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ALTERNATIVE VIEWS OF THE MONETARY TRANSMISSION MECHANISM: WHAT DIFFERENCE DO THEY MAKE FOR MONETARY POLICY?

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This paper examines how alternative views of the monetary transmission mechanism affect the choice of a monetary policy rule. The main finding is that many different structural models indicate that the same simple monetary policy rule—one in which the central bank's target short-term interest rate reacts to inflation and to real output—would perform well. Such rules work well even in models where the monetary transmission mechanism has a relatively strong exchange-rate channel. The models differ, however, in their implications for more complex monetary rules.

I. INTRODUCTION

Economists' views of how monetary policy affects the economy differ widely, as is readily apparent from an examination of the many different empirical models that they use for policy evaluation.[2] From a policy perspective, however, the important question is whether these widely different views lead to different recommendations about what constitutes a good policy. Although the models may indeed be quite different in certain dimensions, they may actually be very similar in the dimensions that matter for policy. The purpose of this paper is to investigate this question by examining the conclusions of a large number of recent policy evaluation studies.

I begin by reviewing how empirical models of the monetary transmission mechanism are actually used

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[2] For example, the symposium on 'The Monetary Transmission Mechanism' in the autumn 1995 *Journal of Economic Perspectives*, **9**(4), 3–72, contains several papers describing widely different structural models.

for policy evaluation. The method that has been used most frequently in recent years—I call it the *new normative macroeconomics*—is to simulate stochastically a model with different monetary policy rules, and then look for rules that work well. This new normative macroeconomic research is ideally suited for investigating the question about how alternative views of the monetary transmission mechanism affect policy choices, because one can rigorously trace the connection between the views and policy choices. A possible disadvantage, however, is that by focusing only 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.

Using this approach I consider a total of 18 different policy models. I then examine how the different models affect the estimated performance of several classes of policy rules.

II. USING MODELS TO EVALUATE POLICY

What kinds of models are used to express the different views of the monetary transmission mechanism? Virtually all the models (certainly the ones examined in this paper) are now *stochastic, dynamic*, and *economy-wide* models and they are used in essentially the same way for analysis and policy evaluation. 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 in the models.

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 are *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*., 1997*a*, 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:

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

for $i = 1,...,n$ 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 with 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 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 non-linear versions of equation (1) are not uncommon. A solution to equation (1) is a stochastic process for y_t.

How do researchers use the model $f_i(.)$ 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.

(i) Place the candidate policy rule into model $f_i(.)$.
(ii) Solve the model using an appropriate solution algorithm.[3]
(iii) Look at the properties of the stochastic steady-state (stationary) distribution of the variables (inflation, real output, and unemployment).
(iv) Choose the rule that gives the most satisfactory performance (a loss function may by useful here to help compare points on the trade-off between the variance of one target variable and another).
(v) 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.[4] The introduction of the rational expectations assumption into macroeconomics significantly increased the advantages of using policy rules in this way to evaluate policy. People's expectations of policy matter 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 (1999*b*) has emphasized the importance of the 'timelessness' aspect of the above approach to policy evaluation. By focusing on a stationary policy rule and the stationary distribution, one is ensuring that the policy rule is no different than the one that the policy-maker would follow in the same conditions at any other time.

III. THE ALTERNATIVE VIEWS AND THE MODELS THAT EXPRESS THEM

One view of the monetary transmission mechanism, 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 econo-

[3] Many papers have been written on algorithms for obtaining solutions to systems such as equation (1). In the case where $f_i(.)$ is linear, Blanchard and Kahn (1980) showed how to get the solution to the deterministic part of equation (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 non-linear 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 non-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 programme within existing user-friendly computer programmes such as *Eviews*. I use such iterative methods to solve my multi-country rational expectation model (Taylor, 1993*b*).

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] Of course, there are examples of policy rules research that predate the rational expectation assumption (see 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.

mies 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 such as 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 *et al*., 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?

(i) Eighteen Models

I consider 18 different models that differ in the dimensions described above. Several of the models consist of only two structural equations: (1) an *aggregate demand* or *IS equation,* showing how real GDP 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. Examples of 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 (1999*b*) or Clarida *et al*. (1999) simplified 'new Keynesian' models.[5] Other models (for example, Taylor (1993*a*) or the Federal Reserve Board's FRB/US) involve many more than three equations; they have a more detailed description of aggregate demand (with consumption, investment, net exports, and government purchases being modelled separately, for example), or a more detailed description of price adjustment (with both wages and prices being modelled 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

[5] The use of the term 'New Keynesian' is not universal, and may be confusing as used here 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 *et al*. (1999*a*) and New Neoclassical Synthesis models by Goodfriend and King (1997). In my view the key characteristic of the models is that they are dynamic, stochastic, economy-wide models with forward-looking behaviour and some rigidities that make them useful for policy evaluation along the lines defined in this paper.

Table 1
Classification of Some Models According to the Approach Taken to the 'Aggregate Demand' Component of the Monetary Transmission Mechanism

	Size S/M/L	Price/ credit	Long rate/ short rate	Partial adjustment	Exchange rate?
Ball (1997)	S	P	S	Y	N
Ball (1999)	S	P	S	Y	Y
Bernanke–Gertler–Gilchrist (1999)	M	C	L	N	N
Batini–Haldane (1999)	M	P	S	Y	Y
FRB/US: Brayton *et al.* (1997*a*)	L	P[a]	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 (1999*a*)	S	P	L	N	N
McCallum–Nelson (1999*b*)	S	P	L	N	Y
MSR: Levin *et al*. (1999)	M	P	L	N	N
Rotemberg–Woodford (1999)	M	P	L	N	N
Rudebusch–Svensson (1999)	S	P	S	Y	N
Svensson (1999*a*)	M	P	L	Y	Y
TaylorMCM: Taylor (1993*b*)	L	P	L	Y	Y
Woodford (1999*a*)	S	P	L	N	N

Notes: Eighteen models are organized according to (i) size, (ii) whether they incorporate a 'financial market price' view or a 'credit' view of the transmission mechanism, (iii) whether the short-term interest rate or the long term interest rate—through a rational expectations model of the term structure—influences demand, (iv) whether there is some type of delayed or partial adjustment in response to changes in interest rates, and (v) whether the exchange rate affects aggregate demand. [a] 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.

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

Tables 1 and 2 use this framework to classify the 18 different models. The tables show several ways in which models differ in their treatments of the monetary transmission mechanism as defined in section II above. Table 1 focuses on differences relating to aggregate demand and Table 2 focuses on differences relating to price adjustment.

I think the 18 models in Tables 1 and 2 are representative, but they certainly do not include all the models now being used for policy evaluation. Only two of the many models now being 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 *et al*., 1998), the Reserve Bank of New Zealand (Drew and Hunt, 1998), the Riksbank (Dillen and Nilsson, 1998), the Bank of England (King, 1999), and other central banks where research is under way.

This classification system is, of course, a simplification of the differences between the models, and for each model I give a reference to a paper that describes the model in more detail. It is through the model descriptions in these references—descriptions in the form of equation (1)—that I have classified each model according to several characteristics such

Table 2
Classification of Models According to the 'Staggered Price Adjustment' Component of the Monetary Transmission Mechanism

	Forward looking?	Type of staggering	Exchange rate?
Ball (1997)	B	B	N
Ball (1999)	B	B	Y
Bernanke–Gertler–Gilchrist (1999)	F	P	N
Batini–Haldane (1999)	F	p	Y
FRB/US:Brayton *et al.* (1997*a*)	F	P	Y
Chari–Kehoe–McGrattan (1999)	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 (1999*a*)	F	P	N
McCallum–Nelson (1999*b*)	F	P	Y
MSR: Levin *et al*. (1999)	F	P	N
Rotemberg–Woodford (1999)	F	P	N
Rudebusch–Svensson (1999)	B	B	N
Svensson (1999*a*)	F	P	Y
TaylorMCM: Taylor (1993*b*)	F	P	Y
Woodford (1999*a*)	F	P	N

Notes: The 18 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 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.

as whether the credit view is used or whether the exchange rate is a channel for monetary policy. Tables 1 and 2 do not include all the differences among the models—for example, some 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 behaviour differently from other models (for example, Ball, 1999; Svensson, 1999*a*). 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 is a variety of approaches to modelling the monetary transmissions mechanism. Now the question is whether the differences shown in Tables 1 and 2 make a difference for the evaluation of policy.

IV. A CLASS OF MONETARY POLICY RULES

In order to examine how these different models affect one's view of policy I consider monetary policy rules of the form

$$i_t = g_\pi \pi_t + g_y y_t + g_{e0} e_t + g_{e1} e_{t-1} + r i_{t-1} \tag{2}$$

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.[6] 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, 1993*a*) that the value of ρ be zero, but others (Woodford, 1999*a*, 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.

Of course, focusing 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, 1999*b*) 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.

V. EFFECTS OF THE MONETARY TRANSMISSION MECHANISM ON THE POLICY 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 (1993*a*) 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. Is the performance of the benchmark rule affected by the different views of the monetary transmission mechanism?

(i) Effects of Different Financial Market Price Views

Existing simulation evidence reported in Taylor (1999*a*) shows that the benchmark rule with a coefficient on inflation of 1.5 and a coefficient on output of 0.5 (Taylor, 1993*a*) performs well across the range of models that use a financial market price and a sticky/staggered price adjustment view of the monetary transmission mechanism. When this simple rule is used the variance of inflation and the variance of real output are small. 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

[6] 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 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.

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 in any of the different 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?

(ii) Effect of the Limited Participation versus the Staggered Price-setting View

Consider the radically different theory of the transmission mechanism based on limited participation, in which people cannot move their funds around rapidly from one type of account to another. This restriction on behaviour is similar in spirit to the sticky price assumption through which people cannot change their prices rapidly.

Surprisingly the analysis of the limited participation model reported by Christiano and Gust (1999) indicates that replacing the sticky price assumption with the limited participation assumption does not lead to much of a change 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. What is the reason? The explanation for the paradox comes from looking at how a change in monetary policy affects the economy in the limited information models. 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 in 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.

(iii) Effects of Credit (Financial Accelerator) versus Traditional Market Price Views

Now consider the model of Bernanke *et al*. (1996), 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 *et al*., 1996, p. 3). The key assumption—which gives the financial accelerator its credit view flavour—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 *et al*. (1999*a*, 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 *et al*., 1999*a*, p. 1364).

In a recent paper, Bernanke and Gertler (1999*b*) 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 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.[7] However, the explanation for the paradox is found 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.

(iv) 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 (1999*a*) 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 (1999*a*) concludes that the rule 'appears somewhat robust; perhaps surprisingly robust.' Again, this robustness finding does not mean that no better rule exists for Svensson's (1999*a*) model; in fact, the benchmark rule leaves the variability of the real exchange rate higher than other rules.[8] 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.

(v) 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 has a significant negative effect on the performance of this rule.

As I have emphasized, however, one cannot conclude from these findings that there is no better monetary policy rule. Moreover, from a very practical perspective, although there have 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, 1999*a*; Williams, 1999). Others have considered incorporating a response to the exchange rate (Ball, 1999; Svensson, 1999*a*) in order to improve on the benchmark rule. In sections VI

[7] Because Bernanke and Gertler (1999*b*) 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.

[8] 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.

and VII below, I consider these two suggestions for improvement from the perspective of different views of the monetary transmission mechanism.

(vi) Why Are the Models Similar in These Policy Dimensions?

The striking thing about all the results described thus far is that there is something similar about the models—the same type of policy rule works well in all of them. The reason is that the 'reduced form' of the transmission mechanism—that is the solution of the equations that describes the impact of the policy instruments on the endogenous variables—is similar. Why? In my view the reason is that the models are empirical; they are fit to the data. Since these types of cross-auto-correlations between the changes in the policy instruments and the endogenous variables are in the data, they must be matched by the model. In other words, even though the models differ in structure they are similar in reduced form.

VI. 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, 1999*a*) 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 five of the nine models in Tables 1 and 2 for which results are available (TaylorMCM: Taylor, 1993*b*; FRB/US: Brayton *et al.*, 1997; McCallum–Nelson, 1999*a*; Rotemberg–Woodford, 1999; and MSR: Levin *et al.*, 1999). The same rule leads to poorer performance in two of the models (Ball, 1999; 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; 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 behaviour 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 multi-country 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 pay-offs may be even greater when the exchange rate is considered in addition to the interest rate.

VII. THE TRANSMISSION MECHANISM AND THE USE OF THE EXCHANGE RATE IN POLICY RULES

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 (1993*a*) proposal for a policy rule did consider the role of the exchange rate. Simulations of my multi-country model and other models (see Bryant *et al*., 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 (1993*a*) 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*a*) 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 per cent) 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 per cent to 1.9 per cent (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*a*) 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*a*) 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, 1999*b*) I considered the use of such a rule for the European Central Bank (ECB). I simulated my multi-country 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)	–0.37	0.17
Svensson (1999*a*)	–0.45	0.45
Taylor (1999*b*)	–0.25	0.15

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 favourable effects of the appreciation on inflation will be followed by unfavourable 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 inflation 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.

VIII. CONCLUDING REMARKS

This paper shows that big differences in the monetary transmission mechanism have surprisingly small effects on the evaluation of simple monetary policy rules. Within the range of views that are represented in quantitative models used for policy evaluation—'financial market price' views, 'credit' views, staggered price setting, limited participation, and exchange-rate channels—the monetary transmission mechanism leads to very similar choices about simple monetary policy rules. A simple rule seems to be robust to all these views about how monetary policy works. Evidently the 'reduced form' of all these models is similar because the models are fit to the data.

The performance of more complex policy rules that incorporate inertial factors is more dependent on the structure of the monetary transmission mechanism; for example, their performance appears to depend on the rational expectations assumption. While this suggests a lack of robustness, the estimated gains in rational expectations models are large enough to motivate further research on the performance of such rules.

Although those 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 inflation and output are small. More research on the effect of exchange-rate fluctuations and on policy rules that take account of the exchange rate is needed.

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