'Is the Taylor Rule the same as the Friedman Rule?'‡

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Abstract

Our objective in this paper has been to provide more theoretically coherent microfoundations for monetary policy rules in response to Lucas's (1976) critique of econometric policy evaluation and, more importantly, to show that the Taylor rule can be derived via Friedman's k% money supply rule. A key difference with respect to the traditional IS-LM framework, is that, the aggregate decision rules evolve explicitly from optimisation by households and firms. We conduct counterfactual historical analysis - to compare and contrast Friedman's rule alongside Taylor's (1993) rule.

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1 Introduction

Recent years have witnessed an upsurge of interest among both academic economists and central bankers alike in the topic of simple and explicit rules for conducting monetary policy. As Taylor (1999a) points out, the key question posed in this line of research is: what type of monetary policy rule should the central bank use to guide its decision making process, and in particular, how responsive should the central bank's interest rate decision be to real output and the inflation rate?[1] To implement this response central banks have generally favoured interest rate rules over money supply rules. Demand for broad money aggregates have proved highly unstable in the world of deregulated banking, while narrow money aggregates, though immune to deregulation, have proved to be vulnerable to technological change. However, for this approach to be successful, one needs a stricter definition of the class of parameters that can be regarded as "genuinely structural".

Our objective in this paper has been to provide a more theoretically coherent micro-foundation for such rules in response to Lucas's (1976) critique of econometric policy evaluation and perhaps, more importantly, to show that the Taylor Rule is an implication of Friedman's ($k\%$) money supply rule. Our benchmark framework, as in McCallum and Nelson (1999) and Clarida et al (1999) is a dynamic general

[1] *Placing some weight on real output seems to work better than a simple policy rule, but it is not clear whether the weight on output should be greater than or less than the weight on the price level.*

equilibrium model with money. It also embeds nominal overlapping wage contracts as pioneered by Phelps and Taylor (1977) for which a rationale can be found in insurance against shocks given indexation imperfections (e.g. Minford, Nowell, and Webb, 1999). A key difference with respect to the traditional IS-LM framework, is that, the aggregate behavioural equations evolve explicitly from optimisation by households and firms. A common feature of our modelling approach with that of the Real Business Cycle (RBC) school is to imagine that the model economy is governed by a benevolent social planner i.e., a representative agent. The problem faced by Robinson Crusoe is to choose sequences for consumption, labour supply, and 'real' money balances that maximises his utility subject to the aggregate resource constraint. In addition, a representative firm's objective function along with its constraints are specified. Firms rent capital and labour inputs from households and transform them into output according to a production technology and sell consumption and investment goods to households and the government. The interaction between firms and households is crucial, as they provide valuable insights for our understanding of fluctuations, and by implication guides us towards optimal rules for conducting monetary policy.

The purpose of the present paper is to conduct counterfactual historical analysis - and to compare and contrast Friedman's money supply rule alongside Taylor's (1993) rule[2]. Discrepancies between rule-specified and actual values for interest rates is then evaluated in light of ex-post judgement concerning macroeconomic performance of the US economy from 1960 Q1 to 1999 Q4. All this, however, does not mean that such rules should be mechanically followed by policy makers. Moreover, there will be episodes where monetary policy need to be adjusted to deal with special circumstances. Witness for example, the Federal Reserve's response after the stock-market crash of 1987 or for that matter its response to the recent Asian financial crisis of 1997-98; in both instances quite sharp cuts in interest rates were made to prevent a contraction of liquidity and erosion of confidence in the financial system. Thus, a rule just serves as a guideline for policy makers and should not and need not be used mechanically to determine interest rates.

2 Theoretical Structure

Consider an economy populated by identical infinitely lived agents that produce a single good as output. The single good produced in the economy can be used both for consumption and investment. At the beginning of each period t, the representative agent chooses (a) the commodity bundle necessary for consumption during the period,

[2] *Our paper uses a historical methodology to evaluate policy rules in the United States à la Friedman and Schwartz (1963), Taylor (1999c), and McCallum (2000). Moreover, the paper uses a tightly specified model to interpret historical evidence and in doing so examines whether the (implied) rule results in good macroeconomic performance.*

(b) the total amount of leisure that he would like to enjoy during the period, and (c) the amount of real money balances required during the period. All of these choices are constrained by the fixed amount of time available and the aggregate resource constraint that agents face. During the period t, the model economy is influenced by various random shocks. Factor inputs and the exogenous technological shock would help determine the total stock of commodities that would be available at the economy's disposal at the beginning of the next period (t+1).

The Representative Household

In a stochastic environment the consumer maximises his expected utility subject to his budget constraint. Each agents preferences are given by

$$U = MaxE_t\left[\sum_{i=0}^{\infty}\beta^i u\left(C_{t+i}\ ,\left(\frac{M_{t+i}}{P_{t+i}}\right),\ L_{t+i}\right)\right], \qquad 0 \prec \beta \prec 1 \tag{1}$$

where β is the discount factor, C_t is consumption in period t, L_t is the amount of leisure time consumed in period t, $\frac{M_t}{P_t}$ is real money balances held in period t, and E_t is the mathematical expectations operator. The essential feature of this structure is that agents' tastes are assumed to be static over time and are not influenced by exogenous stochastic shocks. The preference ordering of consumption subsequences $\left[\left(C_t\ ,\ L_t,\ \frac{M_t}{P_t}\right),\left(C_{t+1}\ ,\ L_{t+1},\ \frac{M_{t+1}}{P_{t+1}}\right),...\right]$ does not depend on t or on consumption prior to time t. We assume that u(C,L,$\frac{M}{P}$) is increasing in (C,L,$\frac{M}{P}$) and concave - $u^1\left(C\ ,\ L,\ \frac{M}{P}\right) \succ 0,\ u^{11}\left(C\ ,\ L,\ \frac{M}{P}\right) \prec 0$. We also assume that u(C,L,$\frac{M}{P}$) is well behaved and satisfies *Inada-type* conditions.

As Barro and King (1984) point out, preference ordering (time-separable) of this form would not restrict the sizes of intertemporal substitution effects. However, time-separability does constrain the relative size of various responses, such as those of leisure and consumption to relative-price and income effects. As the authors argue, for the purpose of business cycle analysis, the presumption that departures from separability matters only for days and weeks and not for months or years is wholly justified. Macroeconomic analysis is primarily concerned with time periods such as quarters or years. Hence, time-separability of preferences is a reasonable approximation in this context.

The representative household's budget constraint is given by

$$(d_t + p_t) S_t + \frac{M_{t-1}}{P_t} + b_t + w_t N_t = C_t + \frac{M_t}{P_t} + \frac{b_{t+1}}{1 + r_t} + p_t S^d_{t+1} + T_t \qquad (2)$$

where $w_t N_t$ is labour income, b_t is real bonds, P_t is the general price level, p_t is the price of shares, T_t denotes lump-sum taxes, and r_t is the real rate of interest. S_t and d_t are shares and dividend income respectively.

If each household can borrow an unlimited amount at the going interest rate, then it has an incentive to pursue a Ponzi game. The household can borrow to finance current consumption and then use future borrowing to roll over the principal and pay all of the interest. Since debt grows forever i.e., no principal ever gets repaid, today's added consumption is effectively free. In order to rule out a strategy of infinite consumption supported by unbounded borrowing, we have to impose a restriction that, for $t \geq 0$

$$C_t + \sum_{j=1}^{\infty} \left(\prod_{k=0}^{j-1} R_{t+k}^{-1} \right) C_{t+j} = Y_t + \sum_{j=1}^{\infty} \left(\prod_{k=0}^{j-1} R_{t+k}^{-1} \right) Y_{t+j} + A_t \tag{3}$$

where A_t denotes financial wealth (bonds and shares in our set up) and Y_t denotes labour (and dividend) income. Furthermore, each agent is endowed with a fixed amount of time which can be spent for leisure L_t or work N_t. If H_t (total endowment of time) is normalised to unity then it follows that

$$N_t + L_t = 1 \tag{4}$$

or

$$L_t = 1 - N_t$$

There are also the non-negativity constraints $L_t \geq 0$, $N_t \geq 0$, $\frac{M_t}{P_t} \geq 0$, and $C_t \geq 0$.

The Representative Household's Optimisation problem

We assume a log-linear utility function in order to carry out our constrained optimisation exercise. Market equilibrium is characterised by the following set of equalities:

$$0 = \frac{\partial L}{\partial C_t} = \frac{1}{C_t} - \lambda_t \tag{5}$$

$$0 = \frac{\partial L}{\partial b_{t+1}} = -\frac{\lambda_t}{1+r_t} + \beta E_t \lambda_{t+1} \tag{6}$$

$$0 = \frac{\partial L}{\partial M_t} = \frac{1}{M_t} - \frac{\lambda_t}{P_t} + \beta E_t \frac{\lambda_{t+1}}{P_{t+1}} \tag{7}$$

$$0 = \frac{\partial L}{\partial L_t} = \frac{1}{1-N_t} - \lambda_t w_t \tag{8}$$

$$0 = \frac{\partial L}{\partial S_{t+1}} = -\lambda_t p_t + \beta E_t \lambda_{t+1} \left(d_{t+1} + p_{t+1} \right) \tag{9}$$

Substituting **(5)** in **(7)** yields:

$$\frac{1}{M_t} + \beta E_t \left(\frac{1}{C_{t+1} P_{t+1}} \right) = \frac{1}{C_t P_t} \tag{10}$$

or

$$\frac{1}{C_t P_t} = \frac{1}{M_t} + \beta E_t \left(\frac{1}{M_{t+1}} \right) + \beta^2 E_t \left(\frac{1}{M_{t+2}} \right) + ... + \beta^N E_t \left(\frac{1}{C_{t+N+1} P_{t+N+1}} \right) \tag{11}$$

Imposing the transversality condition $\lim_{N \to \infty} \beta^N E_t \left(\frac{1}{C_{t+N+1} P_{t+N+1}} \right) \to 0$ yields:

$$\frac{1}{C_t P_t} = \frac{1}{M_t} + \beta E_t \left(\frac{1}{M_{t+1}} \right) + \beta^2 E_t \left(\frac{1}{M_{t+2}} \right) + ... + \beta^N E_t \left(\frac{1}{M_{t+N}} \right) \tag{12}$$

If we impose a constant money growth (μ) rule i.e., $M_t = (1+\mu)^4 M_{t-4}$ on equation **(12)**, we get in natural logarithms

$$\log M_{t-4} - \log P_t = \log \left[\frac{1}{1 - \beta \left(1+\mu\right)^{-1}} \right] - \log(1+\mu)^4 + \log C_t \tag{13}$$

Thus we have a relation expressing real money balances as a function of consumption spending and the subjective discount factor. Note that real money balances are positively related to consumption and negatively related to an opportunity-cost variable.

Substituting **(9)** for λ_t in **(6)** yields**:**

$$\left(\frac{d_{t+1} + p_{t+1}}{p_t} \right) = 1 + r_t \equiv R_{1t} \tag{14}$$

Substituting **(5)** and **(14)** in **(9)** for λ_t and λ_{t+1} respectively results in:

$$\frac{1}{C_t} = \beta E_t \left(\frac{1}{C_{t+1}} \right) (1 + r_t) \tag{15}$$

The expression for consumption is in line with developments in contemporary macroeconomic research which suggests the dependence of current consumption on expected future consumption i.e., forecasts of the future enter importantly into current decision making. The negative effect of the real interest rate on current consumption, in turn reflects intertemporal substitution of consumption.

The Government

In this general equilibrium framework let us introduce a government that spends current output according to a non negative stochastic process (G_t) that satisfies G_t □ Y_t for all t. The government budget constraint is

$$G_t + \frac{M_{t-1}}{P_t} + b_t = \frac{M_t}{P_t} + \frac{b_{t+1}}{1+r_t} + T_t$$

The variable G_t denotes government expenditure at time t. It is assumed that government expenditure does not enter the agents objective function. In the case of equilibrium business cycle models embodying rational expectations output is always at its 'desired' level. Given the information set, agents are maximising their welfare subject to their constraints. Since there are no distortions in this set-up government expenditure may not improve welfare through its stabilisation programme. This is why government expenditure has been excluded from the representative agent's utility function. The government finances its expenditure by a stream of lump-sum taxes (T_t) and seigniorage revenue. The government also issues debt, bonds (b_t) each of which pays a return next period given the state of the economy at t+1.

The Representative Firm

The technology available to the economy is described by a constant-returns-to scale production function.

$$Y_t = Z_t f\left(N_t,\ K_t\right)$$

or

$$Y_t = Z_t N_t^{\alpha} K_t^{1-\alpha}$$

where $0 < \alpha < 1$, Y_t is aggregate output, K_t is capital carried over from previous period (t-1), N_t is labour supply and Z_t reflects the state of technology. We assume that f(N, K) is smooth and concave and it satisfies *Inada-type* conditions i.e., the marginal product of capital (or labour) approaches infinity as capital (or labour) goes to zero and approaches zero as capital (or labour) goes to infinity.

$$\begin{aligned} \lim_{K \longrightarrow 0} (F_K) &= \lim_{N \longrightarrow 0} (F_N) = \infty \\ \lim_{K \longrightarrow \infty} (F_K) &= \lim_{N \longrightarrow \infty} (F_N) = 0 \end{aligned}$$

The capital stock evolves according to:

$$K_{t+1} = (1-\delta) K_t + I_t$$

where δ is the depreciation rate and I_t is gross investment. In a single-good model, that part of output not consumed becomes part of capital stock the next period. Here, firms operate in competitive markets and therefore take prices as given when solving their own constrained maximisation problem. Each firms objective in period t is to maximise profit subject to the constant-returns-to-scale production technology i.e.,

$$\underset{K_t,\ N_t}{Max}\ Y_t - r_t K_t - w_t N_t$$

Subject to

$$Y_t = Z_t N_t^{\alpha} K_t^{1-\alpha}$$

where r_t and w_t are prices of inputs used by the firm.

The cost of the capital and labour inputs is equal to $r_t K_t + w_t N_t$, where r_t and w_t are taken as given by the firm. Output of the firm depends not only on capital and labour inputs but also on Z_t. The firm optimally chooses capital and labour so that their marginal products are equal to the price per unit of input; that is,

$$\begin{aligned} r_t &= Z_t f_K (N_t,\ K_t) \\ w_t &= Z_t f_N (N_t,\ K_t) \end{aligned}$$

The non-negativity constraint applies i.e., $K_t \geq 0$.

Introduction of overlapping non-contingent wage contracts[3]

The idea behind the introduction of non-contingent wage contract in a dynamic general equilibrium model is to investigate whether money can be a cause for persistent economic fluctuations. Fischer (1977) in a seminal paper introduces an overlapping labour contract model, with contracts running for two periods. Contractual

[3] *For a lucid exposition of this topic see Minford (1992).*

arrangements of this form tend to bring in an element of wage-stickiness in the short-run into the model. Given that monetary authorities change money stock/interest rates more frequently than labour contracts are renegotiated, nominal disturbances do have the ability to influence the short-run dynamics of output. Fischer argues that, if contracts run for only one period, the Sargent and Wallace (1975) result that, the solution for output is invariant to the parameters of the money supply rule is readily obtained. However, this result is reversed if there are longer-term nominal contracts. It follows that even fully anticipated (leave alone unanticipated) monetary policy affects the behaviour of output.

The suppliers of labour in this framework are assumed to stand ready to supply whatever labour is demanded in exchange for the certainty of a fixed money wage. Being tied into a contract, both sides of the market have to live with the pre-committed money wage until the review date. The wage rate is set to achieve an equilibrium in the labour market based on the expected price level.

In what follows we replace the standard spot labour market with a market characterised by imperfectly flexible wages. As noted by Lucas (1996) nominal rigidities of some sort motivate most macroeconomic thinking, 'classical' as well as 'Keynesian'. However the main issue is not the type of rigidity as such but whether it can be motivated as the result of optimising behaviour in a dynamic general equilibrium framework. The microeconomic rationale for this sort of arrangement between workers and firms follows from the costs involved in writing contracts frequently and also the difficulties associated with contract writing. It is assumed that the nominal wage is set to try and maintain equilibrium real wage (i.e., where supply equals demand in expectation).

Note that the fundamental postulate of equilibrium business cycle theory is (a) markets clear and (b) individuals are governed by self-interest. Writing nominal contracts in this form is clearly consistent with equilibrium business cycle theory. Suppose we have a situation where all wage contracts are set for four periods and the contracts drawn in period 't' specifies nominal wages for periods t+1, t+2, t+3 and t+4. At any given point in time three-fourth's of the labour force is covered by a pre-existing contract. The assumption of rational expectations here entails that the forecast of the next period wage decisions is an unbiased one, given that agents possess the necessary information set. The actual wage rate at any given point in time would be an average of the wages that have been set at various dates in the past. Hence, nominal wage at time 't' in natural logarithms would be

$$W_t = 0.25\,\left({}_{t-1}W_t +_{t-2} W_t +_{t-3} W_t +_{t-4} W_t\right)$$

or

$$\ln\left(W_t\right) = \ln\left(w^{\star}\right) + 0.25 \cdot \sum_{i=1}^{4} E_{t-i}\left[\ln\left(P_t\right)\right]$$

where $w^{\star}$ denotes equilibrium real wage. If we let output supply be a declining function of the real wage then one can derive the New-Keynesian Phillips curve which is expressed in natural logarithms as follows:

$$\log Y_t = \log Y^{\star} + q \left\{ \log P_t - \frac{1}{N} \sum_{i=1}^{N} E_{t-i} \left[\log \left(P_t \right) \right] \right\} \tag{16}$$

where $Y^{\star}$ is potential output[4].

The trickiest equation to linearise is the Euler equation (15). It contains the expected value of a nonlinear function of random future consumption. We assume that the random variable on the righthand side of Euler equation (15) is lognormally distributed, with a conditional variance that is constant over time. Since we are interested in the system's dynamic response to shocks rather than in trend movements, we henceforth omit the variance term. Under perfect foresight equation **(15)** can be expressed in natural logarithms as

$$\log C_{t+1} = \log \beta + \log \left(1 + r_t\right) + \log C_t \tag{17}$$

The representative household's lifetime budget constraint (given that all output (GDP) except government expenditure and investment expenditure is consumed) yields:

[4] *We set q=1 in what follows.*

$$\sum_{i=0}^{\infty}\left(\frac{1}{1+r_t^{\star}}\right)^i C_{t+i} = \sum_{i=0}^{\infty}\left(\frac{1}{1+r_t^{\star}}\right)^i (Y_{t+i} - G_{t+i} - I_{t+i})$$

or

$$\sum_{i=0}^{\infty}\left(\frac{1}{1+r_t^{\star}}\right)^i \left(\beta^i (1+r_t^{\star})^i C_t\right) = \sum_{i=0}^{\infty}\left(\frac{1}{1+r_t^{\star}}\right)^i (1+g)^i \left(\overline{Y_t} - \overline{G_t} - \overline{I_t}\right)$$

where 'g' denotes steady state growth of consumption, $r_t^{\star}$ is long-run interest rate, and $\overline{Y_t}$, $\overline{G_t}$, and $\overline{I_t}$ denote steady state values for output, government expenditure, and investment expenditure respectively. Leading the above equality one-period and expressing it in natural logarithms yields:

$$\log C_{t+1} = \log(1-\beta) + \log\overline{C_t} + \log(1+r_t^{\star}) - \log(r_t^{\star} - g) \tag{18}$$

To get an expression in terms of r_t we first substitute **(18)** into **(17)** for logC_{t+1}. The resulting expression for logC_{t+1} together with that of $\log P_t$ given by the New-Keynesian Phillips curve **(16)** are then substituted into **(13)**. Thus we have:

$$\Longrightarrow r_t = \theta + (\log Y_t - \log Y_t^{*}) + \left(\frac{1}{N}\Sigma_{i=1}^{N} E_{t-i}\log P_t - \log P_{t-N}\right) - (\log M_{t-4} - \log P_{t-N})$$

where we have used the common approximation $\log(1+x) = x$ (for x small relative to 1.0) and θ includes all the constant terms from equations (13), (17), and (18). Invoking the Fisher equation we get

$$\Longrightarrow R_t = \alpha + (\log Y_t - \log Y_t^{*}) + \left(\frac{1}{N}\Sigma_{i=1}^{N} E_{t-i}\log P_t - \log P_{t-N}\right) - (\log M_{t-4} - \log P_{t-N})$$

Here α is a sum of the term θ and expected inflation, which is treated as a constant, R_t is the short-term interest rate that the central bank uses as its "operating target" and $(\log Y_t - \log Y^{\star})$ is a measure of the output gap, the percentage difference between actual and capacity output. The term $\left(\frac{1}{N}\sum_{i=1}^{N} E_{t-i} \log P_t - \log P_{t-N}\right)$ can be interpreted as "core inflation" and $(\log M_{t-4} - \log P_{t-N})$ can be interpreted as "target inflation".

An important issue under a simple interest rate rule is the possibility of analytical indeterminacy of prices and other nominal variables in a model embodying rational expectations. In a seminal paper, Sargent and Wallace (1975) find that there was nominal indeterminacy (in an IS-LM-AS type model) under a pure interest rate rule. As Kerr and King (1996) point out, there is nothing in the model that determines the levels of money and prices i.e., the money demand function determines the expected level for real balances, not the level of nominal money and prices. However, in our framework interest rate rules do not produce indeterminacy. As pointed out by Clarida et al (1999), nominal indeterminacy vanishes when there is rigidity in either the goods or labour market. Last period's price/wage level effectively serves as a nominal anchor.

3 Data Sources and Definitions

In analysing the interest rate rule, we will interpret a period as a quarter[5]. All

[5] *Given that our database is for 1960.1 to 1999.4, rule-implied values begin with 1961.2 because*

series are taken from the FRED database of the Federal Reserve Bank of St.Louis. We set α the intercept term to 4.0. As in Taylor (1999c), the Hodrick -Prescott filter is used to generate residuals from trend which is taken to represent deviation of output from 'potential' output. For Y_t we use the logarithm of real (chain-linked) values. In order to compute the inflation rate we use the GDP deflator series. M_t is adjusted monetary base series. Finally, R_t is the Federal funds rate averaged over the quarter. All variables except R_t and P_t are seasonally adjusted[6].

4 Comparison of alternative response coefficients and their effects on Macroeconomic Stability

The preceding discussion takes the nominal interest rate as the instrument of monetary policy. The interest rate rule with real output in fact mimics important features of the money supply rule. The Taylor rule is closely related to the quantity equation of money (MV=PY) and can be easily derived from the quantity equation if we assume that the money supply is growing at a constant rate (see Taylor (1999c)). With money supply growing at a constant rate, interest rates are free to fluctuate in response to the state of the economy, with both coefficients on output deviation and inflation deviation turning out positive. Recent work on monetary policy rules have

of the lags needed to determine price surprise inflation terms.

[6] *Note that our rule contains expectational variables. We proceed with calibration of the interest rate equation by replacing these expected values with their corresponding realised values.*

been quite precise about these response coefficients. For example, Taylor (1999b) has emphasised the importance of having a coefficient on the inflation deviation term that is higher than 1.0. If the coefficient is below 1.0, then an increase in inflation will call for an increase in the (nominal) interest rate that is smaller than the increase in inflation (implying a reduction in the real rate). While the exact size of coefficients differ from study to study, recently there has been some indication of a consensus emerging with regard to the exact size of these coefficients. In a recent book, Taylor (1999b) compared various parameterizations of such rules within a variety of econometric models of different economies. The average behaviour across all the nine models examined showed:

Standard deviation of:	Inflation	Output	Interest rate
Output coefficient=0.5	2.13	1.94	2.82
Output coefficient=1.0	2.16	1.63	3.03

There is therefore some evidence of a trade-off in estimated models between output and inflation variability; also between output and interest rate variability, the latter naturally rising with a higher output coefficient.

Finally, with the Friedman implied rule and the Taylor rule at our disposal, we examine episodes in the US monetary history when the actual Federal funds rate deviated from rule specified behaviour in order to ascertain the impact on the economy.

Figures 1 and 2 (see appendix) plots values of R_t implied by constant money growth and Taylor's rule (with a coefficient of 0.5 and 1.0 on output deviation respectively) together with actual values over 1960 Q1 to 1999 Q4. Note that with a coefficient of 1.0 on output deviation being imposed on the Taylor rule, the money growth rule clearly mimics the Taylor Rule. By looking at these figures, it can be seen that the actual interest rate was lower than the rule-implied value (this is true regardless of the rule used) throughout the 1970s, clearly revealing that monetary policy was *too* loose. Beginning in 1981 policy was too tight until 1987, when the stock market crash forced the Federal Reserve to cut interest rates sharply. Moreover, the gap between the actual Federal funds rate and the policy rules is large during the 1960s till late 1980s as shown in figures 3 and 4. This is in sharp contrast to the relatively small gap in the late 1980s and throughout 1990s as shown in figure 5. Between 1987-1995 policy was about right, but since 1996 it has been some what too tight.

Figure 6 clearly illustrates the large change in economic stability that has occurred in the US since 1960[7]. It shows the GDP gap, which is defined as the percentage difference of real GDP from trend. One can clearly see that the variance of GDP gap is much less volatile in the latter period (especially since the mid-1980s) than in the earlier period. During the same period the difference between actual Federal funds rate and the rate implied by both the rules considered in this paper (a measure of

[7] *For a more detailed analysis of this issue see Clarida et al. (2000).*

discretion) is much lower than before. Furthermore, since 1991 the American economy has experienced its longest ever peace time expansion with moderate inflation.

5 Conclusion

The concept of a monetary rule is attractive for many reasons. Adhering to a monetary rule imposes accountability and transparency upon a central bank. In this article, we have looked at how interest rate rule such as the one proposed by Taylor (1993) can be derived by assuming a constant growth rate rule for money supply. Moreover, we use the dynamic general equilibrium modelling approach that constitutes the contemporary macroeconomic research paradigm. The presentation of explicit utility and profit maximisation problems provides clarity and analytical rigor.

Our basic result is derived from comparing actual federal funds rate against interest rates implied by Taylor-style hybrid (inflation plus output gap) target variables– along with the Friedman implied rule that we derive. For the US, all of the rules considered would have called for looser monetary policy during the 1960s and tighter monetary policy during the 1970s, although there is some disaggregement among the rules concerning the size of response coefficients. However, both the rules analysed here indicate that policy response has been appropriate since 1987.

Finally, our analysis, as in much of the literature was restricted to closed economy models. In an open economy, the real exchange rate plays a prominent role in the transmission mechanism of monetary policy. Extensions to open economy are likely to provide invaluable insights on the desirability of alternative policy rules.

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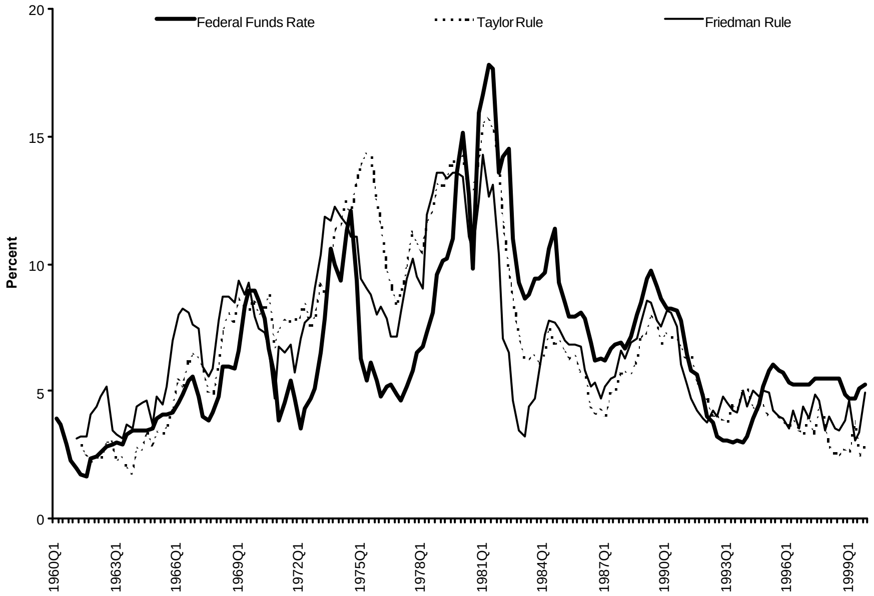


Figure 1:

Appendix

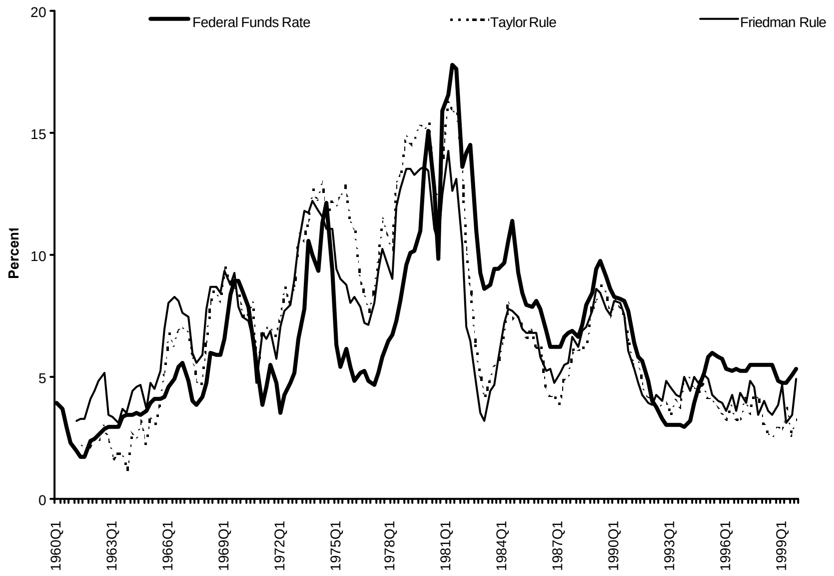
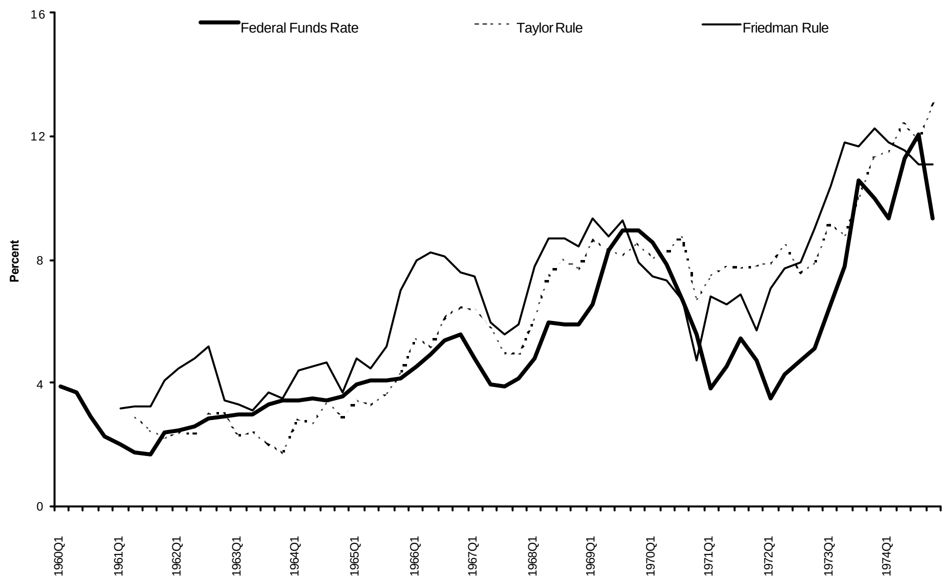


Figure 2:



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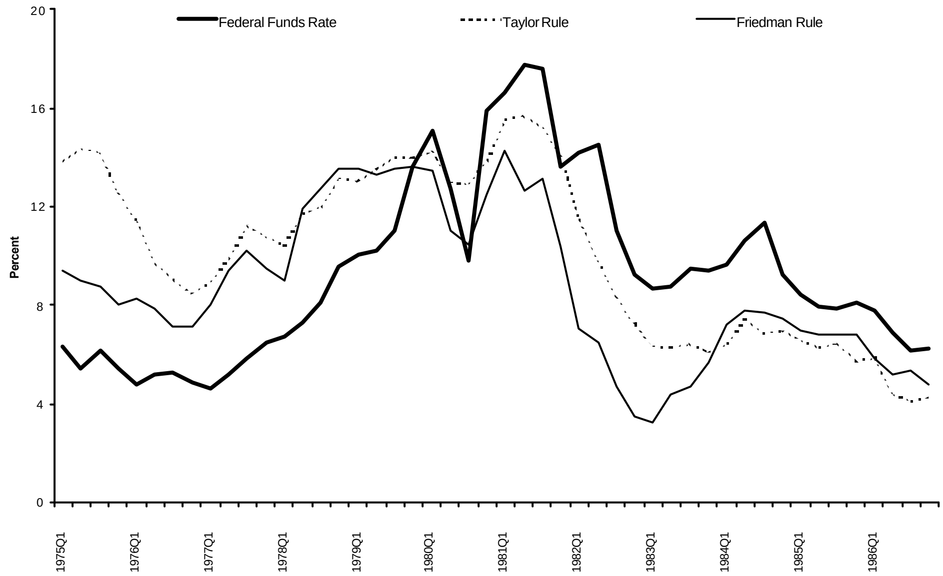

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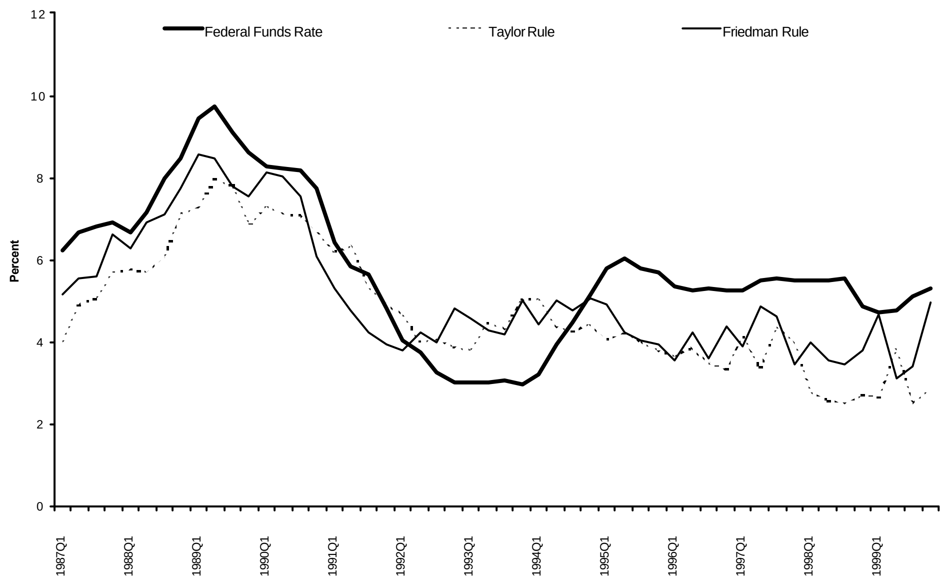

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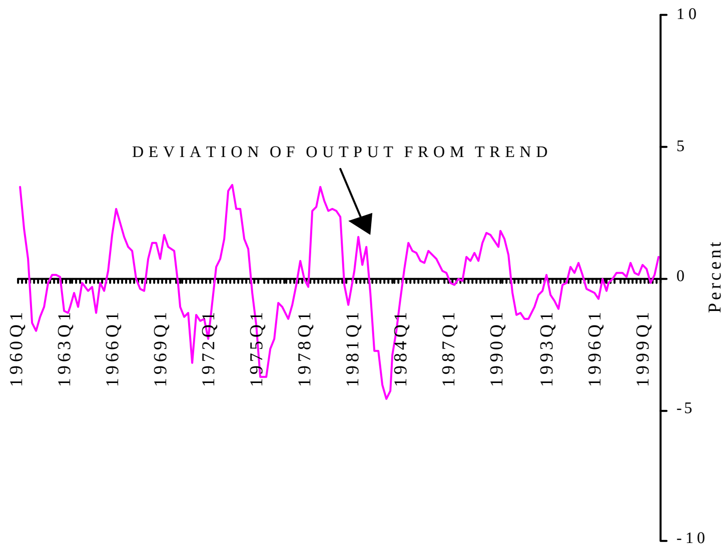
DEVIATION OF OUTPUT FROM TREND
10
5
0
-5
-10
Percent
1960Q1
1963Q1
1966Q1
1969Q1
1972Q1
1975Q1
1978Q1
1981Q1
1984Q1
1987Q1
1990Q1
1993Q1
1996Q1
1999Q1

Figure 6: