Why Did the Fed Act Gradually?
Tracking Inflation Pressure in Real Time+

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ABSTRACT

This paper estimates indicators of inflation pressure for the United States in real time for select vintages of data that span the period between 1998 and 2004. The Fed first reduced the fed funds rate to 1% and then, shortly thereafter, began gradually raising the policy instrument rate to over 5%. The object is to ascertain whether the inherent uncertainties stemming from data revisions may partially explain both the gradual loosening and tightening of monetary policy over time. We find that the Fed acted gradually because the arrival of new data led to frequent changes in the assessment of the state of economic performance and Fed actions, or inaction, influenced expectations reinforcing the desirability to act gradually.

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1. Introduction

Central banks signal the stance of monetary policy through discrete changes in a policy instrument, usually an interest rate. Frequently, such changes appear to take place gradually, and almost always in steps of 25 to 50 basis points (bp). Many authors have referred to this phenomenon as evidence that changes in monetary policy occur gradually. However, this interpretation is also driven by empirical estimates based on studies that rely on final revised data.

It is now becoming more commonly accepted that a policy evaluation exercise should attempt to replicate the environment decision makers faced at the time policy changes are made. This, of course, requires that investigators have at their disposal real time data, since subsequent data are well-known to be subject to considerable revision. This poses a particular problem for monetary policy. Thanks in large measure to the insights of Orphanides (1998), which stimulated much subsequent research (e.g., inter alia, see Croushore and Evans (2006) for a survey)[1], retrospective analyses of monetary policy decisions are more frequently expected to rely on real time data. Ideally, however, we also require a quantitative indicator of the stance of monetary policy both prior to and following an interest rate decision. Unfortunately, a consensus on the proper measurement of the stance of monetary policy has proved to be somewhat of an elusive goal. Indeed, the literature has generated several indicators of monetary policy. Many are based on a vector autoregressive (VAR) model (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

[1] Dean Croushore maintains an up to date list of the literature on real time data. See http://oncampus.richmond.edu/~dcrousho/data.htm.

actions and typically resort to final revised data. As Weymark and Shintani (2006) point out, any indicator of inflation pressure should possess several attributes. These include ease of interpretation and wide applicability to facilitate cross-country comparisons. Perhaps more importantly, a useful expression of the performance of monetary policy should be informative about the impact of interest rate decisions prior to and following any action taken regarding the policy instrument, as well as being conditioned on whether or not agents anticipated any change in the policy stance.

In the present paper we adapt the three indicators developed by Weymark and Shintani (2006) to examine the impact of systematic monetary policy decisions in the U.S. by employing real time data. As argued below their measures possess several desirable attributes. They represent summary indicators of inflation pressure, the degree to which any monetary policy decision changes inflation pressure, and as well as an overall indicator of the effectiveness of monetary policy. Of course, ours are not the only indicators of monetary policy performance. Nevertheless, we believe that the proposed metrics may be relatively more informative than most about the impact of central bank decisions both before and after action is taken.

The particular era in U.S. monetary history we are interested in covers roughly the period between 1998 and 2004. Between 1998 and 2002 the Fed regularly reduced the fed funds rate while, beginning in 2004, the same interest rate rose following every single FOMC meeting until June 2006 when the Fed left rates unchanged, until the 50 basis point drop in September 2007. Indeed, the 2004-2005 Fed actions produced a rotation of the yield curve that former Fed Chairman Alan Greenspan (2005) termed a ‘conundrum’ (also see Backus and Wright 2007). The period covered is also one consistent with the widespread view that the Fed under Greenspan successfully held inflation in check. Nevertheless, movements in the fed funds rate such as the ones just described are not especially unique. For example, between January 2001 and June 2003, the Fed also reduced its policy instrument. Almost 70% of the reductions were

50bp at a time. No doubt part of the explanation has to do with the events of September 11th , and its aftermath, but this cannot be the whole story. In contrast, the easing that took place between June 1989 and September 1992 consisted of 25bp cuts almost 90% of the time. It is also worth noting that recent episodes of tightening of monetary policy (e.g., in 1994-1995, 1999-2000, and 2004-2006) usually involved 25bp rises, with 50bp increases generally infrequent (Bernanke 2004, Siklos 2002 (Chapter 4)).

The title of the paper suggests that the Fed did act gradually. We argue that the central bank's interpretation, as viewed through our procedure, changes sufficiently as to prompt the Fed to take relatively small methodical steps to convey its position about the appropriate stance of monetary policy. More importantly, it is the resort to real time data that allows this result to emerge from the data. Second, since the 1980s, the lion's share of the effectiveness of monetary policy stems from the Fed's influence on agent's expectations, that is, its credibility. What remains unclear is the precise source of this credibility. For example, we are unable to determine the extent to which the so-called "Great Moderation' (Bernanke 2004) is due to Fed actions versus other factors.

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 three proposed indicators that measure the quality of monetary policy decisions. Section 4 outlines the economic model that must be specified in order to derive a measure of inflation pressure. Section 5 discusses the data and the empirical results, while section 6 concludes.

2. Gradualism in Monetary Policy

Although the debate about the advantages and drawbacks 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. Hence, even if one accepts the steady state requirement of the Taylor principle,[2] namely that a tightening of monetary policy requires a relatively larger interest rate response to a rise in inflationary expectations, this does not prevent the central bank from doing so in measured steps. Therefore, it is common in empirical reaction function estimates of the Taylor variety to add a lag, or lags, in the nominal interest rate as explanatory variables. Whether this formulation of a central bank reaction function is appropriate or simply a useful data fitting device (Sack 2000) – Taylor's (1993) original rule did not contain a lagged interest rate – has been the subject of considerable debate. 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.[3] English, Nelson, and Sack (2003) find that Rudebusch's (2002) findings are due to a co-existence of serial correlation and partial adjustment. Hence, it is not possible to unequivocally reject gradualism in the setting of the policy instrument.

Several explanations have been advanced to explain the interest rate smoothing phenomenon.[4] Central banks that change interest rates too frequently run the risk of overreacting unnecessarily in the face of constant shocks, thereby giving the impression that they are not competent in managing monetary policy. The consequence can be a threat to financial stability (Goodfriend 1991). Additionally, 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. Because it is unclear to what extent a perceived change in inflation expectations is believed to be transitory as opposed to being permanent, a series of small interest rate movements may in fact be more

[2] See Walsh (2003), Woodford (2003, p. 254) both of whom regard this long-run principle as a crucial one for the conduct of good monetary policy.
[3] Söderlind, Söderström and Vredin (2002) report that the finding of 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.
[4] Goodhart (2005). Sack and Wieland (2000), and Walsh (2003) review various aspects of this literature.

stabilizing than a one-time interest rate change (e.g., Levin, Wieland, and Williams 1998). Uncertainty about whether the central bank's model adequately describes the current state of the economy, combined with uncertainty about the transmission mechanism of monetary policy, might also lead the central bank to temper interest rate movements in the face of an inflation shock.[5]

Another oft-relied upon explanation for interest rate smoothing is that the central bank also evinces a concern for reducing interest rate volatility and is not solely focused on inflation and output gap stabilization alone. Consequently, the most effective way for a central bank to conduct monetary policy is to respond to infrequent large shocks while essentially downplaying the effects of smaller shocks (Woodford 1999).

More recently, the suggestion is that a gradualist policy can better anchor long-term interest rates. Although the idea originated with Goodfriend (1991), it has been formalized by Woodford (2000, 2003). However, this explanation must confront the recent puzzle over the behavior of long-term interest rates that has emerged as the 'conundrum' referred to in the introduction.

The explanation most germane to this paper stems from the observation that some key data series are frequently revised or are, in any event, observed with error. By following a gradualist approach, a central bank can adjust its views concerning the appropriate stance of monetary policy (Sack 1998). This strategy also permits less reliance on unobservable but critical variables in central bank decision-making such as the output gap (e.g., Orphanides and Williams 2002).

It is conceivable then that good monetary policy practice requires caution not for its own sake but because the most recently available data may foretell future economic conditions with

[5] Tetlow and von zur Muehlen (1999) show, however, that to prevent the worst case scenario of a spiraling inflation, or deflation, more aggressive central bank reactions are called for.

sufficient error or imprecision to tip the balance toward taking a go slow approach. In what follows, we focus on the role of the economic environment faced by the central bank at the time the decision to choose a particular stance in the conduct of monetary policy is made.

3. Measuring the Stance of Monetary Policy: Definitions

Monetary policy decisions are based on the set of information available to policymakers at the time decisions are taken. For the period considered in this study, agents know ahead of time when decisions are to be taken since the Fed, in this case, fixes the dates when the FOMC meets and announces the level of the federal funds rate.[6] This is also true nowadays for several central banks. The central bank policy setting committee must, among other elements of policy making, evaluate the implications of an unchanged policy rate conditional on current economic prospects. This gives rise to a natural definition of *inflation pressure*, namely as the inflation rate that would have been observed in a given period, such as over the policy horizon of the central bank (e.g., 4 to 8 quarters ahead), if the policy rate, namely the federal funds rate for the U.S., is left unchanged. As a consequence, inflation pressure arises because random shocks (not of the expectational kind) hit the economy. Any subsequent inflationary pressure cannot be influenced by central banks actions until some time in the future due to lags in the effect of monetary policy. If the nominal interest rate is denoted by i_t, then a constant interest rate over one quarter, for example, implies that $i_t = i_{t-1}$. Hence, ex ante inflation pressure (EAIP) is simply defined as

$$EAIP_t = \pi_t^{\Delta i_t = 0} - \pi_{t-1} \tag{1}$$

where $\pi_t^{\Delta i_t = 0}$ is the inflation rate under the assumption that $i_t = i_{t-1}$, while π_{t-1} represents last period's inflation rate. Depending on the precise formulation of the model of inflation, the output gap, and the interest rate, ex ante inflation pressure is the inflation rate that is observed if the Fed

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[6] The FOMC calendar, statements, and minutes (with a lag) are available at http://www.federalreserve.gov/monetarypolicy/home.htm#calendars.

held the nominal interest rate fixed at least 2 quarters or longer, if longer lags are incorporated into the model, and then returns to the average policy rule thereafter. It is also implicitly assumed that interest rate changes and inflation are negatively related, as this is one of the core notions that lies behind the Taylor principle. Moreover, since the central bank can change interest rates after the next meeting of the FOMC, equation (1) is, therefore, interpreted as an *ex ante* indicator of inflation pressure.[7]

If the monetary policy authorities decide to, say, raise interest rates then a proportion of the inflation pressure will be removed as agents who are forward-looking (viz., agents possess rational expectations) will anticipate a lower future inflation rate. Crucially, however, the impact of any change in the stance of monetary policy will depend on the combination of the size of the interest rate change relative to the size of the change in inflationary expectations. The resulting Policy Induced change in Inflation Pressure (PIIP) is therefore defined as

$$PIIP_t = \frac{\pi_t^{\Delta i_t = 0} - \pi_t}{EAIP_t} = 1 - \frac{\Delta \pi_t}{EAIP_t} \qquad (2)$$

The numerator in (2) is simply the change in inflation induced by monetary policy during a particular period. Evaluated in terms of the level of inflation pressure at time t, $PIIP_t$ takes the form of an indicator such that, when $PIIP_t = 1$, this is equivalent to holding inflation constant. When $PIIP_t = 0$, that is, $\Delta\pi_t = \mathrm{EAIP}_t$, the policy decision did not change inflation pressure relative to its ex ante value. It is also conceivable that the policy impact on inflation can be either larger or smaller than ex ante IP, resulting in values for $PIIP_t$ that can either be 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 $PIIP_t < 0$. An

[7] The complexity of the solution of the specified model (see the following section) under the assumption of rational expectations is such that a closed-form solution cannot be obtained for one period deviations from the assumed policy rule. Hence, the solution is approximated by assuming that expectations are formed based on the observed instrument rule.

especially aggressive change in the stance of monetary policy could produce a sufficiently large reduction in inflation resulting in a $PIIP_t$ that exceeds one. Alternatively, one can think of monetary policy as displaying a form of overshooting as positive or negative $EAIP_t$ is offset by a change in inflation in the opposite direction. In either case, values for PIIP that are negative or exceed one would be inconsistent with good monetary policy practice.

Finally, as expectations change, policymakers can evaluate how much inflation pressure remains once the effects of the policy change have taken place. This leads to a definition of the effectiveness of monetary policy that is determined by the ratio of ex post to ex ante inflation pressure. Ex post inflation pressure can therefore be thought of as the amount of inflation pressure that remains after the change in interest rate shifts the (negative) trade-off between inflation and interest rates. Here, it is defined as the change in inflation, conditional on the current level of interest rates, had agents anticipated no change in the policy instrument. Consequently, we can write the expression for monetary policy effectiveness (MPE) as:

$$MPE_t = \frac{EPIP_t}{EAIP_t} \tag{3}$$

here ex post inflation is the inflation rate consistent with an unchanged interest rate but changed inflationary expectations. Clearly, if $EPIP_t = 0$, then monetary policy is completely effective in eliminating inflation pressure resulting in $MPE_t = 0$. A monetary policy that leaves ex post and ex ante inflationary pressures identical to each other, results in $MPE_t = 1$. This is a sign of policy ineffectiveness since agents expected no change in the policy instrument and left $EPIP_t$ unchanged. Partial reductions in inflationary pressure result in values for MPE_t that range between 0 and 1. As in the case of $PIIP_t$ negative values for MPE_t , as well as values that exceed 1, are also possible. A negative value indicates, for example, that ex post inflation pressure or ex ante inflation pressure move in the opposite direction, clearly a sign of policy effectiveness. A value for MPE_t that exceeds one suggests that *EPIP* exceeds *EAIP*. Therefore, the actual monetary policy has magnified inflation pressure and this is clearly an indication that policy is ineffective.

Clearly, equations (1) and (3) are not directly observable. Consequently, it is necessary to specify a structural model and obtain the results from the appropriate counterfactuals (see the next section) in order to obtain estimates of $EAIP_t$ and $EPIP_t$. Since there is a vast literature that relies, more or less, on a fairly common structure for a small model of the U.S. economy, we follow the current consensus and estimate a variant of the model specified by Clarida, Gali, and Gertler (CGG 1999). Also, see Fuhrer (2002), Rudebusch (2002), and Svensson (1997).

4. A Model of the U.S. Economy

The CGG (1999) model consists of three equations that describe aggregate demand, supply, and the U.S. Fed's reaction function. All three equations contain both forward and backward-looking elements which is also consistent with Woodford's (2003) view that models ought to contain a history dependent component. The following equations then describe the U.S. economy:

$$\tilde{y}_t = -\beta_1[i_t - E_t\,\pi_{t+1}] + \beta_2\,E_t\,\tilde{y}_{t-1} + u_t \tag{4}$$

$$\pi_t = \alpha_1\,E_t\,\pi_{t+1} + \alpha_2\,\pi_{t-1} + \alpha_3\,\tilde{y}_t + e_t \tag{5}$$

$$i_t = \gamma_0 + \rho\,i_{t-1} + (1-\rho)[\gamma_\pi\,E_t\,\pi_{t+m} + \gamma_{\tilde{y}}\,E_t\,\tilde{y}_{t+n}] + \upsilon_t \quad m, n \geq 0 \tag{6}$$

where $\tilde{y}_t$ is the output gap, i_t is the nominal interest rate, and π_t is the inflation rate. Equation (4) is an IS or aggregate demand curve, equation (5) is the aggregate supply or Phillip curve (PC), while the model is rounded out with a Taylor rule shown in equation (6). Both the IS and PC curves are hybrids in the sense of containing both forward and backward-looking components, as opposed to forward-looking models of the pure rational expectations variety. The Taylor rule is written in the standard form wherein interest rate smoothing captured by the ρ parameter, together with forward-looking terms for inflation and the output gap that combine to dictate the current setting of the policy instrument.[8] Note that, for convenience and simplicity, the 'forecasting' horizon of the central bank, that is, m and n are not specified as this can clearly change as the economic environment dictates. Additionally, we do not impose the condition often found in the literature (e.g., see Gali, and Getler (2007), and references therein) whereby $m=n$. Therefore, the central bank can be more or less forward-looking about inflation vis-á-vis the output gap, or vice-versa over time. A similar argument applies, in principle, to the IS and PC curves in equations (4) and (5). However, in keeping with the vast majority of aggregate demand and supply specifications available in the literature, we retain the specifications as shown. Equation (4), of course, is based on the IS curve derived from a representative agent who maximizes an inter-temporal utility function with some habit persistence (Fuhrer 2000). The form of the aggregate supply or PC curve can trace its origins to Calvo (1983) and emerges from the staggered pricing phenomenon. Weymark and Shintani (2006) provide details about the derivation of the three indicators described in the previous section. Essentially, this involves a conjecture, under the assumption of rational expectations, for the state variables $\tilde{y}_t$ and π_t, for a solution, using the method of undetermined coefficients, to the following set of expressions:

$$\tilde{y}_t = \theta_1 u_t + \theta_2 e_t + \theta_3 i_{t-1} \tag{7}$$

$$\pi_t = \delta_1 u_t + \delta_2 e_t + \delta_3 i_{t-1} \tag{8}$$

$$i_t = \mu_1 u_t + \mu_2 e_t + \mu_3 i_{t-1} \tag{9}$$

As shown in Weymark and Shintani (2006), the solution is non-linear and requires resort to numerical methods. A solution also requires an estimate of the disturbances from (4) to (6). Although the form of the solution in (7) and (8) is fairly general, it is not unique. An appendix

[8] 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 (2003).

provides an illustration. Moreover, 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.[9] More importantly, the data themselves will have been revised and, even if the structure of the model has not changed, the resulting parameter estimates may be different. In what follows we cannot, of course, accommodate all of these variants. Nevertheless, this does suggest that our indicators of inflation pressure, as is true of all such indicators, are subject to error.

5. Data and Inflation Pressure Estimates

5.1 Data and Vintages

Real time data 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 and money supply estimates in real-time. Interest rates and consumer prices are from the Federal Reserve Bank of St. Louis' FRED II data base (www.research.stlouisfed.org/fred2). Since the IS curve requires estimation of a real interest rate variable we consider several candidates as proxies for $E_t\,\pi_{t+1}$. 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. These data are available from the Federal Reserve Bank of Philadelphia (www.philadelphiafed.org/econ/forecast1).[10] A difficulty is that the available data are not always available for the sample in each vintage we have chosen to examine (see below). The Greenbook forecasts are available only until 2001:4, the SPF data end in 2004:2, the Livingston data are available until 2002:2, while the University of Michigan survey series ends

[9] The entire structure of the model may have changed. However, under the circumstances, even a change in *m* or *n* in equation (6) is sufficient.

[10] 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.

in 2004:2. Accordingly, the available data are supplemented with inflation forecasts from *The Economist* and Consensus forecasts (www.consensuseconomics.com) which are more up to date although the series are relatively shorter. All forecasts are one year ahead forecasts (e.g., four quarter ahead forecasts).[11]

The output gap can also be estimated in several ways. For the most part we rely on estimated based on an H-P filter (with a smoothing parameter of 1600). However, we have also examined estimates relying on data for real potential Gross Domestic Product generated by the Congressional Budget Office (www.cbo.gov/Spreadsheets.shtml), as well as estimated based on quadratic and cubic detrending (also see Siklos and Wohar 2006).

The interest rate variable is given by the fed funds rate, also obtained from FRED II, while inflation is evaluated at annual rates. Since least squares cannot be used to estimate (4) to (6) 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). A 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 example, in setting the policy instrument. Nevertheless, in what follows, we opt to fix the choice of instruments but chose indicators that are not only likely to be correlated either with inflation or the output gap but are believed to capture a wide range of other economic phenomena 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 sample period over which equations (4) to (6) 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

[11] It is also the case that 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 conclusions are unchanged.

that begins in 1970:1, and another one that begins in 1980:4. The latter sample is chosen because there is considerable evidence of a structural break arising in part out 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. All the models are estimated using quarterly data.

As noted in the introduction, the choice of vintages is dictated by the desire to replicate the environment facing the U.S. Fed between 1998 and 2004. As shown in Figures 1A and 1B, between 1999 and 2000, the fed funds rate rose steadily before the tech bubble led to the start of a period of looser 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 and 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 until steady increases in the fed funds rate were made until 2006. Thereafter, at least until later summer 2007, the rate remained unchanged. Hence, estimation of inflation pressure should illuminate both how the Fed saw the economic environment as well as permit an evaluation of the degree of the success of decisions about the policy stance.

Six vintages are chosen to illustrate the potential for the inflation pressure indicators. They are: August 1998, February 1999, May and November 2002, May 2003, and May 2004. Table 1 provides a synopsis of the contents of the minutes released shortly after the meetings, in the months when the vintages chosen for analysis would also have been available to policymakers. In others words, we chose vintages that match the last available dataset FOMC officials would have seen prior to a particular FOMC meeting. The Table provides selected excerpts, the voting record of the meeting, as well as a summary statement of the FOMC’s views concerning the appropriate stance of monetary policy going forward. August 1998 is approximately two years prior to the interest rate peak of 2000. It is generally assumed that the current setting of a policy instrument reflects the central bank's outlook over the next two years. Note that interest rates peak around two years later. The February 1999 vintage reveals that, while FOMC members unanimously chose to leave the policy rate unchanged, there was an expectation that a policy move 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), 2004Q1 (May 2004). Figure 1B makes clear that all chosen vintages are consistent with periods when the fed funds rate was unchanged. However, if the Fed is forward-looking then the minutes and, presumably the data, can offer clues as to whether the central bank would act in the near future and, hopefully, provide some indication about whether policy changes would be gradual or not. Moreover, as will be seen below, in spite of the unchanged fed funds rate around the chosen vintages, the Fed's decisions would have substantial impact of inflation pressure and the effectiveness of monetary policy, a clear sign of some of the virtues of gradual adjustments in the policy rate.

5.2 Model Estimates for the U.S. Economy

The objective is to produce estimates of equations (4) to (6) with plausible coefficients judged on a priori grounds while also being congruent with the data. This implies, for example, that reaction functions should satisfy the Taylor principle, while both the IS and PC curves ought to contain a considerable amount of output and inflation persistence. As Orphanides (1998) has shown models may fail, ex post, to produce estimates consistent with good monetary practice.

Tables in an Appendix provide detailed estimates of IS, PC and Taylor rules based on a variety of proxies for the real interest rate, expected inflation, and covering samples defined previously. As there are far too many estimates to discuss, Table 2 instead provides an general summary of the range of parameter estimates obtained for the key variables in equation (4) to (6) in the post-1980 sample. Estimates of the IS curve reveal considerable variation in the response of output to the real interest rate. Interestingly, the coefficient on the real interest rate is only consistently negative (and significant) when the Michigan survey of inflation expectations is used, while this is not always the case when, say, Greenbook forecasts are employed (results not shown). There is considerably less diversity in the degree of output gap persistence though the August 1998 vintage appears to stand out as one displaying the least amount of output persistence. Phillips curve estimates reveal that the forward-looking inflation term has generally greater weight than is true of the lagged inflation parameter, especially when the ‘min’ estimates are considered (these are the smallest coefficient estimates obtained across all estimated versions). Otherwise, current inflation is generally influenced in a balanced manner by both forward and backward-looking elements. Finally, Taylor rule estimates suggest that steady state real interest rates (γ_0) are low throughout the vintages considered, and this is certainly consistent with the view that monetary policy was, more often than not, accommodative (also, see Table 1). The Fed is also seen to respond strongly to inflation (γ_π) as required by the Taylor principle. Nevertheless, the central bank clearly also evinces a concern for output gap developments. As expected, Taylor rule estimates display considerable nominal interest rate persistence (ρ), although it is worthwhile noting that coefficient estimates display significant variation across the vintages examined. Finally, the Table also highlights how Taylor rule estimates are affected by the choice of the proxy for the output gap as seen most clearly from estimates of the steady state real interest rate.

As will become clear below, there is strong evidence of a shift in all indicators of inflation pressure when model estimates include data before 1980. This is not terribly surprising as several authors have noted that a major change took place in monetary policy after 1980 following Paul Volcker's appointment. Nevertheless, our results clearly highlight this fact. Indeed, one's interpretation of the effectiveness of monetary policy is very much dependent on the sample over which model estimates are generated. Not only then does the resort to real time data provide useful insights about the Fed's conduct of monetary policy but the sample over which policy is evaluated is also critical. This is simply just another manifestation of the Lucas critique of econometric policy evaluation.

5.3 Ex Ante, Ex Post Inflation Pressure, and Monetary Policy Effectiveness

Figure 2A plots four estimates of EAIP (see equation (1)) for the August 1998 vintage. This serves to illustrate both the sensitivity of the indicators to the sample estimation period as well as the range of estimates that can be obtained depending on the estimated model upon which the counterfactuals are based. The estimates that begin in 1970, of course, are based on full sample estimates of equations (4) through (6), while other estimates are based on a sub-sample that begins in 1980.4. There are a few notable features in the figure. First, estimates of EAIP are considerably higher when data since 1970 are employed. In addition, estimates of inflation pressure are relatively more sensitive to model specification. In contrast, estimates of EAIP are not sensitive to coefficient estimates of the model in the sub-sample. This is true in spite of the fact that there is a fair amount of diversity in coefficient estimates in the three equation model used here to estimate inflation pressure, as shown in Table 2. Accordingly, in what follows, we concentrate exclusively in estimates based on the post-1980 sample. Clearly, a 'structural' break of some kind in the economy or in monetary policy took place around that time.[12] Indeed, estimates of EAIP since the early 1980s do not seem plausible in light of actual Fed policies whereas estimates based on data since 1980 appear more sensible. Nevertheless, regardless of the chosen EAIP, the figure shows that there has been a noticeable drop in ex ante inflation pressure since the early 1980s. Therefore, our model picks up quite well the substantial decline in inflation that is the legacy of the Volcker-Greenspan years. The sharp changes in the fed funds rate target in the early portion of the sample (see Figure 1A) may have contributed to this result.

Figure 2B plots ex ante measures since 1980, based on the six chosen vintages considered in the paper. Three aspects stand out in the Figure. First, differences in EAIP across vintages are relatively small in the early part of the sample. By the early 1990s differences become larger. Nevertheless, if one examines at the data in 2002, ex ante inflation pressure is approximately 2% lower based on the November 2002 vintage, relative to the May 2003 vintage. This seems like a fairly sizeable shift in the estimates of inflation pressure over a very short time interval. Hence, it is conceivable that such movements might warrant caution on the part of the Fed. Finally, notice that EAIP appears to be very high, based on the February 1999 vintage, before falling again sharply by 2002. While the sharp rise may appear implausible, the February 1999 FOMC minutes (see Table 1) are noteworthy in that these suggest that "…normal historical relationships…' seem to have been suspended. The EAIP estimates are consistent with this interpretation. Note that the Fed did raise the fed funds rate shortly thereafter (see Figure 1B) before reversing course based on data from subsequent vintages. An analysis based on final revised data would not have been able to reveal this facet of monetary policy making nor would an approach that did not attempt to quantify the unobservable inflation pressure facing Fed policymakers.

[12] Other 'breaks' are possible of course. We simply chose the 1980 date as there is clear evidence in the literature that Fed behavior changed around that time. The point here is merely to illustrate that one's interpretation of Fed policies is not only a real time issue but also a sample choice, and, possibly, a model specification issue.

By the early 1990s, EAIP is fairly stable, after the initial sharp declines in the early 1980s, across all vintages. The minutes themselves, as the highlights shown in Table 1 reveal, show that the Fed became concerned, if not occasionally puzzled, about future prospects for inflation. At least initially, the bias was apparently in favor of higher short-term inflation. Indeed, Figure 1B shows that the fed funds rate would rise for a time shortly after the February 1999 meeting. By 2002, inflation pressure would fall and would then begin to rise again, though modestly, as the Fed turned away from being concerned about the prospects of an unwanted deflation toward expectations of rising inflation by the time the data from the May 2004 vintage would be used to set the policy rate. The sharp fall in the fed funds rate between 2001 and 2002 follows a decline in EAIP. Nevertheless, the Fed acted gradually. Similarly, the sharp fall in the fed funds rate (see Figure 1B) between 2001 and 2002, partly due to factors outside the normal course of monetary policy (i.e., 9/11) would lead to a rise in EAIP of up 2%, as noted earlier. Hence, this may partly explain the Fed's reluctance to raise the policy rate or to decide to leave the rate unchanged for a considerable period of time as the rise in inflation pressure was thought to be tolerable.[13]

Figure 3 plots the $PIIP_t$ (see equation (2)) for all six vintages based, exclusively on model estimates for the post 1980 sample. Other than for the November 2002 vintage, when Fed policy appears to have had little impact on inflation pressure relative to its ex ante value, there is a clear tendency to permit inflation to rise. The only exception is the February 1999 vintage when Fed policy comes closest to attempting to keep inflation constant. Notice that there is considerable variation in the PIIP index across most vintages but the Fed rarely overreacts or acts aggressively to change inflation pressure. Changes are seemingly gradual.

[13] It is worth pointing out, however, that shortly after the sample considered in this study ends, the fed began a tightening cycle lasting until the middle of 2007. see Figure 1A.

Finally, figure 4 plots our measure of the effectiveness of monetary policy (MPE, see equation (3)). Recall that this measure is intended as a metric of the impact of any surprise element in monetary policy. The constructed index is such that values near 1 indicate policy ineffectiveness as EAIP ≈ EPIP while an index that approaches zero indicates a fully effective monetary policy. MPE estimates hover around 1 for both the August 1998 and November 2002 vintages. The latter vintage reveals a preponderance of values that are consistent with Fed policies magnifying inflation pressure. [14] Monetary policy is most effective in the February 1999 vintage, in the sense of extinguishing EAIP, while the November 2002 vintage reveals that the Fed was least effective since EAIP is essentially the same as ex post inflation pressure. Nevertheless, as Figure 1B makes clear this reversal of fortune did not require rapid changes in the fed funds rate. Instead changes in expectations largely did the job for the Fed. There is once again a gradual rise in policy effectiveness thereafter until a reversal takes place by May 2004. The precise source of this drop is not entirely clear. However, the minutes note a definite trend towards policy tightening and it may very well be the case that markets were unconvinced of a pending rise in inflation.

What is most striking about the results is that MPE varies considerably more than actual changes in the fed funds rate would suggest. In other words, the Fed can and does act gradually so long as changes in expectations in the absence of changes in the policy rate take place producing the desired changes in ex ante (and ex post) inflation pressure. Otherwise, of course, changes in the fed funds rate must do the job

6. Conclusions

This paper has proposed some indicators that separately measure the impact of monetary policy stemming from changes in the setting of the policy instrument versus the accompanying changes in inflationary expectations that changes in the policy stance can generate. These

[14] Almost 72% of the estimates of MPE for the November 2002 vintage exceed 1.

indicators shed new light on the effectiveness of Fed monetary policy and justify a policy of gradual adjustment in policy rates. Using real time data for select vintages during the 1998-2004 period, when the Federal Reserve raised and lowered its target federal funds rate methodically but, at times, slowly while, at other times, the changes in the policy rate were more aggressive, we find that the fed may have acted gradually simply because it was successful in influencing expectations of future inflation. This does not mean that the Fed was always conducting a successful monetary policy. For example, based on the August 1998 and November 2002 vintages, monetary policy was clearly unsuccessful since inflationary pressure ex post was often higher than it was ex ante. Nevertheless, a sharp turnaround took place by the time of the May 2003 vintage. Indeed, we find that the biggest impact on monetary policy performance occurs not because the Fed changes its policy rate but via the changes in inflationary expectations these changes promote. Equally important perhaps is that our results not only reinforce the dramatic revisions in our assessment of the conduct of monetary policy based on real time data but also that models that evaluate policies based on data that stretch back before 1980 must allow for the fact that a notable structural shift occurred in a widely used version of a small structural model of the US economy.

Figure 1A Target Federal Funds Rate: 1982-2007

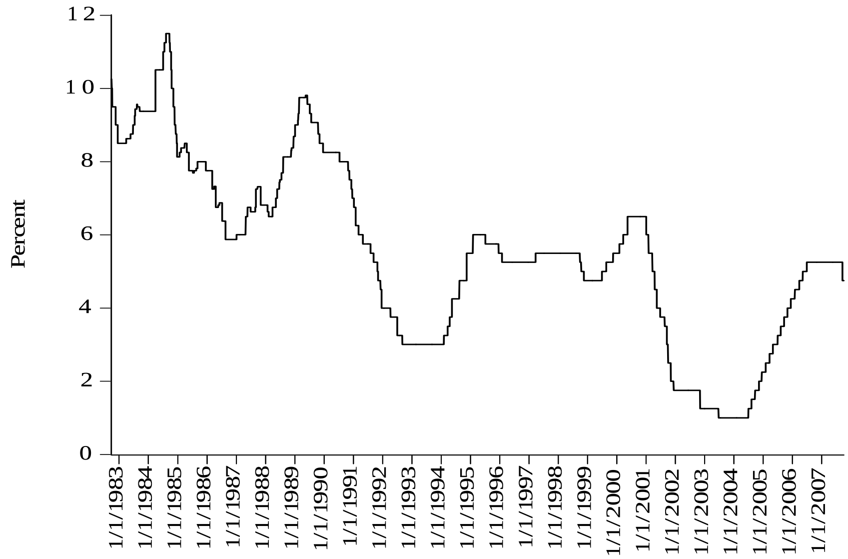
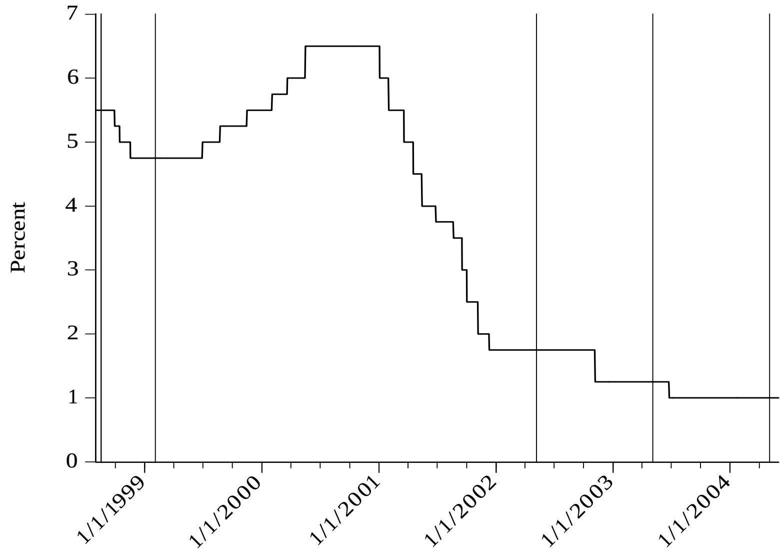


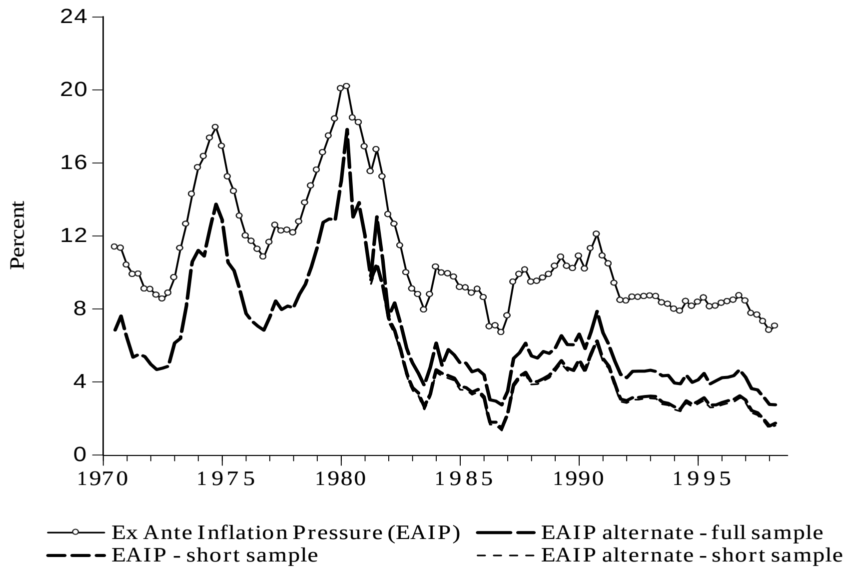
Figure 1B Target Federal Funds Rate: 1998-2004



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 2 Ex ante Inflation Pressure in the United States

A) *Varieties of Ex ante Inflation: August 1998 vintage*



Note: Short sample refers to model estimates estimated beginning with 1980.4 data. Full sample uses data since 1970.1. Differences are due to the variety of coefficient estimates (equations (4) to (6)) used in generating counterfactual estimates.

B) *Ex ante Inflation Across Vintages since 1980*

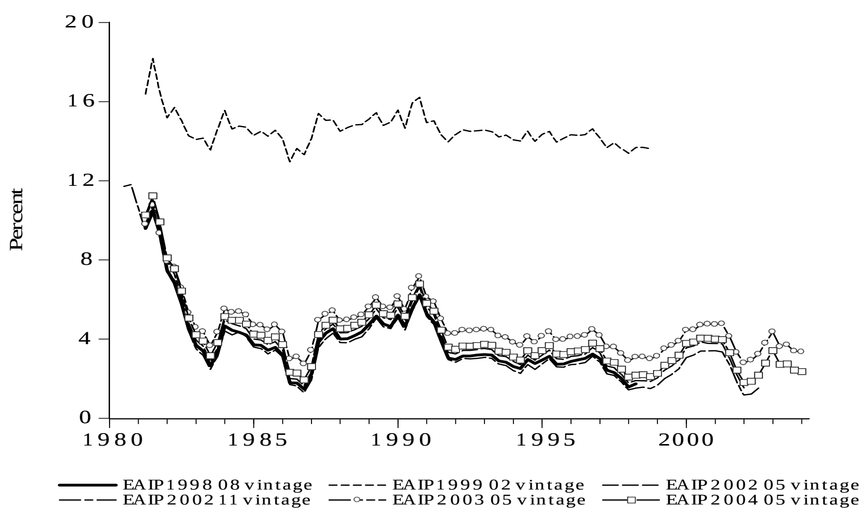
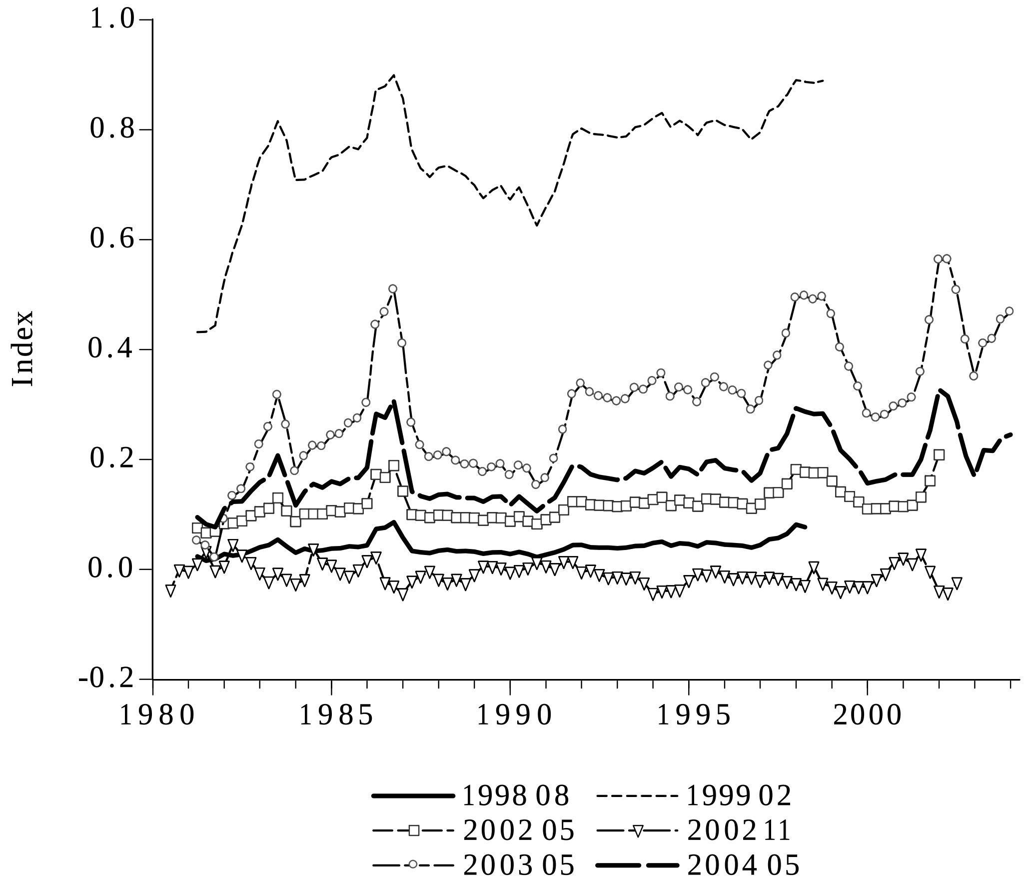
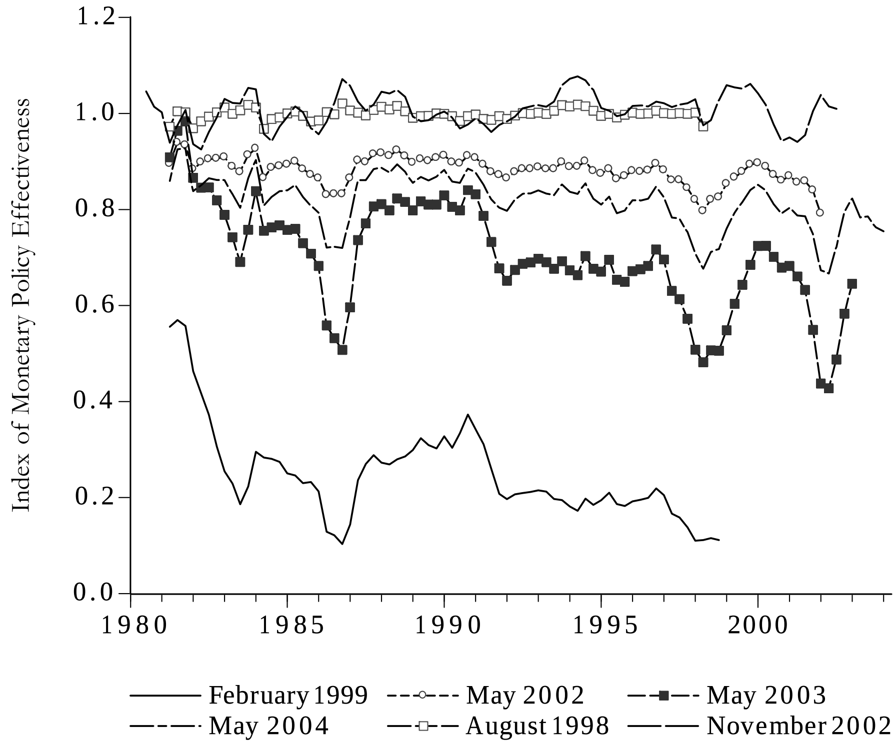


Figure 3 Policy Induced Inflation Pressure in the United States



Note: The dates refer to the year-month of the vintage used to calculate PIIP. Also see equation (2) for the definition of PIIP.

Figure 4 Monetary Policy Effectiveness in the United States



Note: The dates refer to the year-month of the vintage used to calculate PIIP. Also see equation (3) for the definition of MPE.

Table 1 Excerpts from FOMC Minutes

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 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."	11-0	"…all the members favored an unchanged policy stance."
May 7, 2002	"All the members favored the retention of a neutral balance of risks statement to be released shortly after this meeting."	10-0	"…all the members agreed on the desirability of maintaining an

	"…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 favorable." "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."		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." "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."	12-0	"…the current stance of monetary policy was still quite accommodative and was providing important support to economic activity,…"
May 6, 2003	"…the probability of some disinflation from an already low level exceeded that of a pickup in inflation."	11-0	"…all members indicated that they could support a proposal to

	"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 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, whicj seemed likely to diminish only gradually."		maintain an unchanged policy stance."
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.

Table 2 Range of Estimates for Key Parameters in U.S. Macromodel (equations (4) – (6))

		IS curve		Phillips curve			Taylor rule			
Vintage		$\beta_1\rho_t$	$\beta_2\tilde{y}_{t-1}$	$\alpha_1\pi_{t-1}$	$\alpha_2 E_t\pi_{t+1}$	$\alpha_3\tilde{y}_{t-1}$	ρ	γ_π	$\gamma_{\tilde{y}}$	γ_0
August 1998	Max	-.26	.05	.84	.84	.21	.87	1.62	.45	1.05
	Min	-.11	.02	.21	.57	-1.29	.86	1.35	.39	.86
February 1999	Max	.07	.49	.82	.77	.09	.60	2.96	1.66	-1.78
	Min	-.60	.29	.22	.59	.06	.78	2.55	.82	2.89
May 2002	Max	-.05	.47	.73	.76	.12		1.13	1.82	.22
	Min	-.20	.44	.16	.74	.04	.91	2.67	.77	.65
							.83			
November 2002	Max	.003	.48	.63	.75	.13	.93	1.34	1.61	.10
	Min	-.36	.37	.20	.70	.10	.82	2.67	.46	.19
May 2003	Max	.06	.48	.60	.74	.13	.57	2.46	3.05	.38
	Min	-.06	.46	.21	.69	.10	.79	2.44	1.88	2.46
May 2004	Max	.09	.49	.59	.75	.12	.81	3.06	.94	.08
	Min	-.15	.44	.20	.70	.10				

Notes: Max refers to the largest estimated coefficient obtained, Min to the smallest estimated coefficient obtained. Detailed estimates are relegated to an Appendix available from the first author. Taylor rule coefficients are steady state parameter estimates, except for the interest rate smoothing parameter. The first line represents estimates based on an H-P filter (smoothing parameter = 1600) while the second line relies on the CBO's estimate of potential output in estimating the output gap. For the May 2004 vintage only one set of plausible Taylor rule estimate was found (using the CBO's potential output measure). All results are based on a sample that begins in 1980.4, before differencing or lags.

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APPENDIX: Detailed Estimates

Table 1.1 IS Curves

1998 August Vintage:

	Full Sample					*Sub-Sample*		
	***Greenbook* 75.1 – 98.2**	***Michigan* 78.1 – 98.2**	***SPF* 82.2 – 98.2**	***Consensus* 90.1 – 98.2**	***Mean Inflation* 70.2 – 98.2**	***Greenbook* 80.4 – 98.2**	***Michigan* 80.4 – 98.2**	***Mean Inflation* 80.4 – 98.2**
Constant	.001 (.01, .99)	.12 (1.67, .10)	.11 (1.04, .30)	-.08 (-1.01, .32)	-.27 (-3.43, .00)	.08 (.58, .56)	.02 (.29, .78)	.05 (.75, .45)
$\tilde{y}_{t-1}$	.47 (18.50, .00)	.40 (8.88, .00)	.30 (4.32, .00)	.66 (10.31, .00)	.53 (8.64, .00)	.44 (9.09, .00)	.43 (6.35, .00)	.44 (15.67, .00)
$\tilde{y}_{t+1}$	.60 (21.64, .00)	.66 (13.40, .00)	.77 (8.57, .00)	.16 (1.63, .12)	.41 (4.91, .00)	.61 (10.83, .00)	.64 (8.39, .00)	.65 (21.97, .00)
ρ_t	-.19 (-2.38, .02)	-.36 (-5.93, .00)	-.64 (-2.78, .01)	.37 (2.88, .01)	.31 (1.98, .05)	-.26 (-1.04, .31)	-.11 (-.46, .65)	-.20 (-3.12, .00)
ρ_{t-1}	.19 (2.78, .01)	.31 (5.34, .00)	.59 (2.88, .01)	-.29 (-2.79, .01)	-.25 (-1.66, .10)	.24 (1.09, .28)	.09 (.46, .65)	.18 (3.32, .00)
$\bar{R}^2$	.89	.85	.90	.70	.82	.87	.90	.91
J	.04 ( )	.05 ( )	.08 ( )	.17 ( )	.06 ( )	.02 ( )	.03 ( )	.05 ( )

Table 1.2 IS Curves

1999 February Vintage:

	Full Sample					***Sub-Sample***		
	Greenbook 75.1 – 98.4	***Michigan 78.1 – 98.4***	***SPF 82.2 – 98.4***	***Consensus 90.1 – 98.4***	***Mean Inflation 70.2 – 98.4***	***Greenbook 80.4 – 98.4***	***Michigan 80.4 – 98.4***	***Mean Inflation 80.4 – 98.4***
Constant	0.10 (1.37, .18)	0.08 (1.22, .23)	0.09 (.93, .35)	-0.17 (-2.43, .02)	0.07 (.78, .44)	0.03 (.21, .83)	0.16 (1.26, .21)	0.03 (.41, .68)
$\tilde{y}_{t-1}$	0.55 (15.15, .00)	0.41 (10.63, .00)	0.34 (5.81, .00)	0.76 (10.42, .00)	0.54 (15.43, .00)	0.45 (9.54,.00)	0.29 (3.69, .00)	0.49 (14.62, .00)
$\tilde{y}_{t+1}$	0.48 (10.33, .00)	0.65 (15.00, .00)	0.74 (9.87, .00)	-0.01 (-.15, .88)	0.49 (11.79, .00)	0.60 (11.42,.00)	0.82 (7.01, .00)	0.55 (12.15, .00)
ρ_t	-0.33 (-7.76, .00)	-0.31 (-5.59, .00)	-0.52 (-2.57, .01)	0.56 (6.00, .00)	0.003 (.07, .95)	-0.20 (-.82, .42)	-0.60 (-2.32, .02)	0.07 (1.87, .07)
ρ_{t-1}	0.30 (6.60, .00)	0.28 (5.26, .00)	0.48 (2.66, .01)	-0.46 (-5.78, .00)	-0.02 (-.34, .74)	0.19 (.90, .37)	0.53 (2.32, .02)	-0.08 (-2.15, .04)
$\bar{R}^2$	.87	.87	.92	.58	.89	.88	.90	.91
J	.04	.05	.11	.13	.06	.03	.05	.02

Table 1.3 IS Curves

2002 May Vintage:

	Full Sample					*Sub-Sample*		
	***Greenbook* 75.1 – 01.4**	***Michigan* 78.4 – 02.1**	***SPF* 82.2 – 02.1**	***Consensus* 90.3 – 02.1**	***Mean Inflation* 70.2 – 02.1**	***Greenbook* 80.4 – 01.4**	***Michigan* 80.4 – 02.1**	***Mean Inflation* 80.4 – 02.1**
Constant	.07 (1.35, .18)	.08 (1.48, .14)	.02 (.29, .77)	-.21 (-2.07, .04)	.001 (.007, .99)	-.08 (-.81, .42)	-.01 (-.20, .84)	-.04 (-.48, .64)
$\tilde{y}_{t-1}$	.48 (16.53, .00)	.42 (11.15, .00)	.39 (5.22, .00)	.54 (6.63, .00)	.48 (18.08, .00)	.47 (7.76, .00)	.44 (8.64, .00)	.44 (7.77, .00)
$\tilde{y}_{t+1}$	.58 (10.28, .00)	.64 (16.17, .00)	.67 (7.89, .00)	.38 (4.11, .00)	.60 (19.93, .00)	.58 (9.06, .00)	.61 (11.31, .00)	.62 (9.65, .00)
ρ_t	-.31 (-6.37, .00)	-.29 (-5.69, .00)	-.37 (-1.68, .10)	.16 (1.22, .23)	-.22 (-3.12, .00)	-.05 (-.24, .81)	-.15 (-1.08, .29)	-.20 (-1.34, .18)
ρ_{t-1}	.27 (5.46, .00)	.26 (5.28, .00)	.34 (1.78, .08)	-.06 (-.52, .61)	.22 (3.08, .00)	.08 (.39, .70)	.15 (1.17, .25)	.20 (1.42, .16)
$\bar{R}^2$	.88	.88	.93	.82	.89	.90	.90	.88
J	.04 ( )	.05 ( )	.08 ( )	.07 ( )	.03 ( )	.02 ( )	.01 ( )	.01 ( )

Table 1.4 IS Curves

2002 November Vintage:

	Full Sample					***Sub-Sample***		
	Greenbook 75.1 – 01.4	***Michigan 78.4 – 02.2***	***SPF 82.2 – 02.2***	***Consensus 90.3 – 02.2***	***Mean Inflation 70.2 – 02.2***	***Greenbook 80.4 – 01.4***	***Michigan 82.2 – 02.2***	***Mean Inflation 80.4 – 02.2***
Constant	.08 (1.40, .16)	.08 (1.64, .10)	.04 (.67, .50)	-.14 (-2.38, .02)	.003 (.04, .97)	-.11 (-1.09, .28)	.04 (.66, .51)	-.04 (-.56, .58)
$\tilde{y}_{t-1}$	.47 (14.92, .00)	.42 (9.85, .00)	.39 (5.80, .00)	.46 (6.65, .00)	.48 (17.55, .00)	.48 (7.96, .00)	.37 (3.09, .00)	.46 (8.79, .00)
$\tilde{y}_{t+1}$	.60 (14.64, .00)	.65 (13.74, .00)	.68 (8.65, .00)	.48 (5.81, .00)	.60 (19.32, .00)	.58 (9.20, .00)	.71 (7.88, .00)	.61 (10.27, .00)
ρ_t	-.31 (-6.46, .00)	-.30 (-5.67, .00)	-.40 (-2.06, .04)	.06 (.41, .68)	-.21 (-2.95, .00)	.003 (.02, .99)	-.36 (-1.66, .10)	-.08 (.49, .62)
ρ_{t-1}	.28 (5.57, .00)	.26 (5.06, .00)	.37 (2.10, .04)	.01 (-.05, .96)	.21 (2.92, .00)	.03 (.15, .88)	.33 (1.66, .10)	.09 (.55, .58)
$\bar{R}^2$	.88	.88	.93	.87	.89	.92	.93	.91
J	.04 ( )	.05 ( )	.08 ( )	.11 ( )	.04 ( )	.02 ( )	.04 ( )	.01 ( )

Table 1.5 IS Curves

2003 May Vintage:

	Full Sample					***Sub-Sample***		
	Greenbook 75.1 – 01.4	***Michigan 78.4 – 03.1***	***SPF 82.2 – 03.1***	***Consensus 90.3 – 03.1***	***Mean Inflation 70.2 – 03.1***	***Greenbook 80.4 – 01.4***	***Michigan 80.4 – 03.1***	***Mean Inflation 80.4 – 03.1***
Constant	0.08 (1.41, .1.41)	0.09 (2.07, .04)	0.07 (1.13, .26)	-0.16 (-3.04, .00)	0.01 (0.18, .86)	-0.11 (-1.10, .27)	-0.01 (-0.21, .84)	0.02 (.28, .78)
$\tilde{y}_{t-1}$	0.47 (14.68, .00)	0.41 (9.30, .00)	0.36 (4.94, .00)	0.51 (5.49, .00)	0.52 (18.95, .00)	0.48 (7.68, .00)	0.46 (8.74, .00)	0.48 (14.30, .00)
$\tilde{y}_{t+1}$	0.60 (14.42, .00)	0.65 (13.11, .00)	0.70 (8.05, .00)	0.41 (4.00, .00)	0.51 (13.75, .00)	0.58 (8.93, .00)	0.61 (10.56, .00)	0.57 (12.46, .00)
ρ_t	-0.31 (-6.44, .00)	-0.30 (-5.62, .00)	-0.47 (-2.26, .03)	0.22 (1.26, .21)	0.01 (.27, .78)	0.001 (.01, .99)	-0.06 (-.38, .70)	0.06 (1.36, .18)
ρ_{t-1}	0.28 (5.54, .00)	0.26 (4.94, .00)	0.43 (2.25, .03)	-0.14 (-0.88, .39)	-0.01 (-0.31, .76)	0.03 (.16, .87)	0.06 (.40, .69)	-0.07 (-1.47, .14)
$\bar{R}^2$	.88	.88	.92	.85	.90	.92	.91	.91
J	.04	.05	.08	.11	.05	.02	.02	.02

Table 1.6 IS Curves

2004 May Vintage:

	Full Sample					*Sub-Sample*		
	Greenbook 75.1 – 01.4	***Michigan 78.4 – 04.1***	***SPF 82.2 – 04.1***	***Consensus 90.3 – 04.1***	***Mean Inflation 70.2 – 04.1***	***Greenbook 80.4 – 01.4***	***Michigan 80.4 – 04.1***	***Mean Inflation 80.4 – 04.1***
Constant	.08 (1.40, .16)	.01 (.33, .74)	.03 (.61, .55)	-.06 (-1.24, .22)	.002 (.03, .97)	-.11 (-1.09, .28)	-.02 (-.75, .46)	.003 (.04, .97)
$\tilde{y}_{t-1}$	.47 (14.92, .00)	.45 (11.48, .00)	.36 (4.28, .00)	.45 (6.88, .00)	.52 (19.24, .00)	.48 (7.96, .00)	.44 (9.00, .00)	.49 (15.13, .00)
$\tilde{y}_{t+1}$	.60 (14.64, .00)	.60 (13.82, .00)	.69 (6.87, .00)	.56 (6.26, .00)	.51 (14.55, .00)	.58 (9.20, .00)	.62 (11.24, .00)	.55 (12.59, .00)
ρ_t	-.31 (-6.46, .00)	-.27 (-5.58, .00)	-.62 (-2.97, .00)	-.07 (-.43, .67)	.02 (.46, .65)	.003 (.02, .99)	-.15 (-.84, .41)	.09 (1.71, .09)
ρ_{t-1}	.28 (5.57, .00)	.26 (5.04, .00)	.60 (2.97, .00)	.08 (.51, .61)	-.02 (-.47, .64)	.03 (.15, .88)	.15 (.87, .39)	-.09 (-1.82, .07)
$\bar{R}^2$	.88	.89	.89	.87	.89	.92	.89	.90
J	.04 ( )	.06 ( )	.08 ( )	.13 ( )	.07 ( )	.02 ( )	.02 ( )	.02 ( )

Table 2.1 Phillips Curves

1998 August Vintage:

	Full Sample					***Sub-Sample***		
	Greenbook 74.4 – 98.2	***Michigan 78.3 – 98.2***	***SPF 82.1 – 98.2***	***Consensus 90.2 – 98.2***	***Mean Inflation 70.3 – 98.2***	***Greenbook 80.4 – 98.2***	***Michigan 78.4 – 98.2***	***Mean Inflation 80.4 – 98.2***
Constant	-.21 (-1.36, .18)	-.74 (-2.44, .02)	-.59 (-4.17, .00)	.17 (-.18, .85)	.04 (.69, .49)	.19 (1.52, .13)	-1.29 (-4.19, .00)	.21 (2.16, .03)
$\tilde{y}_{t-1}$	.12 (3.42, .00)	.10 (2.19, .03)	.07 (2.30, .02)	-.14 (-1.22, .23)	.11 (3.47, .00)	.07 (1.47, .15)	.08 (4.03, .00)	.09 (1.87, .07)
$E_t\pi_{t+1}$	.29 (4.05, .00)	.75 (6.33, .00)	.51 (5.62, .00)	.79 (2.24, .03)	.70 (6.38, .00)	.21 (2.52, .01)	.84 (4.47, .00)	.64 (3.19, .00)
π_{t-1}	.78 (17.34, .00)	.33 (3.81, .00)	.66 (11.56, .00)	.12 (.82, .42)	.79 (30.50, .00)	.73 (13.72, .00)	.57 (5.92, .00)	.76 (18.43, .00)
$\overline{R}^2$	.97	.83	.98	.62	.97	.94	.93	.94
J	.04 ( )	.08 ( )	.09 ( )	.09 ( )	.09 ( )	.07 ( )	.07 ( )	.11 ( )

Table 2.2 Phillips Curves

1999 February Vintage:

	Full Sample					***Sub-Sample***		
	Greenbook 74.4 – 98.4	***Michigan 78.3 – 98.4***	***SPF 82.1 – 98.4***	***Consensus 90.2 – 98.4***	***Mean Inflation 70.3 – 98.4***	***Greenbook 80.4 – 98.4***	***Michigan 78.4 – 98.4***	***Mean Inflation 80.4 – 98.4***
Constant	-0.19 (-1.41, .16)	-0.63 (-4.51, .00)	-0.73 (-2.66, .01)	-0.49 (-1.88, .07)	0.09 (.88, .38)	0.17 (1.41, .16)	-1.31 (-4.31, .00)	0.22 (2.26, .03)
$\tilde{y}_{t-1}$	0.12 (3.52, .00)	0.07 (2.14, .04)	0.10 (2.28, .03)	-0.10 (-2.66, .02)	0.08 (2.60, .01)	0.06 (1.40, .17)	0.09 (4.07, .00)	0.09 (2.04, .05)
$E_t\pi_{t+1}$	0.28 (4.10, .00)	0.52 (5.63, .00)	0.74 (6.48, .00)	0.42 (4.41, .00)	0.74 (6.36, .00)	0.22 (2.71, .01)	0.82 (4.56, .00)	0.56 (2.89, .01)
π_{t-1}	0.78 (17.39, .00)	0.66 (11.18, .00)	0.33 (3.81, .00)	0.67 (18.53, .00)	0.77 (27.03, .00)	0.72 (13.69, .00)	0.59 (6.36, .00)	0.77 (19.71, .00)
$\overline{R}^2$	.97	.98	.84	.88	.97	.94	.93	.94
J	.04	.09	.08	.08	.09	.07	.07	.11

Table 2.3 Phillips Curves

2002 May Vintage:

	Full Sample					*Sub-Sample*		
	Greenbook 74.4 – 01.4	***Michigan 78.3 – 02.1***	***SPF 82.1 – 02.1***	***Consensus 90.2 – 02.1***	***Mean Inflation 70.3 – 02.1***	***Greenbook 80.4 –01.4***	***Michigan 78.4 – 02.1***	***Mean Inflation 80.4 – 02.1***
Constant	-.02 (-.14, .89)	.08 (.44, .66)	-.46 (-3.53, .00)	-.38 (-2.05, .05)	.12 (1.22, .23)	.27 (2.88, .01)	-.31 (-1.32, .19)	.42 (2.53, .01)
$\tilde{y}_{t-1}$	.14 (3.76, .00)	.15 (4.82, .00)	.11 (3.77, .00)	.26 (8.40, .00)	.12 (2.55, .01)	.11 (3.00, .00)	.12 (5.09, .00)	.04 (1.93, .06)
$E_t\pi_{t+1}$	.24 (4.28, .00)	.30 (3.49, .00)	.45 (5.58, .00)	.33 (3.50, .00)	.61 (3.98, .00)	.16 (2.42, .02)	.34 (2.39, .02)	.73 (23.10, .00)
π_{t-1}	.78 (20.08, .00)	.62 (9.61, .00)	.68 (13.49, .00)	.78 (14.53, .00)	.79 (18.61, .00)	.76 (17.71, .00)	. 74 (10.07, .00)	.76 (23.10, .00)
$\bar{R}^2$	.97	.88	.98	.90	.97	.95	.95	.94
J	.03 ( )	.08 ( )	.07 ( )	.11 ( )	.08 ( )	.05 ( )	.07 ( )	.11 ( )

Table 2.4 Phillips Curves

2002 November Vintage

	Full Sample					Sub-Sample		
	Greenbook 74.4 – 01.4	***Michigan 78.3 – 02.3***	***SPF 82.1 – 02.3***	***Consensus 90.2 – 02.3***	***Mean Inflation 70.3 – 02.3***	***Greenbook 80.4 –01.4***	***Michigan 78.4 – 02.3***	***Mean Inflation 80.4 – 02.3***
Constant	-.04 (-.34, .73)	.04 (.23, .82)	-.55 (-4.27, .00)	-.61 (-4.01, .00)	.13 (1.50, .14)	.35 (3.25, .00)	-.45 (-2.00, .05)	.23 (2.67, .01)
$\tilde{y}_{t-1}$	.14 (4.26,.00)	.15 (5.13, .00)	.10 (3.45, .00)	.25 (8.96, .00)	.10 (3.15, .00)	.10 (2.96, .00)	.13 (5.45, .00)	.10 (3.22, .01)
$E_t\pi_{t+1}$	.24 (4.39, .00)	.33 (3.78, .00)	.48 (5.98, .00)	.46 (4.75, .00)	.70 (6.29, .00)	.20 (3.09, .00)	.42 (3.12, .00)	.63 (4.37, .00)
π_{t-1}	.78 (20.98. .00)	.60 (9.58, .00)	.68 (13.63, .00)	.72 (12.09, .00)	.77 (26.50, .00)	.70 (16.58, .00)	.70 (10.00, .00)	.75 (29.82, .00)
$\bar{R}^2$	.97	.89	.98	.91	.97	.94	.95	.94
J	.03 ( )	.08 ( )	.07 ( )	.11 ( )	.08 ( )	.05 ( )	.07 ( )	.11 ( )

Table 2.5 Phillips Curves

2003 May Vintage

	Full Sample					***Sub-Sample***		
	Greenbook 74.4 – 01.4	***Michigan 78.3 – 02.3***	***SPF 82.1 – 02.3***	***Consensus 90.2 – 02.3***	***Mean Inflation 70.3 – 02.3***	***Greenbook 80.4 –01.4***	***Michigan 78.4 – 02.3***	***Mean Inflation 80.4 – 02.3***
Constant	-0.04 (-0.37,.70)	-0.56 (-4.37, .00)	0.04 (.21, .84)	-0.75 (-4.14, .00)	0.18 (1.85, .07)	0.34 (3.22, .00)	-0.42 (-1.94, .06)	0.31 (3.05, .00)
$\tilde{y}_{t-1}$	0.14 (4.27, .00)	0.09 (3.16, .00)	0.15 (5.01, .00)	0.27 (8.71, .00)	0.10 (3.01, .00)	0.10 (2.92, .00)	0.13 (5.28, .00)	0.10 (3.12, .00)
$E_t\pi_{t+1}$	0.24 (4.46,.00)	0.50 (6.27, .00)	0.32 (3.80, .00)	0.46 (4.63, .00)	0.70 (6.05, .00)	0.21 (3.16, .00)	0.41 (3.29, .00)	0.60 (3.76, .00)
π_{t-1}	0.78 (20.98, .00)	0.66 (13.51, .00)	0.60 (9.66, .00)	0.76 (12.39, .00)	0.76 (24.79, .00)	0.69 (16.05, .00)	0.70 (10.44, .00)	0.74 (25.96, .00)
$\bar{R}^2$	0.97	.98	.88	.86	.97	.94	.95	.94
J	.03	.08	.08	.13	.08	.05	.08	.10

Table 2.6 Phillips Curves

2004 May Vintage

	Full Sample					***Sub-Sample***		
	Greenbook 74.4 – 01.4	***Michigan 78.3 – 04.1***	***SPF 82.1 – 04.1***	***Consensus 90.2 – 04.1***	***Mean Inflation 70.3 – 03.4***	***Greenbook 80.4 –01.4***	***Michigan 78.4 – 04.1***	***Mean Inflation 80.4 – 03.4***
Constant	-.04 (-.34, .73)	-.02 (-.10, .92)	-.76 (-6.33, .00)	-.49 (-3.23, .00)	.17 (1.75, .08)	.35 (3.25, .00)	-.33 (-1.72, .09)	.28 (8.93, .00)
$\tilde{y}_{t-1}$	.14 (4.26, .00)	.15 (5.12, .00)	.03 (.72, .47)	.23 (4.28, .00)	.10 (2.88, .00)	.10 (2.96, .00)	.12 (4.93, .00)	.11 (2.19, .00)
$E_t\pi_{t+1}$	.24 (4.39. .00)	.31 (4.08, .00)	.57 (6.20, .00)	.35 (3.64, .00)	.70 (6.00, .00)	.20 (3.09, .00)	.37 (3.09, .00)	.59 (3.71, .00)
π_{t-1}	.78 (20.98, .00)	.63 (9.92, .00)	.67 (10.67, .00)	.78 (12.38, .00)	.76 (23.69, .00)	.70 (16.58, .00)	.72 (11.08, .00)	.75 (25.43, .00)
$\bar{R}^2$	.97	.88	.97	.87	.97	.94	.95	.94
J	.03 ( )	.08 ( )	.07 ( )	.11 ( )	.08 ( )	.05 ( )	.07 ( )	.11 ( )

Table 3.1 Taylor Rules

1998 August Vintage

	Full Sample		*Sub-Sample*	
	HP	POT	HP	POT
γ_0	0.03	0.19	1.05	0.86
ρ	0.89	0.81	0.87	0.86
γ_π	1.61 (t+3)	1.43 (t+3)	1.62 (t+2)	1.35 (t+3)
$\gamma_{\tilde{y}}$	1.06 (t+7)	2.81 (t+3)	0.45 t+8)	0.39 (t+3)
$\overline{R}^2$	.87	.92	0.85	.94
J	.10 (.40)	.10 (.74)	.10 (.39)	.16 (.65)

Table 3.2 Taylor Rules

1999 February Vintage

	Full Sample							***Sub-Sample***		
	HP	HP	POT	POT	POT	POT	POT	HP	HP	POT
γ_0	0.04	0.04	2.09	1.96	1.69	1.61	1.13	*-1.78*	*-0.52*	2.44
ρ	0.92	0.92	.94	.94	.95	.96	.90	0.60	0.88	0.78
γ_π	1.21 (t)	1.22 (t+1)	1.07 (t+2)	1.07 (t+3)	1.19 (t+5)	1.36 (t+6)	1.24 (t+2)	2.96 (t+3)	2.96 (t+3)	2.55 (t+2)
$\gamma_{\tilde{y}}$	4.92 (t+2)	4.60 (t+2)	2.09(t+6)	1.88 (t+6)	1.92 (t+6)	2.27 (t+6)	0.61 (t+7)	1.66 (t+4)	4.98 (t+3)	0.82 (t)
$\overline{R}^2$	.88	.88	.86	.86	.86	.86	.87	.90	.77	.92
J (p)	.31	.32	.54	.56	.55	.54	.64	.81	.68	.80

Table 3.3 Taylor Rules

2002 May Vintage

	Full Sample				***Sub-Sample***		
	POT	POT	POT	HP	POT	POT	HP
γ_0	0.73	0.60	0.73	0.15	1.21	0.65	0.22
ρ	0.92	0.93	0.95	0.92	0.83	0.82	0.91
γ_π	1.00 (t+7)	1.61 (t+4)	1.95 (t+4)	1.10 (t+3)	2.93 (t+2)	2.67 (t+3)	1.13 (t+3)
$\gamma_{\tilde{y}}$	0.99 (t+4)	1.38 (t+4)	2.33 (t+6)	1.37 (t+7)	1.29 (t+1)	0.77 (t+4)	1.82 (t+1)
$\overline{R}^2$	.88	.89	.88	.88	.93	.94	.94
J	(.66)	(.66)	(.55)	(.35)	(.90)	(.90)	(.78)

Table 3.4 Taylor Rules

2002 November Vintage

	Full Sample		***Sub-Sample***		
	POT	POT	POT	POT	HP
γ_0	0.70	0.74	1.09	0.19	0.10
ρ	0.93	0.94	0.83	0.82	0.93
γ_π	1.16 (t+8)	1.69 (t+3)	3.28 (t+4)	2.67 (t+3)	1.34 (t+4)
$\gamma_{\tilde{y}}$	1.25 (t+4)	1.95 (t+6)	1.62 (t+1)	0.46 (t+1)	1.61 (t+1)
$\overline{R}^2$	.88	.88	.94	.89	.94
J	(.61)	(.70)	(.91)	(.91)	(.80)

Table 3.5 Taylor Rules

2003 May Vintage

	Full Sample					*Sub-Sample*				
	HP	HP	POT	POT	POT	POT	POT	HP	HP	HP
γ_0	0.01	0.02	1.48	1.03	1.17	1.98	2.46	0.40	0.38	0.34
ρ	0.91	0.91	0.90	0.92	0.92	0.80	0.79	0.55	0.57	0.81
γ_π	1.32 (t)	1.28 (t)	1.07 (t+1)	1.15 (t+8)	1.71 (t+1)	1.22 (t+4)	2.44 (t+4)	2.68 (t+4)	2.46 (t)	2.34 (t+3)
$\gamma_{\tilde{y}}$	4.33 (t+2)	4.12 (t+2)	1.89 (t)	1.60 (t)	2.31 (t+1)	1.21 (t+3)	1.88 (t+4)	1.07 (t+1)	3.05 (t+4)	3.04 (t+4)
$\overline{R}^2$	.89	.90	.90	.91	.88	.86	.83	.75	.82	.87
J	.43	.48	.74	.56	.74	.84	.78	.88	.80	.82

Table 3.6 Taylor Rules

2004 May Vintage

Full Sample				***Sub-Sample***
	POT	HP	HP	POT
γ_0	0.11	0.06	0.23	0.08
ρ	0.94	0.93	0.89	0.81
γ_π	1.07 (t)	1.08 (t+2)	1.02 (t+2)	3.06 (t+2)
$\gamma_{\tilde{y}}$	0.73 (t+4)	3.46 (t+4)	1.23 (t)	0.94 (t+3)
$\overline{R}^2$	.89	.91	.90	.90
J	(.47)	(.37)	(.40)	(.81)

Appendix I

Estimates used for US Full Sample Aug. 1998 Vintage IP Computations

(1) Phillips Curve

$$\pi_t = \underset{(0.8343)}{1.3267} + \underset{(0.0410)}{0.7475}\pi_{t-1} + \underset{(0.0904)}{0.2457}\mathrm{E}_t\pi_{t+4} + \underset{(0.0400)}{0.0778}y_{t-1} + \epsilon_t$$

(2) IS Curve

$$y_t = \underset{(0.1636)}{0.3521} + \underset{(0.0485)}{0.4821}y_{t-1} + \underset{(0.0685)}{0.7653}\mathrm{E}_t y_{t+1} - \underset{(0.1184)}{0.3158}[i_t - \mathrm{E}_t\pi_{t+4}] + \underset{(0.0974)}{0.1837}[i_{t-1} - \mathrm{E}_{t-1}\pi_{t+3}] + \eta_t$$

(3) Taylor Rule

$$i_t = 0.899 i_{t-1} + (1 - 0.899)[0.780 + 12.9802\mathrm{E}_t\pi_{t+2} + 3.5346 y_t] + \sigma_t$$

Appendix II

Date	Scheduled (S)/ Unscheduled (U)	Direction of change in the fed funds rate
Jan. 3, 2001	U	**50bp** ↓
Jan. 31, 2001	S	**50bp** ↓
Mar. 20, 2001	S	**50bp** ↓
Apr. 18, 2001	U	**50bp** ↓
May 15, 2001	S	**50bp** ↓
June 27, 2001	S	**25bp** ↓
Aug. 21, 2001	S	**25bp** ↓
Sept. 17, 2001	S	**50bp** ↓
Oct. 2, 2001	S	**50bp** ↓
Nov. 6, 2001	S	**50bp** ↓
Dec. 11, 2001	S	**25bp** ↓
Nov. 6, 2002	S	**50bp**↓
June 25, 2002	S	**25bp** ↓
June 30, 2004	S	*25bp* ↑
Aug. 10, 2004	S	*25bp* ↑
Sept. 21, 2004	S	*25bp* ↑
Nov. 10, 2004	S	*25bp* ↑
Dec. 14, 2004	S	*25bp* ↑
Feb. 2, 2005	S	*25bp* ↑
Mar. 22, 2005	S	*25bp* ↑
May 3, 2005	S	*25bp* ↑
June 30, 2005	S	*25bp* ↑
Aug. 9, 2005	S	*25bp* ↑
Sept. 25, 2005	S	*25bp* ↑
Nov. 1, 2005	S	*25bp* ↑
Dec. 13, 2005	S	*25bp* ↑
Jan. 31, 2005	S	*25bp* ↑
Mar. 28, 2005	S	*25bp* ↑
May 10, 2005	S	*25bp* ↑
June 29, 2005	S	*25bp* ↑

Source: http://www.federalreserve.gov/fomc/previouscalendars.htm.