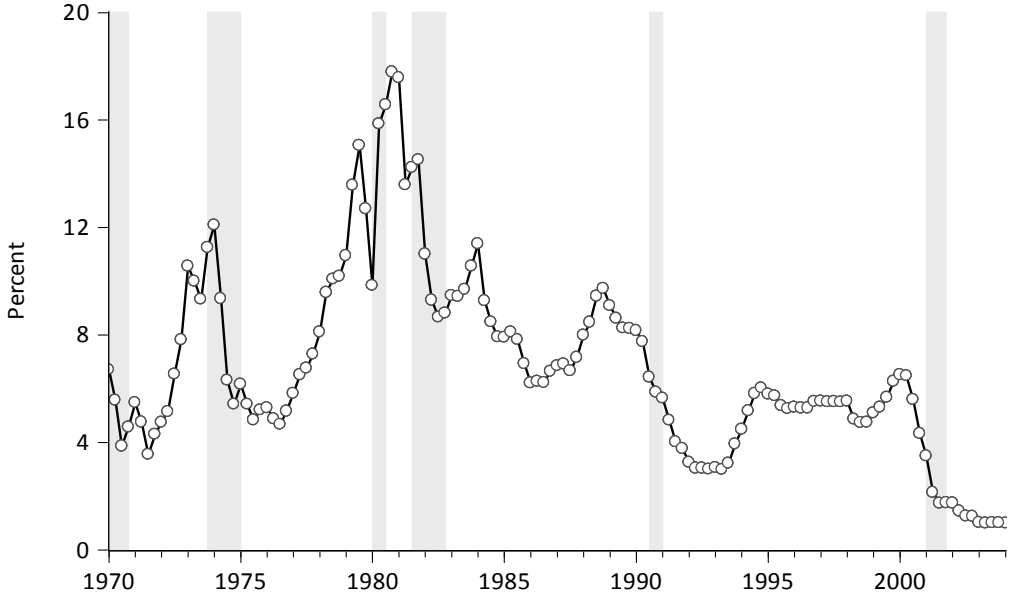
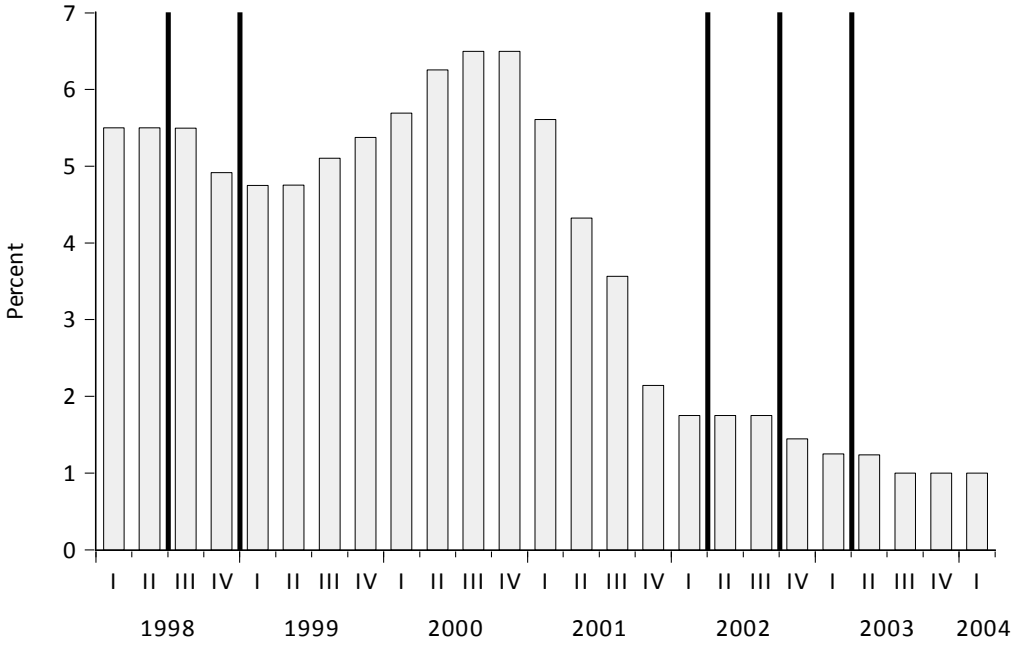
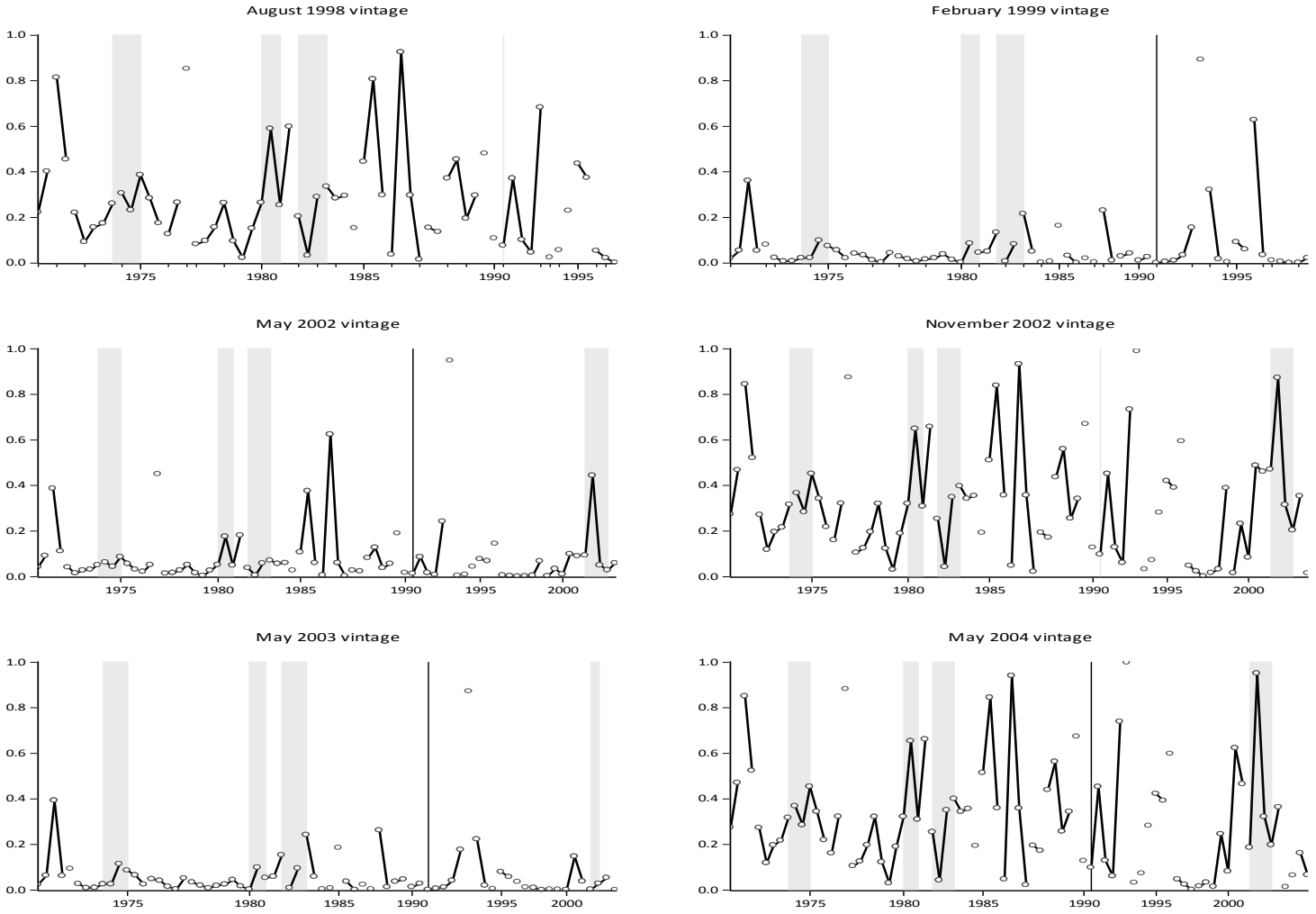


Figure 3B Target Federal Funds Rate: 1998-2004



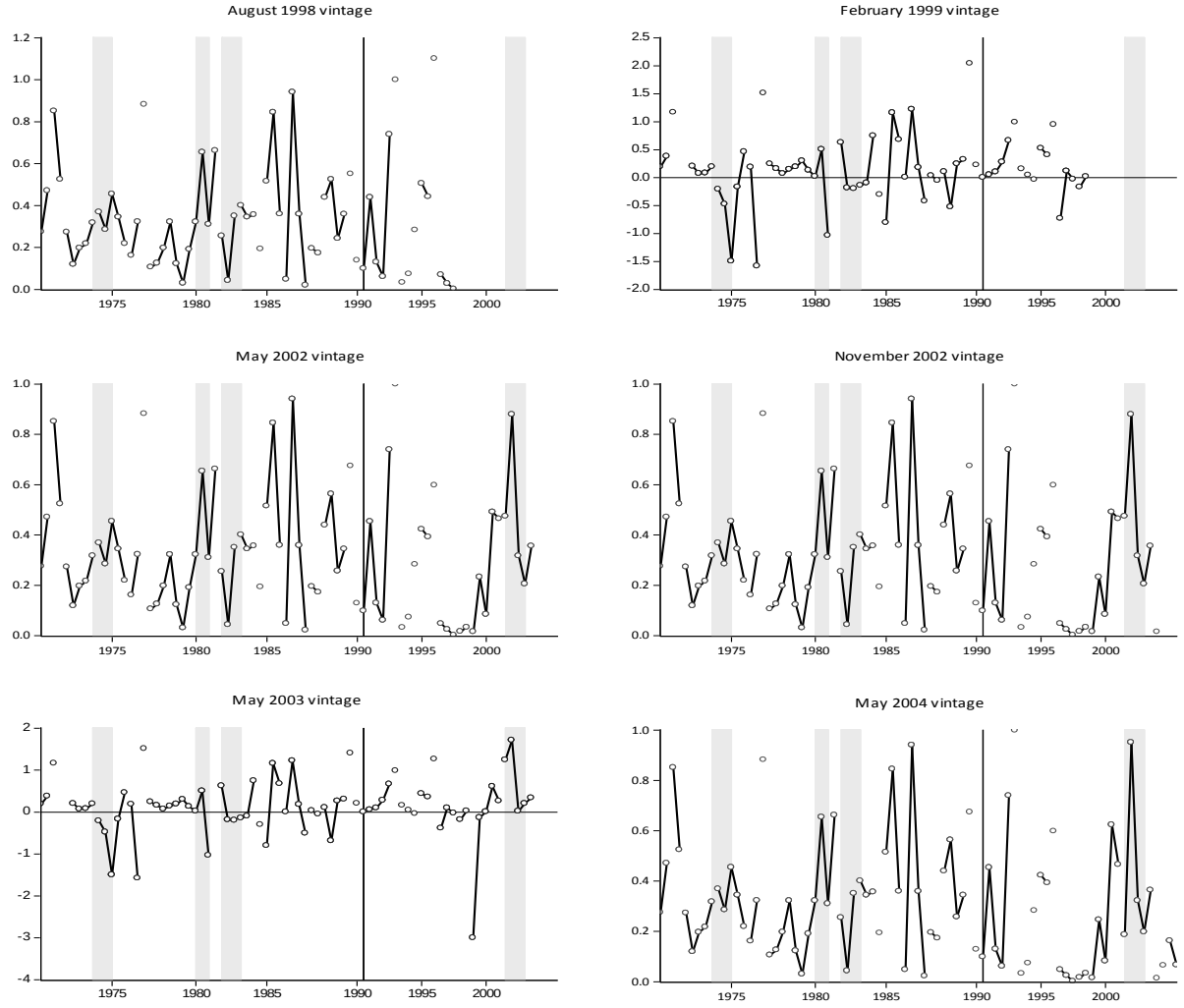
Source: Series DFEDTAR, from FRED II, daily (http://research.stlouisfed.org/fred2/series/DFEDTAR/downloaddata?cid=118). The vertical lines date the vintages employed in the analysis of inflation pressure.

Figure 4 Monetary Policy Effectiveness By Vintage:
Successful Occurrences of Changes in Inflation Expectations



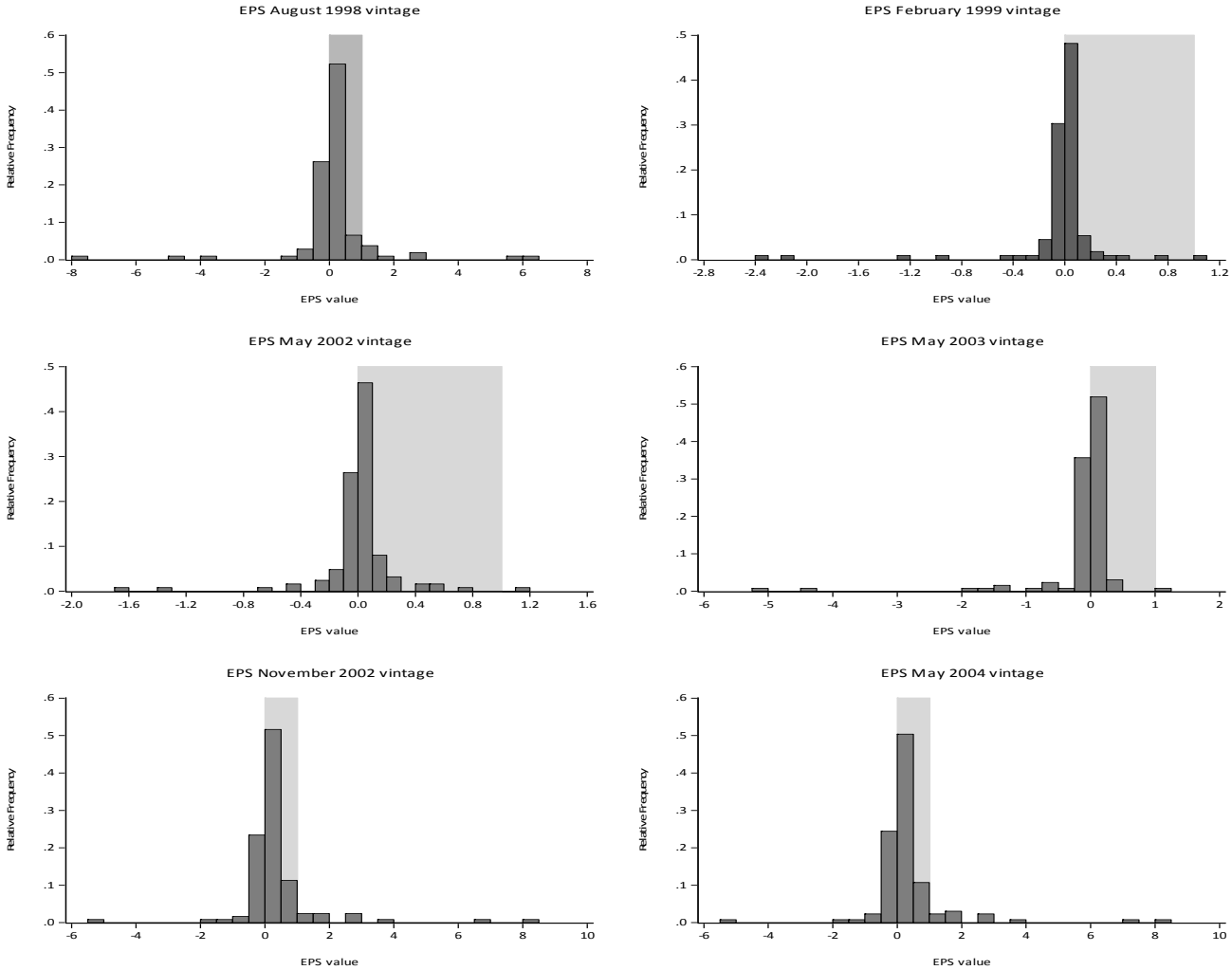
Note: For each vintage the index of Monetary Policy Effectiveness (MPE) is measured on the vertical axis. Only instances where the MPE indicates that 'ex post' inflation pressure is lower than 'ex ante' inflation pressure (i.e., $0 < EPS < 1$), that is, monetary policy succeeded in influencing inflation expectations in the correct direction, are plotted. See also Table 3. The shaded areas are the NBER recession dates.

Figure 5 Revisiting Past Monetary Policy Decisions:
Monetary Policy Effectiveness Based on the May 2004 Vintage



Note: see the note to Figure 3. The plot for the May 2004 vintage is the same as in Figure 3. Plots for the other vintages are based on the May 2004 vintage when the condition $0 < EPS < 1$ is satisfied.

Figure 6 How Successful was the Fed in Reducing Ex Ante Inflation Pressure: The Distribution of Effective Price Stabilization (EPS)



Note: the vertical axis shows the fraction of the sample with values of the EPS shown on the horizontal axis. The shaded area highlights the mass of the distribution with values for EPS>0 but <1, that is, when the Fed was partially successful in reducing inflation pressure. For the Aug 1998 vintage 1981Q1, November 2002, 1972Q3, 1999Q1, 2000Q4, for the May 2004 vintage, 1972Q and 1999Q1 values removed as these were outlier values.

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APPENDIX

A1. Deriving Operational Inflation Pressure Formulae

This appendix provides details of the derivation of operational inflation pressure formulae for the illustrative example given in Section 3 of the main text.

A1.1 Ex Ante Inflation Pressure

Ex ante inflation pressure (EAIP) provides a quantitative characterization of the inflationary environment that the policy authority faced prior to implementing a particular policy in a given period. An implication of the Lucas critique is that changes in policy will, when agents form expectations rationally, also bring about changes in private agents' expectations. According to our definition, measuring EAIP entails a counterfactual policy experiment in which we must not only ascertain what impact an observed change in the interest rate had on the inflationary environment, but also the extent to which the inflationary environment was affected by any expectational changes brought about by the observed interest rate change.

In terms of our illustrative example, we need to determine what impact the observed policy change Δi_{t-2} had on each of the expectational terms in (4). In order to accomplish this task, we need to make some assumption about the private sector's expectation formation process. We assume that agents form expectations rationally and that their information sets contain contemporaneous and lagged observations of the variables π_t, y_t, and i_t, but only lagged information about the disturbance terms ϵ_t, η_t, and σ_t.

The first step in deriving a model-consistent EAIP formula is to recognize that the illustrative model specifies a two period control lag between the interest rate and inflation. In order to conduct our counterfactual policy experiment, we therefore need to determine which of the variables that appear on the right-hand-side of (4) are functions of i_{t-2}. It is apparent from the structural equations that π_{t-1} depends on $\mathrm{E}_{t-1}\pi_t$, and $\mathrm{E}_{t-1}\pi_t$ depends on y_{t-1}, which, in turn, depends on i_{t-2}. Lagging (1)

one period and substituting the resulting expression into (4) results in

$$\begin{aligned}\pi_t &= A_0 + \alpha_1^2\pi_{t-2} + A_1 y_{t-2} - \alpha_3\beta_3 i_{t-2} + \alpha_2 \mathrm{E}_t\pi_{t+1} + \alpha_1\alpha_2 \mathrm{E}_{t-1}\pi_t \\ &\quad + \alpha_3\beta_3 \mathrm{E}_{t-2}\pi_{t-1} + \beta_2 \mathrm{E}_{t-1} y_t + \epsilon_t + \alpha_1\eta_{t-1} + \alpha_3\eta_{t-1} \qquad \text{(A.1)}\end{aligned}$$

where $A_0 = \alpha_0(1+\alpha_1) + \alpha_3\beta_0$ and $A_1 = \alpha_3(\alpha_1 + \beta_1)$.
Having expressed the observable variables in terms of i_{t-2} or earlier, we turn our attention to the expectational terms in (A.1). The assumption agents are fully rational implies that agents will adjust their expectations about the future path of the economy in response to changes in policy variables. This means that in order to obtain a measure for π_t^{xa}, we need to determine what impact the observed policy change, Δi_{t-2}, had on each of the expectational terms in (A.1). This, in turn, requires us to make some assumption about the private sector's expectation formation process so that we may solve for the expectational terms as functions of i_{t-2}.

We assume that agents form expectations rationally and that their information sets contain contemporaneous and lagged observations of the variables π_t, y_t, and i_t, but only lagged information about the disturbance terms ϵ_t, η_t, and σ_t.[30]. For appropriate coefficient values, the model described in (1)-(3) will have a unique rational expectations solution of the form

$$\pi_t = g_0 + g_1\pi_{t-1} + g_2 y_{t-1} + g_3 i_{t-1} + g_4\epsilon_t + g_5\eta_t + g_6\sigma_t \qquad \text{(A.2)}$$

$$y_t = h_0 + h_1\pi_{t-1} + h_2 y_{t-1} + h_3 i_{t-1} + h_4\epsilon_t + h_5\eta_t + h_6\sigma_t \qquad \text{(A.3)}$$

$$i_t = k_0 + k_1\pi_{t-1} + k_2 y_{t-1} + k_3 i_{t-1} + k_4\epsilon_t + k_5\eta_t + k_6\sigma_t \qquad \text{(A.4)}$$

In order to express the expectational variables $\mathrm{E}_t\pi_{t+1}$, $\mathrm{E}_{t-1}\pi_t$, $\mathrm{E}_{t-2}\pi_{t-1}$, and $\mathrm{E}_{t-1}y_t$ in terms of i_{t-2}, (A.2)-(A.4) are used to make successive backward substitutions until

[30]It turns out that even this simple illustrative model is sufficiently complex to preclude a closed form analytical rational expectations solution. Using numerical methods to solve the model would require estimation of (1)-(3) and as a numerical solution is not necessary for the purpose of this illustration, we postpone the application of numerical methods and the accompanying estimation until Section 5, where we estimate our indices for the United States using a quarterly empirical model

all expectational variables are written in terms of variables dated $t-2$ or earlier.[31] An example of the reverse substitution procedure as well as the resulting expressions for the expectational variables obtained by this method are provided in Section A3. With expectations expressed in terms of exogenous and predetermined variables, and all right-hand-side variables dated $t-2$ or earlier, (A.1) may be written as

$$\begin{aligned}\pi_t &= \Gamma_0 + \Gamma_1\pi_{t-2} + \Gamma_2 y_{t-2} - \alpha_3\beta_3 i_{t-2} + \Gamma_3 i_{t-2} + \epsilon_t \\ &\quad + (\alpha_1 + \alpha_2 Q_4)\epsilon_{t-1} + (\alpha_3 + \alpha_2 Q_5)\eta_{t-1} + \alpha_2 Q_6\sigma_{t-1} \qquad \text{(A.5)}\end{aligned}$$

where the Γ and Q coefficients are complex composites of the structural coefficients in, (1)-(3), and the coefficients in the rational expectations solutions, (A.2)-(A.4). In (A.5), the term $-\alpha_3\beta_3 i_{t-2}$ reflects the direct impact of the interest rate on inflation (via the output gap), while the term $\Gamma_3 i_{t-2}$ captures the effect that the interest rate has on inflation through its impact on expectations.

The unobservable variable π_t^{xa} can now be obtained by setting $i_{t-2} = i_{t-3}$ in (A.5):

$$\begin{aligned}\pi_t^{xa} &= \Gamma_0 + \Gamma_1\pi_{t-2} + \Gamma_2 y_{t-2} - \alpha_3\beta_3 i_{t-3} + \Gamma_3 i_{t-3} + \epsilon_t \\ &\quad + (\alpha_1 + \alpha_2 Q_4)\epsilon_{t-1} + (\alpha_3 + \alpha_2 Q_5)\eta_{t-1} + \alpha_2 Q_6\sigma_{t-1}. \qquad \text{(A.6)}\end{aligned}$$

Using (A.5) and (A.6), we obtain the following operational measure of ex ante inflation pressure

$$\text{EAIP}_{t-2} = \Delta\pi_t + \alpha_3\beta_2\Delta i_{t-2} - \Gamma_3\Delta i_{t-2}. \qquad \text{(A.7)}$$

Note that in (A.7) the first interest rate component on the right-hand-side captures the impact that interest rate changes have on inflation through the output gap term while the second interest rate component reflects the impact that the policy change had on expectations.

[31] Note that the length of the control lag between the interest rate and inflation determines how far back in time one needs to go, and therefore how many reverse iterations are needed at this stage.

A1.2 Ex Post Inflation Pressure

Ex post inflation pressure is the inflation pressure that remains after the monetary policy response has taken effect. In Figure 1, ex post inflation pressure in period t is given as the vertical distance between the two feasibility constraints, IR_0 and IR_1, at i_{t-3}. Using the notation in Figure 1, ex post inflation pressure is given by $\pi_t^{xp} - \pi_{t-1}$. In order to obtain this measure, we need to express Δi_{t-2} in inflation-equivalent units. We therefore need to know how many period t inflation units and interest rate unit in period $t-2$ represents.

In the context of our illustrative model, ex post inflation pressure is the change in inflation that would have been generated by ϵ_t, η_{t-1}, π_{t-1}, y_{t-2}, and i_{t-3}, given the expectations that were formulated under the policy actually implemented (i.e., under i_{t-2}). Replacing i_{t-2} with i_{t-3} in (A.1) yields

$$\begin{aligned} \pi_t^{xp} &= A_0 + \alpha_1^2\pi_{t-2} + A_1 y_{t-2} - \alpha_3\beta_3 i_{t-3} + \alpha_2 \mathrm{E}_t\pi_{t+1} + \alpha_1\alpha_2 \mathrm{E}_{t-1}\pi_t \\ &\quad + \alpha_3\beta_3 \mathrm{E}_{t-2}\pi_{t-1} + \beta_2 \mathrm{E}_{t-1} y_t + \epsilon_t + \alpha_1\eta_{t-1} + \alpha_3\eta_{t-1} \end{aligned} \tag{A.8}$$

It follows directly from (A.1) and (A.8) that $\pi_t^{xp} = \pi_t + \alpha_3\beta_3\Delta i_{t-2}$.[32] Substituting this expression into (6) yields the operational, model-consistent ex post inflation pressure formula

$$\mathrm{EPIP}_{t-2} = \Delta\pi_t + \alpha_3\beta_3\Delta i_{t-2}. \tag{A.9}$$

Comparing (A.7) and (A.9), it is immediately apparent that

$$\mathrm{EAIP}_{t-2} = \mathrm{EPIP}_{t-2} - \Gamma_3\Delta i_{t-2}. \tag{A.10}$$

Note that when the expectational changes induced by policy initiatives are consistent with the objectives of stabilization policy, Γ_3 would be expected to be negative, resulting in $\mathrm{EAIP}_t > \mathrm{EPIP}_t$.

Owing to the two period policy control lag in the example that we employ here, EAIP_t and EPIP_t may both be subject to disturbances that cannot be anticipated at

[32] Note that (A.1) and (A.5) are equivalent expressions, so that π_t^{xp} could have been obtained from (A.5) by setting $\alpha_3\beta_3 i_{t-2} = \alpha_3\beta_3 i_{t-3}$ while leaving $\Gamma_3 i_{t-2}$ unchanged.

the time policy is formulated. Equation (A.10) shows that unanticipated disturbances will affect both inflation pressure measures equally. Consequently, any observed difference between EAIP_t and EPIP_t can properly be interpreted as reflecting the impact of the policy initiative on the inflationary environment.

A2. Shocks, Inflation Pressure, and Policy Effectiveness

This section provides analytical details of the manner in which our measures of inflation pressure and policy effectiveness capture the impact of shocks on the economic environment and the degree to which policy initiatives were successful in moderating the impact of those shocks on the economy. In what follows, we consider, individually, a supply shock as well as a demand shock.

A2.1 Supply Disturbances

We consider a situation in which there is a positive price shock in period $t-2$ so that $\epsilon_{t-2} > 0$. In the context of the illustrative model we use in Section 3, where there is a two-period control lag between the policy instrument and the inflation rate, there is nothing that the policy authority can do to moderate the impact of this shock on inflation in periods $t-2$ or $t-1$. Policy undertaken in period $t-2$ can, however, affect the impact of the period $t-2$ shock on inflation in period t.

For an economy with the structure described in by (1)-(3), ϵ_{t-2} affects π_t through its impact on π_{t-2}, π_{t-1}, and y_{t-1}. According to (A.5), with all disturbances other than ϵ_{t-2} set to zero, the realized inflation rate in period t is given by

$$\pi_t = \Gamma_0 + \Gamma_1[\pi_{t-3} + \epsilon_{t-2}] + \Gamma_2 y_{t-2} - \alpha_3\beta_3 i_{t-2} + \Gamma_3 i_{t-2}. \tag{A.11}$$

From (9), the impact of the shock on the economic environment prior to the implementation of interest rate policy in period $t-2$ can be expressed as

$$\pi_t^{xa} = \Gamma_0 + \Gamma_1[\pi_{t-3} + \epsilon_{t-2}] + \Gamma_2 y_{t-2} - \alpha_3\beta_3 i_{t-3} + \Gamma_3 i_{t-3}. \tag{A.12}$$

Because ϵ_{t-2} is, in this example, assumed to be the only disturbance, and y_{t-2} is independent of ϵ_{t-2}, $y_{t-2} = y_{t-3}$. After lagging (A.11) one period and setting $y_{t-2} =$

y_{t-3} in (A.12), we obtain

$$\text{EAIP}_t = \pi_t^{xa} - \pi_{t-1} = \Gamma_1 \epsilon_{t-2}. \tag{A.13}$$

Comparing (A.11) and (A.12) we see that $\pi_t^{xa} = \pi_t + [\alpha_3\beta_3 - \Gamma_3]\Delta i_{t-2}$. From this it follows that

$$\text{EAIP}_t = \pi_t^{xa} - \pi_{t-1} = \Gamma_1 \epsilon_{t-2} = \Delta\pi_t + [\alpha_3\beta_3 - \Gamma_3]\Delta i_{t-2}, \tag{A.14}$$

which establishes that the conceptual and operational EAIP measures are fully equivalent.

Ex post inflation pressure is intended to characterize the post-policy inflationary environment. When a policy initiative successfully moderates the impact of a disturbance (such at $\epsilon_{t-2} > 0$) on the economy, the observed inflation rate only partially reflects the underlying post-policy inflationary environment. This is because part of the underlying inflation pressure is absorbed by the change in the policy instrument. Notice that in Figure 1, π_t^{xp} reflects the combined magnitudes of π_t and Δi_{t-2}. Notice also that the expectations relevant for measuring π_t^{xp} are those held under i_{t-2}, and not those associated with the past policy i_{t-3}. The expression for π_t^{xp} that we obtain from (A.11) when ϵ_{t-2} is the only economic disturbance is then given by

$$\pi_t^{xp} = \Gamma_0 + \Gamma_1[\pi_{t-3} + \epsilon_{t-2}] + \Gamma_2 y_{t-2} - \alpha_3\beta_3 i_{t-3} + \Gamma_3 i_{t-2}. \tag{A.15}$$

After lagging (A.11) one period and setting $y_{t-2} = y_{t-3}$ in (A.15), we obtain

$$\text{EPIP}_t = \pi_t^{xp} - \pi_{t-1} = \Gamma_1 \epsilon_{t-2} + \Gamma_3 \Delta i_{t-2}. \tag{A.16}$$

As we have pointed out above, the term $\Gamma_3\Delta i_{t-2}$ reflects the impact of interest rate on inflation through the expectation formation channel. Equation (A.16) indicates that our concept of ex post inflation pressure characterizes changes in the inflationary environment in terms of changes in inflation expectations.

Comparing (A.11) and (A.12) we see that $\pi_t^{xp} = \pi_t + \alpha_3\beta_3\Delta i_{t-2}$, from which it follows directly that

$$\text{EPIP}_t = \pi_t^{xp} - \pi_{t-1} = \Gamma_1 \epsilon_{t-2} + \Gamma_3 \Delta i_{t-2} = \Delta\pi_t + \alpha_3\beta_3\Delta i_{t-2}. \tag{A.17}$$

The conceptual and operational EPIP measures are therefore fully equivalent.

The analysis of the impact of the supply disturbance ϵ_{t-2} on observed inflation and on our measures of inflation pressure provides us with an analytical basis for interpreting the measures of policy effectiveness that were introduced in Section 3 of the main text. Substituting (A.13) into (7) yields

$$\text{EPS}_{t-2} = 1 - \frac{[\Gamma_1\epsilon_{t-2} - \alpha_3\beta_3\Delta i_{t-2}]}{\Gamma_1\epsilon_{t-2}} = \frac{\alpha_3\beta_3\Delta i_{t-2}}{\Gamma_1\epsilon_{t-2}}. \tag{A.18}$$

The coefficient $\alpha_3\beta_3$ measures impact of a one unit change in the interest rate in period $t-2$ on inflation in period t. Consequently, EPS_{t-2} measures the proportion of period t ex ante inflation pressure that was relieved by the interest rate policy implemented in period $t-2$. Because disturbances like ϵ_{t-2} are generally not individually observable, even in retrospect, it would be very difficult to compute (A.18) directly. Fortunately, the equivalence between the conceptual and operational characterizations of ex ante inflation pressure that is demonstrated above, provides us with a means of obtaining an EPS index that can be computed from observed data. Using (A.14) and (A.18) we obtain the following operational EPS index:

$$\text{EPS}_{t-2} = 1 - \frac{\Delta\pi_t}{\Delta\pi_t + [\alpha_3\beta_3 - \Gamma_3]\Delta i_{t-2}}, \tag{A.19}$$

which appears in the main text as (11).

To show the impact of the supply disturbance ϵ_{t-2} on the index of monetary policy effectiveness, we substitute (A.13) and (A.16) into (8) to obtain

$$\text{MPE}_{t-2} = 1 - \frac{[\Gamma_1\epsilon_{t-2} + \Gamma_3\Delta i_{t-2}]}{\Gamma_1\epsilon_{t-2}} = \frac{-\Gamma_3\Delta i_{t-2}}{\Gamma_1\epsilon_{t-2}}. \tag{A.20}$$

The coefficient Γ_3 in (A.5) measures the impact that the expectational changes brought about by the change in the period $t-2$ interest rate have on inflation in period t. Thus (A.20) shows that the MPE index measures the degree to which the policy initiative undertaken in period $t-2$ was successful in moderating inflationary expectations. Using (A.14) and (A.18) we yields the following operational MPE index:

$$\text{MPE}_{t-2} = \frac{\Delta\pi_t + \alpha_3\beta_3\Delta i_{t-2}}{\Delta\pi_t + [\alpha_3\beta_3 - \Gamma_3]\Delta i_{t-2}}, \tag{A.21}$$

which appears in the main text as (12).

A2.2 Demand Disturbances

A demand disturbance in period $t-2$ (such as, for example, $\eta_{t-2} > 0$) is, in its impact on our inflation pressure and policy effectiveness measures, very similar to the supply disturbance discussed in the previous sub-section. In the context of our illustrative model, a positive demand disturbance in $t-2$ would bring about an increase in y_{t-2}, which would cause π_{t-1} and y_{t-1} to increase, and thus lead to an increase in π_t. Under the assumption that the demand disturbance in $t-2$ is the only disturbance to the economy, the realized inflation rate in period t is then given by

$$\pi_t = \Gamma_0 + \Gamma_1\pi_{t-2} + \Gamma_2[y_{t-3} + \eta_{t-2}] - \alpha_3\beta_3 i_{t-2} + \Gamma_3 i_{t-2}. \tag{A.22}$$

Using the same procedures as those employed above for the supply disturbance, it is straight forward to show that EAIP_t and EPIP_t can be expressed as

$$\text{EAIP}_t = \pi_t^{xa} - \pi_{t-1} = \Gamma_2\eta_{t-2} = \Delta\pi_t + [\alpha_3\beta_3 - \Gamma_3]\Delta i_{t-2} \tag{A.23}$$

$$\text{EPIP}_t = \pi_t^{xp} - \pi_{t-1} = \Gamma_2\eta_{t-2} + \Gamma_3\Delta i_{t-2} = \Delta\pi_t + \alpha_3\beta_3\Delta i_{t-2}. \tag{A.24}$$

The remaining analysis is analogous to that given above for the supply disturbance.

A3. Derivation of Equation (A.5)

When there is a two-period control lag between inflation and the policy authority's interest rate instrument, it is necessary to express (4) in terms of i_{t-2} in order to obtain our operational (and counterfactual) ex ante and ex post inflation pressure formulae. In the context of our illustrative model, we therefore need to express the expectational variables $\text{E}_t\pi_{t+1}$, $\text{E}_{t-1}\pi_t$, $\text{E}_{t-2}\pi_{t-1}$, and $\text{E}_{t-1}y_t$. In this appendix we show how (A.5) is derived from (A.1).

We begin by solving for each of the expectational terms in (A.1) as functions of variables dated $t-2$ or earlier. The number of iterations required to obtain the desired expression increases with the number of periods that lie between the expectational variable and the policy instrument. In this appendix, we use $\text{E}_t\pi_{t+1}$, which leads the policy instrument i_{t-2} by three periods, to demonstrate our methodology.

It follows from (A.2) and our assumptions about the information set available to private agents, that $\mathrm{E}_t\pi_{t+1}$ can be expressed as

$$\mathrm{E}_t\pi_{t+1} = g_0 + g_1\pi_t + g_2 y_t + g_3 i_t. \tag{A.25}$$

Substituting (A.2)-(A.4) into (A.25) results in

$$\mathrm{E}_t\pi_{t+1} = G_0 + G_1\pi_{t-1} + G_2 y_{t-1} + G_3 i_{t-1} \tag{A.26}$$

where $G_0 = g_0(1+g_1)+g_2h_0+g_3k_0$, $G_1 = g_1^2+g_2h_1+g_3k_1$, $G_2 = g_1g_2+g_2h_2+g_3k_2$, and $G_3 = g_1g_3+g_2h_3+g_3k_3$. Lagging (A.2)-(A.4) one period and making the appropriate substitutions into (A.26) yields

$$\mathrm{E}_t\pi_{t+1} = Q_0 + Q_1\pi_{t-2} + Q_2 y_{t-2} + Q_3 i_{t-2} + Q_4\epsilon_{t-1} + Q_5\eta_{t-1} + Q_6\sigma_{t-1} \tag{A.27}$$

where $Q_0 = G_0 + G_1g_0 + G_2h_0 + G_3k_0$ and $Q_j = G_1g_j + G_2h_j + G_3k_j$, for $j = 1, ..., 6$. The expressions for the remaining expectational terms can be obtained in a similar manner and are summarized below.

$$\mathrm{E}_{t-2}\pi_{t-1} = g_0 + g_1\pi_{t-2} + g_2 y_{t-2} + g_3 i_{t-2} \tag{A.28}$$

$$\mathrm{E}_{t-1}\pi_t = G_0 + G_1\pi_{t-2} + G_2 y_{t-2} + G_3 i_{t-2} \tag{A.29}$$

$$\mathrm{E}_{t-1}y_t = H_0 + H_1\pi_{t-2} + H_2 y_{t-2} + H_3 i_{t-2} \tag{A.30}$$

where $H_0 = h_0(1+h_2) + h_1g_0 + h_3k_0$, $H_j = h_1g_j + h_2h_j + h_3k_j$, for $j = 1, ..., 3$.

Equation (A.5) can then be obtained by substituting (A.27)-(A.30) into (A.1):

$$\begin{aligned} \pi_t \;=\; & \Gamma_0 + \Gamma_1\pi_{t-2} + \Gamma_2 y_{t-2} - \alpha_3\beta_3 i_{t-2} + \Gamma_3 i_{t-2} + \epsilon_t \\ & + (\alpha_1 + \alpha_2 Q_4)\epsilon_{t-1} + (\alpha_3 + \alpha_2 Q_5)\eta_{t-1} + \alpha_2 Q_6\sigma_{t-1} \end{aligned} \tag{A.5}$$

where $\Gamma_j = \phi_0 + \alpha_2 Q_j + \alpha_1\alpha_2 G_j + \alpha_3\beta_3 g_j + \alpha_3\beta_1 H_j$, for $j = 0, ..., 3$, with $\phi_0 = A_0$, $\phi_1 = \alpha_1^2$, $\phi_2 = A_1$, and $\phi_3 = 0$.

A4. GMM Estimates and Rational Expectations Solutions

A4.1 Estimates used in the Gensys Computations

Results of the GMM estimations for (13)-(15) are given below. Barlett kernels were employed in all estimations.

TABLE A4.1.1

Phillips Curve Estimates

Vintage	Sample	Coefficient Estimates				J-stat	Prob (J-stat)
		α_0	α_1	α_2	α_3		
Aug 1998	1982.1-1998.2	1.16^{**} (0.53)	$0.68^{\dagger}$ (0.04)	$0.21^{\dagger}$ (0.08)	0.06^{**} (0.02)	9.7003	0.4672
Feb 1999	1982.1 - 1998.4	1.09^{**} (0.52)	$0.68^{\dagger}$ (0.23)	$0.23^{\dagger}$ (0.07)	0.06^{**} (0.02)	9.2332	0.5101
May 2002	1974.1 - 2002.1	$0.55^{\dagger}$ (0.13)	$0.82^{\dagger}$ (0.03)	$0.25^{\dagger}$ (0.04)	$0.10^{\dagger}$ (0.02)	9.0947	0.5231
Nov 2002	1974.4 - 2002.3	$0.52^{\dagger}$ (0.13)	$0.80^{\dagger}$ (0.03)	$0.28^{\dagger}$ (0.04)	$0.10^{\dagger}$ (0.01)	8.5152	0.5786
May 2003	1974.1 - 2003.1	$0.57^{\dagger}$ (0.14)	$0.80^{\dagger}$ (0.03)	$0.27^{\dagger}$ (0.05)	$0.09^{\dagger}$ (0.02)	8.9670	0.5352
May 2004	1974.1 - 2004.1	-0.07 (0.13)	$0.80^{\dagger}$ (0.03)	$0.29^{\dagger}$ (0.04)	$0.09^{\dagger}$ (0.02)	9.2136	0.51196

Note: Shown above are the vintage-specific GMM coefficient estimates for (13). Newey-West standard errors are given below the coefficient estimates in parentheses. The significance level is indicated with a * for 10%, ** for 5% and † for 1%. Details of variable definitions and instrument lists are available in an appendix containing the raw estimation output.

TABLE A4.1.2
IS Curve Estimates

Vintage	Sample	Coefficient Estimates				J-stat	Prob (J-stat)
		β_0	β_1	β_2	β_3		
Aug 1998	1975.3-1997.2	1.12† (0.36)	0.78† (0.03)	0.27† (0.03)	0.07† (0.02)	8.4965	0.8098
Feb 1999	1975.3 - 1997.4	1.04† (0.36)	0.78† (0.03)	0.27† (0.03)	0.07† (0.02)	8.0587	0.8398
May 2002	1975.31 - 2002.1	0.66† (0.24)	078† (0.03)	0.28† (0.05)	0.06* (0.03)	11.0192	0.6092
Nov 2002	1975.3 - 2002.3	0.60** (0.27)	0.78† (0.03)	0.27† (0.05)	0.07** (0.03)	11.3205	0.5540
May 2003	1975.3 - 2003.1	0.68** (0.28)	0.77† (0.03)	0.30† (0.05)	0.06* (0.03)	10.5150	0.6514
May 2004	1975.3 - 2004.1	0.20** (0.09)	0.76† (0.03)	0.28† (0.05)	0.06** (0.03)	11.8489	0.5401

Note: Shown above are the vintage-specific GMM coefficient estimates for (14). Newey-West standard errors are given below the coefficient estimates in parentheses. The significance level is indicated with a * for 10%, ** for 5% and † for 1%. Details of variable definitions and instrument lists are available in an appendix containing the raw estimation output.

TABLE A4.1.3
Taylor Rule Estimates

Vintage	Sample	Coefficient Estimates						J-Stat	Prob (J-Stat)
		const	$E_t\pi_{t+m}$		$E_t y_{t+n}$		i_{t-1}		
		$\tilde{\gamma}_0$	m	$\tilde{\gamma}_\pi$	n	$\tilde{\gamma}_y$	ρ		
Aug 1998	1980.1-1997.2	0.4114 (6.32)	3	1.5487† (0.34)	3	0.1680 (0.36)	0.8897† (0.03)	8.876	0.884
Feb 1999	1980.1 - 1997.4	2.4757 (13.06)	1	0.3136 (0.42)	2	1.4288** (0.73)	0.9131† (0.03)	12.015	0.678
May 2002	1980.1 - 2002.1	0.6642 (3.53)	3	0.6498* (0.41)	3	0.4428 (0.56)	0.9018† (0.04)	10.428	0.579
Nov 2002	1980.1 - 2002.3	0.6752 (3.64)	3	0.7204† (0.29)	3	0.5636** (0.29)	0.9072† (0.03)	11.907	0.750
May 2003	1980.1 - 2003.1	0.6956 (13.23)	2	4.0522** (2.31)	2	3.9338* (3.16)	0.9586† (0.03)	13.720	0.547
May 2004	1980.1 - 2004.1	0.0807 (1.83)	0	1.4397† (0.32)	2	0.8592† (0.39)	0.9262† (0.02)	11.366	0.837

Note: Shown above are the vintage-specific GMM coefficient estimates for (15). Newey-West standard errors are given below the coefficient estimates in parentheses. The significance level is indicated with a * for 10%, ** for 5% and † for 1%. Note that $\tilde{\gamma}_0 = (1-\rho)\gamma_0$, $\tilde{\gamma}_\pi = (1-\rho)\gamma_\pi$, and $\tilde{\gamma}_y = (1-\rho)\gamma_y$. Details of variable definitions and instrument lists are available in an appendix containing the raw estimation output.

A4.2 Numerical Rational Expectations Solutions

The rational expectations solutions for the endogenous variables π_t, y_t, and i_t that were computed using Sims' Gensys program are reported in Table A4.2.4

TABLE A4.2.4

Numerical Rational Solutions

	Aug 1998	Feb 1999	May 2002	Nov 2002	May 2003	May 2004
	Coefficient Estimates for π_t					
const	1.9498	2.0366	1.5020	1.1993	1.8255	−0.5996
π_{t-1}	0.7461	0.7810	1.1964	1.3230	1.0956	1.1306
y_{t-1}	0.0360	0.0368	0.1678	0.2673	0.0956	0.1358
y_{t-2}	0.0659	0.0689	0.1458	0.1653	0.1232	0.1131
i_{t-1}	−0.0084	−0.0052	−0.0310	−0.0665	−0.0070	−0.0358
ϵ_t	1.0944	1.1462	1.4465	1.6263	1.3637	1.4032
η_t	0.0354	0.0305	0.1436	0.2367	0.0705	0.1185
σ_t	−0.0006	− 0.0003	− 0.0024	− 0.0050	− 0.0003	− 0.0023
	Coefficient Estimates for y_t					
const	−3.2783	−3.2723	−1.4281	−0.3979	−1.2531	−0.0455
π_{t-1}	0.0509	0.0530	−0.2109	−0.2597	−0.2002	−0.2925
y_{t-1}	0.8293	0.8293	0.6854	0.6658	0.6670	0.6966
y_{t-2}	0.0044	0.0047	−0.0258	−0.0302	−0.0225	−0.0292
i_{t-1}	−0.1103	−0.1102	0.0604	−0.0429	−0.0560	−0.0948
ϵ_t	−0.0067	−0.0072	−0.3377	−0.4021	−0.3247	−0.4468
η_t	1.0605	1.0606	0.9196	0.8635	0.9069	0.9579
σ_t	−0.0034	− 0.0034	− 0.0004	0.0022	− 0.0001	− 0.0028
	Coefficient Estimates for i_t					
const	9.7908	9.8841	6.6600	7.4924	36.7859	−1.2742
π_{t-1}	0.2014	02205	0.6498	0.8818	6.5555	1.3824
y_{t-1}	0.4705	0.4733	0.4744	0.6622	3.9703	0.6306
y_{t-2}	0.0177	0.0195	0.0792	0.1102	0.7375	0.1382
i_{t-1}	0.6634	0.6648	0.7656	0.6967	0.2255	0.6398
ϵ_t	0.2523	0.2783	0.7500	1.0248	7.8676	1.6650
η_t	0.5729	0.5734	0.4845	0.6687	3.9772	0.7430
σ_t	0.0670	0.0671	0.0866	0.0764	0.0477	0.0547

Note: Shown above are the reduced-form, rational expectation coefficient values obtained using Sims' (2001) computational program and the estimated coefficients for equations (13)-(15) given in Tables A4.1.1-A4.1.3. The coefficients characterize a unique rational expectations equilibrium.

A5. Excerpts from FOMC Minutes

Table 1 FOMC Minutes Excerpts

MEETING DATE	HIGHLIGHTS	VOTE	STANCE OF POLICY
August 18, 1998	"…a directive that called for maintaining conditions consistent with an unchanged federal funds rate of about 5 ½ percent." "…members remained persuaded that a significant rise in price inflation was not likely to occur in the nearer term." "…it was clear one the basis of any measure that consumer prices and inflation more generally had remained remarkably subdued in the context of very tight labor markets…" "The members generally anticipated somewhat more moderate growth than they had in their previous forecasts, with prospective expansion at a pace near or somewhat below the growth of economy's potential."	10-1	"…all but one of the members agreed on the desirability of maintaining a steady policy stance."
Feb. 2-3, 1999	"…the Committee believes that prospective developments are equally likely to warrant an increase or a decrease in the federal funds rate operating during the intermediate period." "…the persistence of subdued inflation and the absence of current evidence of accelerating inflation were seen as arguing against a policy tightening move at this point." "Indeed, the conjuncture over an extended period of strong economic growth, very low rates of unemployment, and the absence of any buildup of inflation could not be explained in terms of normal historical relationships." "…members referred to continuing indications of an exceptional economic performance that was characterized by the persistence of	11-0	"…all the members 20avourab an unchanged policy stance."

	quite low inflation despite very high and rapidly rising levels of overall output and employment. The members currently saw few signs that more sustainable rate, but most continued to anticipate substantial showing over the year ahead at a pace close to or somewhat above that of the economy's long-run potential."		
May 7, 2002	"All the members favoured the retention of a neutral balance of risks statement to be released shortly after this meeting." "…current inflation pressures were subdued and were expected to remain so for a considerable period, thereby providing adequate opportunity to evaluate ongoing developments and tighten policy as needed later." "The outlook for inflation remained favourable." "The current accommodative stance of policy continued to be viewed as appropriate." "…the stance of monetary policy would have to become less accommodative once clearer evidence emerged that a healthy expansion was firmly established." "Nonetheless, activity would remain below the economy's potential for a period ahead and the persistence of underutilized resources was expected to contribute to damped core consumer price inflation."	10-0	"…all the members agreed on the desirability of maintaining an unchanged policy stance,…"
Nov. 6, 2002	"Members commented that the potential costs of a policy easing action that later proved not to have been needed were quite limited in that there was little risk that such a move would foster inflationary pressures under likely economic conditions over the next several quarters."	12-0	"…the current stance of monetary policy was still quite accommodative and was providing important support to

	"A 50 basis point move would tend to have a more pronounced effect than usual in financial markets, at least initially, because it would be largely unexpected and would come after an extended hiatus in implementing policy changes." "…the Committee currently saw a likely need for further easing later." "…a failure to take action that was needed because of a faltering economic performance would increase the odds of a cumulatively weakening economy and possibly even attendant deflation. An effort to offset such a development, should it appear to be materializing, would permit difficult policy implementation problems." "The staff forecast prepared for this meeting suggested that, in light of further weaker-than-expected incoming economic data, the expansion of economic activity would be relatively muted for some time."		economic activity,…"
May 6, 2003	"…the probability of some disinflation from an already low level exceeded that of a pickup in inflation." "They [the members] recognized that the usual summary statement did not allow for the circumstances in which the Committee saw some probability, albeit minor, of a significant further decline in inflation to an unwelcome level." "Members commented that substantial additional disinflation would be unwelcome because of the likely negative effects on economic activity and the functioning of financial institutions and markets, and the increased difficulty of conducting an effective monetary policy, at least potentially in the event the economy was subjected to adverse shocks." "Members anticipated that inflation would remain at a low level for an	11-0	"…all members indicated that they could support a proposal to maintain an unchanged policy stance."

	extended period and indeed that the probability of further disinflation was higher than that that of a pickup in inflation, given the current high levels of excess capacity in labor and product markets, which seemed likely to diminish only gradually."		
May 4, 2004	"All of the members agreed that, with policy tightening likely to begin sooner than expected, the reference to patience was not longer warranted. The Committee focused instead on a formulation that would emphasize that policy tightening, once it began, probably could proceed at a pace that would be "measure"." "…the statement should again indicate that the upside and downside risk to sustainable growth for the next few quarters seemed to be roughly equal. Members saw both downside and upside risks to prospects for inflation." "Overall, Committee members were now more convinced that recent robust growth would be sustained and most likely at a pace that would be adequate to make appreciable headway in narrowing margins of unutilized resources." "Survey measures of near-term inflation expectations edged up somewhat in March and April, but measures of longer-term expectations decreased."	12-0	"…the Committee saw a continuation of its existing policy stance as providing a degree of support to the economic expansion that was still appropriate."

Source : http ://www.federalreserve.gov/fomc/minutes.