Understanding the Greenspan Standard

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I. Introduction

Alan Greenspan was sworn in as Chairman of the Board of Governors of the Federal Reserve System almost exactly 18 years ago. At the time, the Reagan administration was being rocked by the Iran-contra scandal. The Berlin Wall was standing tall while, in the Soviet Union, Mikhail Gorbachev had just presented proposals for *perestroika*. The stock market had not crashed since 1929 and, probably by coincidence, Prozac had just been released on the market. The New York Mets, having won the 1986 World Series, were the reigning champions of major league baseball. A lot can change in 18 years.

Turning to the narrower world of monetary policy, central banks in 1987 still doted on money growth rates and spoke in tongues—when indeed they spoke at all, which was not often. Inflation targeting was two or three years away from being invented in New Zealand, and the Taylor rule was not yet a gleam in John Taylor's eye. European monetary union seemed like a far-off dream. And the world-famous Jackson Hole conference was not yet world-famous. A lot can happen in 18 years.

No one has yet credited Alan Greenspan with the fall of the Soviet Union or the rise of the Boston Red Sox, although both may come in time as the legend grows. But within the domain of monetary policy, Greenspan has been central to just about everything that has transpired in the practical world since 1987 and to some of the major developments in the academic world as well. This paper seeks to summarize and, more important, to evaluate the significance of Greenspan's impressive reign as Fed chairman—a period that can rightly be called the Greenspan era. It is a period that started in earnest with a frightening one-day crash of the stock market in October 1987, and included wars in Iraq in both 1990 and 2003, a rolling worldwide financial crisis in 1997-1998, the biggest financial

bubble in history, an amazing turnaround in productivity growth after 1995, and a deflation scare in 2003. It is now culminating with Greenspan's fourth attempt at a soft landing.[1]

We do not offer an exhaustive monetary history of the period here, although we must indulge in a bit of that. Rather, our aim is to highlight what we see as the most notable contributions of the Greenspan Fed to both the theory and practice of monetary policy—and to speculate on what Alan Greenspan's legacy might therefore be. There is no doubt that Greenspan has been an amazingly successful chairman of the Federal Reserve System. So this paper will appropriately include a great deal of praise for his decisions—and even some criticism. But our focus is not on grading Greenspan's performance. It is, rather, on the lessons that both central bankers and academics can and should take away from the Greenspan era. How is central banking *circa* 2005 different from what it was *circa* 1987 because of what Alan Greenspan did at the Fed? Which Greenspanian policies are replicable? Which strategies can be generalized? Which ideas are of durable significance?

Section II is the heart of the paper. It deals with the conduct of what we call *workaday monetary policy*, that is, the strategy and tactics behind the central bank's month-to-month manipulation of short-term interest rates to keep both inflation and unemployment low and stable. This topic leads naturally into discussions of the mark Greenspan has made on the rules-versus-discretion debate, on his approach to managing risks, on the choice of the monetary policy instrument and of what it should respond to (and hence on the relevance of the Taylor rule), on the use of the Fed's dual mandate, on how to deal

[1] The other three were in 1988-89 (a failure), 1994-95 (a success), and 1999-2000 (you decide).

with oil shocks, on the Fed's movement toward greater transparency, and on what we call—perhaps a bit provocatively—the resurrection of fine tuning.

Section III then follows with analyses and evaluations of Greenspan's intellectual and practical contributions to how a central bank should deal with three special issues that arose on his watch: a large change in the productivity trend, a financial market bubble, and the Fed's responsibilities (if any) for *global* financial stability.

Mindful of the fact that the financial markets now view Chairman Greenspan's infallibility more or less as the Chinese once viewed Chairman Mao's, we nonetheless turn in Section IV to some possible negative aspects of the Greenspan legacy. There are a few, though not many. We question the wisdom of a central bank head taking public positions on political issues unrelated to monetary policy. And we ask whether the extreme personalization of monetary policy under Greenspan has undercut his ability to pass any "capital" on to his successor and/or has undermined the presumed advantages of making monetary policy by committee.

Section V is a summary of what we think we have learned, offered in the form of a list of ten main principles that have underpinned and defined the Greenspan standard, and which may therefore define his legacy.

While our focus is not on grading Greenspan, a paper like this is necessarily judgmental and evaluative. Rather than keep the reader in suspense, we might as well reveal our overall evaluation right up front. While there are some negatives in the record, when the score is toted up, we think he has a legitimate claim to being the greatest central banker who ever lived. His performance as chairman of the Fed has been impressive,

encompassing, and overwhelmingly beneficial—to the nation, to the institution, and to the practice of monetary policy.

But the central questions of this paper are different. They are whether that stellar performance will also leave a lasting legacy, and what that legacy might or should be.

II. Inside the Black Box: Defining the Greenspan Standard

For years now, U.S. monetary policy has been said to be on "the Greenspan standard," meaning that it is whatever Alan Greenspan thinks it should be. What sort of standard is that?

Greenspan cherishes option value. Federal Reserve policy under his chairmanship has been characterized by the exercise of pure, period-by-period discretion, with minimal strategic constraints of any kind, maximal tactical flexibility at all times, and not much in the way of explanation. He is a careful manager of the many different risks facing the Fed, and he is prepared to adjust interest rates in response to incoming news. But that does not mean that monetary policy under Greenspan has been haphazard. In fact, it has become rather predictable in recent years as the Fed has become more transparent.

Greenspan takes the dual mandate of the Federal Reserve seriously, and he is not shy about fine tuning policy to rather exacting targets for inflation and unemployment. As an empirical matter, the monetary policy decisions of the Greenspan era are well described by a Taylor rule—a fact that has been documented by many scholars and which we demonstrate once again below.[2] But any Taylor rule for the Greenspan Fed needs to be interpreted as an econometric allegory, not as a literal description of how the FOMC (or Greenspan) actually reaches decisions.

We proceed now to flesh out this bare-bones description.

[2] Taylor (1993) made this point 12 years ago. Among the many other sources that could be cited, see Clarida, Gali, and Gertler (2000) and, more recently, Rudebusch (2005).

II.A Discretion rather than rules

The Greenspan standard is highly situational, even opportunistic. FOMC decisions are made one meeting at a time, without pre-commitment to any future course of action and often without much indication as to what those future actions might be.[3] The secret to Greenspan's success remains a secret. When the next leader of the Fed takes his seat behind the chairman's desk and opens the top drawer in search of Alan Greenspan's magic formula, he will be sorely disappointed.

One important strand of modern thinking on monetary policy views the rejection of rules in favor of period-by-period discretion as a serious shortcoming of Greenspanian monetary policy.[4] After all, long-term interest rates matter more than the federal funds rate, and expectations are better managed if the market can better anticipate what the central bank will do in the future.[5] Some have even argued that period-by-period discretion will lead to excessive inflation.[6]

Greenspan, not surprisingly, does not agree with this academic critique.[7] As he stated right here at Jackson Hole two years ago (Greenspan (2003), p.5):

> *Some critics have argued that [the Fed's] approach to policy is too undisciplined —judgmental, seemingly discretionary, and difficult to explain. The Federal Reserve should, some conclude, attempt to be more formal in its operations by tying its actions solely to the prescriptions of a formal policy rule.*

[3] Some would argue that this style of policymaking has changed recently, with such forward-looking phrases as "for a considerable period" and "at a pace that is likely to be measured" serving as (weak) pre-commitment devices. More on this later.
[4] The idea dates back to Kydland and Prescott's (1977) seminal paper. For a clear statement, see Fischer (1990).
[5] This view is central to recent work on optimal monetary policy with forward-looking agents. If the central bank commits to a rule, it can steer the private sector's expectations in a way that ensures that there will be some automatic stabilization of shocks. See, for example, Woodford (1999).
[6] See Barro and Gordon (1983) for the original argument. Athey, Atkeson and Kehoe (2005) show that the argument holds even if the central bank has better information on the economy than the private sector does. For counterarguments, see among others Blinder (1998, Chapter 2).
[7] Some academics seem to take Greenspan's side, however. See, for example, Feldstein (2003), Fischer (2003), and Yellen (2003).

> *That any approach along these lines would lead to an improvement in economic performance, however, is highly doubtful.*

Nor, in our judgment, have the facts been kind to the critics' argument. For example, the Fed brought inflation down dramatically under Paul Volcker and has controlled both inflation and real fluctuations well under Greenspan—all without rules or even any serious pre-commitments.

There is, furthermore, a powerful counter-argument to the alleged virtues of rule-like behavior, one that seems to be insufficiently appreciated in the academic world, but which was well articulated in an important address that Greenspan delivered at the January 2004 meetings of the American Economic Association (Greenspan, 2004). Monetary policy under Greenspan has been remarkably flexible and adaptable to changing circumstances—a point that he has frequently emphasized. His scrutiny of the details in the data is, of course, legendary. But his flexibility, his unwillingness to get stuck in a doctrinal straitjacket that becomes dysfunctional, may be his greatest strength. For example, he is the Fed chairman who officially jettisoned the institution's vestigial attachment to the monetary aggregates in 1993.[8] Later in the decade, he refused to accept the Phillips curve canon with a 6% natural rate. Compared to those two doctrines, each of which once had legions of devoted adherents, the ill-defined Greenspan standard looks pretty good.

Modern academic macroeconomists like to theorize about central banks as minimizing the expected discounted value of a periodic loss function such as:

$$(1) \quad L = (\pi - \pi^*)^2 + \lambda(y - y^*)^2$$

[8] In some sense, Volcker did this tacitly, years earlier. But Greenspan made it official—and permanent.

where π is inflation, y is output, and π^* and y* are targets, subject to a *fixed* model of the economy with *known* parameters (or sometimes unknown parameters with known probability distributions).[9] In stark contrast, Greenspan has never accepted the idea that *any* model with unchanging coefficients, or even with an unchanging structure, can describe the U.S. economy adequately. Rather, he sees the economy as in a state of constant flux, and he sees the central bank as constantly in learning mode. In his words:

> *The economic world… is best described by a structure whose parameters are continuously changing. The channels of monetary policy, consequently, are changing in tandem. An ongoing challenge for the Federal Reserve… is to operate in a way that does not depend on a fixed economic structure based on historically average coefficients.*[10]

To be sure, the more analytical, models-based framework favored by academics has some clear advantages; for example, it facilitates computations, estimation, and policy evaluation exercises. Tightly-specified models are also testable, and therefore falsifiable. And you can't very well ask counterfactual questions unless you have a specific model. The Greenspan non-model described in the preceding quotation shares none of these desirable traits. But that said, who among us would really like to defend the proposition that the equations that described the U.S. economy in 1965 still do so in 2005?

This point should not be misinterpreted as a brief against econometrics. There are ways to cope (albeit imperfectly) with shifting parameters, and one should be wary of those who would too readily declare the death of statistical regularities that have been observed in the past. Rather, our point is that we economists should not delude ourselves into believing that we know enough to use precisely-specified models to design

[9] This objective function is typically assumed in models because it approximates the mandate of many central banks. But it can also be derived as an approximation to society's welfare function (Woodford, 2002).
[10] Greenspan (2004), p. 38.

quantitative policy rules to which a real central bank would want to commit *for a lengthy time period*. In the world of practical policymaking, robustness is probably more important than a model-specific optimality that may be spurious. Alan Greenspan certainly thinks so; and he acts on that belief.[11] Which brings us directly to the next issue.

II.B Is risk management different from optimization?

All economists cut their teeth on optimization techniques and feel at home in that framework. Greenspan, however, has suggested a different methodological paradigm for monetary policy—that of *risk management*. Are the two methods really different and, if so, in what respects?

As Greenspan describes it, the risk management framework,

> *emphasizes understanding as much as possible the many sources of risk and uncertainty that policymakers face, quantifying those risks when possible, and assessing the costs associated with each of the risks.*[12]

And we might add, by analogy to the risk management criteria that the Fed sets for the financial institutions under its supervision: building structures and control mechanisms that mitigate vulnerabilities to adverse outcomes.

Let us first take seriously the analogy to risk management as practiced by banks, and then ask if this paradigm is really different from optimization. This discussion will draw us into a crucial question that will arise repeatedly in this paper: Is the Greenspan standard replicable? After all, Greenspanian monetary has been highly successful under a wide variety of circumstances. It would be nice if we could put it in a bottle.

[11] This is clear, once again, in Greenspan (2004), especially pages 37-38.
[12] Greenspan (2004), p. 37.

All modern financial institutions of any size have formal risk-management systems that blend quantitative and qualitative aspects, that evolve over time, and, most germane to the question just raised, that survive changes in personnel. These *systems* are at least somewhat independent of the *people* who run them. Why can't a central bank do something like that?

The central tool in such a risk-management system is often a *risk matrix* that, according to criteria set forth in the Fed's manual for bank supervisors, should be "used to identify significant activities, the *type and level of inherent risks* in these activities, and the *adequacy of risk management* over these activities, as well as to determine composite-*risk assessments* for each" (emphasis added). Risk is typically understood as the probability of a large, adverse deviation of an outcome from some goal or prudential limit. The manual goes on to tell bank examiners to determine the risk assessment "by balancing the overall level of inherent risk" (which can be rated high, moderate or low) "with the overall strength of risk-management systems for that activity" (which can be rated strong, acceptable, or weak). For example, a risk that is inherently "high" might merit a composite risk assessment of "moderate" if the risk management system for it is "strong."[13]

By analogy, Table 1 offers an example of an imaginary risk management matrix that the FOMC might have developed for thinking about *its own* responsibilities in the spring of 2005, when the incoming data on both inflation and real growth turned adverse for about two months. The table considers two main categories of risk, each with subcategories: macroeconomic risk (e.g., that inflation will rise too high or that

employment growth will be too slow), and risks of financial instability. In recognition of the fact that macro risks can emanate from either the demand side (where the Fed has some control) or the supply side (where it does not), the table calls separate attention to risks from demand shocks and supply shocks. Furthermore, since the Fed is also a regulator with significant responsibilities for financial stability, the table breaks down both banking sector risk and "other financial sector risks" into some of their key components.

Table 1
A Risk Management Matrix for the FOMC
Spring 2005

Risk category	Level of risk	Direction of risk	Quality of risk management
Macroeconomic risks			
Inflation risk	Moderate	*Increasing*	Strong—but with long lags
Employment risk	Moderate	*Increasing*	Acceptable—with lags
Supply shock risk	*High*	Stable	*Weak*
Demand shock risk	Moderate	*Increasing*	Strong—but with lags
Financial risks			
Banking sector risk	Low	Stable	Strong
Credit risk	Low	Stable	Strong
Other financial sector risk	Moderate (varies by sector)	Stable	Varies by sector
Stock market risk	Low	*Increasing*	*Weak*
Bond market risk	*High*	Stable	Acceptable

In general, a risk matrix that looked like this would not cause a central banker to lose much sleep. However, it would focus attention on two things to worry about: the

[13] Federal Reserve *Bank Holding Company Supervision Manual* at 2124.01. The quotes come from pages 11 and 13. While this is a manual for Fed examiners, it is a public document, available on the Fed's

rising (though not high) levels of both inflation and employment risk. Moreover, it takes note of the fact that supply shocks (principally, high oil prices), over which the Fed has no control, were the big danger at the time. Finally, it also draws attention to concern over a possible bond market shock, about which the Fed might be able to do something—e.g., by preparing the market with words, or even by adjusting short rates.

To our knowledge, the Fed does not produce tables like this, and only Alan Greenspan can say whether he carries something like it in his head. But we offer Table 1 as an illustration of how the risk management paradigm can lead to different thought processes than the paradigm of optimizing subject to a formal model. If risk management of this sort is judged to be a good framework for the Fed, then it seems to us that the next chairman can make use of it even though he won't be Alan Greenspan. Thus, the highly-judgmental Greenspan standard might survive Greenspan's retirement, albeit without its most artful practitioner.

But is this risk management paradigm something different from constrained optimization? Many academics will insist that it is not. They see risk management a la Greenspan as Bayesian optimization of an expected loss function subject to a meta-model that may encompass several models, with shifting coefficients and maybe even occasional changes in structure, and attributes to each of these models probabilities that are updated with the arrival of new information. For example, Feldstein (2004, p. 42), in discussing Greenspan's 2004 speech, wrote that:[14]

> *The key to what he called the risk-management approach to monetary policy is the Bayesian theory of decision-making…[which] begins by identifying all of the different possible "states of the world"… and assigning a subjective probability to each state….For each potential outcome, it is then in principle possible to*

website. So the criteria are known to bankers.

[14] This also seems to be Bernanke's (2004b) view. See also Svensson (2005).

> *calculate the expected utility of the outcomes, using the subjective probabilities... The optimal policy is the one with the highest expected utility.*

But we believe that Greenspanian risk management is actually something different.

Start with the daunting task of assigning probabilities to every possible "state of the world." Radner and Rothschild (1975, pp. 358-359) argued many years ago that "it is simply not tenable to maintain that managers in complex situations…formulate complete preference orderings, find optimal strategies, and pursue them." As an alternative based on bounded rationality, they explored how well a decisionmaker might do by pursuing each of several *satisficing* strategies that are definitely *not* optimizing. They called the one that seems to capture corporate risk management practices best "putting out fires," that is, directing your efforts at the most pressing problem of the day. Displays like Table 1 seem an appropriate tool for a central banker intent on putting out fires before they erupt into conflagrations.

A second, and related, possible difference between risk management and optimizing inheres in the recognition that "only a limited number of risks can be quantified with any confidence," so that "risk management often involves significant *judgment*" which requires that policymakers "reach *beyond models* to broader, though less mathematically precise, hypotheses about how the world works."[15] Quintessentially Greenspanian phrases like "significant judgment" and "beyond models" seem to pull us away from the standard models-based optimization framework into a rather less structured decision-making environment—one that may be captured better by devices like Table 1. Risk management as practiced in the real world is part art, part science. That said, models are best viewed as allegories, not literal descriptions of behavior, and there are ways to graft

judgment from outside the model onto an optimizing framework. Thus the mere use of "significant judgment" does not preclude optimization.[16]

A third possible difference between the optimizing and risk management paradigms pertains to the notion of *robustness*. If conditions are changing rapidly or sharply, then acting on a computed "optimal" policy derived from a model that might be misspecified or out of date can produce poor results, especially if the central bank's (quadratic) loss function has a sharp minimum. A satisficing solution that is not optimal with respect to any one specific model, but which performs well across many different scenarios, may be more robust to model misspecification. The risk-management framework just sketched suggests satisficing, not optimizing.

Once again, however, a sufficiently complicated Bayesian optimization framework would take into account changes in parameters, or even in model structures, that might not be known with certainty. Indeed, just as Greenspan was taking the helm at the Federal Reserve, McCallum (1988) started a line of research that looks for policy rules that perform well across different models of the economy.[17] In recent years, researchers have made substantial progress in building economic models in which the parameters are subject to shocks. This body of research, though still in its infancy, has already uncovered a few robust prescriptions for policy.[18] It may well be on its way toward formalizing a more complex version of optimizing behavior that resembles Greenspan's risk management approach.

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[15] Again, these quotes (with emphasis added) come from Greenspan (2004), p. 38.
[16] See, for example, Svensson and Tetlow (2005) or Svensson (2005).
[17] For a more recent application of this approach, see Levin, Wieland, and Williams (1999).
[18] See Onatski and Williams (2003) for a survey of progress, and Svensson and Williams (2005) for some recent developments.

A final possible distinction stems from the concept of *insurance* and, in particular, to insurance against low-probability but highly-adverse events. Greenspan (2004) has used the Fed's interest rate cuts in the fall of 1998 as an example of taking out such an "insurance policy." The U.S. economy was growing strongly at the time and was not in any apparent need of monetary stimulus. In fact, several FOMC members had been urging Greenspan to tighten since 1996. But after the double whammy of the Russian debt default in August 1998 and the collapse of the giant hedge fund Long Term Capital Management (LTCM) widened risk premiums and threatened to snowball into a worldwide financial crisis, the FOMC "eased policy because we were concerned about the low-probability risk that the default might trigger events that would severely disrupt domestic and international financial markets."[19]

You would not get that policy response from a Taylor rule (nor from any other rule). For example, the specific empirical Taylor rule that we discuss below (equation (4)) displays a large residual in 1998:4: The actual funds rate was 47 basis points below what the Taylor rule predicts. On the other hand, it can be argued that the 1998 example just illustrates that the Taylor rule is *not* the solution to the central bank's optimization problem, and that optimizing under risk surely involves insurance concepts.[20] Recent research has even shown that, under some circumstances, a Bayesian optimizer may focus on minimizing the cost of the worst conceivable outcome.[21]

On balance, however, and recognizing that it is not unreasonable to reach the opposite conclusion, we are inclined to think of Greenspanian risk management as something different from optimization subject to a formal model—at least as normally practiced by

[19] Greenspan (2004), p. 37.
[20] On the specific issue of low probability adverse events, see Svensson (2003).

economists today.[22] But our more important point is that, whatever you call it, Greenspan's practical approach to risk management may be replicable.

II.C The real interest rate and the Taylor rule

One Greenspanian innovation that surely can (and, we believe, will) survive Greenspan's reign is his choice of monetary policy instrument. Greenspan has focused—or perhaps we should say refocused—the Fed on setting the federal funds rate. More important, however, he has made it clear since 1993 that he thinks of the Fed as trying to set the *real* federal funds rate and, more particularly, the deviation of that rate from its "neutral" level.[23] What makes this possible—and, we would argue, sensible—is that the expected inflation rate, π^e, is a slow-moving state variable rather than a fast-moving "jump" variable. So when the FOMC sets the *nominal* federal funds rate, i, at a meeting, it more or less also sets the *real* federal funds rate, $r = i - \pi^e$. And if the *neutral* real rate, which we denote by r*, is pretty stable over time, it also sets the deviation of the real funds rate from its neutral value, $r - r^*$.

The concept of the neutral (real) rate of interest dates back to Wicksell (1898), who called it the "natural" interest rate, meaning the real rate dictated by technology and time preference. In modern New Keynesian models of monetary policy, it often appears as the

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[21] See, e.g., Chamberlain (2000).

[22] There is a danger that this debate, like the age-old debate over whether consumers maximize utility, can degenerate into the realm of tautology. We do not dispute the tautological notion that Greenspan is doing what he thinks is best, nor that there may be a sufficiently complicated model with a very large number of degrees of freedom that can approximate his behavior. But a theory of optimization should have more content than that.

[23] This concept first appeared in his July 1993 Humphrey-Hawkins testimony (Greenspan, 1993), and was controversial at the time. There, Greenspan referred to judging the stance of monetary policy "by the level of real short-term interest rates" and noted that "the central issue is their relationship to an equilibrium interest rate," which he defined as the rate that "would keep the economy at its production potential over time."

real rate of interest that makes the output gap equal to zero, which makes the difference between r and r* a natural indicator of the stance of monetary policy.[24] As with the natural rate of unemployment, there are also many ways to estimate the neutral rate of interest. Some propose measuring the neutral interest rate as the rate at which inflation is neither rising nor falling (Blinder, 1998); others use low-frequency movements in output and real interest rates (Laubach and Williams, 2005); and still others prefer to "back it out" of an economic model as the real rate that would obtain under price flexibility (Neiss and Nelson, 2003).

With π^e_t predetermined, either i_t or r_t can be viewed as the lefthand variable in Greenspan's reaction function. What's on the righthand side? As mentioned earlier, the actual decisions of the Greenspan Fed adhere fairly closely to a Taylor rule of the form:

$$(2)\ i_t = \pi_t + r^* + \alpha(u^* - u_t) + \beta(\pi_t - \pi^*) + \varepsilon_t,$$

where u is the unemployment rate, u* is the natural rate of unemployment, π is the core CPI inflation rate, and π^* is the target inflation rate.[25] Once you have estimates for all the parameters in (2), you don't need Alan Greenspan's astute judgment to produce interest rate decisions; a hand-held calculator will do.

Estimating (2) straightforwardly by ordinary least squares leads to severely autocorrelated residuals, however, and it turns out that *two* lags of the funds rate are necessary to eliminate the serial correlation. Hence, we estimated the following empirical Taylor rule, using quarterly data from 1987:3 through 2005:1:[26]

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[24] Among the many references that could be cited, see Woodford (1998).

[25] Taylor (1993) and many others since have used the GDP gap instead of the unemployment rate gap. Nothing much rides on this decision. However, core inflation works significantly better than headline inflation, even though the latter is the conventional choice.

[26] The coefficient 0.15 at the front comes from the lag structure; it is the sum 1 – 1.48 + .63. Thus the coefficients 1.39 and 1.62 can be interpreted as the "steady state" effects of u and π on i, while the "impact" effects are only 15% as large.

$$(3)\ i_t = (.15)(7.50 - 1.39u_t + 1.62\pi_t) + 1.48i_{t-1} - 0.63i_{t-2} + \varepsilon_t.$$
$$(1.94)\ (0.37)\quad (0.35)\qquad (0.11)\qquad (0.10)$$

$$\text{Adj. } R^2 = 0.97,\ \text{s.e} = 0.39,\ \text{n} = 69,\ \text{D-W}=1.84.$$

Comparing (3) to (2) shows that the constant (7.50) can be interpreted as the sum $r^*+\alpha u^*-\beta\pi^*$, leaving the three parameters r^*, u^*, and π^* unidentified. If we follow Taylor (1993) and set $r^*=\pi^*=2$, the implied natural rate of unemployment is 4.85%. That estimate of u^* seems reasonable for the later part of the sample period, but looks rather low for the earlier parts—which brings up the sub-sample stability of equation (3).

Notice that even if the two slope coefficients, α and β, the neutral rate of interest, r^*, and the target rate of inflation, π^*, were all constant over time, (2) would still be subject to parameter shift if the natural rate of unemployment (u^*) changed over time—and virtually everyone believes that it does. So it is not surprising that (3) shows clear evidence of sub-sample instability. For example, the sup-Wald test, which looks for a *single* break at an *unknown* date in the sample,[27] rejects the null hypothesis of no break at the 5% level. The Bai and Perron (1998) sequential method for detecting multiple structural breaks finds two breaks, one in 1994:3 and the other at 2000:3. Finally, conventional Chow tests for breaks at specific dates like 1995:1 and 2000:3 reject stability at even higher confidence levels, whether jointly or individually.

One obvious question to ask is whether the sub-sample instability is (almost) entirely attributable to a time-varying natural rate, u^*. The answer appears to be yes. There are several ways to deal with the possibility of a time-varying natural rate. The best would be to use a well-established time-series for the unemployment *gap* instead of the unemployment *rate* on the right-hand side of the Taylor rule. The world is, of course, not

[27] See Andrews (1993).

that simple. However, there have been several attempts to estimate the time path of the natural rate. One of these, covering the period ending 2000:1, was by Staiger, Stock, and Watson (2001). Using their quarterly estimate of u_t^*, the estimated empirical Taylor rule covering 1987:3 to 2000:1 is:

$$(4)\ i_t = (.34)[3.65 - 1.93(u_t - u_t^*) + 0.57\pi_t] + 1.01i_{t-1} - 0.34i_{t-2} + \varepsilon_t.$$
$$(0.54)\ (0.21) \qquad (0.16) \quad (0.14) \quad (0.11)$$

$$\text{Adj. } R^2 = 0.97,\ \text{s.e.} = 0.33,\ n = 49,\ \text{D-W} = 1.69.$$

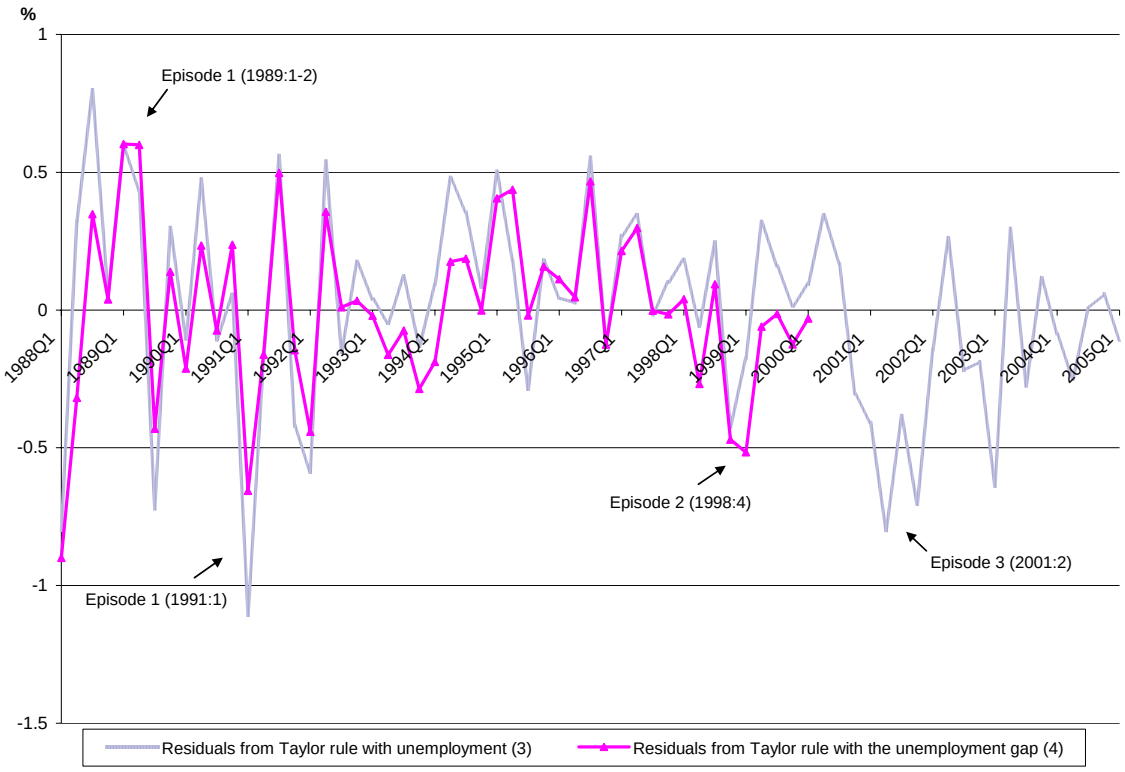
Taken as a literal description of Greenspan's decision algorithm, this equation presupposes that he was aware in real time of the changes in the natural rate of unemployment that Staiger, Stock and Watson (and most other observers) were only able to detect after 2000.[28] While this may seem difficult to believe, the fact is that the instability of the estimated Taylor rule disappears when the Staiger *et al*. estimate for u_t^* is used. There is no longer any evidence of a structural break at the 10% significance level, either at an unknown date or at 1995:1 specifically.[29]

One feature shared by both Taylor rules, equations (3) and (4), is their good fit: The adjusted R^2 is 0.97 in both regressions, and the standard errors are 39 and 33 basis points respectively. For all the mystery, secrecy, and tactical flexibility, Greenspan's actions were in the end quite predictable. This predictability should not be over-stated, however. According to equation (4), the (two-sided) 95% confidence interval for the predicted federal funds rate on any given date is 130 basis points wide. Greenspan is certainly not erratic; but his statistical Taylor rule leaves much room for discretion.

[28] It does not presuppose that Greenspan knew *exactly* what the natural rate was, only that he had a reasonably good estimate. Estimation errors would be captured by the residuals in equation (4). Reis (2003) studies how uncertainty about the natural rate of unemployment affects monetary policy.
[29] The small coefficient (0.57) on inflation is, however, troublesome.

Besides, in some sense the most interesting episodes are when the Federal Reserve under Greenspan departed most from its estimated "rule," that is, when it exercised the most discretion. Figure 1 plots the residuals from regressions (3) and (4). There are hardly any residuals as large as two standard deviations. Still, three episodes in which monetary policy differed significantly from the prescriptions of the Taylor rule seem worth mentioning.

Figure 1
The residuals from the Taylor rules and the stories they tell



The first episode took place between 1989 and 1992 when interest rates were at first rather high and later quite low, relative to the regression estimates. This was Greenspan's failed attempt at a soft-landing. The second episode occurred in 1998:4 and 1999:1: The federal funds rate was reduced when the international financial system was rocked by the Russian default and the demise of LTCM. The simple Taylor rule, of course, makes no

allowance for such events; but Greenspan did. The final episode is the sharp reduction of the federal funds rate from 6% to 1.75% between 2001:1 and 2002:1. According to the Taylor rule, this easing was excessive. But the terrorist attacks of September 11, 2001 and the (reasonable) fears of recession and/or financial instability that ensued were presumably behind these low interest rates. This was Greenspanian risk management in action.

II.D Respect for the dual mandate

The Federal Reserve Act directs the Board of Governors and the FOMC to use monetary policy "to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates."[30] Since "moderate long-term [nominal] interest rates" flow naturally from low inflation, this phrase has come to be called the Fed's "dual mandate."

Since it instructs the FOMC to penalize *both* inflation *and* deviations of output from its full-employment level, the dual mandate can be thought of as a literary version of an objective function like equation (1). What it should *not* be thought of is boilerplate. Compare the ESCB's legal mandate from the Maastricht Treaty, which states unequivocally that "the primary objective of the ESCB shall be to maintain price stability." It then adds that "without prejudice to the objective of price stability, the ESCB shall support the general economic policies in the Community" (which include high employment).[31] The phrasing certainly seems to create a lexicographic ordering: Price stability comes first. The Bank of England's policy "remit" establishes a similar lexicographic ordering between its two goals: "(a) to maintain price stability, and (b)

[30] At section 2(A)1. The Federal Reserve Act dates from 1913, but this phrase went into the Act in 1977.

subject to that, to support the economic policy of Her Majesty's Government, including its objectives for growth and employment."[32]

In stark contrast, the Federal Reserve Act puts "maximum employment" and "stable prices" on a par. The former is not an afterthought to be attended to after the latter is assured. It has been argued that all three legal mandates are consistent with minimizing a loss function like (1).[33] But the different wordings of the legal mandates *can* and *should* lead to different policy decisions from time to time. In particular, Congress's directive to the Fed almost certainly instructs it to pay *more* attention to employment than do either the Maastricht Treaty's instructions to the ECB or the BoE's policy remit. One way to put this point formally is to say that the Fed's objective function places a higher weight, λ, on output (or employment). But a possibly more accurate version is that the ECB, the BoE, and other inflation-targeting central banks should order inflation and unemployment lexicographically—in violation of equation (1)—whereas the Fed should not.

In any case, the Federal Reserve has taken its dual mandate very seriously during the Greenspan years.[34] There have been only two mild recessions during the 18 years ending August 2005, and the second of them (in 2001) was so mild that it actually disappears when quarterly data are aggregated to years. The average unemployment rate over the period was just 5.55 percent. By contrast, during the 18 years ending in August 1987, the U.S. economy suffered its two worst recessions since the Great Depression, plus two other recessions by official NBER dating. The unemployment rate averaged 6.85 percent.

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[31] Treaty of Maastricht, Article 105.1.
[32] Quoted from The Bank of England Act (1998).
[33] For example, the annual letter to the Bank of England from the Chancellor of the Exchequer does not reflect a lexicographic ordering; it instructs the Bank to balance inflation reduction against output volatility.
[34] One can argue that the dual mandate was also taken seriously in the Volcker years, *after* inflation was brought under control. But that behavior seems more consistent with a lexicographic ordering.

On the inflation side, the 12-month trailing increase in the core CPI was 3.9 percent when Alan Greenspan became chairman of the Fed in August 1987. Today it is 2.0 percent, and about 0.6 percentage points of the decline is attributable to measurement changes that the BLS made between 1995 and 1999.[35] Modern macroeconomic analysis suggests that the cumulative decline in inflation (in this case, 1.3 points over 18 years) should be roughly indicative of the average amount of slack the central bank has engineered or allowed over the period. If so, Greenspan has not presided over much slack.

Of course, Greenspan's initial image was not that of an inflation "dove." In fact, he was typically portrayed by the media as an inflation "hawk" in the early years of his chairmanship. It took the media almost a decade to catch on to the fact that, relative to the center of gravity of the FOMC, Greenspan was actually a dove—which became crystal clear when he restrained a committee that was eager to raise rates in 1996-1997.[36] But it should have been evident earlier. After all, over the first eight years of the Greenspan chairmanship, inflation was consistently above the Fed's likely long-run target, and yet the core CPI inflation rate fell by less than one percentage point. That hardly looks like the handiwork of an "inflation nutter."[37]

But it was the 1996-1999 episode, which Blinder and Yellen (2001) dubbed the period of "forbearance," that removed all doubts. As we will discuss in detail later, an acceleration of productivity gives a central bank a pleasant choice: It can have some combination of lower inflation and lower unemployment than previously planned. The Greenspan Fed opted for both, but the gains on the unemployment front were far more

[35] See Blinder and Yellen (2001), p. 48.
[36] On this episode, see Meyer (2004).

impressive. The inflation rate inched down by less than 1 percentage point between the beginning of 1996 and the beginning of 2000,[38] and most of that was from changes in measurement. But the unemployment rate kept falling lower and lower, eventually eclipsing just about anyone's estimate of the natural rate. And yet the FOMC held its fire. We doubt that many central bankers in history would have had the fortitude to show that much forbearance, and we believe that the U.S. economy reaped many social benefits from Greenspan's "dovish" stance.[39]

The claim that Greenspan was, relatively speaking, a dove can be backed up—and, to an extent, quantified—by comparing the Taylor rule for the Greenspan period to that of (a) the Volcker period and (b) the Bundesbank.[40] Since our efforts to estimate a Taylor rule for Paul Volcker's tenure as Fed chairman found no evidence of interest-rate smoothing, we compare the following two equations which, for ease of comparison, omit the lagged values of the funds rate:[41]

Volcker (1979:3-1987:2):

$$(5) \qquad i_t = \underset{(2.21)}{0.61} + \underset{(0.21)}{0.48}u_t + \underset{(0.17)}{0.95}\pi_t + \varepsilon_t.$$

$$\text{Adj. } R^2 = 0.66,\ \text{s.e} = 2.15,\ n = 32,\ \text{D-W:} = 1.45$$

Greenspan (1987:3-2005:1):

$$(6) \qquad i_t = \underset{(0.67)}{7.69} - \underset{(0.11)}{1.62}u_t + \underset{(0.18)}{2.02}\pi_t + \varepsilon_t.$$

$$\text{Adj. } R^2 = 0.84,\ \text{s.e} = 0.90,\ n = 71,\ \text{D-W:} = 0.31$$

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[37] The phrase belongs to Mervyn King (1997), who did *not* apply it to Greenspan.
[38] As usual, we use the 12-month trailing average of the core CPI inflation rate, which was 2.9% in February 1996 and 2.2% in February 2000.
[39] Sinai (2004) attempts to quantify some of them.
[40] The history of the ECB is still too short to permit any reasonable comparisons of the Greenspan Fed to the ECB.

Equation (6) differs only slightly from the Greenspan equation presented earlier (see equation (3)); it has a worse fit and somewhat larger slope coefficients. But the differences between (5) and (6) are stark. The Taylor rule for the Volcker period (equation (5)) actually displays the wrong sign for the response to unemployment. Surprisingly, it shows a smaller response to inflation than equation (6) does. Thus, if we define "dovishness" as a strong response to unemployment—which is our preferred definition—then Greenspan was vastly more dovish than Volcker. But if we define "dovishness" as a weak response to inflation, then Volcker, not Greenspan gets labeled as the dove. We submit that any definition that classifies Paul Volcker as a dove is a poor definition.[42]

Now comparing the Greensan Fed to the Bundesbank, Clarida and Gertler (1997) estimated the following Taylor rule using monthly data from 1974:9 to 1993:9:

Bundesbank (1974:9-1993:9):

$$(7) \qquad i_t = \underset{(0.12)}{6.35} + \underset{(0.03)}{0.20}(ip_t - ip\ trend_t) + \underset{(0.07)}{0.71}\pi_t + \varepsilon_t.$$

$$\text{Adj. } R^2 = 0.43,\ \text{s.e} = 1.82,\ \text{n} = 240$$

This Taylor rule differs from ours in that real activity is measured as the deviation of industrial production from trend and inflation refers to headline inflation. To compare the two rules, we can use the econometrically-estimated rule of thumb that, in Germany, a 1% increase in the unemployment rate typically comes with a 1.63% fall in industrial production. The Bundesbank therefore reacted to a 1% increase in the unemployment rate

[41] Because of the serial correlation, we corrected the standard errors for heteroskedasticity and autocorrelation.

[42] A more natural measure of dovishness is the weight, λ, on unemployment in the central bank's loss function. It does not follow as a general result that a larger λ leads to a larger coefficient on unemployment in the Taylor rule. But in many currently popular models, it does.

by lowering interest rates by about 0.33%—well below the 1.62% reaction of the Greenspan Fed. Thus, Greenspan also looks dovish by Bundesbank standards.

II.E The resurrection of fine tuning

By the time Alan Greenspan became chairman of the Fed, the notion that fiscal or monetary policy should be used to "fine tune" the economy had been relegated to the dustbin of history. For example, Lars Svensson (2001, p.1) wrote on the opening page of his widely-respected review of the Reserve Bank of New Zealand that "the complex transmission mechanism of monetary policy, the varying lags and strength of the effects through different channels, unpredictable shocks and inherent uncertainty combine to prevent the use of monetary policy for fine-tuning." Although our guess is that Greenspan would shun the label "fine tuner," his actions (not his words) have breathed new life into the idea by demonstrating that it is actually possible. Indeed, he is probably the most successful fine tuner in history, and we are not inclined to attribute all that success to luck.[43]

To give concrete meaning to the Helleresque (that's Walter, not Joseph) term "fine tuning," we need a working definition. Since we are not aware of any agreed-upon definition, we offer the following three closely-related options:

1. Pursuing an activist stabilization policy that tries to keep inflation or unemployment (or both) close to their target levels.

2. Operating with large coefficients α and β in the Taylor rule, equation (2).

3. Using frequent small changes in the central bank's instrument, as necessary, to try to hit the central bank's targets fairly precisely.

Definition 1 is a generic definition of the notion of fine tuning, portraying it as conventional stabilization policy but with fairly ambitious goals. Definition 2 specializes that general definition to the case in which the central bank follows a Taylor rule, whether tacitly or explicitly. This definition also makes the presence or absence of fine tuning potentially testable, since α and β can be estimated empirically. Definition 3 takes the analogy to tuning a TV set seriously, by envisioning a central banker who makes frequent fine adjustments to his or her control dials.[44] The three definitions are similar; and by any of them, we submit, Alan Greenspan not only qualifies as a fine tuner, but as a highly successful one.

Definition 2 is the easiest one to deal with, since it invites comparisons of the Greenspanian Taylor rule to other estimated Taylor rules. The estimated coefficients in (3)—and, even more so, those in (6)—are both a bit larger than suggested by Taylor (1993).[45] But, of course, Taylor's original parameters were not intended to set a standard of fine tuning. In fact, they were intended to capture the behavior of Alan Greenspan! Comparison of the estimated Taylor rule for the Greenspan Fed with the optimal policy rules calculated for several specific models suggests that Greenspan's average historical response to unemployment was higher than what is typically optimal.[46] Thus, if you believe the models, this is another indication of dovish fine tuning.

Definition 3 characterizes a fine tuner as someone who "twiddles the dials" a lot. Despite some remarkable episodes of constant interest rates for protracted periods of time (especially 1992-1994, 1996-1999, and 2003-2004), this third definition of fine tuning

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[43] We return to the relative roles of luck and skill in the Greenspan record later.
[44] The term dates from the old days, when TV sets had knobs!
[45] Taylor's coefficient of ½ was on the GDP gap, not unemployment. Given Okun's Law, this translates, roughly, to a coefficient of about 1 on the unemployment gap.

seems to capture the Greenspan style pretty well. Prior to June 1989, the FOMC under Greenspan changed the funds rate 27 times in less than two years. Notably, only six of those changes were of the now-familiar 25 basis-point variety. However, since June 1989, the FOMC has changed rates 67 times, and 50 of those changes were of ±25 basis points. Sixteen of the other 17 changes were of ±50 basis points.[47]

The penchant to move the funds rate by *exactly* 25 basis points is a notable feature of the Greenspan style, and it was not present before him. Indeed, as just noted, it was not even present during his first two years. This stylistic change is probably attributable to the Fed finally weaning itself away from its old procedure (left over from the Volcker days) of setting a target for borrowed reserves. During 1988 and 1989 period, the FOMC was focusing less and less on borrowed reserves and more and more on the funds rate. That change in focus, in turn, encouraged the use of round numbers for the funds rate.[48]

If interest rate changes are *small*, then any sizable cumulative tightening or easing requires *numerous* discrete adjustments of the funds rate. And that, too, is part of Greenspan's *modus operandi*. When the Fed tightened by a cumulative 331 basis points in 1988-1989, it did so in 18 separate steps. When it eased from mid 1989 through September 1992, it took 24 steps to bring the funds rate down by 681 basis points. The 300-basis-point tightening in 1994-1995 came in seven steps, and the 175-basis-point tightening in 1999-2000 took six. The easing during 2001 brought the funds rate down 425 basis points in 11 distinct moves.[49] Finally, the most recent tightening cycle has, as

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[46] This is our distillation of the findings in Rotemberg and Woodford (1997), Levin, Wieland, and Williams (1999), and Orphanides and Williams (2005).

[47] The sole exception was the 75-basis-point increase on November 15, 1995. (This draft was written before the Fed's interest rate hike on August 9, 2005.)

[48] We are grateful to Donald Kohn for a discussion on this point.

[49] The Fed subsequently added one 50-basis point cut in 2002 and one 25-basis-point cut in 2003.

of the time of this writing, brought the funds rate up 225 basis points in nine steps. Clearly, Greenspanian rate cycles resemble staircases, not elevators.

It is interesting to speculate why, especially since viewing monetary policy through optimizing lenses would seem to suggest that the anticipated path of the federal funds rate should respond only to news about, e.g., the economic outlook and/or likely future deviations of inflation and unemployment from their targets. As William Poole (2003, pp. 5-6) put it:

> *In my view of the world, future policy actions are almost entirely contingent on the arrival of new information… Given information available at the time of a meeting, I believe that the standing assumption should be that the policy action at the meeting is expected to position the stance of policy appropriately.*

Despite this logic, it appears to us that Greenspan, like other central bankers, has a clear revealed preference for gradualism.[50] Why? We can think of at least three reasons.

1. *Multiplier uncertainty*: Years ago, Brainard (1967) made a simple but compelling point: If a policymaker is uncertain about the marginal impact of his policy instrument on the target variable ("the multiplier"), he should probably use the instrument in smaller doses (that is, more "conservatively"). As Blinder (1998) later observed, such conservatism probably means that subsequent doses of the same medicine will be required to get the job done.

The most important word in the preceding capsule summary of Brainard's idea is "probably." Brainard conservatism is *not* a general theoretical result; even Brainard's original paper noted that covariances could upset the basic result. But then again, neither

[50] Rudebusch (2005) reminds us that finding a significant coefficient on the lagged funds rate in an inertial Taylor rule, such as our equation (3), does not necessarily imply a preference for gradualism—that is, for partial adjustment of the funds rate toward its "desired" level. Griliches (1967) pointed out decades ago that it is very hard to distinguish between partial adjustment and serially correlated errors. Rudebusch also notes that, as an empirical matter, the yield curve does not reflect any perception by the financial markets that the federal funds rate moves inertially.

can the negative slope of the demand curve be established by pure theory. Subsequent literature elaborated on the conditions under which Brainard's original conclusion would or would not hold. Onatski and Williams (2003) survey a number of recent contributions on robust control and conclude that an adequate approach to model uncertainty most likely sides with Brainard. As Blinder (1998, p. 12) put it some years ago, "My intuition tells me that [Brainard's] finding is more general—or at least more wise—in the real world than the mathematics will support."

2. *Interest-rate smoothing*: Almost all central banks these days use a short-term interest rate as their main monetary policy instrument, and there may be good reasons to move interest rates gradually rather than abruptly. For example, if sharp gyrations in short-term interest rates lead to greater volatility in long-term interest rates, they will produce sizable capital gains and losses that might undermine financial market stability. In formal optimizing models, this idea is often captured by the shortcut device of including a term like $\gamma(i_t - i_{t-1})^2$ in the periodic loss function—on the grounds that large changes in interest rates can precipitate financial instability. Doing so naturally carries i_{t-1} into the central bank's reaction function, leading to interest rate smoothing.

Woodford (1999) makes a different case for gradualism in the context of a specific forward-looking model in which only some prices are free to adjust each period. He argues that, if the central bank can *commit* to a future path for interest rates in response to shocks, price-setters will expect the bank to continue to move interest rates in the same direction. For that reason, those who adjust prices today will change their prices by more—thereby compensating for those who do not adjust prices at all.

3. *Reversal aversion*: The simple optimizing paradigm might well call for a central bank to raise interest rates at one meeting and then lower them at the next. It all depends on how the news comes in. But anyone who has ever lived in or near a central bank knows that policymakers have a strong aversion to policy reversals like that. One obvious reason may be a reluctance to (seem to) admit error—in direct contradiction of the doctrine of central bank infallibility. For example, Greenspan told the FOMC in July 1996 that, "If we are perceived to have tightened and then have been compelled by market forces to quickly reverse, our reputation for professionalism will suffer a severe blow."[51]

There may be other reasons for reversal aversion. For example, we just noted that policymakers do not want to increase volatility in financial markets. Frequent reversals might well do that. And a cautious approach can probably be rationalized on the robustness criterion discussed earlier.

All of these virtues of gradualism notwithstanding, there is also a possible vice: namely that a central bank that is too gradual or too cautious may find itself falling "behind the curve"—not raising rates fast enough to prevent an acceleration of inflation, or not cutting rates fast enough to support a sagging economy. The Greenspan Fed has in fact been accused of falling into this trap several times—for example, in the 1990-1992 easing cycle, the 1994-1995 tightening cycle, the 1999-2000 tightening cycle, and the current tightening cycle. Should Greenspan plead guilty or innocent to these charges? If we may be permitted to serve as preliminary judge and jury:

[51] Quoted by Meyer (2004), p. 56.

1. The criticism probably has some validity in the case of fighting the 1990-1991 recession and its aftermath. The Fed was slow to recognize the recession.[52] Then, from its first 25-basis-point cut in July 1990 until the end of October 1991, it took the FOMC 15 months to reduce the funds rate by 300 basis points, which it accomplished mostly in 25-basis-point increments. Along the way, the FOMC chose to leave rates unchanged at eight meetings, which suggests a somewhat unhurried attitude. The Fed picked up the pace in late 1991, however, slashing the funds rate 125 basis points in less than two months, including three intermeeting moves.

2. As the FOMC was raising rates in 1994-1995 ("preemptively," it claimed), the markets began clamoring—loudly at times—that the Fed was falling behind the inflation curve. At one point, the futures markets were actually predicting that the funds rate would rise as high as 7.5 or 8%.[53] This criticism eventually helped persuade Greenspan to promulgate the only 75-basis-point rate hike of his career. But, in retrospect, the criticism seems unwarranted. In the event, the funds rate topped out at 6% and there was no acceleration of inflation whatsoever. Just five months later, the Fed started cutting rates again. So we declare Greenspan innocent of the charge of falling behind the curve in 1994. Indeed, we see this use of preemptive monetary policy as one of his signal achievements.

3. The tightening cycle that began in June 1999 started late, according to many financial market participants, some of whom were urging the Fed to counteract the effects of the stock market bubble much earlier. And since there was some acceleration of

[52] Needless to say, recognizing the onset of recession is much easier with hindsight than with foresight.
[53] It is hard to document this fact, which Blinder remembers, in a published source. Merrill Lynch (2005) states that the market in early February 1995 had "priced in an 8% funds rate."

inflation during the year 2000, the critics may have had a point.[54] But it must be remembered (a) that inflation was on a slight *downward* trajectory for most of 1999, and (b) that Greenspan was not persuaded that the Fed should be in the business of bursting stock market bubbles. (More on that later.) The bubble finally began to burst in 2000, months after the Fed started hiking rates; and a (mild) recession followed.

On balance, we believe that history will judge Greenspan more correct than his contemporaneous critics, who were often too excitable and "quick on the draw." Only 1990-1991 looks, in retrospect, like a mistake. And note that we reach these judgments with the magnificent wisdom of hindsight. In real time, with enormous uncertainty in each episode, Greenspan's penchant for gradualism may have been even wiser—for the "risk management" and "conservatism" reasons discussed earlier.

II.F Moving (slowly) toward greater transparency

There is yet another reason why movements of the federal funds rate may now be smaller than used to be thought necessary. It has recently become a commonplace that, if the Fed is reasonably transparent, the bond market will do much of its work for it. The reasoning is simple. Long-term interest rates are more important to economic activity than is the federal funds rate. But long rates reflect market expectations of where the funds rate is heading. So, if the Fed signals its future intentions successfully, the markets may move long rates up or down quickly, and in the direction the Fed wants, *in*

[54] The 12-month trailing core CPI inflation rate rose from 1.9% in December 1999 to 2.6% in December 2000. Others (including one of us) contend that there were reasons other than the stock-market bubble to tighten sooner—namely the acceleration of nominal wage growth starting in 1998. See Mankiw and Reis (2003a).

anticipation of future increases in the funds rate.[55] Thus, many modern monetary economists argue, greater transparency reduces the lags and enhances the power of monetary policy.[56]

A second class of arguments for greater transparency stems not from economics at all, but rather from democratic theory. Milton Friedman complained years ago that central bankers' two main goals were "avoiding accountability on the one hand and achieving public prestige on the other."[57] While Friedman was being deliberately polemical, he had a point. A powerful independent agency within a democratic government needs to be held accountable to the citizenry and to its elected representatives. But accountability is pretty much impossible without at least a modicum of transparency, for how else are citizens to know whether the central bank's deeds match its words?

The Fed has become much more communicative during Alan Greenspan's long tenure, albeit with a certain grudging reluctance. The early Greenspan (say, before February 1994) can be characterized fairly as "old school" on the transparency issue, meaning that he believed that the Fed should speak rarely and cryptically. There certainly was no discernible increase in transparency when Greenspan replaced the famously opaque Paul Volcker in 1987. Soon Greenspan, who is far from plainspoken in any case, became known for such memorable phrases as "mumbling with great incoherence"—which he used (with a hint of humor) to characterize his own version of Fedspeak.

But Greenspan was not joking when he told a House committee in October 1989 that immediate announcement of the FOMC's interest rate decisions "would be ill-advised"

[55] Oddly, this has not seemed to have happened in 2004-2005, as long rates fell despite the Fed's tightening (and its expressed intention to tighten more). Greenspan has called this a "conundrum."
[56] Blinder (2004, Chapter 1) expounds on this point, and on the case for transparency in general, in much greater detail. For a longer treatment, see Blinder *et al*. (2001).

and "could impede timely and appropriate adjustments to policy." In amplifying his remarks in a subsequent written communication to the committee, he explained that the Fed might want to conceal its decisions in order to forestall "outsized market reactions."[58] In a nutshell, the chairman of the Fed was saying that he did not want to reveal the FOMC's decisions contemporaneously because markets might overreact—and that might inhibit the Fed from taking the right decisions. Viewed from a contemporary perspective, that is a stunning assertion—one which we doubt Greenspan would defend today.

But four years later, he expressed precisely the same sentiments to FOMC members in a confidential October 1993 telephone call on the disclosure issue. In his words, "immediate release of the directive could threaten to roil markets unnecessarily, and concern about market reaction could reduce flexibility in decisionmaking." While Greenspan noted that some FOMC members were "favorably disposed" toward immediate release of the interest rate decision, and while he conceded that doing so "might give the appearance of openness without doing too much substantive harm to the policy process," he nonetheless opposed the idea.[59]

His view apparently changed quite dramatically, however, within a few months—for the FOMC first began announcing its funds rate decision, on Greenspan's firm recommendation, at its February 1994 meeting. Why?

First of all, some members of Congress were clamoring for more openness after the embarrassing revelation, in the fall of 1993, that the Fed had been secretly keeping tapes of FOMC meetings. The House Banking Committee, chaired at the time by the Fed-bashing Henry Gonzalez of Texas, had held hearings on that subject in October 1993,

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[57] Quoted in Fischer (1990), page 1181.
[58] Greenspan (1989), pp. 49, 50, and 70.

with Greenspan and other members of the FOMC testifying.[60] The hearings, and the revelations about the tapes, had put the close-mouthed Fed on the defensive.

Second, when it came time to raise interest rates in February 1994, Greenspan was more worried about the consequences of *failing to announce* the FOMC's decision than of announcing it. Why the change of heart? We know the answer—sort of—from the transcript of the meeting.[61] The 25-basis-point rate hike on February 4, 1994 was to be the Fed's first interest rate change since September 1992, and Greenspan was worried that it would shake up the markets.[62] For that reason, he told the committee, "when we move… we are going to have to make our action very visible… I am particularly concerned that… we make certain that there is no ambiguity about our move." In other words, in February 1994 he was saying that calling attention to the rate hike would *stabilize* the markets, not *roil* them—precisely the reverse of the position he had taken the previous October.

The transcript further reveals that Greenspan did not want the February 1994 announcement to be construed as setting a precedent.[63] Other members of the FOMC were skeptical that he could pull off that Houdini trick and, in the event, he did not. Transparency proved to be precisely the slippery slope that its opponents had feared. That first announcement turned out not only to set a precedent that would never be revoked, but also to be the first of many steps toward a more open Fed. One year later, the Fed

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[59] *Transcript of FOMC Conference Call, October 5, 1993*. The quotations come from pages 1 and 3.
[60] It was at the October 13th hearing, and an FOMC conference call two days later, that many members of the FOMC first learned that the tapes were being retained. Previously, they thought the tapes were erased once the minutes were prepared.
[61] The short quotations that follow come from *Transcript of Federal Open Market Committee Meeting, February 3-4, 1994*, p. 29.
[62] For this reason, he insisted—against the will of the FOMC majority—that the funds rate go up only 25 basis points, rather than 50.

officially adopted what had become its *de facto* policy of announcing all decisions immediately. But contemporaneous recommendations for further disclosures were roundly rejected by the FOMC.[64]

There things stood until May 1999, nearly 12 years into the Greenspan era, when the Fed took two important steps toward greater transparency. It decided (a) to issue a statement after every FOMC meeting, even if the funds rate was not changed, and (b) to reveal the "bias" in its directive immediately. (Previously, the bias had been kept under wraps until the minutes were released, a few days after the next FOMC meeting.)

The resulting increase in the volume of FOMC communication was noteworthy. During each of the years 1996 and 1997, the FOMC had issued exactly one statement—not one *per meeting*, but one *per year*. In 1998, it had issued three statements, all in conjunction with its reaction to the global financial crisis. The average number of substantive words in those five statements was just 58.[65] This tight-lipped policy applied also to the first two FOMC meetings of 1999, neither of which was followed by a statement. But the quantity—and, we would argue, also the quality—of Fedspeak increased noticeably starting with the May meeting. A statement was issued after each of the remaining six FOMC meetings in 1999, and the substantive word count rose to an average of 135. The year 2000 saw much the same thing: eight statements (one for each

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[63] In his words: "I'm very strongly inclined to make it clear that we are doing this but to find a way to do it that does not set a precedent."

[64] A committee headed by Alan Blinder, who was then Vice Chairman of the Board of Governors, brought several recommendations to the FOMC. These included making an explanatory statement after every meeting, even those that left the funds rate unchanged. See *Transcript of Federal Open Market Committee Meeting, January 31-February 1, 1995.*

[65] We count words as follows. An FOMC statement normally begins by announcing the decision ("The Federal Open Market Committee decided today to …") and, if the discount rate is changed, it normally ends by listing the Reserve Banks that had recommended the discount rate change. We exclude those and similar words and count only the substantive words describing the economy and/or providing the rationale for the decision.

meeting), averaging 119 words each. Thus May 1999 was a watershed in the history of the Fed's reluctant peregrination toward transparency.

Of course, the FOMC did not implement its new communication policy perfectly from the start. By February 2000, dissatisfaction with the way the "bias" statement was being handled led the committee to replace it with a new "balance of risks" sentence, stating whether the FOMC was more concerned with "heightened inflationary pressures" or "economic weakness" (or neither) in "the foreseeable future." That last phrase was a deliberate, and successful, attempt to make it clear that the time frame for the balance of risks extended beyond the next FOMC meeting.

The next step came in March 2002, when the FOMC began announcing the vote—with names—in the statement released at the end of each meeting. Of course, since dissents are rare on the Greenspan Fed, the vote *per se* contains little information. In May 2003, the committee again modified its approach to the balance of risks statement by distinguishing between inflation risks and risks to real growth—which remains the Fed's approach today.

But perhaps a more significant, if informal, change in communications policy was also made in 2003. Seeking to manage expectations better in an economy where an (admittedly minor) threat of deflation had emerged, the Fed started using more descriptive forward-looking prose in its statements.[66] This new "policy" began in August, when the statement famously said that "the Committee believes that policy accommodation can be maintained *for a considerable period"* (emphasis added), a phrase

[66] Actually, there was a now-forgotten precursor in August 1994, when the Fed raised both the funds rate and the discount rate by 50 basis points and declared that "these actions are expected to be sufficient, *at least for a time*, to meet the objective of sustained, noninflationary growth." (emphasis added) Markets soon decided that those vague words meant "for the rest of 1994," which was never the Fed's intent.

it repeated precisely in its September, October, and December statements. Greenspan's intent, it was widely believed, was to hold intermediate and long rates down by squashing expectations that the Fed was on the verge of increasing the funds rate. Then, at its first meeting in 2004, the FOMC changed its stock phrase to "the Committee believes that it can be *patient* in removing policy accommodation" (emphasis added). Translation: *We are in no hurry to raise rates*. And two meetings later (in May 2004), it changed it again to the now-famous "the Committee believes that policy accommodation can be removed at a pace that is likely to be *measured*" (emphasis added)—words it has retained *verbatim* to this day—and which came to mean 25 basis points at each FOMC meeting.

Finally, in February of this year, the Fed took its most recent step toward greater transparency by releasing the FOMC minutes earlier. Previously, the minutes of each meeting were not released until three days after the *next* meeting, making the release pretty much "old news." Now, the minutes are released about three weeks after each FOMC meeting, so that each release is—at least potentially—a market event.

None of these changes in communications policy can be considered earth-shattering *per se*. There was no sudden "regime change." Yet, cumulatively, they add up to quite a lot. It is no exaggeration to say that the FOMC's disclosure policies today bear no resemblance whatsoever to its policy of stone-walling prior to February 1994. Were it not for the fact that the Fed took over eleven years to get from there to here, we might call these changes revolutionary. But revolutions proceed at a faster pace.[67] And when it

[67] Hence Blinder's (2004) title, *The Quiet Revolution*.

comes to transparency, the Greenspan Fed has been more of a laggard than a leader among central banks.[68]

The Greenspan legacy is therefore *not* that he will leave behind an unusually open central bank. It is, instead, the unmistakable *trend* toward transparency that he has followed for eleven years now. The Fed has been moving gradually in the direction of greater openness ever since it first dipped its toe in the water in February 1994. And while the pace has rivaled that of a snail, none of those changes would have happened without Greenspan's backing. In all that time, the FOMC never took a single step backward and, as far as is known, never regretted any of its steps forward. That forward momentum, we presume, will continue and perhaps even accelerate after Greenspan retires.

II.G Core inflation and the reaction to oil shocks

Another Greenspan innovation, which is rarely mentioned but is likely to prove durable, is the way he has focused both the Fed and the financial markets on core, rather than headline, inflation.[69] This aspect of Federal Reserve monetary policy contrasts sharply with the concentration on headline inflation at the ECB and to the stated inflation targets of most other central banks, which are rarely core rates.[70] And it is *not* an inconsequential detail. In the United States today, an oil shock is viewed as a "blip" to the

[68] For a detailed discussion and evaluation of transparency at a variety of central banks, see Blinder *et al*. (2001).

[69] Core inflation excludes food and energy prices. The choice between core and headline inflation does not exhaust the question of which measure of inflation a central bank should focus on. See Mankiw and Reis (2003a) for a theoretical framework that suggests giving a large weight to nominal wages.

[70] Berg (2005, Table 1) lists the inflation targets of 20 inflation-targeting central banks, only two of which are core rates. However, Lars Svensson has pointed out to us that many inflation targeters act or even speak as if their target was *core* inflation. Furthermore, if the forecasting horizon is two to three years, the forecasts of core and headline inflation are probably identical.

inflation process that does not affect long-term inflationary expectations and should mostly be ignored by the Fed because it will fade away of its own accord. This is not the case in Europe.

One way to assess whether the Fed's focus on core inflation makes sense is to investigate whether core or headline inflation is the better predictor of future *headline* inflation. Table 2 displays the forecasting performance of regressions of the form:

$$\pi_{t,t+h} = \text{constant} + \beta x_{t-12,t} + \varepsilon_t \ ,$$

where $\pi_{t,t+h}$ is the *headline* inflation rate between months t and t+h, and $x_{t-12,t}$ is either core or headline inflation over the previous 12 months. Each column compares the performance of the two possible forecasts of headline inflation at time horizons ranging from six months to three years. First, we consider the *in-sample* ability to forecast by displaying the standard error of regressions estimated using the entire sample of monthly data from October 1987 to March 2005. Second, we assess *out-of-sample* forecasting performance by estimating the regressions stopping at December 1995 and computing the root mean squared errors from forecasting inflation from then to the end of the sample. Third and finally, we estimate multivariate regressions over the whole sample in which *both* core *and* headline inflation are used to forecast the future of headline inflation. The bottom rows of the table display the coefficients and standard errors on each variable.

Table 2
Forecasting future inflation: core versus headline inflation

	Forecasting horizon			
	6 months	12 months	24 months	36 months
In-sample standard error				
Core	1.08	0.91	0.73	0.65
Headline	1.10	0.93	0.81	0.72
Both	1.08	0.90	0.73	0.65
Out-of-sample root mean squared error				
Core	1.09	0.89	0.63	0.42
Headline	1.16	1.00	0.89	0.70
Both	1.07	0.98	0.82	0.60
Multivariate regression coefficients				
Core	0.43 (0.13)	0.39 (0.11)	0.66 (0.10)	0.61 (0.09)
Headline	0.23 (0.12)	0.23 (0.10)	-0.04 (0.09)	-0.07 (0.08)

Notes: Each cell is derived from a regression of the form $\pi_{t,t+h} = \text{const.} + \beta\, x_{t,t-12} + \varepsilon_t$, where x is a vector in the multivariate case. Reading across columns, the forecasting horizon, h, varies. Reading down rows, the variable x, which is either core inflation, headline inflation, or both varies—as does the approach to assessing forecasting performance. The top panel displays the in-sample standard errors of regressions on the full data set. The middle panel displays the out-of-sample root mean squared errors from 1996:1 to 2005:3 generated from forecasting equations estimated over the period from 1987:8 to 1995:12. The bottom panel shows the coefficients and standard errors from a single regression, estimated on the whole sample, that included both core and headline inflation on the right-hand-side.

Every specification in the table points to the same conclusion: that recent *core* inflation is a better predictor of future *headline* inflation than is recent headline inflation itself. Using core inflation always leads to a smaller in-sample prediction error, a smaller out-of-sample forecasting error, and receives a larger coefficient in multivariate regressions. (It is also always a very significant predictor, unlike headline inflation.) Although the margin of victory is rather slender at short horizons, it is typically substantial at the two- or three-year horizons that are most relevant for monetary policy.

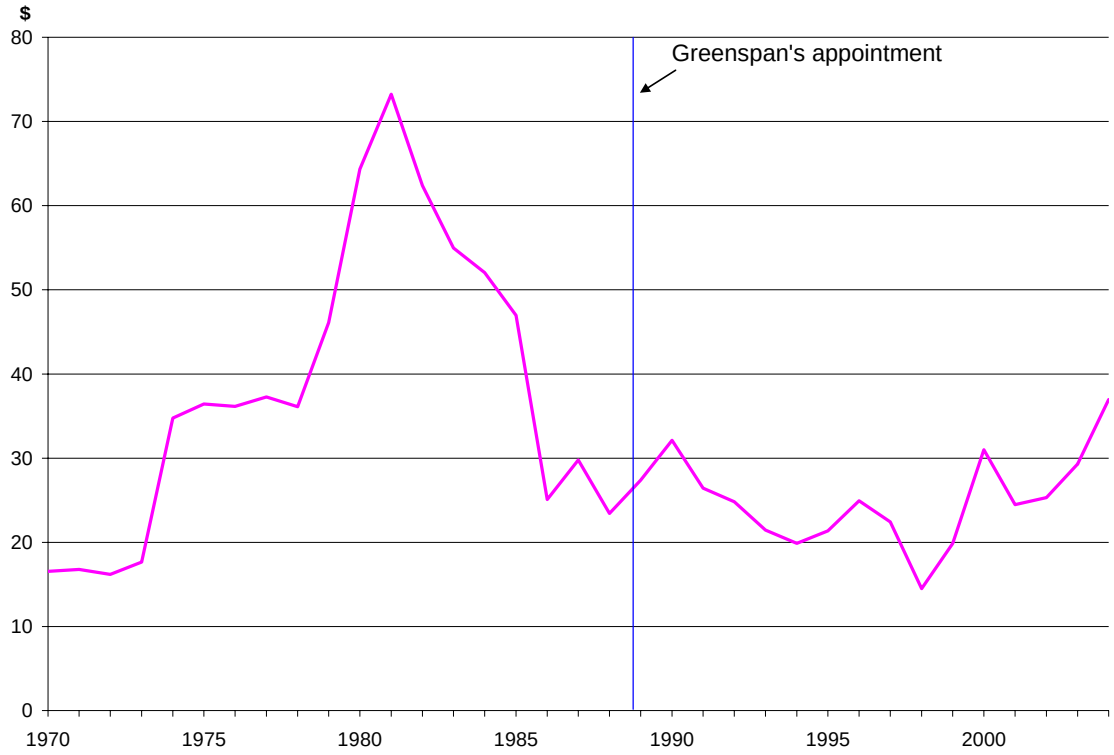
Indeed, once you take core inflation into account, adding headline inflation has at best no effect on forecasting performance, and at most horizons makes forecasts even worse. The table thus clearly supports the Fed's practice of responding to core, not headline, inflation.

Figure 2 offers a clue as to why oil prices have not helped forecast future headline inflation (which *includes* oil prices)—and why, therefore, it has made sense to ignore oil shocks in forecasting inflation. It shows the history of the *real* price of oil *to the United States* since 1970.[71] The graph displays no upward trend whatsoever. In fact, a descriptive annual regression of ln(p) on time, covering the period from 1970 to 2004, yields a statistically insignificant estimate of b of -0.007. More important, it takes no more than eyeballing the data to see that almost every oil price shock has reversed itself; only OPEC I appears to have been permanent. If strong mean reversion is a reasonable expectation for the *level* of oil prices, then the contribution of oil prices to *inflation* should not just dissipate, it should actually reverse itself.

The FOMC's decision to focus on core inflation tacitly resolved a long-simmering debate over how a central bank should react to an oil shock, which simultaneously threatens both goals in the Fed's dual mandate.[72] Ever since OPEC I, some academics and central bankers have argued that monetary policy should tighten to fight the higher inflation brought on by an oil shock, especially the feared "second round" effects, even if doing so means higher unemployment. But others have argued for cushioning the recessionary impact with easier monetary policy. Which answer is right?

[71] Specifically, the oil price used here (annual data) is refiners' acquisition cost in the U.S., deflated by the CPI. Since oil is priced in dollars, the oil price faced by, say, Europe or Japan is affected by the dollar exchange rate. *Source*: Department of Energy website.

Figure 2
Real oil prices in the U.S., 1970-2004



If the oil shock is *permanent*, there is no reason to accommodate it with easy money. After all, potential GDP will be lowered *permanently*, so actual GDP should fall *pari passu* to keep the GDP gap close to zero. But if the oil shock is *transitory*, which Figure 2 suggests was typical,[73] and if there are meaningful adjustment costs associated with cyclical fluctuations, then using monetary easing to mitigate the temporary decline in output makes more sense, even though inflation will be transitorily higher. The ECB, with its strategy of maintaining a fixed target for headline inflation regardless of what happens to oil prices, seems to be in the first camp. The Fed, by contrast, seems firmly in the second camp; and it promulgates that strategy by focusing on core inflation. As is

[72] Blinder (1981) anticipates much of what is said in this paragraph and next; it also contains a variety of early references. For more recent discussions, see Svensson (1997) or Woodford (2004).
[73] This is a backward-looking statement about history. We do not pretend to know what the future will bring.

probably clear from what we have said already, we believe that the history of oil prices shows that the Fed has it right. And if this aspect of Fed policy continues, it will constitute another important part of the Greenspan legacy.

II.H Was Greenspan Lucky or Good?

There is no doubt that, by any reasonable standard, U.S. monetary policy in the Greenspan era has been highly successful. But so have the monetary policies of a number of other countries. An old adage holds that, "I'd rather be lucky than good." Which one was Greenspan?

We can start with the good luck by referring back to Figure 2, in which a vertical line separates the Greenspan and pre-Greenspan eras. A large oil shock may be the single worst thing that can happen on a central banker's watch, since it will almost certainly produce both higher inflation and higher unemployment. And there were two whoppers in 1973-74 and 1979-80. On this one criterion (and, clearly, there are others to consider), it was surely easier to lead the Fed from 1987 to 2005 than from 1970 to 1987. In fact, the one super-sized supply shock of the Greenspan chairmanship was the remarkable acceleration of productivity after 1995, which we discuss below.[74] A favorable supply shock like that makes the central bank's job easier, because it brings in its wake either lower inflation, faster real growth, or both *automatically*.

The preceding paragraph considers only the truly gigantic shocks. But something similar can be said about the garden-variety shocks that buffet an economy all the time. Blanchard and Simon (2001), Stock and Watson (2003), and others have documented

[74] Notice also, in Figure 2, that a huge decline in the real price of oil preceded Greenspan's appointment as Fed chairman. Since there are lags, this event also made conditions more favorable for Greenspan.

what has come to be called the Great Moderation—the remarkable decline in the volatility of many macroeconomic variables after 1984. This stylized fact is documented in Table 3, where we display the notable declines in the standard deviations of a few key macroeconomic variables since 1984.

Table 3
The volatility of the macroeconomy: before and after 1984

	Standard deviation (in percent)		
	1960-1983	1984-2005	Ratio
Real GDP growth	2.8	1.6	0.57
Unemployment rate	1.7	1.1	0.65
Headline Inflation	3.7	1.1	0.30
Core Inflation	3.3	1.1	0.33
Output per hour growth	2.1	1.4	0.67
Unit labor costs growth	3.9	1.6	0.53

Source: Bureau of Labor Statistics and Bureau of Economic Analysis. Data are quarterly. All the variables except unemployment are measured as annual growth rates. Output per hour and unit labor costs refer to the nonfarm business sector. The 4th column shows the ratio of the entries in the 3rd and 2nd columns.

The methodology used by Stock and Watson (2003) attributes relatively little of the Great Moderation to better monetary policy and a great deal to good luck. Bernanke (2004a) argues that Stock and Watson and others overlook potential effects of monetary policy on what their model calls "shocks," and therefore concludes that "improved monetary policy has likely made an important contribution" (p. 9) to the Great Moderation. But regardless, there was still a good deal of good luck. Thus, on balance, Alan Greenspan appears to have been a lucky Fed chairman.[75]

[75] According to Sims and Zha (forthcoming), the best-fitting time series model of the U.S. economy displays no particular break in the nature of monetary policy during the Greenspan era; instead, the shocks were smaller. Thus they, too, view Greenspan as lucky.

Or was he? Barely two months into the job, Greenspan was greeted by a frightening crash of the stock market. Two to three years later, the U.S. banking system plunged into its deepest crisis since the Great Depression, with thrifts failing by the thousands and commercial bank failures rising to levels not seen since the 1930s. Next, a series of emerging market currency crises rattled the world economy, beginning in 1994 (Mexico) and lasting into 2002 (Argentina). During this period, the Russian default and the failure of LTCM shook the world financial system to its roots in the fall of 1998. Then came the terrorist attacks of 2001 and the corporate scandals of 2001-2002. So maybe Greenspan has led the Fed in "interesting times" after all.

We believe the more fundamental point is this. The challenges faced by the Greenspan Fed over an 18-year period have come in a wide variety of shapes and sizes, and many of them required fairly subtle and even creative responses. The right answers were not to be found in any pre-existing monetary policy manual. Central banker kindergarten teaches you to raise interest rates when inflation rises; that requires backbone, sometimes even nerves of steel (and probably central bank independence), but not much subtlety. The Greenspan Fed has faced only one fleeting spike in inflation, when the core CPI rate rose into the 5.5-6% range between August 1990 and February 1991. (By January 1992, it was back down to 4%.) On the other hand, there were no cookbook recipes for dealing with stock market bubbles and crashes, financial "headwinds" of the 1990-92 variety, dramatic widenings of risk spreads (as in 1998), unrecognized (by most!) productivity shocks, and so on. Greenspan handled most of these challenges with great aplomb, and with immense benefits to the U.S. economy.

So while Alan Greenspan may have enjoyed more than his share of good luck during his storied tenure as Fed chairman, he was also confronted with a wide variety of challenges that required subtlety, a deft touch, and good judgment. And the maestro surely wielded the chairman's baton with extraordinary skill. His stellar record suggests that the only right answer to the age-old question of whether it is better to be lucky or good may be: both.

III. Thinking Outside the Box: Dealing with Extraordinary Circumstances

In this section, we turn away from what we earlier called workaday monetary policy and toward three special issues that arose at critical junctures on Greenspan's watch. Since the issues themselves, and how the Greenspan Fed coped with each, are familiar to everyone at this conference, we will not dwell on descriptive details. Our purpose, instead, is to evaluate Greenspan's decisions, compare them with some clear alternatives, and draw lessons for the future.

III.A How should monetary policy deal with a change in the productivity trend?

Roughly the first eight years of Greenspan's chairmanship fell squarely within the period of the great—and still largely unexplained—productivity slowdown (1973-1995), during which time labor productivity in the nonfarm business sector advanced at a paltry 1.4% annual average rate.[76] But then productivity growth accelerated suddenly and markedly, averaging (in annual data) 2.5% over the six-year period 1995-2001 and 4.2% over the three-year period 2001-2004 (thus 3.1% over the entire nine years).

This sudden acceleration came as a surprise to virtually all economists, who had grown accustomed to thinking of slow productivity growth as the norm. And most of us were slow to adapt to the new reality. One objective indicator of this perception lag can be found by comparing the tables entitled "Accounting for Growth in Real GDP" in successive annual issues of the *Economic Report of the President.* Since 1996, this table has always included a *forecast* of nonfarm productivity growth over the coming years.[77] It is worth pointing out that the White House never has any reason to low-ball this

[76] This is with currently-available data. With contemporaneous data, the performance looked even weaker—more like 1.1% per annum.

forecast, because a rosier productivity path always brightens the budget outlook. So, if the CEA had departed from pure intellectual honesty in any way, its clear incentive was to declare the arrival of the productivity acceleration early, not late. However, Table 4 shows that the Clinton CEA was, quite literally, honest to a fault. As late as February 1999, it was still projecting a conservative 1.3% productivity growth trend. The big change in its forecast came only in February 2000.

Table 4
CEA Estimates of Long-Run Productivity Growth, 1996-2001

Forecast date	Approximate Coverage	Estimated Growth Rate	Actual, Previous year
February 1996	1995-2002	1.2%	0.5%
February 1997	1996-2003	1.2%	2.7%
February 1998	1997-2005	1.3%	1.6%
February 1999	1998-2007	1.3%	2.7%
February 2000	1999-2007	2.0%	2.8%
January 2001	2000-2008	2.3%	2.8%

Source: *Economic Report of the President*, various issues.

Alan Greenspan clearly reached that conclusion much sooner. As early as the December 1995 FOMC meeting, while carefully labeling his hypothesis as tentative, he expounded at great length on the reasons to think productivity had accelerated, even though no such acceleration could be seen in the official data. He concluded that the problem was more likely faulty data than lagging productivity.[78] Over the coming months and years, Greenspan's conviction grew firmer. Laurence Meyer, who joined the FOMC

[77] The length of the forecast period varies from year to year, as can be seen in Table 4.
[78] See *Transcript of December 19, 1995 FOMC Meeting,* pages 35-38. Greenspan actually dropped a hint of this conclusion even earlier, at the August 1995 FOMC meeting, when he opined: "I think the difficulty is not in productivity; I think it is at the Department of Commerce." See *Transcript of August 22, 1995 FOMC Meeting*, p. 6.

as a confirmed productivity skeptic at its July 1996 meeting, wrote that Greenspan's "call on the productivity acceleration was truly a great one…He got it right before the rest of us did."[79] And we agree wholeheartedly.[80] The question is: What did the chairman know, and how did he know it? What did Greenspan see that others failed to see? The impetus to declare a faster productivity trend was certainly not coming from the Fed staff, nor from other FOMC members. As Meyer (2004, p. 125) put it, referring to Greenspan's efforts to persuade others in the spring of 1997, "the Chairman's insight played to an unresponsive audience. The staff and most of the other Committee members [were] not convinced."

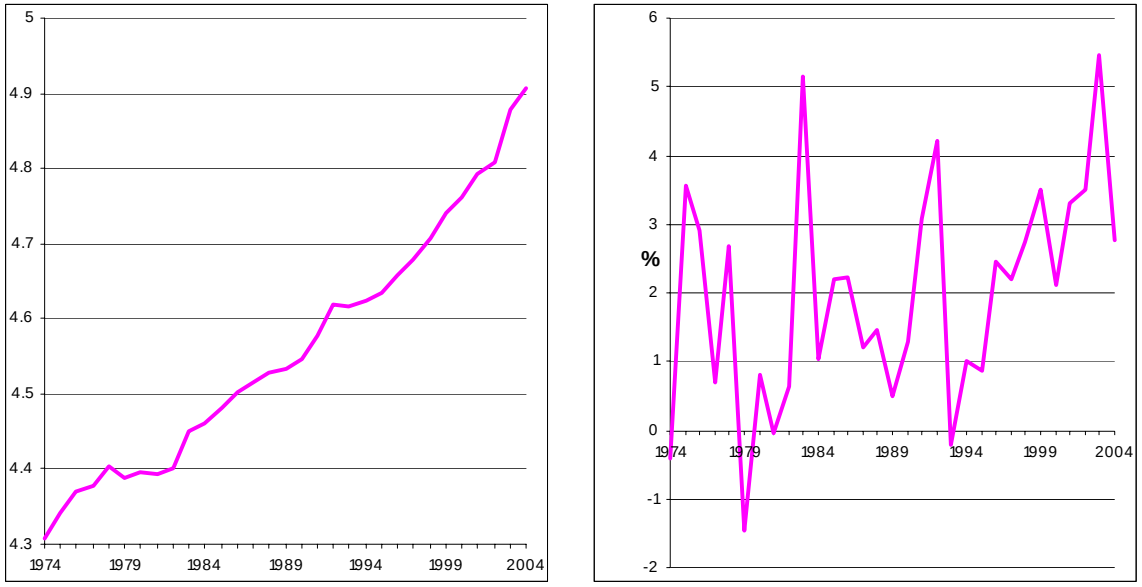
Suppose an econometrician was looking only at data on labor productivity. When would he have spotted the acceleration? Figure 3 plots the (log) level of output per hour in the business sector (lefthand panel) and its annual growth rate (righthand panel) from 1974 to 2005. Staring at the figure, there is a (barely) noticeable shift upwards in the growth rate in the second half of the 1990s and a further, much more noticeable, increase around 2002.

Because productivity tends to rise faster during booms, and the late 1990s were a boom period, such eye-balling of the data may be misleading. To control for the cycle, we estimated a regression of the quarterly growth rate of labor productivity on an intercept and the current and three lags of real GDP growth, using quarterly data from 1974:1 to 2005:1. We then used the sup-Wald test to look for a shift in the intercept at an

[79] See Meyer (2004), pp. 125 and 134. Meyer notes that he himself came to believe in a higher productivity trend only in early 1999.
[80] The senior author of this paper confesses to have been part of the incorrect majority who remained skeptical long after Greenspan converted.

unknown date somewhere in the 1990s. This test finds significant evidence (at the 1% level) of an acceleration in productivity beginning in the first quarter of 1997.

Figure 3
Level and annual growth rate of output per hour in the U.S.



This procedure has the advantage of using all of the available data, just as we see them today—including the robust productivity numbers of 2001-2004. Alan Greenspan, of course, did not have this advantage of hindsight; he had to figure out what was going on in real time. An alternative, more realistic, approach is to imagine that an econometrician in possession of data only through quarter t was looking for a break in the productivity trend in 1995:4, using a standard Chow test. Advancing t one quarter at a time, beginning with 1997:1, we ask when the econometrician would have rejected the null hypothesis of no change at the 10% significance level. The surprising answer is that the productivity acceleration would not have been detected until 2001:4.[81]

[81] We still give the hypothetical econometrician the advantage of using today's revised data, which are presumably better than real time data and which show faster productivity growth. We pick 1995:4 as the first date of the new regime because this was the date of the productivity acceleration estimated by Blinder and Yellen (2001) and by many others. If, instead, we use our estimate from the previous paragraph

But Alan Greenspan was apparently seeing more than the econometric equations showed at the time. To him, sluggish productivity growth did not square with other facts on the ground—such as modest price increases, rising profits, soaring stock prices, a large statistical discrepancy between gross national *income* and gross national *product*, and numerous anecdotal reports of miracles in information technology. He concluded that the productivity data were wrong, and only later did data revisions (and estimated equations such as those just described) bear him out.[82]

Econometricians using conventional hypothesis testing may have been able to detect the productivity acceleration only in 2001 or so, but when did Greenspan? The answer seems to be: quite early. But let's return to that question after providing some analysis that may also have been on Greenspan's mind at the time. A sudden permanent increase in trend productivity growth is unmitigated good news for the central bank, because it makes better outcomes attainable. However, it also almost certainly requires an adjustment of monetary policy. But how much, and in what direction? Furthermore, the particular experience of the United States in the late 1990s raises a second question: Why did the large *productivity* gains show up in lower *unemployment*, rather than just in higher *output*?

Given Greenspan's unusual perspicacity in the late 1990s, let us look for conceptual answers by examining three theoretical cases:

1. The productivity acceleration is recognized immediately by everyone.
2. The productivity acceleration is recognized at first only by the central bank.

(1997:1), we obtain more or less the same conclusion: that the productivity acceleration would have been detected only in 2002:1

[82] Just the data revisions stemming from lower measured inflation boosted the productivity growth rate by about 0.4 percent per annum.

3. The productivity acceleration is not recognized by anyone at first.

To fix ideas, start with the patently unrealistic Case 1, and with the simple (but long gone) world in which the growth rate of money is the relevant policy instrument. Then the appropriate adjustment of monetary policy is straightforward. Both nominal and real wage growth should rise by an amount equal to the increase in the productivity trend. That would leave both labor market equilibrium (e.g., the NAIRU) and the growth of unit labor costs unchanged. So, in a frictionless world, the central bank should raise the money growth rate by that amount; and doing so would not change the inflation rate. In the real world, with frictions and lags, even faster money growth for a while probably makes sense, since a short-run stimulus to aggregate demand will help the economy accelerate up to the new higher growth rate of potential GDP.[83] Indeed, for this reason, inflation might actually fall a bit at first since the GDP gap, $y - y^*$, would probably be negative for a while.

Now consider a central bank that is setting short-term interest rates instead, using a Taylor rule:

$$(8) \qquad i = \pi + r^* + \alpha(y - y^*) + \beta(\pi - \pi^*) + \varepsilon.$$

It faces a more subtle problem because two conflicting forces operate at once. On the one hand, the GDP gap will turn negative, as just noted, nudging inflation downward. Since there is no reason to adjust the inflation target down, the declines in both π and $y - y^*$ would seem to call for the central bank to *reduce* i. But on the other hand, faster productivity growth presumably raises the equilibrium real interest rate, r^*, which would seem to call for an *increase* in i. What to do? It appears to us that the central bank's target

[83] Aggregate demand would be pushed up both by faster money growth and by wealth creation in the stock market as higher expected future productivity was capitalized into equity values. Both work with lags.

for the *difference* r - r* should probably be negative for a while to ease the transition to higher trend growth, but then should revert back to zero. With r* higher, this means that the target real and nominal funds rates should eventually go higher, too—which sounds like a poor description of what the Greenspan Fed did in 1996-1998.

Clearly, however, the productivity shock was *not* recognized promptly by everyone. So let us turn next to Case 2, in which *only the central bank* perceives that productivity growth has increased. Given how early Greenspan made his celebrated "call," this may be the most appropriate model for thinking about U.S. monetary policy in those years.

If workers and firms fail to catch on to the new underlying productivity trend at first, money wages will *not* accelerate. The growth rate of unit labor costs (ULC) will therefore decline, and firms that set prices as a markup over ULC will raise their prices more slowly. So inflation will start inching down, but presumably by less than the rise in productivity growth. With real wages thus lagging behind productivity, labor becomes cheaper. As more and more firms start to realize that ULC is declining and labor is a bargain, the pace of hiring should pick up—leading to a falling unemployment rate. In Phillips curve terms, the NAIRU will be temporarily reduced. Notice that it is *misperceptions*, especially workers' misconceptions, of productivity growth that convert the rise in the growth rate of potential GDP into a decline in the NAIRU.[84]

The central bank is now left with a pleasant policy choice. If it does nothing, both inflation and unemployment will decline, although the decline in unemployment will be temporary. If inflation is high when the productivity acceleration hits, and unemployment

[84] On this, see Blinder and Yellen (2001), Ball and Moffitt (2001) and Mankiw and Reis (2003b). The argument is symmetric: A productivity slowdown which is perceived by the central bank but *unperceived* by the private sector calls for a tighter monetary policy. Orphanides (2003) blames the Fed's failure to tighten after the productivity slowdown of the 1970s for much of the acceleration of inflation.

is already low, the central bank may want to *raise* interest rates in order to take more of its gains in the form of lower inflation. Alternatively, if inflation is already at or below target and/or unemployment is high, the central bank may want to *reduce* interest rates to take more of its gains in the form of lower unemployment. Eventually, however, the Taylor rule (equation (8)) reminds us that *real* interest rates, and probably also *nominal* rates, must go higher.[85]

Finally, suppose that *no one* notices the productivity shock when it first occurs (Case 3.) With no perceived changes, monetary policy will not change at first. So, relative to Case 2, policy will be too tight. In the real economy, if neither workers nor employers notice the acceleration of productivity at first, there will be no reason for a hiring surge. But as firms see ULC falling, hiring will rise and the NAIRU will fall. The central bank will see inflation drifting down, and will presumably then start cutting interest rates in conformance with (8). But it will be late off the mark.

Now let's compare this conceptual framework to what actually happened in the United States in the late 1990s, using Case 2 (wherein the central bank recognizes the productivity shock, but workers do not) as our main interpretive lens. Table 5 displays evidence supporting the notion that the acceleration of productivity after 1995 took labor by surprise.

[85] The adverb "probably" allows for the possibility that inflation might decline by more than r* rises.

Table 5
Labor Market Data, 1996-2000

Year	(1) Output per hour	(2) Real compensation per hour	(3) Wage gap (2)-(1)	(4) Labor's share	(5) Unemployment rate
1996	2.7	0.7	-2.0	64.2	5.4
1997	1.6	0.9	-0.7	63.9	4.9
1998	2.8	4.5	1.7	64.7	4.5
1999	2.8	2.5	-0.3	65.0	4.2
2000	2.7	3.6	0.9	65.7	4.0

Source: Bureau of Labor Statistics. Data on productivity and compensation pertain to the nonfarm business sector.

Over the first two years in the table, 1996 and 1997, real compensation per hour advanced by 2.7% *less* than productivity (column 3), and labor's share of national income fell (column 4), suggesting that labor "missed" the productivity acceleration. But Alan Greenspan did not. He took advantage of the temporarily reduced NAIRU by holding the federal funds rate steady as the unemployment rate dropped (column 5), breaching all conventional estimates of the NAIRU.

The compensation/productivity relation then reversed itself in the tight labor markets of 1998-2000, allowing American workers to make up some of their lost ground (column 3) as the unemployment rate fell further (column 5). One might, in fact, view the partial catchup of real compensation to productivity as a salutary side effect of the Fed's easy monetary policy, which allowed unemployment to drift all the way down to the 4% range.

On this interpretation, the decline of the unemployment rate to as low as 3.8% was *not*, as is sometimes said, an experiment to see how low the Fed could push unemployment without igniting inflation. Rather, it simply reflected the way in which the

economy split the gains from the favorable productivity shock between lower inflation and lower unemployment. Greenspan just held the funds rate (roughly) steady and watched, refusing to take away the punch bowl even though the party was going pretty good.

Was that the *optimal* monetary policy response? Who really knows (though we suspect it was close)? But it certainly wasn't the *obvious* policy response. In fact, we believe that few central bankers would have had the nerve to stand by calmly as the unemployment rate dipped (and stayed) that low. And we know from firsthand accounts that Greenspan was holding back an FOMC that was eager to raise rates.[86] We give him enormous credit for doing so.

This analysis suggests that an *unperceived* productivity acceleration should reduce the natural rate of unemployment *temporarily*. Earlier, we noted that a Taylor rule that uses the Staiger *et al*. (2001) estimates of the natural rate of unemployment (equation (4)), which decline during the 1990s, fits Greenspan's behavior well and is stable. Let us now put these two pieces of the puzzle together to see what they tell us about what Greenspan might have believed in real time. Specifically, we use the estimated Taylor rule to "back out" an implicit real-time estimate of the natural rate of unemployment, quarter by quarter.[87]

Our procedure is as follows. Since the productivity acceleration did not begin until 1995, at the earliest, we start by estimating a Taylor rule like (3)—with a *constant* natural rate of unemployment—on data through 1994. Not surprisingly, this regression turns out to be stable and to fit the pre-1995 behavior very well, with an adjusted R^2 of 0.98. Next,

[86] See Meyer (2004) and the FOMC Transcripts for 1996 and 1997, which are now in the public domain.

we assume that the funds rate deviated from this rule after 1994 *only* for one of two reasons: (1) because Greenspan's estimate of the natural rate, u_t^*, was changing (rather than constant) or (2) because of the disturbance term in the reaction function, ε_t. That enables us to transform the deviations of the actual federal funds rate from the Taylor rule predictions into a plausible estimate of the u_t^* path implicit in Greenspan's interest-rate decisions as follows.

The time series residuals are the sum of two elements, one stemming from changes in $u_t^*$and the other from ε_t. The first component is what we care about. To disentangle the two, we use an unobserved components model that assumes that the movements in the natural rate were well approximated by a random walk, while the ε_t shocks were approximately white noise. Given an assumption on the relative variances of the two shocks, and an initial value for u_t^* in 1994:4, we can then create estimates of both time series. Figure 4 displays three such estimates, based on assuming that the standard deviation of natural-rate shocks was one-half, equal to, or twice as large as the standard deviation of ε_t shocks, and that Greenspan's natural rate estimate for 1994:4 was 5.5%.

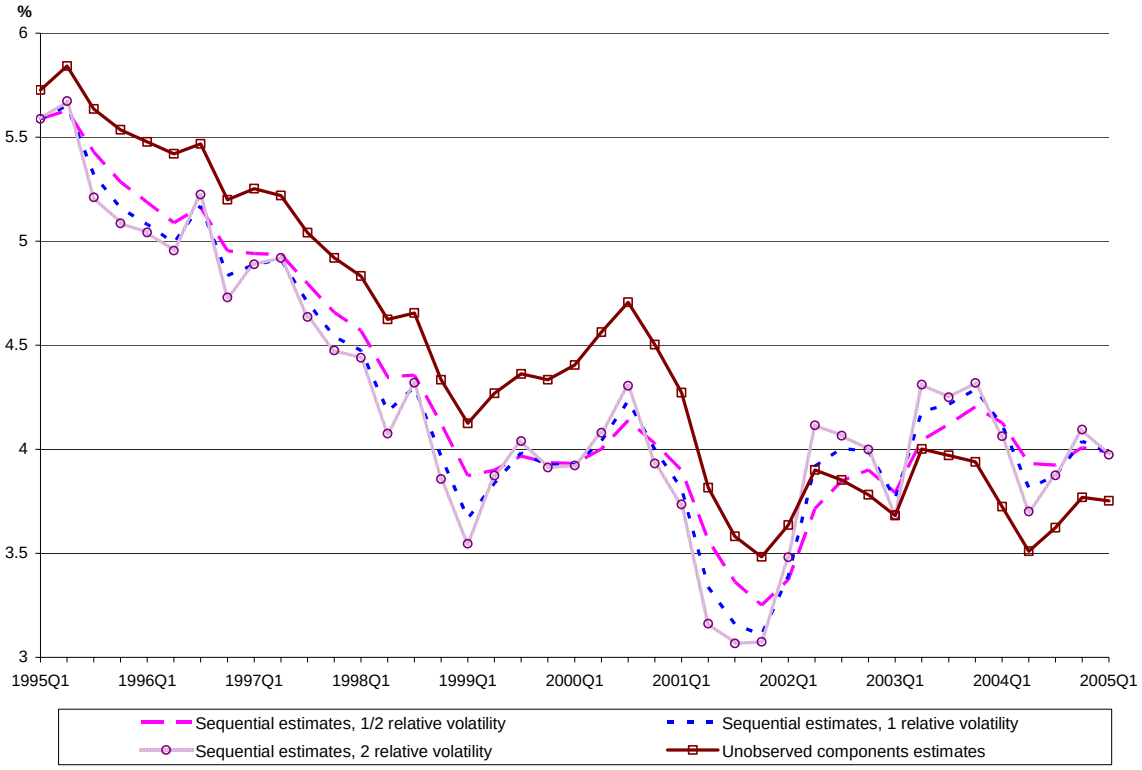
Alternatively, we can improve upon this two-step procedure by using an unobserved components model to estimate *simultaneously* the Taylor rule residuals, the time series for the natural rate, *and* the relative volatility of the two shocks. Figure 4 displays this estimate as well.

This exercise should not be taken literally. We are reverse-engineering Greenspan's thought process by assuming that he made his decisions strictly according to a stable Taylor rule with a time-varying NAIRU, which we know was not so. But since the Taylor

[87] Ball and Tchzaide (2001) first proposed the idea of backing out what was in Greenspan's mind from a Taylor rule. Our method is an extension of theirs.

rule approximates Greenspan's behavior so closely, this procedure, while imperfect, should get us close enough to reality to be interesting.

Figure 4
The natural rate of unemployment "according to Greenspan"



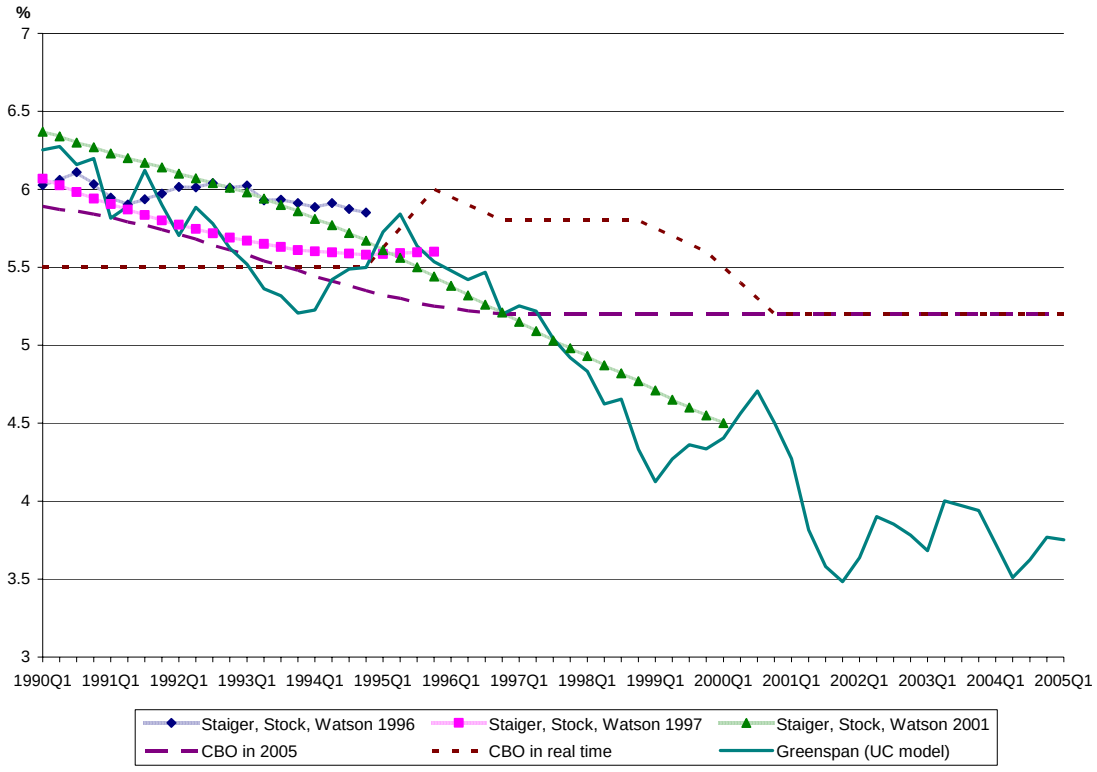
All four estimates in Figure 4 agree that, from 1995 to 1999, Greenspan acted as if he believed that the natural rate was falling sharply, from something between 5.5 and 6 percent to something closer to 4 percent. In his speeches during this period, Greenspan frequently talked about how outstanding productivity performance was keeping a lid on inflation.[88] His decision to hold the federal funds rate steady despite the declining unemployment rate clearly reflected this view.

It was a view *not* shared by many others. Figure 5 displays the estimates of u_t* published in the Congressional Budget Office's *Budget and Economic Outlook*—both in

[88] A particularly clear case was Greenspan (1998), but he had talked around these themes for a long time. See, for example, Greenspan (1996).

real time and in their current incarnation (January 2005). To give some indication of the best "real time" academic estimates, the figure also shows three different vintages of Staiger, Stock and Watson's (1996, 1997, 2001) estimates of the natural rate. Remarkably, only the most recent vintage comes close to our estimate of Greenspan's real-time view. Thus, starting in 1995, he was apparently very close to the best estimates economists can make *even today* about what the (unanticipated) productivity shock did to the natural rate of unemployment.

Figure 5
Estimates of the natural rate of unemployment: Greenspan versus others



The second remarkable feature of the figure is how much better Greenspan did than any of the other estimators, including the CBO and earlier vintages of Staiger *et al*., after about mid-1997. While others were systematically overestimating the natural rate during the decade, and were therefore nervous that monetary policy was too permissive,

Greenspan seems to have been quite close to the mark. This "call" may go down in history as Greenspan's greatest accomplishment at the helm of the Fed: He not only detected the change in productivity growth well before almost anyone else did, he also figured out its implications for the natural rate of unemployment. Whether the call was a stroke of luck or a stroke of genius is probably unknowable, given that it was essentially one observation.

In time, the way the Greenspan Fed dealt with rapidly rising productivity during the period 1995-2004 may come to be considered the "textbook" response to such shocks. But in real time, it certainly was not. Greenspan deserves high marks not only for sticking to his guns, but for following a policy that required some subtlety. It was not an easy call. That said, and especially with inflation now so low all over the world, future central bankers may want to follow Greenspan's lead and take more of the gains from a favorable productivity shock in terms of temporarily lower unemployment rather than permanently lower inflation.

III.B Does the Fed have global responsibilities?

The next issue can be put simply, if crudely, as follows: Because the Federal Reserve is the 800-pound gorilla in the global financial system, its actions at times literally shake the financial world. Should the FOMC therefore take effects on other countries into account in formulating and executing what is normally considered *domestic* monetary policy (e.g., setting the federal funds rate)? Note that we exclude from this question instances of obvious international cooperation, such as participation in occasional concerted foreign currency interventions.

This question is not new. Many Latin American economies were caught in the crossfire when the Fed tightened U.S. monetary policy severely beginning in October 1979. As part of the aftermath, Paul Volcker personally wound up devoting much effort after 1982 to dealing with the resulting Latin American debt crisis. It is even conceivable that Volcker lowered interest rates sooner or more vigorously on account of the problems in Latin America.

Similar issues arose on Alan Greenspan's watch because of the Fed's role in the series of emerging-market crises that marked the 1990s—beginning with Mexico in 1994-1995 and gathering steam in Southeast Asia in 1997-1998. The Asian crises, in particular, were caused in part by the rising value of the U.S. dollar—to which many Asian currencies were (formally or informally) pegged.

The Fed's role in resolving these crises was mostly of a technical and advisory nature, supporting U.S. Treasury and IMF efforts as well as serving as the Treasury's fiscal agent. But the 1998 financial crisis, which began with the Russian debt default and increased in intensity with the collapse of LTCM, led to something *qualitatively* different. The FOMC actually *cut* the Federal funds rate three times in the fall of 1998, during an economic boom in the United States. The first of these cuts, in late September 1998, came to be called "the 25 basis points that saved the world." Hyperbole aside, notice that the phrase was "saved *the world*," not "saved *the United States*."

The issue of global responsibilities is a delicate one for the Fed. Its legal mandate, as stated in the Federal Reserve Act, gives it no basis for taking the welfare of any country other than the United States into account when making monetary policy decisions. And

we believe that Alan Greenspan has never said that it should do so. In fact, here is what he told a member of Congress who asked posed the question in 1999:

> *I would never want to be concerned about how our individual policies impact everybody else, because we would never be able to get a sensible policy for the United States, and I think that would not be appropriate for us. Indeed, as I read the statutes which give us the authorities that enable us to function as a central bank, it is the United States, and solely the United States, which must be the focus of our policies.*[89]

That said, one might ask why else the FOMC cut interest rates in September and October of 1998? When the FOMC promulgated the first of these cuts, the accompanying statement carefully claimed that "the action was taken to cushion the effects on prospective economic growth *in the United States* of increasing weakness in foreign economies and of less accommodative financial conditions domestically"[90] (emphasis added). But many contemporary observers saw that claim as far-fetched, and thought that Greenspan must have had his fingers crossed behind his back when he made it.

This incident posed a quite specific version of the general normative question that concerns us in this section: *Should* the FOMC have eased U.S. domestic monetary policy at a time when macroeconomic conditions in the United States were not calling for easing?

A subtle but important distinction needs to be made here—one that Greenspan has made several times. It is true, as he pointed out in justifying his 1998 actions, that the U.S. economy is linked to the rest of the world in many ways. So there are undoubtedly instances in which events abroad might call for an adjustment of U.S. monetary policy *because of their likely effects on the U.S. economy*. For example, a slump abroad will

[89] Greenspan (1999).
[90] FOMC Statement, September 29, 1998.

reduce U.S. aggregate demand, which may give the Fed a reason to reduce interest rates. But that is not the issue here. The harder question is whether events abroad *per se* ever warrant a U.S. monetary policy response *apart from domestic considerations*. The 1998 cuts, we submit, were a case in which that was done, despite the Fed's rhetoric to the contrary.

There is no simple answer to this question. On the one hand, we have just observed that the Fed's legal mandate does not extend to the welfare of the rest of the world. And Federal Reserve governors, who take an oath of office, must take that mandate seriously. On the other hand, however, the U.S. economy is so large, and the Fed is so central to the global financial system, that the Fed's influence spreads well beyond our borders. Shouldn't the Fed therefore behave like a good citizen of the world?[91] In the limit, might it even serve the role that many people envision for it as the world's central bank?

One possible resolution to this dilemma might hearken back to the quasi-lexicographic orderings implied by the legal mandates of the ECB and the Bank of England. Perhaps the Federal Reserve Act should instruct the Fed to use monetary policy "to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates," but then add something like: "and, without prejudice to those goals, to support global economic and financial stability." Of course, the Fed cannot make such a change unilaterally, and it strains credulity to think that the current U.S. Congress and Administration would support any such amendment to the Act. So the dilemma is likely to complicate life for Greenspan's successor. It is one issue that Alan Greenspan did not resolve.

[91] The same point, of course, applies to U.S. foreign policy, immigration policy, and trade policy—to name just a few.

III.C Should the central bank burst bubbles?

Perhaps the biggest financial event of the Greenspan era was the incredible stock market bubble that inflated in the late 1990s, and especially from the fall of 1998 to the middle of 2000, and then burst spectacularly—leading to what was probably the largest destruction of financial wealth in history. It is also the event that produced the most criticism of Greenspan, with various observers faulting him for (pick one):

- giving up too easily on his anti-bubble rhetoric (e.g., "irrational exuberance")
- not raising interest rates more aggressively and/or sooner to burst the bubble
- refusing to raise margin requirements
- helping to inflate the bubble by acting as a "cheerleader" for the New Economy
- encouraging excessive risk-taking by creating what came to be called "the Greenspan put," that is, the belief that the Fed would, if necessary, support the economy and therefore the stock market.

Greenspan himself has stated clearly why he does *not* believe, as a general matter, that a central bank should be in the business of bursting bubbles. He has also explained why, as a specific matter, he does *not* think the Fed erred in the 1998-2000 episode.[92] We will briefly consider the arguments for and against bubble-bursting—where we basically agree with Greenspan—and then address the five specific criticisms.[93]

The argument for actively bursting, or at least trying to "lean against" bubbles, comes in five steps:[94]

[92] Greenspan (2002a)
[93] For a lengthier treatment of these issues, see for example Bernanke and Gertler (1999); for a recent survey, see Gilchrist and Leahy (2002).
[94] For a good statement, see Cecchetti *et al*. (2000).

1. Bubbles—that is, cases in which financial market valuations become unhinged from reality—do exist.
2. When bubbles inflate and then burst, they can and do (a) distort resource allocation, (b) affect the central bank's target variables (such as inflation and output), mainly via wealth creation and destruction, and (c) threaten financial stability.
3. The central bank has responsibility for financial stability.
4. Bubbles can be identified early enough to do something about them—without committing too many Type II errors (that is, imagining bubbles that aren't).
5. The central bank has instruments at its disposal that can burst bubbles without doing undue harm to its other goals.

While some economists would dispute #1, we do not. And #2 and #3 are non-controversial. So the contentious parts of the argument are the ideas that central banks can recognize bubbles early enough (#4) and have suitable tools that they should direct at bubbles *per se* (#5). Notice that #2(b) more or less implies that monetary policy *should* react to bubbles *indirectly*—because bubbles affect traditional target variables such as inflation and output. So the issue is whether or not the central bank should react to financial bubbles *over and above* their estimated effects on, say, current inflation and output. There could be (at least) two reasons for this: because bubbles predict the *future* of the traditional target variables, or because the central bank should target asset prices directly. In Taylor-rule terms, the latter issue is whether a third argument—the gap

between, say, stock market values and "fundamentals"—should be added to the central bank's reaction function.[95] Like Greenspan, we are deeply skeptical.

Let's start with the central bank's very-fallible early-warning system. The argument for bursting bubbles implies that the bank can perceive them—with a reasonable degree of accuracy—well before the market does. The truth is that this is very difficult, if not impossible, to do. For example, even at the top of the biggest (and therefore most obvious?) bubble in history, real buyers were paying real money for the "ridiculously overvalued" NASDAQ stocks that others were selling—and volume was high.

Furthermore, the risk of bursting a non-bubble (that is, committing a Type II error) must be taken seriously. Remember that Alan Greenspan first suggested that the market was irrationally exuberant in December 1996, when the Dow Jones Industrial Average was around 6400—a level to which it has never returned, even in its darkest subsequent days. In fact, the now-published transcripts of the FOMC meetings in 1995 and 1996 make it clear that Greenspan believed there was a stock market bubble long before December 1996—with the Dow in the 5000s . Just imagine the macroeconomic opportunities that might have been lost if the FOMC, acting on that belief, had raised interest rates to burst the "bubble" in 1995 or 1996.

Then there is the bothersome fact that, once it decides that a bubble needs bursting, a central bank is normally equipped only with a sledge hammer (the general level of short-term interest rates), not a surgical scalpel that can be aimed, specifically and selectively, at the bubble. Furthermore, the sledge hammer probably must be wielded with great force even to dent a bubble.

[95] This is precisely how Cecchetti *et al*. (2000) phrase the argument.

Put yourself in Greenspan's shoes in, say, November 1998. Stock prices were rising rapidly, and you were convinced that there was a bubble in tech stocks. But you were not so sure about the rest of the stock market. And you had just *cut* interest rates by 75 basis points to stave off a crisis in the fixed-income markets. Was there any reason to believe that a modest increase in short-term interest rates (say, taking the 75 basis points back) would deter intrepid investors in high-flying tech stocks—many of whom were expecting 100% annual returns? We think the answer is self-evident. In all likelihood, an interest rate hike large enough to burst the bubble would have damaged the economy quite severely. And we should all remember the macroeconomic conditions that followed November 1998: a year and a half of rapid real growth, falling unemployment, and *falling* inflation.

Greenspan's preferred approach to bubbles is to let them burst of their own accord, and then to use monetary policy (and other instruments) as necessary to protect the banking system and the economy from the fallout. This "mop up after" strategy received a severe real-world stress test in 2000-2001, when the biggest bubble in history imploded, vaporizing some $8 *trillion* in wealth in the process. It is noteworthy, but insufficiently noted, that the ensuing recession was tiny and that not a single sizable bank failed. In fact, and even more amazingly, not a single sizable stock brokerage or investment bank failed, either. Thus the fears that the "mop up after" strategy might be overwhelmed by the speed and magnitude of the bursting bubble proved to be unfounded.

Regarding Greenspan's legacy, then, let us pose a simple rhetorical question: If the mopping up strategy worked this well after the mega-bubble burst in 2000, shouldn't we

assume that it will also work well after other, presumably smaller, bubbles burst in the future? Our suggested answer is apparent.

With all that said, our verdicts on the five charges leveled against Alan Greenspan will probably not surprise readers:

- *Did Greenspan give up his anti-bubble rhetoric too easily?* This is a difficult question to answer, for it is certainly possible that "open-mouth policy" might eventually have succeeded in talking down stock prices. But our answer to the question is something between "no" and "it wouldn't have mattered anyway." It should be remembered that Greenspan's "irrational exuberance" utterance (a) caused only a brief flutter in the stock market and (b) was not a one-shot event, but was repeated several times—to no avail. In brief, he did try; he just didn't succeed. Kohn and Sack (2003) report evidence suggesting that the Fed chairman's remarks on the stock market—as opposed to his remarks on monetary policy—do not have much systematic effect on stock prices.
- *Should the Fed have raised interest rates sooner?* This is the bubble-bursters' favorite charge, but we are not persuaded of its validity. For reasons given above, there is no strong reason to believe that a modestly tighter monetary policy would have made any material difference to the evolution of the bubble. Such a policy probably would have slowed down the growth of aggregate demand somewhat, and thereby have had some marginal negative impact on stock valuations. But with no inflation problem, it is not clear why the Fed should have sought slower growth. Of course, we cannot assert with confidence that June 30, 1999 was the optimal date on which to start tightening. But the wisdom of hindsight makes it

look like a reasonable choice. Notice, by the way, that the bubble continued to inflate anyway, more or less throughout the Fed's tightening cycle.

- *Should the Fed have raised margin requirements?* Many critics argued, both at the time and since, that the Fed should have fought the bubble by raising margin requirements. This is neither the time nor the place to delve deeply into the details of margin borrowing, but we view this argument as a triumph of hope over reason. Leave aside the fact that only a minor part of the speculative froth was due to buying on margin.[96] Our guess is that, if the Fed had raised margin requirements in, say, 1998, the major brokerages and investment banks would have laughed at its naïveté and found ways around this "obstacle" in a matter of weeks, e.g., with options or other derivatives. Only the proverbial "little guys" who bought on margin would have been deterred, and they did not amount to much.
- *Was Greenspan a "cheerleader" for the New Economy?* Here we think the charge sticks. The fact that the normally-staid Chairman of the Federal Reserve was so exuberant about the prospects for productivity growth and profitability may have pumped up stock prices somewhat. Less happy-talk from Greenspan *might* have led to a smaller bubble. But this criticism needs to be tempered by at least one pertinent fact: His exuberance was not irrational. For the most part, Greenspan's optimism was well-founded.
- *Did a "Greenspan put" encourage excessive risk taking?* To some extent, this charge just repeats the previous one. To dig deeper, we must distinguish between

[96] In March 2000, when total outstanding consumer margin debt in the NYSE peaked, it amounted to $278 billion—approximately 3% of the value of NYSE stocks at the time. *Source:* NYSE website.

> a (figurative) put option on the stock market and one on the whole economy. If the critics are complaining that the Greenspan Fed's success in stabilizing inflation and economic activity reduced the perceived level of macroeconomic risk, we are totally unsympathetic—for that is precisely what a central bank is supposed to do. If the critics are asserting that Greenspan & Co. were tacitly underwriting equity values with an implicit promise to cut interest rates if the stock market sagged, we vigorously dispute the existence of any such put option. And we offer as evidence the Fed's lack of reaction to the falling stock market after March 2000. In fact, it *raised* interest rates in March and May (and then held them steady for the balance of the year). If there was a put option on the market, the Fed didn't pay off.

So, on balance, we find very little validity in the charges leveled at Greenspan for his handling of the stock market bubble. Yes, we think he did a little more cheerleading than he should have. But that is a minor misdemeanor, at worst; certainly not a felony. And, more important to the concerns of this paper, it will *not* be part of the Greenspan legacy. The legacy, we believe, is the strategy of mopping up after bubbles rather than trying to pop them. And we judge that a salutary one.

IV. Is There a Downside to the Greenspan Legacy?

Nobody's perfect, and Alan Greenspan has certainly made a few mistakes over his 18 years as Fed Chairman. For example, he gets pretty low marks for transparency. But perfection is not the relevant standard; even Babe Ruth frequently struck out. In this short section, we ask whether there are any genuine *negatives* (not just mistakes) in the Greenspan legacy—any precedents or procedures that might hinder, rather than help, the Fed in the future. We can think of two.

IV. A Opining on non-monetary issues

The first is Greenspan's apparent role as the nation's guru on all things economic. By dint of his longevity, his evident success on the job, and, it must be admitted, his willingness to assume the role, Alan Greenspan has become what amounts to the nation's unofficial economic wise man—on just about any subject. It is a role that frequently thrusts him into the political maelstrom, as Democrats and Republican alike seek to enlist his support on a bewildering variety of issues, ranging from the level and structure of taxation to reform of the Social Security System, trade agreements, relations with China, education, and more. Most of these issues have little or nothing to do with monetary policy and fall outside the Fed's remit or area of special competence.

What's wrong with that? After all, if the nation wants a wise man, it could do a lot worse than Alan Greenspan. Nature will, after all, ensure that *someone* fills the vacuum. Actually, we believe there are several things wrong with Greenspan's penchant for offering his opinion on just about any economic issue, even if the issue is politically

charged. The problems have to do both with the Fed's proper *role* in society and with its political *independence*.

Starting with the latter, the Federal Reserve is a truly independent central bank. As long as it stays within its statutory authority, it has complete control over monetary policy. And it has been years since there was even a veiled threat to that independence, much less an overt one. To our way of thinking, that is all to the good. But central bank independence is best thought of—and best preserved—as a two-way street. If Congress is supposed to stay out of monetary policy, then the Fed should stay out of fiscal policy and other political matters. When the Fed poaches into political territory, it invites Congress to reciprocate. As Congressman Rahm Emanuel (D.-Ill.) recently told the Washington Post (Milbank and Henderson, 2005) in criticizing Greenspan, "There's a moat around the Fed that says he doesn't get involved in political discussions. He took the moat down."

Of course, we understand that fiscal and monetary policy cannot be completely separated. The government budget constraint, for example, states that fiscal deficits must be covered by either money creation or the issuance of interest-bearing debt. So, at the very least, large deficits can create pressures for monetization.[97] Taken to the limit, this kind of reasoning can lead to the "fiscal theory of the price level," according to which the canonical role of the central bank (determining the price level) passes into the hands of the fiscal authorities.[98] So we are perfectly comfortable with the long-standing practice of central bankers all over the world to rail against excessive fiscal deficits—and to favor thrift and virtue.

[97] See, among many possible sources that could be cited, Blinder (1982). More recently, Dixit and Lambertini (2003) study the strategic interaction between fiscal and monetary policymakers.

But that's a good place to draw the line. It is not the place of an unelected central banker to tell elected politicians which taxes to raise or reduce or which spending programs to expand or contract. It is not even his place to tell politicians whether spending cuts or tax increases are the best way to reduce the deficit. Most of these decisions are highly political and have little if anything to do with the conduct of monetary policy. When a central banker crosses the line into the political arena, he not only imperils central bank independence but runs the risk of appearing (or, worse, of being) partisan.

Greenspan's outspoken views in support of the Bush tax cuts in 2001 and partial privatization of Social Security in 2005 are two prominent cases in point. They have made him a partisan figure in the eyes of many. And that, in turn, may account for the sharp decline in the number of Americans who tell the Gallup poll that they have either "a great deal" or "a fair amount" of confidence in him "to do or to recommend the right thing for the economy." This measure of Greenspan's confidence rating plummeted from a lofty 82% of respondents in April 2001 to just 62% of respondents in April 2005. It is also, sadly, far higher among Republicans than among Democrats.[99]

The perception of partisanship brings us to our other point. When the older author of this paper was the age of the younger author (which was quite a few years ago!), monetary policy decisions had a clearly partisan cast: Democrats were typically softer on inflation than Republicans, who in turn seemed less concerned than Democrats about growth and employment. Those days are long gone now—and good riddance. Today, there are essentially no partisan differences on monetary policy, and FOMC members are

[98] See, among many possible sources that could be cited, Canzoneri, Cumby, and Diba (2002).
[99] See Gallup (2005). The numbers in the text ignore the "don't knows".

seen as technocrats whose views on interest rates bear little if any relation to their politics. Yes, it remains true that Democratic presidents generally appoint Democrats to the Federal Reserve Board while Republican presidents generally appoint Republicans. But most Federal Reserve governors are not highly-political people, and they normally check whatever partisanship they have at the door. The same is true of Reserve Bank presidents, who are not even political appointees.

All this is good for the Federal Reserve as an institution, good for the conduct of monetary policy, and good for the country. No one wants the Fed to become as partisan an institution as the Supreme Court. And the politicians and citizenry are more likely to be comfortable with a high degree of central bank independence if the Fed stays out of politics.

So, we believe that the next Chairman of the Federal Reserve would be wise to forsake this aspect of the Greenspan record and—to the maximum extent possible—keep his views on most non-monetary matters to himself. We furthermore think this will not be too difficult to do, despite the Greenspan precedent, because the Fed's next leader will assume the office as a human being, not as a living legend. The precedent can be broken easily.

IV.B The extreme personalization of monetary policy

One possible response to the criticism just made is that Greenspan's well-publicized views on political matters are always offered as his *personal* opinions, not as the *institutional* views of the Federal Reserve. Indeed, Greenspan makes this point constantly. It only takes us so far, however, owing to the second potentially problematic

aspect of the Greenspan legacy: He has been on the job so long, and has been so dominant and so successful, that few Americans any longer draw a distinction between "Alan Greenspan" and "the Federal Reserve." The media, for example, routinely reports that "Greenspan raised interest rates today." U.S. monetary policy has, in a word, become intensely *personalized*. It's Alan Greenspan's policy—period.

Furthermore, this view is not far from the truth. Greenspan has, of course, never lost an FOMC vote. But, more significantly, dissent has been minimal during the Greenspan era, and especially in recent years. Over the seven full years 1998-2004, which included 60 FOMC meetings and some turbulent times in which the right course of action was far from obvious (e.g., responding to the 1998 financial crisis and to 9/11), the total number of recorded dissents was a mere 14. Under the Greenspan standard, Greenspan's rule is rarely questioned.

As we have stated repeatedly in this paper, the Greenspan standard has served America well. So what's the problem? Maybe there isn't any. But we have at least three concerns—which we state in increasing order of importance.

First, the coming replacement of Alan Greenspan by a mere mortal in January 2006 will not—to overwork Keynes's analogy—be like changing dentists. It may in fact prove to be a traumatic experience for the markets. We will soon learn whether the Greenspan era has created a deep reservoir of faith in the Federal Reserve, or just in Alan Greenspan. However, we do not wish to overstate the case. Back in 1987, the financial markets viewed the impending retirement of Paul Volcker as tantamount to the end of civilization as they knew it. But they got over it, as they will in 2006. Furthermore, we would be the

last to *fault* Greenspan for doing such a superb job—which is the main reason for the cult of personality.

Second, and more serious, is the concern that has served as a kind of leitmotif for this paper: What will Greenspan's successor find when he opens the proverbial desk drawer? We have tried to elucidate and emphasize those aspects of the Greenspan standard that are replicable, and the lessons that have been (or should have been) learned. In our view, there are quite a few—more, we think, than is popularly realized. The desk drawer is not as empty as it seems. That said, much of the secret to Greenspan's success remains a secret. It is too bad that he has not seen fit to share more of what he apparently knows with staff, FOMC colleagues, economists, and the broader public. But, of course, it is not too late. Alan Greenspan is only leaving the Fed, not the planet. Maybe he should deliver the main paper at the next Jackson Hole conference.

Finally, and most important, the fact that the FOMC has functioned so much like a "one-man show" during the Greenspan years means it may have eschewed many of the presumed benefits of decisionmaking by committee. Since one us has written on this subject extensively, we can be brief here.[100] Blinder (2004, Chapter 2) examines four potential advantages of group over individual decisionmaking in monetary policy, which we list briefly here:

- *Reduced volatility*: Policy made by a committee is likely to be less volatile than policy made by an individual.[101]

[100] See Blinder (2004), Chapter 2). The Netherlands Bank is also holding a conference on this subject in November 2005.

[101] Another way to put this point would be to say that committee decisions are likely to be more inertial—which could be either an advantage or a disadvantage.

- *Insurance against outliers*: Group decisionmaking offers some insurance against the possibly extreme views of a lone-wolf central banker.
- *Pooling of knowledge*: In an uncertain world, pooling should lead to better information—and thus, hopefully, to better decisions.
- *Different decision heuristics*: Evidence shows that a group of people who process and act on information differently often outperform even highly-skilled individuals when it comes to complex tasks.

There is also persuasive experimental evidence that committees outperform individuals in making simulated monetary policy decisions in a laboratory.[102] Finally, the worldwide trend toward monetary policy committees, rather than individual decisionmakers, reveals the preferences of other countries. There is now, we would argue, a rebuttable presumption in favor of making monetary policy decisions by committee.

Do we therefore mean to imply that the FOMC would have made systematically better decisions if Alan Greenspan had been less dominant? Certainly not. Throughout this paper, we have emphasized the exquisite success of the Greenspan standard. It's an enviable record that will be hard to match. And that's precisely our point. It makes sense to put all your eggs in one basket by investing (essentially) all the authority in one person *only* if you are quite sure that you have found the *maximum maximorum*. Alan Greenspan may well have been that man for the past 18 years. But can President Bush pull off the trick that President Reagan apparently did in 1987? It's not impossible. The Yankees

[102] See Blinder and Morgan (2005) and Lombardelli *et al*. (2005), which replicates Blinder and Morgan's findings (and adds a few new ones).

managed to replace Joe DiMaggio in centerfield by Mickey Mantle in 1951. But no Yankee centerfielder has approached that standard since.

So our view is that the FOMC would be wise to function more like a true committee—albeit one with a clear leader—in the future than it has in the past. And that, of course, would directly contradict one notable aspect of the Greenspan legacy.

V. Conclusion: What's in that Top Desk Drawer?

The reader who has come this far will no doubt have noticed that we are full of admiration for Alan Greenspan's *record* as chairman of the Fed. Both in what we have termed "workaday monetary policy" and in his deft handling of a number of unusual situations, his job performance has, in the current vernacular, been awesome.

But what about his *legacy*? How much of the outstanding performance of the Greenspan Fed can be expected to survive Greenspan's impending retirement? And how, in the absence of human cloning, will that be accomplished? As is well known, Greenspan has never written down his "magic formula" nor even, with a few notable exceptions, offered much of a window into his thinking.[103] Fermat did not leave a proof of his last theorem, and Greenspan does not appear to be leaving an instruction manual behind. Is his legacy therefore in jeopardy?

To some extent, the answer is yes—and that's a shame. But we actually think that Greenspan is leaving more in the proverbial top desk drawer than is popularly believed—provided you look hard enough. We have tried to demonstrate in this paper that a set of *principles* underpins the Greenspan standard. But economists and central bankers cannot incorporate these principles into their thinking unless they know what they are. So we conclude the paper by summarizing what we believe to be the main, mostly unspoken, principles that define the Greenspan standard *and that can be emulated*. What follows is not ours or anyone else's list of the most cherished central banking principles. Rather, it is our distillation of what economists and central bankers can and should take away as the

[103] One such exception is his handling of financial bubbles, where he has expounded at some length. See, for example, Greenspan (2002a). Another is his speech on risk management (Greenspan, 2004).

Greenspan legacy, that is, it is what Alan Greenspan could have told us—if he had chosen to.

Principle No. 1: Keep your options open.

Academic economists are fond of writing about the conceptual virtues of rules, pre-commitment devices, and the like. Greenspan, the great practitioner, is unsympathetic. Rather, as we have noted, he believes that the economy changes far too much and far too fast for conventional econometric tools ever to pin down its structure with any accuracy and, for this reason, committing to a rule for monetary policy or even to a fixed response to a specific shock is dangerous. In this context, the concept of *option value* should perhaps be interpreted literally: In a world of great uncertainty, the value of keeping your options open is high. And that, presumably, makes it wise to move gradually. Alan Greenspan certainly acts as if he believes that.

Principle No. 2: Don't let yourself get caught in an intellectual straitjacket.

Similarly, one of Greenspan's great strengths has been flexibility. He has never let himself get locked in to any economic doctrine (e.g., monetarism), any treasured analytical approach (e.g., the expectational Phillips curve), nor any specific parameter value (e.g., the 6% natural rate). He has also changed his mind—without, of course, saying so!—on certain issues (e.g., transparency). The downside of this flexibility is, of course, that nobody knows what "the Greenspan model" of the economy is; that will *not* be part of his legacy. But the upside is more important. To paraphrase the wise words of

James Duesenberry in another context, Greenspan will not "follow a straight line to oblivion." That's a good principle for any central banker.

Principle No. 3: Avoid policy reversals.

Greenspan believes that rapid changes of direction are damaging to the reputations of both the central bank and its leader, and are also likely to cause volatility in markets. This, of course, both helps explain the importance of "option value" and provides a reason for monetary policymakers to move gradually once they start moving. There is no going back—at least not for a while.

Principle No. 4: Forecasts, though necessary, are unreliable.

A paradox is defined as an *apparent contradiction*. Here's one: Greenspan is sometimes credited with inventing the idea of "preemptive" monetary policy—which means, of course, acting on the basis of a forecast.[104] Yet he is deeply skeptical about the accuracy of economic forecasts—a result, perhaps, of a lifetime of seeing forecasts go awry. So he is constantly examining what's going on in the economy *right now* and trying to figure out which of these developments will be lasting and which will be fleeting. This, we believe, is another reason why Greenspan prefers to move gradually once he starts moving. Like an attentive nurse, he is constantly taking the economy's temperature.

Principle No. 5: Formal optimization procedures work in theory, but risk management works better in practice—especially as a safeguard against very adverse outcomes.

[104] See Sinai (2004).

In Greenspan's view, economists don't know enough to compute and follow "optimal" monetary policies, and we delude ourselves if we pretend we can. So *robustness,* and probably even *satisficing*, rather than *optimizing* (as that term is normally understood) are among the touchstones of the Greenspan standard. As we have seen, Greenspan has characterized himself as practicing the art of *risk management*—somewhat like a banker does. And like a commercial or investment banker, a central banker must be constantly on guard against very adverse scenarios, even if they have low probabilities of occurring. So, for example, Greenspan's preoccupation with the dangers of deflation in 2002 and 2003 was seen by some observers as excessive, given the actual risk. But he was determined not to allow the Fed to follow the Bank of Japan into the zero-nominal-interest-rate trap.

Principle No. 6: Recessions are bad, as is growth below potential.[105]

It may seem silly even to list this principle, much less to credit it to Greenspan—until you remember some of the most cherished traditions in central banking. While he has certainly enjoyed his share of good luck, we think it is no accident that there have been only two mild recessions on his long watch, and that he is now in the process of attempting his fourth *soft* landing (note the adjective). The Greenspan standard internalizes the fact that society finds recessions traumatic; it therefore takes the Fed's dual mandate seriously. When the economy appeared to need more running room—in the late 1990s and, one might say, into 2004—Greenspan was less then eager to withdraw the punch bowl.

[105] We omit the collateral idea that inflation is bad from our list on the grounds that it is too obvious and certainly not special to Greenspan.

Principle No. 7: Most oil shocks should not *cause recessions.*

As we have noted, oil shocks—defined as sharp increases in the relative price of oil—have almost always been temporary. And a *short-run* change in a *relative* price is not a good reason to have a recession. (See Principle No. 6.) By focusing on core rather than headline inflation, the Greenspan standard has not only used a more reliable indicator of future headline inflation but has also avoided the error of piling tight money on top of an adverse oil shock—which is a pretty sure recipe for recession.

Principle No. 8: Don't try to burst bubbles; mop up after.

First of all, you might fail—or bring down the economy before you burst the bubble. (Again, see Principle No. 6.) Furthermore, bubble bursting is not part of the Fed's legal mandate, and it might do more harm than good. Finally, the "mop up after" strategy seems to work pretty well.

Principle No. 9: The short-term real interest rate, relative to its neutral value, is a viable and sensible indicator of the stance of monetary policy.

The idea of using the real short rate as the main instrument of monetary policy appears to have been a Greenspan innovation, one which was highly controversial at the time (how can the Fed control a *real* rate?) but has since found its way into scores of scholarly papers. While the neutral rate can never be known with certainty, the potential errors in estimating it seem no larger than for other candidate instruments. (Who would like to guess the optimal growth rate for M2?)

Principle No. 10: Set your aspirations high, even if you can't achieve all of them.

Sure, a central banker needs to be realistic about what monetary policy can accomplish. (See Principles No. 4 and 5.) But that is not a reason to set your aspiration levels low. Even if an attempt at fine tuning fails (as happened in 1988-1989), it is likely to do more good than harm as long as it is done gradually and flexibly (see Principle No. 1). And if it succeeds (as in 1994-1995 and perhaps in 1999-2000), society benefits enormously. The appropriate translation for monetary policymakers of Teddy Roosevelt's famous motto, "Talk softly, but carry a big stick" is: Talk modestly, but set your sights high.

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