Monetary Policy with Changing Financial and Labor-Market Fundamentals

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Abstract:

The Taylor rule tells the central bank to adjust its interest-rate target in response to current inflation and economic activity. The intercept of the Taylor rule depends on the equilibrium real interest rate and the equilibrium or potential level of GDP. The rule shifts as those financial and labor-market fundamentals change. I show that the optimal monetary policy in the United States drifted in important ways during the past 40 years, as fundamentals shifted. The 1980s saw a dramatic increase in the equilibrium real interest rate, while the 1970s and 1980s had a high level of the natural unemployment rate and correspondingly low level of potential GDP. The net effect was to shift the intercept of the Taylor rule upward by more than 4 percentage points during the 1980s. In recent years, there has been little net drift, as modest increases in the equilibrium real rate have been offset by modest decreases in the natural unemployment rate.

I. Introduction

A strong consensus has emerged, both among economists and central bankers, in favor of conducting monetary policy with a target for a short-term interest rate. The last vestiges of interest in monetary aggregates has vanished from monetary policy-making in the past decade. Today, central bankers around the world establish an interest rate target for the daily management of their portfolios, and change that target as needed to achieve the goals of policy, generally some combination of the exchange rate, the rate of inflation, and the level of economic activity.

In the United States—whose monetary policy is the focus of this paper—the international value of the dollar has a rather smaller role than does the exchange rate in other countries or in the Euro block. The most influential commentator on U.S. monetary policy, John Taylor, has proposed a policy rule that considers only inflation and aggregate activity. He describes the current policy of the Federal Reserve as placing a weight of 1.5 on recent inflation and 0.5 on the percentage departure of real GDP from potential when it sets the target for the federal funds interest rate (Taylor [1993]). Moreover, he sees this policy rule as roughly optimal.

In practice, however, the setting of the interest-rate target seems much more challenging than following the simple Taylor rule. First, as recent U.S. experience has amply confirmed, there appear to be important shifts in the natural unemployment rate and potential GDP over time. Today, the U.S. economy is humming along with 3.9 percent unemployment, a level that all experts thought was deeply inflationary only a few years ago. The Taylor rule should be adjusted for shifts of this type. Measuring the shift has proven to be a major challenge. This paper documents the importance of the shift both in data on unemployment and in

a direct examination of the optimal monetary policy rule in a simple empirical framework.

Second, there is a concern that economic activity may surge to levels that are inescapably inflationary. The main recent focus of this concern is that high levels of wealth from the strong stock market will result in consumption demand that will propel the economy into inflationary territory. The relationship of this concern to the Taylor rule has been less clear than questions about potential GDP or the natural unemployment rate. I formulate the issue in the following way: Financial conditions enter the Taylor rule just as directly as potential GDP. The constant in the Taylor rule is the equilibrium real interest rate. Any increase in that equilibrium rate should translate into an equal increase in the interest-rate target. Observers who state that there is no cause for an increase in the interest rate until there is a threat of increased inflation are simply mistaken. Rather, any change in the equilibrium real interest rate should raise the target even with inflation unchanged.

Most of the recent discussion of this issue in the United States has considered a channel described as stock market values to consumption to aggregate activity. In that setting, the equilibrium real interest rate rises because of the increase in the demand for goods and services. In terms of the simple IS-LM model, a higher stock market shifts the IS curve outward and causes higher output and a higher interest rate.

Modern finance theory reaches the same conclusion by a more direct route. It treats the level of the stock market as an endogenous variable, responsive to underlying fundamentals, rather than as an exogenous driving force. In most versions of the theory, the expected returns to all types of securities and investments move in parallel, separated by constant risk premiums. If the return to physical capital rises because of favorable developments in productivity, returns in the stock market rise by the same amount. Interest rates rise by that amount as

2

well. The full story includes increases in the value of the stock market and responses to the resulting increased wealth. That is, the finance accounts of a strong economy are not substantively different from the conventional story.

This paper develops a framework for studying and quantifying these issues. The starting point for the framework is the assumption that recent empirical research on the effects of monetary policy has developed reasonably accurate measures of these effects, and that the effects are stable. In particular—contrary to the deep wisdom of Lucas [1976]—I assume that it is permissible to ignore the feedback from the policy rule to the structural coefficients describing the response of inflation and economic activity to exogenous changes in the interest rate. I make this assumption because research describing feedback from the policy rule to the structural features of the economy reaches dramatic and impractical conclusions. For example, Woodford [1999] shows that monetary policy can achieve perfect price stability with a credible policy of following small interest-rate changes with predictable changes that are vastly larger—much larger than any central banker would dream of in practice.

I show that the optimal monetary policy rule in an environment with known stable structural responses to changes in the interest rate can be recovered in a statistical regression. The regression has the important feature that it describes optimal policy irrespective of the rules governing actual policy. The optimal policy can be found from data during which policy was wildly suboptimal and where the policy rule changed over time. The regression takes inflation aversion as an input and describes a different optimal policy depending on the degree of aversion.

The regression applied to U.S. data for the past 40 years shows that Taylor's coefficients are roughly optimal for the period as a whole, if the policy rule considers only inflation and economic activity. But the optimal rule drifts in important ways. A preliminary examination of the data suggests that the natural

unemployment rate was much higher during the 1970s and 1980s than in the 1960s or 1990s. And it suggests that the equilibrium real federal funds rate was much higher in the 1980s than in other decades. The combined effect of these two sources of drift appears to have raised the constant in the Taylor rule substantially during the 1980s. A dummy variable for the 1980s in the regression for the optimal monetary policy rules confirms this finding: For given levels of inflation and unemployment, the federal funds rate target needed to be more than 4 percentage points higher in the 1980s than in other decades to deliver the optimal response to current economic conditions.

I develop econometric measures of the low-frequency movements of the real interest rate and the unemployment rate, in a form suitable for inclusion in the regression for the optimal monetary policy. They reveal large and statistically unambiguous shifts in the Taylor rule over time. Interestingly, recent movements in the intercept of the Taylor rule have not been particularly large by historical standards. Moderate increases in equilibrium real rates have been offset by moderate decreases in the natural unemployment rate. The challenge to monetary policy was much greater in the 1970s and 1980s than it is today in the United States.

II. A Framework for Studying Policy Rules

I start with the following structural model of the interest rate, the rate of inflation, and the unemployment rate:

$$\pi_t = -\phi r_t + \lambda u_{t-1} + \omega \pi_{t-1} + x_{t-1}\beta + \varepsilon_t \qquad (2.1)$$

$$u_t = \alpha r_t + \mu u_{t-1} + \delta \pi_{t-1} + x_{t-1}\psi + \eta_t \qquad (2.2)$$

Inflation π_t, unemployment u_t, and the interest rate r_t are jointly determined variables governed by these two equations and the central bank's monetary policy. x is vector of variables determined at time t or earlier and β and ψ are corresponding vectors of coefficients. The central bank chooses the interest rate to achieve the target

$$u_t = u* + \gamma \left(\pi_t - \pi* \right), \tag{2.3}$$

where $u*$ is the natural unemployment rate and $\pi*$ is the long-run target for the rate of inflation. The coefficient γ measures the bank's aversion to inflation in the short run. A high value of γ implies that the bank will bring about a high level of unemployment in the process of bringing inflation under control. All rules with positive values of γ keep inflation under control in the longer run.

The level of the interest rate required to achieve the target is

$$r_t = \frac{\gamma\lambda - \mu}{\alpha + \gamma\phi} u_{t-1} + \frac{\gamma\omega - \delta}{\alpha + \gamma\phi} \pi_{t-1} + \frac{1}{\alpha + \gamma\phi} \left[(\gamma\beta - \psi)x_{t-1} + \eta_t - \gamma\varepsilon_t \right] \tag{2.4}$$

I assume that the variables in x include a constant that absorbs the constants in the policy target, equation 2.3. The first two terms of equation 2.4 constitute a Taylor [1993] rule. The term involving x_{t-1} is the rest of the rule, treated as the intercept in a Taylor rule. A major purpose of this paper is to investigate the importance of the omitted elements of the Taylor rule and the drift that occurs in the rule as these variables change.

Now consider the statistic

$$r_t - \frac{u_t - \gamma\pi_t}{\alpha + \gamma\phi} =$$
$$\frac{\gamma\lambda - \mu}{\alpha + \gamma\phi} u_{t-1} + \frac{\gamma\omega - \delta}{\alpha + \gamma\phi} \pi_{t-1} + \frac{1}{\alpha + \gamma\phi} \left[(\gamma\beta - \psi)x_{t-1} + \eta_t - \gamma\varepsilon_t \right] \tag{2.5}$$

5

If the structural coefficients α and ϕ are known, then the complete monetary policy rule for any value of the inflation aversion parameter γ is the projection of $r_t - \dfrac{u_t - \gamma \pi_t}{\alpha + \gamma \phi}$ on lagged variables. A crucial feature of this setup is that no assumption is required about the monetary policy rule actually in use. If the full monetary policy rule of equation 2.4 is in use, then $\dfrac{u_t - \gamma \pi_t}{\alpha + \gamma \phi}$ will be an unpredictable random variable and the policy rule will be the forecast of r_t. If the policy rule is different from the one implied by this setup, then the term $\dfrac{u_t - \gamma \pi_t}{\alpha + \gamma \phi}$ adjusts so that the projection reveals the rule that would be optimal for the given value of γ in this setup. Moreover, the projection reveals the optimal policy rule even if the actual policy rule varies over time.

The key assumptions underlying this finding are:

Assumption 1. Structural Stability. The coefficients of equations 2.1 and 2.2 are fixed structural features of the economy

Assumption 2. Identification. The structural coefficients α and ϕ are known.

Assumption 1 rules out the interdependence between policy and decision rules made famous by Lucas [1976]. Equations 2.1 and 2.2 are treated here as deep structural features of the economy, not as decision rules that depend on the economic environment including policy.

Assumption 2 leads me to research on structural models of the effects of monetary policy on inflation and unemployment. I rely entirely on existing research.

The derivation so far does not do justice to timing considerations. The effect of a change in the interest rate on inflation does not begin to occur until more than a year after the change, according to the research I rely on. Although

6

the effect of the interest rate on unemployment begins earlier, it too reaches its peak more than a year after the change. On the other hand, the change itself tends to be temporary—the interest rate reaches a maximum after about two months and then begins to return to normal. Accordingly, I take the interest rate 15 months earlier than the values of inflation and unemployment, and take the date of policy formulation to be 18 months earlier, 3 months before the peak effect on the interest rate. Thus the actual equation to measure the optimal policy is

$$r_t - \frac{u_{t+15} - \gamma\pi_{t+15}}{\alpha + \gamma\phi} = \frac{\gamma\lambda - \mu}{\alpha + \gamma\phi} u_{t-3} + \frac{\gamma\omega - \delta}{\alpha + \gamma\phi} \pi_{t-3} + \frac{1}{\alpha + \gamma\phi} \left[(\gamma\beta - \psi)x_{t-3} + \eta_t - \gamma\varepsilon_t \right] \quad (2.6)$$

III. Structural Parameters

The strategy of this paper rests on prior knowledge of the structural parameters governing the effect of a change in the interest rate on inflation and unemployment. These parameter values are not identified in equation 2.6. Rather, I draw them from the large body of empirical research on the effects of monetary policy. Specifically, the parameters are the 18-month points on the impulse response functions relating an innovation in the federal funds rate to inflation and unemployment.

Research on the effects of monetary policy generally characterizes aggregate economic activity in terms of real GDP rather than unemployment. Taylor [1993] states his monetary policy rule in terms of the departure of real GDP from a measure of potential. I use Okun's Law with a coefficient of 1/3 to translate changes in real GDP into changes in unemployment. I do not believe that there is a stable procedure for inferring potential GDP that is more reliable than Okun's

7

Law coupled with a reasonable inference about the natural unemployment rate.[1] Hence the simplest approach is to deal with unemployment directly.

To determine the values of the structural parameters, I consulted with a leading scholar in this area, Ben Bernanke. He replied as follows:

> Bernanke-Mihov [1998], especially Figure II, and Christiano-Eichenbaum-Evans [1999], especially Figure 2, are the most systematic in comparing the results from a number of different specifications. However, the results from all papers were qualitatively similar (by which I mean that the shapes of responses were quite similar, and the maximum differences in magnitudes were about a factor of 2). So I base my answer primarily on Bernanke-Mihov [1998], Figure II, page 893, tempered slightly by the other papers.
>
> The shock I consider is an innovation to monetary policy that has an initial impact of 25 basis point on the federal funds rate. The typical behavior of the funds rate following such a shock is to rise for the first two or three months, peaking abound 35 basis points, then declining sharply. The funds rate is back to zero at about 12 months.
>
> In response to this shock, real GDP begins to decline after about three months. The decline is maximal over the 12 to 18 month range at about 18 log points; that is, the cumulative change over the period is -0.18 percent. From about 18 months to 24 months real GDP is actually recovering, to 12 to 15 log points, So an answer to your question is that for every basis point the funds rate rises today, real GDP will be half a log point lower in 24 months.
>
> In response to the same shock, the level of the GDP deflator has no perceptible change for the first 12 months. It falls about 8 basis points over the second year. In other words, the inflation rate does not change over the first year and falls about 0.08 percentage points in the second year. This decline in inflation appears to be permanent,

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[1] Historically, it has been my responsibility to develop data on potential GDP for my intermediate macro textbook with Taylor. The only stable method that I have found over the years is to decide upon a time series for the natural rate, use Okun's Law to restate real GDP by adding a percentage equal to three times the departure of unemployment from the natural rate, and then smoothing the resulting series.

8

but there is only a little additional decline in inflation after the second year. So, in short, each basis point increase in the funds rate today lowers inflation by about one-third of a log point, permanently, beginning in the second year.

Based on Bernanke's opinion, I take the 18-month-out structural effect of the funds rate on inflation, ϕ, to be 0.33. The 18-month-out structural effect on real GDP is –0.18/0.25. The corresponding effect on unemployment is one third as large and opposite in sign, or $\alpha = 0.25$.

Equation 2.6 also contains the policy design parameter γ, locating the central bank on the dove-to-hawk axis with respect to inflation. Hall [1984] discusses this way of thinking about monetary policy design. Notice that γ is not an unknown parameter to be measured. Rather, equation 2.6 finds the monetary policy rule corresponding to any designated value of the inflation-aversion parameter.

In this paper, I will use the value 0.95 for inflation aversion, γ. Not only is this a reasonable value, but it results in a Taylor rule with close to the coefficients proposed by Taylor [1993].

IV.   Potential Sources of Drift in the Taylor Rule

The simple Taylor rule has the form

$$r_t = \rho \pi_{t-1} - \lambda u_{t-1} + k \tag{4.1}$$

Monetary policy holds the interest rate at a level given by a simple function of the unemployment rate and the rate of inflation. Taylor's [1993] proposal was that the coefficient applied to the output gap be 0.5. The corresponding value for the coefficient on unemployment is 1.5. Taylor also proposed that the weight on inflation should be 1.5.

9

This paper is about the intercept k in the Taylor rule. There are two ways to look at the intercept. First, Taylor and other proponents of this type of monetary policy rule think of the constant in the following parameterization:

$$r_t = \bar{r} + \pi^* + \rho\left(\pi_{t-3} - \pi^*\right) - \lambda\left(u_{t-3} - u^*\right) . \tag{4.2}$$

Here $\bar{r}$ is the equilibrium real interest rate, and, as before, π^* is the target inflation rate and u^* is the natural unemployment rate. Thus the constant is

$$k = \bar{r} + \left(1 - \rho\right)\pi^* + \lambda u^* . \tag{4.3}$$

Obviously the Taylor rule could drift if the target inflation rate drifted. I will not consider that aspect further. I will be concerned with drift arising from changes over time in the equilibrium real rate $\bar{r}$ and the natural unemployment rate u^*.

A.   Evidence on Drift in the Real Federal Funds Rate

Figure 1 shows the realized monthly real federal funds rate using the Consumer Price Index. The heavy solid line is the Epanechnikov kernel smoother of the data with a bandwidth of 40 (see Härdle [1991] and QMS [1997]). There is an unmistakable rise in the real rate in the early 1980s, followed by a drift downward in the late 1980s and early 1990s, and finally a modest increase in the late 1990s.

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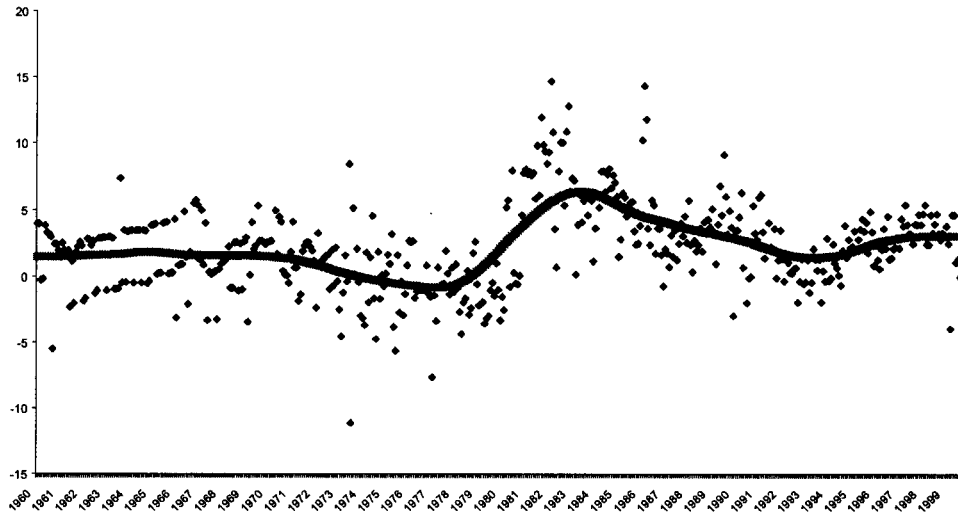
Figure 1. Monthly real federal funds rate and kermel smoother

There seems little doubt that the equilibrium real interest rate undergoes low-frequency variations that complicate monetary policy-making. Simple models of finance suggest that all returns move in parallel, separated by risk premiums that are constant over time. Figure 2 shows data from Hall [2000] on quarterly real returns for all the outstanding financial claims on U.S. non-farm, non-financial corporations. These returns include all forms of net cash flows to securities holders plus capital gains on stocks and bonds. Again, there are important low-frequency movements in the returns, but the movements are not at all parallel. There are large variations in the risk premium over time. Figure 3 displays the risk premium directly. It shows the quarterly excess returns of corporate securities over the 3-month Treasury bill rate plus the average risk premium. Its smoother shows changes over time in the risk premium—it would be flat at zero if the premium were constant. Instead, the premium was higher in the 1950s and 1960s, fell to its lowest level in the 1970s, and rose to an all-time high toward the end of the 1990s.

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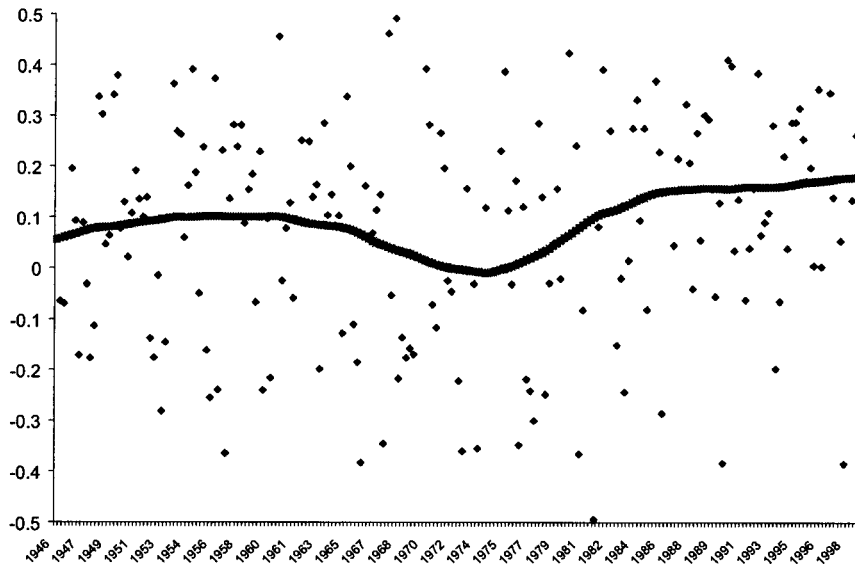
Figure 2. Quarterly real returns for securities of the non-financial corporate sector, with kernel smoother
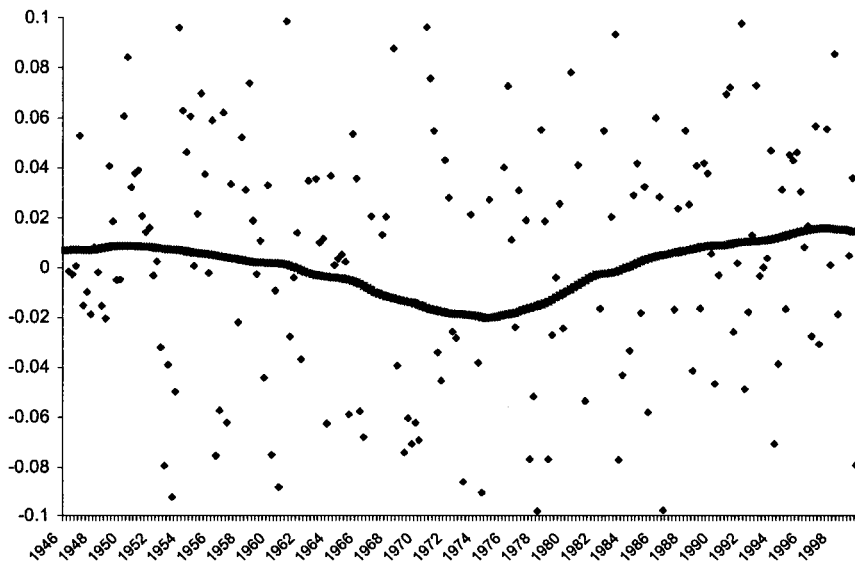
Figure 3. Quarterly excess returns for non-financial corporate securities, with kernel smoother

12

Figure 3 suggests that the risk premium separating corporate returns from the short-term interest rate is anything but constant. Since the mid-1970s, the premium has grown continuously. The interpretation of this finding is intensely controversial. One view is that the stock market has risen to unrealistic heights and is likely to fall in the future or at least pay low returns. Proponents of this view speak of the equity premium as having fallen because of their belief in low future returns.

Translated into the language of current debates about monetary policy, the evidence in Figure 3 says that something has prevented the stock-market-wealth to consumption to interest-rate mechanism from operating in full. The natural stopping place for that mechanism is when returns in the stock market are brought into their normal relationship with short-term interest rates. The mechanism of higher spending and higher interest rates has been inhibited, it appears. The drift in the monetary policy rule has been much smaller than it would have been under standard financial equilibrium conditions.

An important question for monetary policy is the future of this relationship. Will the equilibrium real rate rise to its normal relation to returns on corporate assets? If so, the interest rate target should be raised. Will returns to corporate assets fall and the risk premium remain at its current level? If so, the interest-rate target should be lowered.

B. Evidence on Drift in the Natural Unemployment Rate

Modern theories portray unemployment as deviating temporarily above and below its natural rate in response to short-term fluctuations. Hence a smoothed time series of unemployment will reveal changes in the natural rate over time. Figure 4 displays the results of that exercise. The bandwidth of the smoother is chosen to eliminate almost all of the pronounced business cycle in monthly unemployment. The facts shown in the figure are familiar—the natural rate was at low levels in the 1960s, rose to around 7 percent in the 1970s, and fell to below 5

percent by the end of the 1990s. Discussions of the implications of this change for monetary policy have been more extensive that those for changes in the equilibrium real rate.
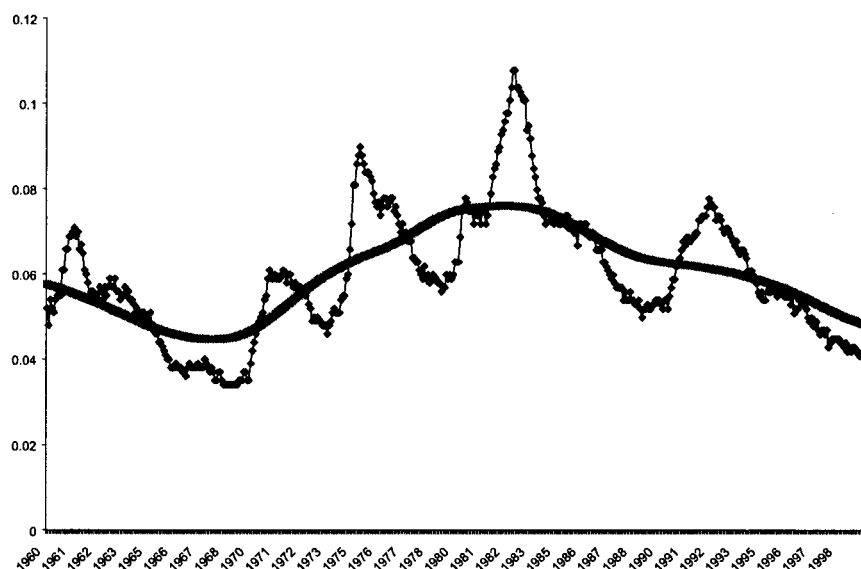

Figure 4. Actual unemployment and smoothed unemployment (interpreted as the natural rate)

C.   Net Drift

Equation 4.3 shows that the net effect of drift in the equilibrium real interest rate and in the natural rate of unemployment is the sum of the real rate and the natural rate, with the latter multiplied by the weight in the Taylor rule, 1.5. Figure 5 displays the total drift term. It reaches a maximum of almost 18 percent in the early 1980s. Its level of about 10 percent in the mid and late 1990s is a little higher than its nearly constant level of around 9 percent in the period from 1960 to 1977. The stability in that period was the result of offsetting increases in the natural unemployment rate and decreases in the equilibrium real interest rate.

14
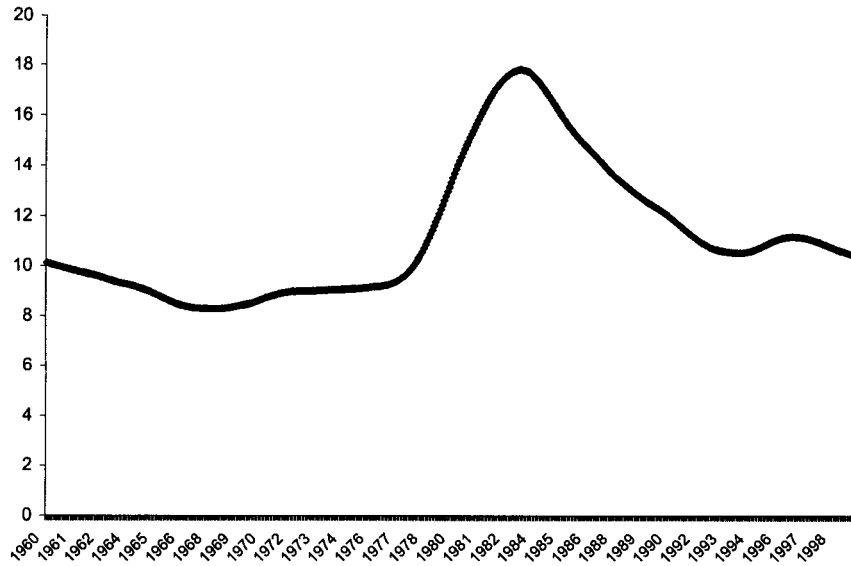
Figure 5. Net drift in the Taylor rule: equilibrium real rate plus 1.5 times the natural unemployment rate

V. Econometric Evidence

Estimation of the Taylor rule for the period 1960 through 1999 yields the following results:

$$r_t - \frac{u_{t+15} - \gamma\pi_{t+15}}{\alpha + \gamma\phi} = \underset{(0.32)}{-1.32}\, u_{t-3} + \underset{(0.19)}{1.46}\, \pi_{t-3} \qquad (5.1)$$

In this and all subsequent results, Newey-West standard errors are in parentheses, and constants are estimated but not reported. Equation 5.1 comes close to Taylor's original prescription for coefficients of –1.5 on unemployment (that is, 0.5 on the GDP gap) and 1.5 on inflation. As noted earlier, this is partly by construction—I

15

picked the value of γ to match the coefficient on inflation. The coefficient on unemployment is a validation of Taylor's original choice, nonetheless.

Although the equation reproduces the simple Taylor rule, it fails tests against drift. First, Figure 5 suggests that the 1980s were a time when the intercept of the optimal monetary policy was substantially higher. Adding a dummy variable for the 1980s to equation 5.1 confirms this finding:

$$r_t - \frac{u_{t+15} - \gamma \pi_{t+15}}{\alpha + \gamma \phi} = \underset{(0.30)}{-1.88} u_{t-3} + \underset{(0.17)}{1.32} \pi_{t-3} + \underset{(1.16)}{4.17} d_t \qquad (5.2)$$

Here d_t has the value 1 during the 1980s and zero at other times. The Taylor rule shifted upward in the 1980s by more than 4 percentage points, according to these results.

The earlier discussion suggested that low-frequency movements in interest rates and unemployment—interpreted as movements in their equilibrium values— should result in corresponding shifts in the monetary policy rule. I tested against this possibility by constructing a two-year-ahead autoregressive forecast of unemployment:

$$u_t = u_0 + \sum_{\tau=24}^{48} b_\tau u_{t-\tau} \qquad (5.3)$$

and a similar forecast of the funds rate. These forecasts extract the lower-frequency movements in the series in much the same way as the kernel smoothers, but are one-sided and therefore eligible for inclusion in the regression for determining the optimal monetary policy rule. Figures 6 and 7 show forecasted and actual values of the variables.
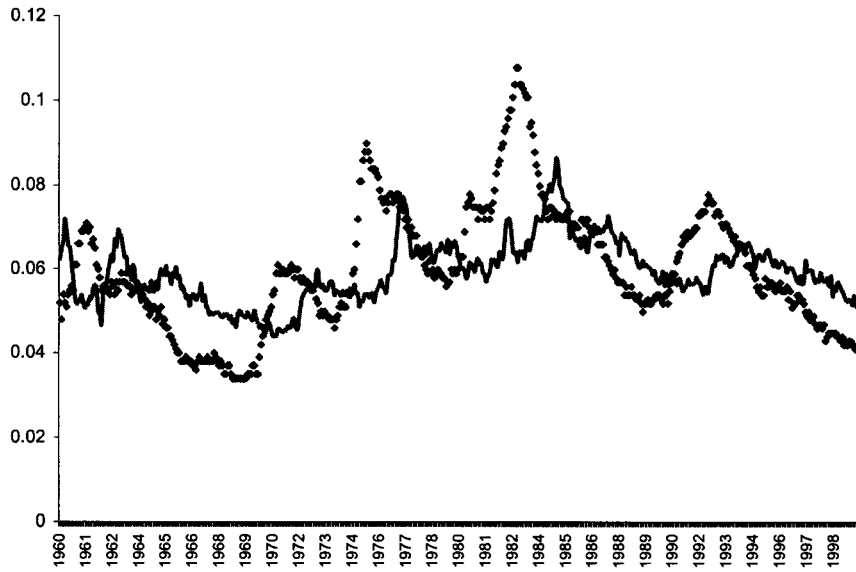
Figure 6. Unemployment and low-frequency component
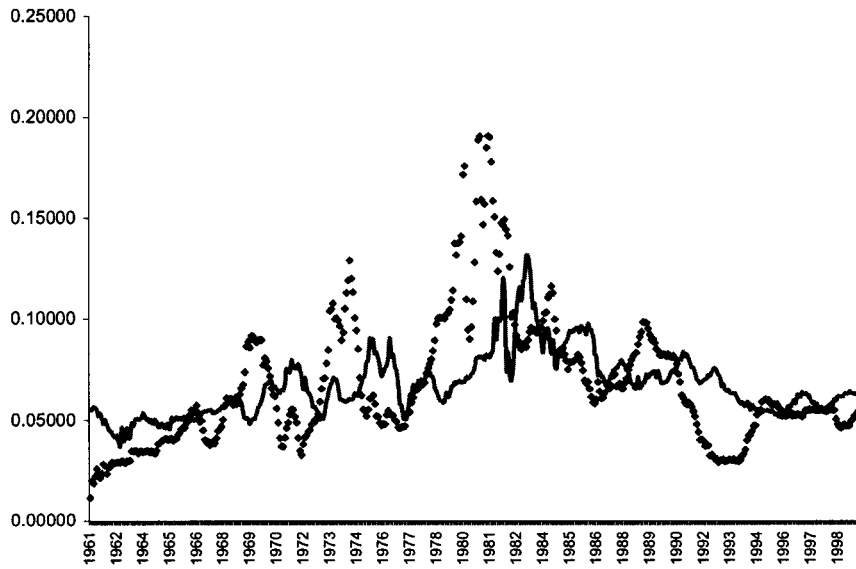
Figure 7. Federal funds rate and low-frequency component

17

The Taylor rule shows unambiguous shifts associated with these components:

$$r_t - \frac{u_{t+15} - \gamma \pi_{t+15}}{\alpha + \gamma \phi} = \underset{(0.64)}{-3.81} u_{t-3} + \underset{(0.18)}{1.44} \pi_{t-3} + \underset{(1.32)}{4.24} \hat{u}_{t+15} + \underset{(0.27)}{0.69} \hat{r}_t \qquad (5.4)$$

This equation confirms that the Taylor rule drifts along with the low-frequency movements in unemployment and the interest rate.

VI. Conclusions

Making monetary policy is not as simple as the Taylor rule suggests. The intercept of the rule drifts over time. A rule that delivers good performance today would have been destabilizing in the 1980s, when the intercept of the Taylor rule was more than 4 percentage points higher. Policy needs to study the two central issues: the equilibrium real interest rate and the natural unemployment rate (or potential GDP, essentially the same thing).

The extraordinary performance of the U.S. stock market has, so far, created a smaller problem than standard finance theory would predict. High returns in the stock market would normally occur at the same time as high real interest rates. In fact, as the evidence studied here shows, the rise in the real rate has been modest during the period of the 1990s when stock-market returns were extraordinary. Instead of a constant risk premium, the standard finance view, the risk premium widened in the 1990s. If the risk premium returns to normal, one of two things must happen—either the equilibrium real rate must rise or returns from equity must fall. In the first case, monetary policy must be vigilant. A wave of inflation will accompany an increase in the equilibrium rate if the increase is not properly diagnosed and the intercept of the Taylor rule raised. In the second case, no change in policy is required. So far in 2000, the second case seems to hold.

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