

2004

The Federal Reserve System and the federal funds rate: evaluating the Fed's rate-targeting decisions through the use of Taylor-type monetary policy rules

Michelle Lynn Mireault
Iowa State University

Follow this and additional works at: <https://lib.dr.iastate.edu/rtd>

 Part of the [Economics Commons](#)

Recommended Citation

Mireault, Michelle Lynn, "The Federal Reserve System and the federal funds rate: evaluating the Fed's rate-targeting decisions through the use of Taylor-type monetary policy rules" (2004). *Retrospective Theses and Dissertations*. 17200.
<https://lib.dr.iastate.edu/rtd/17200>

This Thesis is brought to you for free and open access by the Iowa State University Capstones, Theses and Dissertations at Iowa State University Digital Repository. It has been accepted for inclusion in Retrospective Theses and Dissertations by an authorized administrator of Iowa State University Digital Repository. For more information, please contact digirep@iastate.edu.

**The Federal Reserve System and the federal funds rate:
Evaluating the Fed's rate-targeting decisions
through the use of Taylor-type monetary policy rules**

by

Michelle Lynn Mireault

A thesis submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of
MASTER OF SCIENCE

Major: Economics

Program of Study Committee:
Helle Bunzel, Major Professor
Joydeep Bhattacharya
Geoffrey Friesen

Iowa State University

Ames, Iowa

2004

Graduate College
Iowa State University

This is to certify that the master's thesis of

Michelle Lynn Mireault

has met the thesis requirements of Iowa State University

Signatures have been redacted for privacy

TABLE OF CONTENTS

LIST OF FIGURES	iv
LIST OF TABLES	v
ABSTRACT	vi
CHAPTER 1. INTRODUCTION AND BACKGROUND MATERIAL	1
Introduction	1
Federal Reserve System	1
The original Taylor rule	6
Critiques of the Taylor rule	8
CHAPTER 2. DATA ANALYSIS	13
Data collection and definitions	13
Model development and testing	13
Model selection	21
CHAPTER 3. CONCLUSION	24
APPENDIX	30
REFERENCES CITED	34
ACKNOWLEDGEMENTS	36
BIOGRAPHICAL SKETCH	37

LIST OF FIGURES

<i>Figure 1.</i> Intended federal funds rate change, 1990 to present, taken from The Federal Reserve Board: Open market operations, 2004.	26
<i>Figure 2.</i> Test for parameter stability for model (2) starting 1987.Q4 and ending annually 1993.Q4 through 2004.Q1 successively.	27
<i>Figure 3.</i> Test for parameter stability for model (2) starting annually 1987.Q4 through 1997.Q1 successively and ending 2004.Q1.	27
<i>Figure 4.</i> Test for parameter stability for model (5) starting 1987.Q4 and ending annually 1993.Q4 through 2004.Q1 successively.	28
<i>Figure 5.</i> Test for parameter stability for model (5) starting annually 1987.Q4 through 1997.Q1 successively and ending 2004.Q1.	28
<i>Figure 6.</i> Test for parameter stability for model (6) starting 1987.Q4 and ending annually 1993.Q4 through 2004.Q1 successively.	29
<i>Figure 7.</i> Test for parameter stability for model (6) starting annually 1987.Q4 through 1997.Q1 successively and ending 2004.Q1.	29
<i>Figure A1.</i> The range of Taylor-type rule recommendations for different measures of inflation and the output gap, taken from Kozicki, 1999, page 11, chart 3.	30
<i>Figure A2.</i> The Taylor rule and its components, taken from Judd and Rudebusch, 1998, page 5, figure 1.	31
<i>Figure A3.</i> Political regimes and the real interest rates, 1961-1992, taken from Caporale and Grier, 2000, page 330, figure 2.	31

LIST OF TABLES

<i>Table 1.</i> Reserve requirements, taken from The Federal Reserve Board: Reserve requirements, 2004.	4
<i>Table 2.</i> Dickey-Fuller test for unit root on variables.	14
<i>Table 3.</i> Dickey-Fuller test for unit root on models (1) and (2).	16
<i>Table 4.</i> Dickey-Fuller test for unit root on models (3), (4), (5), and (6).	19

ABSTRACT

In the U.S., monetary policy decisions are handled by our central bank, the Federal Reserve System. By targeting a desired interest rate level and using three main “tools” to adjust the money supply in order to achieve this rate, the Federal Reserve guides our economy in order to maintain its long-term goals of price stability and sustainable economic growth. To help the public better understand the actions of the Federal Reserve, economist John B. Taylor devised a monetary policy rule in 1993 that is both simple and reasonably accurate. In the decade since his pivotal rule, numerous researchers have attempted to challenge, expand, or redefine this equation to make it more accurate and useful. My paper reexamines two rules, Taylor’s original rule as well as another expanded rule, by using a larger set of observations. I also present and test additional models that build on these two to determine if there are other important factors the Fed takes into account when deciding on the appropriate targeted federal funds rate. In the two models that I present, it appears that when inflation is above the target level, the Fed responds to changes in inflation and GDP much more aggressively. On the other hand, when inflation is at or below the objective, the Fed follows a policy of interest rate smoothing.

CHAPTER 1. INTRODUCTION AND BACKGROUND MATERIAL

Introduction

In most nations throughout the world there are two main functions that guide the economy: fiscal policy and monetary policy. Usually separate, the government deals with fiscal policy through the collection and spending of tax money while a central bank handles the supply of money available to consumers and businesses. In the U.S. the central bank is the Federal Reserve System. To help the public better understand the actions of the Federal Reserve, economist John B. Taylor formulated a monetary policy rule that is both simple and reasonably accurate.

In the remainder of Chapter 1, I will further discuss the organization and function of the Federal Reserve System and how it guides our economy by taking actions that affect the interest rates by changing the money supply. Taylor's monetary policy rule will be defined and numerous critiques will be provided. Chapter 2 covers my own data analysis in which I describe and define the data and present various models and the statistical tests performed on those models. Chapter 3 concludes this paper with a discussion of the importance to the public of being able to anticipate the Federal Reserve's targeted interest rates.

Federal Reserve System

The Federal Reserve System was initiated by an act of Congress, The Federal Reserve Act, on December 23, 1913, "to provide for the establishment of Federal reserve banks, to furnish an elastic currency, to afford means of rediscounting commercial paper, to establish a more effective supervision of banking in the United States, and for other purposes." The organization's main body consists of a seven-member Board of Governors in Washington,

DC, plus banks located in twelve Federal Reserve Districts located throughout the country, which are in Boston, New York, Philadelphia, Cleveland, Richmond, Atlanta, Chicago, St. Louis, Minneapolis, Kansas City, Dallas, and San Francisco (Federal Reserve Board: The structure of the Federal Reserve System, 2003).

The Federal Reserve (often referred to as just “the Fed”) is responsible for the country’s monetary policy decision-making. While it is commonly reported in the media that the Federal Reserve “sets” interest rates, this is not entirely accurate. They first decide on a target rate and then work to reach that target by use of three tools: open market operations, reserve requirements, and the discount rate policy. They are also responsible for numerous other operations, including regulation and supervision of member institutions, as well as laws regarding consumer credit, such as the Truth in Lending Act and the Equal Credit Opportunity Act.

With these operations, the Fed directly affects the level of money available to the economy, through the so-called creation or destruction of money. When the nation’s financial markets react to these new levels of available money, a new interest rate is established. So, clearly the Fed must have some knowledge that money supply and interest rates are related; otherwise this mechanism would not be effectual. Basic macroeconomic fundamentals, particularly demonstrated in the LM curve, a positively sloped curve that graphs the relationship between real GDP and interest rates by equating the supply of real money balances and the money demand function, show how interest rates respond to changes in the supply or demand of money, of which the supply is controlled for the most part by the Fed. An increase in the money supply leads to an outward shift in the LM curve, leading to a new equilibrium where it crosses the IS curve at a new lower interest rate and a new higher

GDP. John R. Hicks is credited with inventing the IS-LM model in 1937 in an attempt at summarizing John Maynard Keynes' macroeconomic principles outlined in his *General Theory of Employment, Interest, and Money*. Many college-level economic textbooks cover this topic and the website TheFreeDictionary.com (2004) offers a brief description.

Monnet and Weber (2001) present two seemingly opposing views when it comes to the direction of the relationship between rates and money supply, the liquidity effect view and the Fisher equation view (named after Irving Fisher, 1896). The liquidity effect view posits that a *decrease* in the money supply will lead to an increase in rates. This is the same as in the IS-LM model. On the other hand, the Fisher equation view states that an *increase* in the money supply will lead to an increase in rates. Monnet and Weber's research reconcile these differences by bringing in the notion of surprise, commonly referred to as shocks, and the expectation of the likelihood of future events. If financial markets believe that a surprise increase in the money supply is only temporary and will not affect their expectations of the future growth rate of money, then the interest rate will fall, or move in the opposite direction as the change in the money supply (liquidity effect view). Otherwise, if the change is expected to be permanent then the rate will rise, or move in the same direction (Fisher equation view). So besides merely analyzing relevant economic data, the Fed must take into account such shocks in order to guide interest rates toward the desired targets.

In directing monetary policy, their principle tool is open market operations. The 12-member Federal Open Market Committee (FOMC) buys and sells US Treasury notes and federal agency securities. When buying notes, money is put back into public circulation, thereby expanding the money supply, the so-called creation of money. When notes are sold, money moves out of circulation when the public pays for the notes. This destruction of

money decreases the money supply. By changing the money supply, they are able to achieve their short-term goals of maintaining a desired federal funds rate. This is the overnight interest rate at which depository institutions lend their money to other institutions through the Federal Reserve System. The current rate, as of November 10, 2004, is 2.00%. See Figure 1 for the Fed's announced federal fund rates from 1990 to present.

The second tool is the reserve requirement, while powerful is actually rarely adjusted. The requirement specifies how much money a depository institution needs to "hold", either as cash in its vault or as deposits with a Federal Reserve Bank. This limits the amount of money it can grant in loans. A high reserve ratio effectively takes money out of circulation, whereas lowering the ratio will increase the supply of money available to the economy, which the banking institution is able to distribute in the form of loans. Current rates are in the table below.

Table 1. Reserve requirements, taken from The Federal Reserve Board:
Reserve requirements, 2004.

Type of liability	% of liabilities	Effective date
Net transaction accounts		
\$0 to \$6.6 million	0	12-25-03
More than \$6.6 m to \$45.4 million	3	12-25-03
More than \$45.4 million	10	12-25-03
Non-personal time deposits	0	12-27-90
Eurocurrency liabilities	0	12-27-90

The third tool is the discount rate, whose movements often follow closely to the federal funds rate. The Fed's definition is included here.

The discount rate is the interest rate charged to commercial banks and other depository institutions on loans they receive from their regional Federal Reserve Bank's lending facility--the discount window. Loans are extended

for a very short term (usually overnight) to depository institutions in generally sound financial condition (The Federal Reserve Board: The Discount Rate, 2004).

While the Federal Reserve functions to serve the public by working with other government agencies, members of Congress, banking industry groups, central bankers from foreign countries, and even members of academia, all of its operations and the decision-making processes behind the monetary policies are not necessarily transparent. Indeed Romer and Romer focused on this issue in their 2000 study. They looked at asymmetric information between the Fed and commercial forecasters. They believe that the Fed has an advantage due to its vast resources devoted to forecasting compared to a typical private firm, as well as the fact that the Fed does not release its complete and final forecasts to the public until some five years after the relevant time period. This greatly hinders commercial firms' ability to analyze the information in the same timely manner as does the Fed. Financial markets must make guesses as to the Fed's actions and the motivations behind its policies. This leads to greater volatility and uncertainty. Romer and Romer suggest that the Fed should release its Green Book forecasts immediately after they have been made. They do caution that this may inadvertently cause the Fed to change the way it makes forecasts, which could be quite detrimental. Even without the Green Book forecasts, there still would be a definite benefit to society, particularly businesses, local government agencies, and university researchers, if there was a way to anticipate some of the Federal Reserve's actions. See Appendix for details regarding the release of statements by the FOMC and a recent press release. The press release does not include quantitative information, which would be more helpful. This is where the Taylor rule serves a very useful purpose.

The original Taylor rule

John B. Taylor, a Stanford University Economist currently serving as the Under Secretary for International Affairs at the U.S. Department of Treasury, is credited with developing a simple and useful monetary policy rule detailing how the Federal Reserve sets the real short-term interest rates that now bears his name. His research and refinement of this rule developed through the 1990s has become a benchmark idea on which other economists have continued to critique, expand, and change. The Federal Reserve acts to achieve targeted interest rates to help ensure its immediate goals of stabilizing the economy and its long-term goals of keeping inflation in check. Having a plausible insight into how this rate is set can be a valuable tool to understanding the US economy. Decision makers will be better able to take appropriate long-term actions, leading to financial success rather than loss.

According to the rule, there are three factors that Taylor has identified as having an impact on the determination of the real short-term interest rate. The first factor is the interest rate level most consistent with full employment. The second factor is inflation, both the rate of price inflation over the previous four quarters as well as the difference between the actual inflation rate and the target rate the Fed is trying to achieve, also called the inflation gap. The final factor is the difference between actual economic activity and the “full employment” level of activity, also referred to as the output gap. Equal weights are assigned to the inflation gap and the output gap. This led Taylor to set up the following equation:

$$r = p + 0.5y + 0.5(p-2) + 2$$

Where

r = federal funds rate

p = rate of inflation over previous four quarters

y = percent deviation of real GDP from a target.

That is,

$$y = 100(Y - Y^*)/Y^*$$

Y = real GDP

Y^* = trend real GDP

The first 2 (in $p-2$ term) is the objective for inflation. The last 2 is the “equilibrium” real rate which is close to the assumed steady-state growth rate of 2.2 percent (Taylor, 1993).

Taylor’s rule can be simplified to the following, in which case, inflation as a whole received three times the weight as does the output gap.

$$r = 1 + 1.5p + 0.5y$$

Of course, Taylor concedes that this one simple rule cannot and should not be used by the policy makers at the Federal Reserve when setting rates and even provides two examples where the Fed deviated from the rule, during the oil-price shock of 1990 and during the bond market, inflation and German reunification situation. So much more can be added to the equation to account for shocks or other changes in the economy, but then that would defeat its purpose of being a straight forward, easily calculated rule. However, a stable rule is important for the public to understand the Fed’s intentions. In the absence of any rules, the Fed basically follows a discretionary policy. When this occurs, the public decision-makers are unable to anticipate the Fed’s actions. Similar to having no rule would be having a series of rules that change frequently. This leads to a lack of confidence in the rule and is specifically apparent during the transition periods between rules. If the Fed puts into place a new policy rule while the public is not yet informed of or confident about this new rule, the public will continue to anticipate a future consistent with the old rule. Their short-term behaviors will continue to follow that old rule and will likely counteract the new actions the Fed is trying to undertake. In addition, long-term decisions made under the old rule, such as

investment projects and contracts, cannot be immediately changed when the new rule takes affect which also could undermine the Fed's new intentions (Taylor, 1993).

Taylor states that his "rule fits the actual policy performance during the last few years remarkable well" (1993). However, he only looks at data from 1987 to 1992, or a maximum of 24 quarterly observations. Not only is it a short time frame, but also the period occurs under only one political regime (Reagan-Bush) and almost entirely under the chairmanship of Greenspan, both of which could have an impact on how these two rates are related. I will discuss the regime implications in the next section.

Critiques of the Taylor rule

Although the original Taylor rule has done well in explaining the Fed's actions, it is not completely accurate. One reason for inaccuracies involves the definitions and measurements of some of the factors used in the rule. For instance, inflation can be measured by various means: GDP deflator, CPI, core CPI, wage inflations, and other methods. In addition, both the "full employment" rate (particularly the so-called natural unemployment rate) and the GDP trend are estimates, so care must be taken in how these figures are estimated otherwise an inaccurate short-term interest rate may result. For instance, although somewhat controversial, the general consensus regarding the natural rate of unemployment ranges from 5% to 6%, often depending on how liberal or conservative the policy makers are. Economic shocks also have to be taken into consideration when setting rates, such as the downturn in certain sectors following the events of September 11th, 2001, particularly the airline and travel industries, and the recent increase in energy prices. Due to the exogenous nature of shocks, they are not necessarily quantifiable nor do they figure into

the original Taylor rule. The notion of using identical 0.5 weights on both the inflation gap and the output gap terms has also been questioned. The use of equal weights for both terms implies that the Fed considers each of these factors to be equally important rather than having one dominate the other. Kozicki (1999) delves into all of these issues. For a rule to be useful, it should remain robust even under different measurements, as well as being reliable. She argues that the Taylor-type rules don't necessarily hold and provides several graphs that track the federal funds rate from 1983 to 1997 to prove this. In particular, see Figure A1 in the Appendix. This graph also shows the range suggested when using each of the six measures of the GDP output gap and the four measures of inflation (resulting in 24 combinations). The Taylor-type rules don't perform as well during the 1983-1985 and the 1992-1994 periods and they also have excessively large ranges during 1983 and 1987. Kozicki concludes that, "policy rules may aid in focusing policy discussions. But, lack of robustness with respect to the measurement of inflation and the output gap, estimates of the equilibrium real rate, and settings for weights limit the usefulness of rules to recommend funds rate settings in real time."

As with any idea, there are always new ways to think about a situation, expanding and hopefully enhancing the original theory. The notion of monetary policy inertia has led to new equations that incorporate a lag factor. Setting the new rate by taking a weighted average of the target rate the Fed hopes to achieve and what the rate was in the last period (typically assumed to be approximately .2 and .8 respectively) allows for the rate to move smoothly, bringing about less volatility and uncertainty. At least this was the standard view until questioned by Rudebusch (2002). In his work, he tries to prove that if it is the case that a lagged interest rate value should be included, there should be greater forecast accuracy.

For research using the 3-month Eurodollar rate, this holds up reasonably well for the first quarter. But going further out into the future, the 3-6 month and 6-9 month rates lose this predictability. Rudebusch believes that the apparent lag in Taylor's rule is actually due to special circumstances and persistent shocks, such as the commodity scares in 1988-1989 and 1994-1995 (higher rates), the so called "credit crunch" of 1992-1993 (lower rates), and a worldwide financial crisis in 1998 and 1999 (lower).

Carlstrom and Fuerst (2001) warn us that the Fed and the public may be in a dangerous cycle when it comes to having rules that explain the interest rates. Having a rule is a good way of keeping long-term goals in mind and not forsaking them when trying to achieve short-term objectives. The process becomes transparent, allowing the public to react. But there is a danger of self-fulfilling expectations in this case, especially when using only *expected* inflation as a basis for determining the inflation gap. They argue that when the Fed uses expected inflation to set policy, the public interprets that policy and then anticipates a certain level of future inflation. If people believe prices will be higher tomorrow, they will act a certain way today that they normally would not have, resulting in exactly the higher prices they feared. This self-fulfilling expectation is exacerbated by the fact that coordination among the members of the public is unlikely. This is known as "sunspot" behavior. A sunspot is extraneous information that affects behavior, an observable signal that influences actions. One such example is the run on banks during the Great Depression. If someone believes that others will run to the bank to remove their money that person will be more likely to run to the bank to remove his own money, thus compounding the bank run panic he had feared. As a way to prevent this, Carlstrom and Fuerst recommend also using

past inflation trends in the calculations, not solely depending on future forecasts. This way, the funds rate will respond to past price movements.

Questions have been raised about how the differing political and Fed chairmanship regimes have had an affect on interest rates, something that typically cannot be captured in a simple rule. Judd and Rudebusch (1998) looked at how the Taylor rule performed against the actual federal funds rate from 1970 to 1998 during the chairmanships of Arthur Burns (1970.Q1-1978.Q1), Paul Volcker (1979.Q3-1987.Q2), and Alan Greenspan (1987.Q3-present). The period from 1978.Q2 to 1979.Q2 under G. William Miller was not included in the analysis due to the extremely short time frame. In a revealing graph, Figure A2 in the Appendix, the Taylor rule approximation was consistently above the actual rate during Burns' reign. The two crossed over in the early 1980s but still maintained a significant gap, reaching nearly 5 percentage points in 1983. During this time the actual federal funds rate was higher, meaning that the Fed was being much more aggressive in combating inflation than the Taylor rule would have recommended. But by the Greenspan era the gap is quite a bit narrower, meaning the Taylor rule was doing a much better job in anticipating the actual rate. Caporale and Grier (2000) also focus on the political regimes in power in addition to the chairmen, analyzing data from 1961 to 1992. While the president and Congress are responsible for fiscal decision-making and not monetary policy, the two functions are closely related and therefore it cannot be ignored when focusing on the changes in the interest rate. The political regimes were broken down to include the presidencies of Kennedy-Johnson, Nixon-Ford, Carter, and Reagan-Bush, as well as the Republican Senate era from 1981 to 1986. Using alternative mean-shifting models of the real interest rates, they concluded that:

[C]hanges in the political party controlling the presidency or Congress match up very closely to the shift dates estimated in the data using statistical methods, explain a large amount of the variation in the real rate, and are robust to the inclusion of a variety of macro variables. Conversely we find little to no evidence that changes in the Federal Reserve chairmanship are robustly related in real rate shifts (Caporale and Grier, 2000).

Their graph, Figure A3 in the Appendix, demonstrates the shifts.

Taking these last two articles together, we can note that the Burns' chairmanship somewhat overlaps with the Nixon-Ford period, Volcker's with the Reagan-Bush and Republican Senate eras, and Greenspan's time was subsequent to that, which may be why the political regime change dominates the chairmanship regimes. The closer consistency between the federal funds rate and the Taylor rule's recommendations under Greenspan may be better explained by the political climate. George HW Bush's presidency from 1989 to 1993 shows a tighter correlation than during Bill Clinton's time in the White House from 1993 to the end of the study in 1998 when the actual rate dipped below then shot back up above the estimated rate.

These five articles are just a small representation of the critiques and criticisms of the original Taylor rule. Many people have not only given their opinions but have tried to expand or improve upon this simple rule, hoping to also leave their mark in the world of monetary policy. What follows is my contribution to this field.

CHAPTER 2. DATA ANALYSIS

Data collection and definitions

Data was collected from the Federal Reserve Bank of St. Louis' website and covers the period of 1987.Q4 through 2004.Q1, or 66 quarterly observations. Taylor's (1993) data covers 1987 through 1992 while Rudebusch's (2002) covers 1987.Q4 through 1999.Q4. The year 1987 was chosen as a breakpoint because Alan Greenspan was appointed as the Chairman of the Federal Reserve Board effective August 11, 1987.

Taylor's notation will be used throughout my work; however I will make use of some of Rudebusch's definitions. Phrases in quotation marks are the names used by the Federal Reserve to specify the data. Taylor's r , is the "effective federal funds rate". Inflation is calculated by using the "Gross Domestic Product: Chain-type Price Index", P_t , where $\pi_t = 400(\ln P_t - \ln P_{t-1})$. So Taylor's p , the rate of inflation over the previous four quarters, is equal to $\frac{1}{4} \sum \pi_{t-j}$ where $j = 0, 1, 2, 3$. The output gap, y , is defined by Taylor as the percent deviation of real GDP, Y , from trend real GDP, Y^* , whereas Rudebusch words it as the percent difference between actual GDP, "Real Gross Domestic Product, 3 Decimal", and potential output, "Real Potential Gross Domestic Product". Both use the same formula but with slightly different letter notion, $y = 100(Y - Y^*)/Y^*$.

Model development and testing

Before deciding on possible models, it is important to understand the nature of the variables and how they behave. As is frequently the case with time-series data, the value of one observation can depend on its value one or more periods back. The purpose of testing if a variable contains a unit root is to see if it is stable and returns to a certain mean, or is

nonstationary and continues to move in a certain direction without returning to a stable mean. To test, we start with the equation $x_t = \rho x_{t-1} + \varepsilon_t$ and subtract x_{t-1} from both sides. This gives us $\Delta x_t = \gamma x_{t-1} + \varepsilon_t$, where $\gamma = \rho - 1$. So, testing a null hypothesis of $\rho = 1$ in the first case is the same as testing if $\gamma = 0$ in the second. We proceed by using the Ordinary Least Squares (OLS) method of regression, estimating the value of γ and its standard error. The t-statistic generated is then compared to the critical values calculated by Dickey and Fuller which allows us to either reject or fail to reject the null hypothesis. If we fail to reject $H_0: \gamma = 0$, then the series contains a unit root. Besides $\Delta x_t = \gamma x_{t-1} + \varepsilon_t$, which is a pure random walk model, Dickey and Fuller have two more models: $\Delta x_t = \alpha_0 + \gamma x_{t-1} + \varepsilon_t$, which includes an intercept or drift term, and $\Delta x_t = \alpha_0 + \gamma x_{t-1} + \alpha_2 t + \varepsilon_t$, which includes both a drift and a linear time trend. Therefore, three separate tables of critical values are provided by Dickey and Fuller. The results returned by Stata when performing the Dickey-Fuller test for unit root provides a test statistic, $Z(t)$, as well as a p-value for $Z(t)$. The interpolated Dickey-Fuller critical values at the 1%, 5%, and 10% confidence levels are also reported. The higher the p-value, the more certain you can be that you should fail to reject the null hypothesis, i.e. the series is nonstationary. In performing the Dickey-Fuller unit root test on the variables, I fail to reject the null hypothesis for each variable and thus assume the existence of unit roots. Therefore the variables are not stable and do not return to a given mean.

Table 2. Dickey-Fuller test for unit root on variables.

Variable	Z(t)	p-value	Unit root
Federal funds rate: r	-0.372	0.9158	Yes
Inflation: p	-0.926	0.7803	Yes
Output gap: y	-1.257	0.6482	Yes
Lagged Federal funds rate: r_{t-1}	-0.082	0.9514	Yes
Critical values: 1% -3.559; 5% -2.918; 10% -2.594			

In light of the conclusion that the variables are nonstationary, we proceed to the next step of determining if cointegration is present. Cointegration refers to a linear combination of nonstationary variables. If the individual variables are not stable, it may still be possible to combine them in such a way that the difference between the variables is stable, or always staying close to or returning to a given mean, in which case the variables are considered to be cointegrated. This test only needs to be performed when the variables are nonstationary. If they were stable, then when they were combined, the combination would necessarily be stable as well, thus eliminating the need to test for cointegration.

To test for cointegration requires running a regression on a model and then predicting the residuals. The residuals are then tested for the presence of a unit root by using the Dickey-Fuller method as described above. I started with two models. Model (1) uses the variables from Taylor's original rule and model (2) comes from Rudebusch's (2002) work, which includes a lagged federal funds rate on the right hand side of the equation. Standard deviations are provided in parentheses. The constant term was only found to be significant in model (1) and therefore was removed from model (2).

$$r = 0.838 + 1.975p + 0.859y + \varepsilon \quad (1)$$

(0.375) (0.154) (0.077) n = 66, R² = 0.8027

$$r = 0.414p + 0.257y + 0.816r_{t-1} + \varepsilon \quad (2)$$

(0.107) (0.048) (0.046) n = 66

Before proceeding with a Dickey-Fuller unit root test on the residuals, I must first check to determine the appropriate number of lags to include. I proceeded with the following equation using the residuals from the regressions of models (1) and (2):

$$e = \delta_0 + \delta_1 e_{t-1} + \delta_2 \Delta e_{t-1} + \delta_3 \Delta e_{t-2} + \delta_4 \Delta e_{t-3} + \delta_5 \Delta e_{t-4} + \delta_6 \Delta e_{t-5} + \varepsilon$$

Running a regression on the above equation, I tested to see if the last term, $\delta_6 \Delta e_{t-5}$, is significantly different from zero. If not, I re-ran the regression after eliminating that variable. Successive regressions are run until a significant coefficient is reached, thereby determining the appropriate number of lags. If none are significantly different from zero, no lags are required. Repeating this sequence on both models, I concluded that none of the δ_i parameters on the differenced residuals were significantly different from zero. Therefore, I ran the Dickey-Fuller unit root tests without including any lags, using the critical values provided by Hamilton in Table B.9 in his Appendix B (1994). For this test, it is discovered that the residuals for model (1) contain a unit root since again I fail to reject the null hypothesis. This means that there is no cointegration and the residuals are nonstationary. Thus, the model is invalid because there is no stable relationship between the variables over time. However, for model (2) that includes the lagged federal funds rate, I rejected the null hypothesis and concluded that there is cointegration, that there exists a linear combination of the variables which is stable. Therefore I will proceed with testing on model (2) only. Even though Rudebusch (2002) criticized the use of a lagged federal funds rate due to its inability to accurately forecast the target rate more than a few months into the future, I believe that not including it leads to an invalid model.

Table 3. Dickey-Fuller test for unit root on models (1) and (2).

Model	Z(t)	Cointegrated
(1) $r = 0.838 + 1.975p + 0.859y$	-1.959	No
(2) $r = 0.414p + 0.257y + 0.816r_{t-1}$	-4.579	Yes
Critical values for 2 right-hand variables (case 2 with constant), model (1): 1% -4.31; 5% -3.77; 10% -3.45.		
Critical values for 3 right-hand variables (case 1 without constant), model (2): 1% -4.30; 5% -3.74; 10% -3.44		

In general, the Taylor-type models have been known to be unstable. This can be observed by looking again at Figure A2 in the Appendix, which shows the rate predicted by the Taylor rule versus the actual federal funds rate. There is greater discrepancy between the two from 1970 to 1987 than from 1988 to 1998. To try to eliminate this, I have limited my data to cover the period starting when Alan Greenspan became the chairman of the Federal Reserve Board, beginning in the fourth quarter of 1987. Referring back to Judd and Rudebusch's 1998 work discussed earlier, the Taylor rule was doing a much better job in anticipating the actual rate during the Greenspan regime than under either of the two previous chairmen. To examine the validity of model (2), my next step was to look at the stability of the coefficients over time. The rationale for this is to determine the model's reliability. If there is little variation in a variable's coefficient over time, this means the predicted federal funds rate should move proportionally to the movement of that variable. On the other hand, if the coefficient is not stable, we can assume that the Fed is not consistently following only one simple rule. This instability could be caused when the Fed relies more so on one variable than another, i.e. places different weighting factors on inflation and output during each decision-making process, or when the Fed takes into account other variables previously not considered, such as the unemployment rate or housing starts.

To test for stability, I ran and graphed two different expanding series of regressions, see Figures 2 and 3. The first one always started with 1987.Q4 and ended with 1993.Q4 yearly through 2003.Q4 successively, as well as a regression that covered the entire period of 1987.Q4 to 2004.Q1. The other series was generally the same, only in reverse. This time I started with 1988.Q1 yearly through 1997.Q4 successively and always ended with 2004.Q1, as well as the overall period. Only the inflation coefficient in Figure 2, shows a moderate

amount of instability varying by approximately 0.6. The output gap and the lagged interest rates coefficients are much more stable, varying by only 0.18 and 0.26 respectively. Figure 3 shows much more stability in all three coefficients: a 0.3 variation for inflation and 0.12 variations for both the output gap and the lagged interest rate.

The next step was to form some new models to see if it was possible to improve the stability of the coefficients, particularly the one for inflation. A general consensus has been formed that the Fed's objective for inflation is around 2%. One thought is that it is possible that the Fed would follow one course of action when the real inflation rate was near, at, or below the objective and a different course of action when the rate was higher than the objective. Explicitly modeling this behavior could take care of the problem regarding some of the instability in the coefficients of the variables. By including two scenarios in the model, this would account for the fact that the coefficients on the variables can take on different values. From this idea, four new models were formed:

$$r = \alpha_0 + \alpha_1 p + \alpha_2 y + \beta_0 d2 + \beta_1 d2(p) + \beta_2 d2(y) \quad (3)$$

$$r = \alpha_0 + \alpha_1 p + \alpha_2 y + \beta_0 d2.5 + \beta_1 d2.5(p) + \beta_2 d2.5(y) \quad (4)$$

$$r = \alpha_0 + \alpha_1 p + \alpha_2 y + \alpha_3 r_{t-1} + \beta_0 d2 + \beta_1 d2(p) + \beta_2 d2(y) + \beta_3 d2(r_{t-1}) \quad (5)$$

$$r = \alpha_0 + \alpha_1 p + \alpha_2 y + \alpha_3 r_{t-1} + \beta_0 d2.5 + \beta_1 d2.5(p) + \beta_2 d2.5(y) + \beta_3 d2.5(r_{t-1}) \quad (6)$$

Initially I included the dummy variables on the constants, i.e. $\beta_0 d2$ and $\beta_0 d2.5$, but discovered that the dummy-times-constant variable and the dummy-times-inflation variable had a simple correlation coefficient of 0.97, meaning I have a problem with multicollinearity. Simply removing one of the variables can eliminate this problem. I also found that the constant itself was not significant. After removing both the constant and the dummy-times-constant variables, I was left with the following four revised models.

$$r = \alpha_1 p + \alpha_2 y + \beta_1 d2(p) + \beta_2 d2(y) \quad (3)$$

$$r = \alpha_1 p + \alpha_2 y + \beta_1 d2.5(p) + \beta_2 d2.5(y) \quad (4)$$

$$r = \alpha_1 p + \alpha_2 y + \alpha_3 r_{t-1} + \beta_1 d2(p) + \beta_2 d2(y) + \beta_3 d2(r_{t-1}) \quad (5)$$

$$r = \alpha_1 p + \alpha_2 y + \alpha_3 r_{t-1} + \beta_1 d2.5(p) + \beta_2 d2.5(y) + \beta_3 d2.5(r_{t-1}) \quad (6)$$

Where

$d2$ is a dummy variable = 1 when $p \leq 2\%$; = 0 otherwise

$d2.5$ is a dummy variable = 1 when $p \leq 2.5\%$; = 0 otherwise

All other variables are as in Taylor's original rule.

Again, I regressed and then predicted the residuals for the above four models. Using the differenced residual equation to determine the number of lags to include, I found that two lags were required for model (3) but zero lags were required for the remaining three models, (4), (5), and (6). Performing the Dickey-Fuller unit root test on the residuals for models (3) with two lags and (4) with zero lags, both without the lagged federal funds rate, I fail to reject the null hypothesis and conclude the existence of unit roots but no cointegration. This is the same conclusion I reached with model (1). However, for models (5) and (6), I reject the null hypothesis at the 5% probability level, determining that there is no unit root and therefore conclude that cointegration does exist, just as I did with model (2). So I again found that the models without the lagged value are invalid and continued with only models (5) and (6).

Table 4. Dickey-Fuller test for unit root on models (3), (4), (5), and (6).

Model	Z(t)	Cointegrated
(3) $r = \alpha_1 p + \alpha_2 y + \beta_1 d2(p) + \beta_2 d2(y)$	-2.577	No
(4) $r = \alpha_1 p + \alpha_2 y + \beta_1 d2.5(p) + \beta_2 d2.5(y)$	-2.215	No
(5) $r = \alpha_1 p + \alpha_2 y + \alpha_3 r_{t-1}$ $+ \beta_1 d2(p) + \beta_2 d2(y) + \beta_3 d2(r_{t-1})$	-5.092	Yes
(6) $r = \alpha_1 p + \alpha_2 y + \alpha_3 r_{t-1}$ $+ \beta_1 d2.5(p) + \beta_2 d2.5(y) + \beta_3 d2.5(r_{t-1})$	-4.705	Yes
Critical values for 4 right-hand variables (case 1), models (3) and (4): 1% -4.67; 5% -4.13; 10% -3.81.		
Critical values for 6 right-hand variables (case 1), model (5) and (6): 1% -5.27; 5% -4.62; 10% -4.38.		

When inflation is greater than 2% or 2.5%, $d2$ and $d2.5$ are zero. Regressing models

(5) and (6) results in the following:

$$r = 0.735p + 0.353y + 0.668r_{t-1} \quad (5a)$$

$$r = 1.057p + 0.395y + 0.528r_{t-1} \quad (6a)$$

When inflation is less than or equal to 2% or 2.5%, $d2$ and $d2.5$ are one. In this case the coefficients on the variables become $\alpha_i + \beta_i = \gamma_i$:

$$r = (0.735 - 0.536)p + (0.353 - 0.227)y + (0.668 + 0.246)r_{t-1} \quad (5b)$$

$$r = (1.057 - 0.782)p + (0.395 - 0.2)y + (0.528 + 0.346)r_{t-1} \quad (6b)$$

Or:

$$r = 0.199p + 0.126y + 0.914r_{t-1} \quad (5b)$$

$$r = 0.275p + 0.195y + 0.874r_{t-1} \quad (6b)$$

Comparing (5a) and (5b), when the inflation level is *above* the target of 2%, more emphasis is placed on the combined inflation and output gap, 0.332 vs. 0.086, than when inflation is less than or equal to 2%. In particular, much of the focus is on inflation, which carries a higher coefficient, 0.735, than what even the lagged federal funds rate does, 0.668. This means that there is much more smoothing occurring when inflation is *below* the target level desired by the Fed. Selecting 2.5% as the cutoff point results in even more emphasis being placed on both the inflation and output gap combined, 0.472, and inflation alone, 1.057, when inflation is higher than 2.5%, (6a). When inflation is less than or equal to 2.5%, the lagged federal funds rate takes on more importance, 0.874 (6b).

Examining the stability of the coefficients was achieved by again running and graphing two expanding series of regressions on models (5) and (6) in the same method as described previously for model (2). Although stability of the coefficients on a few of the variables was quite good, overall, the performance of each of the models showed less stability than the original model before the dummy variables were added. The coefficient on

the dummy-times-output gap variable in model (5) varied by nearly 1.7 points, see Figure 4, and the coefficient on the inflation variable moved as much as 1.4 points, see Figure 5. The coefficient on the dummy-times-inflation variable in model (6) varied by over 0.7 points, see Figure 6, and the coefficient on the inflation variable moved by over 2.3 points, see Figure 7. All of these movements were greater than the 0.6 point variation on inflation observed in model (2).

Model selection

After performing all robustness tests on the six models, model (2) seems to be the best choice, using Taylor's original variables but also including the lagged federal funds rate as Rudebusch (2002) did, resulting in the following equation:

$$r = 0.414p + 0.257y + 0.816r_{t-1}$$

Rudebusch's regression yielded the following:

$$r = 0.27(1.53p + 0.93y) + 0.73r_{t-1}$$

Converting it to match my notation gives us:

$$r = 0.413p + 0.251y + 0.73r_{t-1}$$

The coefficients on both inflation and the output gap for my equation are almost identical to Rudebusch's. However, when adding 13 quarterly observations, my equation shows a stronger link between the lagged federal funds rate and the new targeted rate, 0.816 vs. 0.73, or greater persistence. This equation shows that when the Fed is making its decision on what the targeted federal funds rate should be, it looks at the rate of inflation over the previous four quarters as well as the percent deviation of real GDP from a target, or the output gap, but only assigns an importance of around 20% to that value. A full 80% of the new target is based on its last targeted rate. This is known as interest rate smoothing, or

inertia, which essentially eliminates some of the possible volatility in the movement of the rate. While many consider this valid, as discussed earlier in the critiques of the Taylor rule section Rudebusch argued against it, stating that if it was indeed true then the equation should be a very reliable forecasting tool. On the contrary, his work revealed that when looking out into the future beyond one quarter, this equation does not remain robust.

The Fed itself may actually refute Rudebusch's findings. In reviewing the Federal Reserve Board's semiannual Monetary Policy Report to the Congress in July, 2004, Alan Greenspan states that, "monetary policy neutrality can be restored at a *measured pace*, [so that a] relatively smooth adjustment of businesses and households to a more typical level of interest rates seems likely." Italics are mine. This smoothing is important because, "considerably more uncertainty and hence risk surrounds the behavior of the economy with a more rapid tightening of monetary policy than is the case when tightening is more measured." Tightening refers to decreasing the money supply, which leads to an increase in interest rates. This shows that the Fed acknowledges that it wants to avoid abrupt changes in the federal funds rate, which can be achieved by placing some weight on the rate's past value.

Rudebusch's theory that special circumstances and persistent shocks affect the Fed's decisions is actually supported in the same report. Greenspan mentions "corporate accounting and governance scandals", "geopolitical tensions", and "potential terrorism" as some of the uncertainties in the economy, which are difficult to quantify. This lends support to the idea that although a simple mathematical rule may be useful, the Fed still must take into account countless other pieces of information when making monetary policy decisions. This is best summed up in the closing paragraph of Greenspan's testimony:

As we attempt to assess and manage these risks, we need, as always, to be prepared for the unexpected and to respond promptly and flexibly as situations warrant. But although our actions need to be flexible, our objectives are not. For twenty-five years, the Federal Reserve has worked to reestablish price stability on a sustained basis. An environment of price stability allows households and businesses to make decisions that best promote the longer-term growth of our economy and with it our nation's continuing prosperity (The Federal Reserve Board: Testimony of Chairman Alan Greenspan, 2004).

CHAPTER 3. CONCLUSION

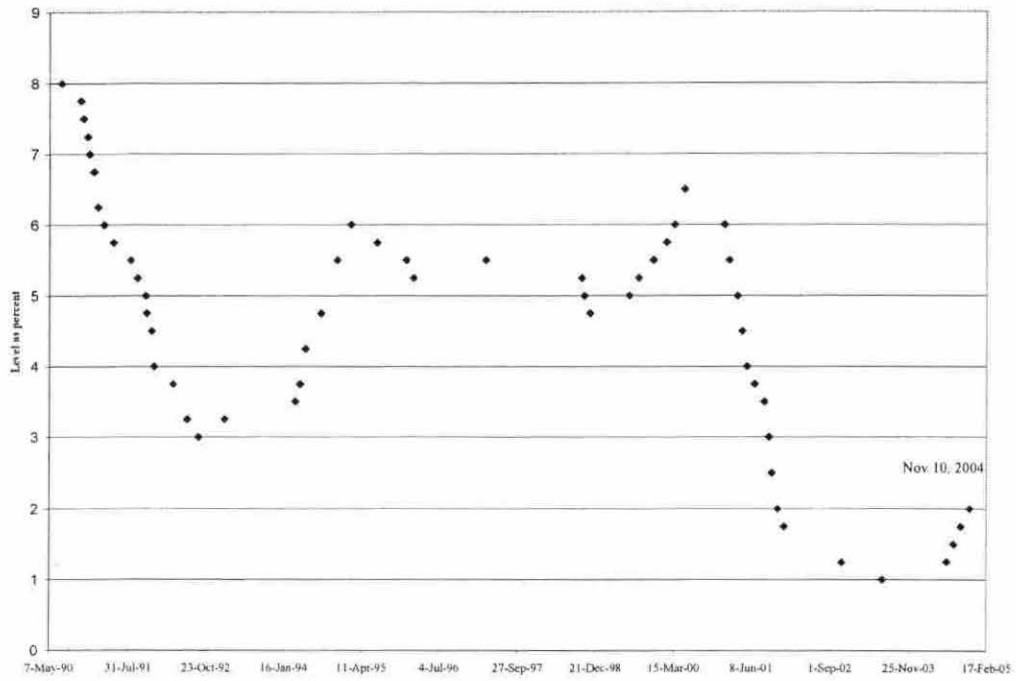
The introduction in 1993 of the Taylor rule equation was a pivotal moment in history. Although it probably doesn't rival the publication of Albert Einstein's special theory of relativity equation of $E = mc^2$ in 1905, it's still considered very significant, especially among monetary policy focused macroeconomists and other decision makers. In the decade following the rise of this simple monetary policy rule, many others have sought to challenge, expand, or redefine this equation to make it more accurate and useful. However, Hetzel (2000, page 3) might have summed it up best when he stated, "Even if one assumes that a functional form like the Taylor rule successfully predicts the behavior of the funds rate, what has one learned about the behavior of the FOMC? Unfortunately, the answer is 'nothing'...". Simply put, there typically arises some exogenous shock or "sunspot" which changes the behaviors of the public or the interest rate setting policies of the Federal Open Market Committee that cannot possibly be captured in a simple, or even a complex, equation. In other words, the Fed still exercises some level of discretionary policy making decisions.

While many of the articles I surveyed in my paper suggest that it is not optimal for the Fed to base their short-term decisions on the mechanical workings of a Taylor-type rule, few seem to mention that there is a world outside the Federal Reserve that can benefit from being able to use a simple tool in order to anticipate future interest rate levels. U.S. corporations, financial markets, state and local governments, individuals, and even foreign countries would be included in this group. A company's long-term financing strategies can greatly be influenced by where it sees interest rates heading in the future. A company will be more willing to invest in major projects if it believes it can acquire loans at low interest rates.

Individual homeowners are also concerned about this information when deciding when to take on a home mortgage loan or whether or not to refinance an existing mortgage.

While the original Taylor rule still may be the gold standard, through my paper I have tried to find support for a new model which takes into account several more years of observations than Taylor's very limited time period. By including a lagged federal funds rate term, changes will be more gradual, allowing for the public to be better able to anticipate future actions by the Fed. Knowing the Fed is keeping long-term goals in focus when targeting short-term interest rates will raise the level of confidence the public has in the Federal Reserve.

Even though my two new models didn't prove to have the same level of stability in the coefficients as the simple model with only the lagged federal funds rate added, I was able to show that when inflation is below the Fed's objective, they are much more likely to be content with the current course of action, heavily basing a new rate on the previous period. However, when inflation rates rise above the objective, the Fed appears to respond more strongly to changes in inflation and the output gap, particularly the former. Adding more observations, especially over different regimes, may lend support to the idea that the Fed follows a different course of action during times of increased inflation than it does during periods of price stability.



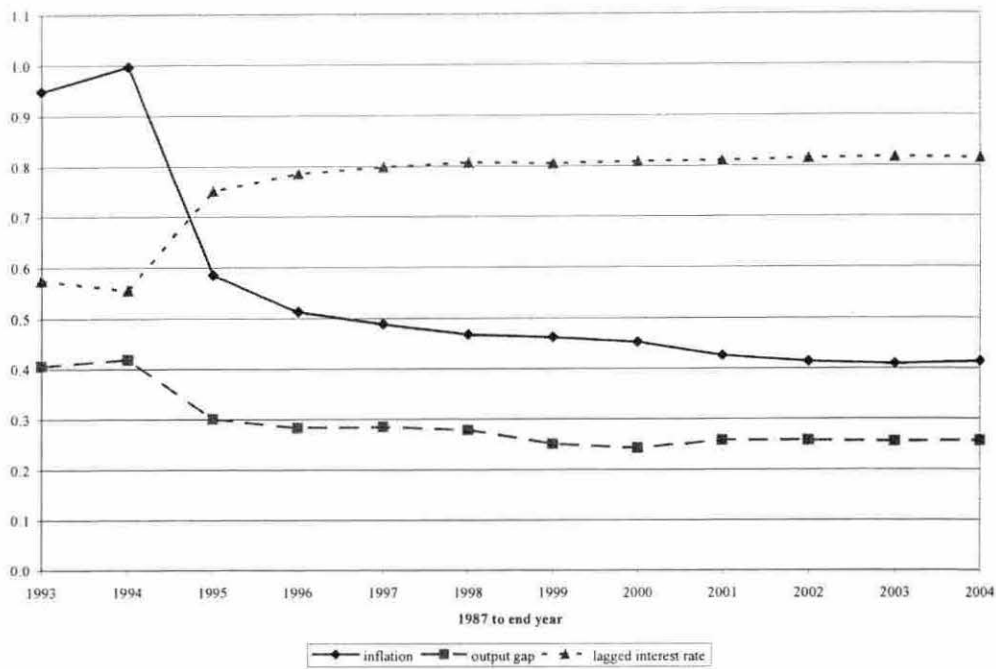


Figure 2. Test for parameter stability for model (2) starting 1987.Q4 and ending annually 1993.Q4 through 2004.Q1 successively.

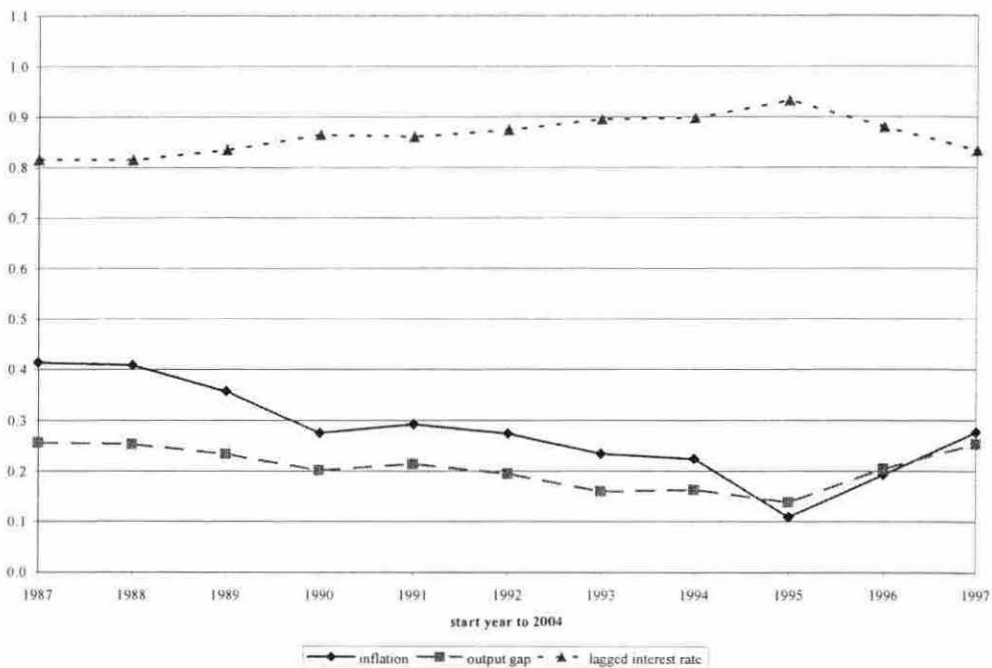


Figure 3. Test for parameter stability for model (2) starting annually 1987.Q4 through 1997.Q1 successively and ending 2004.Q1.

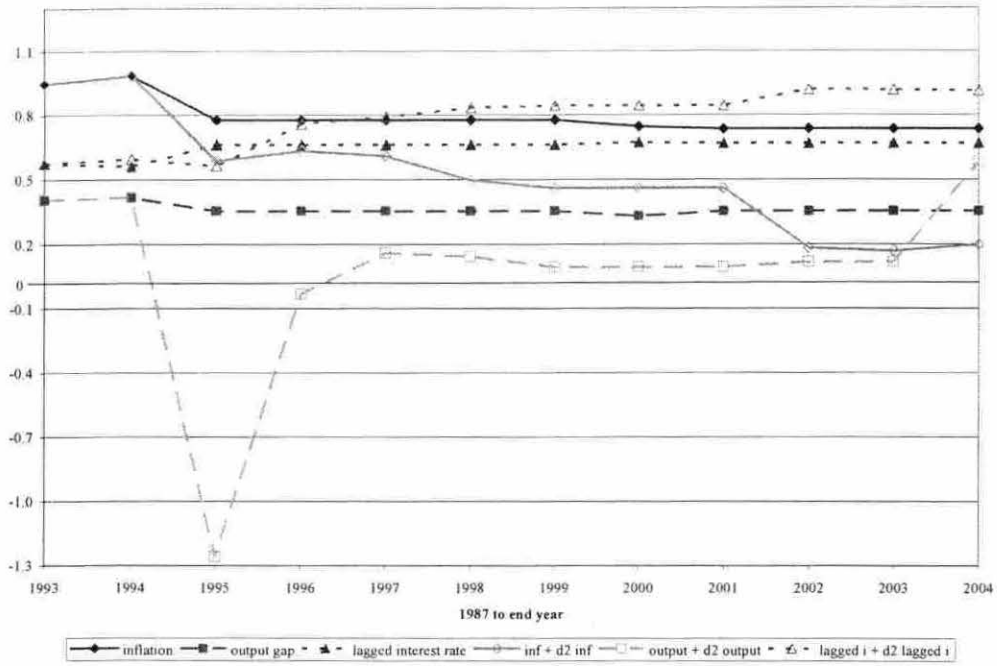


Figure 4. Test for parameter stability for model (5) starting 1987.Q4 and ending annually 1993.Q4 through 2004.Q1 successively.

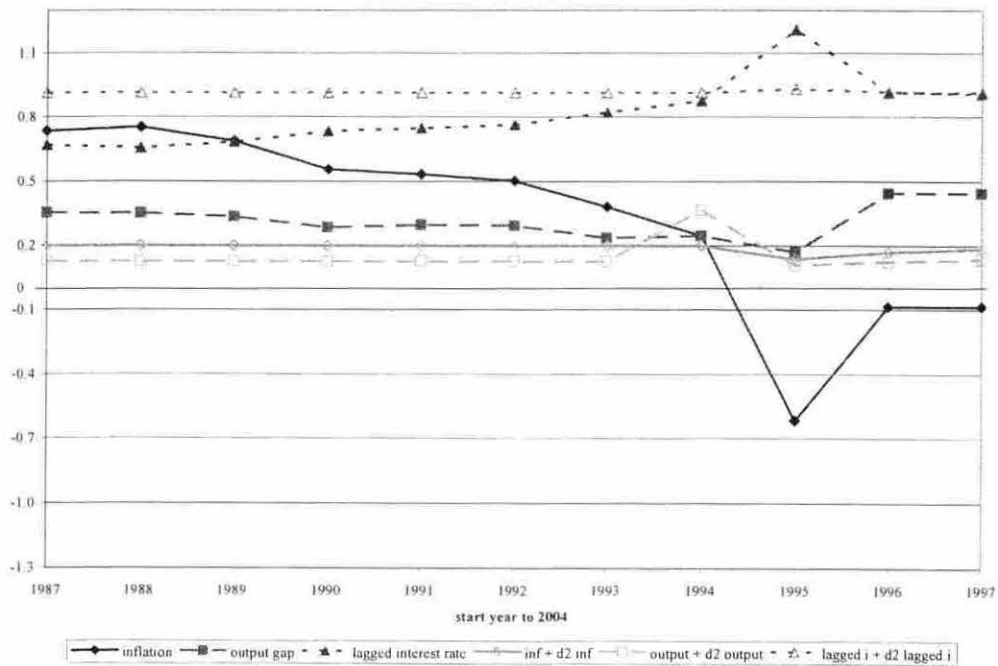


Figure 5. Test for parameter stability for model (5) starting annually 1987.Q4 through 1997.Q1 successively and ending 2004.Q1.

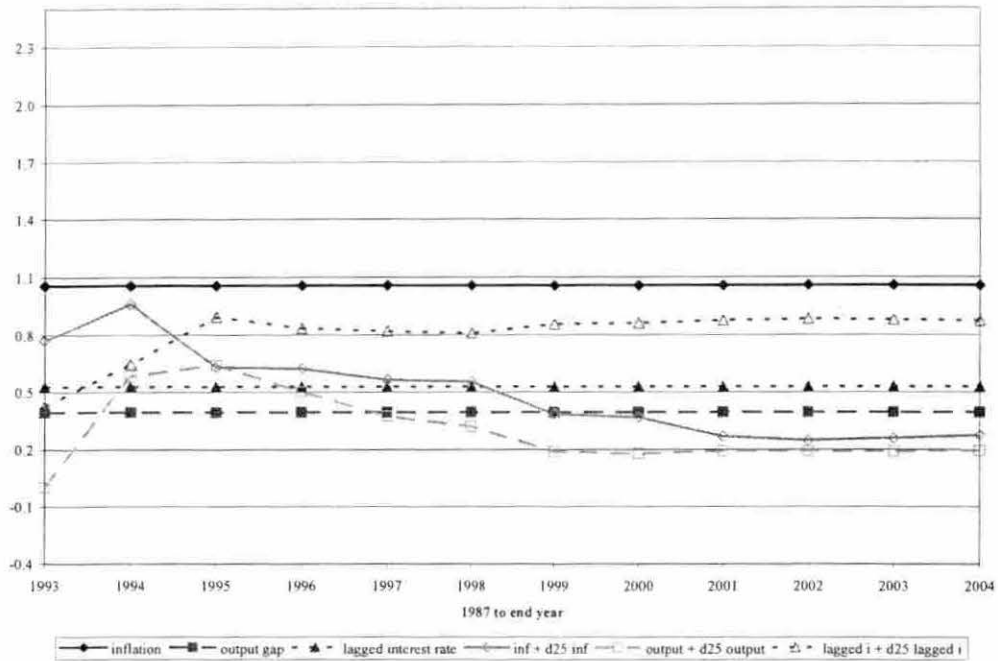


Figure 6. Test for parameter stability for model (6) starting 1987.Q4 and ending annually 1993.Q4 through 2004.Q1 successively.

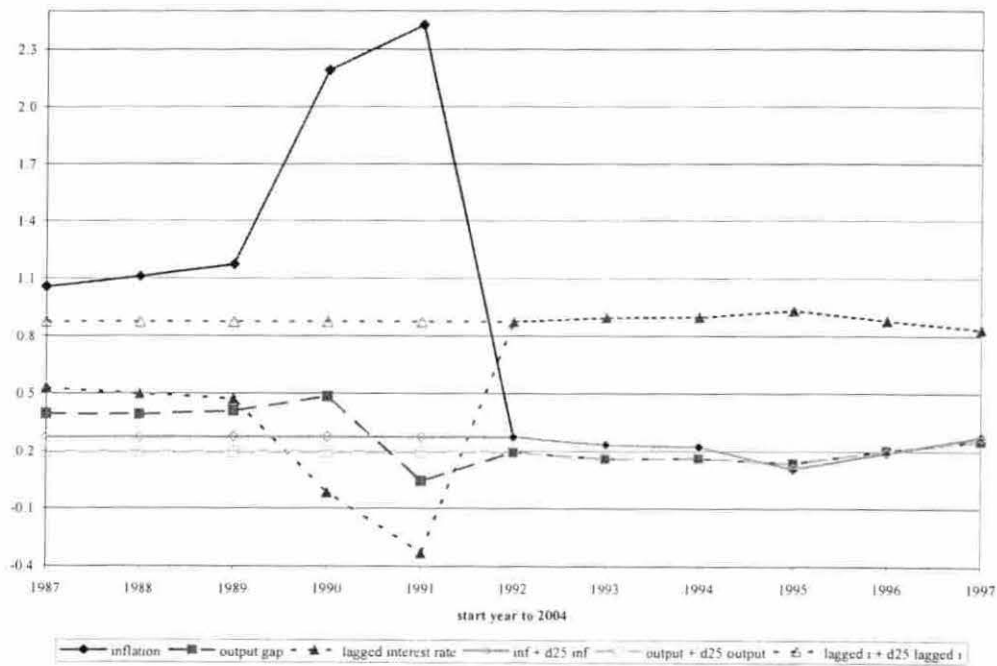
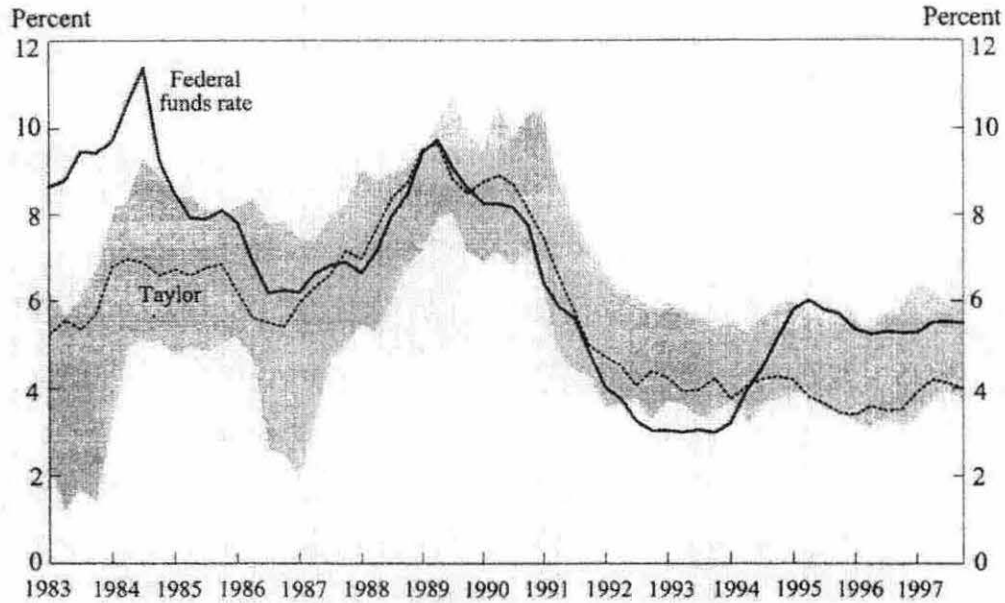


Figure 7. Test for parameter stability for model (6) starting annually 1987.Q4 through 1997.Q1 successively and ending 2004.Q1.

APPENDIX



Note: The shaded area reflects the range of rule recommendations based on recommendations calculated for each of the six measures of the output gap and each of the four measures of inflation. In each quarter, the maximum of the range corresponds to the maximum of the 24 rule recommendations, and the minimum of the range corresponds to the minimum of the 24 rule recommendations. Taylor recommendations were calculated by the author using the Taylor rule in (1) and the latest version of data for real GDP and the GDP chain price index available in December 1998. These recommendations were based on the Taylor output gap described in Appendix A. Sources: Board of Governors of the Federal Reserve System, author's calculations.

Figure A1. The range of Taylor-type rule recommendations for different measures of inflation and the output gap, taken from Kozicki, 1999, page 11, chart 3.

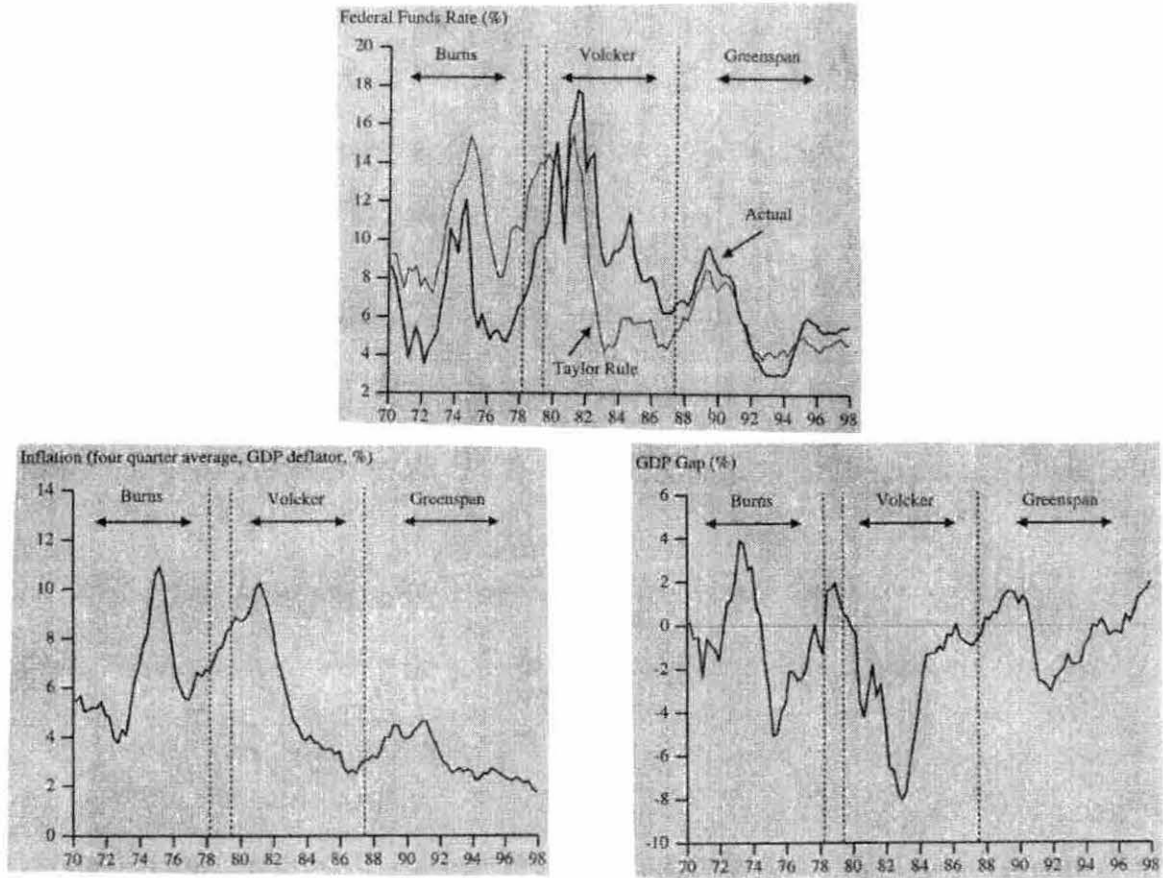


Figure A2. The Taylor rule and its components, taken from Judd and Rudebusch, 1998, page 5, figure 1.

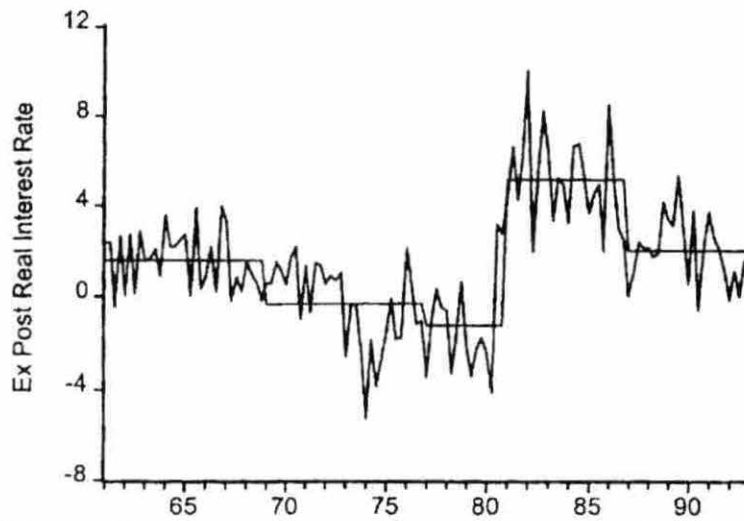


Figure A3. Political regimes and the real interest rates, 1961-1992, taken from Caporale and Grier, 2000, page 330, figure 2.

Description of statement release policy from the Federal Reserve Bank of St. Louis website:

A statement is released at 2:15 pm on the final day of each FOMC meeting. The disclosure policy has evolved over the years as the FOMC has sought to provide more information on its views on economic activity and risks to the outlook.

- From 1994 through 1998, a written statement was released whenever the FOMC changed the stance of monetary policy.
- In 1995, the statement began to include the objective for the federal funds rate. In late 1998, the FOMC began releasing a statement immediately after certain meetings when the stance of monetary policy remained unchanged but the Committee nonetheless wanted to communicate to the public a major shift in its views about the balance of risks or the likely direction of future policy.
- Since February 2000, the FOMC has issued a statement after each meeting. That statement has usually included language that describes the Committee's judgment about the risks to the attainment of its long-run goals of price stability and sustainable economic growth.
- Since March 2002, the statement has included each member's vote on monetary policy decisions (About the Fed: FedFAQ, 2004).

Recent press release from the Board of Governors of the Federal Reserve System website.

Release Date: November 10, 2004

For immediate release

The Federal Open Market Committee decided today to raise its target for the federal funds rate by 25 basis points to 2 percent.

The Committee believes that, even after this action, the stance of monetary policy remains accommodative and, coupled with robust underlying growth in productivity, is providing ongoing support to economic activity. Output appears to be growing at a moderate pace despite the rise in energy prices, and labor market conditions have improved. Inflation and longer-term inflation expectations remain well contained.

The Committee perceives the upside and downside risks to the attainment of both sustainable growth and price stability for the next few quarters to be roughly equal. With underlying inflation expected to be relatively low, the Committee believes that policy accommodation can be removed at a pace that is likely to be measured. Nonetheless, the Committee will respond to changes in economic prospects as needed to fulfill its obligation to maintain price stability.

Voting for the FOMC monetary policy action were: Alan Greenspan, Chairman; Timothy F. Geithner, Vice Chairman; Ben S. Bernanke; Susan S. Bies; Roger W. Ferguson, Jr.; Edward M. Gramlich; Thomas M. Hoenig; Donald L. Kohn; Cathy E. Minehan; Mark W. Olson; Sandra Pianalto; and William Poole.

In a related action, the Board of Governors unanimously approved a 25 basis point increase in the discount rate to 3 percent. In taking this action, the Board approved the requests submitted by the Boards of Directors of the Federal Reserve Banks of Boston, New York, Philadelphia, Cleveland, Richmond, Atlanta, Chicago, St. Louis, Minneapolis, and Kansas City.

REFERENCES CITED

- About the Fed: FedFAQ – Search Results (objectives for monetary policy). *The Federal Reserve Bank of St. Louis* 02/06/2004.
http://www.frbatlanta.org/fedfaq/search/dsp_faqsearchformUFAQSTL.cfm Accessed Nov 11, 2004.
- Caporale, Tony, and Kevin B. Grier, Aug 2000. Political regime change and the real interest rate. *Journal of Money, Credit, and Banking* 32-2, 320-334.
- Carlstrom, Charles T., and Timothy S. Fuerst, First Quarter 2001. Monetary policy and self-fulfilling expectations: The danger of forecasts. *Economic Review – Federal Reserve Bank of Cleveland* 37-1, 9-19.
- Economic Research Federal Reserve Bank of St. Louis: Economic Data – FRED® II. *The Federal Reserve Bank of St. Louis* 02/06/2004. <http://research.stlouisfed.org/fred2/>. Accessed Nov 1, 2004.
- The Federal Reserve Board: The discount rate. *Board of Governors of the Federal Reserve System*, Aug 2004. <http://www.federalreserve.gov/monetarypolicy/discountrate.htm>. Accessed on Sept 23, 2004.
- The Federal Reserve Board: Open market operations. *Board of Governors of the Federal Reserve System*, Aug 2004. <http://www.federalreserve.gov/fomc/fundsrate.htm>. Accessed on Nov 11, 2004.
- The Federal Reserve Board: Reserve requirements. *Board of Governors of the Federal Reserve System*, Mar 2004.
<http://www.federalreserve.gov/monetarypolicy/reservereq.htm>. Accessed on Sept 23, 2004.
- The Federal Reserve Board: The structure of the Federal Reserve System. *Board of Governors of the Federal Reserve System*, July 2004.
<http://www.federalreserve.gov/pubs/frseries/frseri.htm>. Accessed on Sept 23, 2004.
- The Federal Reserve Board: Testimony of Chairman Alan Greenspan. Federal Reserve Board’s semiannual Monetary Policy Report to the Congress. *Board of Governors of the Federal Reserve System*, July 20, 2004.
<http://www.federalreserve.gov/boarddocs/HH/2004/July/testimony.htm>. Accessed on Nov 5, 2004.
- Federal Reserve release: Press release. *Board of Governors of the Federal Reserve System*, Nov 2004.
<http://www.federalreserve.gov/boarddocs/press/monetary/2004/20040921/default.htm> Accessed Nov 11, 2004.

- Hamilton, James D. (1994). *Time Series Analysis*. Princeton: Princeton University Press.
- Hetzl, Robert L., Spring 2000. The Taylor Rule: Is it a useful guide to understanding monetary policy? *Economic Quarterly – Federal Reserve Bank of Richmond* 86-2, 1-33.
- IS/LM model. *TheFreeDictionary.com* by Farlex, 2004.
<http://encyclopedia.thefreedictionary.com/IS%2FLM%20model> Accessed Nov 11, 2004.
- Judd, John P., and Glenn D. Rudebusch, 1998. Taylor's Rule and the Fed: 1970-1997. *Economic Review – Federal Reserve Bank of San Francisco* 3, 3-16.
- Kozicki, Sharon, Second Quarter 1999. How useful are Taylor Rules for monetary policy? *Economic Review – Federal Reserve Bank of Kansas City* 84-2, 5-41.
- Monnet, Cyril, and Warren E. Weber, Fall 2001. Money and interest rates. *Federal Reserve Bank of Minneapolis, Quarterly Review – Federal Reserve Bank* 25-4, 2-13.
- Romer, Christina D., and David H. Romer, June 2000. Federal reserve information and the behavior of interest rates. *The American Economic Review* 90-3, 429-457.
- Rudebusch, G.D., 2002. Term structure evidence on interest rate smoothing and monetary policy inertia. *Journal of Monetary Economics* 49, 1161-1187.
- Taylor, John B., 1993. Discretion versus policy rules in practice. *Carnegie-Rochester Conference Series on Public Policy* 39, 195-214.

ACKNOWLEDGEMENTS

I'd like to thank my major professor, Helle Bunzel, for giving her time, knowledge, and advice to help me complete this project, as well as my committee members, Joydeep Bhattacharya and Geoffrey Friesen. Thanks also to the Iowa State University faculty and staff that have helped me out along the way. Thank you to Adina Schwartz, my academic advisor and economics professor at Lakeland College, for all her passion and love of the economics, as well as the other faculty and staff in the department of Business Administration. Thank you to Stephen Silver, my academic advisor and economics professor at The Citadel, for encouraging me to specialize in economics, as well as the other faculty and staff in the School of Business.

I'd also like to thank all other people who have helped me throughout my life, including high school teachers, friends, and family members.

Finally, a great thank you to my mother, for always supporting me, emotionally (and financially). We have been there for each other through the sad times, the happy times, and ATT. You are the wind beneath my wings. And although my father passed away before seeing me earn my Bachelor's degree, earn my first Master's degree, and work toward my second Master's degree, I know that he has always been by my side.

BIOGRAPHICAL SKETCH

Michelle Lynn Mireault was born August 15, 1972 in White Lake, Wisconsin. She received a Bachelor of Science degree in Business Administration with a minor in Economics from Lakeland College in Sheboygan, WI in 1994, where she was recognized as the Outstanding Student in Economics. She also received a Master of Business Administration degree from The Citadel in Charleston, SC in 2002.