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Explaining and Forecasting the US Federal Funds Rate

A Monetary Policy Model for the US

Matthew Clements

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To Vanessa and Jim for your friendship and encouragement

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Acronyms

BEA	Bureau of Economic Analysis
CBO	US Congressional Budget Office
CPI	consumer price index
EDF	eurodollar future
Fed	US Federal Reserve
FFR	federal funds rate
FOMC	Federal Open Market Committee
GDP	gross domestic product
IMF	International Monetary Fund
MPM	monetary policy model
OECD	Organization for Economic Cooperation and Development
PCE	personal consumption and expenditure

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Introduction

Explaining and Forecasting the US Federal Funds Rate has been written very much with financial market participants, such as dealers, fund managers and treasurers, in mind. It is designed to offer a specific explanation as to why interest rates, specifically the federal funds rate (FFR), may be set at a particular level. It also offers a scientific method of explaining the prevailing FFR, and a means to make forecasts of the future rate.

The book is aimed at all financial market players who not only have an interest in being able to make autonomous forecasts of the US Federal Reserve (Fed) FFR, but wish to be able to understand the mechanics behind the forecasts and explain them to clients. Financial markets would benefit from a user-friendly model that can describe and forecast underlying trends in US monetary policy. It allows those with little knowledge of economic theory to translate economic indicators commonly used by the financial markets in the United States into current or future policy moves.

The ability to estimate the future FFR has implications for all market players other than for those directly involved in the short term interest rate market. Asset markets, foreign exchange, short and long term securities and the futures markets are all, to varying degrees, dependent on the short term interest rate outlook in the United States. This book allows for the estimation of the shorter and longer term interest rate outlook via the use of reliable economic projections, and aims to answer such questions as, why are rates at the level they are? If the Fed changes the FFR to a new level, how is this figure arrived at? Is there a mathematical rationale behind the decision? These questions can be confronted with the monetary policy models described in subsequent chapters.

Financial institutions are frequently bombarded with periodical economic reports from commercial banks and the like, which include forecasts of various economic variables. Ultimately, the aim of these forecasts and application to its recipients is in their implications for monetary policy. The ubiquity of these forecasts should provide a basis for estimating monetary policy direction in the future. If economic growth and inflation are expected to rise over the next year, what will be the consequences for interest rates? This outcome in turn affects bond, stock and foreign exchange markets. Naturally, inherent in these forecasts will be some stance towards where interest rates may go, but the mechanism behind such a view is rarely explained. This book covers that area while offering alternatives for which forecasts may be best to use.

Chapter 1 provides an explanation of monetary policy models, including an overview of the most widely known rule: the Taylor rule.

The history of the Federal Reserve's policy procedures, targets and instruments since 1970 is examined in Chapter 2. The evolution of Fed policy since 1970 has implications for the validity and performance of US monetary policy models, and this forms the basis for the monetary policy model described in Chapter 3.

In Chapter 3, a Taylor-type monetary policy model is explained, and the accuracy of the model is analysed from 1980 to 2002. This book does not claim to be able to forecast the FFR precisely. Moreover, the forecasting ability of the model can only be as good as the quality of the economic forecasts that are used. Furthermore, the Fed does not adjust interest rates in a mechanical fashion but acts on many different influences: economic, political, domestic and international. The timing of interest rate changes also varies, as it acts both pre-emptively and with a lag according to what other factors are taken into account in its decision making. This can make forecasting rates for a particular period more precarious. Nevertheless, the model in this book shows a consistent degree of accuracy over the sample period, and when used in concert with the user's discretion and judgement, offers a reliable and valuable method of estimating and explaining the FFR.

Chapter 4 goes on to explain how the economic projections of the US Congressional Budget Office (CBO) can be used to make forecasts over a period of one to five years. However, the forecasts from any institution may be used, and the user's confidence in the reliability of economic forecasts from a particular institution or organisation should lend added weight to expectations that the model will produce a more reliable explanation of the future FFR.

Chapter 5 compares the accuracy of the monetary policy model with the FFR implied by the then contemporaneous three month eurodollar futures price – the market consensus on the path of the future interest rate level.

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CHAPTER 1

Monetary Policy Models

INTRODUCTION

This chapter discusses the emergence of monetary policy models in the United States and presents a detailed overview of the most celebrated monetary policy model, the Taylor rule.

Monetary policy models are mathematical equations that use economic data, or statistics, to describe how central bank monetary policy targets should be set.

The value of a US monetary policy model is that it can convert economic data and statistics directly into an implied FFR level – the chosen monetary policy target of the Fed. Alternative models have dealt with obtaining an optimal money supply growth rate, but such models are really only appropriate when the monetary authority uses the growth of money supply as its primary target. Both the German Bundesbank and the US Federal Reserve have used money supply growth rates as policy targets, but by the late 1990s the central banks of the major economies had all reverted to a short term interest rate as the principal policy target.

The Fed's chosen policy target is the FFR. This is the interest rate at which US banks lend to other banks overnight. The Federal Open Market Committee (FOMC) within the Fed is responsible for setting the FFR.

Monetary policy models began to emerge in the 1980s as a method of describing and explaining how economic factors, and other variables, determine how monetary policy is, or should be, conducted. The experience of the United States in the 1970s that saw prolonged recessions coupled with high inflation and unemployment placed greater emphasis on the role of monetary authorities and central banks in controlling inflation. The end of the Bretton Woods fixed exchange rate regime in 1973 meant that responsibility for monetary and inflation control fell more on the domestic authorities. Monetary policy was in its infancy, and the Fed had little experience in dealing with the economic conditions that were to prevail later in the decade after the stable inflation levels enjoyed during the 1950s and 1960s. Moreover, the interaction between economic growth, inflation and interest rates was less understood, and the US government, rather than the Fed, still took an active role in influencing price and wage levels in the economy. As such, the emergence of monetary policy models provided a more systematic means of determining the appropriate, or optimal, policy stance that should be pursued by the Fed to achieve the desired policy goal. This proved potentially attractive to the Fed, and central banks across the world, after the more discretionary policies pursued in the 1970s had failed to contain inflation.

Pursuing a more systematic policy approach may help avoid some of the negative consequences associated with a purely discretionary approach. This is because it leaves less scope for errors in the decision making process by providing a mathematically derived figure. A more systematic approach to the setting of the FFR can enhance the credibility of the bank, by improving transparency and providing an understanding of Fed operations, while contributing to accountability should it deviate significantly from policy described by the model.

The appeal of monetary policy models to the financial markets lies in their simplicity and ease of application. Little or no grounding in economic theory is required to understand and use the models. Furthermore, they reduce market uncertainty if they provide a simple explanation of how policy is being, or will be, conducted. Moreover, if there is evidence that Fed policy can be tracked, even approximately, by a model then there exists some scope for forecasting future policy moves.

An interest rate based monetary policy rule is effectively designed to describe the Fed's optimal reaction function. It assumes that the Fed reacts purely in a mechanical fashion to the growth and inflation data available at the time of each FOMC meeting. However, any reading of

FOMC meeting minutes or examination of policy statements makes it clear that much of the Fed's policy making is discretionary, not systematic.

A policy model based on an algebraic equation allows no scope for discretion, and takes no account of special factors such as shocks that may temporarily impact on the Fed's decisions. The models described in this book are not all encompassing of factors that influence economic growth and inflation in the United States, such as the dollar exchange rate and the fiscal policy stance. However, the model assumes that rates are set using observed economic data so that under normal conditions, the Fed's longer term outlook for growth and inflation does not impact on their decision making. For example, monetary policy has little scope to deal with inflation induced by higher oil prices. This is because inflation associated with rising oil prices is not induced by excess demand. Therefore, higher interest rates will do little to curb the inflation but may only lead to slower growth. Moreover, the Fed may decide that an oil price shock is only temporary and will not impact on longer term inflation. Hence the common resort to 'core' inflation levels that exclude volatile factors such as energy and food, from the inflation measure.

As the Fed has no explicit numerical objectives such as a set inflation target, model derivation requires an assessment of the correlation between the FFR and economic conditions over a long period of time in order to build a model, along with taking inferences regarding the constants in the model. This is because of the unobservable elements in the model, such as the long term average natural real interest rate, the level of potential output and the Fed's inflation target. The models are also based on the observed behaviour of inflation and the output gap.

A basic assumption underlying the models presented here is that inflation in the US economy is non-monetary. That is, there is no connection between the money supply and the price level. Although this assumption is open to controversy, it is also true that the correlation between money supply and prices has broken down in recent years, and the Fed undoubtedly pays less attention to the issue of money aggregates and growth rates.

Figure 1.1 plots M2 money supply growth against consumer price index (CPI) inflation for the years 1970 to 2002. Typically, higher

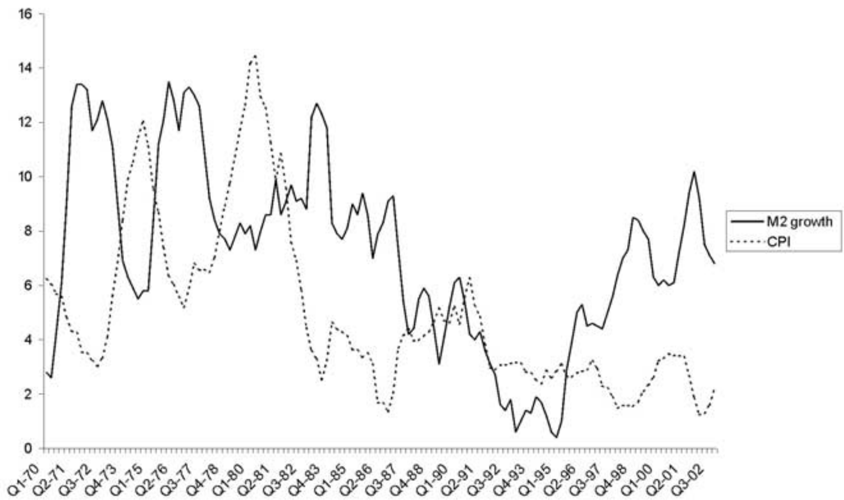

Figure 1.1 M2 money supply growth (y/y) and CPI inflation (y/y)

money supply growth has been associated with higher inflation, but since the early 1980s the relationship has broken down, as financial innovation has distorted the factors that determine the money supply. This change supports the assertion that inflation rates in the United States are now largely independent of the money supply, and so the latter need not be considered in the formulation of monetary policy models.

The models also assume that factors that create inflation in the United States are exogenous to the Fed, in that the central bank plays no role in actually creating inflation. It only responds when inflation reaches, or threatens to reach, undesirable levels.

THE TAYLOR RULE

Fed staff regularly prepare Taylor models for the FOMC.

(*Wall Street Journal Europe*, 7 February 2000)

John Taylor was an economist at Stanford University in the United States when he presented his now famous ‘Taylor rule’ in 1993. He went on to become an advisor to Bob Dole, the Republican Party’s presidential candidate in 1996, and has more recently been cited as a possible successor to Alan Greenspan as chairman of the Fed.

The Taylor rule is a monetary policy model that describes the optimal short term interest rate (FFR) that should be set by the Fed's FOMC at its regular policy meetings. The strength and attraction of the model lies in its simplicity, and in the accuracy it has displayed in explaining movements in the FFR over the period, 1987–92, analysed by Taylor. Indeed, by the mid-1990s the model had gained legitimacy within the Fed itself. Although it has never been explicitly adopted as a strict guide to policy decision making within the bank, it has nevertheless continued to perform well in describing trends in the FFR since its introduction.

Its acceptance within the Fed as a valid and potentially useful mathematical description of movements in the FFR was highlighted by comments made by Fed governor, Janet Yellen, in March 1996. She said that the Taylor rule should give the Fed 'credibility in the public's mind for its anti-inflationary resolve ... and could help the Fed communicate to the public the rationale behind policy moves'. Furthermore, she described the Taylor rule as 'a positive description of how policy actually has been conducted over the past decade or so'.

The Taylor rule says that the FFR should be set according to the deviation of inflation from the Fed's 'target' rate, and gross domestic product (GDP) from its trend level. The Fed's inflation target was assumed by Taylor to be 2 per cent, while trend GDP growth was set at around 3 per cent. The model explains how the GDP growth rate and the rate of inflation are the primary determinants of Fed policy changes, and that interest rates are adjusted as these two economic indicators diverge from their trend and target levels.

Significantly, the Taylor rule assumes that Fed monetary policy is essentially reactive rather than proactive, in that it responds only to the quarterly GDP data available to the Fed at each FOMC meeting. Taylor himself used final estimates of GDP and inflation for the current quarter. This data however is not available to the FOMC at the time of each meeting.

The Taylor rule equation

Equation 1.1:

$$\text{Taylor rule } \% = \text{i} + \text{inflation}^* + 0.5 \times (\text{inflation gap}) + 0.5 \times (\text{output gap})$$

i = natural real interest rate
inflation* = actual or expected inflation
inflation gap = actual inflation – Fed inflation 'target'
output gap = actual GDP – trend GDP.

Equation 1.1 becomes:

Equation 1.2:

$$\text{FFR}\% = 2\% + \text{GDP def} + 0.5 \times (\text{GDP def} - 2\%) + 0.5 \times (\text{GDP} - 3\%)$$

As Equation 1.2 shows, Taylor used the GDP deflator as the chosen level of actual inflation, with all data being based on year-on-year growth rates. The GDP deflator was assumed to give a more accurate representation of inflationary pressures in the economy. The coefficients of 0.5 assume that the Fed places equal importance on changes in the inflation gap as it does on changes in the output gap.

The first term in the equation is the long term average 'natural real interest rate' which was set at a constant of 2 per cent.

The model dictates that if inflation is on target and GDP is at its trend level, the prevailing FFR should be 4 per cent. The rate should be raised (lowered) by 1.5 percentage points for every percentage point inflation is above (below) its target of 2 per cent. Meanwhile, the rate should be raised (lowered) by 0.5 percentage points for every percentage point GDP growth is above (below) its trend level.

The model highlights how the Fed places more emphasis on observed movements in the inflation rate than changes in the growth rate of GDP. Higher interest rates will then control inflation via its impact on the cost of credit and borrowing for businesses and households, which in turn affects spending and investment. Higher interest rates may also strengthen the dollar, which will further subdue inflationary pressures. The model's dependence on only two economic variables – inflation and GDP – assumes that all other indicators that

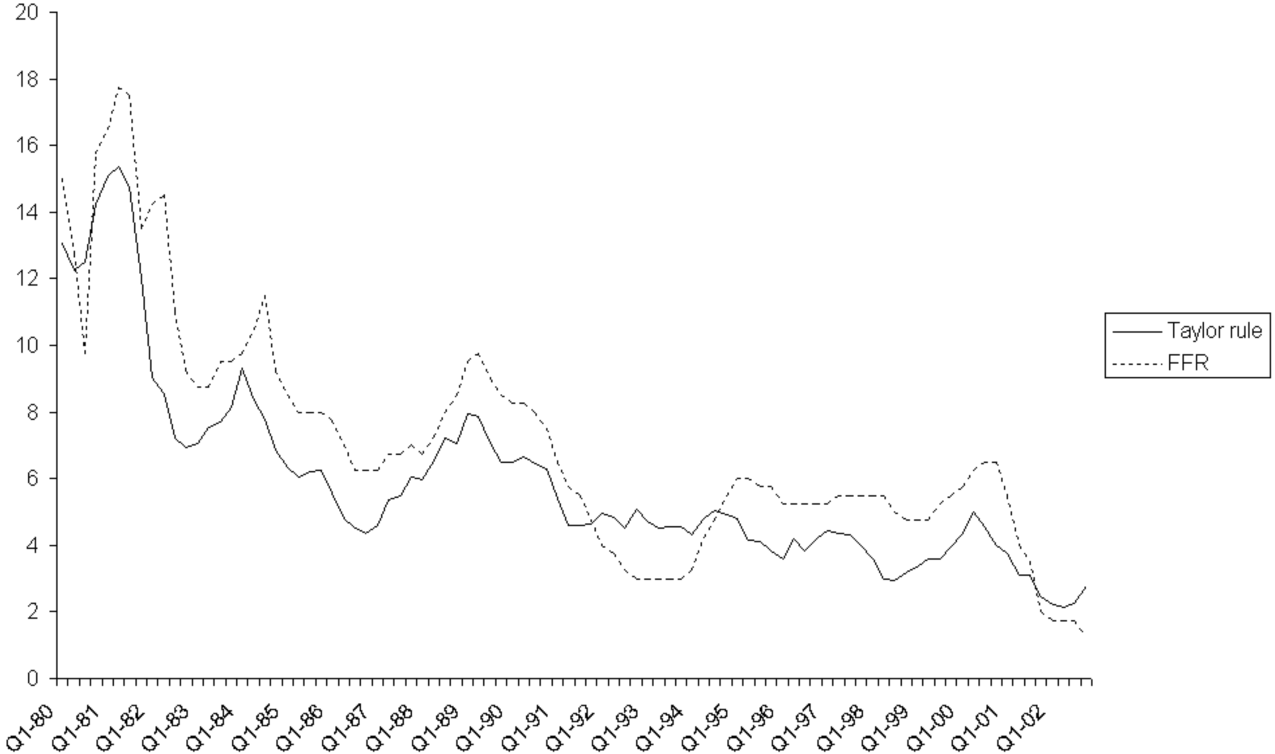

Figure 1.2 The Taylor rule 1980–2002 based on quarterly data

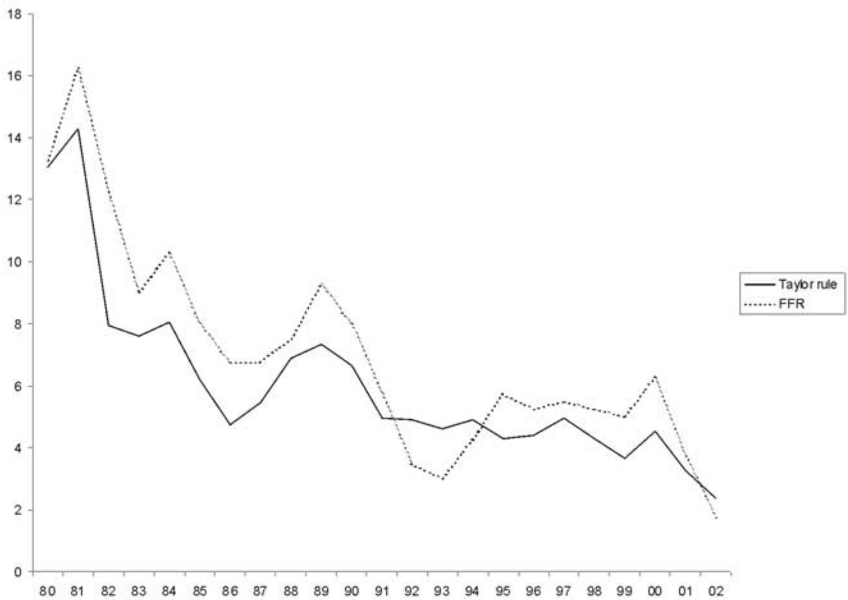

Figure 1.3 The Taylor rule 1970–2002 based on annual data

influence growth and prices are reflected in full in the quarter's GDP and GDP deflator.

The version of the Taylor rule applied in this chapter has consistently underestimated the actual FFR since 1980, with the exception of the period from 1992–5. However, it has been successful in tracking variations in the FFR over the period, which strongly suggests that Fed policy decisions are based, to a large extent, on the concept and consideration of monetary policy models.

The natural real interest rate

A controversial component of the Taylor rule is the 'natural real interest rate' term. Taylor set this as a constant at 2 per cent – the rate assumed to be compatible with trend growth and an inflation rate on 'target'. The natural real interest rate is equivalent to the equilibrium interest rate for the economy, the real interest rate at which monetary policy is neutral – neither too easy or too tight. The model says that when inflation is on target and GDP at trend, the FFR should be set to equal per cent – the natural real interest rate plus inflation (2 per cent). The assumption of a constant natural interest rate is a potential source of error in the Taylor rule.

The level of the real FFR relative to the natural real interest rate determines whether the chosen FFR by the Fed is easy or tight. If the real FFR is below the natural rate then this means policy is more expansionary. If it is above the natural rate, then it is tight or restrictive. Factors that can affect the natural rate include rising or falling productivity, inflation or financial shocks.

Trend GDP

A trend GDP growth rate of 3 per cent approximates to the average annual rate over the past two decades or so. If growth exceeds this level it is assumed to be potentially inflationary, and so requires an increase in the FFR. The difference between the trend level and actual GDP is closely related to the concept of the 'output gap'.

The output gap is the difference between actual GDP and the potential level of GDP. The gap measures the amount of excess productive capacity in the economy. GDP typically falls below potential during recessions and above during expansions. If the gap is positive and GDP is above trend, the economy is operating above capacity. In this case, inflationary pressures will be generated, as a strain is put on existing labour and capital resources, and the economy reaches the limits of its productive capacity.

Typically, higher growth leads to lower unemployment and an increase in wage levels, which tends to impact directly on inflation. A negative output gap indicates the economy is operating below capacity.

Trend GDP is sometimes also referred to as 'potential output' although, strictly speaking, the two are defined differently and are not necessarily equal. More formally, potential GDP is the annual GDP growth rate consistent with a stable inflation rate. Trend GDP is often used as a proxy for potential GDP simply because the latter is an unobservable measure.

The inflation target

The Taylor rule assumes the Fed has an inflation target of 2 per cent. This assumption is not based on any formal mandate of the Fed, nor on any explicit policy directive or pronouncement. Rather, it is inferred from actual Fed policy behaviour and Fed reaction to inflation levels above 2 per cent towards the late 1980s. This figure has also been the subject of some debate among economists, as the Fed has never had an explicit inflation target in its directive from the government. The assumption was based on a perception that Fed concern over rising price pressures became more vociferous when inflation rose above 2 per cent, and tended to relax if inflation fell towards 2 per cent or less.

EXPLAINING DEVIATIONS IN THE TAYLOR RULE FROM THE ACTUAL FFR

If the Taylor rule performed relatively poorly during the 1970s, is this a reflection of the shortcomings of the model, or a reflection of the failure of monetary policy during that period? The rule certainly implies that the Fed should have raised the FFR much more aggressively to contain rampant inflation during the decade. It was only after around 1980 that the Fed begun consistently raising the FFR on a greater than one-to-one basis with increases in the inflation rate, as the model dictates. There is certainly little disagreement among economists and policy commentators that monetary (and economic) policy during the 1970s was unsuccessful, especially in containing inflation and managing periods of recession. Since the 1980s the Taylor rule has tended to reflect changes in the FFR rather than accurately describe the actual FFR. This part of the chapter analyses some of the reasons why the Taylor rule has sometimes failed to fully explain the FFR.

The model is too simplistic

Is it realistic to assume that the Fed only reacts to quarterly GDP and inflation data? Throughout any particular quarter numerous economic data are released that indicate the prevailing economic conditions in the United States. Figures such as retail sales, non-farm payrolls, business surveys and industrial production all attract the attention of the financial markets, and are watched as an indicator of future monetary policy. Indeed, the Fed itself often refers to these and various other economic indicators in its FOMC meeting minutes and policy statements.

However, the Fed rarely responds to an individual monthly statistic, but more often responds to a succession of data releases that, taken together, indicate the direction of the economy. A breakdown of GDP growth and inflation data (see Table 1.1) shows that changes in monthly economic indicators are largely reflected in the GDP report published after the end of the quarter. Furthermore, the Fed almost certainly attaches more importance to the GDP report than it does to other indicators, and so the latest report will have a greater influence on the FOMC at its policy meetings than other indicators. The systematic application of the Taylor rule takes no account of periods when Fed policy has become highly discretionary, such as the banking crisis of the early 1990s. In such cases, the Fed may attach greater importance to political or financial factors than prevailing economic conditions.

Inflation does not respond to a change in the FFR

Rising GDP is typically associated with higher inflation and vice versa. If GDP is above its trend, or its potential, then price pressures increase as a result of capacity constraints within the economy, as demand outstrips supply. Manufacturers and producers are less able to meet demand, so prices tend to increase. As this happens, wage claims tend to rise, forcing firms to raise prices still further to meet these extra costs. This demand-induced type of inflation can be alleviated by higher interest rates described by the Taylor rule. However, during periods of stagflation seen in the 1970s higher inflation was associated with slower, not stronger, economic growth.

This so-called cost–push inflation typically occurs during periods when GDP growth is below its trend, or potential, level, and is usually caused by factors that do not respond to higher interest rates, such as rising oil prices. If the economy is already in recession, higher interest rates may only exacerbate and prolong the slowdown. A lower FFR may help alleviate the recession but will add to inflationary pressures in the economy. In this case the Taylor rule is much less effective in describing an appropriate policy stance, as Fed action is more prone to a discretionary approach. During the 1970s and early 1980s, periods of high inflation were blamed on a sharp rise in oil and food prices, and excessive wage claims among US workers. This cost-push inflation shows less response to higher interest rates, and usually requires government intervention to remove its underlying causes.

Taylor observed that the persistent high inflation seen during the 1970s was largely due to an inadequate Fed response to rising inflation. His view was that much of the inflation seen during that decade has been blamed not only on rising oil prices but also on monetary policy mistakes committed in the late 1960s and early 1970s. Taylor claimed his rule might have avoided the inflation of the 1970s. In recent years this type of inflation that characterized the 1970s has seldom been seen.

Trend GDP is inaccurate or not constant

Taylor took trend GDP to be a constant at about 3 per cent in his model, and assumed that GDP growth above this would stoke inflation. In reality this figure is rarely constant, as economic factors such as productivity growth and structural changes in the labour market come into play to influence the maximum GDP growth obtainable without increasing inflation. During the late 1990s it did appear as though higher growth could be achieved without provoking the kind of inflation rates historically associated with GDP growth rates above 4 per cent. Higher productivity levels in the late 1990s contributed to views that the economy had entered a 'new paradigm' era of low inflation. The IT revolution, low oil prices and a moderation in wage demands, despite falling unemployment, all contributed to keeping inflation under control. As a result, it appeared that the US economy could grow at a rate in excess of 3 per cent per annum without an increase in inflation. However, Fed scepticism about the possibility of a new economy environment prevented excessive rate cutting in anticipation that inflation would eventually begin to rise.

Nevertheless, what matters above all else is the Fed's estimate of potential GDP. Because the figure is unobservable, estimates vary widely, and the Fed itself does not appear to attach weight to the proposal of the trend GDP rate of 3 per cent closely approximating the potential GDP rate for the US economy. During the 1970s, the Fed and US government were being accused of consistently overestimating the level of potential GDP growth. As a result, interest rates were often lower than was appropriate, and this contributed to higher inflation.

The Federal Reserve's inflation 'target' is not constant

Like the natural real interest rate, the Taylor rule assumes that the Fed's inflation target is a constant at 2 per cent. While there is empirical evidence the Fed has reacted more aggressively when the inflation rate exceeds 2 per cent, it is unlikely that this response has been consistent over the past few decades.

During periods of very high inflation seen during the 1970s, an inflation rate of 2 per cent would have been seen more as a policy nirvana than as an achievable target. Furthermore, during periods of economic turmoil, the Fed may temporarily abandon any inflation target, giving precedence to other economic factors. Examples include the stock market crash of 1987, the credit crunch of the early 1990s, the Asian and Russian economic crises of 1998, and September 11 2001. During recessions or periods of negative GDP growth, Fed policy may become more discretionary in an attempt to boost economic growth.

The natural real interest rate is not constant

The assumption of a 2 per cent natural real interest rate underpins the Taylor rule. However, short term shocks to inflation mean this rate is also unlikely to remain constant. This makes the rule prone to temporary inaccuracies during periods when the inflation rate has changed rapidly, such as oil price changes or a fall in the value of the dollar. The concept of a natural real interest rate implies that the economy ultimately responds to real interest rate levels – the inflation adjusted FFR.

The Fed acts pre-emptively or with policy inertia

The Taylor rule states that Fed monetary policy should respond only to current inflation and GDP data, and not to other factors that may impact directly on the economy. It also assumes that the Fed acts immediately in response to changing economic conditions by responding to current data. However, historical evidence suggests the Fed can act pre-emptively in expectations of future economic conditions by, for example, raising the FFR in anticipation of higher inflation in the future.

Alternatively, the Fed may display policy inertia whereby changes in the FFR are imposed only gradually over more than one FOMC policy meeting. The Fed may also believe that changes in GDP or inflation that would usually warrant an adjustment in the FFR may only be temporary, and so decide not to adjust the FFR at all. Fed pre-emptive action and policy inertia are discussed in more detail in Chapter 3.

VARIATIONS ON THE TAYLOR RULE USING OTHER DATA

The original Taylor rule has often been subject to modification, to include different variables such as lagged GDP and inflation values, alternative measures of inflation, and perhaps most commonly, expected inflation.

The rationale behind using expected inflation is that when the Fed sets a particular FFR rate, it is the real interest rate – the FFR adjusted for inflation, as opposed to the nominal – that impacts on the economy. For example, spending and investment decisions made by firms and businesses today may be influenced if inflation is expected to rise or fall significantly in the coming months. This is because higher inflation, for example, will erode the future value of capital purchased today, thereby reducing returns and providing a disincentive to invest. At the same time, for borrowers, if inflation is expected to rise over the lifetime of the loan then the real interest rate will necessarily fall, making for cheaper borrowing. Perhaps most significantly of all, a rise in expected inflation tends to lead to workers demanding higher wages. This can contribute to higher inflation in the near term. Consequently, expectations of future inflation rates may be more relevant than consideration of the prevailing inflation rate.

Because of its influence on short term economic conditions and inflation trends, expected inflation has been seen as a more valid measure of inflationary pressures in the US economy, and has consequently been incorporated into the Taylor rule. However, expected inflation is difficult to measure, and survey results taken from consumers and businesses may differ. Figure 1.4 plots the Taylor rule that uses one recognized measure of expected inflation – the University of Michigan's quarterly survey of consumer's price expectations of changes in the CPI measure of inflation over the coming 12 months. Even allowing for the use of a CPI rather than a GDP deflator measure of inflation, the short term volatility of inflation expectations means the implied FFR derived from the rule is unreliable in describing the actual FFR.

There is no doubt that the concept of expected inflation had some application for monetary models in the early 1980s, when fears of high inflation persisted, as the high inflation levels of the 1970s were still comparatively recent. However, the performance of the Fed during the 1990s and the surge in confidence in the Fed's ability to control inflation mean that survey data of expected inflation is beginning to converge with current inflation rates. Consequently, the application of an expected inflation variable to the model adds little to the accuracy of its FFR derivations.

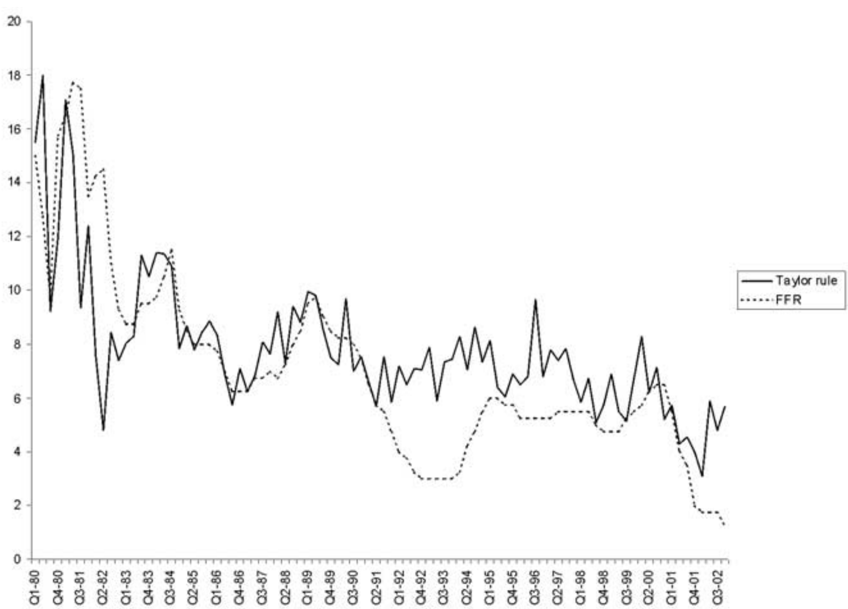

Figure 1.4 Taylor rule using expected inflation 1980–2002 using quarterly data

The Taylor rule using the CPI inflation measure actually results in an improved performance when compared with the rule using the GDP deflator. However, CPI inflation is prone to volatility in energy and food prices, which leads to periods when the Taylor rule deviates significantly from the FFR, as it did in 1987 and 1999. (See Figure 1.5.)

Using 'headline' or annualized GDP and GDP deflator data produces an excessively volatile Taylor rule. This is because the annualized measure is an estimation of the annual rate for each quarter. (See Figure 1.6.)

DISCRETION VERSUS RULES BASED MONETARY POLICY

Monetary policy rules make rate changes more predictable and therefore more effective and the decision-making process more transparent. It also increases the accountability of the Fed and makes the Fed less

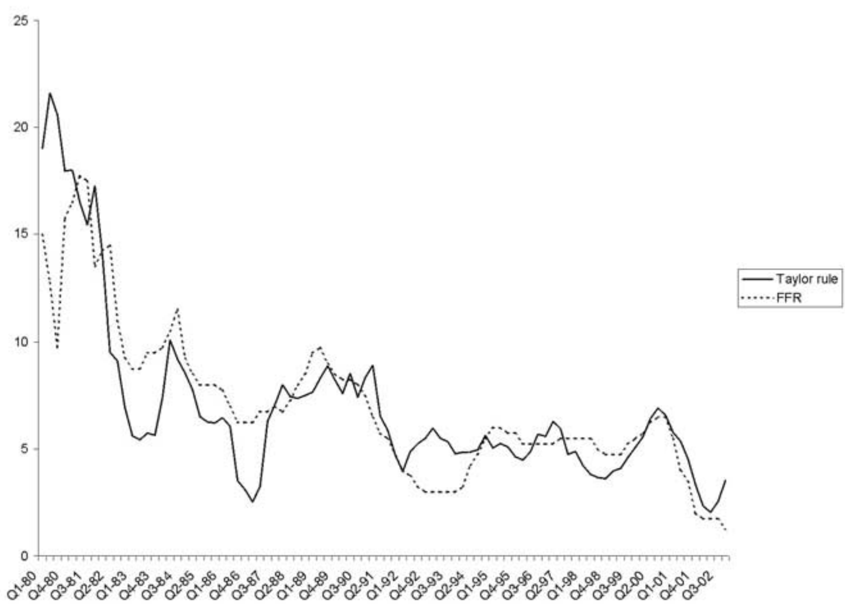

Figure 1.5 Taylor rule using CPI inflation 1980–2002 using quarterly data

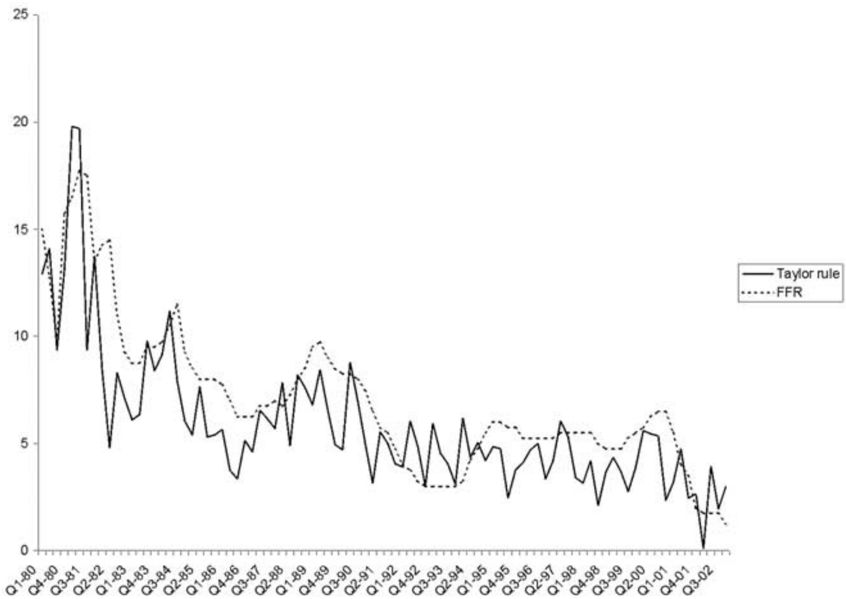

Figure 1.6 Taylor rule using annualized GDP data 1980–2002 using quarterly data

susceptible to outside pressure, either political or from the markets. A discretionary policy approach assumes that the Fed's decision at each FOMC meeting is based on a more subjective assessment of all economic factors.

After the end of the gold standard and Bretton Woods and the subsequent floating of the US dollar in 1973, US monetary policy effectively became discretionary for the first time. Bretton Woods acted, in effect, like a monetary policy rule in that the dollar, and therefore the money supply, was tied to the gold standard. Although a discretionary policy approach offers the Fed greater flexibility in dealing with unexpected shocks to the economy, it also allows far greater room for policy errors. Today, the Fed can be assumed to use a combination of discretion and the policy rules approach.

The concept of an inflation target is closely linked with monetary policy rules. However, it remains something of an irony that although the Fed is associated with using policy rules, it still does not have an explicit inflation objective, even though the use of Taylor-type rules requires the adoption of an inflation target. Consequently, Fed watchers have to infer this target from Fed statements and behaviour. Conversely, other central banks such as the European Central Bank (ECB) and Bank of England have explicit inflation targets but their policy decisions are perhaps considered to be more discretionary in nature. The adoption of an explicit inflation target helps reduce inflation expectations (ideally to the same level as the target rate itself), and can greatly enhance the credibility of a central bank if it establishes a record of consistently meeting the target.

As such, it remains something of a dichotomy that the Fed has shown little willingness to adopt a target.

Needless to say, when Fed decision making becomes more discretionary, monetary policy rules perform less well in describing movements in the FFR.

However even Taylor himself did not advocate the exclusive adoption of a policy rules approach and recognized the importance of discretion in the decision-making process. Otherwise, the FOMC would be redundant and monetary policy could just as effectively be set by computer.

It appears the Fed attaches great importance to the ability to disregard policy rules, and monetary policy rules of the Taylor-type variety are also highly dependent on the measure of inflation used. There needs to be a consistent view on the appropriate measure to use. Many FOMC members have commented that most of the inflation measures published on the US economy overstate actual or 'true' inflation by as much as two percentage points. Consequently, monetary policy could be persistently too tightly based on a model using these measures. As a result, economic growth would be stifled unnecessarily.

DATA USED IN MONETARY POLICY MODELS

The performance of any monetary policy model is largely dependent on the type and quality of data used in its calculation. As explained, all models in this book use the year-on-year real GDP growth rate and the year-on-year GDP deflator growth rate as the measure of inflation. For quarterly data, this is the rate of growth on the same quarter a year ago. For annual data, it is the rate of growth over the previous year.

All GDP data is released in the *Survey of Current Business* published quarterly by the US Department of Commerce. The 'advance' estimate is released around three weeks after the end of the quarter. This is followed by two revisions – the 'preliminary' and 'final' estimates – released one month apart. The headline figure familiar to the financial markets is the quarterly 'annualized' measure. This differs from the annual measure in that it is the percentage change on the previous quarter multiplied by four, which creates an implied annual rate. The annual growth rate can, however, also be found in the GDP report.

The inflation measure is the chain-weighted GDP price deflator also published with the GDP report. This again differs from the headline deflator rate typically used by the market, in that it is the percentage change on the same quarter one year ago. Monetary policy models based on the 'headline' GDP and GDP deflator rates tend to produce excessively volatile results that provide little guidance on the FFR.

The most closely watched measure of US inflation by the financial markets is the consumer price index (CPI). The CPI measure is typically higher than the GDP deflator, and Alan Greenspan himself has estimated that the headline measure overstates 'actual' inflation by between 0.5–1.0 per cent.

Gross domestic product (GDP)

GDP is a measure of economic activity in goods and services, and is the most comprehensive measure of growth in the US economy. Factors such as consumer spending, business investment and government spending are all incorporated in the report. After 1992, the GDP measure replaced the gross national product (GNP) measure of economic output. As GDP covers goods and services produced within the United States, it was viewed as a better reflection of economic conditions.

GNP was used in the original Taylor model, but the difference between the two measures is small. Like the headline GDP figure, all measures of GDP used in this book are 'real' measures – that is, they are adjusted for inflation.

The construction and comparison of monetary policy models using historic GDP and GDP deflator data is susceptible to changes in methodology and to revisions. As such, *ex-post* revised GDP data for a particular period will differ from the same figure that was published at the time. Not only are GDP measures periodically re-based to a new year (for example, from 1992 = 100 to 1996 = 100), all figures are subject to a three-yearly revision that takes account of changes in measurement methodology. Furthermore, until 1996, a fixed weight constant-dollar measure was used instead of a chain-weighted index for GDP and the deflator used now. This adjustment tended to lower the overall published GDP growth rates, by eliminating the overstatement of GDP for periods after the base year, and the understatement of GDP for periods before the base year.

Why use the GDP deflator inflation measure?

In spite of a reliance of the Taylor rule on the GDP deflator measure of inflation, it will often prove to be a less convenient figure than the CPI inflation index, which is the headline US inflation figure most familiar to the financial markets. The GDP deflator provides a broader measure of prices in the US economy than the headline CPI measure of inflation. CPI measures the average change in prices of goods and services purchased by households, whereas the GDP deflator measure covers the prices of goods and services paid by all components of the GDP report itself, such as consumers, businesses and the government. The value of a broader inflation measure in conducting monetary policy was acknowledged by the Fed itself, which adopted the quarterly personal consumption expenditure (PCE) measure as its preferred indicator of underlying inflation in the US economy. The Fed has stated that the PCE measure better reflects the changing composition of expenditure. Since February 2000, the Fed has been using the PCE chain-type price index measure in its semi-annual economic projections.

Table 1.1 Components of gross domestic product (GDP) for 2000

Component	*% of total*
Personal consumption expenditures:	
Durable goods: motor vehicles and parts, furniture and household equipment	
Non durable goods: food, clothing, energy	
Services: housing, utilities, transportation, medical, recreation	56 %
Gross private domestic investment:	
Fixed investment: construction, utilities, industrial and transport, computers	
Private inventories: farm, construction, manufacturing, wholesale, retail	21 %
Net exports of goods and services:	
Food, energy, autos, consumer goods	14 %
Government consumption expenditures and gross investment:	
Federal defence and non-defence	
State and local	9 %

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CHAPTER 2

Monetary Policy at the US Federal Reserve

INTRODUCTION

The Fed describes monetary policy as 'actions undertaken ... to influence the availability and cost of money and credit to help promote national economic goals'. The Federal Reserve Act specifies that in conducting monetary policy, the Federal Open Market Committee (FOMC) should seek 'to promote effectively the goals of maximum employment, stable prices, and moderate long term interest rates'.

The Fed controls the three main tools of monetary policy: open market operations (the FFR), the discount rate, and reserve requirements. This book examines only the FFR, which is influenced by open market operations, the buying and selling of securities, which is the Fed's primary instrument for controlling monetary policy. The FOMC is responsible for open market operations and setting the FFR. The committee comprises 12 voting members and meets at eight scheduled meetings a year. The FFR is the interest rate at which depository institutions (banks) lend balances at the Fed to each other overnight. Changes in the FFR in turn affect other interest rates, both long and short term, such as government and corporate bonds, mortgage and credit rates. The exchange rate of the dollar is also sensitive to changes in the FFR. Using this rate, the Fed can affect the price of money and credit. In this way it influences employment, output and inflation.

Strictly speaking, the Fed's mandate of 'price stability' is a misnomer. Price stability means, by definition, zero inflation. Also, the mandate does not specify which inflation measure should be targeted. In reality, the Fed looks to achieve *inflation* stability using an inflation measure that it considers to best represent price movements across the economy.

In February 2000, the Fed ostensibly signalled a preference for the Commerce Department's Personal Consumption Expenditure (PCE) price index as its chosen inflation measure. It is released along with the quarterly GDP report and covers spending on finished goods and services across the economy. The PCE price index is typically lower than the CPI and is more closely related to the GDP deflator. The Fed stated that the index more closely reflects changing spending patterns of consumers, avoiding the upward bias that has attracted critisicm of the CPI measure that was formerly used by the Fed.

The Fed's 'dual mandate' means it exercises some degree of trade-off between inflation and economic growth.

Moreover, the Fed adopts a symmetrical inflation target, a factor that has become more obvious during the recent threat of deflation.

THE HISTORY OF FED POLICY SINCE 1970

This chapter presents a history of Fed practices and monetary policy since 1970. It is designed to illustrate the factors that have influenced policy behaviour and how policy procedure has evolved towards the adoption of the FFR as the primary target, an important factor in the validity of interest rate based policy models discussed here.

Federal Reserve monetary policy since 1970

The performance of any monetary policy model designed for the US economy needs to be considered in the context of the Federal Reserve's changing approach to control of monetary policy. The shifts in the Fed's priorities, along with changes in policy instruments and targets adopted by the bank, have implications for the validity and performance of models, and these are discussed in this chapter.

The history of Fed policy since 1970 can be divided into three periods coinciding with the terms of the respective Fed chairmen since then: Alan Burns, Paul Volcker and Alan Greenspan. (The chairmanship of G. William Miller from January 1978 to August 1979 is not considered separately.) Each period is characterized by different approaches in dealing with the inflation, and can, in essence, be viewed as a learning curve for the Fed, which faced the challenges of rampant inflation during the 1970s after the relative stability of the previous decades.

The role of central banks across the world also changed as monetary authorities gained experience in dealing with long term inflation levels not witnessed in recent history. Also of consideration is how the Fed has dealt with adverse economic circumstances that have prevailed since 1970, such as wars, oil crises and periods of recession. This has implications for the performance of monetary policy models and how they might perform during similar periods of economic activity. What follows is an overview of Fed policy in dealing with inflation since 1970.

Arthur Burns, 1970–8

Arthur Burns took over the chairmanship of the Fed in 1970, the beginning of a decade that is often considered to be a period of poor monetary policy performance by the Fed. Persistently high inflation, often into double figures, and two deep recessions led to the coining of the term ‘stagflation’. This is a situation that seemingly confounds the economic rules inherent in monetary policy models – that inflation and GDP growth tend to move in the same direction. Stronger GDP growth typically leads to inflationary pressures while weaker growth generally means inflation tends to decline. With stagflation, a central bank faces a dilemma. Should it raise rates to quell inflation or lower rates in an effort to bring the economy out of recession? In these circumstances the application of monetary policy models such as the Taylor rule will provide little guidance. The appropriate policy for the Fed to pursue is largely dependent on its preferred objectives at the time. With high unemployment rates, considerations of economic stability will have some impact on the bank’s decision.

In fact, the Taylor rule will always attach more importance to inflation than GDP growth because of the specification of the model. This could mean very high interest rates when the economy is in a slump, or very low rates when the economy is already overheating.

Fortunately, stagflation is a rare phenomenon and the Fed has not had to deal again with the extreme circumstances seen in the mid-1970s. What is more, pre-emptive action by the Fed is now more likely to prevent periods of stagflation or deflation taking hold in the first place.

However, it highlights the kind of dilemmas that may face the Fed, or any central bank, when needing to balance the need to fight inflation and support economic growth. Contrary to widespread opinion, Fed monetary policy is not designed solely in the pursuit of price stability. Economic growth will always be a factor in decision making, not least because of the impact growth itself has on future inflation levels. Moreover the Fed, despite its relative independence, is still, to some extent, a political body, whose members, and mandate, are appointed by the White House. The occasional need for a purely discretional approach to policy necessarily means that monetary policy models are always prone to underperform. Circumstances when this has arisen are discussed in this half of the chapter.

Figure 2.1 illustrates the change in the Fed's response to inflation (GDP deflator) after 1970. Until about 1980, the inflation rate remained almost exclusively above the FFR, even when facing periods

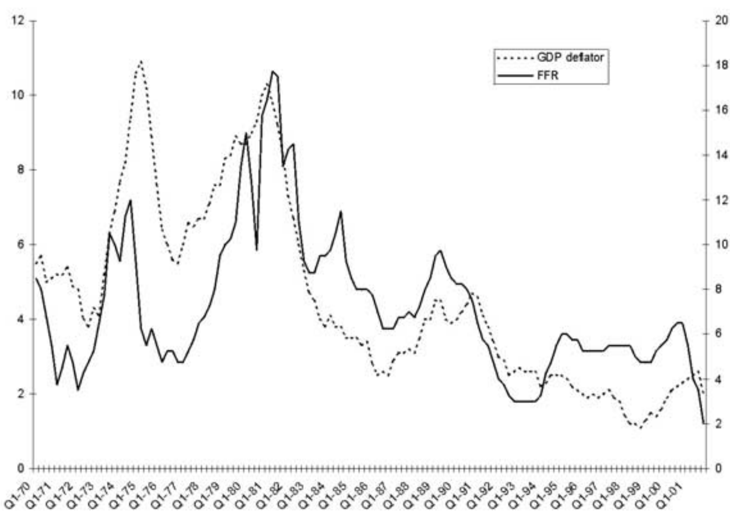

Figure 2.1 The GDP deflator and the FFR 1970–2002

of strong GDP growth such as 1973–4 and 1977–9. In retrospect, it appears the Fed did not set the FFR high enough to bring inflation under control even when it had the opportunity to do so. Based on the Taylor rule, interest rates should have risen at least 1.5 percentage points for each percentage point increase in inflation, assuming rate changes were timed correctly. The apparent failure of the Fed to raise the rates more aggressively during periods of both high inflation and GDP growth meant inflation persisted, especially when exacerbated by inflation shocks such as higher oil and food prices.

The relative success of monetary policy during the Greenspan era is highlighted by the continual decline of inflation after the Gulf War, which produced a temporary rise in inflation as a result of higher oil prices. Only the boom of the late 1990s saw a significant rise in inflationary pressure, which prompted a sharp rise in the FFR. By the end of 2001 inflation has already begun to decline again, indicating that the Fed had managed to quell a sustained rise in inflation.

Under chairman Arthur Burns the Fed followed what can be described as an 'activist' monetary policy. By the early 1970s, the concept of potential output had become popular with government policy makers, and along with it the belief that the output gap could be manipulated to achieve a lower inflation rate. However, Fed and government economists commonly considered potential GDP growth to be as high as 4 per cent, and that inflation would not persist at growth rates below this level. In hindsight, this rate is now considered too optimistic and accounts for the Fed's failure to raise FFR sufficiently to dampen inflation. This also contributed to the boom and bust path of monetary policy followed throughout the decade, which paid less attention to stabilizing growth and inflation, and more to responding to sharp changes in the output gap.

The notion of potential output was closely linked to a natural rate of unemployment – the rate of unemployment consistent with a stable inflation rate. The oil crisis of the early 1970s also coincided with government efforts to bring unemployment down to its natural rate, considered to be around 4 per cent. With central bank control of monetary policy being still very much in its infancy in the early 1970s, Keynesian-style demand management policies still dominated much official economic thinking, which saw the government take a role in attempting to control inflation and inflation expectations. Such action included the Nixon administration's price and wage controls introduced in 1971.

The view was that control of cost factors that may contribute to higher inflation, such as wage levels, would alone be enough to lower inflation. The Philips curve that came to prominence during the 1960s supported the idea that control of labour market wage pressures would bring inflation under control. However after 1971 inflation continued to rise even after taking into account the higher food and energy prices that characterized the decade.

The Fed's activist and discretionary policy approach practised during the 1970s accounts for much of the failure of the Taylor rule and other monetary policy models to describe movements in the FFR throughout the decade. Arthur Burns saw inflation as being primarily cost-push in nature, as well as being strongly influenced by consumer and business expectations of future inflation rates. Cost-push inflation is typically caused by expansionary fiscal policies, increases in wage levels and higher oil and food prices, and is generally less responsive to changes in interest rates. Consequently, rises in the FFR used to reduce cost-push inflation in the 1970s merely led to slower growth and higher unemployment, whereas government intervention would have been more effective in eradicating many of the causes of inflation.

Paul Volcker, 1979–87

Paul Volcker was elected chairman of the Federal Reserve in August 1979 and soon gained a reputation for being staunchly anti-inflationary. Volcker's appointment led to a distinct change in the Fed's approach in dealing with inflation. He abandoned activist policies in favour of a more single-minded approach dedicated to controlling inflation, even at the cost of economic growth and higher unemployment. This approach ultimately contributed to the recessions of 1981 and 1982. In effect, Volcker ignored the size of the output gap until inflation fell to more acceptable levels. As a result of this aggressive anti-inflation policy, inflation fell sharply by the mid-1980s, from 9 per cent to 3 per cent, after the Fed raised rates sharply to 20 per cent in March 1980, in part to reverse the policy mistakes made during the late 1970s. During Volcker's term the applicability of the Taylor type policy rules to monetary policy began to take shape as the FFR remained consistently above the inflation rate, being raised on a greater than one-to-one basis with increases in the inflation rate. What is more, Volcker also placed greater emphasis on the stabilization of inflation and growth than had been considered in the previous decade.

Volcker's anti-activist policy approach meant the Fed ceased responding to short term deviations in the output gap. By the early 1980s, although interest rates were being raised more aggressively, Volcker wished to see monetary policy conducted in a more systematic fashion and be less prone to errors of judgement. This provided the basis for Taylor's rule. Crucially, the Fed had sole responsibility for inflation control – a prerequisite for the Taylor rule. By 1985 inflation had fallen to its lowest level in more than a decade. More importantly, inflation continued to decline and remained at a lower level than that seen during the whole of the previous decade. This led to reduced expectations of inflation, which also contributed to reducing the inflation premium built into wage settlements and long term interest rates.

Alan Greenspan, 1987–present

The years following the appointment of Alan Greenspan as Fed chairman are generally seen as being the most successful for monetary policy control of inflation. Greenspan's chairmanship has been characterized by a continued period of relatively low inflation. This in turn has led to the lowest interest rates seen for more than 30 years. It has had the effect of further reducing inflation expectations amongst business and consumers. This has helped to break the vicious circle of higher prices and wages to compensate for expectations of higher inflation. This has played a large part in the Fed's ability to keep interest rates low, and so has greatly enhanced the credibility of the Fed. Greenspan has also placed greater emphasis on stability, not only of inflation and growth, but also of interest rate levels themselves. He has also attached more importance to the stability of financial markets than previous chairmen, especially with regard to the impact that interest rate volatility could have on the value of the dollar. Relative dollar stability during the 1990s also made inflation control and forecasting easier. Confidence in the Fed to control inflation has, in itself, contributed to containing price pressures. This has been a major achievement of Alan Greenspan's reign.

Greenspan's appointment also coincided with Taylor's analysis of movements in the FFR and inflation, which was ultimately to lead to the publication of his model in 1993. There can be no doubt that the changes in Fed policy during the 1980s enhanced the validity of the Taylor rule when applied retrospectively. The Greenspan years have culminated in a convergence towards the optimal conditions in the application of monetary policy for the Taylor rule as discussed in Chapter 1. However, under Greenspan, the Taylor rule still diverged significantly from the FFR for a prolonged period between 1992 and 1995. Fed behaviour and economic conditions during this period need to be examined in more detail in order to explain how monetary policy models can still be subject to large errors even when monetary policy approach appears to be optimal for the efficient working of the model.

The banking crisis of the early 1990s

The 1980s saw a revolution in the US banking industry, with changes in regulation requirements that had a significant impact on lending practices of domestic banks. The decade saw a sharp decline in commercial banks' profits because of new capital requirements and higher deposit insurance premiums introduced in the early 1980s. Financial innovation also decreased bank profitability as new products began to emerge, such as commercial paper, which squeezed their traditional lending business. The situation was further aggravated by competition from Japanese financial institutions. Widespread corporate downsizing in the United States further reduced lending, and as a result, US banks began to diversify their lending in an effort to replace this lost business. This led to a greater proportion of high risk lending on the banks' portfolios, such as real estate. A collapse in the real estate market at the end of the 1980s, coupled with poor regulation of lending practices, led to huge losses for commercial banks and a crisis in the US banking industry. As a consequence there were a sharp rise in the number of bank failures, which rose to more than 200 in 1985 alone, and the beginnings of a credit crunch that reached its peak in the early 1990s.

Greenspan's comments on the events of the early 1990s have been interpreted as an admission of failure in monetary policy to avoid the prolonged recession that followed. The ensuing credit crunch led to reduced business and consumer confidence, which overlapped with the Gulf War and a sharp rise in oil prices. Although in 1990 Greenspan himself forecast a high probability of imminent recession, he saw this as a way of reducing headline inflation, which had climbed back up to levels seen in the early 1980s. It is now widely agreed that Greenspan was too late in appreciating the full extent of the credit crunch. This greatly increased political pressure on Greenspan to cut rates at a time when the Bush administration planned to introduce what was at the time the biggest tax hike in US history in an attempt to reduce the government's budget deficit.

Greenspan resisted pressure from the White House and Congress to ease monetary policy, although when the FFR was finally reduced sharply in early 1991, the Fed were eventually forced to reduce cut rates more aggressively than would have been necessary if it had acted earlier. Consequently, the FFR eventually fell to 3 per cent and remained there throughout 1993. As a result of the combination of economic and financial circumstances, and the Fed's inertia in reacting, the Taylor rule and other monetary policy models failed to follow the path of the FFR until rates were raised again in 1994.

Since the mid-1990s, the Fed has undoubtedly become more conscious of the need to act pre-emptively during periods of economic or financial instability. Moreover, the enhanced credibility of the Fed, and its perceived ability in fighting inflation during the second half of the decade, mean Greenspan is less prone to political and market pressure to adjust interest rates. These factors have effectively contributed to a heightened state of independence for the Fed, another important factor in the validity of the Taylor rule.

The late 1990s

The perceived failure of Alan Greenspan to dampen the dot.com bubble and boom in asset prices during the late 1990s has since been a source of criticism, especially given the sharp slowdown in the US economy since 2001. Greenspan himself has defended his actions by insisting that asset bubbles are difficult to identify and may show little response to moderate increases in interest rates. There is the risk that hiking rates more aggressively to quell asset prices risks pushing the economy into a recession. He preferred to let the bubble burst and then adjust monetary policy to the new conditions. Although the Fed did act pre-emptively by hiking the FFR to 6.5 per cent, this was done more in anticipation of higher inflation than as a direct means of subduing existing price pressures. Despite this, Greenspan has undoubtedly attached greater importance to stabilisation of economic conditions and interest rates than previous Fed chairmen. This is due, to some extent, to Greenspan's closer association with the financial markets and an appreciation that frequent changes in direction of the FFR threatens the credibility of the Fed. However, cyclical swings in the economy have not been completely eliminated.

Despite the failure of the Fed to adopt an inflation target, under Greenspan's governorship, transparency has increased and Fed operations have become more market friendly. In February 2000, it began announcing an 'assessment of the balance of risks to the attainment of long-term goals of price stability and sustainable economic growth' with the statement after each FOMC meeting. This followed the Fed's decision to announce a 'policy directive' in May 1999.

The behaviour of the FFR under different Fed chairmen is illustrated in Figure 2.2. During the 1970s, Fed monetary policy was presided over by Alan Burns. The persistence of high inflation, oil shocks notwithstanding, implies the FFR was not raised to the levels that the Taylor rule would later dictate as applicable to the inflation rates seen at the time. The concept of raising the FFR on a greater than one-to-one basis with increases in inflation, as dictated by the Taylor rule, led to a sharp decline in inflation after the appointment of Paul Volcker. The Greenspan era has seen a continuation of this approach, and a subsequent period of relatively low inflation.

Post 2000: the threat of deflation

The political and economic events of 2001 and 2002 have greatly complicated the task of the Fed. The unique combination of circumstances, both domestic and international, is arguably the most

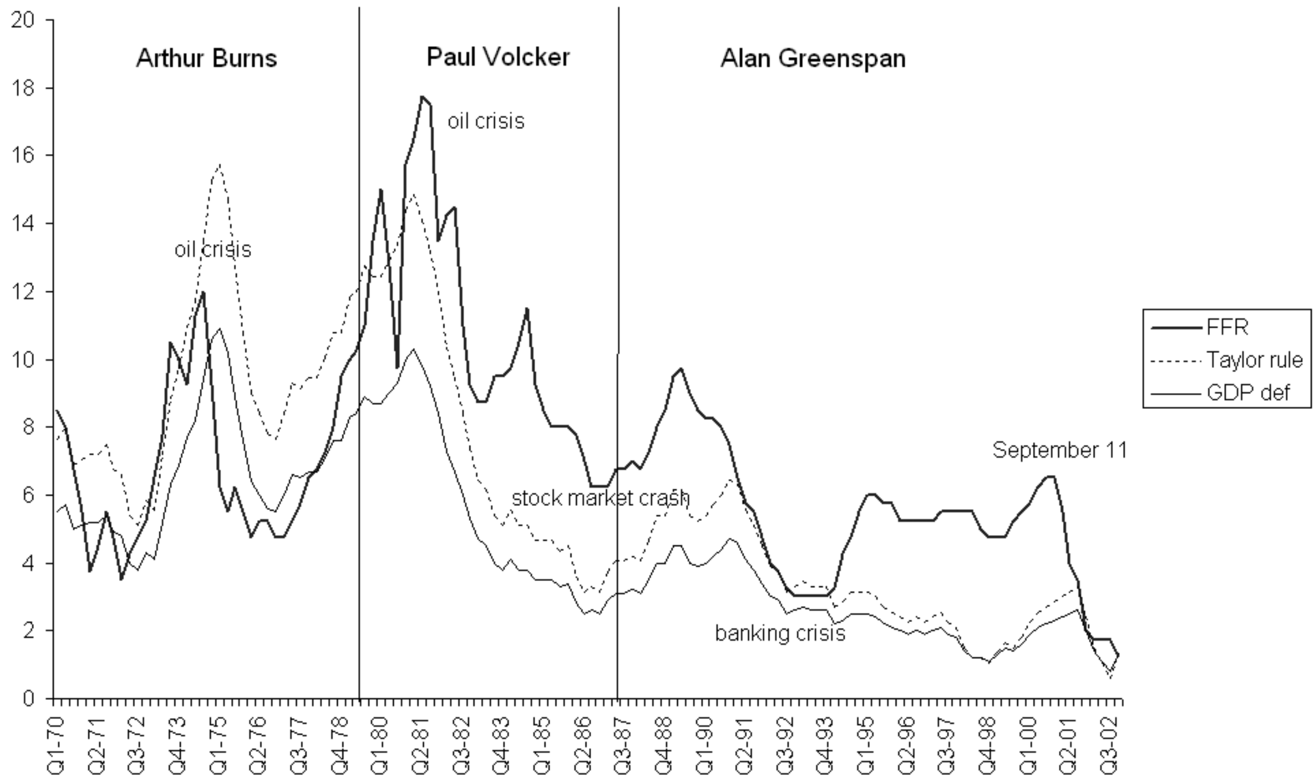

Figure 2.2 Fed chairmen and the FFR since 1970

challenging faced by the Fed in modern times. After the recession and terrorist attacks of 2001, the threat of deflation re-emerged for the first time since the 1920s. This half of the chapter analyses the nature of deflation, the potential threat it poses to the United States and the problems it presents for the Fed. It goes on to discuss how the threat of deflation altered Fed behaviour.

Having spent the past 30 years or so dealing with the threat of inflation, the Fed has entered new territory with the emerging of deflationary fears in 2001. Moreover, the threat of deflation has raised concerns about the appropriate objectives of the Fed during periods of weaker growth and falling inflation. Deflation is defined as a fall in general prices (negative inflation). The causes of deflation are usually associated with a sharp and prolonged fall in demand within the economy.

The destructive impact of deflation does have some precedence in the United States: most notably, the Great Depression of the 1930s. These examples have provided economists and academics with ample opportunity to examine the full impact of deflation on mature economies. The recent threat of deflation in the United States is largely a result of the slowdown that followed the boom of the late 1990s. Excess capacity of firms and businesses greatly reduced their pricing power at a time of falling business and consumer confidence, aggravated by the terrorist attacks of 11 September 2001 and the war in Iraq.

What problems can deflation cause?

Deflation increases the debt burden of businesses, households and consumers, as the negative inflation increases the real interest rate commitment. Households and businesses saddled with large debts will suffer particularly from a prolonged period of deflation, which in turn will stifle additional borrowing. Eventually, the cost of borrowing may become so prohibitive that spending is severely curtailed. Weak demand will also be perpetuated if businesses and individuals postpone spending and investment if they believe prices will continue to decline. Deflation can also act to increase the real wage bills of firms, putting more pressure on business balance sheets. This may lead to layoffs and rising unemployment as firms attempt to reduce their operating costs.

Deflation can also make monetary policy less effective as short term interest rates approach zero. This reduces the scope for further policy easing to bolster demand in the economy. As a result, the central bank has no room for manoeuvre in easing policy by lowering the real rate of interest because the nominal rate cannot fall below zero. Moreover, if inflation continues to fall when the short term interest rate is at zero, the real rate of interest will begin to increase. As well as adhering to an implicit symmetrical inflation objective, the Fed has looked to increase inflation expectations, by signalling that the FFR will remain at a low level until price pressures start to re-emerge.

How does the US situation compare with the Japanese experience of the 1990s?

During the 1990s Japan experienced a slump in domestic demand, which was followed by the onset of deflation. However, few parallels can be drawn between the events in Japan and the situation in the United States after 2001. The economic slowdown in Japan was largely the result of a crisis in the domestic banking industry, brought about by a collapse in the real estate market after the bubble of the late 1980s. This led to a 'credit crunch' scenario where banks were unwilling to lend to finance business investment. The situation was then aggravated by a tax rise which severely curtailed consumer spending. The Japanese authorities were slow to foresee the threat of deflation, and the monetary and fiscal policy response was probably a matter of too little, too late.

In the United States, the banking and financial sector remains essentially sound and consumer spending has remained relatively robust. More importantly, the Fed anticipated a slowdown in growth and acknowledged the possible threat of deflation early on (see Figure 2.3). Consequently, the monetary policy response has been pre-emptive and aggressive. A weaker dollar has also contributed to an inflationary environment.

Meanwhile, the threat of deflation has raised the question of whether the Fed, and other central banks around the world, are targeting too low an inflation rate. If the Fed does have a preferred inflation level of 2 per cent, there is little margin for error should the economy suffer a deflationary shock. However, central banks already

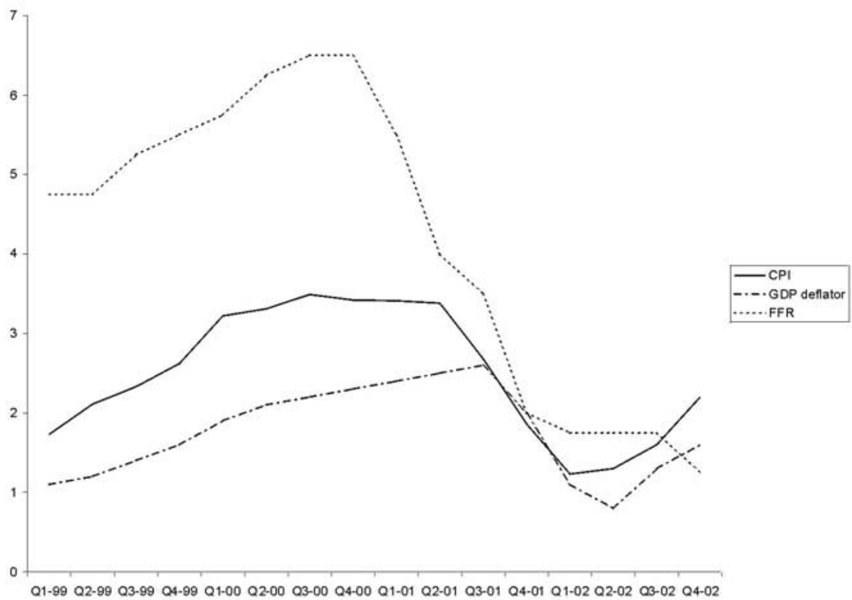

Figure 2.3 US CPI and GDP deflator inflation and the FFR (1999–2002)

take account of this by having a 'symmetrical' inflation target or mandate. That is, an inflation rate below the target level is as undesirable as an inflation rate above it. It seems most likely that once the perceived threat of deflation has subsided, the importance of the appropriate inflation objective, at least at the Fed, will take a back seat.

Alternative monetary policy measures available to the Fed

Should the FFR fall to zero so there is no further scope for reducing interest rates, alternative measures to ease policy are available to the bank. These include reducing the discount rate, buying Treasury bonds, and even currency intervention to weaken the dollar. The Fed can also attempt to manipulate the inflation expectations of households and businesses by indicating that the FFR will remain at very low levels for as long as it takes to eliminate any threat of deflation. This will also contribute to a decline in longer term interest rates, an important factor in determining credit and borrowing costs.

The change in the Fed's reaction to inflation since 1970 is best illustrated by scatter diagrams for each chairmanship that plot the FFR against inflation only. The corresponding equation for each chart displays how much the FFR has risen or fallen for each percentage point change in inflation. The optimal change in the FFR to increases in inflation for the monetary policy models used in this book is 1.5. This has virtually been achieved in the most recent years of Alan Greenspan's tenure as chairman.

Figure 2.4 plots the FFR against the GDP deflator using quarterly data for the period of Arthur Burns' chairmanship. The slope of the chart represents a trend measure of the Fed's reponse to inflation during the period. If the slope is less than 1.0 then an increase in inflation produces a fall in the real FFR. From 1970–80 the Fed increased the FFR by a factor of 0.69 for each percentage point increase in inflation. This has been taken as an explanation for the failure of monetary policy to contain inflation during the 1970s.

After the appointment of Paul Volcker, the Fed adopted a more aggressive anti-inflation stance. This produced a steeper reaction curve to inflation with the FFR being raised by a factor of around 1.2 to each percentage point increase in inflation over the period 1980–7 (Figure 2.5).

Figures 2.6 and 2.7 show that under the chairmanship of Alan Greenspan, the Fed has become more anti-inflationary in its response to rising prices. By the mid-1990s, the Fed had adopted a more preemptive stance leading to a rise in the FFR of approximately 1.4 for each percentage point increase in inflation.

FED TARGETS AND POLICY INSTRUMENTS

The monetary policy models described in this book are constructed on the basis of the FFR being the sole target of monetary policy. That is, the FFR is adjusted to its desired, or target, level via open market operations conducted by the Fed. The shifts in policy targets adopted by the Fed since 1970 account for much of the improved performance of models during the past decade. This section analyses how policy instruments and targets have been adopted and abandoned since 1970, and explains how the validity of FFR models has evolved as Fed procedures have changed since the 1970s.

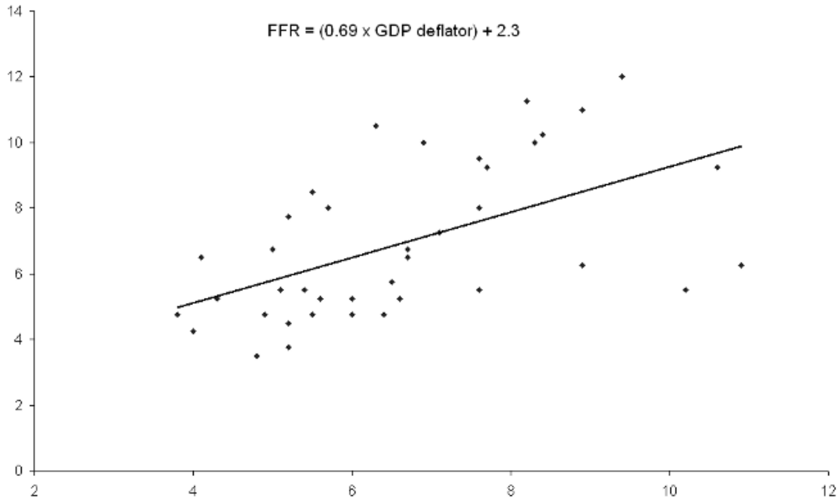

Figure 2.4 Arthur Burns 1970–8

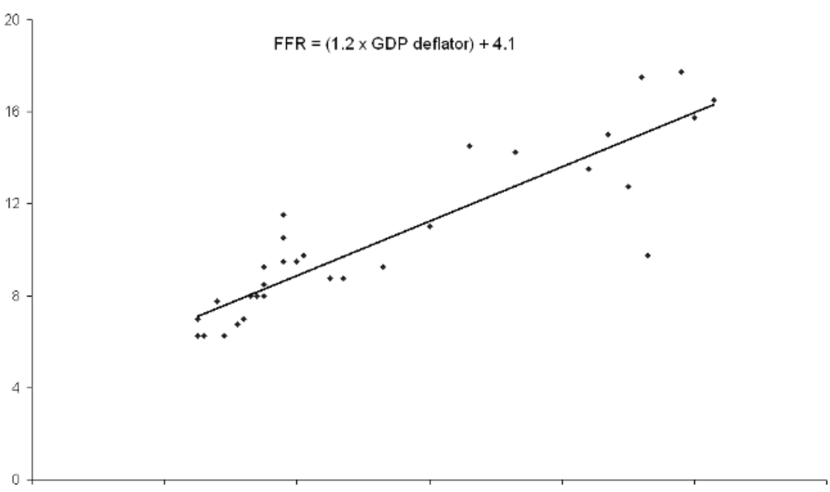

Figure 2.5 Paul Volcker 1979–87

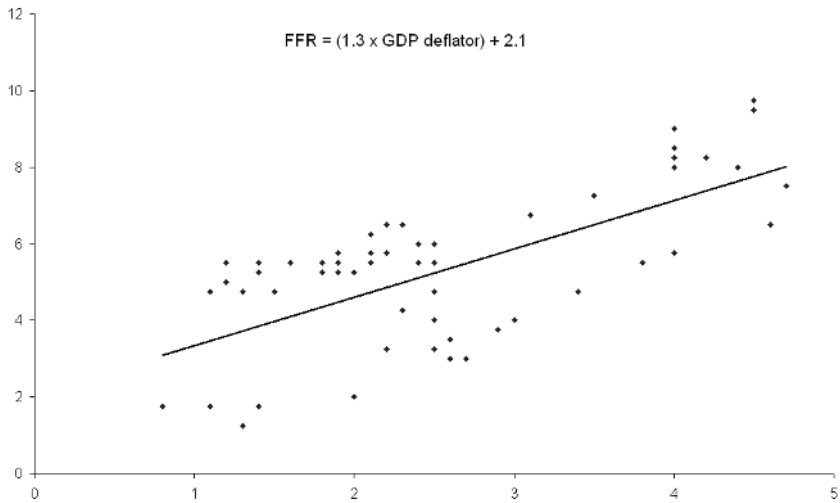

Figure 2.6 Alan Greenspan 1987–present

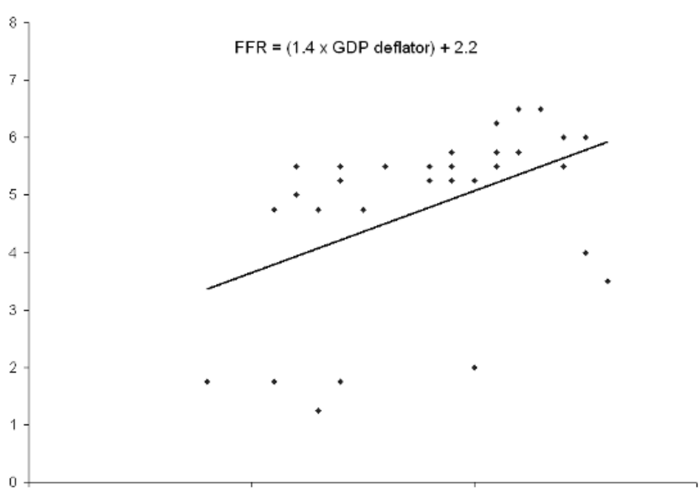

Figure 2.7 Alan Greenspan 1995–present

Table 2.1 Statistics under different Fed chairmen

Averages	*Alan Burns 1970–8*	*Paul Volcker 1979–87*	*Alan Greenspan 1987–present*
GDP	3.2	2.4	2.7
GDP deflator	6.5	5.7	2.6
FFR	6.6	10.4	5.3
Real FFR	0.1	4.7	2.7

1970–9: Monetary aggregates and FFR targeting

In 1970, the Fed's monetary policy targets became the monetary aggregates and the FFR. These were chosen according to the level of employment and inflation that the Fed wanted to achieve. The FOMC would set ranges for both targets although the two often proved to be conflicting in achieving the Fed's objectives. Since the FFR remained the Fed's operating target and priority, money supply would subsequently tend to grow out of control, leading to a sharp rise in inflationary pressures. The adoption of the FFR as an operating target led to poor control of the money supply and ultimately a pro-cyclical monetary policy.

1979–82: Non-borrowed reserve targeting

In October 1979, following the appointment of Paul Volcker as chairman, the Fed moved away from targeting the FFR by drastically increasing its target range. The main operating target then became non-borrowed reserves. Consequently, movements in the FFR became more volatile although the money supply failed to come under greater control. Economic shocks coupled with financial deregulation and the introduction of new financial products made the money supply more difficult to control. It has also been suggested that the Fed paid scant attention to its own monetary aggregate targets in an effort to concentrate on using the FFR to control inflation. This could only be achieved by abandoning FFR targets. Changes in the FFR between 1979 and 1982 do suggest that the Fed was adjusting the rate to manipulate inflation and growth.

1982–7: Borrowed reserves targeting

After October 1982, achieving FFR stability became more of a priority after the sharp swings seen in the rate during the previous three years or so. As such, the Fed moved towards targeting borrowed reserves and away from monetary aggregates. Although this led to increased stability in the FFR, the money supply growth rate once again became more volatile. Consequently, M1 targets were abandoned in Febraury 1987 after the traditional relationship between M1 money growth and inflation began to break down.

1987–present: FFR targeting

Sporadic demand for borrowed reserves meant the effectiveness of targeting borrowed reserves was diminished. After switching to targeting the M2 money aggregate measure, the Fed finally dropped all money aggregate targeting in 1993, following the appointment of Greenspan as chairman. Consequently, FFR targeting, via open market operations, came into its own in the mid-1990s. In February 1994 the Fed announced that any policy changes would occur at scheduled FOMC meetings and in 1995, an explicit target level was announced at each meeting.

Figure 2.8 summarizes the changes in the annual rate of M1 money supply growth since 1970. Fed policy procedures and targets can be divided into four distinct periods since then. The gradual move away from targeting money supply and reserve levels to adoption of the FFR as the primary target has meant that monetary policy rules, such as the Taylor rule, have become more applicable in describing policy since the early 1990s.

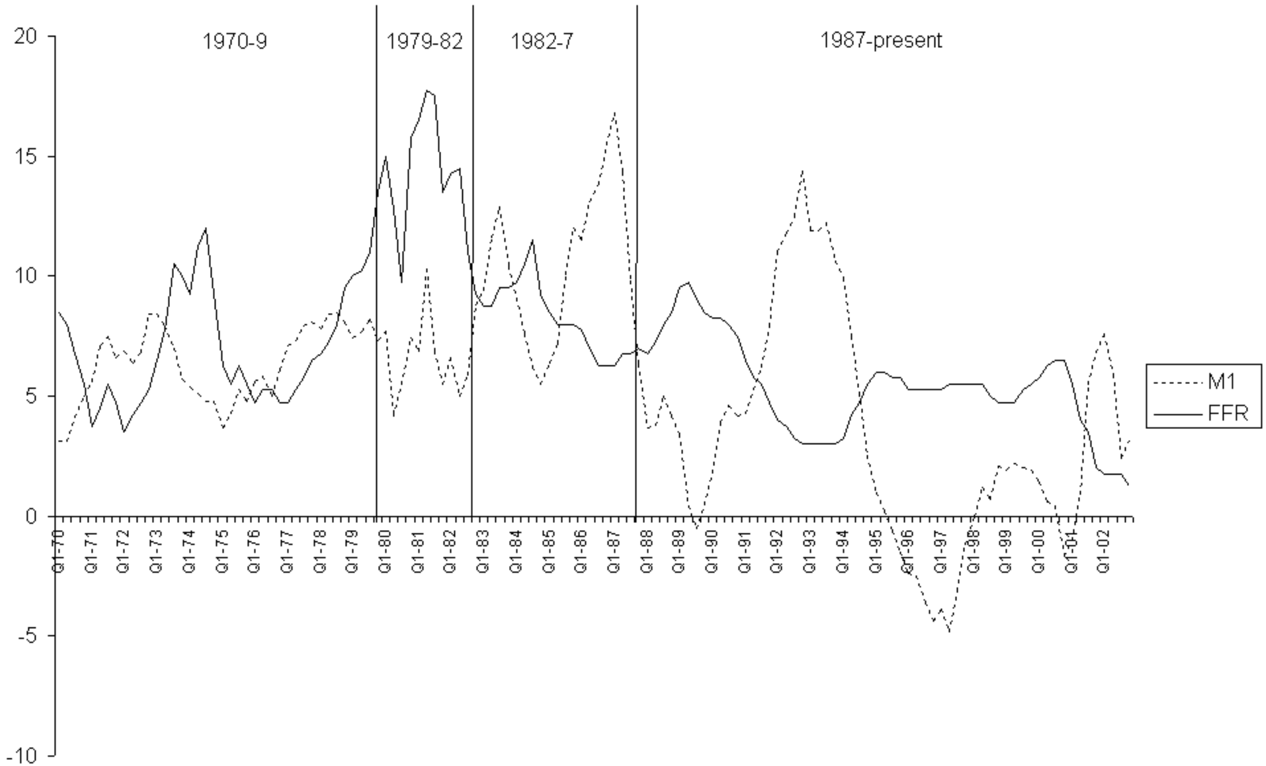

Figure 2.8 M1 money growth (y/y) and the FFR, 1970–2002

CHAPTER 3

The Monetary Policy Model (MPM)

INTRODUCTION

Now we have considered the major policy shifts of the Fed since 1970 and analysed perhaps the best-known monetary policy model for the United States, the Taylor rule, this chapter presents a new version based on an empirical study of Fed policy.

The monetary policy model (MPM) is a Taylor-type rule for the US economy that attempts to describe and explain changes in the FFR between 1980 and 2002 using fundamental economic data from the US economy, similar to that used in the Taylor rule. Using both quarterly and annual data, the model's accuracy is assessed in describing the FFR since 1980. As explained in previous chapters, this highly systematic treatment of Fed decision making applies to any monetary policy model based on mathematical equations. Monetary policy decisions however are also discretionary, and as this chapter will explain, non-statistical considerations also come into play.

APPLICATIONS OF THE MPM

Explaining the current FFR

Using the MPM facilitates the assessment of the impact of economic fundamentals on the Fed's policy contemporaneous decisions. The simplicity of the model allows for a direct interpretation of how changing GDP and inflation data may affect the current, or short term, FFR. This can mean using the latest data to calculate an implied FFR for the present quarter or year. This also allows for a better understanding of the short term path of the FFR by examining how the present trend in economic fundamentals will impact the FFR. Quarterly estimates are based on the previous quarter's data, and annual on estimates of the present year's data. As this chapter will explain, periods of policy inertia by the Fed may allow the MPM to anticipate short term changes in the FFR.

Making medium to long term FFR forecasts

The application of reliable GDP and inflation projections to the MPM produces longer term forecasts of the FFR. These are most suitable for forecasting the average FFR over a one and two year period, up to five years ahead. This chapter uses the economic projections of the US Congressional Budget Office (CBO) in its forecasting of the FFR.

Enhancing or supporting an existing view on the FFR

The MPM for a particular period can help to support an existing view on the FFR, be it long or short term. Whether this view is garnered from the futures market, yield curve, or is just based upon an assessment of prevailing conditions, the MPM can add credence to it and act as a cross-check.

Assumptions underlying the MPM

The starting point for the derivation of the MPM is a reassessment of the most appropriate values for trend GDP growth and the natural real interest rate applied in the Taylor rule, although the MPM adheres to the basic structure of the original rule. The figures presented here have been obtained using a combination of empirical analysis of FFR correlations with economic data, and observations that are in accordance with those expressed by the Fed itself. Econometric and regression techniques have not been applied in order to obtain the coefficients in the model.

The MPM assumes that all economic information on the US economy considered by the Fed at its FOMC meetings on the setting of the

FFR is incorporated in the quarterly US GDP and inflation data. Consequently, the Fed is assumed to not respond to individual monthly indicators, but rather base its decisions on an assessment of the aggregate economic conditions reflected in the quarterly GDP report. The first estimates of GDP are released in the months after the end of the quarter, so this assumes that the FFR is set in accordance with the economic conditions that prevailed during the previous quarter. This assumption allows for Fed consideration and assimilation of the economic indicators pertaining to growth and inflation that are released throughout the current quarter. The confirmation of any change in economic trends provided by the subsequent actual GDP data may then prompt a policy response.

The MPM then presumes that the Fed adjusts the FFR, in full, to its desired level (if any adjustment is considered necessary) before the next quarterly GDP release. No pre-emption or inertia in Fed decisions is allowed for within the MPM, although this can be a potential source of error in the model, which is examined more fully later in this chapter.

THE MPM EQUATION

Equation 3.1 shows the MPM equation:

FFR (%) = i + inflation + 0.5 × (inflation gap) + 0.5 × (output gap)

i = long term average natural real interest rate
inflation = GDP deflator
inflation gap = GDP deflator – Fed inflation 'target'
output gap = actual GDP – trend GDP.

Equation 3.1 states that the average FFR during any period (quarterly or annual) is the sum of the natural real interest rate and inflation, plus the inflation and output gaps divided by two. The chosen measures of inflation and output are real GDP and the GDP deflator.

This produces Equation 3.2:

FFR (%) = 3 % + GDP def. + 0.5 × (GDP def. – 2 %) + 0.5 × (GDP – 2.5 %)

The chosen inflation measure is the year-on-year measure of the GDP deflator, released quarterly in the GDP report. The MPM assumes that the Fed's inflation target, based on the GDP deflator measure, is 2 per cent. The output gap is calculated by subtracting a constant 'potential' GDP rate of 2.5 per cent from the actual GDP, based on year-on-year values. Equation 3.2 states that changes in the average FFR implied by the MPM are wholly dependent on only two variables: the previous period's year-on-year GDP and the year-on-year GDP deflator. The level of the FFR is also dependent on the real natural interest rate. This is calculated to be 3 per cent.

Figure 3.1 shows how the MPM has tracked the actual FFR since 1980. Since the mid-1980s, the MPM has also displayed an ability to anticipate major changes in the trend of the FFR, such as during the years 1986 and 2000. Most conspicuous is the deviation of the MPM from the FFR from 1992–5 and after 2001. The second half of this chapter shows how the MPM can be modified to explain the behaviour of the FFR during these periods.

Figure 3.2 plots the MPM against the FFR using annual data for the years 1980–2002. This comparison produces a slightly more accurate result, as deviations in the MPM are averaged out over a four-quarter period. However, the periods 1992–5 and post-2001 remain significant discrepancies for the MPM.

The assumptions of a 2 per cent Fed inflation target and a potential GDP growth rate of 2.5 per cent are now considered in more detail.

Fed inflation target of 2 per cent

The MPM assumes that the Fed has a preferred policy goal of 2 per cent inflation, based on the GDP deflator measure. This figure coincides with the rate chosen by Taylor, and stands up to basic empirical scrutiny, in that a GDP deflator above 2 per cent tends to correspond to a rising FFR. Periods when inflation is at or near 2 per cent correspond to a relatively stable FFR, and the rate has shown little tendency to fall when the GDP deflator is at, or approaching, 2 per cent. This superficial analysis tends to support Taylor's original estimate of a 2 per cent inflation target for the Fed.

The various inflation measures published for the US economy pose a dilemma for the Fed in its efforts to assess the 'true' level of

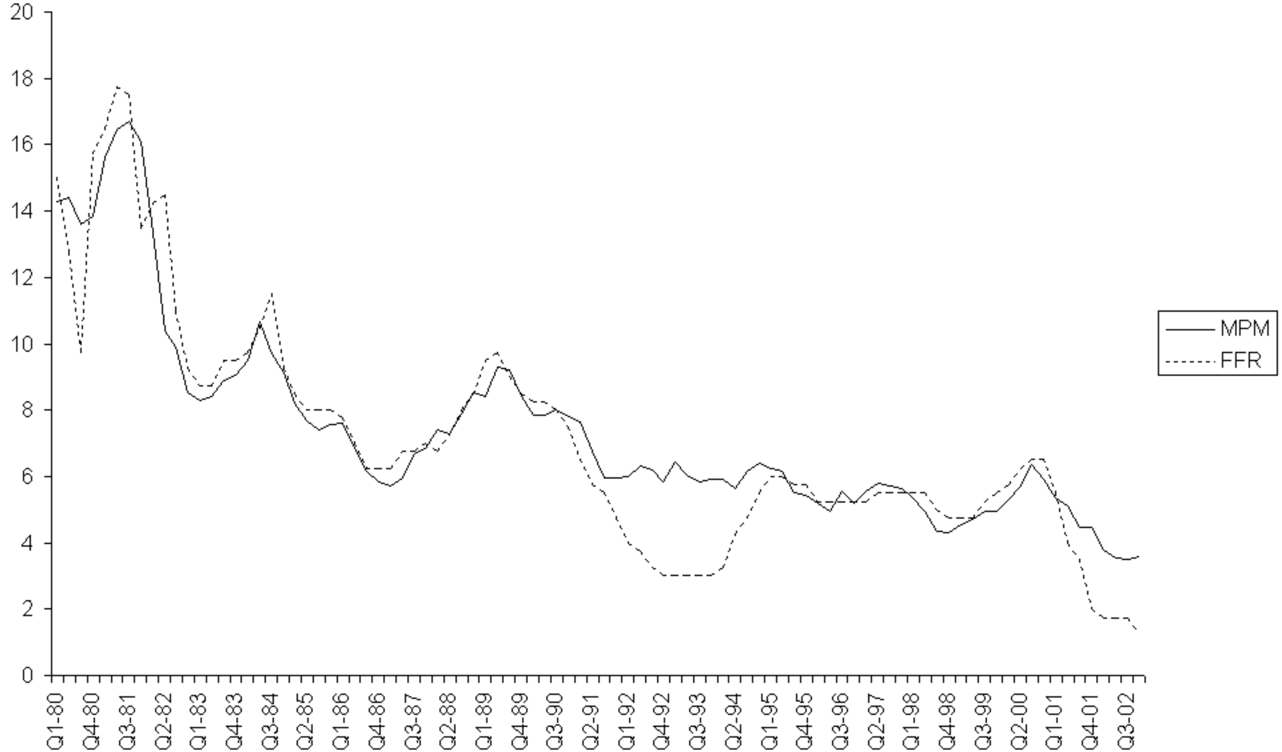

Figure 3.1 The MPM and FFR 1980–2002: quarterly data

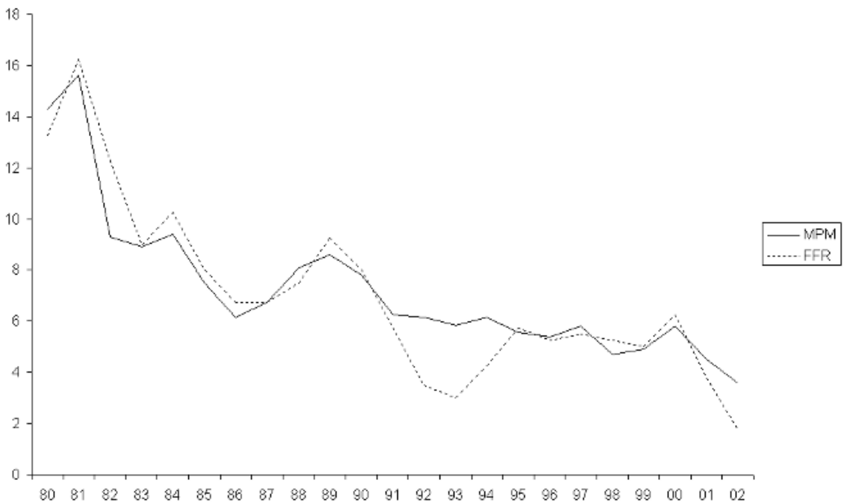

Figure 3.2 The MPM and FFR 1980–2002: annual data

price pressures in the economy. Which measure is the most authentic reflection of inflation in the economy? Appendix 4 presents a comparison of the various inflation measures available to the Fed, and assesses the relative importance attached to them.

Figure 3.3 shows how the FFR has changed with the GDP deflator for the period 1980–2002. The behaviour of the FFR rate during the period of approximately 1995–2000 saw a period of relative stability of the GDP deflator at around 2 per cent, or 'on target'. At the same time, the FFR remained relatively stable, its high rate being accounted for by the sustained strength of the GDP growth during the period. A GDP deflator above 2 per cent tends to correspond to a rising FFR.

The potential GDP of 2.5 per cent

Estimating the long term rate of potential output

Figure 3.4 plots quarterly real GDP data for the years 1980 to 2002. The mean value over the period equals 2.5 per cent, which is taken to be the trend level of GDP. This in turn is taken as a proxy for the potential level of real GDP used in the MPM.

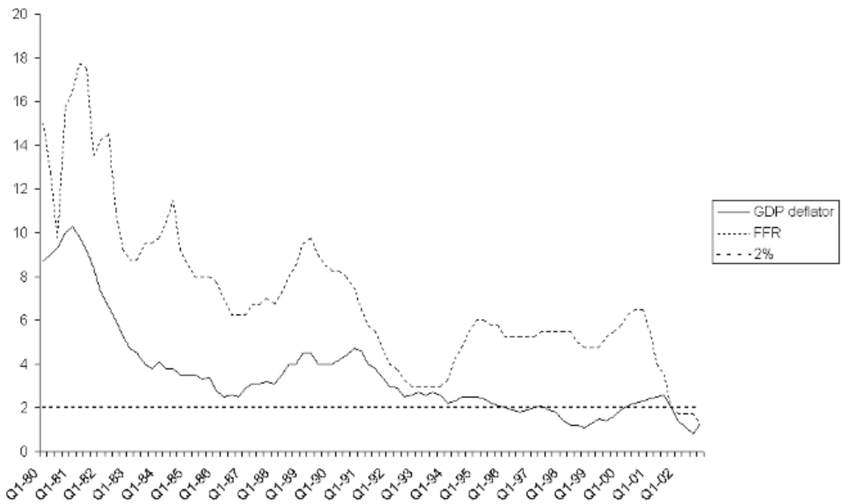

Figure 3.3 The FFR and GDP deflator 1980–2002

Chapter 1 explains the distinction between trend and potential GDP. Whereas trend GDP represents merely the average, or mean, growth rate over a specified period, potential GDP is based on an assessment of the maximum GDP growth rate that can be achieved without creating inflation. Moreover, the assumption of a 2.5 per cent potential GDP is supported by Fed pronouncements and statements (see notes).

Estimates of the potential growth rate of the US economy have tended to be revised down over the years. This is partly because of the revised chain-weighted GDP measure introduced in 1996, which has tended to lower annual growth rates. Moreover, estimates of potential GDP above 2.5 per cent made in previous decades have increasingly been viewed as overly optimistic because of the higher inflation rates seen in the 1970s and 1980s. The potential rate effectively acts as a GDP 'target' level for the Fed. Growth above this level requires a higher FFR to combat the threat of inflationary pressures. GDP below 2.5 per cent allows the Fed to cut the FFR in order to boost growth, without creating inflation. This way, the Fed can achieve the two major elements of its remit, price stability and economic growth.

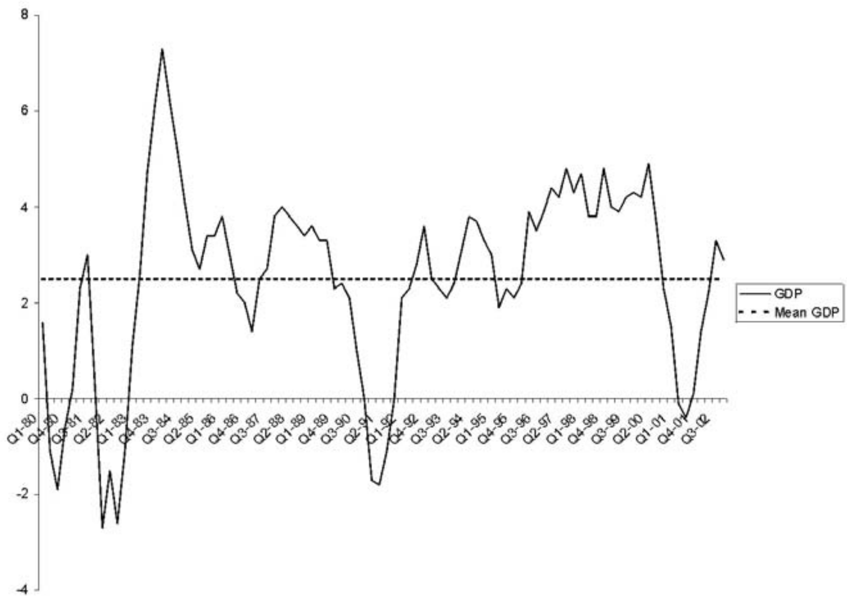

Figure 3.4 Real GDP 1980–2002

Potential output may be subject to fluctuations due to demographic shifts, and labour market and productivity changes

The natural real interest rate of 3 per cent

Like potential GDP, the long term average natural real interest rate is an unobservable quantity. It is the real interest rate that exists when the inflation and output gaps are zero, and so is equal to the FFR adjusted for the GDP deflator when inflation is on target and GDP growth is at its potential level. However, because this set of circumstances rarely exists, the natural rate presents challenges in its measurement. Recent studies have tended to suggest that the figure has risen in recent years, from the 2 per cent estimated at the time the Taylor rule was developed in the early 1990s. The natural rate of 3 per cent used in the MPM is taken from the average real FFR and US real commercial paper rate for the years 1980 to 2002.

Figure 3.5 plots the FFR adjusted for the GDP deflator for the years 1980 to 2002. The average value of 3 per cent is taken as the value for

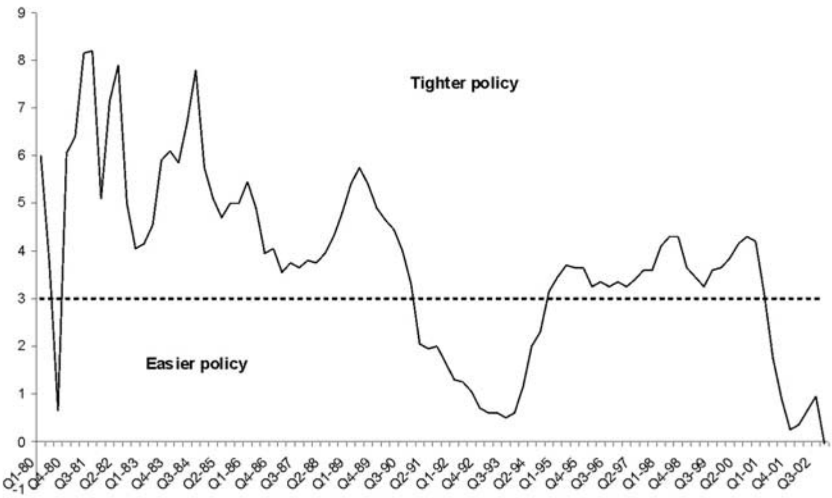

Figure 3.5 The real FFR rate 1980–2002 (adjusted for the GDP deflator)

the long term average natural real interest rate used in the MPM. The chart also highlights how the Fed's policy stance has changed over the period. It illustrates how control of the real interest rate became relatively stable between 1995 and 2001. Apart from 1998, the real FFR was either approximately neutral or only slightly restrictive, as high-productivity growth allayed fears of higher inflation despite strong economic growth in the late 1990s. The fear of deflation has since led to the most accommodative policy stance adopted in 20 years.

Figure 3.6 plots the real US commercial paper rate for the years 1980–2002. This is the commercial rate adjusted for CPI inflation, and is taken as a good proxy for the natural real interest rate. The average rate over the period is 2.96 per cent.

EXPLAINING DEVIATIONS IN THE MPM FROM THE ACTUAL FFR

The timing of Fed rate changes is crucial to the validity of the MPM, so pre-emptiveness and policy inertia exercised by the Fed are the main sources of error in the MPM. However these factors can be overcome, at least partially, through evaluation of the Fed's short

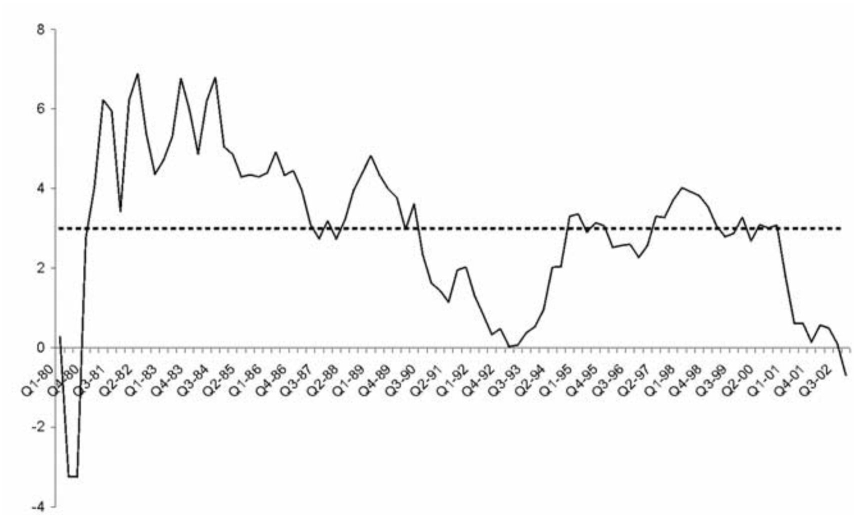

Figure 3.6 Three-month real commercial paper rate 1980–2002

term policy stance. This part of the chapter explains how the MPM can be sometimes be modified to take account of pre-emptive Fed action, and how policy inertia can be used to anticipate trend changes in the FFR.

Fed pre-emptiveness and policy intertia

The comparison between the quarter-on-quarter and year-on-year MPM and FFR rates listed in Appendix 5 reveals that the MPM often fails to explain the precise FFR in any particular period. This is largely a result of the timing of Fed policy moves outside the period in question, because of the practices of pre-emption and policy inertia already explained.

When economic or financial conditions threaten to destabilize growth or inflation, the Fed may respond by adjusting the FFR pre-emptively. This involves anticipating future economic conditions by adjusting the FFR regardless of the prevailing data. Notable examples of the Fed acting pre-emptively include late 1990 in response to the US banking crisis, the months following the October 1987 stock market crash, the 1998 financial crisis in Asia and Russia, and at the beginning of 2001 during the dot.com crash. In these instances the Fed elected to cut the

FFR to forestall weaker growth in the US economy, or to stabilize financial markets. Both in the United States and internationally, Fed pre-emptive action can underpin market confidence with its ability to respond to changing economic and financial circumstances. Pre-emptive action can also involve a raising of the FFR. In 2000 interest rates were raised by the Fed in order to moderate a surge in US stock markets and a boom in consumer borrowing. At the time, the Fed made it clear in its policy announcements that these factors, coupled with strong economic growth, posed a threat to the stability of the US economy and future inflation rates.

The greater importance attached by the Fed to its credibility since the Volcker days has undoubtedly made policy more pre-emptive as the Fed attempts to quell rises in inflation. Alan Greenspan has further enhanced the credibility of the Fed by reacting more proactively to the major economic and financial disturbances during his tenure. Furthermore, Greenspan has occasionally acted pre-emptively by adjusting the FFR between scheduled FOMC meetings – an action that prompts an adjustment to the MPM as described earlier.

If the Fed acts pre-emptively, it may be described as being ‘ahead of the curve’, in financial market parlance, in that it has anticipated changing economic conditions ahead of the market. Conversely, policy inertia is typically described as the Fed being ‘behind the curve’. It refers to Fed inaction, or sluggishness, in responding to prevailing conditions, whether they are economic, political or financial. More accurately, it assumes that the markets have already made some adjustment in anticipation of a subsequent policy response from the Fed.

Why should the Fed practise policy inertia?

It should be stressed that policy inertia may be a deliberate approach adopted by the Fed to smooth the impact of policy changes on the economy. Alternatively, and less desirably, it may be the result of Fed misjudgement in adjusting policy with sufficient punctuality in line with current economic fundamentals. In this case the Fed may have failed fully to appreciate the extent of policy adjustment that is required by the latest economic data. This was exemplified during the credit crunch of the early 1990s, as described in the previous chapter. This effect can lead to persistent inaccuracies in monetary policy models: in describing the prevailing FFR as successive, policy decisions are marred by the need to correct the mistakes of the past.

The practice of controlled, or deliberate, policy inertia undoubtedly contributes to the effective transmission of monetary policy to the economy. For example, the Fed may decide at a regular FOMC meeting that economic conditions warrant a 0.5 per cent cut in the FFR. However, rather than implement the reduction in full at one meeting, the Fed may decide to stagger the cut across two successive FOMC meetings. Moving the FFR closer to its desired level incrementally has the advantage of avoiding sudden large changes in the rate. This helps to reduce turbulence and uncertainty in the financial markets, which could be generated by large sudden movements in interest rates. This in turn avoids large swings in the value of the dollar, as well as volatility in longer term interest rates and asset prices. Furthermore, the impact of the FFR on longer term interest rates means policy will be better transmitted if the short term rate is more predictable.

The Fed will also be conscious of the impact that FFR changes have on overseas markets. International financial market stability is undoubtedly now a major concern of the Fed, and minimizing undue market disturbances is an important consideration in achieving its policy objectives. Policy inertia also reflects the inherent caution of the Fed and its policy makers. This is most prevalent when the bank is implementing a change in the trend direction of the FFR, rather than merely adjusting the FFR in the direction of the existing trend. For example, by the second quarter of 1995, the FFR had been on a constant upward trend since the beginning of 1994. However, despite the Fed recognizing the need for an easier policy stance, the FFR fell only 0.25 per cent over the following two quarters, before falling another 0.5 per cent in the first quarter of 1996. Alternatively, the Fed may merely be waiting for the release of data for subsequent quarters in order to confirm a perceived change in economic conditions. This is especially relevant as many changes in economic indicators can be transitory in nature.

A policy inertia approach also reduces the likelihood of the Fed needing to reverse previous changes in the FFR. The gradual adjustment of rates allows time for the Fed to consider more carefully what magnitude of change in rates may be needed. Furthermore, the subsequent release of additional economic indicators will give the

Fed a clearer picture of the direction the economy is taking. Judging the optimal policy response required, especially when economic indicators are especially ambiguous, often leads to the Fed adopting a wait-and-see approach before adjusting the FFR once indicators become more conclusive.

Fed policy inertia when raising the FFR

The classic example of policy inertia exercised when raising rates is the concept of the 'soft landing'. During periods of expansion and strong economic growth, such as those seen in the late 1990s, the Fed has adopted the concept of a 'soft landing'. This involves an increase in the FFR in order to prevent the economy overheating, but in a measured fashion to avoid the risk of pushing the economy into recession. This is perhaps the most lucid example of Fed policy inertia, and was a major factor in Fed policy during the rate hikes of the late 1990s.

'Interest rate smoothing' is a recognized practice carried out by the Fed. The Fed undoubtedly sees excess variability in the FFR as undesirable. The MPM shows greater variability than the FFR and if the Fed conducted policy using this purely rules based approach then the FFR would be changed at every meeting, often in different directions.

Finally, a gradual adjustment of the FFR makes communication of the Fed's policy stance to markets easier. This gives the Fed more time to explain and prepare the markets for a subsequent change in the rates. Consequently, the intended path for interest rates becomes more predictable, thus further reducing volatility and uncertainty. Larger, more abrupt movements in the FFR only serve to support market expectations that the Fed may suddenly adjust rates in the opposite direction if economic indicators changed direction.

Central bank ethos dictates that pre-emptive action is desirable when conditions are warranted, but that policy inertia implies indecision and procrastination by the bank. The Fed is more vociferous and transparent when its policy approach is pre-emptive, as this implies the bank is ahead of the game, or 'ahead of the curve'. As such, gauging a pre-emptive policy stance is usually aided by Fed and FOMC comments and press statements, FOMC meeting minutes, and testimony given by chairman Alan Greenspan in his semi-annual monetary policy reports to Congress.

USING THE MPM

Quarterly data

Box 3.1 shows how the MPM is calculated for the first quarter of 1999.

Box 3.1

Data on the US economy for Q4 of 1998 shows GDP growth at 4.8 per cent and the GDP deflator at 1.1 per cent. Substituting these figures into Equation 3.2:

$$\text{MPM (\%)} = 3\ \% + 1.1\ \% + 0.5 \times (1.1\ \% - 2\ \%) + 0.5 \times (4.8\ \% - 2.5\ \%)$$

$$= 3\ \% + 0.65\ \% + 1.15\ \%$$

$$= 4.8\ \%$$

Using GDP and GDP deflator data for Q4 1998, Equation 3.2 produces a rate of 4.8 per cent, (4.75 per cent rounded to the nearest 0.25 per cent). This correlates exactly with the actual mean FFR in that quarter (see Appendix 5).

What is the value of this calculation?

Box 3.1 shows how the MPM can be used to 'explain' the prevailing FFR using the latest economic data. It can also be used to assess the reliability of the model over a longer time span. This calculation also forms the basis of making shorter term estimates of the FFR. Not until economic projections of the GDP and GDP deflator figures are used does the model have any ability to forecast the medium to longer term FFR.

Attempting to anticipate short term changes in the FFR

Box 3.2

Data on the US economy for Q3 2000 shows GDP growth at 3.7 per cent and the GDP deflator at 2.2 per cent.
Substituting these figures into Equation 3.2:

$$\text{MPM } (\%) = 3\,\% + 2.2\,\% + 0.5 \times (2.2\,\% - 2\,\%) + 0.5 \times (3.7\,\% - 2.5\,\%)$$

$$= 5.2\,\% + 0.1\,\% + 0.6\,\%$$

$$= 5.9\,\%$$

Box 3.2 shows that the MPM describes a rate of 6.0 per cent for Q4 of 2000. The actual mean FFR in that quarter stood at 6.5 per cent, but fell to 6.0 per cent during Q1 2001. Therefore, the MPM anticipated the actual FFR by at least one quarter. In this case it is possible the market had already anticipated the fall to 6 per cent. However, the MPM can then be used to enforce the rate outlook implied by the futures markets.

Data revisions as a source of error

Using historical data to construct MPM results is itself prone to errors, as data for a particular quarter typically differs from the data that was published at the time because of revisions to past data and changes in measurement practices. Most notably, the Commerce Department switched from a fixed-weight to a chain-weighted measure of GDP and GDP deflator measurements in Q4 1995.

Added to this is a revision to the base year from 1992 = 100 to 1996 = 100 in 1999. Finally, all historical data is then subject to a three-yearly revision that incorporates new information not available at the time of the original estimate. Comprehensive revisions may also occur every five or ten years due to definitional changes.

Subsequent revisions to the advance, preliminary and final estimates used by the FOMC occur because of changes in measure methodology, definitional changes, base-year adjustment, general conceptual changes and error corrections.

Whether the FOMC responds to advance, preliminary or final estimates depends largely on the timing of the FOMC meeting, as it will tend to use the latest estimate.

GDP and GDP deflator revisions

Since the early 1980s, the Bureau of Economic Analysis (BEA) estimates that revisions to year-on-year quarterly GDP growth rates has averaged less than one percentage point. The BEA says revisions may have raised GDP by an average of around 0.4 percentage points since the mid-1990s.

These factors may account for differences between the MPM result and the actual FFR when making quarterly and annual comparisons from previous years. For example, a revision in the quarterly GDP deflator measure of only 0.1 per cent can lead to a 0.25 per cent error in the MPM, as all calculations of the MPM have been rounded to the nearest 0.25 per cent. Needless to say, every effort has been made to include the changes and revisions made to the national accounts data.

In recent years, the degree of revision to initial GDP and GDP deflator estimates has tended to decline as measurement techniques have improved. However, there is evidence that the various data revisions made by the BEA over time do, to a large extent, cancel each other out.

Data revisions also raise the spectre that data used by the FOMC at the time of its decisions actually gives a misleading representation of the economy. As such, interest rate decisions will be inappropriate and lead to the need for corrective action by the Fed as subsequent, and more accurate, data is published. This possible source of error in policy making is most apparent, for example, during subsequent revisions to economic data from 1974 and 1975, which suggest the GDP growth was not as weak as originally thought at the time. Using historic data, Taylor-type rules perform relatively poorly during the period, although the application of real-time data produces a more accurate description of movements in the FFR at the time.

MODIFYING THE MPM DURING 'CRISIS' PERIODS

Under exceptional circumstances, Fed policy decisions may not be wholly influenced by current or recent economic fundamentals. Financial or geopolitical events may temporarily take precedence if they are viewed by the Fed as potentially destabilizing to the US economy. Examples include the banking crisis and credit crunch of the early 1990s, and the stock market crash of October 1987, when the Fed acted to cut interest rates aggressively in anticipation of weaker growth, or to avoid a sharp decline in business and consumer confidence.

The collapse of the dot.com bubble in late 2000 prompted aggressive rate cutting by the Fed, as the prospect of a sharp and prolonged decline in asset prices threatened to push the US economy into recession. Fed rate cuts came at a time of low inflation, which afforded the Fed some scope for an easing of policy. Soon after came the events of 11 September 2001, when the FFR was reduced sharply to 1.75 per cent. Although the Fed had already cut the FFR by 3 per cent in the nine months before September of that year, it is uncertain whether the FFR would have fallen below 3 per cent if the events of 11 September had not occurred. It seems safe to presume that, at the very least, Fed policy easing was greatly hastened after 11 September. Furthermore international considerations may prevail upon the Fed, as in late 1998, when interest rates were reduced temporarily as a debt crisis in Brazil threatened the stability of the financial markets.

Movements in the FFR during these 'crisis' periods are unlikely to be captured by the standard MPM. Fed response represents an extreme form of pre-emptive action, often initiated by policy decisions taken in between the regular six-weekly FOMC meetings. What is more, during crisis periods the Fed will usually embark on a prolonged period of rate cutting, lasting a year or more, such as those seen during 1991–4 and 2001. In contrast, pre-emptive decisions under 'normal' circumstances may involve only one or two isolated policy changes conducted at scheduled FOMC meetings.

Fed action outside of its usual scheduled FOMC meetings can prompt a modification of the MPM to embrace the shift in Fed priorities brought about by the conditions prevailing at the time. Equation 3.4 modifies the MPM to yield a rate that more accurately represents Fed policy during a crisis period. The modified MPM effectively equates to a reduction in the MPM of 2 per cent after four quarters. When dealing with quarterly and annual data, it cannot be assumed that the Fed will lower the FFR by an additional 2 per cent in full within one quarter. Consequently a staggering of this adjustment needs to be made over four quarters, and a similar adjustment is required to annual data; see Equation 3.5. The modified MPM would then continue to apply until the Fed begins to start raising rates.

Equation 3.3:

Modified MPM % = 3 % + GDP def. + 0.5 × (GDP def. – 6 %) + 0.5 × (GDP – 2.5 %)

This abbreviates to Equation 3.4:

Modified MPM% = MPM% – 2 %

Equation 3.4 forms the basis of the modified MPM, although its application is subject to incremental changes over a four-quarter period. The significant assumption of Equation 3.4 is that the Fed will tolerate an inflation rate (based on the GDP deflator) of up to 6 per cent in its attempt to alleviate the 'crisis'. The modified MPM has most recently been triggered in January 2001 in response to the sharp economic slowdown seen in 2000. Equation 3.4 implies that the Fed will make an adjustment of 2 per cent to the FFR during crisis periods in order to stave off, or compensate for, extreme conditions.

However, the policy approach of gradual FFR adjustment by the Fed, or deliberate policy inertia, implies that the 2 per cent adjustment will be phased in by the Fed over a period of time. For example, the crisis periods of 1991 and 2001 did not see a 2 per cent reduction in the FFR during the first quarter of the crisis. The modified MPM assumes that the adjustment is made over four consecutive quarters as follows. The same incremental adjustment would apply when rates are raised at the end of crisis period.

Equation 3.5:

Modified MPM 1st quarter = (MPM% – 0.5%)
Modified MPM 2nd quarter = (MPM% – 1.0%)
Modified MPM 3rd quarter = (MPM% – 1.5%)
Modified MPM 4th quarter = (MPM% – 2.0%)

Like the MPM, the modified version can also be applied on an annual basis to calculate a mean implied FFR for a year. The incremental adjustment applied to quarterly estimates applies to annual data during the initial year in which the modified MPM comes into effect. This application over the year leads to a mean adjustment of 1.25 per cent to the MPM. This is calculated by taking the mean of the year's four quarterly adjustments:

0.5 % (Q1) + 1.0 % (Q2) + 1.5 % (Q3) + 2.0 % (Q4) / 4 = 1.25 %

As Figures 3.1 and 3.2 show, the MPM described the actual FFR rate closely since the early 1980s. However, the MPM is less successful in explaining movements in the FFR from 1992–5 and after late 2001. Application of the modified MPM to these periods provides a close correlation between the two rates, as illustrated by Figures 3.7 and 3.8.

USING THE MODIFIED MPM

Box 3.3 shows how to calculate the modified MPM for Q2 2001.

Box 3.3

Data on the US economy for Q1 2001 shows GDP growth at 1.5 per cent and the GDP deflator at 2.4 per cent.
Substituting these figures into Equation 3.5:

Modified MPM (%) = 3 % + 2.4 % + 0.5 × (2.4 % – 2 %) + 0.5 × (1.5 % – 2.5 %) – 1.0 %

= (5.4 % + –0.3 %) – 0.1 %

= 4.1 %

Box 3.3 produces a modified MPM of 4.1 per cent for Q2 2001. This compares with the actual FFR in that quarter of 4.0 per cent.

Figure 3.7 plots the modified MPM against the FFR for the years 1980 to 2002. Application of the modified MPM during the crisis

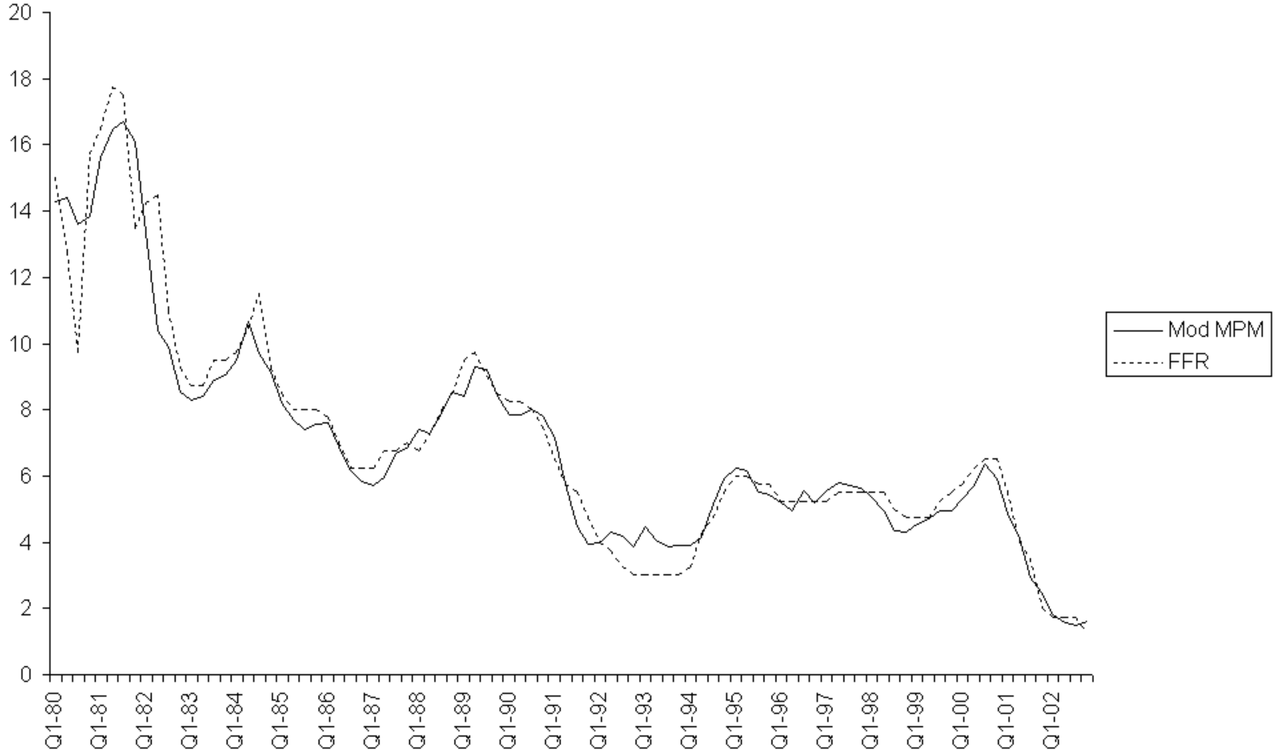

Figure 3.7 The modified MPM and the FFR 1980–2002: quarterly data

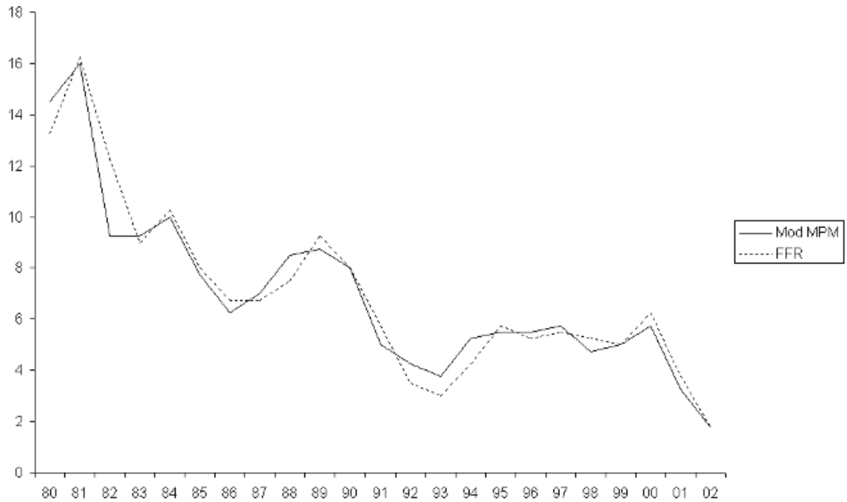

Figure 3.8 The modified MPM and the FFR 1980–2002: annual data

periods of 1992–5 and 2001 produces a very close correlation between the two rates, which the original MPM fails to match.

ASSESSING THE ACCURACY OF THE MPM IN DESCRIBING THE FFR

This section looks at the accuracy of the MPM from 1980 to 2002 and from 1995 to 2002. This breakdown highlights the increasing accuracy of the model in describing the FFR over the time scales tabulated. 1995 onwards captures the adoption of the FFR as the sole policy target and omits the distortion caused by the period of low FFR from 1990–4 resulting from the prevailing credit crunch.

Tables 3.1 and 3.2 show how accurate both the MPM and modified MPM have been in describing the average FFR since 1980 and 1995. The modified MPM produced an error of only 0.1 per cent in explaining both the average quarterly and annual FFR since 1980.

Table 3.3 lists the absolute errors in the MPM describing the FFR from 1980 to 2002 and from 1995 to 2002. Absolute errors, as opposed to mean errors, present a more honest assessment of the accuracy of

Table 3.1 The average MPM, modified MPM and FFR: quarterly data

Averages	*1980–2002*	*1995–2002*
FFR	7.1 %	4.8 %
MPM	7.4 %	5.1 %
Modified MPM	7.0 %	4.6 %

Table 3.2 The average MPM, modified MPM and FFR: annual data

Averages	*1980–2002*	*1995–2002*
FFR	7.1 %	4.8 %
MPM	7.3 %	5.0 %
Modified MPM	7.0 %	4.7 %

Table 3.3 Absolute percentage-point errors in describing the FFR, 1980–2002 and 1995–2002

Model	*Errors 1980–2002*	*Errors 1995–2002*
Quarterly MPM	0.9	0.6
Quarterly modified MPM	0.6	0.3
Annual MPM	0.9	0.5
Annual modified MPM	0.6	0.2

the MPM since positive and negative errors in the MPM are not cancelled out. As such, an error in the MPM overestimating the FFR is treated no differently from the MPM underestimating the FFR.

The table clearly highlights the improved performance of the models since 1995 with the quarterly and annual modified MPM producing an error of approximately 0.25 per cent in describing the FFR between 1995 and 2002.

CHAPTER 4

Making FFR forecasts using the MPM

INTRODUCTION

The value of the MPM lies in its ability not only to explain the prevailing FFR, but to forecast future FFR levels. The performance of the model since 1980 when using annual data means that the use of dependable annual economic forecasts for GDP and inflation should produce estimates of the FFR for forthcoming years. This chapter looks at the economic projections of the US Congressional Budget Office (CBO), uses the CBO's economic projections from 1987 to 2002 in the MPM, then compares the results with the actual FFR.

The ultimate aim is to arrive at a result that can confidently be explained and relied upon to provide an accurate guide to future monetary policy moves. Needless to say, a lower degree of accuracy is perhaps to be expected for longer term forecasts than for more short term estimates. The average accuracy of the model in estimating the future FFR depends largely on the reliability of the projections used in the model. The forecasting records of the CBO are examined at the end of the chapter.

As well as the CBO, numerous other government, and non-government, organizations such as the Organization for Economic Co-operation and Development (OECD) and the International Monetary Fund (IMF) publish economic projections that can also be used. The Fed also publishes twice-yearly forecasts that can be applied to the MPM. This book makes no judgement regarding the relative accuracy of an organization's economic forecasts. This allows for some discretion on the part of the user as to which forecasts he or she is most confident will yield the most accurate results. As well as government and non-government organizations, virtually all commercial banks regularly publish similar forecasts, and the relative accuracy of these can best be assessed by comparing their past forecasts with the historical GDP and inflation data. Government organizations such as the US Administration also publish forecasts, as do most central banks.

Using the CBO's projections has several advantages, perhaps the most notable being the relative impartiality of its projections. For obvious reasons, the US Administration, the Fed and commercial banks may shy away from making overly pessimistic predictions for growth and inflation. The CBO also offers an easily accessible and comprehensive range of forecasts on the US economy. These include projections ranging from one to five years. Its forecasts are also particularly relevant to the MPM because the CBO now uses the GDP chain-type price index as its chosen measure of inflation, which is virtually identical to the GDP deflator. The majority of independent inflation forecasts use the headline CPI rate, which requires conversion into an implied GDP deflator rate. The Fed, however, has adopted the PCE inflation measure for its forecasts, which is more closely correlated with the GDP deflator and so can be used as a substitute, although this will result in some loss of accuracy in the resulting MPM rate.

USING CBO ECONOMIC PROJECTIONS WITH THE MPM TO ESTIMATE THE FUTURE FFR

The US Congressional Budget Office publishes semi-annual economic forecasts of GDP and inflation (the *GDP Price Index* since 1996). These include a one and two year projection published in January of each year and an updated/revised forecast published in the second half of the year. The CBO also publishes a five year economic forecast.

The CBO *Economic and Budget Outlook* for January 1999 is reproduced in Table 4.1.

Table 4.1 The economic outlook, January 1999: the CBO forecast for 1999 and 2000

Fourth quarter to fourth quarter (percentage change)	*Estimate 1998*	*Forecast 1999*	*2000*
Nominal GDP	4.6	3.9	3.9
Real GDP	3.6	1.8	1.9
GDP price-index	1.0	2.1	2.0
Consumer price index	1.6	2.7	2.6

Notes: The GDP price index is virtually the same as the implicit GDP deflator
Based on 1992 dollars
Source: Congressional Budget Office

MAKING ONE YEAR AHEAD FFR FORECASTS

Table 4.2 lists the CBO one year forecasts from 1997 to 2002 and the MPM rate derived from this data. These projections for each year are made in the CBO's *Economic Outlook* report in January of the same year. The results are then compared with the actual FFR over the forecast year. For four out of the six years between 1997 and 2002, the MPM forecast the FFR to within 0.25 percentage points. In 2000, the model produced an error of one and a half percentage points in its forecast. This reflects the overly optimistic

Table 4.2 One year ahead CBO economic forecasts and MPM results

%	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*
GDP	2.3	2.3	1.8	3.3	2.4	2.5
GDP price-deflator	2.3	2.1	2.1	1.6	2.3	1.6
MPM	5.25	5.0	4.75	4.75	4.25	2.5
FFR	5.5	5.25	5.0	6.25	4.0	1.75
MPM error	0.25 %	0.25 %	0.25 %	1.5%	0.25 %	0.75 %

Note: Figures rounded to nearest 0.25 per cent inflation forecast made by the CBO in January of that year, rather than excessive monetary tightening by the Fed during 2000. The actual GDP deflator for 2000 was nearer to 2.1 per cent than to the January forecast of 1.6 per cent. GDP growth also turned out to be somewhat higher than forecast.

The forecasts are derived by applying the CBO's inflation and GDP forecasts to Equations 3.2 and 3.3 in Chapter 3.

MAKING TWO YEAR AHEAD FFR FORECASTS

The results from using the CBO two year forecast in MPM yields slightly less accurate results than those of the one year forecasts. This is only to be expected given the longer time span involved. Again, low GDP and deflator forecasts for 2000 meant that the MPM performed significantly worse in that year. (See Table 4.3.)

Table 4.3 Two year ahead CBO economic forecasts and MPM results

%	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*
GDP	1.9	2.1	1.9	1.9	3.1	3.4
GDP price-index	2.7	2.6	2.2	2.0	1.6	2.1
MPM	5.75	5.75	5.0	4.75	4.75	2.75
FFR	5.5	5.25	5.0	6.25	4.0	1.75
MPM error	0.25 %	0.5 %	0 %	1.5 %	0.75 %	1 %

Note: Forecasts made in January of previous years

MAKING TWO YEAR AHEAD AVERAGE FFR FORECASTS

Table 4.4 plots MPM results based on the CBO two year average forecasts since 1987.

The average absolute error in MPM using the CBO's two year average forecasts for the period 1987–2002 is 0.5 percentage points. This

Table 4.4 Two year ahead average CBO economic forecasts and MPM results (percentage rates)

Period	*GDP*	*GDP deflator*	*MPM*	*Actual FFR*	*MPM error*
1987–8	2.9	3.6	7.5	7.25	+ 0.25
1988–9	2.4	3.9	7.75	8.25	– 0.5
1989–90	2.5	4.3	8.5	8.5	0.0
1990–1	2.0	4.1	8.0	7.0	+ 1.0
1991–2	1.6	4.1	6.0	4.75	+ 1.25
1992–3	2.6	3.1	4.75	3.25	+ 1.5
1993–4	2.9	2.4	3.75	3.75	0.0
1994–5	2.8	2.8	5.5	5.0	+ 0.5
1995–6	2.4	2.8	5.5	5.5	0.0
1996–7	1.9	2.8	6.0	5.5	+ 0.5
1997–8	2.2	2.4	5.5	5.5	0.0
1998–9	2.2	2.2	5.25	5.25	0.0
1999–00	1.9	2.1	4.75	5.5	– 0.75
2000–1	3.2	1.6	4.75	5.0	– 0.25
2001–2	2.9	2.2	3.75	2.75	+ 1.0

includes the modified MPM being applied to the period 1991–4, as described in Chapter 3. The modified MPM has not been applied to 2001 because there was no trigger for a crisis period at the time the 2000–1 forecast was made but has been applied to the 2001–2 period.

MAKING THREE TO FIVE YEAR AHEAD FORECASTS

The CBO's annual forecasts also include economic projections three to five years into the future. Because of the difficulties and inherent inaccuracies in making longer term forecasts, they can only represent approximations of future GDP and inflation. Nevertheless, they still provide a useful guide as to the likely direction of the FFR. The example shown in Table 4.5 lists the CBO's forecasts made in January 1997 for the years 1999, 2000 and 2001, although the MPM still managed to forecast the average annual FFR to within 0.75 percentage points.

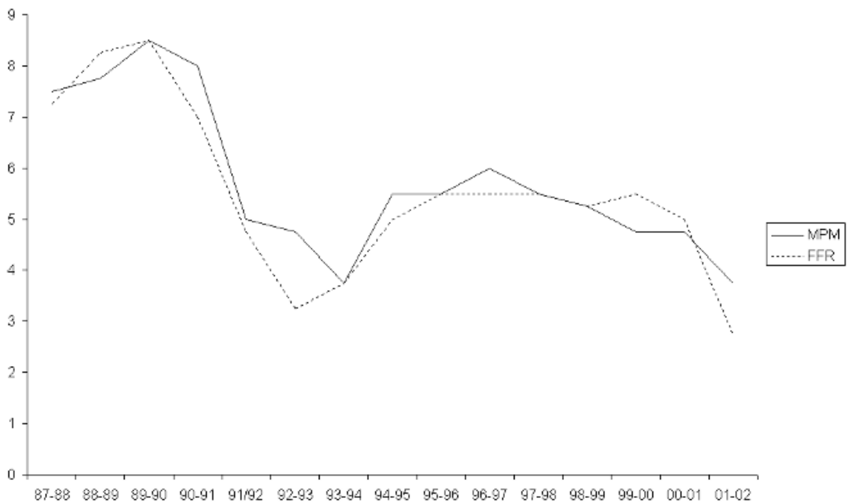

Figure 4.1 The MPM from two year average CBO forecasts and the FFR

Table 4.5 CBO forecasts made in January 1997 for the years 1999–2001

%	1999	2000	2001
GDP	2.2	2.1	2.1
GDP price-index	2.6	2.6	2.6
MPM	5.75	5.75	5.75
FFR	5.0	6.25	5.0
MPM error	0.75 %	0.5 %	0.75 %

CHAPTER 5

Comparing MPM Results with the Eurodollar Futures Market

INTRODUCTION

This chapter assesses the value of the MPM forecasts described in Chapter 4 compared with the FFR implied by the corresponding three month eurodollar interest rate future at the time the forecasts were made. This is achieved by comparing MPM results with historical data on eurodollar futures going back to 1987. This year is taken as the starting point of comparisons since the volume or liquidity of eurodollar futures trading prior to 1987 was insufficient to provide a reliable indication of market expectations of the future direction of the FFR.

The reliability and value of the MPM estimated future FFR using CBO economic projections needs to be compared not only with the actual FFR that prevailed over the forecast period, but also with the market expectations of the future FFR at the time the forecasts were made. Three month eurodollar futures contracts are taken to be the most reliable guide to what the market considers to be the future level of the FFR. They have been chosen in preference to the 30 day federal funds futures contract, because the eurodollar rate is a three-month rate and so more applicable for quarterly forecasts, and because it has a longer history, thereby allowing for comparison across a longer time period. A complete list of the eurodollar contract prices is provided in Appendix 2.

Consequently, this chapter compares the one, two and two year average MPM rates derived from the CBO economic projections discussed in Chapter 4 with the prevailing rates implied by the corresponding eurodollar futures (EDF) strips.

ONE YEAR AHEAD FUTURES PRICES

Table 5.1 shows the comparative accuracy of the MPM and EDF strip in estimating the average FFR over the coming 12 months for the years 1997–2002.

The MPM for each year is estimated in January, the month of publication of the CBO's *Economic and Budget Outlook*. This estimate is then compared with the rate implied by the eurodollar futures strip at the beginning of January. The rate implied by the EDF strip is calculated as the average of the March, June and September contracts as shown in Equation 5.1:

$$\text{EDF} (\%) = 100 - (\text{Mar} + \text{Jun} + \text{Sep}) / 3$$

More precisely, the average rate for the 12 months implied by the market should include the prevailing three month cash rate in January. This has been omitted for the sake of clarity, and because for the years in question, including the rate in the calculation produces no variation in the average EDF rate for the year.

Table 5.1 Accuracy of the MPM and EDF strip in estimating the average FFR for the coming 12 months (1997–2002)

Year	*EDF strip (Jan)*	*MPM*	*Actual FFR*
1997	5.75	5.5	5.5
1998	5.75	5.0	5.25
1999	5.0	4.75	5.0
2000	6.75	4.75	6.25
2001	5.25	4.25	4.0
2002	2.5	2.5	1.75

As Table 5.1 shows, the MPM betters the accuracy of the EDF in 1997 and 1998 and is in error by only 0.25 percentage points in 1999. However, the overly optimistic inflation forecasts of the CBO for 2000 means the futures market significantly outperforms the MPM for that year. Nevertheless, the MPM captures the aggressive easing in policy by the Fed in 2001, which the futures market failed to anticipate. The relatively short term period of one year ahead, or 12 month, forecasts results in a reasonably high degree of accuracy of the futures market. Unless there is a significant change in Fed policy stance during the year the futures market should give an adequate implied estimate of the average FFR for the forthcoming 12 months. The value of the MPM is in either endorsing the market view or indicating a possible trend change in the FFR should the economic forecasts used foretell a significant rise or fall in GDP, or inflation that belies the market consensus, such as in 2001.

TWO YEAR AHEAD FUTURES PRICES

When looking two years ahead, the MPM begins to convincingly outperform the eurodollar futures market, with the exception again of the year 2000. Table 5.2 lists the average two year ahead MPM rate based on CBO forecasts made in January of each year. These are compared with the implied EDF strip for the following year. For example, the average FFR implied by the EDF strip in January

Table 5.2 Average two year ahead MPM rate based on CBO forecasts made in January each year

Year	*EDF strip (Jan)*	*MPM*	*Actual FFR*
1997	6.5	5.75	5.5
1998	5.75	5.5	5.25
1999	5.5	5.0	5.0
2000	7.25	4.75	6.25
2001	5.25	4.75	3.75
2002	5.25	2.75	1.75

2000 for 2001 is calculated from the futures contracts as shown in Equation 5.2:

EDF (%) Jan 2000 = 100 – (Dec 2000 + Mar 2001 + Jun 2001 + Sep 2001) / 4

Once again, the MPM exhibits a high degree of accuracy for the years 1997–8. Although the model underperforms in 2000, the futures market was overly pessimistic by pricing in aggressive monetary policy tightening by the Fed. As a result, the MPM captures much more of the easing seen in 2001 and 2002.

TWO YEAR AHEAD AVERAGE FUTURES PRICES

Table 5.3 compares the average FFR outlook to the end of the following year implied by the three month eurodollar futures strips in January and March of the first year. This is compared with the average value of the eurodollar futures contract up until the end of the two year period. The average FFR over the next two years implied by the EDF strip in January of each year is calculated using the same method for the one and two year ahead forecasts. The results are plotted in Figure 5.1.

The MPM forecast is made in January of each year, so the table compares the FFR implied by the eurodollar futures strip at the time this forecast is made, then again in March. This is done to allow for any significant changes that may have occurred in eurodollar prices between January and March, thus allowing for a more honest comparison of market expectations of the two year average FFR in the first quarter of the forecast period. For example, in January 1989 MPM forecast the average FFR over the next two years (until the end of 1990) as being 8.5 per cent, based on CBO projections just published. In January the eurodollar futures strip forecast the rate as being 9.5 per cent. By March the forecast to the end of 1990 had risen to 10.5 per cent.

Of the 15 forecast periods, the MPM outperforms the futures market by 0.5 percentage points or more on ten occasions, five of which occurred between 1995 and 2002.

As Table 5.3 illustrates, the period 1992–5 is a source of inaccuracy, not only for MPM estimates of the FFR, but also for the implied EDF rates. However, by 1993–4 the eurodollar futures market had began to price in the prospect of a lower FFR than current economic fundamentals suggested. From 1995 onwards the MPM outperforms the futures market in all but two periods (1996–7 and 1999–2000). The MPM rate of 4.75 per cent calculated for that period provided a precursor of the rate cuts to come in 2001, and consequently the MPM forecast for 2001 was significantly more accurate than that of the EDF market.

Table 5.3 Comparing the implied FFR from the EDF strips in January and March of each year and the MPM constructed from CBO forecasts with the actual FFR for the years 1987–2002 (percentage rates)

Period	*EDF strip (Jan)*	*EDF strip (Mar)*	*MPM*	*Actual FFR*
1987–8	6.75	7.0	7.5	7.25
1988–9	8.0	8.0	7.75	8.25
1989–90	9.5	10.5	8.5	8.5
1990–1	8.75	9.0	8.0	7.0
1991–2	7.5	7.25	6.0	4.75
1992–3	5.5	5.5	4.75	3.25
1993–4	4.25	4.0	3.75	3.75
1994–5	4.75	4.75	5.5	5.0
1995–6	7.0	6.75	5.5	5.5
1996–7	5.25	6.0	6.0	5.5
1997–8	6.0	6.5	5.5	5.5
1998–9	5.5	5.75	5.25	5.25
1999–2000	5.25	5.5	4.75	5.5
2000–1	7.0	7.0	4.75	5.0
2001–2	5.0	4.75	3.75	2.75

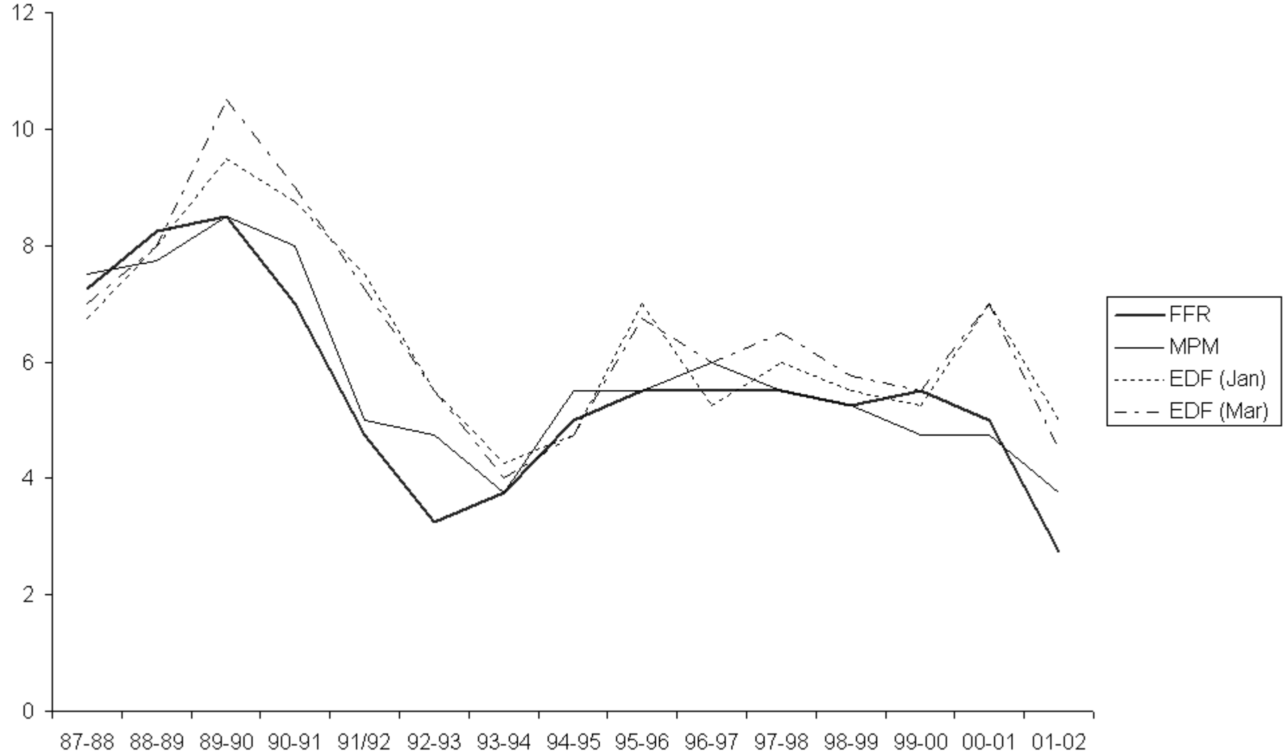

Figure 5.1 Two year ahead average MPM and eurodollar futures strips (1987–2002)

COMPARING THE TWO YEAR AHEAD AVERAGE FORECASTING ERRORS OF THE MPM AND EURODOLLAR FUTURES STRIPS

Table 5.4 summarizes the relative accuracies of the two forecasts in terms of the average absolute errors of each two year period. Since 1995, the average two year average error in the MPM forecasts is only 0.50 percentage points as compared with 1.0 percentage points for the eurodollar strip. If a modified MPM (as described in Chapter 3) is included to cover the period 1992–5, the error since 1987 is only 0.36 percentage points for each period. An explanation for the stronger performance of the MPM has been discussed in Chapters 2 and 3. The lasting relevance of these factors is the MPM should continue to outperform the futures market in making these longer term forecasts of the FFR when the model is used in conjunction with reliable economic projections.

Table 5.4 Two year ahead average forecasting errors of the MPM and EDF strips

	EDF strip (Jan)	*EDF strip (Mar)*	*MPM*
Since 1987	1.1	1.1	0.50
Since 1995	1.0	1.0	0.36

Note: Errors are average absolute for each period

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Appendices

APPENDIX 1

Historic Economic Data (1980–2002)

QUARTERLY DATA

Period	*GDP (y/y)*	*GDP deflator (y/y)*
Q4–79	1.0	8.7
Q1–80	1.2	8.7
Q2–80	– 1.3	9.0
Q3–80	– 1.7	9.3
Q4–80	– 0.3	10.0
Q1–81	0.5	10.3
Q2–81	2.5	9.8
Q3–81	3.1	9.2
Q4–81	0.0	8.4
Q1–82	– 2.6	7.3
Q2–82	– 1.5	6.6
Q3–82	– 2.4	6.0
Q4–82	– 0.8	5.3
Q1–83	1.2	4.7

Period	*GDP (y/y)*	*GDP deflator (y/y)*
Q2–83	2.8	4.5
Q3–83	4.6	4.0
Q4–83	6.1	3.8
Q1–84	7.5	4.1
Q2–84	6.5	3.8
Q3–84	5.4	3.8
Q4–84	4.4	3.5
Q1–85	3.4	3.5
Q2–85	2.8	3.5
Q3–85	3.7	3.3
Q4–85	3.5	3.4
Q1–86	3.9	2.8
Q2–86	3.3	2.5
Q3–86	2.4	2.6
Q4–86	2.4	2.5
Q1–87	1.7	2.9
Q2–87	2.6	3.1
Q3–87	2.9	3.1
Q4–87	3.7	3.2
Q1–88	3.8	3.1
Q2–88	3.8	3.5
Q3–88	3.6	4.0
Q4–88	3.3	4.0
Q1–89	3.6	4.5

Period	*GDP (y/y)*	*GDP deflator (y/y)*
Q2–89	3.4	4.5
Q3–89	3.3	4.0
Q4–89	2.2	4.0
Q1–90	2.2	4.0
Q2–90	1.9	4.2
Q3–90	0.9	4.4
Q4–90	– 0.3	4.7
Q1–91	– 1.8	4.6
Q2–91	– 1.6	4.0
Q3–91	– 1.0	3.8
Q4–91	0.3	3.4
Q1–92	2.1	3.0
Q2–92	2.2	2.9
Q3–92	2.7	2.5
Q4–92	3.6	2.6
Q1–93	2.5	2.7
Q2–93	2.4	2.6
Q3–93	2.2	2.7
Q4–93	2.5	2.6
Q1–94	3.2	2.2
Q2–94	3.9	2.3
Q3–94	3.8	2.5
Q4–94	3.5	2.5
Q1–95	3.3	2.5

Period	*GDP (y/y)*	*GDP deflator (y/y)*
Q2–95	2.3	2.4
Q3–95	2.8	2.2
Q4–95	2.6	2.1
Q1–96	2.4	2.0
Q2–96	3.9	1.9
Q3–96	3.5	2.0
Q4–96	3.9	1.9
Q1–97	4.1	2.0
Q2–97	3.6	2.1
Q3–97	4.1	1.9
Q4–97	3.8	1.8
Q1–98	4.2	1.4
Q2–98	3.6	1.2
Q3–98	3.5	1.2
Q4–98	4.3	1.1
Q1–99	4.0	1.3
Q2–99	3.9	1.5
Q3–99	4.2	1.4
Q4–99	4.3	1.6
Q1–00	4.2	1.9
Q2–00	4.9	2.1
Q3–00	3.7	2.2
Q4–00	2.3	2.3
Q1–01	1.5	2.4

Period	*GDP (y/y)*	*GDP deflator (y/y)*
Q2–01	– 0.1	2.5
Q3–01	– 0.4	2.6
Q4–01	0.1	2.0
Q1–02	1.4	1.4
Q2–02	2.2	1.1
Q3–02	3.3	0.8
Q4–02	2.9	1.3

ANNUAL DATA

Period	*GDP (y/y)*	*GDP deflator (y/y)*
1980	– 0.5	9.2
1981	1.5	9.4
1982	– 1.8	6.3
1983	3.7	4.2
1984	5.9	3.8
1985	3.3	3.4
1986	3.0	2.6
1987	2.7	3.1
1988	3.6	3.7
1989	3.1	4.2
1990	1.2	4.3
1991	– 1.0	4.0
1992	2.7	2.7
1993	2.4	2.6
1994	3.6	2.4
1995	2.7	2.3
1996	3.6	1.9
1997	4.4	1.9
1998	4.3	1.2
1999	4.1	1.4
2000	3.8	2.1
2001	0.3	2.4
2002	2.4	1.1

Quarterly data:
1980–1995 GDP fixed weighted 1992=100
1996–2002 GDP chain weighted 1996=100

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APPENDIX 2

Eurodollar Futures: Historical Data (1987–2002)

Appendix 2 presents a table of historical three month eurodollar futures rates, or yields. Each column lists the contract yield at the end of each month since 1987. The second column, +3m, represents the yield for the nearest contract month. For example, for 31/12/86, the +3m contract would be for March 1987, +6m is for the next contract month June 1987, and so on.

When utilizing economic projections to derive an MPM forecast of the future FFR, the table allows a comparison between the MPM results and the prevailing appropriate eurodollar futures, taken as a proxy for the market view on future FFR levels.

Yields (%) on three month eurodollar futures contracts

Date	*+ 3m*	*+ 6m*	*+ 9m*	*+ 12m*	*+ 15m*	*+ 18m*	*+ 21m*
31/12/86	6.11	6.14	6.24	6.43	6.69	7.01	7.34
30/01/87	6.31	6.23	6.26	6.38	6.57	6.81	7.07
27/02/87	6.42	6.33	6.34	6.43	6.57	6.75	6.96
31/03/87	6.65	6.67	6.72	6.84	7.03	7.24	7.46
30/04/87	7.39	7.69	7.88	8.05	8.22	8.39	8.56

Date	*+ 3m*	*+ 6m*	*+ 9m*	*+ 12m*	*+ 15m*	*+ 18m*	*+ 21m*
29/05/87	7.26	7.82	8.13	8.35	8.53	8.67	8.81
30/06/87	7.42	7.69	7.91	8.11	8.30	8.49	8.67
31/07/87	7.29	7.69	7.99	8.24	8.46	8.67	8.87
31/08/87	7.29	7.93	8.27	8.54	8.77	8.97	9.16
30/09/87	8.60	8.98	9.26	9.47	9.63	9.78	9.94
30/10/87	7.58	7.78	8.26	8.62	8.89	9.1	9.27
30/11/87	7.68	7.67	7.98	8.31	8.60	8.85	9.06
31/12/87	7.56	7.80	8.14	8.48	8.77	9.02	9.22
29/01/88	7.04	7.24	7.53	7.81	8.06	8.28	8.46
29/02/88	6.87	7.00	7.25	7.53	7.78	8.0	8.19
31/03/88	7.28	7.58	7.87	8.13	8.35	8.55	8.73
29/04/88	7.59	7.97	8.24	8.44	8.61	8.77	8.91
31/05/88	8.31	8.63	8.82	8.97	9.10	9.22	9.32
30/06/88	7.96	8.30	8.48	8.64	8.78	8.89	8.98
29/07/88	8.49	8.81	8.86	9.01	9.14	9.25	9.33
31/08/88	8.67	9.19	9.14	9.31	9.44	9.54	9.59
30/09/88	8.78	8.67	8.81	8.98	9.15	9.13	9.2
31/10/88	8.59	8.42	8.49	8.63	8.78	8.75	8.83
30/11/88	9.18	8.97	9.01	9.10	9.26	9.21	9.28
30/12/88	9.38	9.44	9.47	9.65	9.59	9.65	9.69
31/01/89	9.54	9.57	9.55	9.65	9.51	9.51	9.5
28/02/89	10.27	10.53	10.49	10.36	10.03	9.84	9.69
31/03/89	10.71	10.87	10.96	10.61	10.29	10.06	9.96
28/04/89	9.85	9.75	9.79	9.60	9.57	9.57	9.65

Date	*+ 3m*	*+ 6m*	*+ 9m*	*+ 12m*	*+ 15m*	*+ 18m*	*+ 21m*
31/05/89	9.46	9.09	9.06	9.00	9.05	9.13	9.24
30/06/89	8.53	8.34	8.21	8.31	8.39	8.58	8.59
31/07/89	8.21	7.79	7.67	7.76	7.88	8.09	8.15
31/08/89	8.89	8.70	8.5	8.56	8.74	8.93	8.89
29/09/89	8.95	8.71	8.61	8.67	8.93	8.93	8.94
31/10/89	8.37	7.98	8.0	8.12	8.33	8.3	8.36
30/11/89	8.37	7.79	7.69	7.79	8.07	8.18	8.31
29/12/89	8.02	7.84	7.85	8.08	8.20	8.38	8.46
31/01/90	8.35	8.40	8.50	8.73	8.81	8.92	8.97
28/02/90	8.37	8.41	8.51	8.70	8.80	8.92	8.97
30/03/90	8.69	8.81	8.98	9.04	9.14	9.16	9.25
30/04/90	8.81	9.08	9.29	9.39	9.49	9.51	9.57
31/05/90	8.40	8.42	8.53	8.67	8.84	8.9	9.03
29/06/90	8.16	8.18	8.21	8.36	8.49	8.65	8.7
31/07/90	7.89	7.79	7.76	7.91	8.07	8.29	8.41
31/08/90	8.01	7.92	7.99	8.14	8.34	8.63	8.73
28/09/90	8.06	8.01	8.12	8.35	8.64	8.71	8.81
31/10/90	7.89	7.68	7.74	7.92	8.22	8.39	8.56
30/11/90	8.22	7.70	7.53	7.56	7.82	7.92	8.15
31/12/90	7.20	7.11	7.22	7.53	7.68	7.93	8.14
31/01/91	7.06	7.00	7.15	7.45	7.54	7.79	8.01
28/02/91	6.87	6.74	6.94	7.34	7.50	7.78	8.02
29/03/91	6.52	6.79	7.29	7.49	7.79	8.04	8.32
30/04/91	6.08	6.34	6.85	7.17	7.60	7.93	8.22

Date	*+ 3m*	*+ 6m*	*+ 9m*	*+ 12m*	*+ 15m*	*+ 18m*	*+ 21m*
31/05/91	6.09	6.35	6.8	6.96	7.35	7.66	7.98
28/06/91	6.41	6.98	7.09	7.49	7.89	8.22	8.22
31/07/91	6.14	6.56	6.61	7.07	7.55	8.03	8.02
30/08/91	5.72	6.02	6.00	6.29	6.71	7.3	7.42
30/09/91	5.65	5.54	5.71	6.06	6.62	6.78	7.07
31/10/91	5.25	5.13	5.34	5.63	6.19	6.39	6.73
29/11/91	4.95	4.73	4.86	5.12	5.66	5.9	6.32
31/12/91	4.04	4.15	4.36	4.84	5.09	5.54	5.98
31/01/92	4.18	4.40	4.77	5.44	5.77	6.27	6.7
28/02/92	4.21	4.41	4.74	5.37	5.65	6.13	6.59
31/03/92	4.53	4.93	5.72	5.99	6.49	6.98	7.53
30/04/92	4.15	4.57	5.30	5.53	6.02	6.5	7.05
29/05/92	4.02	4.29	4.91	5.04	5.48	5.98	6.58
30/06/92	3.93	4.41	4.51	4.91	5.40	5.98	6.14
31/07/92	3.52	3.91	4.01	4.35	4.75	5.35	5.54
31/08/92	3.46	3.63	3.66	3.95	4.33	4.92	5.16
30/09/92	3.14	3.19	3.49	3.85	4.46	4.78	5.2
30/10/92	3.67	3.66	4.09	4.54	5.17	5.41	5.79
30/11/92	3.99	3.96	4.44	4.93	5.59	5.8	6.17
31/12/92	3.64	4.07	4.48	5.11	5.33	5.68	5.98
29/01/93	3.31	3.51	3.83	4.37	4.61	5.01	5.33
26/02/93	3.23	3.35	3.55	3.93	4.13	4.51	4.84
31/03/93	3.32	3.52	3.94	4.11	4.48	4.8	5.22
30/04/93	3.21	3.32	3.71	3.81	4.15	4.47	4.91

Date	*+ 3m*	*+ 6m*	*+ 9m*	*+ 12m*	*+ 15m*	*+ 18m*	*+ 21m*
31/05/93	3.39	3.61	4.13	4.26	4.61	4.93	5.34
30/06/93	3.43	3.81	3.90	4.18	4.46	4.87	4.96
30/07/93	3.35	3.79	3.91	4.20	4.50	4.93	5.02
31/08/93	3.25	3.55	3.59	3.80	4.04	4.44	4.52
30/09/93	3.49	3.53	3.74	3.97	4.34	4.42	4.62
29/10/93	3.52	3.53	3.75	3.99	4.38	4.46	4.67
30/11/93	3.49	3.62	3.92	4.22	4.63	4.73	4.94
31/12/93	3.51	3.85	4.16	4.57	4.72	4.96	5.16
31/01/94	3.36	3.65	3.96	4.33	4.48	4.71	4.9
28/02/94	3.78	4.16	4.47	4.86	5.06	5.3	5.51
31/03/94	4.37	4.84	5.34	5.59	5.91	6.2	6.51
29/04/94	4.73	5.36	5.86	6.13	6.39	6.62	6.86
31/05/94	4.74	5.41	6.01	6.26	6.54	6.76	6.99
30/06/94	5.36	6.05	6.34	6.64	6.87	7.11	7.15
29/07/94	5.06	5.71	5.94	6.26	6.53	6.8	6.86
31/08/94	5.05	5.70	5.96	6.28	6.56	6.85	6.92
30/09/94	5.95	6.33	6.73	7.03	7.33	7.39	7.51
31/10/94	5.95	6.39	6.86	7.20	7.53	7.63	7.77
30/11/94	6.24	6.94	7.54	7.85	8.08	8.11	8.17
30/12/94	7.23	8.00	8.35	8.53	8.45	8.38	8.33
31/01/95	6.55	7.15	7.47	7.73	7.76	7.83	7.88
28/02/95	6.25	6.51	6.75	6.97	7.06	7.17	7.22
31/03/95	6.50	6.76	7.02	7.03	7.14	7.23	7.32
28/04/95	6.29	6.45	6.68	6.68	6.81	6.91	7.03

Date	*+ 3m*	*+ 6m*	*+ 9m*	*+ 12m*	*+ 15m*	*+ 18m*	*+ 21m*
31/05/95	6.04	5.8	5.79	5.74	5.82	5.9	6.08
30/06/95	5.67	5.67	5.64	5.74	5.84	6.02	6.06
31/07/95	5.76	5.69	5.69	5.83	5.97	6.18	6.23
31/08/95	5.81	5.72	5.68	5.77	5.89	6.06	6.1
29/09/95	5.79	5.66	5.72	5.83	6.01	6.03	6.1
31/10/95	5.78	5.50	5.50	5.56	5.73	5.77	5.86
30/11/95	5.74	5.32	5.21	5.22	5.32	5.34	5.44
29/12/95	5.32	5.07	5.01	5.10	5.12	5.24	5.36
31/01/96	5.22	4.85	4.71	4.73	4.80	4.94	5.1
29/02/96	5.30	5.23	5.25	5.38	5.47	5.62	5.76
29/03/96	5.41	5.54	5.75	5.93	6.08	6.19	6.31
30/04/96	5.49	5.71	6.03	6.20	6.36	6.49	6.62
31/05/96	5.54	5.81	6.19	6.38	6.55	6.69	6.84
28/06/96	5.73	5.99	6.11	6.30	6.46	6.61	6.65
31/07/96	5.78	6.09	6.24	6.40	6.52	6.67	6.7
30/08/96	5.66	6.06	6.28	6.46	6.61	6.78	6.83
30/09/96	5.79	5.93	6.10	6.26	6.43	6.5	6.59
31/10/96	5.53	5.56	5.67	5.79	5.97	6.04	6.14
29/11/96	5.49	5.45	5.53	5.61	5.75	5.8	5.89
31/12/96	5.56	5.72	5.87	6.05	6.13	6.24	6.32
31/01/97	5.59	5.72	5.88	6.07	6.17	6.27	6.34
28/02/97	5.57	5.79	6.00	6.20	6.31	6.42	6.49
31/03/97	6.0	6.32	6.61	6.74	6.84	6.92	7.01
30/04/97	5.93	6.13	6.37	6.49	6.61	6.7	6.8

Date	*+ 3m*	*+ 6m*	*+ 9m*	*+ 12m*	*+ 15m*	*+ 18m*	*+ 21m*
30/05/97	5.82	6.00	6.23	6.35	6.47	6.57	6.68
30/06/97	5.88	6.10	6.20	6.32	6.43	6.54	6.56
31/07/97	5.70	5.79	5.83	5.91	5.99	6.09	6.1
29/08/97	5.74	5.91	6.01	6.12	6.22	6.35	6.37
30/09/97	5.83	5.90	5.99	6.08	6.2	6.21	6.26
31/10/97	5.74	5.76	5.82	5.89	5.99	6.01	6.05
28/11/97	5.90	5.86	5.91	5.97	6.05	6.05	6.09
31/12/97	5.78	5.79	5.84	5.93	5.93	5.96	5.99
30/01/98	5.59	5.49	5.48	5.53	5.51	5.55	5.6
27/02/98	5.68	5.65	5.67	5.74	5.74	5.77	5.81
31/03/98	5.71	5.75	5.87	5.86	5.89	5.91	6.02
30/04/98	5.71	5.75	5.84	5.83	5.86	5.9	6.0
29/05/98	5.69	5.70	5.77	5.74	5.77	5.81	5.91
30/06/98	5.70	5.73	5.68	5.70	5.73	5.83	5.78
31/07/98	5.69	5.73	5.69	5.72	5.74	5.87	5.81
31/08/98	5.56	5.38	5.22	5.22	5.24	5.4	5.34
30/09/98	5.05	4.69	4.58	4.53	4.64	4.57	4.64
30/10/98	5.02	4.52	4.38	4.34	4.49	4.44	4.6
30/11/98	5.25	4.84	4.815	4.86	5.15	4.98	5.04
31/12/98	4.96	4.91	4.90	5.27	4.99	5.03	5.07
29/01/99	4.96	4.91	4.89	5.21	4.99	5.05	5.09
26/02/99	5.04	5.19	5.36	5.75	5.65	5.71	5.76
31/03/99	5.01	5.11	5.44	5.39	5.50	5.60	5.73
30/04/99	5.01	5.16	5.47	5.40	5.52	5.63	5.79

Date	*+ 3m*	*+ 6m*	*+ 9m*	*+ 12m*	*+ 15m*	*+ 18m*	*+ 21m*
31/05/99	5.12	5.38	5.72	5.75	5.93	6.06	6.23
30/06/99	5.41	5.83	5.79	5.96	6.11	6.33	6.37
30/07/99	5.49	5.93	5.98	6.26	6.44	6.67	6.64
31/08/99	5.56	6.01	5.99	6.25	6.44	6.67	6.69
30/09/99	5.97	5.80	5.96	6.10	6.30	6.36	6.46
29/10/99	6.02	5.92	6.10	6.23	6.40	6.43	6.53
30/11/99	6.07	5.99	6.26	6.44	6.62	6.65	6.74
31/12/99	6.17	6.48	6.68	6.91	6.91	7.0	7.04
31/01/00	6.32	6.70	6.98	7.22	7.32	7.43	7.49
29/02/00	6.21	6.57	6.83	7.08	7.18	7.28	7.33
31/03/00	6.66	6.94	7.16	7.22	7.28	7.30	7.32
28/04/00	6.78	7.11	7.30	7.34	7.39	7.39	7.41
31/05/00	6.95	7.28	7.56	7.55	7.57	7.56	7.59
30/06/00	6.94	7.13	7.11	7.12	7.12	7.16	7.10
31/07/00	6.82	7.01	6.98	7.00	7.01	7.06	7.01
31/08/00	6.67	6.82	6.75	6.77	6.79	6.86	6.8
29/09/00	6.74	6.54	6.49	6.47	6.55	6.49	6.53
31/10/00	6.71	6.52	6.43	6.39	6.49	6.44	6.49
30/11/00	6.64	6.31	6.14	6.05	6.12	6.07	6.13
29/12/00	5.89	5.59	5.44	5.54	5.54	5.65	5.73
31/01/01	5.15	4.87	4.82	4.99	5.06	5.25	5.39
28/02/01	5.01	4.72	4.64	4.82	4.89	5.07	5.22
30/03/01	4.41	4.31	4.47	4.55	4.79	5.03	5.29
30/04/01	4.19	4.21	4.51	4.68	4.97	5.22	5.51

Date	*+ 3m*	*+ 6m*	*+ 9m*	*+ 12m*	*+ 15m*	*+ 18m*	*+ 21m*
31/05/01	3.91	3.87	4.21	4.47	4.86	5.19	5.53
29/06/01	3.82	4.19	4.50	4.90	5.22	5.57	5.75
31/07/01	3.54	3.68	3.80	4.11	4.44	4.82	5.05
31/08/01	3.43	3.41	3.52	3.79	4.14	4.54	4.79
28/09/01	2.46	2.58	2.89	3.33	3.81	4.15	4.47
31/10/01	2.09	2.12	2.33	2.67	3.11	3.47	3.84
30/11/01	1.92	2.05	2.50	3.06	3.69	4.16	4.60
31/12/01	1.98	2.34	2.93	3.66	4.31	4.93	5.4
31/01/02	2.01	2.42	2.95	3.54	4.09	4.584	4.94
28/02/02	1.93	2.21	2.67	3.24	3.79	4.30	4.67
30/03/02	2.53	3.27	3.92	4.52	5.0	5.34	5.58
30/04/02	2.07	2.55	3.12	3.68	4.22	4.66	4.94
31/05/02	1.93	2.32	2.91	3.50	4.04	4.44	4.74
29/06/02	1.96	2.27	2.76	3.39	3.96	4.39	4.68
31/07/02	1.79	1.86	2.07	2.46	2.93	3.38	3.75
31/08/02	1.81	1.78	1.94	2.21	2.58	2.96	3.23
28/09/02	1.49	1.51	1.67	1.98	2.36	2.70	2.99
31/10/02	1.46	1.44	1.59	1.83	2.18	2.55	2.91
30/11/02	1.42	1.48	1.75	2.15	2.59	3.01	3.41
31/12/02	1.32	1.37	1.53	1.78	2.12	2.50	2.82

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APPENDIX 3

The Federal Funds Rate (1980–2002)

1980	*Change*	*FFR*
January	gradual increase	14
February 15	+ ½ to 1	14½ to 15
March	gradual increase	20
April to mid May	gradual decrease	10½ to 11½
May 22	– 1 to ¾	9½ to 10¾
June 5	– 1 to 1¼	8½ to 9½
August 7	+ 1½ to ½	10
September	+ 1	11
September 26	+ ¾ to 1	11¾ to 12
October	+ ¼ to 0	12
October	gradual increase	13½ to 13¾
November 7	+ 1½ to 1¼	15
November 26	+ 2 to 3	17 to 18
December 5	+ 2	19 to 20
December 29	– 2	17 to 18

1981	*Change*	*FFR*
January	raised towards	19 to 20
January to April	gradual decrease	16
May 8	raised to	18 to 20
Late May	gradual increase	20
June to October	gradual decrease	14½ to 15½
November 2	– 1½	13 to 14
November	gradual decrease	13
December 4	– 1	12

1982	*Change*	*FFR*
January to April	gradual increase	15
April to July	gradual decrease	12½ to 13
July 20	– 1	11½ to 12
August 2	– ½	11 to 11½
August 16	– 1	10 to 10½
August 27	– ½ to 1	9½
September	+ ½	10
October 12	– ½	9½
November 22	– ½	9
December 15	– ½	8½

1983	*Change*	*FFR*
May to August	gradual increase	9½ to 9⅝
August to October	gradual decrease	9¼ to 9½

1984	*Change*	*FFR*
March	gradual increase	9¾ to 10
March 29	+ ¼ to ½	10 to 10½
April 6–9	+ ½ to 0	10½
June	+ ½	11
July to August	gradual increase	11½ to 11¾
September to October	gradual decrease	10
November	– ½	9½
November 22	– ½	9
December	– ¼	8¾
December 24	– ½	8¼

1985	*Change*	*FFR*
February to March	gradual increase	9
March to April	gradual decrease	8½
Mid April	– ¼	8¼
May 20	– ½	7¾
Mid July	– $^{1}/_{8}$ to 0	7$^{5}/_{8}$ to 7¾
July to August	gradual increase	7¾ to 8
September 6	+ ¼ to 0	8
December 18	– ¼	7¾

1986	*Change*	*FFR*
March 7	– ½	7¼
April 18–21	– ½	6¾
Late May	+ 0 to $^{1}/_{8}$	6¾ to 6$^{7}/_{8}$
Mid June	+ $^{1}/_{8}$ to 0	6$^{7}/_{8}$
July 11	– ½	6$^{3}/_{8}$
Mid August	– $^{1}/_{8}$ to 0	6¼ to 6$^{3}/_{8}$
August 21	– $^{3}/_{8}$ to ½	5$^{7}/_{8}$
Late December	+ $^{1}/_{8}$	6

1987	*Change*	*FFR*
April to May	gradual increase	6¾
September 3	+ 0 to ¼	6¾ to 7
September 4	+ ½ to ¼	7¼
October 19	– ½ to 3/8	6¾ to 6 7/8

1988	*Change*	*FFR*
January to February	gradual decrease	6½
March to June	gradual increase	7½
Mid July	+ $^{1}/_{8}$ to ¼	7$^{5}/_{8}$ to 7¾
August 5	+ $^{1}/_{8}$ to 0	7¾
August 9	+ ¼ to ½	8 to 8¼
Mid November	+ $^{3}/_{8}$ to $^{1}/_{8}$	8$^{3}/_{8}$
Early December	+ ¼ to $^{3}/_{8}$	8$^{5}/_{8}$ to 8¾

1989	*Change*	*FFR*
January to February	gradual increase	9¼ to $9^{3}/_{8}$
February 23	+ ¼	9½ to $9^{5}/_{8}$
February 24	+ ¼ to $^{1}/_{8}$	9¾
Early June	– ¼ to $^{1}/_{8}$	9½ to $9^{5}/_{8}$
July to December	gradual decrease	8¼

1990	*Change*	*FFR*
July 13	– ¼	8
October 29	– ¼	7¾
November 13	– ¼	7½
December 7	– ¼	7¼
December 18	– ¼	7

1991	*Change*	*FFR*
January 9	– ¼	6¾
February 1	– ½	6¼
March 8	– ¼	6
April 30	– ¼	5¾
August 6	– ¼	5½
September 13	– ¼	5¼
October 31	– ¼	5
November 6	– ¼	4¾
December 6	– ¼	4½
December 20	– ½	4

1992	*Change*	*FFR*
April 9	– ¼	3¾
July 2	– ½	3¼
September 4	– ¼	3

1993	*Change*	*FFR*
No changes		

1994	*Change*	*FFR*
February 4	+ ¼	3¼
March 22	+ ¼	3½
April 18	+ ¼	3¾
May 17	+ ½	4¼
August 16	+ ½	4¾
November 15	+ ¾	5½

Rate change at unscheduled FOMC meeting

1995	*Change*	*FFR*
February 1	+ ½	6
July 6	– ¼	5¾
December 19	– ¼	5½

1996	*Change*	*FFR*
January 31	– ¼	5¼

1997	*Change*	*FFR*
March 25	+ ¼	5½

1998	*Change*	*FFR*
September 29	– ¼	5¼
October 15	– ¼	5
November 17	– ¼	4¾

Rate change at unscheduled FOMC meeting

1999	*Change*	*FFR*
June 30	+ ¼	5
August 24	+ ¼	5¼
November 16	+ ¼	5½

2000	*Change*	*FFR*
February 2	+ ¼	5¾
March 21	+ ¼	6
May 16	+ ½	6½

2001	*Change*	*FFR*
January 03	– ½	6
January 31	– ½	5½
March 20	– ½	5
April 18	– ½	4½
May 15	– ½	4
June 27	– ¼	3¾
August 21	– ¼	3½
September 17	– ½	3
October 2	– ½	2½
November 6	– ½	2
December 11	– ¼	1¾

Rate change at unscheduled FOMC meeting

2002	*Change*	*FFR*
November 6	– ½	1¼

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APPENDIX 4

A Comparison of Different US Inflation Measures (1970–2002)

Figure A.1 plots various different US inflation measures for the years 1970–2002 using quarterly, year-on-year data. Since there is no definitive inflation measure for the United States as such, the various inflation measures can all, in theory, be applied to Taylor-type monetary policy rules. However, most do not produce accurate results in describing the FFR over long periods. The chosen inflation measure used in this book is the GDP deflator, which has tended to be lower than the various other measures. This measure is now more closely correlated with the personal consumption and expenditure (PCE) price-index, used by the Fed in its annual inflation forecasts. However, even the PCE inflation measure has been criticized for overstating the US economy's 'true' inflation rate by as much as half a percentage point. Meanwhile, the CPI 'headline' measure has been estimated to overstate inflation by as much as two percentage points.

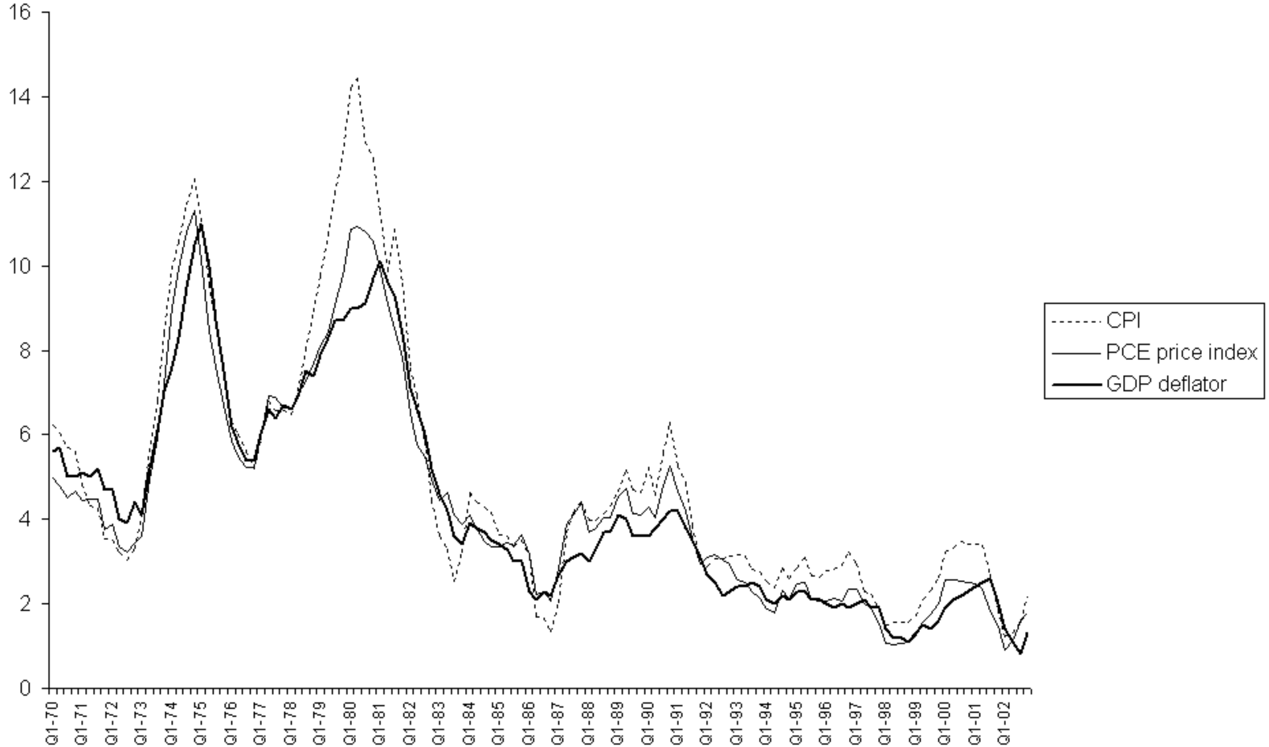

Figure A.1 US inflation measures (1970–2002)

APPENDIX 5

The MPM and the FFR (1980–2002)

QUARTERLY DATA

The MPM and the FFR, (1980–2002)

Quarter	*FFR (%)*	*MPM (%)*
Q1–80	15.0	14.3
Q2–80	12.75	14.4
Q3–80	9.75	13.6
Q4–80	15.75	13.85
Q1–81	16.5	15.6
Q2–81	17.75	16.45
Q3–81	17.5	16.7
Q4–81	13.5	16.1
Q1–82	14.25	13.35
Q2–82	14.5	10.4
Q3–82	11.0	19.9
Q4–82	9.25	8.55
Q1–83	8.75	8.3

Quarter	*FFR (%)*	*MPM (%)*
Q2–83	8.75	8.4
Q3–83	9.5	8.9
Q4–83	9.5	9.05
Q1–84	9.75	9.5
Q2–84	10.5	10.65
Q3–84	11.5	9.7
Q4–84	9.25	9.15
Q1–85	8.5	8.2
Q2–85	8.0	7.7
Q3–85	8.0	7.4
Q4–85	8.0	7.55
Q1–86	7.75	7.6
Q2–86	7.0	6.9
Q3–86	6.25	6.15
Q4–86	6.25	5.85
Q1–87	6.25	5.7
Q2–87	6.75	5.95
Q3–87	6.75	6.7
Q4–87	7.0	6.85
Q1–88	6.75	7.4
Q2–88	7.25	7.3
Q3–88	8.0	7.9
Q4–88	8.5	8.55
Q1–89	9.5	8.4

Quarter	*FFR (%)*	*MPM (%)*
Q2–89	9.75	9.3
Q3–89	9.0	9.2
Q4–89	8.5	8.4
Q1–90	8.25	7.85
Q2–90	8.25	7.85
Q3–90	8.0	8.0
Q4–90	7.5	7.8
Q1–91	6.5	7.65
Q2–91	5.75	6.75 (5.75)
Q3–91	5.5	5.95 (4.5)
Q4–91	4.75	5.95 (4.0)
Q1–92	4.0	6.0 (4.0)
Q2–92	3.75	6.3 (4.25)
Q3–92	3.25	6.2 (4.25)
Q4–92	3.0	5.85 (4.0)
Q1–93	3.0	6.45 (4.5)
Q2–93	3.0	6.05 (4.0)
Q3–93	3.0	5.85 (3.75)
Q4–93	3.0	5.9 (3.75)
Q1–94	3.25	5.9 (3.75)
Q2–94	4.25	5.65 (4.0)
Q3–94	4.75	6.15 (4.5)
Q4–94	5.5	6.4
Q1–95	6.0	6.25

Quarter	*FFR (%)*	*MPM (%)*
Q2–95	6.0	6.15
Q3–95	5.75	5.5
Q4–95	5.75	5.45
Q1–96	5.25	5.2
Q2–96	5.25	4.95
Q3–96	5.25	5.55
Q4–96	5.25	5.2
Q1–97	5.25	5.55
Q2–97	5.5	5.8
Q3–97	5.5	5.7
Q4–97	5.5	5.65
Q1–98	5.5	5.35
Q2–98	5.5	4.95
Q3–98	5.0	4.35
Q4–98	4.75	4.3
Q1–99	4.75	4.8
Q2–99	4.75	4.7
Q3–99	5.25	4.95
Q4–99	5.5	4.95
Q1–00	5.75	5.3
Q2–00	6.25	5.7
Q3–00	6.5	6.35
Q4–00	6.5	5.9
Q1–01	5.5	5.35

Quarter	*FFR (%)*	*MPM (%)*
Q2–01	4.0	5.1
Q3–01	3.5	4.45
Q4–01	2.0	4.45
Q1–02	1.75	3.8
Q2–02	1.75	3.55
Q3–02	1.75	3.5
Q4–02	1.25	3.6

ANNUAL DATA

The MPM and the FFR, (1980–2002)

Year	*FFR (%)*	*MPM (%)*
1980	13.25	14.5
1981	16.25	16.0
1982	12.25	9.25
1983	9.0	9.25
1984	10.25	10.0
1985	8.0	7.75
1986	6.75	6.25
1987	6.75	7.0
1988	7.5	8.5
1989	9.25	8.75
1990	8.0	8.0
1991	5.75	6.25 (5.0)
1992	3.5	6.25 (4.25)
1993	3.0	5.85 (3.85)
1994	4.25	6.25 (5.25)
1995	5.75	5.5
1996	5.25	5.5
1997	5.5	5.75
1998	5.25	4.75
1999	5.0	5.0
2000	6.25	5.75
2001	3.75	4.5 (3.75)
2002	1.75	3.75 (1.75)

Notes: Modified MPM in parenthesis
All rates rounded to nearest 0.25%

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General Notes

CHAPTER 1

1. In 1996, President Bill Clinton called for a 'national debate' on whether the US economy could grow faster than 2.5 per cent without accelerating inflation.

2. In 1995–6 the Fed undertook an analysis of the correct measure of US inflation. The resulting *Boskin Report* estimated that CPI overstates true inflation by between 0.75 and 1.5 percentage points over a 12-month period. Alan Greenspan later announced that the CPI measure typically overstated actual inflation by between 0.5 to 2.0 percentage points. As such, the GDP deflator and PCE price-index were stated as being a more authentic guide to inflation in the US economy.

3. Potential output (GDP) was estimated by the Council of Economic Advisors (CEA) at 4 per cent in 1974 but this estimate was gradually reduced to around 2.5 per cent by the late 1980s.

4. More recent monetary policy rules applied to the Fed include the McCallum rule and the Svensson rule. The former suggests that the Fed should target a nominal GDP growth rate for the US economy. The Svennson rule specifies that the Fed should target the forecast for the inflation rate two years ahead.

CHAPTER 2

1. G. William Miller was Fed chairman between Q2 1978 and Q2 1979. His short tenure has not been considered here.

2. February 2000 saw the introduction of a 'balance of risks' statement issued by the FOMC after each meeting. This replaced the symmetrical or asymmetrical 'policy directive' statements adopted in 1999. The Fed's 'balance of risks' assessment relates to their long term goals of price stability and sustainable economic growth.

3. Alan Greenspan's tenure as Fed chairman has not been without criticism. His handling of the banking crisis of the early 1990s and the Fed's willingness to bail out the Long Term Capital Management (LTCM) hedge fund have both attracted negative comment. More recently, Greenspan's apparent reluctance to quell a housing and consumer borrowing boom that began in the late 1990s has also been called into question by some Fed watchers.

4. Alan Greenspan's fourth term as Fed chairman ends in June 2004.

5. The 'monetary aggregates' are the money supply measures, M1, M2 and M3.

6. Borrowed reserves are funds supplied to banks via the Fed's discount window.

7. Non-borrowed reserves are funds supplied to banks via Fed open market operations.

CHAPTER 3

1. The Fed adjusts the FFR in multiples of 0.25 per cent and as such, all figures for the MPM have been rounded to the nearest 0.25 per cent.

2. In a 1996 speech, FOMC member Edward Kelly described a 2.5 per

cent annual growth rate for GDP as ‘an acceptable, sustainable cruising speed’ for the US economy. Furthermore, in November 1999 Lawrence Meyer described trend GDP of 2.5 per cent as a ‘consensus’.

3. Although the Fed has estimated that a 5 per cent fall in the trade weighted value of the dollar is equivalent to a 0.5 per cent cut in the FFR, the value of the US dollar is not considered in the Taylor rule or MPM. This is because any impact on prices that a change in the dollar exchange rate may have is assumed to be inherent in inflation data considered by the FOMC.

4. Laubach and Williams of the Fed note that a simple estimate of the natural real interest rate entails measuring the long term average real FFR during periods when inflation is stable. The natural real rate is then calculated at about 3 per cent.

5. Interest rate smoothing has been a major topic in some studies estimating an appropriate monetary policy rule for the Fed. This can involve making the FFR for each quarter a function of the rate in the previous quarter. This produces a close correlation with the actual FFR using historical data.

CHAPTER 4

1. Federal Reserve Board forecasts can also be applied to the MPM although the PCE price-index inflation measure adopted in 2000 for their published forecasts produces inferior results compared to the GDP deflator when applied to historical data.

2. *The Survey of Professional Forecasters* published by the Philadelphia Fed is published quarterly and offers alternative independent forecasts of GDP and GDP inflation that can be applied both quarterly and annually to the MPM.

CHAPTER 5

1. The three month eurodollar futures contract is traded on the Chicago Mercantile Exchange (CME).

2. Strictly speaking the eurodollar futures yields are not forecasts of the future FFR but an implied rate of the market consensus of the future FFR.

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