WHAT DRIVES THE FED TO ACT?

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Abstract

This paper studies the determinants of monetary policy since 1980 to see whether the Fed has truly followed an ad hoc approach, or whether some variables play a more important role in determining monetary policy than others. The results suggest that the Fed consistently responds to the unemployment rate, and that changes in the unemployment are the most important determinant of monetary policy. The results also indicate that the Fed responded, for some periods, to the real rate of return in the stock market, especially to lower the risk of financial instabilities, rather than to control asset price inflation.

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I. Introduction

Two trends, among other factors, with important macro policy implications characterized the 1990s. The size of financial markets grew to its highest level since the 1950s, and the U.S. economy became increasingly integrated with the global economy. With financial market growth and internationalization taking shape, monetary policy became an instrument of growing importance to achieve stable economic growth.

A growing body of literature discusses the design of optimal monetary policy with price and output stability as the primary targets. A few extensions of the original monetary policy rules have also incorporated exchange rate and asset price considerations. The discussion over optimal monetary policy rules, though, is based on the assumption that a natural rate of unemployment exists, which has been hard to uphold empirically. Consequently, some researchers have argued that efficient monetary policy would require the Fed to focus on moderate inflation and on low unemployment rates.

Because the Federal Reserve Bank's actions are often not fully transparent, it is not clear whether the Fed follows a strict monetary policy rule, thereby focusing on a specific set of target variable, or whether it uses its discretion in setting its target short-term interest rate, thus changing its targets over time. More specifically, looking at the recent economic experience of the U.S. in the 1990s, the question arises whether the Fed did respond to changes in the exchange rate or in the stock market through its actions.

II. Background

II.1 Determinants of Fed Policy in Theory

The literature focuses on defining an optimal rule for monetary policy. Based on the rational expectations approach, theoretical developments demonstrate that rules are supposedly superior to discretion, the so-called time inconsistency (Kydland and Prescott, 1977; Barro and Gordon, 1983; Blanchard and Fischer, 1989). In his seminal work on policy rules, Taylor (1993a, 1993b) showed that the Fed's monetary policy between 1984 and 1992 could be approximated with a policy rule linking the federal funds rate to price and output fluctuations around assumed targets[1]. Following Taylor's work, researchers have focused on estimating the parameters of Taylor's original rule. Ball (1997) focused on inflation targets to design efficient rules, whereas others advocated nominal income targets, finding them to be efficient in stabilizing prices and output (McCallum, 1993, 1995; Hall and Mankiw, 1994; Feldstein and Stock, 1994).

Taylor's rule was expanded to account for two important developments. First, researchers responded to the fact that the U.S. economy can no longer be treated as a closed economy, and that exchange rate fluctuations should be included in policy considerations (e.g. Ball, 1998)[2]. Second, stock prices have become more prominent as a

[1] Taylor allowed for transitions to new rules changing the parameters of the policy rule to set new targets.
[2] Smets (1997) found the Bank of Canada to respond to exchange rate changes and the Bank of Australia not to.

possible target variable (Goodhart, 1995; Shibuya, 1992), because asset price increases may foreshadow future consumer price increases.

The literature on policy rules assumes that an equilibrium output growth rate exists, which implicitly assumes that a non-accelerating inflation rate of unemployment (NAIRU) exists. When the unemployment rate falls below the NAIRU, and presumably the output growth rate rises above its potential, inflation is just lurking around the corner. Consequently, the unemployment rate is often seen as an indicator of future inflation, and thus as an indicator variable for monetary policy. Stiglitz (1997), for instance, wrote "it is hard to think about macroeconomic policy without the concept of the NAIRU" (see also, Weiner, 1993, 1994; Tootell, 1994; Fuhrer, 1995).

The NAIRU, though, has come under attack, mainly because of weak empirical support for a linear relationship between unemployment and inflation. The fact that the unemployment rate shifted lower than previously believed possible without creating inflationary pressures showed the concept of the NAIRU to be flawed (Eisner, 2000). Galbraith (1997), summarizing the empirical evidence attempting to measure the location of the NAIRU "a professional embarassment". Further, Staiger, Stock and Watson (1997) admit that "it is difficult to estimate the level of unemployment at which the [Phillips] curve predicts a constant rate of inflation", leaving them to conclude that the NAIRU "probably lies between 4.3 and 7.3 percentage points of unemployment".

The natural rate, though, has also had its defenders. For instance, NAIRU may vary over time due to demographic shifts (Gordon, 1997). It is also possible that the expected inflation rate varies with the actual rate, which may be more consistent with findings on individual decision making, therefore resulting in differing NAIRUs over time (Akerlof, Dickens and Perry, 2001).

Despite the broad discussion over optimal target variables, it is not apparent that the Fed actually adheres to strict rules in setting monetary policy. For example, included in his remarks about "irrational exuberance" on the stock market, Fed chairman Alan Greenspan argued the Fed was led by "ad hoc partial models and intensive informative analysis to aid in evaluating economic developments and implementing policy" (Greenspan, 1996).

Two questions remain. First, is the Fed truly using an ad hoc approach to monetary policy or does it follow some underlying theoretical model, at least for periods at a time? Second, if the Fed does not follow an ad hoc approach, which variables play a larger role than others in determining the Fed's monetary policy decisions?

Few studies have investigated the determinants of the Fed's monetary policy decision. Cook (1989) focused on the determinants of the federal funds rate during the years of Volcker's monetary aggregate targeting between 1979 and 1982. And Hamilton and Jorda (1999) found that the spread between the target federal funds rate and the 6-month treasury bill, along with recent changes in the target rate, were good predictors of changes in the target federal funds rate, but that other economic variables had little explanatory power.

II.2 The Economy and the Fed in the 1990s

The early 1990s were distinct from the latter years, posing different challenges for the Fed. From the third quarter of 1990 through the end of 1995, the U.S. economy was characterized by slow economic, productivity, wage and employment growth, amid stable inflation, solid stock market growth, and a modest trade deficit. In comparison, the latter part of the 1990s was marked by rapid productivity growth, increased wage and employment growth, a labor market that was close to full employment, continuously modest price increases, a rapidly rising stock market, and a record trade deficit.

Underlying the slow-growth performance of the early 1990s was the lack of substantial productivity growth. Labor productivity (real output per hour worked) grew on average by 2.2% from the third quarter of 1990 to the third quarter of 2000. In line with the slow productivity growth average hourly wages grew at 0.5%, unemployment averaged 6.5%, and employment grew on average at 1.4% (table 1).

Monetary policy in the early 1990s seemed to respond to weak output and employment growth. Inflation fell quickly below 3% by the end of 1991 after it had surged to 5% and 6% during the Gulf War. Also, the exchange rate depreciated during the first part of the 1990s, and the stock market showed real rates of return of close to 8% at the same time (table 1). With inflation, exchange rates and asset prices in check, the Fed's attention seemed to turn to stimulating output and employment growth. Between July 1990 and March 1991 – the official trough of the business cycle (NBER, 2000) – the Fed lowered the federal funds rate by 2.25 percentage points. Even after the economy grew again, the Fed continued its loose monetary stance through the end of 1992 by lowering the federal funds rate ten times between March 1991 and the end of 1992 for an additional total of 3 percentage points (table 3). However, when the economy regained some of its vigor and as the unemployment rate appeared to encroach on 6% in the second quarter of 1994, the Fed began to raise interest rates again. Throughout 1994 and the first quarter of 1995 the Fed increased the federal funds rate seven times by a combined total of 3 percentage points (table 3). As economic growth seemed to slow again in 1995, the Fed cut interest rates three times in 1995 and 1996 by a combined total of 0.75 percentage points.

The latter part of the 1990s was market by accelerated productivity growth, allowing for faster real economic growth. Labor productivity increased on average by 2.9% between the end of 1995 and the end of 2000 (table 1)[3]. Multifactor productivity (MFP) in the business sector also accelerated during the late 1990s. Three years in a row, 1996 to 1998, MFP grew above 1% annually, and its 1999 level was still strong with 0.9% (BLS, 2001a). Between 1996 and 1999 MFP grew on average by 1.4% as compared to 0.9% for the entire period 1991 to 1999, which is faster than during the late 1970s (0.6%) and the entire 1980s (0.5%). In line with faster productivity growth, output grew

[3]Table 1 shows the business cycle periods used in this paper. Each period is measured from business cycle peak to business cycle peak (NBER, 2000). Unless noted otherwise, quarterly data are used.

above 4% for the period between 1996 and 2000, unemployment fell to close to 4% for an extended period of time, and inflation remained stable around 3%.

Despite tighter labor markets, there was little evidence of accelerated inflation. Unemployment fell below 5.5% in 1996 and remained there throughout the end of 2000, while reaching its lowest level since the beginning of 1970 with 3.9% in October and November 1999 (BLS, 2001b). Real wage growth accelerated as unemployment edged lower. While average real wage growth from the third quarter of 1990 to the end of 2000 averaged 0.5%, it was 1.3% from the end of 1995 to the end of 2000 (table 1). Even after the acceleration in wage growth inflation remained at a modest 2.5% between 1996 and 2000.

In the early 1990s, slow productivity growth was matched by sluggish demand growth. While private demand – consumption and investment – slowly increased in the early 1990s, it accelerated after 1995, largely driven by a more rapid increase in consumption growth, which was carried by a rapid increase in stock market wealth. From 1991 to 2000, personal consumption amounted to two thirds of GDP - a record high by historical standards. A majority of the consumption increase can be attributed to higher stock prices. Total net worth of households averaged 317% of personal disposable income (PDI) between 1990 and 2000, largely because of an increased valuation of equity holdings (table 2). For the period 1996 to 2000, the net worth of households was even higher with an average of 364% of PDI (BoG, 2001). From the end of 1995 through the end of 2000, the stock market grew at an annual average of 15%, and the value of outstanding stocks more than doubled from $8.5 trillion at the end of 1995 to $17.2 trillion by the end of 2000, or from 112% of GDP to 168% (BoG, 2001). The run-up in the stock market translated into increased consumption via the so-called wealth effect, explaining about 84% of the increase in consumption relative to PDI between 1997 and the end of 1999, when reasonable assumptions are used (Poterba, 2000).

The run-up in the stock market also increased the fragility of the U.S. economy. First, less consumption would most likely have translated into less growth. Second, in order to keep stock prices high, corporations redistributed profits to shareholders via share repurchases and dividend pay-outs. Third, increased consumption helped to widen the trade deficit. Rising stock prices made it relatively easy to attract overseas capital to finance the growing trade gap, especially in the wake of the Mexican and Asian financial crises, when international investors were seeking a safe haven. However, a rapid decline in stock prices could have left the U.S. in a situation where interest rates would have had to be raised to finance its trade deficits amid a slowing economy.

Corporations increasingly used their resources to repurchase their own stocks. Net corporate equity issues were negative from the beginning of 1994 through the end of 2000 (table 2), with the exception of the first quarter of 2000 (BoG, 2001), meaning that more stock was retired than issued. By retiring its own stock firms help to maintain a high stock price as an insurance against being watered down due to increased stock options (“dilution”) and against hostile corporate takeovers, and as a “currency” to finance takeovers (O’Sullivan, 2000). Also, non-financial corporations paid out an

average of 47% of before-tax profits in the form of dividends between 1991 and 2000, and still an average of more than 45% between 1996 and 2000. This is substantially higher than previous pay-out ratios in the 1980s (38%), 1970s (20-26%), and the 1960s (25%) (BoG, 2001). Moreover, Liang and Sharpe (1999) estimated that given the rate of stock options and stock grants, most large corporations would have had to dedicate almost all of their future profits to share repurchases. To compensate for the loss of financial resources firms issued bonds at record rates, raising their indebtedness. The ratio of credit market instruments relative to total assets of non-farm non-financial businesses reached 22% between the third quarter of 1990 and the end of 2000, and a record high of 26% of total assets between 1996 and 2000 (BoG, 2001).

Thus, the run-up in stock prices may have posed a policy dilemma for the Fed. In particular, it may have desired to maintain stable and sustainable stock market growth[4]. Even though Fed chairman Alan Greenspan acknowledged that stock prices may have been out of line with economic fundamentals in 1996 (Greespan, 1996), the Fed may not have been able to act swiftly to use interest rates to dampen stock market growth. Tighter monetary policy may have meant lower consumption, and consequently lower resources for corporations to service their debt. Also, concerns other than financial stability regarding asset price inflation may have played a role, too. For example, asset price inflation may serve as a predictor of future consumer price inflation (Goodhart, 1995). Further, tighter monetary policy may have led to rapid capital outflows if stock prices fell quickly. A quick outflow, though, may have meant a rapid depreciation of the U.S. currency with possibly stagflationary results. If the Fed was concerned with asset price inflation, it had also to be concerned with the destabilizing impact a rapidly deflating stock market could have had. That is, once the stock market had increased substantially the Fed may have been bound to maintain continuous stock market growth.

Monetary policy appears to reflect the conflict the Fed found itself in. The real federal funds rate averaged 3% for the years after 1995, whereas it only averaged 1.4% for the period from 1991 to 1995 (table 1). The Fed abandoned its tight stance in the wake of the Asian and Russian financial crisis, though, in the fall of 1998 by lowering the federal funds rate by 0.75 percentage points over the course of two months (table 3)[5]. Once the financial market turmoil had subsided, the Fed raised interest rates by 1.75 percentage points between June 1999 and May 2000. The fact that the Fed raised rates absent clear inflationary pressures emanating from a tight labor market may indicate that the Fed was concerned with asset prices and the stability of the U.S. dollar.

The overview of the 1990s suggests two things. First, the Fed may have been concerned with consumer price inflation, output growth, high unemployment, asset price inflation and external stability at different points in the 1990s. Second, the Fed may have had asymmetric responses to changes in some variables. In particular, it is possible that once consumer price inflation fell low enough, the Fed may have shifted its priorities

[4] Tools other than interest rates, such as margin debt requirements that could be used to curb stock market growth, at least marginally (Weller, 2000), are deliberately not used by the Fed.

[5] Weaknesses overseas and financial market turmoil were the explicit reasons for lowering the key interest rates at the end of 1998 (BoG, 1998a, 1998b, 1998c).

towards other policy goals, such as maintaining stable output growth or financial stability. Similarly, only after asset price inflation continued at annual rates of more than 20% for some time the Fed may have intervened cautiously to slow the further extension of a stock market bubble, but to maintain stable stock market growth rates.

III. Empirical Analysis

III.1 Univariate analysis

I include variables that appear to have empirical relevance and theoretical foundation in studying the response of monetary policy, such as changes in prices, output growth, the level of unemployment, the growth rate of the real exchange rate, and the real rate of return to stocks[6].

Even though the Fed's chairman has explicitly stated that the central bank follows an ad hoc approach, monetary policy may follow certain patterns over time. To study the reaction of the Fed to changes in explanatory variable, I divide the data into observations when the Fed changed the interest rate and those when it didn't. The time frame I look at is the one-month prior to an interest rate decision, since the Fed is likely using the latest available decision in its interest rate decision, rather than longer time periods[7]. Also, to control for the possibility that there is an asymmetry in Fed's reaction when it raises rates and when it lowers rates, I look separately at the months prior to rate increases and to rate cuts. To test for the equality of the variables during the months immediately before an interest change and during other times, I use a Mann-Whitney ranksum test. This test is preferable to a standard t-test because of its small sample properties[8].

To account for shifts in the Fed's monetary policy over time, I compare the situation during the 1990s to the previous business cycle, which I define as the period from March 1980 to September 1990, thereby ignoring the short recession in 1981. Further, it is likely that the Fed shifted its focus in the second half of the 1990s, when asset prices rose rapidly. I divide the 1990s into before and after December 1995[9].

The univariate analysis in table 4 suggests that the decisions to lower or raise interest rates are preceded by different changes in the explanatory variables. Thus, the Fed may indeed follow an ad hoc approach to monetary policy. Between March 1980 and September 1990, the only variables that are different immediately prior to the Fed lowering rates are the unemployment rate and the real exchange rate, indicating that the Fed lowered rates to counter above average unemployment or real exchange rate growth. In comparison, lower interest rates were preceded by below average output growth and above average unemployment rates, and higher rates were preceded by above average growth and below average stock market rates of return.

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[6] Please see the appendix for a detailed list of variables and variable definitions.

[7] The test results, though, are robust with respect to different time period definitions. More detailed results are available from the author.

[8] The test results, though, are robust when a t-test is used instead of a Mann-Whitney test. The test results are available from the author.

[9] While this division is somewhat arbitrary, it has the advantage of separating the 1990s almost in half.

Splitting the period of the 1990s into two periods shows a slightly more differentiated picture. Before 1995, monetary policy tightened after above averaged output growth and below average asset price (stock market, real exchange rate) gains, and loosened monetary policy following below average output growth. After 1995, below average unemployment and below average asset price growth preceded tighter monetary policy. Thus, the results suggest that the Fed may have begun worrying about the NAIRU more after 1995 than it did prior to 1995. A loosening of monetary policy was preceded by below average output and stock market growth, and above average increases in the real exchange rate.

The response to changes in stock market rates of return in the 1990s appears surprising, whereas the reaction to changes in the real exchange rate is less so. In light of a growing trade deficit, it seems reasonable that the Fed may have wanted to maintain stable exchange rate growth to attract the capital inflows necessary to finance the growing current account deficits. The unexpected reaction to changes in real rates of return on the stock market, though, may simply be a result of the fact that the Fed prioritized other targets over asset prices.

III.2 Multivariate analysis

So far, I examined how each variable independently impacts the Fed's monetary policy decisions. Since the Fed most likely considers various variables prior to its decisions, the joint effect of all five variables needs to be considered in a multivariate analysis. The periods under investigation remain the same as for the univariate analysis.

The Fed is likely to respond to higher inflation and faster output growth with higher rates to maintain price stability. Also, a faster currency appreciation should facilitate price stability, and help to attract overseas capital. Thus, I would expect rising interest rates in response to growing real exchange rates. Also, interest rates should fall in response to rising unemployment.

Finally, the Fed's response to the stock market gains is ambiguous. The Fed may be interested in seeing a certain level of the rate of return as it may improve equities as a portfolio allocation choice (Park and Ratti, 2000). However, once real rates of return have reached the target level, the Fed may become concerned about the sustainability of further increases, thus tightening interest rates above the target. Inversely, the Fed may be worried about asset price inflation, and thus may want to raise rates in response to faster growing stock prices. Again, once real rates of return reach a certain level, a tightening by the Fed could lead to significant disruptions in the stock market and in the economy. That is, once the real rate of return goes beyond a threshold level, the Fed may act to stabilize the stock market by pursuing a less tight monetary stance. To account for this two-stage response to the stock market, I add a quadratic term for the real rate of return.

The regression equation thus looks as follows:

$$FFRATE_t = b_1 D1CPI_{t-1} + b_2 D1CPI_{t-1} + b_3 D12IP_{t-1} + b_4 UR_{t-1} + b_5 TTRET_{t-1} + b_6 TTRSQ_{t-1} + b_7 D12RFX_{t-1} + e_{tt} \quad (1)$$

The federal funds rate is a function of inflation, output growth, unemployment, stock market performance and the real foreign exchange rate. All variables are lagged one period since contemporaneous values cannot be observed.

Each series is tested for stationarity. Based on the Dickey-Fuller test statistic several series prove to be non-stationary (table 5). Output growth, unemployment and the growth rate of the real exchange rate are consistently non-stationary. However, the results of the Dickey-Fuller test are not robust for different time period, with the exception of the inflation rate. Consequently, all series are differenced once to make them stationary.

Regression (1) in table 6 shows the estimates for the determinants of the federal funds rate. To correct for autocorrelation, I use a Prais-Winsten regression. The results indicate that changes in the federal funds rate are determined by changes in the unemployment rate. A decline in the unemployment rate by half a standard deviation, which equals 0.9 percentage points, results in an increase of the federal funds rate by 0.8 percentage points.

During the 1980s, the results suggest that the Fed loosened monetary policy to react to sluggish output growth and high unemployment. Regression (2) in table 6 indicates that faster output growth led to an increase in the federal funds rate, while higher unemployment resulted in a lower federal funds rate.

Output growth and unemployment played a smaller role in determining monetary policy in the 1990s as regression (3) in table 6 shows. The reaction to changes in the unemployment rate dropped by more than 80% from the 1980s to the 1990s. During the 1990s, an increase in the unemployment rate by half of a standard deviation led to a reduction of the federal funds rate of 0.2 percentage points. The smaller parameter may indicate that the Federal Reserve Bank was less worried about the unemployment rate in the 1990s, possibly because it was on average lower than during the 1980s. The stock market appears to have played a role in determining monetary policy only during the early 1990s as regression (4) in table 6 suggests. A rise in the real rate of return resulted in a smaller change, or even a decline, of the federal funds rate. Thus, the Fed seemed to ease its monetary policy stance as stock market growth gained steam. During the latter part of the 1990s, the Fed appears to have shifted its focus. Now, output growth appeared to be a significant determinant of monetary policy together with changes in the real exchange rate as regression (5) in table 6 shows.

It is possible that the linear specification may not be appropriate. The sensitivity of monetary policy changes may vary with the level of the explanatory variables. Thus, a logarithmic specification may be more appropriate[10]. This also offers an easier interpretation as the estimated coefficients can be directly interpreted as elasticities.

[10] This specification also offers the advantage that it is less likely to be heteroskedastic.

In specifying the regression in its logarithmic form, three adjustments have to be made that make this specification not directly comparable to the previous one. First, because all variables, except the unemployment rate, take on negative values, each variable is adjusted by adding the absolute value of its smallest value to it. Second, by taking the logarithm of the real rate of return series, the squared term disappears naturally. Third, because all series, with the exception of the inflation rate are not consistently stationary (table 5), all series have been differenced once.

Table 7 presents the regression results for the same five periods as used in table 5. The results vary only slightly from those of the linear regression specification. Unemployment and output growth remain largely consistent determinants of changes in the federal funds rate. Also, inflation continues to be an insignificant determinant of changes in the federal funds rate, as does the growth rate of the real exchange rate. Further, the stock market appears to be a weak determinant of changes in the federal funds rate in the 1980s and in the two subperiods of the 1990s, albeit with changing impacts. During the 1980s and the late 1990s, positive changes in the real rate of return led to an greater tightening of monetary policy, whereas the opposite is true for the early 1980s, similar to the results of the linear specification regression. Thus, the Fed may have been worried about asset prices rising too fast in the 1980s and the late 1990s, while it may have focused on a sluggish asset market in the early part of the 1990s.

Even though the linear specification and the logarithmic specification are not directly comparable, the regression results suggest that the results are robust. Most importantly, unemployment seems to play a significant role in determining monetary policy, even after output growth has been controlled for.

One issue that needs to be considered further, though, is whether the Fed responds to changes in the explanatory variables only after certain target levels in the explanatory variables have been reached. Taylor (1993a), for instance, suggests a target level for the inflation rate of about 2% and of the real output growth rate of 2.2%. Similar target levels may exist for the unemployment rate, for the growth rate of the real exchange rate or for the real rate of return.

I test for different targets for all explanatory variables by creating indicator variables. For the inflation rate, I choose target levels of 2% as suggested by Taylor (1993b), and of 2.5%, and of 3%. For the unemployment rate, I choose target values of 5%, 5.5% and 6%. In addition, I choose a moving target that is derived from the CBO's (2001) NAIRU series. Moreover, for output growth, I use 3.7% - its average between 1960 and 2000 – as target value. Similarly, I use the long-term average real rate of return of 8.1% as the target value for stock market growth. Finally, I test for a target value of 100 for the real exchange rate index.

To preserve space, the results with the target values included are reported in schematic form (table 8)[11]. There is little evidence that the Fed reacted to any specific

[11] The full results are available from the author. All estimates are robust when indicator values are included.

target values. In the linear specification model, only the target value of an inflation rate of 2.5% is significant, and then only during the early 1990s. Similarly, there is a significant, yet negative effect of inflation on the federal funds rate during the early 1990s in the logarithmic specification, suggesting that the Fed raised interest rates as inflation rates were declining. In addition, the parameter for the inflation rate for the entire sample becomes significantly negative. The results are likely to be spurious, though, given the volatility of consumer prices during this period. Finally, there is a weak reaction to real rates of return above 8.1% in the second half of the 1990s, suggesting that a real rate of return above 8.1% elicited a stronger reaction from the Fed.

Finally, to show the relative importance of unemployment compared to real rates of return, I use standardized beta coefficients (table 9). Unemployment is largely the most important parameter in determining monetary policy, suggesting that the Fed prioritizes unemployment over other goals. Further, in the linear specification inflation appears to be the second most important factor in terms of explaining the variance of the dependent variable, despite the fact that it is not significant in the regression analysis, suggesting economic, but not statistical significance. Also, in the logarithmic specification, the real rate of return is consistently the second most important factor in explaining the variance of the dependent variable.

IV. Concluding Remarks

This paper looks at different determinants of monetary policy decisions, such as inflation, output, unemployment, asset prices and real exchange rates. The unemployment rate appears consistently to be a significant factor determining monetary policy. Moreover, the relative importance of the unemployment rate is greater than that of other determinants, suggesting that the Fed prioritizes stable unemployment over other goals. However, there is no indication that the Fed has a set target level for the unemployment rate. Thus, the results support the notion that policy makers use the unemployment rate as an important indicator for future inflation, but most likely with varying targets over time. Put differently, monetary policy makers appear to replace empirical estimates of the natural rate of unemployment with their own discretion of what that rate may be, rather than to forego using unemployment as an indicator for inflation, and for monetary policy decisions, all together.

Also, real output growth and the real rate of return to the stock market appear to be significant factors during some periods between 1980 and 1990. Moreover, with respect to the stock market, the Fed may be less concerned with possible repercussions for consumer price inflation, but with financial stability as it tends to loosen its monetary stance in response to faster asset price growth.

TABLE 1
MACRO INDICATORS, BUSINESS CYCLE AVERAGES, 1959 TO 2000

	1960:2-1969:4	1969:4-1973:4	1973:4-1980:1	1980:1-1990:3	1990:3-2000:4	1990:3-1995:4	1995:4-2000:4
Real federal funds rate	1.83	1.35	-0.84	4.38	2.09	1.36	2.99
Real GDP growth	4.28	3.76	2.84	2.89	3.61	2.40	4.18
Consumption/GDP	61.78	62.08	62.61	64.47	66.97	66.79	67.16
Investment/GDP	9.85	10.51	11.53	12.01	11.41	10.44	12.42
Net Exports/GDP	0.36	-0.19	-0.49	-1.76	-1.44	-0.83	-2.07
Inflation	2.54	5.14	8.77	4.92	2.79	3.05	2.50
Unemployment rate	4.77	5.36	6.77	7.17	5.70	6.54	4.62
Total nonfarm employment growth	2.73	0.19	2.49	2.65	1.77	1.36	2.20
Growth of real hourly, non-supervisory wages	1.72	1.73	-1.22	-0.93	0.43	-0.39	1.31
Non-farm bus. labor productivity (annual growth)	3.18	2.16	1.32	1.43	2.20	1.53	2.94
Real broad exchange rate index (annual growth)	n.a.	n.a.	-1.70	0.32	1.42	-0.95	4.00
Real return to equities	6.04	2.31	-4.47	10.31	13.46	8.04	21.50

Notes: All figures are in percent. Averages are based on quarterly data. Growth rates are annualized. Averages are calculated between business cycle peaks as defined by the NBER. A quarter is considered a peak quarter if the peak month falls into that quarter. The series for wages does not start until the beginning of 1964, and the real broad exchange rate index does not begin until 1973. Real return to equities are the sum of the real appreciation of the S&P500 index plus the dividend yield. Sources are the BEA, National Income and Product Accounts, the BLS, CPI-U, the BLS, National Employment, Hours and Earnings, the BLS, Non-farm Business Labor Productivity; Federal Reserve System, Board of Governors, H.10 Foreign Exchange Rates; R. Shiller, Irrational Exuberance, Princeton NJ: Princeton University Press, 2000.

TABLE 2
THE STOCK MARKET, HOUSEHOLD WEALTH, AND CORPORATE RESOURCE ALLOCATION, BUSINESS CYCLE AVERAGES, 1959 TO 2000

	Total household net worth relative to PDI	Direct holdings of corporate equities relative to PDI	Corporate net new equity issues relative to fixed investment	Dividend pay-outs relative to before tax profits
1960:2-1969:4	307.51	106.70	2.16	25.37
1970:1-1973:4	278.94	76.13	10.51	26.50
1974:1-1980:1	238.83	40.04	2.64	20.25
1980:2-1990:3	249.47	37.24	-15.24	38.51
1990:4-2000:4	316.86	76.74	-11.22	46.98
1996:1-2000:4	364.40	99.10	-21.36	45.44

Notes: All figures are in percent. Source is the Board of Governors, Federal Reserve System, Flow of Funds Accounts, Tables L.100 and F.102.

TABLE 3
MONETARY POLICY DECISIONS, 1990 TO 2000

Date	Discount rate		Federal funds rate	
	Change	New level	Change	New level
1990				
July 13			-0.25	8
October 29			-0.25	7 3/4
November 14			-0.25	7 1/2
December 7			-0.25	7 1/4
December 18-19	-0.5	6 1/2		
December 19			-0.25	7
1991				
January 8			-0.25	6 3/4
February 1	-0.5	6	-0.5	6 1/4
March 8			-0.25	6
April 30	-0.5	5 1/2	-0.25	5 3/4
August 6			-0.25	5 1/2
September 13	-0.5	5	-0.25	5 1/4
October 31			-0.25	5
November 6	-0.5	4 1/2	-0.25	4 3/4
December 6			-0.25	4 1/2
December 20	-1	3 1/2	-0.5	4
1992				
April 9			-0.25	3 3/4
July 2	-0.5	3	-0.5	3 1/4
September 4			-0.25	3
1994				
February 4			0.25	3 1/4
March 22			0.25	3 1/2
April 18			0.25	3 3/4
May 17	0.5	3 1/2	0.5	4 1/4
August 16	0.5	4	0.5	4 3/4
November 15	0.75	4 3/4	0.75	5 1/2

Date	Discount rate		Federal funds rate	
	Change	New level	Change	New level
1995				
February 1	0.5	5 1/4	0.5	6
July 6			-0.25	5 3/4
December 19			-0.25	5 1/2
1996				
January 31	-0.25	5	-0.25	5 1/4
1997				
March 25			0.25	5 1/2
1998				
September 29			-0.25	5 1/4
October 15	-0.25	4 3/4	-0.25	5
November 17	-0.25	4 1/2	-0.25	4 3/4
1999				
June 30			0.25	5
Aug 24	0.25	4 3/4	0.25	5 1/4
Nov 16	0.25	5	0.25	5 1/2
2000				
Feb 2	0.25	5 1/4	0.25	5 3/4
Mar 21	0.25	5 1/2	0.25	6
May 16			0.5	6 1/2
May 19	0.5	6		

Notes: All figures are in percent. Source is the Federal Reserve Bank of New York, Historical Changes of the Federal Funds Rate and the Discount Rate (1971 to the Present), http://www.ny.frb.org/pihome/statistics/dlyrates/fedrate.html.

TABLE 4
UNIVARIATE ANALYSIS OF DETERMINANTS OF INTEREST RATE CHANGES

	March 1980 to September 1990		October 1990 to December 2000		October 1990 to December 1995		January 1996 to December 2000	
	Before interest rate tightening	Before interest rate loosening	Before interest rate tightening	Before interest rate loosening	Before interest rate tightening	Before interest rate loosening	Before interest rate tightening	Before interest rate loosening
D1CPI	0.3	0.8	0.1	-0.2	1.1	-0.7	-0.6	0.9
D12IP	-0.5	1.4	-2.0**	5.3***	-2.2**	4.0***	-0.6	2.7***
UR	0.5	-1.7*	1.3	-2.0***	1.6	-0.2	2.0**	1.0
RTTRET	0.5	0.7	2.3**	1.3	2.5**	-1.1	1.7*	2.2**
D12RFX	1.33	-1.8**	1.0	1.5	1.7*	-0.8	2.6**	-2.6***

Note: All figures are based on Mann-Whitney ranksum test. A negative sign indicates that the average of the respective variable immediately prior to the change in the federal funds rate by the Fed is larger than at other times, and vice versa. * indicates significance at the 10%-level, ** indicates significance at the 5%-level, and *** indicates significance at the 1%-level.

TABLE 5
UNIT ROOT TESTS, 1980 TO 2000

Variable	Dickey-Fuller test, 1980 to 2000	Dickey-Fuller test, 1990 to 2000	Dickey-Fuller test, 1990 to 1995	Dickey-Fuller test, 1996 to 2000
FFRATE	-2.47	-2.99**	-3.02**	-1.25
D1CPI	-8.72***	-10.37***	-7.3***	-7.24***
D12IP	-2.16	-1.57	-1.07	-1.02
UR	-0.38	-0.18	-0.47	-1.78
RTTRET	-3.80***	-2.97**	-2.25	-1.64
RTTRSQ	-5.19***	-3.91**	-1.59	-3.24**
D12RFX	-2.28	-2.06	-2.24	-1.73
LnFFRATE	-2.18	-2.07	-1.98	-1.38
LnD1CPI	-6.60***	-9.38***	-7.25***	-5.19
LnD12IP	-3.68***	-1.59	-1.13	-0.58
LnUR	-0.62	-0.19	-0.45	-1.64
LnRTTRET	-2.50	-2.92**	-2.79**	-0.70
LnD12RFX	-2.70**	-2.38	-2.27	-1.72

Notes: * indicates significance at the 10%-level, ** indicates significance at the 5%-level, and 1% indicates significance at the 1%-level.

TABLE 6
REGRESSION RESULTS FOR DETERMINANTS OF FEDERAL FUNDS RATE, 1980 TO 2000

		1st difference of federal funds rate ($\Delta FFRATE_t$)				
Explanatory variables	Mean	(1) 1980 to 2000	(2) 1980 to 1990	(3) 1990 to 2000	(4) 1990 to 1995	(5) 1995 to 2000
$\Delta D1CPI_{t-1}$	0.007	0.241	0.409	-0.042	-0.072	-0.059
	(0.583)	(0.166)	(0.327)	(0.066)	(0.171)	(0.088)
$\Delta D12IP_{t-1}$	-0.001	0.069	0.176**	0.038*	0.010	0.064**
	(0.317)	(0.046)	(0.078)	(0.021)	(0.039)	(0.027)
ΔUR_{t-1}	-0.030	-0.833***	-1.181***	-0.202**	-0.633***	-0.248
	(1.786)	(0.241)	(0.451)	(0.096)	(0.193)	(0.146)
$\Delta RTTRET_{t-1}$	-0.061	0.004	0.014	-0.006	-0.019**	0.004
	(5.986)	(0.009)	(0.016)	(0.004)	(0.009)	(0.006)
$\Delta RTTRSQ_{t-1}$	-0.783	0.0001	0.0001	0.0001	0.0005	-0.0001
	(243.441)	(0.0002	(0.0004)	(0.0001)	(0.0003)	(0.0001)
$\Delta D12RFX_{t-1}$	0.050	0.014	0.003	0.005	-0.008	0.020*
	(1.688)	(0.025)	(0.044)	(0.010)	(0.018)	(0.011)
Constant	n.a.	-0.052	-0.075	-0.025	-0.035	0.001
		(0.058)	(0.082)	(0.025)	(0.026)	(0.018)
Adj. R^2	n.a.	0.068	0.145	0.057	0.183	0.125
D-W (before correction)	n.a.	1.511	1.558	1.322	1.534	1.463
D-W (after correction)	n.a.	1.916	n.a.	2.218	n.a.	n.a.
No. of obs.	n.a.	250	126	124	62	61

Notes: Standard deviations in brackets. * indicates significance at the 10%-level, ** indicates significance at the 5%-level, and *** indicates significance at the 10%-level.

TABLE 7
REGRESSION RESULTS FOR DETERMINANTS OF FEDERAL FUNDS RATE, LOGARITHMIC SPECIFICATION, 1980 TO 2000

		1st difference of logarithmic of federal funds rate ($\Delta lnFFRATE_t$)				
Explanatory variables	Mean	(1) 1980 to 2000	(2) 1980 to 1990	(3) 1990 to 2000	(4) 1990 to 1995	(5) 1995 to 2000
$\Delta lnD1CPI_{t-1}$		-0.001	0.002	-0.004	-0.008	0.002
		(0.004)	(0.007)	(0.004)	(0.009)	(0.004)
$\Delta lnD12IP_{t-1}$		0.061***	0.061***	0.064	0.003	0.110**
		(0.013)	(0.015)	(0.048)	(0.074)	(0.055)
$\Delta lnUR_{t-1}$		-0.270**	-0.173	-0.364***	-0.858***	-0.323**
		(0.112)	(0.195)	(0.130)	(0.273)	(0.124)
$\Delta lnRTTRET_{t-1}$		0.026	0.057*	-0.033	-0.102*	0.052*
		(0.024)	(0.034)	(0.033)	(0.062)	(0.031)
$\Delta lnD12RFX_{t-1}$		-0.003	-0.001	-0.002	-0.027	0.033
		(0.016)	(0.020)	(0.035)	(0.052)	(0.036)
Constant		-0.001	0.002	-0.004	-0.007	-0.0002
		(0.005)	(0.008)	(0.005)	(0.006)	(0.004)
Adj. R^2	n.a.	0.125	0.136	0.116	0.153	0.157
D-W (before correction)	n.a.	1.294	1.296	1.403	1.650	1.637
D-W (after correction)	n.a.	1.851	1.733	2.01	n.a.	n.a.
No. of obs.	n.a.	217	109	108	58	50

Notes: Standard deviations in brackets. * indicates significance at the 10%-level, ** indicates significance at the 5%-level, and *** indicates significance at the 10%-level.

TABLE 8
REGRESSIONS INCLUDING TARGET VALUES, 1980 TO 2000

	Time period				
Target values	(1) 1980 to 2000	(2) 1980 to 1990	(3) 1990 to 2000	(4) 1990 to 1995	(5) 1995 to 2000
Inflation			Linear specification		
• 2%	~	~	~	~	~
• 2.5%	~	~	~	+*	~
• 3%	~	~	~	~	~
Unemployment					
• 5%	~	~	~	~	~
• 5.5%	~	~	~	~	~
• 6%	~	~	~	~	~
• CBO's NAIRU	~	~	~	~	~
Real rate of return					
• 8.1%	~	~	~	~	-*
Output growth rate					
3.7%	-*	~	~	~	~
Exchange rate index level					
100	~	~	~	~	~
			Logarithmic specification		
Inflation					
• 2%	~	~	~		~
• 2.5%	~	~	~	-**	~
• 3%	~	~	~		~
Unemployment					
• 5%	~	~	~	~	~
• 5.5%	~	~	~	~	~
• 6%	~	~	~	~	~
• CBO's NAIRU	~	~	~	~	~
Real rate of return					
• 8.1%	~	~	~	~	~
Output growth rate					
3.7%	~	~	~	~	~
Exchange rate index level					
100	~	~	~	~	~

TABLE 9
BETA COEFFICIENTS FOR LINEAR AND LOGARITHMIC REGRESSION

	(1) 1980 to 2000	(2) 1980 to 1990	(3) 1990 to 2000	(4) 1990 to 1995	(5) 1995 to 2000
Variable			Linear specification		
$\Delta D1CPI_{t-1}$	0.6 E-02	0.14	-0.01	-0.06	-0.03
$\Delta D12IP_{t-1}$	0.4 E-03	0.1 E-02	0.4 E-03	0.2 E-02	0.02
ΔUR_{t-1}	-0.28	-0.54	-0.10	-0.55	-0.24
$\Delta RTTRET_{t-1}$	0.5 E-04	0.2 E-03	-0.1 E-03	-0.8 E-03	0.2 E-03
$\Delta RTTRSQ_{t-1}$	0.3 E-07	0.4 E-07	0.5 E-07	0.7 E-06	-0.7 E-06
$\Delta D12RFX_{t-1}$	0.5 E-03	0.1 E-03	0.3 E-03	-0.6 E-03	0.1 E-02
			Logarithmic specification		
$\Delta lnD1CPI_{t-1}$	-0.7 E-04	0.2 E-03	0.4 E-03	-0.2 E-02	0.3 E-03
$\Delta lnD12IP_{t-1}$	0.01	0.01	0.6 E-02	0.5 E-02	0.22
$\Delta lnUR_{t-1}$	-0.50	-0.19	-1.25	-4.98	-1.43
$\Delta lnRTTRET_{t-1}$	0.01	0.03	-0.03	-0.13	0.06
$\Delta lnD12RFX_{t-1}$	-0.8 E-03	0.3 E-03	0.2 E-02	-0.03	0.04

List of Variables

Variable	Definition	Source
FFRate	The nominal federal funds rate	Board of Governors, Federal Reserve System, Release H.15 Selected Interest Rates
D1CPI	The monthly rate of growth of the Consumer Price Index	Bureau of Labor Statistics, Consumer Price Index for all Urban Consumers.
UR	The civilian unemployment rate	Bureau of Labor Statistics, Civilian Unemployment Rate
D12IP	The year-on-year growth rate of industrial output	Board of Governors, Federal Reserve System, Release G.17 Industrial Production and Capacity Utilization
RTTRET	Real total rate of return to stocks, which equals the sum of the real year-on-year rate of change in the S&P 500 plus the dividend yield	R. Shiller, Irrational Exuberance, Princeton NJ: Princeton University Press.
RTTRSQ	Squared term of RTTRET	
D12RFX	The year-on-year growth rate of the real broad foreign exchange rate index	Board of Governors, Federal Reserve Bank, Release G.5 Foreign Exchange Rates

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