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Abstract

Is the classic Taylor rule misspecified? I show that the inability of the Taylor rule to explain the federal funds rate using real-time data stems from the omission of a money growth objective. I highlight the significant role played by money in the policy discourse during the Volcker-Greenspan era using new FOMC data, benchmarking a novel characterization of "good" policy. An application of this framework offers a unified policy-based explanation of the Great Moderation and Recession. Welfare analysis based on the New-Keynesian model endorses the rule with money. The evidence raises significant concerns about relying on the simple Taylor rule as a policy benchmark and suggests why money may serve as a useful indicator in guiding future monetary policy decisions.

Keywords: Taylor rule, policy objectives, money aggregates, macroeconomic stability
JEL classification: E30, E31, E42, E52, E58, E61

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1. Introduction

"The evidence that the large swings in inflation are related to money growth indicates, however, that money should continue to play an important role in monetary policy formulation in the future." (John B. Taylor, 1992)

Possibly one of the most influential papers in monetary economics recommends adjusting the nominal interest rate in response to deviations in inflation from a long run target, and a response to the output gap. It is widely believed that adherence to the 'Taylor rule' (Taylor (1993)) may have contributed significantly to the macroeconomic stability observed during the 1980s and 1990s.[1] This view has been challenged by Orphanides (2004). In particular, he shows that, when using real-time data, the same rule does not track well the actual policy rate. Given the prescriptive and descriptive capacity of Taylor's rule, this issue merits further inspection.

In an attempt to address this concern, I present novel empirical evidence from the FOMC transcripts, which enables me to accurately describe Federal Reserve policy. I argue that money growth objectives may have influenced FOMC policy during the post 1980s era, in addition to the policy objectives prescribed by the Taylor rule. The inclusion of this objective is motivated from both empirical and narrative evidence that points towards M1 targeting during the 1970s.[2] I propose that instead of abandoning the money growth targeting framework in the 1980s, the FOMC adopted a broader aggregate, one which displayed stability, and contained the required information for policy making. In this regard, the literature is silent on whether the FOMC treated M3 (or M2) as a policy objective, once M1 was abandoned as an indicator of policy.[3] Consequently, I show that targeting M3 may have contributed to the macroeconomic stability observed during the Great Moderation. It is also possible, that a gradual departure from this objective led the FOMC to base its policy decisions on a less

[1] In fact, Clarida, Galí and Gertler (2000) estimate this policy rule for the period before and after Volcker's appointment as Chairman of the Federal Reserve (the 'Fed') in August 1979. Finding interest rate policy in the Paul Volcker - Alan Greenspan period to be more sensitive to changes in expected inflation than in the pre-Volcker period, they conclude that this rule yields a stabilizing equilibrium and may therefore be worth adopting in practice. More recently, Taylor (2015) has argued that since policy became more focused, more systematic, more rules-based in the 1980s, it delivered the Great Moderation, and the economy was "non-inflationary consistently expansionary" during this period.

[2] See, for example, the evidence presented in Burns (1979), Sims and Zha (2006) and Qureshi (2016). Furthermore, M1 targets are shown to have been abandoned in the early 1980s in these papers. Legally, the Humphrey-Hawkins Act required the Fed to set one-year target ranges for money supply growth twice a year and to report the targets to Congress beginning 1978.

[3] I validate my results by presenting novel descriptive evidence from the FOMC transcripts. Specifically, evidence from the transcripts suggests a gradual emphasis on broader money aggregates during the latter part of the 1980s and the 1990s.

active policy, which may have contributed to the events leading to the Great Recession.

This paper offers three main contributions. First, the money growth framework enables me to outline a novel definition of "good" policy.[4] This policy rule consists of a positive weight on the money growth objective in addition to the objectives prescribed by the classic Taylor rule. I show that welfare analysis based on the New-Keynesian model endorses the rule with money compared to the Taylor rule. Second, my results highlight the significant role played by the money aggregate M3 in the policy discourse during the Volcker-Greenspan era. By showing that the inability of the Taylor rule to track the federal funds rate stems from its omission of the M3 objective, I present evidence of rule-based policy that is robust for meeting-level data. This finding reconciles the conflicting conclusions of Orphanides (2004) and Taylor (1993). My results suggest that monetary policy in the U.S. could be described in terms of the classic Taylor rule that includes a money growth objective. Third, by comparing actual FOMC policy with the predictions based on my "good" policy rule, I highlight an interconnected policy-based explanation of the Great Moderation and the Great Recession. As a consequence, this paper lends support to the possible role of money in future policy formulations, supporting Taylor's aforementioned statement.

I present the benchmark results of this paper in two steps. In the first step, I test whether the policy rule advocated by Taylor explains the behavior of the Federal Reserve during the baseline period considered in his paper (1987 - 1992). I use real-time data to compute alternative paths for the interest rate. Relying on the parameter values recommended by Taylor (1993) allows me to gauge the path of the interest rate based on his recommendation for stable policy. My results confirm the analysis offered in Orphanides (2004), and Taylor's conjectured policy rule is unable to track the federal funds rate for the time period considered in his seminal paper. The results do not improve even when Taylor's ex-ante treatment of the data is incorporated. In particular, Taylor's policy rule systematically proposes an interest rate lower than the actual federal funds rate during this period.

In the second step, I offer an alternative explanation for the decision-making principles that guided policymakers during this benchmark period. I show that the inclusion of money growth objectives improves the fit of the baseline Taylor rule. I present narrative evidence from the FOMC transcripts which validates this claim. Least squares estimates of this policy rule indicate significant evidence of money growth targeting, suggesting that money may have played a central role in FOMC policy. I find that excluding money growth severely distorts estimates of policy parameters. A key implication of these results is that it presents a

[4]This paper interprets good policy to imply a policy that yields a stabilizing price equilibrium, and therefore leads to macroeconomic stability. See, Bernanke (2004) for a detailed exposition.

new definition of what constitutes "good" policy based on a rule that worked well during this period. This proposition is backed by theoretical evidence presented in Qureshi (2016), which suggests that targeting money increases the aggregate response of the monetary authority to changes in inflation, induces history dependence and guarantees an explosive response to changes in the macroeconomy, all which are attributes of good policy (Woodford (2011)).

I apply this framework to explain Federal Reserve policy for the Volcker-Greenspan era. My findings suggest that the money growth targeting rule explains the federal funds rate remarkably well for this period. A key implication of this result is that it offers an alternative channel of rule-based policy that possibly played an important role in generating the extraordinary macroeconomic stability experienced by the U.S. during the Great Moderation. However, a comparison of actual policy with that implied by the "good" money growth targeting rule suggest that the Federal Reserve increasingly adopted a softer policy stance during the second half of the 1990s. I identify a decline in the weight on money growth and inflation, and a rise in the weight on the output gap during this period. It may be that a lack of response to money growth led to a less active policy, and an unobserved growth in the credit market preceding the Great Recession.[5] In this regard, my results provide a reinterpretation of the potentially common principles at work during the two contrasting periods of macroeconomic stability.

I extend these findings along four dimensions. I show that my results are robust to modifications in the policy rule. Money growth objectives better explain the federal funds rate, and deliver a clearer identification of the weights on other policy objectives, compared to a rule with output growth objectives. Introducing interest rate smoothing does not change the main policy implications advocated in this paper. I find significant evidence of money growth targeting using historical data. Extending predictions of the "good" policy recommended in this paper based on historical data confirms evidence of less active policy before the onset of the Great Recession. Finally, I highlight the source of misidentification in estimates of the Taylor rule, which arises when ignoring money objectives. An explicit money growth objective effects estimates of other policy objectives. As a consequence, I confirm the findings of Söderström (2005) and show that responding to money growth targets induces policy inertia, even when the monetary authority does not explicitly smooth interest rates. Welfare evaluation using the prototypical Keynesian model confirms predictions of the "good" policy recommended in this paper. This finding supports the literature that favors simple rules

[5]For example, Nelson (2003) has called for a development in monetary aggregates since they may serve as a useful indicator for the wide range of yields that must be taken into account in a world with imperfect asset markets, or the range of lending and deposit criteria that affect the role of the banking sector in the economy.

over optimal policy rules due to the practical shortcomings of the latter.

At the most general level this paper is related to Taylor (1993). He presents a policy rule to explain FOMC policy for the 1987-1992 period, and suggests it become a vital part of a policymaker's toolkit. I differ from his conclusions by formalizing the critical role played by money in FOMC policy during this period. In doing so, I contribute to the historical narrative on policy rules, and to the literature related to the usefulness of the Taylor rule as a policy yardstick. To support this view, I focus on extracting and utilizing novel FOMC data and engaging with the transcripts to understand the role of different money aggregates in the conduct of policy. My results suggest that a Taylor rule augmented with M3 growth better explains Federal Reserve policy not only during Taylor's original sample, but also during the Volcker-Greenspan era. By identifying a possible misspecification in the classic Taylor rule, my findings contribute both to the classic papers by Taylor (1999), Clarida, Galí and Gertler (2000), Orphanides (2002) and to the more recent papers by Coibion and Gorodnichenko (2011) and Lubik and Matthes (2014).

An application of this framework allows me to contribute to a broad set of literature. For example, Taylor (2014) and Belongia and Ireland (2015b) have examined the role of policy as a possible explanation for the events leading up to the Great Recession. In particular, Taylor (2014) has identified shifts in policy which may have sown the seeds which led to the Great Recession. Estimates of the policy parameters based on my framework suggest that money played a gradually diminishing role in policy making during the second half of the 1990s, with marginal changes in the central banks response to inflation. This may have led the federal funds rate to be less active - in particular, the policy rule with money recommends a tighter policy as compared to the federal funds rate during this period. Secondly, given that growth in broad money may serve as an indicator for credit growth (Kaminsky and Reinhart (1999), Nelson (2003)), my framework proposes a possible explanation for the lack of control over credit growth in the events preceding the Great Recession. On the practical side, this framework may be relevant for central banks that target money growth, such as the European Central Bank (see, for example, Smets (2003)), since it highlights a benchmark of stable, welfare maximizing policy under this type of regime.

A key finding that distinguishes this paper from earlier literature is evidence related to the role of M3, as compared to the commonly considered money aggregate M2, in influencing policy during the post-Volcker period. This parsing may be important when investigating the role of money in DSGE models, as these indicators may provide dissimilar information in a macroeconomic framework. In this regard, my results contribute to the empirical and theoretical literature that has investigated the role of money in describing the macroeconomy

(see, for example, Leeper and Roush (2003), Canova (2002), Ireland (2004), Favara and Giordani (2009), Canova and Menz (2011), Belongia and Ireland (2015a) and Castelnuovo (2012)). More recently, building on a DSGE model with money developed by Ireland (2004), Castelnuovo (2012) has concluded that money does not play an active role in explaining U.S. output and inflation during the Volcker-Greenspan sample. Furthermore, Belongia and Ireland (2016) also present evidence of the relationship between Divisa monetary aggregates and output based on recent data. Different from these findings, I present evidence in favor of the role of broad money aggregate M3 in influencing monetary policy during the 1980s and 1990s using both real-time and historical data. Devoting more effort to explaining both the role of these aggregates in DSGE models, as well as their implications for money demand may be of interest to future researchers.

The paper is structured as follows. In the next section, I use meeting-level data to test Federal Reserve policy. Section 3 tests the robustness of the baseline framework across other data and policy rule specifications, and presents a model-based exposition of welfare. Section 4 concludes and offers suggestions for future research.

2. Policy Rules in Real-Time

In this section, I use meeting-level data to explain Federal Open Market Committee (FOMC) policy during the 1980s and 1990s. I begin my analysis by showing that the classic Taylor (1993) rule is unable to explain the federal funds rate in this setting. Instead, a rule incorporating M3 money growth as an additional policy objective far more accurately tracks the federal funds rate. In the next section, I test these rules for Taylor's baseline time period. I estimate each of the policy reaction functions in section 2.1.2. Section 2.2 uses this framework to describe the evolution of FOMC policy during the Volcker-Greenspan era.

2.1. Baseline Results

2.1.1. Policy from 1987 to 1992

I test the robustness of the classic Taylor rule using meeting-level data. In particular, Taylor (1993) proposed that this simple rule fits the behavior of the interest rates remarkably well for the quarterly period from 1987:1 to 1992:3, which corresponds to a period of extraordinary macroeconomic stability in the United States. For tractability of notation, I generalize

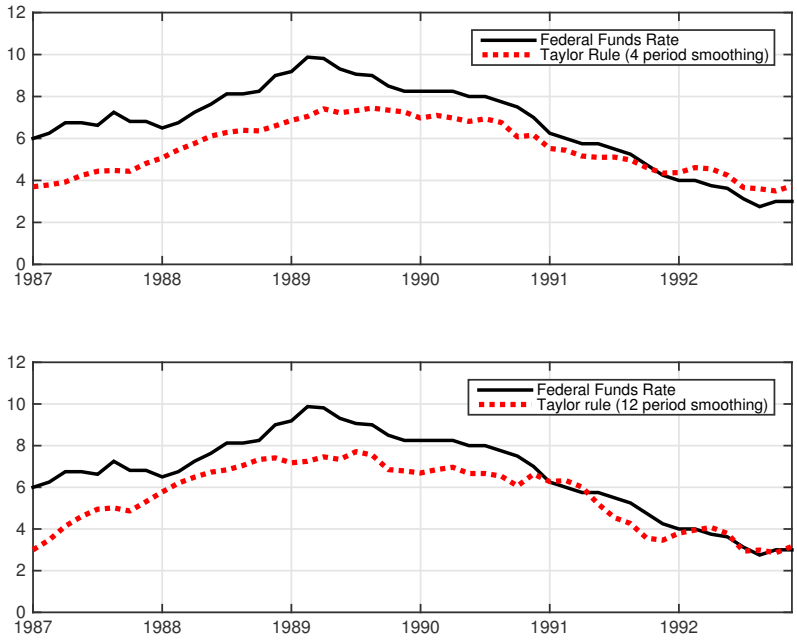
Taylor's original proposition:

$$i_t = \pi_t + \phi_y y_t + \phi_\pi(\pi_t - \pi^T) + r^* \tag{1}$$

here, the funds rate is i_t, r^* is the natural rate of interest, π_t^T is the target rate of inflation over the previous four meetings, and ϕ_π and ϕ_y represent policy preferences. I use Greenbook forecasts of current and future macroeconomic variables prepared by staff members of the Federal Reserve prior to each FOMC meeting. The measures of the output gap and inflation are presented in Orphanides (2002). The generated interest rate is compared using the series for the federal funds rate target compiled by Romer and Romer (2004).

In line with Taylor's recommendation, I smooth the data on inflation over four "quarters," which I take to imply 12 FOMC meetings in the real-time data. I also present the results when the data are smoothed over four FOMC meetings. To be consistent with Taylor's operational version of the policy rule, I use data using variables available in the previous period. For example, inflation data for the period t is the smoothed meeting level data from $t-1$ to $t-4$ for the four period smoothing. In compliance with the policy recommendations made by Taylor (1993), I compute the implied interest rate when π^T is set to 2 percent, r^* is set to 2 percent, and ϕ_π and ϕ_y are set to 0.5, respectively. Therefore, the interest rate implied by this policy rule represents the path of the federal funds rate based on Taylor's recommendation for stable policy. In figure 1, I plot the implied interest rate with the actual path for the federal funds rate.

Figure 1: Taylor's Rule in Real-Time



Note: This figure presents estimates of the nominal interest rate based on the Taylor rule using real-time data and the actual Federal funds rate from 1987 - 1994. I present the suggested nominal interest rate based on four and twelve period smoothed data.

The figure makes clear that replicating the nominal interest rate based on the policy rule espoused by Taylor (1993) using real-time data does not match the behavior of the Federal Reserve for the time period considered in his paper. In fact, Taylor's policy rule *systematically* proposes a lower nominal interest rate compared to the actual funds rate from 1987 through to 1991. This result confirms the findings of Orphanides (2003) in that Taylor's conjectured policy rule is unable to explain actual policy during the 1980s and 1990s. The real-time rendition of Taylor's policy rule tracks policy well only in a few years of his sample.[6]

To explain Federal Reserve policy during this period, I consider a policy rule that incorporates money growth targeting, or considers money growth as an additional policy objective beyond the baseline Taylor rule. The inclusion of this objective is motivated from both

[6]For robustness, I calculate r^* and π^T by taking the sample averages of the interest rate and inflation as done in Clarida, Galí and Gertler (2000). Since the Greenbook data contain future, lagged and contemporaneous estimates of inflation and output gap, I check all possible combinations, and report the results that best fit the federal funds rate based on root-mean-square deviations. Other modifications of the baseline policy rule do not improve the fit of the implied interest rate in comparison with the actual federal funds rate.

narrative and empirical evidence that points towards M1 targeting during the 1970s.[7] I propose that instead of abandoning the money growth targeting framework in the 1980s,[8] the FOMC adopted a broader aggregate, one which displayed stability, and contained the required information for policy making. As an example of the FOMC's emphasis on broader money aggregates, consider the following excerpt from the record of policy actions:

> *"In implementing policy, the Committee agreed that primary emphasis would continue to be placed on the broader aggregates. The behavior of M1 would be monitored, with any increase in the weight placed on that aggregate dependent on evidence that its velocity behavior was assuming a more predictable pattern."*
>
> (Record of policy actions, July 12-13, 1983, p. 5)

The theoretical motivation of this type of policy rule arises from the linkages between money growth objectives and long-run policy goals, particularly concerned with price stability. Money supply variables may also capture the dynamics of the credit market. The augmented policy rule can be written in the following form:

$$i_t = \pi_t + \phi_y y_t + \phi_\pi(\pi_t - \pi^T) + \phi_m(\Delta m_t - \Delta m^T) + r^* \tag{2}$$

here the additional variables beyond the baseline Taylor (1993) rule include Δm_t which is the FOMC target for M3 collected from the Minutes of Action and Transcripts of the FOMC meetings. The money target rate finalized by the FOMC is suggested at the end of each meeting and included in the Minutes of Action.[9] Δm^T is the long-run policy target rate for

[7] See, for example, the evidence presented in Burns (1979), Sims and Zha (2006) and Qureshi (2016). Furthermore, M1 targets are shown to have been abandoned in the early 1980s (Qureshi (2016)). Legally, the Humphrey-Hawkins Act required the Fed to set one-year target ranges for money supply growth twice a year and to report the targets to Congress beginning 1978.

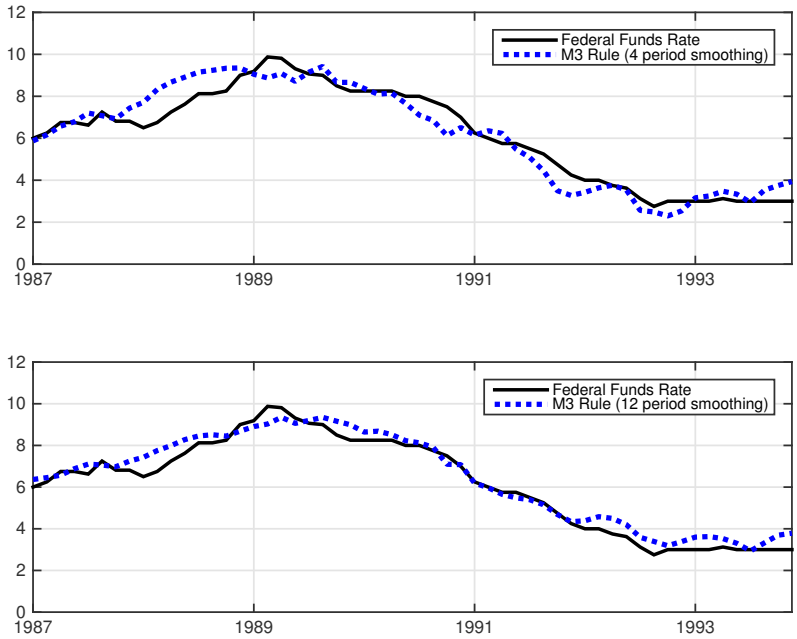
[8] In the first meeting of 1987 the FOMC did not specify a target range for M1. The following excerpt discusses the reasons for this action; these reasons are centred mainly on the uncertainty surrounding M1's relationship with the other macroeconomic variables: "With respect to M1, the Committee recognized that, based on experience, the behavior of that aggregate must be judged in the light of other evidence relating to economic activity and prices; fluctuations in M1 have become much more sensitive in recent years to changes in interest rates, among other factors. During 1987, the Committee anticipates that growth in M1 should slow. However, in the light of its sensitivity to a variety of influences, the Committee decided not to establish a precise target for its growth over the year as a whole at this time. Instead, the appropriateness of changes in M1 during the course of the year will be evaluated in the light of the behavior of its velocity, developments in the economy and financial markets, and the nature of emerging price pressures." (Minutes of Action, February 10-11, 1987, p. 5).

[9] An example of such guidance to establish the target ranges for M2 and M3 can be inferred from the following Minutes of Action: "In the implementation of policy for the immediate future, the Committee seeks to maintain the existing degree of pressure on reserve positions. This action is expected to be consistent with growth in M2 and M3 over the period from January through March at annual rates of about 6 to 7 percent. Growth in M1 is expected to slow substantially from the high rate of earlier months..."(Minutes of Action, February 10-11, 1987, p. 5). The targets for M2 and M3 were last announced in February 2000.

money growth.

The additional terms, ϕ_m, Δm_t and Δm^T are calibrated as follows: following Taylor (1993), I propose that the Federal Reserve assigned an equal weight to both nominal and real policy objectives and therefore set ϕ_m equal to 0.5. Δm^T is set to 2 percent, in concomitance with the long-run inflation target of 2 percent. Since some policy directives include a target range for money growth, I use the average of this series for my computations.[10] Finally, and similar to the treatment to inflation proposed by Taylor (1993), I consider the average rate of inflation and money growth over the previous 12 and four meetings. As before, output gap is considered to be in contemporaneous period growth rates. Figure 2 plots the interest rates implied by this policy rule and compares it to the path of the actual federal funds rate.

Figure 2: Policy Rule with Money



Note: This figure presents estimates of the money growth targeting rule using real-time data. I present the suggested nominal interest rate based on four and twelve period smoothed data.

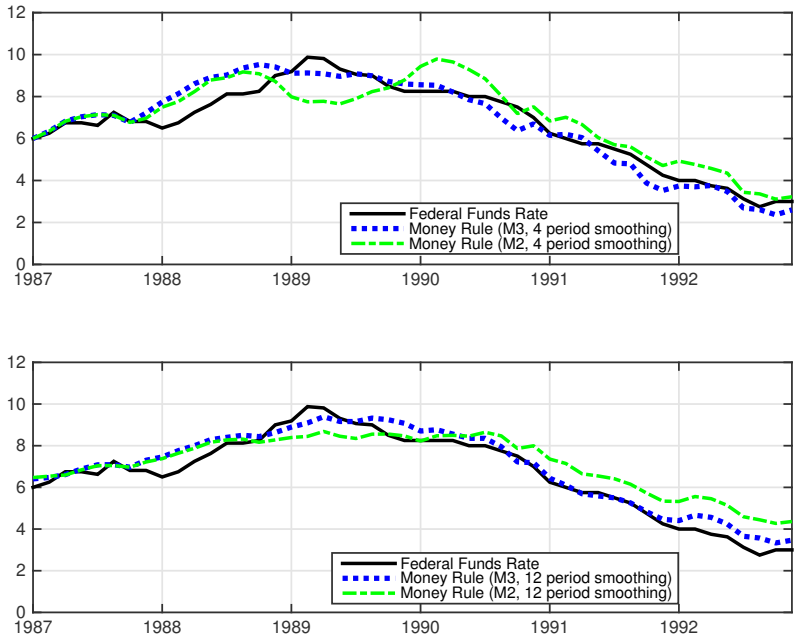
Remarkably, the interest rate based on the policy rule that includes money growth objectives in Taylor's original rule is able to track the actual federal funds rate better than the baseline policy rule. For both the 12 and four-period smoothing, the policy rule implied

[10]This is because the manager of the System Open Market Account (SOMA) was instructed to maintain the actual growth around the mid-range. My results are robust to considering the upper or lower bound instead of the average growth rate.

by the money growth targeting rule rises and falls consistently with the federal funds rate. There is some deviation in the funds rate in the year 1987 when the Federal Reserve eased interest rates in response to the crash in the stock market. During this period, the money growth targeting rule recommends a higher interest rate than the one actually followed by the Federal Reserve. This deviation in the policy rule from the federal funds rate is in line with changes in the *unsystematic* part of monetary policy, rather than a change in objectives. However, for the entire sample, the average interest rate implied by the policy rule that incorporates money growth objectives perfectly matches the average federal funds rate.

Another feature of these results that contrasts sharply with the earlier literature is the dominant role of money aggregate M3 in policy, instead of the commonly considered M2. To compare these two aggregates, I generate the interest rate based on M2 aggregate and plot the results in figure 3. My results stand robust; indeed, a policy rule with M3 better explains the funds rate compared to the M2 aggregate.

Figure 3: Policy Rule: M2 versus M3



Note: This figure presents estimates of the money growth targeting rule using real-time data. I present the suggested nominal interest rate based on four and twelve period smoothed data.

To substantiate these results, and to compare the recommendations made by the policy rule with the actual policy practiced by the FOMC during this period, I test the fit of each

policy rule by comparing the root-mean-square error (RMSE) against the actual federal funds rate. The RMSE suggests that a money growth targeting rule with M3 explains the federal funds rate with far more accuracy - approximately three times better than the Taylor rule and almost two times better than the rule with M2. This suggests that the conjectured policy rate with money growth M3 as a policy objective more successfully explains the behavior of the federal funds rate for this period. The RMSE implied by each policy rule is summarized in the following table.

Table 1: Model Fit based on RMSE

Policy	FFR
Taylor Actual	1.4880
Money Growth (M2)	0.8786
Money Growth (M3)	0.4502

Note: This table outlines the fit of the model using root-mean-square deviation (RMSE) compared to the real-time federal funds rate (FFR). I use twelve period smoothing to compute the rule based interest rate.

Estimates of the real-time Taylor rule suggests that either the policy parameters advocated are divorced from actual policy, or that other policy objectives that are excluded in Taylor's rule could be the underlying drivers of actual policy. In this context, real-time renditions of the classic Taylor rule may provide policy prescriptions that are systematically too tight or too easy for extended periods of time. As identified by Orphanides (2004), this is a significant concern if the aim is to identify a specific rule meant to be useful for real-time policy analysis and decision making. To resolve this issue, I show that money growth M3 was an important feature of FOMC policy from 1987 through to 1992, the baseline time period considered in Taylor's original paper. Including money growth in the policy rule results in an interest rate that is able to successfully track the federal funds rate, suggesting that money served as an important indicator for FOMC policy during this period. A central implication of this result is that it benchmarks a new definition of what constitutes "good" policy.

2.1.2. Estimates of Policy Rules

I formalize evidence of money growth targeting by presenting estimates of the actual coefficients of both policy rules (equation 2 and 3). While computing the interest rate based on a conjectured policy rule serves as a reasonable benchmark to test the predictions of alternative policy rules, estimating this rule explicitly determines the actual policy practiced by the FOMC. This also allows me to compare actual policy conducted by the Federal Reserve with the proposed "good" policy advanced in this paper.

I use both ordinary least squares (OLS) and the generalized method of moments (GMM) to estimate the policy rule based on the data that has been used in this section.[11] Table 2 presents these results.

Table 2: Estimates of the Policy Rules, 1987:02 - 1992:12

	OLS		GMM	
Param.	Taylor Rule	Money Growth	Taylor Rule	Money Growth
ϕ_π	0.6220^{**}	1.9854^{***}	0.6181^{**}	2.0596^{***}
	(0.2398)	(0.1512)	(0.2250)	(0.1288)
ϕ_x	0.8985^{***}	0.4128^{***}	0.8955^{***}	0.3995^{***}
	(0.0495)	(0.0384)	(0.0473)	(0.0424)
ϕ_m	–	0.6073^{***}	–	0.6203^{***}
	–	(0.0414)	–	(0.0421)
c	5.7691^{***}	-2.529^{**}	5.7808^{***}	-2.8574^{***}
	(0.8712)	(0.7187)	(0.8222)	(0.6621)
R^2	0.8792	0.9669	–	–
RMSE	0.6952	0.3680	–	–
AIC	104.2261	44.07481	–	–
BIC	109.8397	51.55961	–	–
Obs.	48	48	48	48
$p-value$	–	–	0.21	0.54

Note: This table presents OLS and GMM estimates of the baseline feedback rule for the period 1987:02 to 1992:12. The set of instruments for GMM are three lags of inflation, output gap and growth in monetary aggregate M3. The bottom panel reports the $p-value$ associated with a test of the models over identifying restrictions (Hansen's J-test). Robust standard errors are reported in parentheses. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$ denote significance levels. 'c' denotes the constant of regression. The acronyms AIC and BIC represent Akaike's and Schwarz's Bayesian information criteria, respectively.

My empirical analysis advances significant evidence of money growth targeting. In particular, my results suggest that actual policy was remarkably close to the conjectured policy parameters. The weight on the policy parameters ϕ_m is estimated to be 0.60 with standard error 0.04, and $\phi_\pi = 1.98$ with standard error 0.15. This implies that both variables are significant at the 1 percent level. The weight on output gap in the augmented policy is statistically significant and close to 0.5, a finding which is similar to the estimates in Coibion and Gorodnichenko (2011). For the Taylor rule the weight on output gap seems to be greater than the weight on inflation during this sample. In short, the Taylor rule without money

[11] In the next section, I relax this assumption and extrapolate policy based on actual instead of smoothed data. Since the main point in this section is to the estimate policy parameters based on the previous figures, I use smoothed data.

targeting appears to suffer from an omitted variable bias, and, as a result, inaccurately measures the response to inflation. From a policy perspective, the additional variable money helps improve the fit of the baseline policy rule, and delivers sharper estimates of the policy parameters.

Based on the goodness-of-fit (R^2), RMSE and the AIC/BIC criterion of the regression, a policy rule with money growth targets is clearly preferred by the data as compared to the simple Taylor rule. The policy targets for the money growth policy rule are also estimated to be close to the conjectured values. These are inferred from the constant term of the regression. For example, based on the estimates of the money growth targeting rule using GMM, and assuming that the target rate of money and inflation are equal, then this value is estimated to be 1.8%. Alternately, if I fix the target rate of inflation to 2%, the target for money growth is calculated to be 1.6%. The estimated results are in line with the computed path for the interest rates based on the two policy rules considered in the earlier part of the paper.

To summarize the main findings of this section: formal empirical evidence suggests that growth in M3 significantly influenced the policy discourse during the 1980s and 1990s. I show that excluding money growth may produce severely distorted estimates of policy rules. In this sense, my novel findings resolve the problem of simple Taylor rules being unable to explain the behavior of the federal funds rate using real-time data by suggesting an alternative specification that successfully explains FOMC policy. Furthermore, the actual policy from 1987 - 1992 obeys the recommendation made by the "good policy" proposed in this paper. In this regard, the inclusion of money growth objectives may offer an alternative channel of rule-based policy that possibly played an important role in generating the extraordinary macroeconomic stability experienced by the U.S during the post-1980s era.

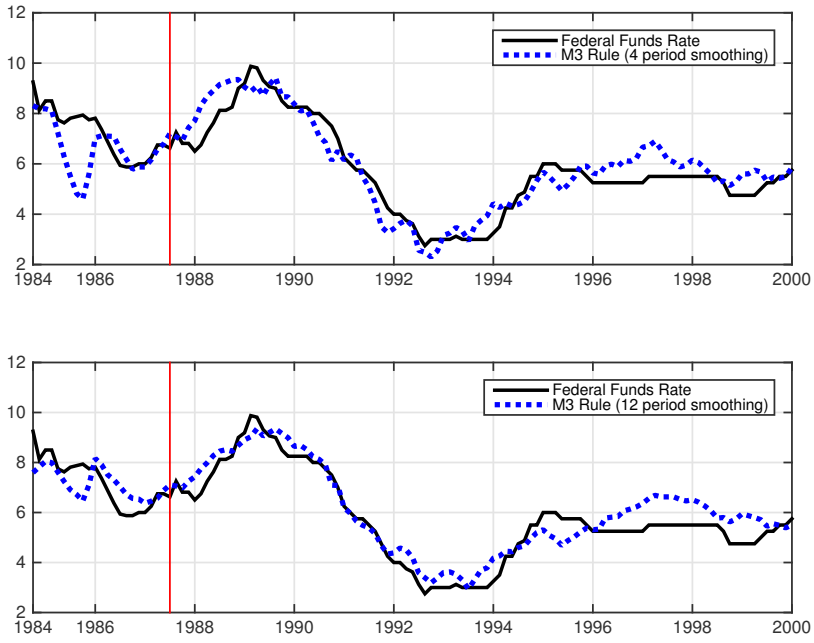
2.2. Federal Reserve Policy from 1984 to 2000

In this section, I test whether the money growth policy rule can explain the behavior of the Federal Reserve from 1984 to 2000. First, I extract the nominal interest rate based on the money growth targeting rule and compare it with the actual funds rate. Second, I estimate this policy rule using least squares.

Figure 3 compares the computed path for the interest rate based on the money growth targeting rule and the actual path of the federal funds rate. The figure suggests that the money growth targeting rule tracks the federal funds rate remarkably well from 1986 through to 1993. During this period, the FOMC seems to be following the "good" policy rule recom-

mended in this paper. Beyond 1993, the policy implied by the money growth targeting rule deviates significantly from the actual federal funds rate. In particular, from 1996 through to 2000, the money growth targeting rule systematically recommends a tighter policy compared to the actual funds rate.

Figure 4: Federal Funds Rate from 1984-2000



Note: This figure presents estimates of the Taylor rule with money growth for the period 1984 - 2000. The vertical line denotes the beginning of Greenspan's tenure as Chairman of the Federal Reserve.

I formalize evidence of money growth targeting by estimating the actual policy coefficients over the entire sample. To dig deeper into the evolution of policy coefficients, I estimate this policy rule for three samples. To understand the Federal Reserve's policy from 1984 through to 2000, policy estimates for this period are considered as the baseline. I further illustrate the evolution of these coefficients by allowing for a break in 1993. This break-date accounts for the Fed's initiation of the targeting of the federal funds rate in 1993, as documented in Thornton (2006). Formally testing for a break date in the federal funds rate using the Zivot and Andrews (2002) test reveals a break in 1992.08. In this context, I estimate the augmented policy rule for 1984.11 through to 1992.12, and 1993 through to 2000.02. Table 3 summarizes these results. As before, estimates from both OLS and GMM are presented.

Table 3: Evolution of Federal Reserve Policy

Param.	OLS			GMM		
	1984.11 - 2000.02	1984.11 - 1992.12	1993.02 - 2000.02	1984.11 - 2000.02	1984.11 - 1992.12	1993.02 - 2000.02
ϕ_π	1.6509***	2.0199***	1.4288***	1.6693***	1.9955***	1.3589***
	(0.0750)	(0.1138)	(0.2337)	(0.0664)	(0.1033)	(0.2111)
ϕ_x	0.4322***	0.4294***	0.7833***	0.4363***	0.4415***	0.7660***
	(0.0251)	(0.0259)	(0.0842)	(0.0226)	(0.0245)	(0.0988)
ϕ_m	0.5023***	0.5639***	−0.2315	0.5162***	0.5621***	−0.2287
	(0.0245)	(0.0222)	(0.1187)	(0.0210)	(0.0212)	(0.1418)
c	−0.7670**	−2.477***	1.8580**	−0.9218***	−2.3444***	1.9700***
	(0.2256)	(0.4363)	(0.6272)	(0.2096)	(0.4104)	(0.5533)
R^2	0.8979	0.9385	0.7034	–	–	–
RMSE	0.5639	0.4500	0.5229	–	–	–
Obs.	123	66	57	120	63	57
$p-value$	–	–	–	0.02	0.92	0.002

Note: This table presents OLS and GMM estimates of the baseline feedback rule. The set of instruments for GMM are three lags of inflation, output gap and growth in monetary aggregate M3. The bottom panel reports the p-value associated with a test of the models over identifying restrictions (Hansen's J-test). Robust standard errors are reported in parentheses. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$ denote significance levels. 'c' denotes the constant of regression. Column (1) and (4) denotes the time period 1984.11 - 2000.02, (2) and (5) denote the time period 1984.11 - 1992.12, and columns (3) and (6) denotes the time period 1993.02 - 2000.02.

My results point to a number of interesting and novel features of actual policy. Starting from the estimates of the entire sample in column 1, my empirical findings present significant evidence of money growth targeting. Second, the policy response coefficients are quite close to the weights recommended by the baseline money growth policy rule. The weight on inflation is estimated to be 1.65, which is close to the policy recommendation of 1.5, while the weight on money growth is 0.5, which is the exact weight advocated for money growth. The weight on output gap is estimated to be 0.5, which suggests that during this period the FOMC focused more on inflation than it did on the real side of the economy. However, the J-statistic based on GMM estimates in column 4 is significant at the 5 percent level, suggesting this policy rule may be misspecified. One possibility may be due to the inclusion of money growth as a policy objective for the entire sample or due to the exclusion of important information from the policy rule. As confirmed in figure 3, the policy rule with money growth objectives may not explain the actual federal funds rate beyond 1993. However, in the next section, I show that including lagged interest rate (that is, accounting for interest

rate smoothing) resolves this issue, and does not effect the parameter estimates advanced in this section.

Focusing next on the sub-samples, the first regime from 1984.11 through to 1992.12 (column 2 and 4) highlights significant evidence of money growth targeting. The weight on the money growth objective is remarkably similar to the numbers recommended by the baseline policy rule, and is estimated to be around 0.53. During this period, the actual policy followed by the Federal Reserve suggests a high weight on inflation, and which is estimated to be close to 2. Output gap does not vary too much from the estimates of the entire time period. The J-statistic based on GMM estimates rejects any possibility of misspecification during this period. These findings support evidence in favor of money growth playing an active role in policy during the 1980s and early 1990s.

The response of the FOMC during the second regime, from 1993.02 to 2000.02, and highlighted in columns 3 and 6, suggests a divergence from the recommendations made by both the Taylor and the money growth targeting rule. First, the weight on money growth is negative and statistically insignificant, suggesting that the FOMC discontinued targeting M3 during this period. This roughly coincides with the estimated break date in the federal funds rate and is in line with Alan Greenspan's testimony to the U.S. Congress in July 1993.[12] The weight on output gap, which is estimated to have declined in the earlier sample, rises above the recommended policy weights. Finally, the weight on inflation is estimated to be below the recommended policy, pointing to a gradual move towards less-active policy during the later period of Greenspan's tenure.

Estimates of the policy parameters suggest that money played a diminished role in policy making during the second half of the 1990s. This may have led the federal funds rate to be less active - in particular, the policy rule with money recommends a tighter policy as compared to the federal funds rate during this period. Given that growth in broad money may serve as an indicator for credit growth (Kaminsky and Reinhart (1999), Nelson (2003)), my framework proposes a possible explanation for the lack of control over credit growth in the events preceding the Great Recession, contributing to the 'policy mistakes' literature by Taylor (2014) and Belongia and Ireland (2015b). In particular, the shift in policy, which according Taylor (2014) 'began about 10 years ago', may be identified as a departure from

[12]In particular, Alan Greenspan argued that "At one time, M2 was useful both to guide Federal Reserve policy and to communicate the thrust of monetary policy to others...the so-called "P-star" model, developed in the late 1980s, embodied a long-run relationship between M2 and prices that could anchor policy over extended periods of time. But that long-run relationship also seems to have broken down with the persistent rise in M2 velocity." Interestingly, M3 fits the data better than M2 as shown in the earlier section. One implication of this results is that while Alan Greenspan may have been interested in M2, the actual policy pursued considered M3 over M2.

money growth objectives.[13] Therefore, my framework highlights the potentially common principles at work during the two contrasting periods of macroeconomic stability.

This section offers two novel contributions that underline FOMC policy since the 1980s. First, the interest rate implied by the policy rule with money growth tracks the federal funds rate remarkably well during this period (1984-2000). These results suggest that growth in M3 significantly influenced the policy discourse during the 1980s and 1990s. This rule may therefore explain a large proportion of the stable monetary policy practiced during their tenure. More formal empirical analysis supports money growth targeting and rule-based policy. Second, my results point to evidence of a gradual decline in the weight on money growth aggregates, as well as a departure from the "good" policy recommended in this paper. The weight on inflation and output gap based on the money growth policy rule suggest that a less active policy was in place during the second half of the 1990s. Based on the estimates of policy rules during the Volcker-Greenspan period, my framework highlights a novel channel of passive policy which may have triggered events leading up to the Great Recession.

3. Extensions

I extend my findings across four dimensions. In the next section, I compare the fit of the policy rule with money growth to a rule with output growth objectives. In section 3.2, I confirm the robustness of my results based on a policy rule that incorporates interest rate smoothing. In section 3.3, I test whether the policy prescriptions based on real-time data can be extended for historical data as well. Last, I conduct a welfare based evaluation of the simple monetary policy rule using the text-book Keynesian model.

3.1. Comparison with Output Growth Objectives

Walsh (2003), Orphanides (2004), Orphanides and Williams (2006) and Coibion and Gorodnichenko (2011) have discussed the merits of output growth targeting as an objective that monetary policymakers can respond to for stabilization purposes. In practise, Coibion and Gorodnichenko (2011) show that the Fed has been increasingly responding to output growth. According to their findings, if the FOMC were to stop responding to both the output gap and output growth, there would have been periods of indeterminacy even during the Great

[13] Taylor (2015) contends that in his view the low interest rates of the 2000s brought on a search for yield, excesses in the housing market, and, along with a regulatory process which broke rules for safety and soundness, and were a key factor in the financial crisis and the Great Recession.

Moderation. A variant of their specification allows for a response to inflation, output gap and output growth:

$$i_t = \phi_y y_t + \phi_\pi(\pi_t - \pi^T) + \phi_{gy}(\Delta g y_t - \Delta g y^T) + r^* \tag{3}$$

However, as suggested in Qureshi (2016), money growth objectives serves to increase the aggregate response of the monetary authority to changes in inflation, and induces interest rate inertia and history dependence. Therefore pursuing money growth objectives have similar theoretical stabilization properties as a policy rule with output growth. To test which policy objective was actually pursued by the FOMC, I compare the fit of both objectives in the standard Taylor rule. Data on output growth is taken from the real-time series used in Coibion and Gorodnichenko (2011).

Table 4 summarizes these findings using OLS estimates. In column 1, the policy rule with money growth is presented. Column 2 presents estimates of the policy rule with output growth objectives. Columns 3 and 4 present a mixture of these policy rules. In column 3, I supress the response to output gap objectives to zero. In column 4, I estimate the baseline policy rule with both money growth and output growth objectives.

Table 4: Estimates of the Policy Rules, 1983.05 - 2000.02

	OLS			
Param.	(1)	(2)	(3)	(4)
ϕ_π	1.2008***	1.5269***	1.0768***	1.2594***
	(0.1089)	(0.1340)	(0.0988)	(0.1060)
ϕ_x	0.1263***	0.05467	–	0.1419***
	(0.0377)	(0.0470)	–	(0.0354)
ϕ_m	0.5380***	–	0.4605***	0.5005***
	(0.0420)	–	(0.0502)	(0.0461)
ϕ_{gy}	–	0.3905***	0.0853	0.1343**
	–	(0.0649)	(0.0512)	(0.0491)
c	0.5191	0.8539	0.8147**	0.1762
	(0.3119)	(0.4567)	(0.2882)	(0.3158)
R^2	0.7605	0.5218	0.7379	0.7702
RMSE	1.0098	1.4268	1.0563	0.99279
AIC	389.6814	483.0121	401.8462	386.0655
BIC	401.3025	494.6332	413.4673	400.5918
Observations	135	135	135	135

Note: This table presents estimates of the baseline feedback rule. Robust standard errors are reported in parentheses. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$ denote significance levels. 'c' denotes the constant of regression. The acronyms AIC and BIC represent Akaike's and Schwarz's Bayesian information criteria, respectively.

Focusing first on the comparison between money growth and output growth objectives (columns 1 and 2), my results favour a policy rule with money growth to explain the federal funds rate. Despite the weight on output growth being statistically significant, the goodness-of-fit (R^2), RMSE and the AIC/BIC criterion of the regression prefer a policy rule with money growth. Moreover, the response of money growth objectives is in line with the "good" policy parameters recommended in this paper. Judging by the size of the standard errors, and the estimates of good policy in previous sections, the response to inflation and the output gap is also sharply identified in the policy rule with money.

Column 3 presents policy rules that contain both output growth and money growth objectives, suppressing the weight on output gap to zero. Estimates of this policy rule suggest that the weight on money growth is more important than the weight on output growth objectives as it remains statistically significant. The response of money growth objectives is also estimated to be line with the "good" policy parameters recommended in this paper. However, the inclusion of both money and output growth objectives worsens the fit of the

model, and the data favors a combination of output gap and money growth objectives.

Finally, column 4 summarizes the combined policy rule with output gap, money and output growth objectives. Estimates of inflation and the output gap display some deviation from the baseline good policy espoused in this paper, but the weight on money growth corresponds to the exact weight recommended in the baseline analysis. The weight on output growth is estimated to be statistically significant, but is a third of the value of the money growth coefficient. Interestingly, judging by the goodness-of-fit (R^2), RMSE and the AIC/BIC criterion of the regressions, this policy outperforms even the simple money growth targeting rule (column 1). However, the additional improvement in the fit of the policy rule is very low. Evidence against the higher BIC is within values of 0 and 2 suggesting that the differences in the two policy rules (columns 1 and 4) may not be significant.

Distilling historical evidence to gain insights into policy for adaptive purposes suggests that a policy with output growth and money growth might yield a more stabilizing equilibrium. However, since a central bank may be subject to economic uncertainty which may lead to large policy errors of the type documented in Orphanides and Williams (2006) and Orphanides (2003), it may be more desirable to adopt money growth objectives. This proposition is in line with the findings of Coenen, Levin and Wieland (2005) who use an estimated model of the euro area and show that current output estimates may be substantially improved by including money growth in the information set. Therefore, and as this section highlights, the gains from adopting both money and output growth objectives may be insignificant.

3.2. Incorporating Interest Rate Smoothing

I test the robustness of my findings against popular modifications to the policy rule, such as the inclusion of interest rate smoothing. Clarida, Galí and Gertler (2000) show that incorporating a partial-adjustment mechanism to the original Taylor (1993) rule helps improve the fit of the actual variation in the nominal interest rate observed in the U.S. economy. This specification of the FOMC's reaction function allows for interest smoothing of order two, a response to inflation, output gap and nominal money growth.

$$i_t = \rho_1 i_{t-1} + \rho_2 i_{t-2} + (1 - \rho_1 - \rho_2)[\phi_\pi \pi_t + \phi_x x_t + \phi_m \Delta m_t] + c_t + \epsilon_t \tag{4}$$

To ascertain estimates of the policy rule that are commonly presented in the literature, I employ actual data instead of smoothed data. I estimate this policy rule for the 1983.05 - 2000.02 time period. Table 5 summarizes the results. For comparative purposes, two versions

of the policy rule are estimated. In the first estimate, presented in columns 1 and 3, I restrict both ρ_1 and ρ_2 to zero. In the second version (columns 2 and 4), I estimate the complete policy rule. As before, both OLS and GMM estimates are provided.

The results with interest rate smoothing support my baseline results. Across all estimates the weight on money growth is significant and close to 0.5 as recommended by the augmented policy rule. The weight on output gap is estimated to be below 0.5, a value that is consistent with other estimates during this period (Coibion and Gorodnichenko (2011)). However, there is greater uncertainty about the weight on inflation. In particular, OLS estimates for the policy rule with interest rate smoothing in column 2 suggest a value of less than one. This is resolved through the use of an appropriate instrument.[14] In this regard, GMM estimates in column 4 suggest values close to the baseline estimates (column 1 and 3). Finally, there is sufficient evidence of interest rate smoothing, as the lagged term on interest rates is estimated to be statistically significant. Moreover, the sum of both the first and second lagged terms is close to 0.90, suggesting a high degree of smoothing. A similar pattern is observed when I estimate this framework using smoothed data used in the previous sections.[15]

[14]Since the lagged interest rate affects estimates of inflation, output gap and money growth targets, GMM estimates may help account for regressor endogeneity, and therefore provide more reliable estimates.

[15]These results are available from the author upon request. More encouragingly for our results, including interest rate smoothing and using actual data instead of smoothing data also solves the over-identification issue encountered in the earlier section.

Table 5: Estimates of the Policy Rules, 1983.05 - 2000.02

	OLS		GMM	
Param.	(1)	(2)	(3)	(4)
ϕ_π	1.2008^{***}	0.6846	1.5839^{***}	1.3181^{***}
	(0.1089)	(0.1512)	(0.1397)	(0.4332)
ϕ_x	0.1263^{***}	0.1699	0.2409^{***}	0.2565^{**}
	(0.0377)	(0.1545)	(0.0382)	(0.0992)
ϕ_m	0.5380^{***}	0.6451^{*}	0.5534^{***}	0.6085^{***}
	(0.0420)	(0.2500)	(0.0435)	(0.1423)
ρ_1	–	1.3140^{***}	–	1.2860^{***}
	–	(0.7187)	–	(0.2603)
ρ_2	–	-0.3858^{***}	–	-0.3982
	–	(0.7187)	–	(0.2149)
c	0.5191	1.4622	-0.57699	-0.0623
	(0.3119)	(1.6616)	(0.3667)	(1.154)
R^2	0.7605	0.9756	–	–
RMSE	1.0098	0.3245	–	–
Observations	135	135	132	132
$\rho_1 + \rho_2$	–	0.9282	–	0.8878
$p - value$	–	–	0.17	0.84

Note: This table presents OLS and GMM estimates of the baseline feedback rule. The set of instruments for GMM are three lags of inflation, output gap and growth in monetary aggregate M3. The bottom panel reports the p-value associated with a test of the models over identifying restrictions (Hansen's J-test). Robust standard errors are reported in parentheses. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$ denote significance levels. 'c' denotes the constant of regression. Columns (1) and (3) denote the policy rule without interest rate smoothing, while the columns (2) and (4) indicate the policy rule with interest rate smoothing.

My findings suggest significant evidence of money growth targeting even when taking into account a partial adjustment mechanism that is commonly considered in the literature. To conclude, including interest rate smoothing does not change the main results proposed in this paper.

3.3. Policy Based on Historical Data

In this section, I test whether the policy implications implied by the rule based on money growth targeting are robust for historical data. I examine whether money growth targeting is able to explain the differences in the policy parameters, which have traditionally been sensitive to the type of data employed. Specifically, I inspect whether money growth targeting

is a feature of real-time data only by estimating the augmented policy over the same dates using historical data.

The specification for the policy rule is the baseline rule augmented with money (equation 3). Corresponding historical data are matched as follows: I use quarterly U.S. data on inflation, money growth, the output gap, and the federal funds rate. The output gap is calculated as the log difference between real GDP and the CBO's Potential GDP estimate,[16] inflation is calculated as the quarterly log difference of the GDP Implicit Price Deflator, and growth in M3 is calculated as the quarterly log difference of the Money Stock M3. Finally, the federal funds rate is used in levels and transformed to yield quarterly rates. Data on the rate of inflation and money growth are smoothed. As before, I use contemporaneous output gap. For comparison, I consider the following real-time periods, from 1984.11 to 2000.02 (1984:4 - 2000:1), 1984.11 - 1992.12 (1984:4 - 1992:4), and the period 1993.02 - 2000.02 (1993:1 - 2000:1). Dates in parentheses represent the parallel historical dates.

Table 5 provides estimates of the policy rule based on both real-time and historical data. Columns 1 - 3 present the results based on real-time data, while columns 4 - 6 present the results based on historical data. Estimates based on historical data provide evidence in favor of money growth targeting, and the coefficient on M3 is estimated to be statistically significant. However, the weight on money growth is approximately three times lower than the value recommended by the augmented policy rule based on the real-time data. The policy parameters for the entire sample (columns 1 and 4) display some sensitivity to the type of data. The policy rules based on historical data suggest a lower weight on inflation, output gap and money growth relative to their estimated values based on real-time data.

This pattern is also detected when considering the first sample in the split-sample estimates. First, for the pre-1993 period in columns 2 and 5, both real-time and historical data support evidence of active policy, suggesting policy parameters to be larger than the recommended parameters. For example, the weight on inflation during this period conditional on real-time data is close to 2, as compared to 1.65 for the entire sample. For the historical data, the weight on inflation is 1.60, as compared to 1.5 for the entire sample. This pattern is consistent across estimates of the other policy objectives as well. As before, historical data assign a lower weight on inflation, output gap and money growth as compared to real-time data. In line with the predictions from the real-time data, money growth targeting is significant during this period, but the estimated coefficient is almost half in value compared to the coefficient estimated from real-time data.

[16] I also use HP-filtered output as discussed in Clarida, Galí and Gertler (2000) as an estimate of potential GDP to check for robustness, but my main results do not change.

This pattern is reversed when considering the post-1993 period. While real-time data suggest a gradual drift towards less-active policy, and present no evidence of money growth targeting, historical data suggest an active policy, with a statistically insignificant weight on the output gap, as compared to the positive weight assigned by the real-time data.

Table 6: Federal Reserve Policy: Real-time versus Historical Data

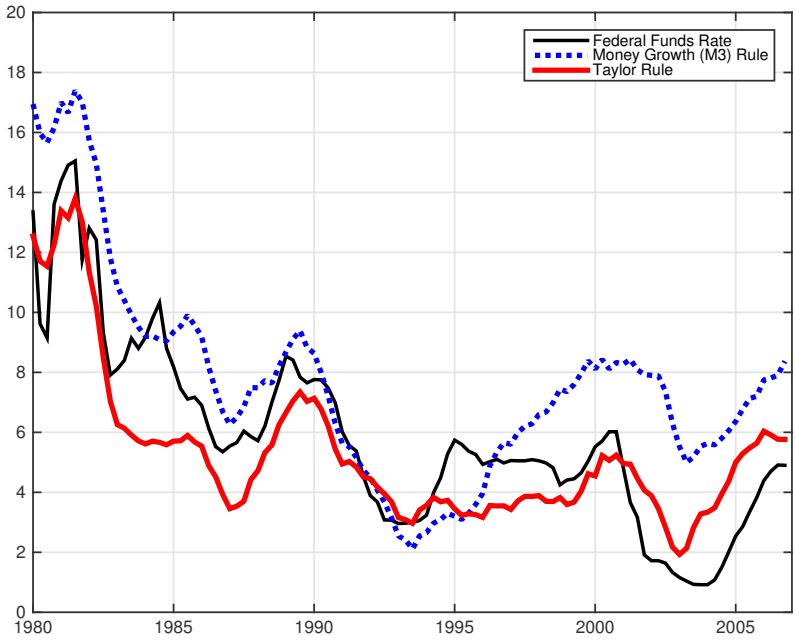
	Real-time			Historical		
Param.	(1)	(2)	(3)	(4)	(5)	(6)
ϕ_π	1.6509^{***}	2.0199^{***}	1.4288^{***}	1.4840^{***}	1.6032^{***}	2.2511^{***}
	(0.0750)	(0.1138)	(0.2337)	(0.1045)	(0.1901)	(0.9390)
ϕ_x	0.4322^{***}	0.4294^{***}	0.7833^{***}	0.3138^{***}	0.4714^{***}	0.1314
	(0.0251)	(0.0259)	(0.0842)	(0.0688)	(0.0887)	(0.1943)
ϕ_m	0.5023^{***}	0.5639^{***}	-0.2315	0.1720^{***}	0.2707^{***}	0.2731^{*}
	(0.0245)	(0.0222)	(0.1187)	(0.0428)	(.0562)	(0.1260)
c	-0.7670^{**}	-2.477^{***}	1.8580^{**}	-1.0253^{*}	0.1318	-0.8080
	(0.2256)	(0.4363)	(0.6272)	(.4370)	(0.8184)	(2.2848)
R^2	0.8979	0.9385	0.7034	0.7493	0.8578	0.2467
RMSE	0.5639	0.4500	0.5229	0.7600	0.6115	0.7650
Obs.	123	66	57	66	33	29

Note: This table presents OLS estimates of the baseline feedback rule. Robust standard errors are reported in parentheses. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$ denote significance levels. 'c' denotes the constant of regression. For the real-time data, column (1) denotes the time period 1984.11 - 2000.02, columns (2) denotes the time period 1984.11 - 1992.12, and column (3) denotes the time period 1993.02 - 2000.02. For historical data, column (4) denotes the time period 1984:4 - 2000:1, column (5) denotes the time period 1984:4 - 1992:4 and column (6) denotes the time period 1993:1 - 2000:1.

I extend predictions of the "good" policy by generating the interest rate based on historical data immediately before the onset of the Great Recession. I compare the recommendations of this policy with the actual path of the federal funds rate for the quarterly period 1980:1 - 2006:4. My results confirm evidence of less active policy during the second half of Greenspan's tenure. As documented by the real-time data, a gradual deviation from this good policy occurred around 1994. In particular, the average interest rate recommended by the policy based on the money growth targeting rule is approximately twice as large as the actual federal funds rate. The policy proposed by Taylor also recommends a relatively low interest rate, suggesting that following this policy might not have guaranteed macroeconomic stability. By recommending an adjustment in the federal fund rate in response to developments in the money market, the money growth targeting rule presents an alternative framework that may

have ensured stability.[17] Figure 4 presents these results.

Figure 5: Federal Funds Rate 1980:I-2006:IV



Note: This figure presents estimates of the nominal interest rate based on the Taylor rule, the money growth targeting rule and the actual federal funds rate for the quarterly period 1980:I - 2006:IV.

My findings based on historical data support evidence of money growth targeting during the Volcker-Greenspan era. Extending predictions of the "good" policy recommended in this paper based on historical data confirm evidence of loose policy before the onset of the Great Recession. These results also extend the conclusions of Favara and Giordani (2009), Canova and Menz (2011) and Castelnuovo (2012) by presenting evidence on the role played by broad money aggregates in explaining fluctuations in the business cycle even in the post 1980s period. These results underline the importance of further exploring the role of money in current macroeconomic models.

[17]This supports the evidence presented by Nelson (2003) who has called for a development in monetary aggregates since they may be a useful indicator for the wide range of yields that must be taken into account in a world with imperfect asset markets, or the range of lending and deposit criteria that affect the role of the banking sector in the economy.

3.4. Model-Based Analysis

I utilize the prototypical New Keynesian DSGE model developed by Gali (2009) and Woodford (2011) to analyze the theoretical implications of money targeting and conduct welfare analysis. In section 3.4.1, I present the model. In the last section, I evaluate welfare using simple policy rules.

3.4.1. The Model

From the optimality conditions of a continuum of household and firms, I derive a dynamic Phillips curve and the dynamic IS curve:

$$x_t = E_t x_{t+1} - \frac{1}{\sigma}(i_t - E_t \pi_{t+1}) \tag{5}$$

$$\pi_t = \beta E_t \pi_{t+1} + \kappa x_t \tag{6}$$

where π_t is inflation and x_t is the output gap.[18] Equation 5 is the log-linearized Euler condition, where the output gap is negatively related to the difference between the nominal interest rate, i_t, and positively related to expected inflation, π_{t+1}. Equation 6 is the New-Keynesian Phillips curve (NKPC), which relates inflation in the current period to expectations of inflation and the output gap. To track money growth, I use a first differenced money demand curve:

$$\Delta m_t = \pi_t + \Delta x_t + \Delta y_t^n - \eta_i \Delta i_t + \Delta \tau_t \tag{7}$$

Δm_t is the log change in the nominal money stock and Δy_t is growth in actual output. τ_t captures exogenous money demand shocks and η_i represents the elasticity of nominal money growth to interest rates. To close this model, I consider the following policy rule:

$$i_t = \phi_\pi \pi_t + \phi_x x_t + \phi_m \Delta m_t \tag{8}$$

The model consisting of equations 5,6,7 and 8 allow me to present the following result.

Result 1: Impact of money growth targeting on other policy parameters *For any $\beta \in (0,1)$, and any $\kappa > 0$, if the monetary authority follows the policy rule $i_t = \phi_\pi \pi_t + \phi_x x_t + \phi_m \Delta m_t$, then the rule can be written as follows:*[19]

$$i_t = \delta_1 \pi_t + \delta_2 x_t + \delta_3 i_{t-1} - \delta_4 x_{t-1} + \epsilon_t \tag{9}$$

[18] Lowercase letters denote the natural logs of the corresponding variable as presented in Gali (2009).

[19] This expression can easily be derived by plugging in equation 8 into equation 9 and simplifying it.

where:

$$\delta_1 = \frac{\phi_\pi + \phi_m}{1 + \eta_i \phi_m} \qquad \delta_2 = \frac{\phi_x + \phi_m}{1 + \eta_i \phi_m}$$
$$\delta_3 = \frac{\eta_i \phi_m}{1 + \eta_i \phi_m} \qquad \delta_4 = -\frac{\phi_m}{1 + \eta_i \phi_m}$$

and $\epsilon_t = \phi_m \Delta y_t^n + \Delta \tau_t$. This analysis confirms the sources of misidentification in the simple Taylor rule, and ignoring money growth targeting effects the estimates of the coefficients on the other policy objectives. This finding lends theoretical support to the empirical results offered in section 2. Moreover, responding to money growth increases the aggregate response to inflation and output, and induces history dependence. As a consequence, this framework suggests that explicitly responding to money growth induces policy inertia in the central banks actions even in this simple policy framework, confirming the findings presented in Söderström (2005). Given that this simple policy is able to induce interest rate inertia, it satisfies some of the attributes of desirable monetary policy highlighted in Woodford (2011)). This finding supports the literature that favors simple rules over optimal policy rules due to the practical shortcomings of the latter.

3.4.2. Evaluation of Simple Policy Rules

Based on the simple three equation model and the money demand equation, I conduct welfare analysis across a battery of simple policy rules, beyond those discussed in Qureshi (2016).[20] First, using different combinations of values for ϕ_π, ϕ_x and ϕ_m, I generate the model implied volatility in output gap and inflation. Second, using the simple loss function formulated in Gali (2009), I calculate welfare, expressed here as steady state loss in consumption. I tabulate these results in Table 7.

Table 7: Welfare Analysis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ϕ_π	1.5	1.5	1.5	2	2	2	1.5	1.5	1.5	1.5
ϕ_x	0.125	0.125	–	0.125	0.125	–	0.125	0.125	0.125	0.25
ϕ_m	–	0.5	0.5	–	0.5	0.5	1	0.25	0.75	0.5
$\sigma(x)$	0.24	0.59	0.67	0.15	0.51	0.56	0.83	0.41	0.72	0.53
$\sigma(\pi)$	1.15	0.83	0.96	0.71	0.69	0.78	1.18	0.75	1.01	0.73
Welfare Loss	0.059	0.031	0.041	0.022	0.021	0.027	0.062	0.025	0.045	0.023

Note: The table presents point estimates of the volatility in inflation, output gap, and the corresponding welfare losses under each parameterization of the monetary policy rule.

[20]Notice that in this model, the only two sources of exogenous disturbances are technology and money demand. The model is parameterized using the values presented in Gali (2009).

Numerical evaluation of these simple policy rules using the prototype Keynesian model confirms the predictions of the recommended policy proposed in this paper. Placing a positive weight on money growth is always welfare improving in this set-up. Specifically comparing the policy espoused by Taylor (1993) in column 1 with the benchmark policy proposed in this paper (column 2), suggests a significant improvement in welfare. This is robust across different values of ϕ_π and ϕ_x. For example, in columns 4,5 and 6, despite the larger weight on inflation, a positive weight on money growth reduces welfare loss. This is in line with my theoretical results, as the money growth targeting rule conforms with the attributes of stable policy.

Holding constant the parameters espoused by Taylor (1993) and varying the response to money growth (columns 7, 8 and 9) suggest that a larger or a smaller weight on money, compared to the benchmark weight of 0.5, yields a worse outcome in terms of welfare. In light of the empirical evidence presented earlier regarding the fit of the Taylor rule and estimates of policy parameters during the Volcker-Greenspan policy era, welfare based analysis confirms the predictions of the "good" policy parameters proposed in this paper. Therefore, a model based exposition of the benchmark policy rule formalizes the role of the Federal Reserve in generating the macroeconomic stability observed during the post 1980 era.

4. Conclusion

I use real-time data to evaluate whether the celebrated good policy recommended by Taylor (1993) was, in fact, practiced by the Federal Reserve during the time period presented in his paper (1987-92), a period of unparalleled macroeconomic stability. I show that this rule is unable to explain the actual behavior of the Federal Reserve during this period. Using novel data on M3 growth, I show that a policy rule incorporating money growth targets beyond the simple Taylor rule far more accurately tracks the actual federal funds rate, even during the Volcker-Greenspan era (1984-2000). I find that excluding money growth as a policy objective may severely distort estimates of actual policy rules. By presenting evidence of rule-based policy that is robust to real-time data, my findings reconcile the conflicting conclusions of Orphanides (2004) and Taylor (1993).

From a descriptive perspective, the empirical evidence presented in this paper offers a unique interpretation of "good" rule-based policy that may help explain the extraordinary macroeconomic stability experienced by the U.S during the post 1980s era. Identifying a departure from this good policy during the latter half of the 1990s, I highlight a new channel of less active policy that may have triggered the events leading to the Great Recession.

Therefore, my results provide a reinterpretation of the common principles at work during the two contrasting periods of macroeconomic stability. Numerical evaluation using the prototype Keynesian model confirms the predictions of the recommended policy.

Viewing the results of this paper from the lens of a policymaker calls for a reinvestigation of the role of money in policy formulations and a rethinking of reliance on the Taylor rule as a sacrosanct central bank policy-making benchmark. Going forward, if policymakers are basing their decisions primarily on the Taylor rule, they risk being either too tight or too loose with money and credit, and therefore, may yield unstabilizing policy. I conclude that before incorporating a modified Tayor rule that incorporates money targeting in policy discussions, future work needs to focus on measuring and resolving the shortcomings of money growth aggregates as indicators of price stability.

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