

The Monetary Transmission Mechanism and
The Evaluation of Monetary Policy Rules

by

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The purpose of this paper is to explore the connection between the monetary transmission mechanism—the channel through which a change in monetary policy affects the economy—and the choice of monetary policy rules to guide central bank decisions. Different views of the monetary transmission mechanism are readily apparent in the many different models that monetary economists use to evaluate monetary policy. For example, a symposium on "The Monetary Transmission Mechanism" in the fall of 1995 (*Journal of Economic Perspectives*, Vol. 9, No. 4, pp. 3-72) contains five papers representing alternative views. The question is: Do these different views lead to substantial differences in the optimal rules for monetary policy?

In order to answer this question, I draw on evidence obtained in recent and ongoing research on the quantitative evaluation of monetary policy rules. In fact, there has been an explosion of this type of normative macroeconomic research in recent years, reflecting both an increase in supply by researchers and an increase in demand by policy makers. Most of the *new normative macroeconomics* takes as given that the central bank has an explicit or implicit inflation target, and this assumption immediately makes the research useful to many central bankers. The purpose of the research is then to find policy rules to guide policy makers in setting the policy instruments so as to bring the inflation rate close to the target, and keep it close to the target, while taking account of short run tradeoffs that impinge on output, employment, and exchange rate variability.

By an inflation target I simply mean that a numerical value (usually near zero) for the inflation rate appears in the objective function used for policy evaluation; the "target rate of inflation is therefore given" (Taylor (1979), p. 1276). Having an inflation target does not necessarily mean that a particular *operating procedure* is being used by the central bank—such as setting the instruments of policy so as to bring a *forecast* of inflation into equality with the

target, or so that the instruments react in a certain way to real output or the exchange rate. The choice of an operating procedure (a policy rule) is an outcome of the normative macroeconomic research, not an input. Although having an inflation target does not necessarily mean that the central bank is explicit rather than implicit in announcing the target, there is wide agreement about the benefits of a more transparent policy.

This new normative macroeconomics is ideally suited for answering questions about the connection between the monetary transmission mechanism and the policy rule. First, the recommendations for policy rules that emerge from this research are highly specific, usually expressible in the form of precise algebraic equations. Second, the recommendations are derived from explicit structural models of the economy in which the researchers have taken clear positions on the monetary transmission mechanism. Hence, it is possible to trace the connection between views of the monetary transmission mechanism and policy choices in a way that was not possible before. The results are therefore new and in some cases quite surprising. One possible disadvantage of this approach should be mentioned at the start. By focusing on quantitative research, the approach does not deal with less formal or "verbal" descriptions of the monetary transmission mechanism, or with more basic theoretical models that have not yet been specified quantitatively for empirical work.

The paper proceeds as follows. I first briefly summarize different views of the monetary transmission mechanism. Because understanding the results of this paper requires an appreciation of the novel nature of the new normative macroeconomics, I next describe the methodology of the policy research in some detail. I then endeavor to classify 18 policy models according to the approach taken to the monetary transmission mechanism, distinguishing between aggregate demand and price adjustment effects. In the remaining parts of the paper, I

examine how these different views affect the estimated performance of different policy rules. I look at a simple benchmark rule, at policy rules with inertia, and at policy rules designed for small open economies. In cases where the results seem surprising or paradoxical I examine and compare the different monetary transmission mechanisms in more detail. One by-product of this approach therefore might be a better understanding of how the different views compare. I summarize and discuss the results in the last section of the paper.

1. Terminology and a Summary of the Different Views

Some terminology is needed to distinguish between the different views of the monetary transmission mechanism. One view, which is very common in new normative macroeconomic research, is the *financial market price* view (see Taylor (1995) for more details). This view stresses the impact of monetary policy on the prices and rates of return on financial assets—including bond prices, interest rates, and exchange rates—and thereby on the spending decisions of firms and households. There are different versions of the financial market view. For example, there are different degrees of emphasis placed on the exchange rate versus other asset prices; these differences are partly a matter of the degree of openness of the economy being studied. In smaller, more open economies the exchange rate is, of course, quantitatively more important than in larger economies. How does a greater influence of the exchange rate affect the optimal policy rule?

Another view of the monetary transmission mechanism, which is frequently put forth as an alternative to the financial market price view, is the *credit* view (see Bernanke and Gertler (1995) for more details). The credit view places emphasis on changes in lending by banks and other financial intermediaries as an alternative to internal finance. Quantitative measures of

credit and corporate cash flows are therefore an important input to this view. Does it matter for the choice of a monetary policy rule whether one thinks the “financial market price” view or the “credit” view dominates?

There are also different views about what *rigidities* are needed to explain why a change in a nominal magnitude like the money supply affects real variables. Most of the research evaluating policy rules uses some variant of a *staggered price* or *wage setting* theory to generate the impact of policy. A distinguishing feature of these models is that expectations of future inflation affect price setting. Modelling differences are the degree of backward-looking that is mixed in with the forward-looking, and whether or not it is the expected inflation rate or the expected price level that affects decisions.

Another completely different type of rigidity that has been used in normative macroeconomic research is the *limited participation* model (see Christiano, Eichenbaum and Evans (1997) for a review). In these models investors are limited in the amount of funds they can transfer from one financial account to another account each period. How much difference do these different models make for the choice of an optimal policy rule?

Finally, there are different views about how to model expectations. While there is wide agreement that expectations are very important in financial markets, and thereby in the monetary transmission mechanism, there is disagreement about the best way to model expectations. How different is the performance of policy rules in models with rational expectations from that of policy rules in models that do not assume rational expectations?

2. The Nature of the Models and the Policy Research

The approach of this paper is to first classify different models used for policy evaluation

into different structural types based on the approach taken to the monetary transmission mechanism, and then to see if these different types of structures affect the evaluation of policy rules in systematic ways. All the quantitative models of the monetary transmission mechanism examined in this paper are *stochastic*, *dynamic*, and *economy-wide*. The models are also used in the same way for analysis and policy evaluation. Hence, the differences are not in the methodology, but rather in the economic structure. It is helpful to discuss these methodological similarities and review their rationale before examining the structural differences.

The stochastic feature of the models is necessary if one is to predict how effective policy rules are at cushioning the economy from unanticipated shocks. The stochastic shocks are added to equations of the model, and their stochastic properties (variances and covariances) are matched with historical experience just as other parameters of the models are.

The models must be dynamic for two reasons: First, there are lags in the monetary transmission mechanism, and second, expectations of the future are important in financial markets. The most common—though not universal—expectation assumption used in these models is the rational expectations assumption in which people's expectations of the future are equal to the model's mathematical conditional expectations.

The models are "economy-wide" or "general equilibrium" because monetary policy has impacts on the whole economy. Moreover, using the rational expectations assumption requires a complete model of the economy in order to explain how expectations are formed. Some researchers prefer to use the term "model consistent" rather than "rational expectations" to emphasize that the expectations depend on a complete model of the economy (see Brayton *et al.*, for example).

Stochastic, dynamic, economy-wide macroeconomic models with rational expectations give rise to mathematical structures that involve systems of difference equations in which both past and expected future values of variables appear. A typical model of the transmission mechanism used for policy evaluation can be written in the form:

$$f_i(y_t, y_{t-1}, \dots, y_{t-p}, E_t y_{t+1}, \dots, E_t y_{t+q}, a_i, x_t) = u_{it} \quad (1)$$

for $i = 1, \dots, n$ where y_t is an n -dimensional vector of endogenous variables at time t , x_t is a vector of exogenous variables at time t , u_{it} is a vector of stochastic shocks at time t , and a_i is a parameter vector.

The simplest rational expectations model of the monetary transmissions mechanism is the case where the model (1) is a single linear equation ($i = 1$) with one lead ($q = 1$) and no lags ($p = 0$). This is the well-known rational expectations version of the Cagan model (see Sargent (1987), for example) in which the endogenous variable (y_t) is the current price level, the expected future variable ($E_t y_{t+1}$) is the one-period ahead price level, and the exogenous variable (x_t) is the money supply (the instrument of policy). Of course, models used to evaluate policy in realistic situations (other than hyperinflations!) need to be more complex than the Cagan model, and indeed all the models examined in this paper have more than one equation and values of p or q greater than one. In many applications, the system of equation (1) is linear, though nonlinear versions of equation (1) are not uncommon.

A solution¹ to equation (1) is a stochastic process for y_t . Obtaining such a solution in a rational expectations difference equation system is much more difficult than in a simple

¹Many papers have been written on algorithms for obtaining solutions to systems like equation (1). In the case where $f_i(\cdot)$ is linear, Blanchard and Kahn (1980) showed how to get the solution to the deterministic part of equation

backward-looking difference equation with no expectations variables. This difficulty makes the new normative macroeconomics difficult to teach and requires more expertise than is needed for conventional policy evaluation methods. This complexity is one reason why the methods are not explained in detail in textbooks in macroeconomics.

How do researchers use the model in equation (1) for policy evaluation? Alternative monetary policies are characterized by monetary policy rules that stipulate how the instruments of policy (usually the short-term interest rate) react to observed variables in the economy. The policy rules may be simple or they may be complex, but in general there is some feature of the policy rule that one is interested in investigating, such as how reactive should the policy be to the exchange rate or to real output. In particular, one might want to know the optimal response of the policy instrument to these variables.

The method used to answer the question can be described in the following series of steps.

- (1) Place the candidate policy rule into model $f_i(\cdot)$.
- (2) Solve the model using one of the solution algorithms.
- (3) Look at the properties of the stochastic steady-state (stationary) distribution of the variables (inflation, real output, and unemployment).

(1) by finding the eigenvalues and eigenvectors of the system. Under certain conditions, the model has a unique solution. Many macroeconomists have proposed algorithms to solve equation (1) in the nonlinear case. (See Taylor and Uhlig (1990) for a review.) The simple iterative method of Fair and Taylor (1983) has the advantage of being very easy to use even in the linear case, but is less efficient than other methods. Brian Madigan at the Federal Reserve Board has developed a very fast algorithm to solve such models. I have found that the iterative methods work very well in teaching advanced undergraduates and beginning graduate students. The algorithms are easy to program within existing user-friendly computer programs such as Eviews. I use such iterative methods to solve my multicountry rational expectation model (Taylor (1993b)).

I think more emphasis on solving and applying expectational difference equations should be placed in the economics curriculum, especially at the graduate level, but also at the undergraduate level. Many graduate students come to economics knowing how to solve difference and differential equations, but expectational difference equations such as (1) are not yet standard and require time and effort to learn well. It is difficult to understand let alone do modern macro policy research without a basic knowledge of how these expectational stochastic difference equations work.

(4) Choose the rule that gives the most satisfactory performance (a loss function may be useful here to help compare points on the tradeoff between the variance of one target variable and another).

(5) Check the results for robustness using other models.

The use of policy rules in this way is the most noticeable characteristic of policy evaluation research in macroeconomics today, especially when compared to the days before the rational expectations revolution.² The introduction of the rational expectations assumption into macroeconomics significantly increased the advantages of using policy rules in this way to evaluate policy. With rational expectations, people's expectations of policy matter greatly for the impact of changes in the instruments of policy, as demonstrated forcefully by Lucas (1976). Hence, in order to evaluate the impact of a policy one must state what that future policy will be in different contingencies. Such a contingency plan is nothing more than a policy rule.

Woodford (1999b) emphasizes the importance of the "timelessness" aspect of the above approach to policy evaluation. By focussing on a stationary policy rule and the stationary distribution, one is ensuring that the policy rule is no different than the one that the policymaker would follow in the same conditions at any other time. This timelessness or stationarity feature makes the evaluation of the policy rule much more accurate and less subject to serious errors. In effect, it assumes away any credibility problems that plague the evaluation of policy rules when people are forward-looking, as discussed in McCallum (1999).

² Of course, there are examples of policy rules research that predate the rational expectation assumption (see A.W. Phillips (1954), for example). Policy rules have always had the appeal of researchers interested in applying engineering control methods to macroeconomics; rules have also had the advantage of less uncertainty and greater accountability as stressed by Milton Friedman.

3. Different Views of the Monetary Transmission Mechanism as Seen from the Policy Models

Several of the quantitative models that I examine in this study consist of only two structural equations: (1) an *aggregate demand* or *IS equation* showing how real GDP (aggregate demand) depends on the interest rate and the exchange rate, and (2) a *price adjustment equation* showing how inflation evolves over time in response to changes in capacity utilization or changes in exchange rates. When combined with a policy rule, these simple models make up a three equation system. Such three equation systems include such models as the Fuhrer-Moore (1995) rational expectations model, the Rudebusch-Svensson (1999) time series model, the Ball (1997, 1999) models of closed or open economies, and the Woodford (1999b) or Clarida, Gali, Gertler (1999) simplified "new Keynesian" models.³ Other models used for policy evaluation (for example, Taylor (1993a) or FRB/US) involve many more than three equations, because they have a more detailed description of aggregate demand (with consumption, investment, net exports, and government purchases being modeled separately, for example), or a more detailed description of price adjustment (with both wages and prices being modeled separately, for example). However, even these larger models can be described conceptually as "three relationship" systems (one relationship being the policy rule). Equations relating consumption, investment and net exports to interest rates and the exchange rate combine to form an IS block of equations; wage and price setting with exchange rate pass through combine to form a price adjustment block of equations. Hence, for both small models and large models it is possible to classify differences in the monetary transmission mechanism according to whether they pertain

³ The use of the term "New Keynesian" is not universal, and may be confusing because it has been associated with particular microeconomic foundations of price and wage adjustment such as menu costs. These types of models are also called "Dynamic New Keynesian" models by Bernanke, Gertler, and Gilchrist (1999) and New Neoclassical Synthesis models by Goodfriend and King (1997). In my view the key characteristic of the models is that they are

to aggregate demand or price adjustment, and such a distinction is useful for the purposes of this paper.

Table 1 and Table 2 use this framework to classify eighteen different models that have been used for policy evaluation in the last few years. The tables show several ways in which models differ in their treatments of the monetary transmission mechanism as defined in Section 1 above. Table 1 focuses on differences relating to aggregate demand and Table 2 focuses on differences relating to price adjustment.

It is not possible to consider all models, but I think the eighteen models in Tables 1 and 2 are representative.⁴ Because of the ongoing nature of the research at central banks at this time, only two models used at central banks (the Federal Reserve Board models FRB/US and MSR) are included in Tables 1 and 2. It would be useful to consider models used at the Bank of Canada (Black, Macklem and Rose (1998)), the Reserve Bank of New Zealand (Drew and Hunt (1998)), the Riksbank (Dillen and Nilsson (1998)), the Bank of England (M. King (1999)) and other central banks where research is underway.

I realize that it is difficult to evaluate my classification method without a direct knowledge of all these models. For each model I give a reference to a paper which describes the model and/or uses the model for the purpose of evaluating monetary policy rules. It is through the model listings and descriptions in these references—descriptions in the form of equation (1)—that I have classified each model according to several characteristics such as whether the credit view is used or whether the exchange rate is a channel for monetary policy. (The exact characteristics are defined in the introduction to each table and are repeated in the text). Of course, Tables 1 and 2 do not include all the differences among the models—for example, some

dynamic, stochastic, economy wide models with forward-looking behavior and some rigidities that make them useful for policy evaluation along the lines defined in this paper.

models use more explicit optimization methods to derive equations than other models, some models fit the data better than others, and some models describe exchange rate behavior differently from other models (for example, Ball (1999) and Svensson (1999)). However, I think the two tables capture the key differences in the monetary transmission mechanism that might affect the evaluation of monetary policy rules. In any case, I think it is clear from Tables 1 and 2 that there are a variety of approaches to modeling the monetary transmissions mechanism. Now the question is whether the differences tabulated in Tables 1 and 2 make a difference for the evaluation of policy rules.

Table 1. Classification of Some Models According to the Approach Taken to the "Aggregate Demand" Component of the Monetary Transmission Mechanism. Eighteen models are organized according to (1) size, (2) whether they incorporate a "financial market price" view or a "credit" view of the transmission mechanism, (3) whether the short-term interest rate or the long term interest rate—through a rational expectations model of the term structure— influences demand, (4) whether there is some type of delayed or partial adjustment in response to changes in interest rates, and (5) whether the exchange rate affects aggregate demand.

	Size S/M/L	Price/ Credit	Long Rate/ Short Rate	Partial Adjustment	Exch. Rate?
Ball (1997)	S	P	S	Y	N
Ball (1999)	S	P	S	Y	Y
Bernanke-Gertler-Gilchrist (1999b)	M	C	L	N	N
Batini-Haldane (1999)	M	P	S	Y	Y
FRB/US:Brayton <i>et al</i> (1997)	L	P*	L	Y	Y
Chari, Kehoe, McGrattan (1999)	M	P	L	N	N
Christiano-Gust (1999)	M	P	L	Y	N
Clarida-Gali-Gertler (1999)	S	P	L	N	N
Fuhrer-Moore (1995)	S	P	L	Y	N
King-Wolman (1999)	S	P	L	N	N
McCallum-Nelson (1999a)	S	P	L	N	N
McCallum-Nelson (1999b)	S	P	L	N	Y
MSR: Levin <i>et al.</i> (1999)	M	P	L	N	N
Rotemberg-Woodford (1999)	M	P	L	N	N

⁴ I hope to consider more models in the final draft of this paper.

Rudebusch-Svensson (1999)	S	P	S	Y	N
Svensson(1999a)	M	P	L	Y	Y
TaylorMCM: Taylor (1993b)	L	P	L	Y	Y
Woodford (1999a)	S	P	L	N	N

* The presence of corporate cash flow in the investment equations of this model may suggest a "credit view" co-existing with a "financial market price" view, but the latter is a much more powerful channel of monetary policy in this model.

Table 2. Classification of Models According to the "Staggered Price Adjustment" Component of the Monetary Transmission Mechanism. The eighteen models are organized according to whether the staggered price adjustment mechanism is purely backward-looking (B), whether it is at least partly forward-looking (F), or whether another rigidity is assumed (LP for limited participation). Those models which have a forward-looking component of price setting are further classified according to whether the price setting and the forward-looking is in terms of the levels of prices (P), as in the staggered contract model in Taylor (1979) or the random geometric version of Calvo (1983), or whether it is in terms of the inflation rate (π) as in Fuhrer-Moore (1995). The models are also classified according to whether the exchange rate is a factor in price determination.

	Forward <u>Looking?</u>	Type of <u>Staggering</u>	<u>Exchange Rate?</u>
Ball (1997)	B	B	N
Ball (1999)	B	B	Y
Bernanke-Gertler-Gilchrist (1999b)	F	P	N
Batini-Haldane (1999)	F	π	Y
FRB/US:Brayton <i>et al</i> (1997)	F	P	Y
Chari-Kehoe-McGrattan	F	P	N
Christiano-Gust (1999)	LP	P	N
Clarida-Gali-Gertler (1999)	F	P	N
Fuhrer-Moore (1995)	F	π	N
King-Wolman (1999)	F	P	N
McCallum-Nelson (1999a)	F	P	N
McCallum-Nelson (1999b)	F	P	Y
MSR: Levin et al (1999)	F	P	N
Rotemberg-Woodford (1999)	F	P	N
Rudebusch-Svensson (1999)	B	B	N
Svensson(1999a)	F	P	Y
TaylorMCM: Taylor (1993b)	F	P	Y
Woodford (1999a)	F	P	N

4. A Class of Policy Rules

In order to answer the question I consider policy rules of the form

$$i_t = g_\pi \pi_t + g_y y_t + g_{e0} e_t + g_{e1} e_{t-1} + \rho i_{t-1} \quad (2)$$

where

i_t is the interest rate,

π_t is the inflation rate (usually smoothed over four quarters for quarterly models),

y_t is the deviation of output from potential output, and

e_t is the exchange rate (an increase in e is an appreciation of the local currency).

The g -parameters and ρ are policy choices. The interest rate is the instrument of monetary policy for all values of the policy parameters in this equation.⁵ The form of this simple policy rule allows for several of the major differences of opinion about policy rules. For example, the question about whether there should be interest rate smoothing (or inertia) in interest rate setting is captured by whether ρ is zero or not. I have suggested (Taylor (1993a)) that the value of ρ be zero, but others (Woodford (1999), for example) have recently argued that it should be greater than zero and even close to one. How much of this difference of opinion about policy is explained by differences of opinion about the monetary transmissions mechanism? Similarly, the question about whether monetary policy—especially in a small open economy—should react to the exchange rate is captured by whether g_{e0} or g_{e1} should be zero or not.

⁵ I could also have considered the impact of the monetary transmission mechanism on the choice of the policy instrument in the policy rule—such as whether the instrument should be the monetary base or the overnight interest rate. That the interest rate is, in fact, the instrument in most of the policy evaluation research is an obvious indication that the monetary transmission mechanism in these models does not focus on the money supply, largely

Of course, focussing on the functional form in (2) does not capture all differences in policy. In fact, fully optimal policy rules will be much more complex than equation (2). However, policy rule research has suggested that the simpler rules are close approximations to fully optimal policy rules in many cases. One might also wonder whether the *forecast* of inflation should be in the policy rule, rather than the four-quarter smoothed inflation rate. However, in my view (supported by simulations reported in Taylor (1999c)) there does not appear to be much difference between the impacts of policy rules that use forecasts of inflation in equation (2) rather than smoothed values of inflation over a few quarters. At least if the forecast is not too far out in the future, such forecast-based rules are in the spirit of equation (2). Moreover, it is difficult to compare different monetary transmission mechanisms for forecast-based rules because the forecasts themselves depend on the monetary transmission mechanism.

5. Effects of the Monetary Transmission Mechanism on a Benchmark Rule

Consider a version of the simple rule in equation (2) for which there is no reaction to the lagged interest rate and no reaction to the exchange rate. This is the type of rule I suggested in Taylor (1993a) as a guideline for the Federal Reserve, and I refer to it here as a benchmark rule because many researchers have examined this rule in comparison with other possible rules or with actual policy performance. A natural question to ask is whether the performance of the benchmark rule is affected by the different views of the monetary transmission mechanism.

Effects of different financial market price views

Simulations of the benchmark rule with a coefficient on inflation of 1.5 and a coefficient

because of uncertainty about velocity. Hence, one of the biggest differences in the monetary transmission mechanism (money versus interest rates) has already had a big impact on policy rules.

on output of 0.5 (Taylor (1993a)) show reasonable performance—at the least, no great depression or great inflation—across the range of models that use a financial market price and a sticky/staggered price adjustment view of the monetary transmission mechanism. Evidence for this comes from simulations of nine of the models in Tables 1 and 2 (see Taylor (1999b)). These simulations indicate that when this simple rule is used the variance of inflation and the variance of real output are small for the models that have a "financial market view" of the monetary transmission mechanism. To be sure, there is some preference for a higher weight on output than 0.5 in the policy rule if the objective function places more weight on output, but there is no dominance—in terms of both output and price stability—of a rule with a weight of 1.0 versus 0.5 on output. In fact, a rule with a coefficient on output of 1.0 is just as reasonable as a rule with 0.5, with the results saying more about the use of rules of this general type rather than about specific coefficients.

The result—that the form of the monetary transmission mechanism does not have much affect on the performance of the benchmark rule—does not mean that there are no other policy rules that will work better in some of the models; indeed as I discuss below a policy rule with a reaction to the exchange rate may work better in small open economy models. Rather the result is more like a robustness property that says the benchmark rule works pretty well; it does not lead to poor performance across a range of models that incorporate a "financial market price" view of the monetary transmission mechanism. Evidently, the range of different approaches to the financial market price view—a short-term rate focus, a long-term rate focus, complete forward-looking, complete backward-looking, more or less disaggregation—generate a similar policy-relevant relationship between interest rates, inflation, and output. Hence, the same

benchmark rule works well for this range of models. But does this robustness result carry over to other models of the monetary transmission mechanism?

Effect of the limited participation versus the staggered price setting view

Consider the radically different theory of the transmission mechanism based on limited participation. Surprisingly, a stability analysis of the limited participation model of Christiano and Gust (1999) indicates that replacing sticky prices with limited participation does not lead to a deterioration in the performance of the benchmark rule. As long as the weight on output is not too high, this simple rule also performs well in keeping the inflation rate and real output stable. (A weight on output of 0.5 works very well, but for some model parameters the weight of 1.0 is too large.)

Again, this is a robustness result. The benchmark rule is robust to a very different view of the monetary transmission mechanism. The result appears paradoxical simply because the limited participation view is so different structurally from the sticky price view. The explanation for the paradox comes from looking at how a change in monetary policy affects the economy. Most important is that a change in monetary policy can temporarily affect the real rate of interest—just as in the sticky price models. This change in the real interest rate then affects spending and employment for the same reasons it does on other models of monetary transmission. As described by Christiano and Gust (1999), "The household's date t decision about Q_t [the amount spent on goods] must be made before the date t realization of the shocks, while all other decisions are made afterwards. This assumption is what guarantees that...the equilibrium rate of interest falls, and output and employment rise." Thus, the paradox is

explained by the fact that a monetary induced decline in the real interest rate affects aggregate demand, much as in the sticky price models.

Effects of credit (financial accelerator) versus traditional market price views

Now consider the model of Bernanke, Gertler and Gilchrist (1999) which is the one model in Table 1 incorporating an explicit credit view. This credit view is embodied in what the authors call a *financial accelerator*. “The idea that fluctuations in borrowers’ net worth lead to fluctuations in real activity is what we mean by the financial accelerator.” (Bernanke, Gertler, Gilchrist (1996), p. 3). The key assumption—which gives the financial accelerator its credit view flavor—is that internal borrowing is cheaper than external borrowing. Hence, an increase in net worth—which would accompany a reduction in the interest rate—increases firms' ability to finance investment internally, and thus stimulates investment much as with the typical interest rate channel. As stated by Bernanke, Gertler, and Gilchrist (1999a, p. 1369), "The unanticipated increase in asset prices raises net worth, forcing down the external finance premium, which in turn further stimulates investment." The financial accelerator amplifies the impact of the interest rate. "With the financial accelerator mechanism present...smaller counter-cyclical movements in interest rates are required to dampen output fluctuations." (Bernanke, Gertler, and Gilchrist (1999a), p. 1364).

In a very recent paper, Bernanke and Gertler (1999b) report simulations of a policy rule like (2) in an estimated model with a financial accelerator. The rule they simulate is not exactly the one obtained by setting the coefficients on the exchange rate term and the coefficient on the lagged dependent variable to zero, because they also set the coefficient on output to zero and use a forecast of the inflation rate rather than a smoothed value of the exchange rate. They find that

this rule, which is similar to the benchmark rule, works reasonably well in their model. The variances of both inflation and output are small. Hence, it appears that if one held a credit view of the monetary transmission mechanism—at least as embodied in the financial accelerator—it would have little effect on one’s assessment of the usefulness of a simple benchmark rule for policy.

As in the case of the limited participation model, this robustness may appear paradoxical.⁶ However, the explanation for the paradox is already contained in the above explanation of the financial accelerator. The change in the interest rate and its effect on spending is still the main story of how monetary policy works. The one change that could make a difference—that the financial accelerator increases the sensitivity to the interest rate—is either not large enough to damage the performance of the benchmark rule, or in the process of estimation the parameters are chosen so that the net effect of an interest rate on spending is similar to other models of the monetary transmission mechanism.

Robustness to the exchange rate channel in a small open economy

An important question about the benchmark rule is how the exchange rate channel affects its performance. Svensson's (1999a) simulations of a small open economy model are directly relevant to this question. He reports that the benchmark rule (without the exchange rate terms) performs well in reducing the variability of inflation around the inflation target and variability of output around potential. In assessing these results with the benchmark rule, Svensson (1999a) concludes that the rule “appears somewhat robust; perhaps surprisingly robust.” Again, this

⁶ Because Bernanke and Gertler (1999) report simulations of a rule without a weight on output and with a forecast of inflation, the results are not strictly comparable with the other simulation results reported here. In my view the rule is close enough to warrant the conclusions stated here, but, until additional simulations are done, one cannot know for sure.

robustness finding does not mean that no better rule exists for Svensson's (1999a) model; in fact, the benchmark rule leaves the variability of the real exchange rate higher than other rules.⁷ The main point is that even a small open economy view of the monetary transmission mechanism does not change the assessment that the simple benchmark rule—responding systematically only to inflation and output—works well and is robust.

As with the other views of the monetary transmission mechanism, the explanation of this finding is that the exchange rate channel effectively makes a connection from the interest rate to aggregate spending. Rather than simply changing the real interest rate, a change in monetary policy changes the real exchange rate as well. The exchange rate magnifies the real interest rate effect, but does not affect its direction. Hence, a reaction of the policy rule only to inflation and output works just fine in stabilizing output and inflation.

Toward Improved Monetary Policy Rules

Thus far I have focused on the benchmark policy rule in equation (2) for which there is no inertia ($\rho = 0$) and for which there is no response to the exchange rate ($g_{e0} = g_{e1} = 0$). The conclusion is that this rule is robust across the range of views of the monetary transmission mechanism that are represented in current policy evaluation models. Stated differently, none of the current alternative views of the monetary transmission mechanism have a significant negative effect on the performance of this rule.

As I have emphasized, however, one cannot conclude from these findings that there are no better monetary policy rules. Moreover, from a very practical perspective, although there have

⁷ In a small open economy the exchange rate has direct effects on the inflation rate, so choosing the correct measure of the target inflation rate is important.

been successes in monetary policy in the 1990s, various kinds of monetary crises have occurred, suggesting that there is a lot of room for improvement.

Many suggestions for improving on the benchmark rule have been made. For example, several researchers have suggested introducing inertia (Woodford (1999a) and Williams (1999)). Others have considered incorporating a response to the exchange rate (Ball (1999), Svensson (1999)) in order to improve on the benchmark rule. In the next two sections, I consider these two suggestions for improvement from the perspective of different views of the monetary transmission mechanism.

6. How the Monetary Transmission Mechanism Affects Policy Rules with Inertia

Simulation results for policy rules with inertia for nine of the models in Tables 1 and 2 (Taylor (1999b)) indicate that the monetary transmission mechanism has a big effect on the performance of such rules. For example, consider the case where $\rho = 1$, $g_\pi = 1.2$, and $g_y = 1.0$. The simulation results show that whether this inertial rule improves performance (in terms of the variability of inflation and output) over the benchmark rule ($\rho = 0$, $g_\pi = 1.5$, and $g_y = 0.5$) depends on the monetary transmission mechanism used in the model. The inertial rule leads to improved performance in 5 of the 9 models in Tables 1 and 2 for which results are available (McCallum-Nelson (1999a), Rotemberg-Woodford (1999), MSR-Levin *et al.* (1999), FRB/US-Brayton *et al.* (1997), and TaylorMCM (Taylor 1993b)). The same rule leads to poorer performance in two of the models (Ball (1999) and Rudebusch-Svensson (1999)), with the inertial rule being completely unstable for the later model. The two rules cannot be ranked for the other two of the nine models (Batini-Haldane (1999) and Fuhrer-Moore (1995)).

There is a systematic difference between the monetary transmission mechanism in models for which inertia enhances performance and for which it detracts from performance. A glance at Table 1 shows that the difference is not open versus closed economy. Inertia makes things better for both some closed and some open economy models, and it makes things worse for some other closed and some other open economy models. Nor is the difference the financial market price view versus the credit view. The key difference is in the degree of forward-looking. The two models for which performance deteriorates are not rational expectations models. The five models for which performance improves are rational expectations models. Moreover, the rational expectations models have the long rate (through an expectations theory of the term structure) affecting spending (see Table 1) and they also have forward-looking behavior in staggered price setting. One might worry that these rational expectations models are too forward-looking with insufficient rigidities. However, some of the rational expectations models have many backward-looking terms. Indeed, the Taylor multicountry model, for which the inertial rule dominates the benchmark rule, has a considerable number of rigidities in wage setting and in the pass through of exchange rate changes.

Identifying rational expectations as the essential difference explaining the effects of inertial policy rules is bolstered by the fact that things get worse for all non-rational expectations models. However, to be sure, things do not get better with inertia for all the rational expectations models. The two models that do not allow a ranking between the two rules (because inflation and output variances move in opposite directions) are rational expectations models. However, both of these models employ a staggered price setting theory in which the rate of inflation rather than the price level is the effective decision variable (see Table 2). While it would be useful to look into this alternative explanation, at the least the comparative results are consistent with

rational expectations being a necessary, if not sufficient, condition for an inertial rule to improve performance.

There are good theoretical reasons why an inertial rule requires rational expectations to generate an improvement over the benchmark rule. The lagged interest rate in the rule means that interest rates will rise for many periods in the future if inflation does not come back to target. Expectations of such rising interest rates raise long interest rates today in a rational expectations model and have an anti-inflationary spending effect, thereby mitigating the need for a rise in future interest rates. In a non-rational expectations model there is no way for these expectations to have a dampening effect, and it is quite possible for the model to become unstable.

Even though the improvement in performance that can come from inertial rules is not robust to the expectations component of the monetary transmission mechanism, it is worthwhile pursuing ways in which using forward-looking expectations can improve monetary policy. If the gains from such inertial policies are great enough, then they might even provide more incentives to institutionalize the rules. Moreover, as hinted at in the next series of results, the payoffs may be even greater when the exchange rate is considered in addition to the interest rate.

7. The Transmission Mechanism and the Use of the Exchange Rate in Policy

Rules

Open economy issues have not been ignored in the research on policy evaluation. The exchange rate is part of the transmission mechanism in six of the models listed in Tables 1 and 2. The exchange rate enters both in the determination of net exports and in the determination of inflation as changes in the price of foreign goods are passed through in part to domestic prices. Moreover, there is a link between the exchange rate and the interest rate through capital markets.

In general the models used for policy evaluation assume perfect capital mobility, either by writing down an *ex ante* interest rate parity condition or a reduced form relationship between the real interest rate and the real exchange rate.

Before discussing the implications of the monetary transmission mechanism for the use of the exchange rate in policy rules, it is important to point out that the policy evaluation research that informed my (1993a) proposal for a policy rule did consider the role of the exchange rate. Simulations of my multicountry model and other models (see Bryant, Hooper, Mann (1993)) led me to believe that if the Fed reacted strongly to the exchange rate then the inflation-output performance in the United States would deteriorate. It was for that reason that I omitted the exchange rate in the rule I proposed in Taylor (1993a) as a guideline for the United States. However, it is clear that the same conclusion would not necessarily be reached for other countries, especially small open economies. A country's size, openness, capital mobility, market completeness and elasticities would matter greatly.

Work by Ball (1999) and Svensson (1999) on small open economy models is therefore most welcome. A policy rule of the form of equation (2) without inertia but with the exchange rate included was proposed by Ball (1999) as a rule designed for small open economies. For the Ball (1999) open economy model, he found that such a rule would improve on the benchmark rule. For example, for the same standard deviation of output (1.4 percent) the interest rate rule that reacts to the exchange rate (with g_{e0} negative and g_{e1} positive) as well as to output and inflation reduces the standard deviation of the inflation rate around its target from 2.0 percent to 1.9 percent (Ball (1999), p. 134). However, although this illustrates the effect that an open economy view of the transmission mechanism has on the policy rule, it is not a very big improvement.

Svensson (1999) considers a very similar rule to that of Ball (1999) in a more forward-looking open economy model. Though the motivation for this rule is not optimality (the rule is not optimal in his model) Svensson (1999) finds that this rule reduces the standard deviation of CPI inflation from 2.1 to 1.8; however, it increases slightly the variance of output from 1.7 to 1.8, and therefore does not even dominate the benchmark rule. Again it seems like the open economy aspect of the monetary transmission mechanism is not finding major improvements in the policy rule.

In another study (Taylor (1999c)) I considered the use of such a rule for the European Central Bank (ECB). I simulated my multicountry model to try it out. The exchange rate (e) relevant to the ECB is the dollar-euro exchange rate. Compared with the benchmark rule I found that the rule with the exchange rate rule led to better performance for France and Italy, but had countervailing effects in Germany. (Because the ECB does not have the freedom to set different interest rates in the different countries, the policy rule cannot, of course, be aimed at different countries.) However, a block of countries as large as the European Monetary Union is similar to the size of the United States and might not be relevant for smaller open economies.

For comparison I list the policy parameters in equation (2) for these three studies.

	g_{e0}	g_{e1}
Ball (1999)	-.37	.17
Svensson (1999)	-.45	.45
Taylor (1999c)	-.25	.15

The parameters all have the same sign. An appreciation of the exchange rate leads to a cut in the interest rate, followed in the next period by an offsetting increase in the interest rate. In the Ball (1999) model, the negative response is called for because the appreciation is contractionary and a cut in interest rates offsets this contraction. The positive offset in the next period occurs because

the favorable effects of the appreciation on inflation will be followed by unfavorable effects which will raise inflation and require an increase in the interest rate.

The implication of these simulations is that while an open economy emphasis on the monetary transmission mechanism makes a difference for policy rules, in practice it does not seem to have a big effect—at least with respect to the current models and the focus on the variability of inflation and output.

Taken at face value, the results imply that simple policy rules that focus on a smoothed inflation measure and real output and do not try to react to the exchange rate might actually work well. However, in my view, it is likely that the current models probably understate the exchange rate effects in small open economies and therefore tend to underestimate the costs of exchange rate fluctuations. This suggests the need for future research to look at the effects of exchange rate variability. The costs of such fluctuations may be very high for countries where there is a mismatch of assets by currency or duration (see Eichengreen and Hausman (1999)) or where there may be large swings in the current account. Moreover, the forward-looking nature of the exchange rate suggests that there may be significant gains from policies that utilize rational expectations in the same way that inertial rules for the interest rate do in the closed economy models discussed in the previous section.

8. Conclusion

The results of this paper can be summarized with three major conclusions. First, some of the biggest and most widely discussed differences in views of the monetary transmission mechanism seem to have only a small effect on the evaluation of simple policy rules. More specifically, within the range of views that are now represented in quantitative models used for policy evaluation—and that includes “financial market price” views, “credit” views, staggered

price setting, limited participation, and exchange rate channels—the monetary transmission mechanism seems to lead to very similar choices about simple monetary policy rules. In particular, a simple benchmark rule seems to be robust to all these views about how monetary policy works.

Second, more complex policy rules that incorporate inertial factors are more dependent on the particular form of the monetary transmission mechanism; in particular they depend on a rational expectations assumption to improve economic performance. While this suggests a lack of robustness, the estimated gains in rational expectations models may be large enough to motivate further research on the performance of such rules. Such rules may be particularly useful in small open economies.

Third, while monetary transmission mechanisms with strong exchange rate channels do affect the choice of policy rule—and suggest the need for the central bank to adjust the interest rate in response to the exchange rate, as well as to inflation and real output—the gains from such rules over simple rules that react only to smoothed inflation and output seem to be surprisingly small. This result suggests the need for more research on the effect of exchange rate fluctuations on small open economies, and the search for policy rules that take account of the forward-looking feature of exchange rates.

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