Targeting versus Instrument Rules for Monetary Policy: What Is Wrong with McCallum and Nelson?

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In their paper "Targeting versus Instrument Rules for Monetary Policy," McCallum and Nelson critique targeting rules for the analysis of monetary policy. Their arguments are rebutted here. First, McCallum and Nelson's preference to study the robustness of simple monetary policy rules is no reason at all to limit attention to simple *instrument* rules; simple *targeting* rules may have more desirable properties. Second, optimal targeting rules are a compact, robust, and structural description of goal-directed monetary policy, analogous to the compact, robust, and structural consumption Euler conditions in the theory of consumption. They express the very robust condition of equality of the marginal rates of substitution and transformation between the central bank's target variables. Indeed, they provide desirable micro foundations of monetary policy. Third, under realistic information assumptions, the instrument rule analog to any targeting rule that McCallum and Nelson have proposed results in very large instrument rate volatility and is also, for other reasons, inferior to a targeting rule.

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1 INTRODUCTION

My good friends Ben McCallum and Ed Nelson have written a paper, McCallum and Nelson (2005), with arguably a somewhat destructive purpose. They attempt to contradict the arguments in favor of targeting rules, rather than instrument rules, in positive and normative analysis of monetary policy that I have presented in Svensson (2003b) and previous papers (for instance, Svensson, 1997 and 1999). In their concluding section, they suggest that Svensson (2003b) "does not develop any compelling reasons for preferring targeting rules over instrument rules." They seem to believe that the concept of targeting rules is unnecessary and that instrument rules are all that is needed in monetary policy analysis.

In their struggle against targeting rules, however, McCallum and Nelson seem to face an uphill battle. There is now a rapidly growing literature by many authors that successfully applies targeting rules to monetary policy analysis. This literature includes recent contributions by Benigno and Benigno (2003), Benigno and Woodford (2004a,b), Cecchetti (1998, 2000), Cecchetti and Kim (2004), Evans and Honkapohja (2004), Giannoni and Woodford (2003a,b and 2004), Kuttner (2004), Mishkin (2002), Onatski and Williams (2004), Preston (2004), Walsh (2003 and 2004a,b), Woodford (2004), and others. In the first drafts of Woodford's (2003) book, there were no targeting rules; in the final, published version, targeting rules are prominent. In 1998, at a distinguished National Bureau of Economic Research (NBER)

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conference on monetary policy rules (Taylor, 1999), Rudebusch and Svensson (1999) was the only paper to use targeting rules; in 2003, at an equally distinguished NBER conference on inflation targeting (Bernanke and Woodford, 2004), several papers used targeting rules and no paper used a simple instrument rule as a model of inflation targeting. A Google search with the string '"targeting rules" AND monetary' gave about 1,700 results in April 2004, about 2,100 in August 2004, and about 5,700 in June 2005. There are, hence, more papers than mine—indeed, some books—that McCallum and Nelson may want to take issue with.[1]

To be clear: An *instrument rule* is a formula for setting the central bank's instrument rate as a given function of observable variables. A *simple* instrument rule makes the instrument rate a simple function of a few observable variables. The best-known example of a simple instrument rule is the Taylor rule, where the instrument rate is a linear function of the inflation gap (between inflation and an inflation target) and the output gap (between output and potential output). Another example is a formula for adjusting the monetary base proposed by McCallum (1988) and Meltzer (1987).[2]

A (specific) *targeting rule* specifies a condition to be fulfilled by the central bank's target variables (or forecasts thereof). A real-world example of a *simple* targeting rule is the one that has been applied by the Bank of England, Sweden's Riksbank, and the Bank of Norway (Goodhart, 2001; Svensson, 2003a; Svensson et al., 2002): The two-year-ahead inflation forecast shall equal the inflation target. More precisely, the instrument rate shall be set such that the two-year-ahead inflation forecast equals the inflation target.[3] An *optimal* targeting rule is a first-order condition for optimal monetary policy. But, importantly, not all targeting rules are optimal targeting rules.[4]

McCallum and Nelson explain that "we are more attracted to analysis with instrument rules than with targeting rules" (p. 598). They imply that the main reason is that "an attractive approach to policy design...is to search for an instrument rule that performs at least moderately well—avoiding disasters—in a variety of plausible models" (p. 599). Thus, McCallum and Nelson are attracted to simple and robust instrument rules; they agree with Svensson (2003b) that a complex optimal instrument rule is not practical. The idea of a robust and simple instrument rule is further developed in McCallum (1988 and 1999).

A simple and robust monetary policy rule is indeed an attractive idea. There is always some uncertainty about the true model of the transmission mechanism of monetary policy, and monetary policy is always conducted under considerable uncertainty of different kinds. A simple and robust monetary policy rule gives the central bank an option that it can fall back on in difficult times. A central bank that knows nothing except current inflation and some estimate of the current output gap can always fall back on a Taylor rule. If the bank does not trust its information about inflation and the output gap, but data on monetary aggregates are more easily accessible or more reliable, the central bank can fall back further on Friedman's rule of *k*-percent money growth.

But several facts stand in the way of McCallum and Nelson's attraction to simple instrument rules. First, the fact is that nothing says that a simple and robust monetary policy rule must be an *instrument* rule. For instance, Friedman's *k*-percent rule is a *targeting* rule! The *k* percent refers to a broad monetary aggregate, such as M2 or M3.

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[1] Sims (1980) and Aizenman and Frenkel (1986) provide early discussions of targeting rules (the former without using the term).

[2] Svensson (2005) provides a compact and general definition of targeting rules and instrument rules. An *explicit* instrument rule is an instrument rule where the instrument is a function of predetermined variables only. An *implicit* instrument rule is an instrument rule where the instrument is related to a non-predetermined variable. An implicit instrument rule is an equilibrium condition, where several variables are simultaneously determined. This makes the practical implementation of implicit instrument rules more complicated than that of explicit instrument rules (see footnote 12). Any given equilibrium is consistent with a continuum of implicit instrument rules.

[3] Strangely, McCallum and Nelson seem to believe that no central bank is using a targeting rule and that a central bank needs to announce an explicit loss function to use a targeting rule. Obviously, neither of these beliefs is correct, as this paragraph shows.

[4] Although McCallum and Nelson seem to want to restrict the discussion of targeting rules to optimal targeting rules, that makes no more sense than to restrict the discussion of instrument rules to optimal instrument rules.

This is an (intermediate) target variable, not an instrument. It reacts with a lag of a quarter or so to changes in the central bank's instrument (the instrument rate or the monetary base). The way to implement Friedman's *k*-percent rule, then, is to make forecasts of broad money growth for the next quarter and set the instrument such that the one-quarter-ahead money-growth forecast equals *k* percent (Svensson, 1999). Thus, the targeting rule: "Set the instrument such that the forecast of money growth equals *k* percent."[5] The simple monetary policy rule used by the Bank of England, the Riksbank, and the Bank of Norway—already mentioned above—is also a targeting rule. Walsh (2004b) has recently demonstrated an equivalence between the robust-control policies of Hansen and Sargent (2003 and 2005) and the optimal targeting rules derived by Giannoni and Woodford (2003a,b).[6]

Second, the fact is that central banks normally do not use the fallback options of the simple instrument rules of Taylor or McCallum and Meltzer or even the simple targeting rule of Friedman's *k* percent. With improved understanding of the transmission mechanism of monetary policy, increased experience, and better-designed objectives for monetary policy, central banks believe that they can do better than follow these mechanical simple rules. They have developed complex decision processes, where huge amounts of data are collected, processed, and analyzed (see Brash, 2001, and Svensson, 2001). They construct forecasts of their target variables, typically inflation and the output gap, conditional on their view of the transmission mechanism, their estimate of the current state of the economy and the development of a number of exogenous economic variables, and alternative instrument rate paths. They select and implement an instrument rate or an instrument rate path such that the corresponding forecasts of the targeting variables "look good" relative to the objectives of the central bank. I have called this monetary policy process "forecast targeting." It is a decision process and implementation of monetary policy that is very different from the mechanical application of the simple instrument rules that McCallum and Nelson favor. Advanced central banks attempt to do better, to fulfill their objectives as well as possible, to optimize. I am advocating targeting rules as a better way to describe and prescribe this kind of monetary policy than the simple instrument rules. Targeting rules are one way to make the "look good" concept precise. Bernanke (2004) endorses this view of practical monetary policy, although he uses the term "forecast-based policies" rather than "forecast targeting."[7]

Third, since central banks in a number of countries have developed this approach of forecast targeting to monetary policy (essentially the implementation of inflation targeting that started in a few countries in the early 1990s and has since spread to a large number of countries), the mon-

[5] A broad monetary aggregate such as M2 or M3 is to a large extent endogenously determined by demand and supply of broad money and an endogenous multiplier between broad money and the monetary base. It reacts with a lag of a quarter or so to central bank adjustments of the instrument rate or the monetary base and is subject to various intervening shocks during that lag. Hence, the central bank does not have complete control over broad money; therefore, it is not an instrument of monetary policy. Even if the money growth forecast is on target, actual money growth will ex post deviate from *k* percent due to unanticipated shocks and imperfections in the forecasts.

[6] In some of the literature mentioned above, the instrument rate is also a target variable (that is, an argument of the loss function). In such cases, the instrument rate appears in the targeting rule, and the targeting rule is also an implicit instrument rule. Some of the literature, for instance, Walsh (2004b), follows Giannoni and Woodford (2003a,b) and frequently refers to such targeting rules as instrument rules, which is a source of some confusion. A good test of whether a rule is fundamentally a targeting rule or an instrument rule is to let the weight on the instrument rate in the loss function go to zero. If the instrument rate then vanishes from the rule, it is better to call it a targeting rule.

[7] McCallum and Nelson note (in Section 4) that many central bank publications refer to simple instrument rules. But this merely demonstrates how the concept of simple instrument rules has previously dominated the monetary policy debate (for instance, as noted, in Taylor, 1999). It does not imply that central banks conduct monetary policy by implementing simple instrument rules. They also note that the Reserve Bank of New Zealand (RBNZ) has used a particular instrument rule in generating forecasts in the so-called Forecasting and Policy System (Black et al., 1997). But, as far as I know, the instrument path generated by the instrument rule is subject to considerable judgmental adjustment, especially for the first few quarters. Furthermore, the instrument rate path and the inflation and output gap forecasts generated can be seen as *reference* paths and forecasts, used as an input in the policy decision, in the same way other central banks use forecasts conditional on a constant interest rate. They are not necessarily the central bank's optimal instrument rate plan and optimal inflation and output gap forecasts (although I am advocating improvements in that direction; see Svensson, 2001, 2003a). Thus, the RBNZ's use of an instrument rule in generating its forecasts does not imply that the RBNZ is actually following that instrument rule in setting its instrument rate.

etary policy outcome in those countries has been extremely good. The past decade has seen unprecedented monetary and real stability with low inflation in a number of countries. This makes it even more important, I believe, to develop the tools and definitions through which this kind of monetary policy can be best understood.[8]

McCallum and Nelson have one somewhat constructive contribution in their paper. They provide further analysis of the proposition, previously put forward in McCallum (1999, p. 1493) and McCallum and Nelson (2000), that there is a useful instrument rule analog, with a very large response coefficient, to any targeting rule. In particular, they maintain that this large response coefficient, counter to what is argued in Svensson and Woodford (2005), Svensson (2003b), and, in a related case, in Bernanke and Woodford (1997), does not imply higher volatility of the instrument rate, even if the central bank makes some realistic errors in determining the arguments for the instrument rule. However, as we shall see, under reasonable information assumptions, McCallum and Nelson are wrong. A large response coefficient does indeed make the instrument rate very volatile. Only under very strange information assumptions is there no extra volatility. Even if they were right on this volatility issue, there still seems to be no point to their proposed instrument rule analog. As we shall see, it simply adds unnecessary complexity to the monetary policy rule for no apparent gain. It is conceptually and numerically inferior to the targeting rule, and it is not neutral from a determinacy point of view. In summary, the idea of instrument rules with very large response coefficients is both impractical and pointless.

Section 2 shows a useful analogy between the development of Euler conditions as structural descriptions of consumption choice in the theory of consumption and the development of targeting rules as a structural description of monetary policy in the theory of monetary policy. Section 3 gives an example of an optimal targeting rule and discusses some of its properties, including its robustness. Section 4 shows that the instrument rule analog proposed by McCallum and Nelson indeed brings high instrument rate volatility under reasonable information assumptions. Section 5 discusses McCallum and Nelson's criticism of my definition of "general" targeting rules. I concede that another term, Walsh's (2003) "targeting regimes," may be preferable. Consequently, in future work, I am inclined to use the term "targeting regime" rather than "general targeting rule" and to let "targeting rules," as in this introduction, refer to what I have also called "specific" targeting rules.

2 AN ANALOGY WITH CONSUMPTION THEORY

To view the issue of targeting rules versus instrument rules from a broader descriptive perspective, it is useful to compare this issue with the modeling of consumption in macroeconomics. Several decades ago, it was common to model consumption in period t, C_t, as a given function of income, Y_t, the real rate of interest, R_t, and possibly other variables,

$$C_t = f\left(R_t, Y_t, \ldots\right). \tag{1}$$

In the past 25 years, especially after Hall (1978), it has become common to model consumption as fulfilling an Euler condition—a first-order condition for optimal consumption choice, which, for an additively separable utility function of a representative consumer, has the simple form,

$$\mathrm{E}_t \frac{\delta U_C\left(C_{t+1}\right)}{U_C\left(C_t\right)} = \frac{1}{1+R_t}. \tag{2}$$

Here, the left side of (2) is the representative consumer's expected marginal rate of substitution of period-t consumption for period-$t+1$ consump-

[8] McCallum and Nelson disagree with my statement that one of the problems with a commitment to an instrument rule as a description and prescription of monetary policy "is that a commitment to an instrument rule does not leave any room for judgmental adjustments and extra-model information" (Svensson, 2003b, p. 442). They state (on p. 600): "This claim is difficult for us to understand, since there seem to be various ways in which judgmental adjustments to instrument rule prescriptions could be made. For example, the interest rate instrument could be set above (or below) the rule-indicated value when policymaker judgments indicate that conditions, not adequately reflected in the central bank's formal quantitative models, imply different forecasts and consequently call for additional policy tightening (or loosening)." McCallum and Nelson seem to believe that a commitment is consistent with discretionary adjustments, an obvious contradiction.

tion ($0 < \delta < 1$ is a discount factor and $U_C(C_t)$ denotes the marginal utility of consumption). The right side is the consumer's marginal rate of transformation of period-$t+1$ consumption into period-t consumption, when the consumer can borrow or lend; that is, the period-t consumption value of consumption in period $t+1$. A loglinear approximation to (2) is

$$c_t = c_{t+1|t} - \sigma(r_t - \rho), \tag{3}$$

where $c_t \equiv \ln C_t$, $c_{t+1|t} \equiv \mathrm{E}_t c_{t+1}$, σ is the intertemporal elasticity of substitution, $r_t \equiv \ln(1 + R_t)$ is the continuously compounded real interest rate, and $\rho \equiv -\ln\delta > 0$ is the rate of time preference.

As is well known, a serious problem with modeling consumption as a given consumption function is that this function is not a structural relation but a reduced form. Its properties and parameters depend on the whole model of the economy, including the existing shocks and their stochastic properties, the monetary and fiscal policy pursued, and so forth.

In contrast, the consumption Euler condition (2) or (3) is more structural, independent of the rest of the model, and independent of the monetary and fiscal policy pursued. It is a robust, compact, and therefore practical description of optimizing consumption behavior. Indeed, this development of a more microfounded modeling of consumption is an integral part of the rational expectations revolution in macroeconomics.

The consumption function can be seen as an instrument rule for consumption behavior, whereas the Euler condition (2) or (3) can be seen as a targeting rule for consumption. When I argue for the adoption of targeting rules rather than instrument rules in modeling monetary policy, I am arguing for a development in the theory of monetary policy that already happened, a long time ago, in the theory of consumption.

McCallum and Nelson are attracted to modeling monetary policy with instrument rules rather than targeting rules also for descriptive purposes (see Section 4). If they were consistent, they should also prefer to model consumption with consumption functions rather than Euler conditions. But they are not consistent. Indeed, it is a great irony that one of McCallum and Nelson's important contributions to macroeconomics is precisely the introduction of Euler conditions in modeling aggregate demand (for instance, in McCallum and Nelson, 1999) and, with other New Keynesian pioneers, the use of a condition such as (3) to derive the New Keynesian aggregate-demand relation.

Do McCallum and Nelson really believe that a modern central bank is less rational and goal-directed and a worse optimizer than the average consumer? At least they must admit that policymakers in modern central banks have the advantage above the average consumer of being advised by a staff with an increasing number of Ph.D. economists with training in modern macroeconomics and intertemporal optimization. Indeed, an increasing proportion of policymakers themselves are Ph.D. economists with such training!

A structural description of consumption choice is essential in estimating meaningful and robust empirical representations of consumption behavior. In the same way, a structural description of monetary policy is essential in estimating meaningful and robust representations of monetary policy—for instance, parameters of a monetary policy loss function. Furthermore, a structural description of consumption choice is essential in generating correct predictions in macro models of the consequences of changes in the policy regime. In the same way, a structural description of monetary policy is essential in generating correct predictions in macro models of consequences of changes in the monetary policy regime (in the form of changes in parameters of the monetary policy loss function), changes in the fiscal policy regime, changes in the policy regime of other countries, or other changes in the relevant economic or political environment.[9]

Indeed, microfoundations of policy are often as helpful as microfoundations of private sector behavior.

[9] See Benigno and Benigno (2003) and Svensson (2004) for examples of the use of targeting rules in discussing international monetary cooperation and transmission of shocks.

3 AN EXAMPLE OF AN OPTIMAL TARGETING RULE

To present an example of a targeting rule, let me consider a variant of the New Keynesian model, a variant used in Svensson and Woodford (2005) and Svensson (2003b), where inflation and the output gap are predetermined.[10] This variant will also be used in discussing McCallum and Nelson's instrument rule analog in Section 4.

Private sector "plans" made in period t for inflation and the output gap in period $t+1$, $\pi_{t+1|t}$ and $x_{t+1|t}$, are determined in period t by

(4)
$$\pi_{t+1|t} - \mathrm{E}\left[\pi_t\right] = \delta\left(\pi_{t+2|t} - \mathrm{E}\left[\pi_t\right]\right) + \alpha_x x_{t+1|t} + \alpha_z z_{t+1|t},$$

(5) $$x_{t+1|t} = x_{t+2|t} - \beta_r\left(i_{t+1|t} - \pi_{t+2|t} - r^*_{t+1|t}\right) + \beta_z z_{t+1|t}.$$

The aggregate-supply relation, (4), follows from the first-order condition for Calvo-style profit-maximizing price-setting firms. The firms are assumed to index prices to the long-run average inflation, $\mathrm{E}[\pi_t]$, between the times of optimal price-setting, which implies that the long-run Phillips curve is vertical. The parameter $\delta\,(0 < \delta < 1)$ is a discount factor, and $\alpha_x > 0$ is the slope of the short-run Phillips curve. The expression $\alpha_z z_{t+1}$ is the inner product of a vector of coefficients, α_z, and a vector of exogenous random variables, z_{t+1} (the "deviation" in period $t+1$), such that $\alpha_z z_{t+1}$ is a simple representation of the difference between this simple model and the true model of the transmission mechanism. The deviation may also include any "cost-push" and other shocks. Then, $z_{t+1|t} \equiv \mathrm{E}_t z_{t+1}$, where E_t denotes expectations conditional on information available in period t, is the private sector's estimate of the deviation—the private sector's "judgment" in period t. Thus, the one-period-ahead inflation plan depends on expected future inflation, $\pi_{t+2|t} \equiv \mathrm{E}_t\pi_{t+2}$, the output gap plan, $x_{t+1|t}$, and the private sector judgment, $z_{t+1|t}$.

The aggregate-demand relation, (5), follows from the first-order condition for optimal consumption choice by households. Here, i_{t+1} is the instrument rate set by the central bank in period $t+1$, r^*_{t+1} is an exogenous Wicksellian natural interest rate (the real interest rate in a hypothetical flexible-price economy with zero deviation), and β_r is a positive constant (in the simplest case, the intertemporal elasticity of substitution in consumption). Thus, the one-period-ahead output gap plan depends on the expected future output gap, $x_{t+2|t}$, the expected one-period-ahead real interest-rate gap, $i_{t+1|t} - \pi_{t+2|t} - r^*_{t+1|t}$, and the private sector judgment, $z_{t+1|t}$ (through the inner product $\beta_z z_{t+1|t}$).

Actual inflation and the output gap in period $t+1$ will then differ from the plans because of unanticipated shocks to the deviation and natural interest rate:

$$\pi_{t+1} - \pi_{t+1|t} = \alpha_z\left(z_{t+1} - z_{t+1|t}\right),$$
$$x_{t+1} - x_{t+1|t} = \beta_r\left(r^*_{t+1} - r^*_{t+1|t}\right) + \beta_z\left(z_{t+1} - z_{t+1|t}\right).$$

Suppose the central bank conducts flexible inflation targeting and has an intertemporal loss function in period t,

(6) $$\mathrm{E}_t\sum_{\tau=0}^{\infty}(1-\delta)\delta^\tau L_{t+\tau},$$

where the period loss is

(7) $$L_t = \frac{1}{2}\left[\left(\pi_t - \pi^*\right)^2 + \lambda x_t^2\right],$$

where π^* is the inflation target and $\lambda > 0$ is the weight on output gap stabilization relative to inflation stabilization.

An equilibrium that minimizes the central bank's intertemporal loss function (under commitment in a timeless perspective) will fulfill the first-order condition

(8) $$\pi_{t+1|t} - \pi^* + \frac{\lambda}{\alpha_x}\left(x_{t+1|t} - x_{t|t-1}\right) = 0$$

for all periods t (Svensson and Woodford, 2005, and Svensson, 2003b). This condition is the central bank's optimal targeting rule for private sector inflation and output gap plans.

Thus, optimal price-setting and consumption

[10] A predetermined variable depends on the current period's realizations of exogenous variables and previous periods' realizations of endogenous and exogenous variables. Equivalently, a predetermined variable has exogenous one-period-ahead forecast errors (cf. Klein, 2000).

choice by the private sector is described by the first-order conditions (4) and (5), and optimal monetary policy is characterized by the first-order condition (8), the central bank's targeting rule. The behavior of the agents of the model—the firms, the households, and the central bank—are each described by a first-order condition, an attractive symmetry. The central bank's targeting rule is a robust, compact, and, therefore, practical way to describe the optimal monetary policy. In particular, it is robust to the central bank's estimate of the deviation—the central bank's "judgment"—and any additive shocks and their stochastic properties, in the sense that neither the judgment nor any shocks enter into the targeting rule. The targeting rule (8) is a structural representation of monetary policy to the same extent that the aggregate-supply and aggregate-demand relations are structural representations of private sector behavior.

As discussed in some detail in Svensson (2003b), the optimal targeting rule is simply, and fundamentally, a restatement of the standard efficiency condition of *equality between the marginal rates of substitution and transformation between the target variables*. The target variables—the variables that enter into the loss function—are inflation and the output gap. The marginal rate of substitution between inflation and the output gap follows from the form of the loss function, including the relative weight, λ. The marginal rate of transformation between inflation and the output gap follows from the form of the aggregate-supply relation, including the slope of the short-run Phillips curve, α_x. Thus, these two parameters appear in the targeting rule. Because the marginal rate of transformation between inflation and the output gap is completely determined by the aggregate-supply relation, the aggregate-demand relation and its parameters do not affect the targeting rule; the targeting rule is, in this case, robust to the aggregate-demand relation.

Thus, fundamentally, the optimal targeting rule is simply the very robust and intuitive relation

$$\text{MRS} = \text{MRT},$$

where MRS and MRT refer, respectively, to the marginal rates of substitution and transformation between the target variables. This relation holds regardless of the particulars of the model and is, in this sense, model independent. Consider the following instruction: "From your loss function, find the marginal rate of substitution between your target variables. From your view of the transmission mechanism of monetary policy, find your marginal rate of transformation between the target variables. Find and implement an instrument rate, or instrument rate plan, that makes these marginal rates of substitution and transformation equal. Optimal monetary policy is, in principle, as easy as that." What more robust description of optimal monetary policy can you find?

The optimal equilibrium can be solved for by combining the targeting rule, (8), with the aggregate-supply relation, (4). This results in a second-order difference equation that can be solved for the optimal inflation and output gap plans. Substitution of these plans into the aggregate-demand relation, (5), gives the corresponding optimal instrument rate plan. Svensson and Woodford (2005) and Svensson (2003b) discuss in some detail how the central bank can implement (8) for private sector plans by "forecast targeting"—constructing and announcing inflation and output gap projections and a corresponding instrument rate plan that "look good" in the sense of fulfilling the analog of (8) for inflation and output gap projections. McCallum and Nelson do not go into those details.

4 VOLATILITY FROM INSTRUMENT RULES?

Instead, McCallum and Nelson provide a more precise analysis of their previous claim (in McCallum, 1999, p. 1493, and McCallum and Nelson, 2000) that there is a useful instrument rule analog of any targeting rule. They discuss two alternatives: The central bank implements a targeting rule, such as (8), directly; and the central bank replaces the targeting rule (8) with an instrument rule such as

(9)
$$i_{t+1} - r^* - \pi_{t+1|t} = \mu\left[\pi_{t+1|t} - \pi^* + \frac{\lambda}{\alpha_x}\left(x_{t+1|t} - x_{t|t-1}\right)\right],$$

where μ is a large positive number. The idea with (9) is that, for a large μ, there would be an equilibrium fulfilling (4), (5), and (9), where the term in the bracket on the right side of (9) is close to zero and the instrument rate on the left side is close to the optimal instrument rate. Therefore, this instrument rule would result in an equilibrium close to the optimal equilibrium.

This is indeed the case, under some circumstances. But what is the point with McCallum and Nelson's instrument rule? *First*, for any finite μ, the corresponding equilibrium is no longer optimal but only close to optimal. Everything else equal, optimal is better. *Second*, equation (9) is a more complex equilibrium condition than (8). Everything else equal, simplicity is better than complexity. *Third*, the targeting rule (8) has the attractive conceptual property of corresponding to a standard efficiency condition, the equality of the marginal rates of substitution and transformation between the target variables. The instrument rule (9) has no such intuitive interpretation. Hence, there is a conceptual disadvantage to (9). *Fourth*, it is no longer possible to solve for the optimal inflation and output gap plans by combining (9) only with the aggregate-supply relation, (4). Because the instrument rate enters, (9) must now be combined also with the aggregate-demand relation, (5), leading to a higher-order system of difference equations. Hence, there is a computational disadvantage to (9).[11] *Fifth*, as discussed in some detail in Svensson and Woodford (2005), modifying targeting or instrument rules in this way often affects the determinacy properties of forward-looking models and is therefore not innocuous.

Finally, as pointed out in Svensson and Woodford (2005) and Svensson (2003b), a high response coefficient, μ, can lead to instrument rate volatility under realistic information assumptions of some central bank mistakes or even just rounding errors. From a practical perspective, a very high response coefficient is a bizarre idea and would cause serious problems, except under very strange circumstances, as we shall see.

Thus, for several reasons, the instrument rule (9) is inferior to the targeting rule (8). I have not found any arguments by McCallum and Nelson in favor of (9). McCallum and Nelson might have thought that (9) would be easier to implement than (8). But a more precise discussion of the implementation reveals that this is not so: Aside from the issue of volatility, they are equally difficult or easy to implement.[12]

To examine the case of central bank mistakes, McCallum and Nelson consider the targeting rule with a random error, e_t,

$$(10)\qquad \pi_{t+1|t} - \pi^* + \frac{\lambda}{\alpha_x}\left(x_{t+1|t} - x_{t|t-1}\right) + e_t = 0,$$

and the alternative instrument rule,

$$(11)\qquad i_{t+1} = r^* + \pi_{t+1|t} + \mu\left[\pi_{t+1|t} - \pi^* + \frac{\lambda}{\alpha_x}\left(x_{t+1|t} - x_{t|t-1}\right) + e_t\right].$$

We can (in a simpler discussion of implementation than in footnote 12) interpret the instrument rule as the central bank attempting to observe private sector plans $\pi_{t+1|t}$ and $x_{t+1|t}$ in period t, using its previous observation of $x_{t|t-1}$ in period t–1, to calculate the expression

[11] More precisely, (8) can be combined with *only* (4) to solve for the optimal inflation and output gap plans. These can then be substituted into (5) to find the optimal instrument rate. If (9) is used instead of (8), it has to be combined with *both* (4) and (5) to solve for the optimal inflation and output gap plans.

[12] The instrument rule (9) is an *implicit* instrument rule, meaning that it is an equilibrium condition, where the variables on the right side depend on the instrument rate; there is a simultaneity aspect that needs to be handled. In contrast, an *explicit* instrument rule makes the instrument a function of predetermined variables, which are hence independent of the instrument. Hence, the implementation of an explicit instrument rule is simply a matter of observing the predetermined variables and calculating and announcing the corresponding instrument value. Implicit instrument rules and targeting rules are both equilibrium conditions, with variables that are simultaneously determined. Hence, their implementation is different from, and more complicated than, that of an explicit instrument rule. As discussed in detail in Svensson and Woodford (2005) and Svensson (2003b), their implementation requires the central bank to use its model of the transmission mechanism, make projections of the variables included in the target rule or implicit instrument rule, and find the combination of instrument and target-variable projections that fulfill the target rule or implicit instrument rule. Announcing these projections and implementing the instrument rate path will then induce the private sector to behave according to the desired equilibrium.

$$\pi_{t+1|t} - \pi^* + \frac{\lambda}{\alpha_x}\left(x_{t+1|t} - x_{t|t-1}\right) \tag{12}$$

for use in (9). In doing this, the central bank introduces a random error, e_t.

McCallum and Nelson then actually calculate the rational expectations equilibrium under the implicit assumption that the error, e_t, is *immediately observed* and known to *both* the central bank and the private sector in period t, *before* the instrument rate i_{t+1} is announced. Suppose that the error is positive, $e_t > 0$. Everything else equal, it would raise the instrument rate by $\mu e_t > 0$, where μ is a large number. The private sector, realizing this, immediately responds by lowering their inflation and output gap plans, $\pi_{t+1|t}$ and $x_{t+1|t}$, according to (4) and (5). Indeed, the private sector is assumed to instantaneously adjust their plans so as to bring about the rational expectations equilibrium for a known error, e_t. Furthermore, the central bank is then assumed to observe the adjusted plans, and then calculate and implement the equilibrium instrument rate according to (11). The result is that the equilibrium instrument rate increases by much less than μe_t. Indeed, with a large μ, (10) is approximately fulfilled, so the equilibrium resulting from (11) ends up being similar to the equilibrium resulting from (10) (disregarding any determinacy issues). In particular, the error introduces no more volatility for the instrument rule (11) than for the targeting rule (10).

But the idea that the central bank and the private sector immediately observe the error in period t is strange, to say the least. If the central bank observes the error, why does it not immediately correct the sum (12) so as to eliminate the error and instead implement (9) without any error?

Assume, more realistically, that the error is not immediately observed by the central bank or the private sector. Instead, the private sector first forms its plans under the assumption of an expected central bank error equal to zero (assuming that the error is i.i.d. and has a zero mean). The central bank then imperfectly observes those plans, introduces the (measurement) error, and announces the corresponding instrument rate, i_{t+1}, for period $t+1$. Assume, realistically, that the instrument rate can be announced only once in each period. In this case, the error hits the instrument rate with the full force of μe_t. If the private sector knows its own plans and how the central bank calculates the instrument rate, the private sector will be able to infer the error when it learns i_{t+1}. If the announcement is early—in period t rather than in period $t+1$—the private sector may be able to adjust its plans after the announcement, and the error will have an impact on the plans. If the announcement is late—in period $t+1$—the private sector plans cannot be adjusted and the plans for inflation and the output gap are unaffected by the error. But, in either case, the error still affects the instrument rate with the full magnitude μe_t. Under this realistic information assumption of the error not being immediately observed by the central bank and the private sector, a large μ will indeed introduce high volatility of the instrument rate, precisely as argued in Svensson and Woodford (2005) and Svensson (2003b). Central bankers, beware of McCallum and Nelson's instrument rule!

Even something as trivial as a small rounding error could be problematic. Suppose that the central bank rounds off its calculation of (12) to one decimal percentage point—that is, 10 basis points. This would introduce a uniformly distributed absolute error with a mean of 2.5 basis points. With $\mu = 50$, the corresponding mean absolute error of the instrument rate is 125 basis points—a sizeable error, especially because instrument changes are seldom larger than 50 basis points. In real-world monetary policy, the error, e_t, could be substantially larger—say, a mean absolute error of 50 basis points (0.5 percent) or more. With $\mu = 50$, this would lead to a huge mean absolute instrument rate error of 2,500 basis points or more.

McCallum and Nelson (2005) defend their informational assumptions by pointing out, in their reply ("Commentary," pp. 627-31), that Svensson and Woodford (2005) and Svensson (2003b) make information assumptions that imply that any error would be immediately revealed. But Svensson and Woodford (2005) and Svensson (2003b) do not attempt to provide any detailed discussion of such central bank errors and related realistic information assumptions. This detail is provided here, instead. One might have wished that McCallum and Nelson would have considered more realistic information assumptions on their own, because these assumptions are so crucial to their proposition. Indeed, realistic assumptions completely contradict their proposition.

Thus, the criticism in Svensson and Woodford (2005) and Svensson (2003b) of McCallum and Nelson's proposed instrument rule stands up to scrutiny: An instrument rule such as (9) with a very large response coefficient is a purely academic construction and completely impractical for any real-world monetary policy. The first five items in the list in the beginning of this section provide additional reasons why such instrument rules are inferior to targeting rules.

5 GENERAL TARGETING RULES?

The discussion here has so far concerned "specific" targeting rules, in the terminology of Svensson and Woodford (2005) and Svensson (2003b). Those papers also define "general" targeting rules for monetary policy as an operational formulation of the objectives for monetary policy—for instance, in the form of listing the target variables and the corresponding target levels and specifying the loss function to be minimized. McCallum and Nelson clearly find this definition confusing and not useful. My idea behind the definition is that the instruction to "specify your loss function in an operational way, construct forecasts of the target variables, and select and implement an instrument rate or an instrument rate path such that the forecasts minimize the loss function" is such a specific instruction to a central bank that it deserves to be called a "rule," in the common (and dictionary, see Merriam-Webster, 1996) sense of a rule being "a prescribed guide for conduct or action."[13] Perhaps it would have been better, and caused less confusion, to refer to this as "general targeting" instead of a "general targeting rule."[14] Walsh (2003) uses the term "targeting regime," which arguably is better.[15]

The idea with a particular terminology and particular definitions is, of course, that it shall contribute to more useful and precise discussion and analysis. I am inclined to concede that the term "general targeting rule" has not been successful and that Walsh's term "targeting regime" is better. Consequently, I am inclined to use that terminology in the future and to let "targeting rules" refer only to what I have previously called "specific" targeting rules.[16]

6 CONCLUSION

Counter to what McCallum and Nelson seem to take as granted, there is no reason at all to limit a study of robust simple monetary policy rules to instrument rules; simple targeting rules may have more desirable properties. Furthermore, targeting rules are a compact, robust, structural and, therefore, practical representation of goal-directed monetary policy. From a descriptive

[13] This is the idea behind the word "rule" in the title of Svensson (1999), "Inflation Targeting as a Monetary Policy Rule."

[14] It should not be necessary to state that "targeting," in the sense of "achieving a target," is best seen as equivalent to minimizing a loss function that is increasing in the deviation between the target variables and the target levels. That is, targeting and target variables refer to a loss function to be minimized and the arguments in that loss function. Previously, the literature has, by "targeting variable *X*," sometimes meant putting variable *X* in the instrument rule. To avoid confusion, it is better to call this "responding to variable *X*." Generally, the best way to target variable *X*, in the sense of minimizing a loss function increasing in deviations of variable *X* from its target level, is to respond, in the explicit instrument rule, to *all* the *determinants* of variable *X*. Even if inflation and the output gap are the only target variables, there are usually many more variables determining future inflation and the output gap, and it is optimal to respond to all of those. Generally, the mapping from a loss function to the optimal reaction function, the optimal explicit instrument rule, is quite complex, and the response coefficients of the optimal explicit instrument rule are complicated and sometimes nonmonotonic functions of the parameters of the loss function and the whole model. The size of the response coefficient of a variable is not an indicator of the weight of the variable in the loss function.

[15] In any case, there is always a close relation between a (specific) targeting rule in the form of some scalar expression $T_t(\pi_t, x_t) = 0$ and a loss function of the form $L_t = [T_t(\pi_t, x_t)]^2$, because the former is a first-order condition for a minimum of the latter.

[16] For a situation when a commitment to an optimal (specific) targeting rule is not possible, Svensson and Woodford (2005) and Svensson (2003b) discuss a "commitment to continuity and predictability," which involves minimizing the central-bank loss function while taking into account the cost of deviating from previously announced forecasts. This will make optimization under discretion result in the optimal outcome under commitment. Strangely, McCallum and Nelson describe this mechanism that induces the central bank to keep previous promises as "the central bank describing its objectives dishonestly to the public" (p. 598).

point of view, they amount to the same development in the theory of monetary policy as the consumption Euler conditions in the theory of consumption. Optimal targeting rules express the intuitive optimality condition of equality between the marginal rates of substitution and transformation of the target variables. They provide microfounded monetary policy, in the same way Euler conditions provide microfounded private sector behavior. Regardless of McCallum and Nelson's skepticism in McCallum and Nelson (2005), targeting rules for the analysis of monetary policy have arrived and are, as indicated by the long list of papers and books mentioned in the introduction, likely to stay. In particular, McCallum and Nelson's proposed instrument rule analog to any targeting rule will, under realistic information assumptions, lead to very high instrument rate volatility; for other reasons, it is also inferior to the targeting rule.

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