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ISSUES IN THE DESIGN OF MONETARY POLICY RULES

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ABSTRACT

Topics covered in this survey paper include the following: distinguishing rules from discretion in practice; the feasibility of rule-like behavior by an independent central bank; optimal control vs. robustness as research strategies; choice among target variables; growth-rate vs. growing-level target paths; feasibility of interest rate and monetary base instruments; nominal indeterminacy as distinct from solution multiplicity; root-mean-square performance measures with interest rate and monetary base instruments; operationality of rule specifications; stochastic vs. counterfactual historical simulation procedures; interactions between monetary and fiscal policies; and the fiscal theory of the price level.

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Introduction

The topic of rules for the conduct of monetary policy has a long and distinguished history in macroeconomic analysis, with notable contributions having been made by Thornton (1802), Bagehot (1873), Wicksell (1907), Fisher (1920, 1926), Simon (1935), Friedman (1948, 1960), and others.[1] A major reorientation in the focus of the discussion was provided as recently as 1983, however. In particular, Barro and Gordon (1983a) built upon the insights of Kydland and Prescott (1977) in a manner that put an end to the previously widespread notion that policy rules necessarily involve fixed settings for the monetary authority's instrument variable. This step served to separate the "rules vs. discretion" dichotomy from the issue of "activist vs. non-activist" policy behavior and thus opened the door to possible interest in policy rules on the part of actual monetary policymakers—i.e., central bankers.

In fact there has been a great increase in apparent interest in rules by policymakers during recent years—say, 1990-1996. Evidence in support of that claim is provided by several studies conducted at the Federal Reserve's Board of Governors of the rule introduced by John Taylor (1993b), such as Brayton et. al. (1996) and Orphanides et. al. (1996), as well as by discussions of this rule in speeches by members of the Board (e.g., Blinder, 1996). In the United Kingdom, interest by the Bank of England in Taylor's rule as well as an alternative due to McCallum (1988, 1993) is clearly indicated in an article by Stuart (1996) that attracted considerable attention in the British press. Numerous analytical studies of these rules (among others[2]) have been conducted by central bank economists from a number of countries.[3] To some extent this upsurge in interest is related to the arrival of inflation targeting as a leading candidate for the provision of a practical guideline for monetary policy, significant applications having been introduced during 1990-1993 in Canada, New Zealand, Finland, Sweden, and the United Kingdom.[4]

There are, to put it mildly, numerous issues concerning monetary policy rules on which professional agreement is far from complete, even among academics—that is, even neglecting the split between academic and central-bank views, which itself has probably diminished in recent years. The main purpose of this paper is to survey the most critical of these issues. The first to be discussed, which concerns the fundamental nature of policy rules and an independent central bank's capacity to behave in accordance with a rule—i.e., the commitment problem—is reviewed in Section 2. Next, Section 3 takes up some special difficulties that bedevil all attempts to design good policy rules and also to study ones previously proposed, namely, the lack of agreement (especially among academics) concerning models of monetary policy effects—and the associated social costs of inflation and unemployment—plus the existence of ongoing changes in economic structure relevant to monetary policymaking (e.g., improvements in payments technology).

Two major substantive areas of rule design, the specification of target and instrument variables, are then taken up in Sections 4-5. In the first of these, the choice among basic target variables—such as exchange rate, price level, or nominal income measures—is considered along with the desirability of specifying target paths in trend-stationary or difference-stationary form (i.e., levels vs. growth rates). In the second, the classic dispute between advocates of interest rate and monetary base (or bank reserve) instruments is reviewed, brief discussions being given of the rather extreme views that one or the other is actually infeasible as an instrument.

The following pair of sections, 6 and 7, take up a number of analytical issues involving the study of candidate rule specifications. Among these are the design of simulation exercises; issues involving operationality (i.e., feasibility of specified instruments and information sets); and the interaction of monetary and fiscal policy rules. Finally, a brief conclusion is included as Section 8.

Since the author has been writing on the subject of monetary rules for well over a decade, it would be futile to pretend that the paper's discussion will be entirely "balanced" or "unbiased." What is intended, rather, is that important alternative points of view are mentioned and presented with reasonable accuracy even where agreement is lacking.

2. Concepts and Distinctions

The crucial point that a policy rule can be activist has already been mentioned. Of course this is a matter of definition; thus the use of a terminological system that does not permit rules to be activist—i.e., to involve policy instrument settings that are conditional on the state of the economy—cannot be ruled out on strictly logical grounds. But since the publication of Barro and Gordon (1983a), standard usage in the profession has been virtually unanimous in permitting activist rules and in basing the "rules vs. discretion" distinction on the manner in which (potentially activist) instrument settings are determined. Roughly speaking, discretion implies period-by-period reoptimization on the part of the monetary authority whereas a rule calls for period-by-period implementation of a contingency formula that has been selected to be generally applicable for an indefinitely large number of decision periods.

The foregoing distinction is satisfying and straightforward to apply in the context of the simple "workhorse" model that features a surprise Phillips curve as utilized by

Kydland and Prescott (1977), Barro and Gordon (1983a, 1983b), and a host of subsequent writers. When it comes to practical application to the behavior of actual central banks, however, the distinction is not so easily drawn. Suppose that a particular central bank, which presumably cares about both inflation and unemployment outcomes, is observed regularly to be more stimulative when recent unemployment is high and/or current macroeconomic shocks threaten to increase unemployment. How does one decide whether this central bank's behavior should be classified as discretionary or rule-based but activist? Within a simple model one can calculate the settings implied by each type of behavior, or simply observe whether inflation exceeds its target value on average (i.e., whether the discretionary inflation bias is present). But such steps are not possible for the outside observer of an actual central bank, since such an observer cannot possess knowledge of the bank's true target values—much less the response coefficients that would be implied by each type of behavior given its implicit model of the economy.

Taylor (1993b) explicitly addressed the problem of distinguishing "rule-like" from discretionary behavior in practice, recognizing that no actual central bank would be likely to follow literally a simple formula for its instrument settings but contending that the distinction could be of importance nevertheless.[5] The key, Taylor suggested, was that rule-like behavior is systematic in the sense of "methodical, according to a plan, and not casual or at random." Clearly, being systematic is a necessary condition for rule-like behavior, but even those central bankers who defend discretionary behavior do not think of it as unsystematic. Accordingly, McCallum (1993b) argues that being systematic it is not sufficient and points out that discretionary behavior in the workhorse model can, even with the inclusion of random shock terms, be accurately represented by systematic application of a simple formula. The needed additional criterion, McCallum suggests, is that the monetary authority "must also design the systematic response pattern [so as] to take account of the private sector's expectational behavior" (p. 217), i.e., to optimize once, not each period. Taking such account is basically what Barro and Gordon (1983a) specified in their characterization, within the workhorse model with rational expectations, of policy according to a rule. There is then no attempt to exploit temporarily given inflationary expectations for brief output gains.

It is interesting to note, parenthetically, that although Milton Friedman has never embraced the concept of activist rules, in one of his most carefully considered arguments on behalf of nondiscretionary monetary policy the crucial advantage of a rule is said to be that decisions are made in the form of a policy applicable to many distinct cases, not on a case-by-case basis, with such a form of policymaking having favorable effects on expectations. In particular, Friedman (1962) suggests that monetary policymaking is in important ways analogous to freedom-of-speech issues, in the sense that adopting a rule that applies in general will on average lead to different—and preferable—outcomes than those generated by decision making on a case-by-case basis. After presenting the analogy and remarking on "our good fortune of having lived in a society that did adopt the self-denying ordinance of not considering each case of [contested] speech separately" (1962, p. 241), Friedman contends that:

> Exactly the same considerations apply in the monetary area. If each case is considered on its [individual] merits, the wrong decision is likely to be made in a large fraction of cases because the decision-makers are ... not taking into account the cumulative consequences of the policy as a whole. On the other hand, if a general rule is adopted for a group of cases as a bundle, the existence of that rule has favorable effects on people's attitudes ... and expectations that

> would not follow even from the discretionary adoption of precisely the same [actions] on a series of separate occasions. (Friedman, 1962, p. 241)

Thus we see that the logic of Friedman's argument is basically the same as that identified by Barro and Gordon (1983a) and is entirely compatible with "activism," i.e., conditioning clauses in the rule.

A controversial issue is whether it is feasible for an independent central bank to behave in a rule-like fashion. The most straightforward point of view is that expressed by Taylor (1983, 1993), McCallum (1995b, 1997), Kydland and Prescott (1977), and Prescott (1977), namely, that an independent central bank is perfectly free to choose its instrument settings as it sees fit. Since it will generate superior outcomes on average if it does so in a rule-like manner, and is presumably capable of understanding that, the well-managed central bank will in fact behave in such a manner. This requires it to adopt instrument settings that are different, however, from those that would appear optimal if it were making a fresh optimization calculation each period (i.e., not considering the cases as a group). Thus many authors have suggested that, since there is no tangible "commitment technology" to guarantee that future choices will be made similarly, independent central banks are inevitably destined to behave in a discretionary fashion, making a fresh optimization calculation each period. One of the strongest explicit statements of this position has been made by Chari, Kehoe, and Prescott (1989, p. 303), as follows. "We should emphasize that in no sense can societies choose between commitment [and] time-consistent [i.e., discretionary] equilibria. Commitment technologies are like technologies for making shoes in an Arrow-Debreu model—they are either available or not." But while this form of language is rather extreme, the position taken is probably more representative of academic thought over (say) 1984-1994 than is the pragmatic Taylor-McCallum position. That is, most analyses of the consequences of various issues simply presume, often without explicit justification, that central bank behavior will be of the uncommitted discretionary type.[6] In many cases it is contended that there is a necessary tradeoff between commitment and flexibility, which the Taylor-McCallum position denies.

The justification typically given, explicitly or implicitly, for the assumption of (suboptimal) discretionary behavior is that although rule-like behavior is superior on average, it remains true that within each period prevailing expectations are "given" so each extra bit of inflation or monetary ease will add output or reduce unemployment, implying that the discretionary choice would typically be superior from the perspective of that single period. Furthermore, the public understands this feature of policy choice, according to the usual position, so individuals will expect the central bank to behave discretionarily, thereby making the discretionary action preferable (from the single-period perspective). But to conclude that the central bank will therefore consistently choose the discretionary outcome is analytically to adopt a particular equilibrium concept—see Chari, Kehoe, and Prescott (1989). The solution concept preferred by Taylor, McCallum, Lucas (1976, 1980), and Prescott (1977) is simply rational expectations in a competitive model with a monetary authority that behaves as a Stackelberg leader vis-a-vis the private sector.[7] To the present writer the latter concept seems more plausible,[8] but the key point here is that neither of the two modes of central bank behavior—rule-like or discretionary—has as yet been firmly established as empirically relevant. Also, it would seem to be indisputable that there is nothing tangible to prevent a central bank from behaving in a rule-like fashion[9] so that there is no necessary tradeoff between "flexibility and commitment," as has often been suggested.[10]

3. Special Difficulties

To economists who do not specialize in monetary or macroeconomic issues, it may seem surprising or perhaps a matter for professional embarrassment that a large volume of debate can be sustained on the subject of monetary policy rules. Surely, the argument would go, it should not be terribly difficult to conduct an optimal control exercise using some reasonably good macroeconometric model and thereby discover what an optimal monetary policy rule would be. This would have to be done for a number of different economies, of course, but the problems involved are in principle almost negligible and in practice are easily surmountable. Admittedly, the model would have to be one that is structural—policy invariant—so as not to be subject to the Lucas critique (1976), but that necessity has been well understood for many years by now.[11]

In fact, however, such an argument fails entirely to recognize one basic and fundamental difficulty that underlies a large fraction of the issues concerning monetary policy rules. This difficulty stems from the lack of professional agreement concerning the appropriate specification of a model suitable for the analysis of monetary policy issues. There are various aspects of such a model that different researchers would emphasize. Many would suggest that money demand theory is quite undeveloped and inadequate for policy analysis. The viewpoint taken in McCallum (1997), by contrast, contends that it is the dynamic connection between monetary policy actions and real aggregative responses that is the main source of difficulty.[12] Others, including King (1993) and Fuhrer (1996) would point to weaknesses in modeling investment or consumption behavior, and of course empirical understanding of exchange rates and other open-economy influences is widely regarded as highly unsatisfactory. But whatever the particular model component that is singled out for special criticism, it seems extremely hard to avoid the conclusion that agreement upon macroeconomic model specification is predominantly absent—and that different models carry highly different alleged implications for monetary policy.

The upshot, clearly, is that in practice one cannot simply conduct an optimal control exercise with an "appropriate" model. That approach simply collapses in response to the question, "What is the appropriate model?" In light of this mundane but fundamental difficulty, the research strategy recommended by several writers—including Blanchard and Fischer (1989, p. 582), McCallum (1988, 1997), and to some extent Brunner (1980)—is to search for a policy rule that possesses "robustness" in the sense of yielding reasonably desirable outcomes in policy simulation experiments in a wide variety of models. In effect, the same type of approach is collectively utilized by the various teams of researchers participating in the Brookings projects directed by Ralph Bryant (Bryant, et. al., 1988, 1993).[13]

It is worth mentioning briefly that the research strategy based on robustness serves to some extent as a protection against failures of the Lucas-critique type. That critique is best thought of not as a methodological imperative regarding model building strategies, but as a reminder of the need to use policy-invariant relations in simulation studies and especially as a source of striking examples in which policy invariance is implausible. The construction of a policy-invariant model faces a major difficulty, however, in the above-mentioned absence of professional agreement about model specification. Thus it would seem sensible to consider a variety of models in the hope that one will be reasonably well specified—and therefore immune to the critique—and search for a rule that will perform satisfactorily in all of them. Of course, there is no need for such a project to be carried out by a single researcher; furthermore, attempts to make each contending model policy invariant would enhance the effectiveness of the overall project. Thus there is no necessary conflict between a robustness-oriented strategy and studies by individual researchers that involve construction of single models (e.g., Ireland, 1997).

Other issues that are of greater technical interest but less fundamental importance—for example, issues concerning operationality and simulation techniques appropriate for investigating a rule's properties—will be taken up below, in Section 6.

In any discussion of monetary policy, but especially in ones involving the design of rules, it is useful to adopt a terminology regarding goals, objectives, targets, instruments, etc., that clearly reflects basic conceptual distinctions and at the same time is reasonably orthodox (or at least non-idiosyncratic). With those criteria in mind, we shall below use the word goals to refer to the ultimate but typically non-operational objectives of the monetary authority, and the term target to refer to an operational variable that takes precedence in the actual conduct of policy. The leading contenders for a central bank's target variable would be some comprehensive price index, nominal GDP or some other measure of nominal spending, a monetary aggregate, or a foreign exchange rate—with growth rates rather than (growing) levels perhaps pertaining in the case of the first three. The choice among target variables will be considered in some detail in Section 4.

At the opposite end of the scale from goals are instrument variables, i.e., the variables that central banks actually manipulate more or less directly on a daily or weekly basis in their attempts to achieve specified targets. For most central banks, some short-term interest rate would be regarded as the instrument variable, but some analysts continue to promote the monetary base (or some other controllable narrow aggregate) in that capacity. It must be said that a term such as "operating target" would probably be nearer to standard for central bank economists or even policy-oriented academics, and there is a sense—to be described momentarily—in which it is more accurate than "instrument variable." But in a paper such as the present one it would seem desirable to employ a terminology that promotes a clear distinction between target and instrument variables. Thus we seek to avoid ambiguous usage such as "interest rate targeting" to refer to a central bank's weekly instrument (or operating target) settings, rather than its policy-governing target variable.

The sense in which "operating target" would be preferable to "instrument" is as follows. Many actual central banks choose not to manipulate their interest rate instruments in a literally direct fashion but rather to conduct open-market operations only once a day with quantities chosen so as to be expected to yield a market-influenced interest rate that lies within (or close to) some rather narrow band. The USA's Federal Reserve, for example, typically enters the Federal Funds market only once a day (normally around 10:30-10:45 a.m.) so that the end-of-day or daily average value of the Federal Funds rate (FF rate) can depart from the open-market desk's "target value" by 20-30 basis points on any given day. Thus writers such as Cook and Hahn (1989) or Rudebusch (1996) will distinguish between "actual" and "target" values at the daily level. But the Fed keeps the FF rate within a few basis points of its operating target on average over periods as short as a week. Thus there is little harm, in a study such as the present one, in using the term instrument variable and pretending that the Fed controls its interest instrument directly.

There is, of course, a substantial amount of debate over the feasibility of a central bank's using one variable or another as its instrument (even in our sense). Those issues will be taken up in Section 5.

In our terminology, then, a policy rule might be thought of as a formula that specifies instrument settings that are designed to keep a target variable close to its specified target path. If r_t and x_t were the instrument and target variables, then, the simplest prototype rule might be of the form

$$(1) \qquad r_t = r_{t-1} + \lambda(x^*_{t-1} - x_{t-1}), \qquad \lambda < 0$$

which specifies that the instrument setting should be decreased if x_t fell short of its target value x^*_t in the previous period. Somewhat more realistic examples involving more variables and other timing patterns will be considered below.

Some writers have taken the position that the specification of a policy rule is complete when a target variable has been selected and a target path (or perhaps a tolerance range) has been designated. Hall and Mankiw (1994, p. 79), for example, recommend that the central bank behave so as to keep each period's externally-generated forecast of future nominal income equal to a value given by a selected target path, but beyond that "we see no need to tell it how to go about achieving the peg." Also, Svensson (1996a) distinguishes between "instrument rules" and "target rules" and expresses a preference for the latter, which specifies target values but not instrument settings. The position taken in the present paper, however, is that a monetary policy rule is a formula that specifies instrument settings, with the choice of a target variable and path constituting only one ingredient. For some particular target choices it might be the case that the problem of designing instrument settings would be extremely simple or uninteresting, but in general such will not be the case. McCallum's series of rule studies (1988, 1993a, 1995a), for example, was undertaken partly in response to a claim by Axilrod (1985)–who was in 1985 the principal monetary policy advisor at the Fed's Board of Governors – that the achievement of nominal GNP targets was technically infeasible. From this practical perspective, the investigation of a rule expressed in terms of a feasible instrument variable becomes an essential portion of the selection of a desirable target. For there is little point in designating a particular target if in fact it is not achievable.

Svensson's (1996a) preference for what he terms target rules is not based on any lack of interest in the instrument-target relationship, but stems (apparently) from a point of view that does not recognize the difficulty emphasized above, namely, the absence of a satisfactory model of the economy. Thus Svensson presumes that any change in knowledge about the economy's workings will typically require some change in an instrument rule, whereas "with new information about structural relationships...a target rule implies automatic revisions of the reaction function" (Svensson, 1996a, p. 216). Indeed, if the central bank were conducting policy by conducting optimal control exercises each period with a single model, it would be true that changes in the latter would typically entail changes in the <u>implied</u> instrument rule. But under the presumption presented above, that it would be unwise to design a rule optimally on the basis of any single model, Svensson's conclusions do not follow. Instead, if an instrument rule has been designed so as to work reasonably well in a wide variety of models, then new information about the economy's structure is unlikely to entail any change in rule specification even when the rule designates instrument settings.

Terminologically, moreover, it seems best to distinguish between the choice of policy rules and policy targets. Thus a target is just that, a target. A rule, by contrast, is a formula that can be handed to a central banker for implementation without any particular knowledge of the analysts' views about model specification or objectives. In any event, in what follows it will typically be presumed that the term monetary policy rule refers to a formula or guide for period by period setting of instrument values in response to specified conditions.

4. Choice of Target Variable

After a long dose of preliminaries, let us now finally turn to substantive issues in the design of a monetary rule. In this section we shall be concerned with the choice of a target variable—both its identity and the question of whether its path should be specified in growth-rate or level form.

In recent years, the most fashionable target variable for the monetary authority has been a nation's inflation rate—in other words, a comprehensive price-level variable with its target path set in growth-rate terms. A great deal has been written about inflation targeting in policy-oriented publications and substantial scholarly efforts have been contributed by Almeida and Goodhart (1996), Bernanke and Mishkin (1996), Goodhart and Vinals (1994), McCallum (1997), and others, as well as the individual authors represented in books edited by Leiderman and Svensson (1995) and Haldane (1995). Other leading target-variable choices are aggregate spending magnitudes such as nominal GNP or GDP—often in growth rate form—and a "hybrid" variable that sums inflation and real output measured relative to some sort of trend or reference value.[14] All of these choices presume, however, that the economy in question does not have its monetary policy dedicated to an exchange rate target, so a brief prior discussion of exchange rate policy should be appropriate.

Perhaps the most basic of all monetary policy choices is whether or not to adopt a fixed exchange rate. The principal considerations involved in this choice are those recognized in the optimal currency area literature began by Mundell (1961) and extended by McKinnon (1963) and Kenen (1969). Basically, these all boil down to the question of whether the microeconomic (i.e., resource allocation) advantages of an extended area with a single medium of exchange outweigh the macroeconomic (i.e., stabilization policy) disadvantages of being unable to tailor monetary policy to local conditions.[15] Some analysts (e.g., Bruno (1993), Fischer (1986)) have contended that there are some macroeconomic advantages of a fixed exchange rate[16] but the arguments seen actually to be based on political or public-relations considerations, not economic costs and benefits.[17] Thus in the case of small economies for which large fractions of their market exchanges are international in character, and which tend frequently to experience the same macroeconomic shocks as their neighbors and trading partners, it is clearly advantageous to forgo the flexibility of an independent monetary policy by keeping a fixed exchange rate (and common currency) with a specified currency or basket of currencies.[18] And at the other extreme, the macroeconomic advantages of a floating exchange rate would seem to be clearly dominant for pairs of nations such as the USA, Japan, and the prospective European monetary union.

The main point of the previous paragraph is that the advantages that might lead a nation to choose to have a fixed exchange rate, and thus to dedicate its monetary policy actions to that criterion, are basically either microeconomic or political in nature. Thus the type of considerations involved are quite different than those that are involved in the selection among macroeconomic target variables such as inflation, nominal spending growth, or the above-mentioned hybrid variable. Because of the scope of the present paper, we shall henceforth focus our attention on the latter type of choice.

In the literature on this subject, which is large, the most popular approach is to determine how well the various targets would perform in terms of yielding desirable values of postulated social and/or policy-maker objective functions, with these pertaining primarily to root-mean-square (RMS) deviations from desired values of variables such as inflation or real GDP relative to trend. Such studies may be conducted with theoretical or estimated models, but in either case need to take account of the various types of macroeconomic shocks that may be relevant—take account, that is, of the variance, covariance, and autocovariance magnitudes of the shock processes. Some of the leading examples of theoretical studies are those of Bean (1983), West (1986), Aizenman and Frenkel (1986), and Henderson and McKibbon (1993), while well-known simulation studies with estimated models have been conducted by Taylor (1979, 1993a), Feldstein and Stock (1994), Haldane & Salmon (1996), and the individual authors in Bryant et. al. (1988, 1993).

In some of these studies it is pretended, for the sake of the issue at hand, that the selected target variables are kept precisely on their target path; the Bean, West, Aizenman-Frenkel, and (in part) Henderson-McKibbon studies are of that type. Others, however, focus on RMS deviations in simulations with policy rules expressed in terms of instrument variables. Proponents of the first approach would argue, presumably, that they prefer to keep the issue of whether a variable can be controlled separate from the evaluation of its effects if well-controlled. Those who disagree would point out that there is little need to know such properties for variables that in fact can be controlled only very poorly. Indeed, they might argue that unless controllability is taken into account, the issue is simply that of specifying an appropriate social objective function; i.e., that "targeting" is not the matter under investigation. In this regard it is worth keeping in mind the point emphasized above, namely, that there is in fact no professional agreement on the on the appropriate specification of a dynamic macroeconomic model. This implies not only an absence of agreement on the "true" social objective function, but also the absence of agreement on a matter as basic as the listing of relevant macroeconomic shocks. Keynesians and real-business-cycle analysts, for example, would disagree sharply as to the very nature of the relevant shock processes.

For the candidate target variables mentioned above, other than the hybrid variable, an important question is whether it is preferable to specify a growth-rate target or one of the growing-levels type, i.e., whether the target should be specified in a difference-stationary or trend-stationary manner. This issue is often discussed under the heading of "inflation vs. price-level targeting," but similar considerations would apply if the target variable were nominal GDP, some other measure of nominal spending, or even a money-stock variable.[19] Specifically, the weakness of the growth-rate choice is that it will—by treating past target misses as bygones—introduce a random walk (or more general unit root) component into the time-series processes for all nominal variables, including the price level. Thus there will exist a possibility that the price level would drift arbitrarily far away from any given value (or predetermined path) as time passes, implying considerable uncertainty as to values that will obtain in the distant future.

By contrast, the main disadvantage with a levels-type target path is that the target variable will be forced back toward the preset path after any disturbance that has driven it away, even if the effect of the disturbance is itself of a permanent nature. Since any such action entails general macroeconomic stimulus or restraint, this type of targeting procedure would tend to induce extra cyclical variability in demand conditions, which may imply extra variability in real output if price-level stickiness prevails. Furthermore, variability in output and other real aggregative variables is probably more costly in terms of human welfare than is an equal amount of variability in the price level about a constant or slowly-growing path. Also, although it is not entirely clear that fully permanent shocks are predominant, most time series analysis seems to suggest that the effects of shocks are typically quite long lasting—indeed, are virtually indistinguishable from permanent. Consequently, it would seem desirable not to drive nominal variables back to preset paths—or at least not to do so quickly and frequently. Thus, it seems preferable to adopt a nominal target of the growth-rate type, rather than the growing-levels type.[20]

One reason for the foregoing conclusion is that very few transactions are based on planning horizons as distant as 50 years. A more representative long-lasting arrangement might be more like 20 years in duration. But price level uncertainty 20 years into the future might not be very large even if the (log of the) price level included a unit root component. Suppose that the log price level were to behave as a pure random walk relative to a preset target path (say, a zero-inflation path). Then if it is assumed that the random, unpredictable component at the quarterly frequency has a standard deviation of 0.0045 (which is approximately the standard deviation of one-step ahead forecast errors for the United States over 1954-1991),[21] it follows that a 95 percent confidence interval for the (log) price level 20 years ahead would be only about 8 percent (plus or minus).[22] This, it seems to the writer, represents a rather small amount of price level uncertainty—at least in comparison with the magnitudes that prevailed over the 1960s, 1970s, and 1980s, because of non-zero and uncertain trend rates.

The foregoing arguments seem moderately persuasive to the present writer, but they are clearly not compelling and the conclusion is certainly not accepted by all analysts. Furthermore, even if it were accepted, it might be possible to obtain the benefits of trend stationarity by adopting a target that is weighted average of ones of the growth-rate and growing-levels types.[23] Accordingly, in the simulations reported below, consideration will be given to growth-rate, growing level, and weighted average types.

Now let us consider some points regarding the comparative merits of three leading target-variable possibilities. Because they seem at present to command the most support, we will discuss (i) the inflation rate, (ii) the growth rate of nominal GDP, and (iii) the above-mentioned hybrid variable. As some notation will be useful, henceforth let x_t, y_t, and p_t denote logs of nominal GDP, real GDP, and the price level (as represented by the deflator so that $x_t = y_t + p_t$), with time periods referring to quarter-years. Then the three contending target variables in their simplest form are Δp_t, Δx_t, and $h_t = \Delta p_t + 0.25\ \tilde{y}_t$, where $\tilde{y}_t = y_t - \bar{y}_t$ with $\bar{y}_t$ denoting the reference value of real GDP.

In choosing among these three contenders, a straightforward approach would be to select the target variable that corresponds most closely to the central bank's views about social objectives that are influenced by monetary policy. From that perspective, it would appear that the hybrid variable h_t might be the most appropriate of the three, a point of view taken implicitly by Blinder (1996), with Δx_t arguably ranking second. But among actual central banks that have adopted formal numerical targets, virtually all have (as of early 1997) opted for inflation targets. So apparently the straightforward approach is not the only one that needs to be considered.

There are undoubtedly several reasons for this tendency for actual central banks to choose Δp_t over the others as their formal target, but three of these seem justifiable and in any event deserve to be mentioned. First, it is believed by a large number of policymakers and a large number of scholars that monetary policy has, from a long-run perspective, no substantial effect on $\tilde{y}_t = y_t - \bar{y}_t$.[24] In other words, while monetary policy may have effects on output relative to capacity, these are only temporary. Therefore, so the argument goes, central banks should concentrate their attention on the Δp_t variable that their policy actions affect strongly on a long-run basis.[25] Second, measurement of $\bar{y}_t$ and therefore $\tilde{y}_t$ is difficult and controversial, even in comparison to measurement of Δp_t. In particular, errors in measuring $\bar{y}_t$ are likely to be much larger than errors in measuring the long-term average value of $\Delta\bar{y}_t$, which is all that is necessary for correct design of a Δx_t target. Thus the h_t target is more demanding of knowledge concerning the economy than is either of the other contenders under discussion. The third reason is related to the other two, especially the first. It is that communication to the public is thought by practitioners to be much easier when only the inflation variable is involved. Typical citizens have an understanding of the concept of inflation, so the argument goes, but not of the national income accounting concepts x_t and y_t, much less the reference value $\bar{y}_t$.

In addition, it must be mentioned that in practice actual inflation targets are typically based on yearly average inflation rates, and with those values forecasted to prevail 1-2 years into the future.[26] Furthermore, inflation targets are usually accompanied by provisions stating that the occurrence of "supply shocks"—such as crop failures, terms-of-trade changes, or indirect tax-rate changes—will entail temporary modification of the current inflation target measures. Thus, for example, the New Zealand legislation includes several such "caveats" that are built into the Reserve Bank's targeting procedures.[27]

Because of considerations such as these, it would probably be unrealistic (and unreasonable) to expect that a truly compelling argument could be made for any one of the candidate target measures. Consequently, it may be of interest to compare actual past values of the three leading measures with those values that would have been called for if corresponding targets had been in place. For the purpose of this exercise, it will be assumed that the desired value of Δp_t is 0.005, which amounts to approximately two percent inflation on an annual basis. Also, for simplicity it will be assumed that $\bar{y}_t$ values are given by deterministic trends obtained by regression of y_t on time for the sample period under consideration. This last assumption is unsatisfactory, of course—as will be discussed again—but should suffice for the limited purpose at hand of making comparisons.

Let us first consider the time period 1960.1-1995.4, with United States GDP data used for x_t and with y_t based on GDP in 1992 fixed-weight prices (i.e., using the fixed-weight rather than the chain-weight deflator). Over this period, the $\bar{y}_t$ trend variable is given by the expression $\bar{y}_t = 7.520749 + 0.006881t$ (with t = 1 in 1947.1). Therefore, $\Delta\bar{y} = 0.006881$ is assumed and the target value for Δx_t is 0.011881, with 0.005 being the target value for both Δp_t and h_t. For each of the three variables we calculate the gap between actually-observed values and these retrospective, hypothetical target values. These gaps are denoted $\Delta pgap_t = \Delta p_t - 0.005$, $\Delta xgap_t = \Delta x_t - 0.011881$, and $hgap_t = \Delta p_t + 0.25\tilde{y}_t - 0.005$. Their values for the first two variables (over 1960.1 - 1995.4) are plotted in Figure 1 and those for the second and third are plotted in Figure 2.

In Figure 1 we see that the Δp_t and Δx_t targets both suggest that monetary policy was excessively expansive most of the time between 1965 and 1989. The Δxgap measure is considerably more variable from quarter to quarter than the Δpgap measure, basically because Δy_t is more variable than Δp_t. Averaging over the whole period, the two measures give the same signals simply because the Δx_t target value was calculated so as to yield the desired inflation rate given the realized average growth rate of output over the sample period. Of course, actual policymakers could not know this rate in advance, when choosing their target value for Δx_t. Thus desired inflation would tend to differ from the average realized value to the extent that average output growth is forecast incorrectly. The magnitude of this error would not be large, however, when averaged over long spans of time. By and large, a striking feature of Figure 1 is that the two target variables do not give greatly different signals when averaged over periods as short as 3-4 years. Nevertheless, there are a few quarters when the Δx variable suggests that policy should be loosened whereas the Δp variable suggests the opposite, and this situation prevails for over a year during 1990-1991. Those analysts who favor Δx_t targeting believe, of course,

Figure 1 -- Gap measures for inflation and nominal GDP targets, 1960-1995

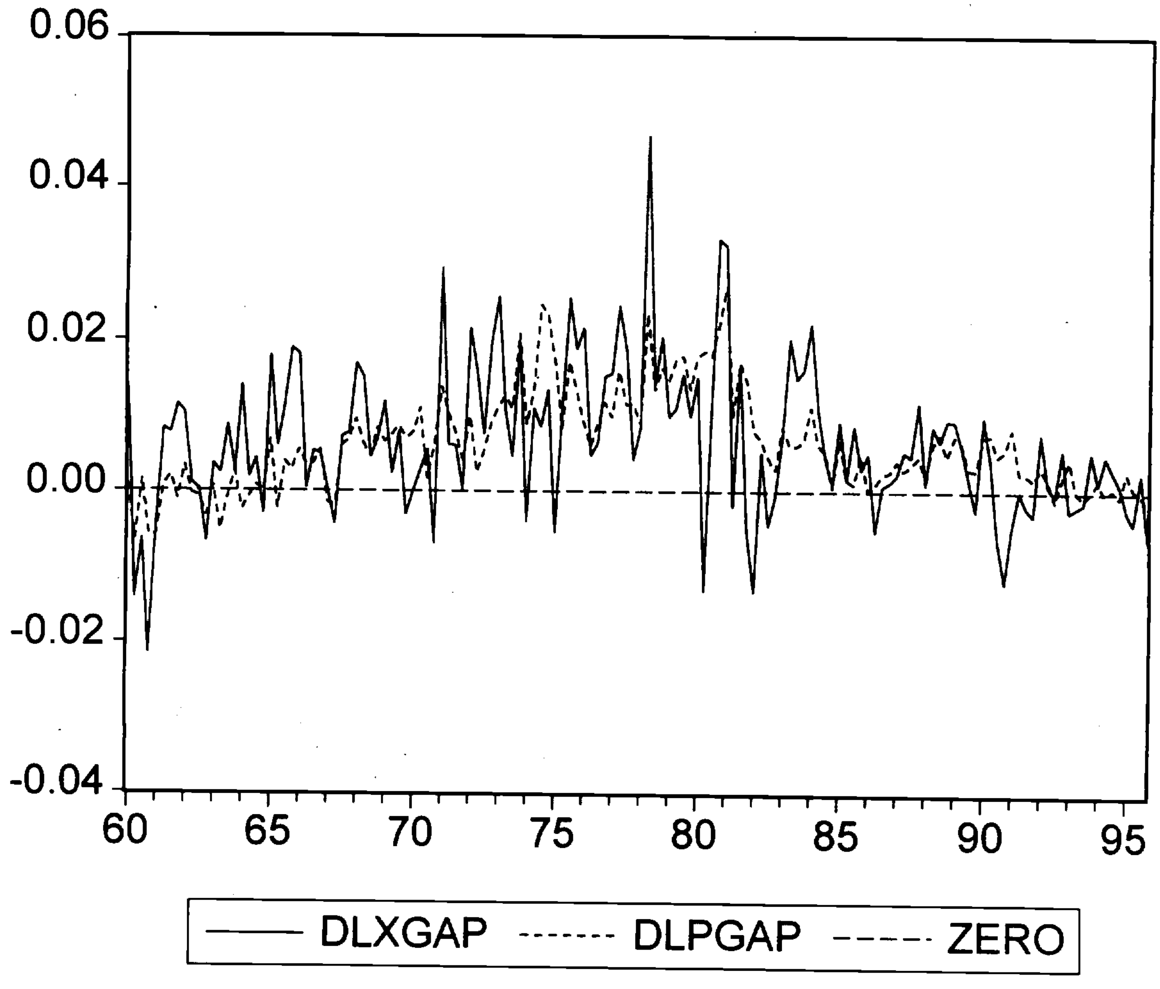
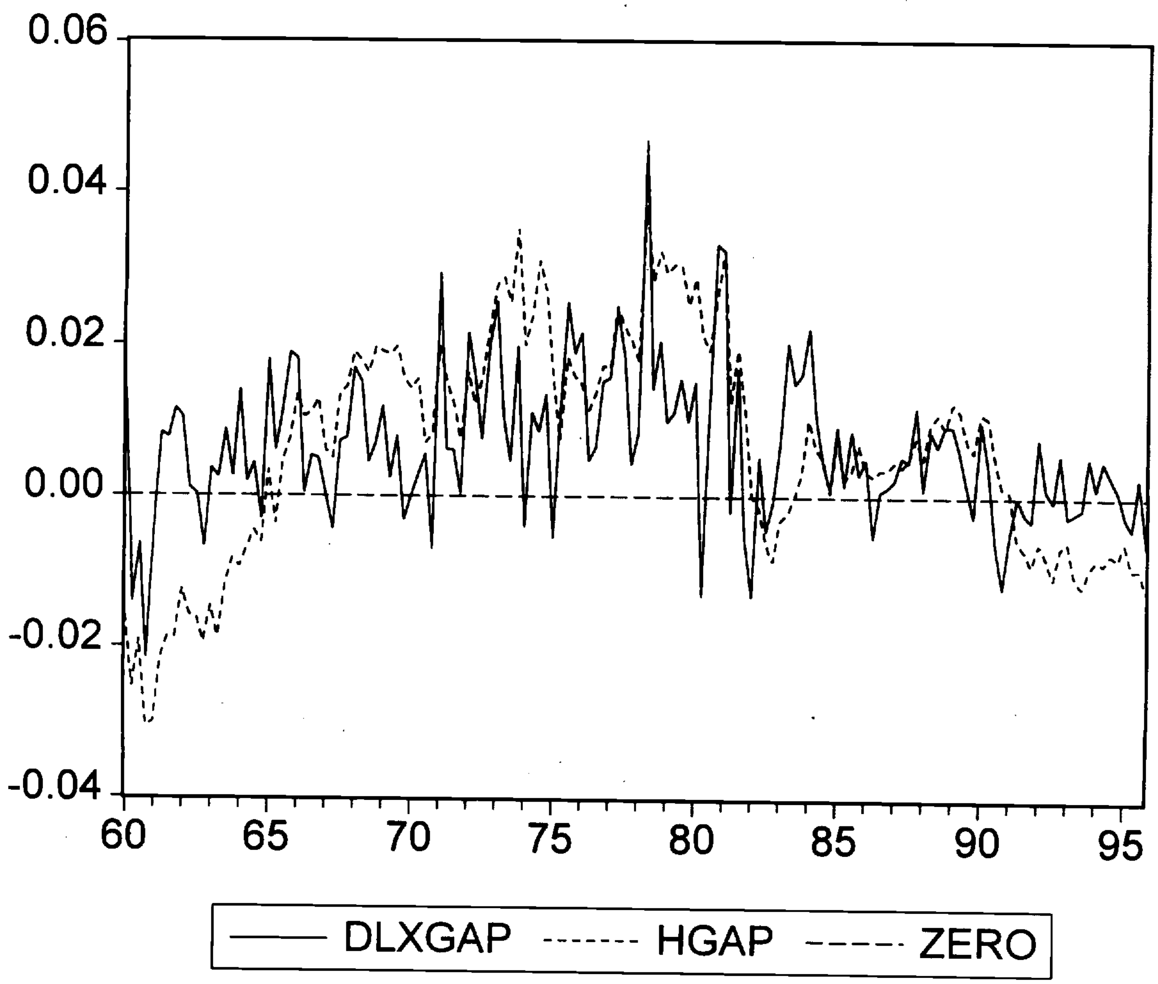


Figure 2 -- Gap measures for hybrid and nominal GDP targets, 1960-1995

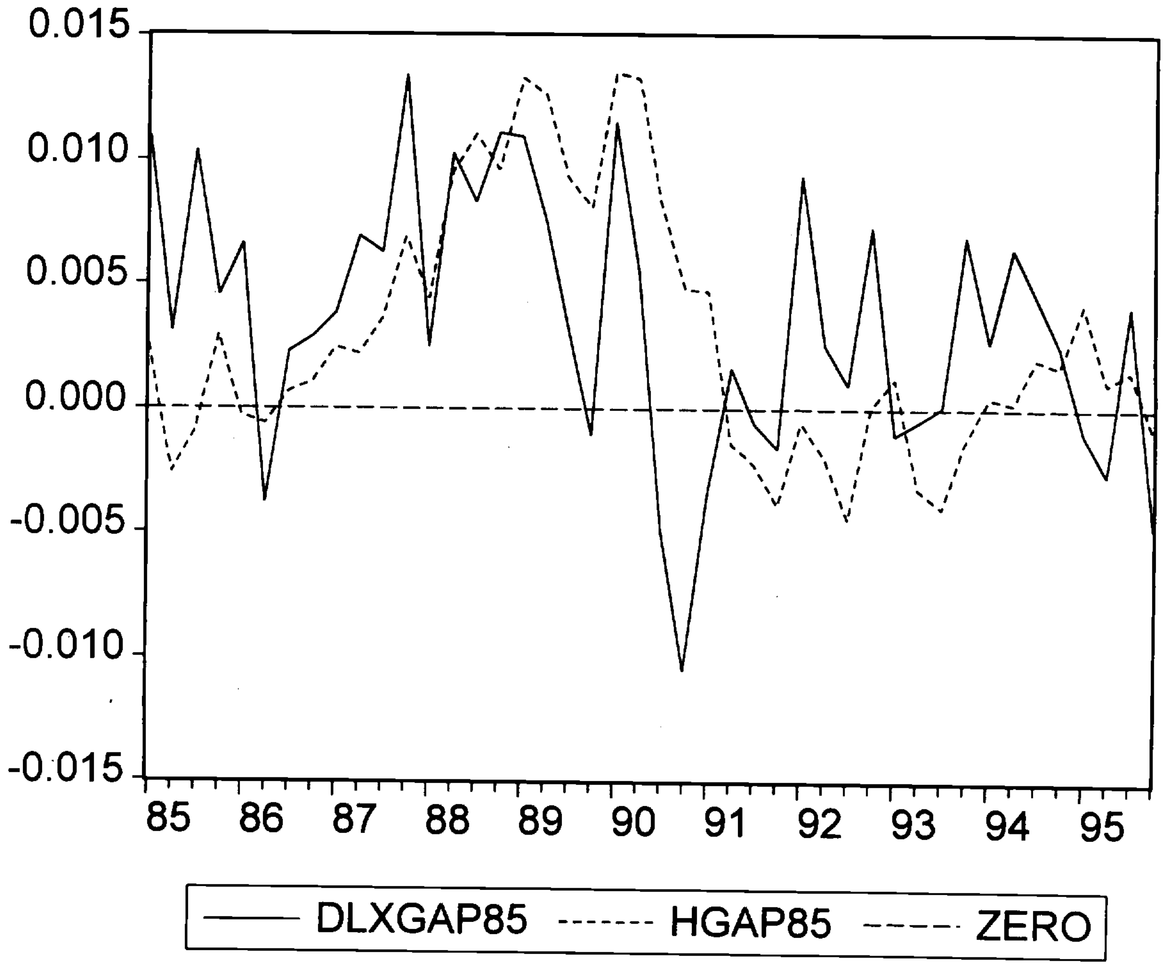


that keeping Δx_t values steady would result in smaller fluctuations in $\tilde{y}_t$ than would a policy of keeping Δp_t values steady. Whether such is the case in fact will depend upon the precise nature of the economy's short-term, dynamic Phillips relation, a point emphasized in McCallum (1988, 1997).

Figure 2 compares gap values for h_t and Δx_t targets. In this case there is much more divergence in signals, with the hybrid measure calling for more monetary expansion over lengthy periods during the early 1960s and 1990s, and tighter monetary policy during much of the 1970s, in comparison with the Δx_t measure. (Of course both measures signal that policy was too inflationary from 1965-1989, as before.) These features of the plots in Figure 2 are basically a consequence of the fact that a linear trend line for y_t implies negative residuals in the early 1960s and 1990s and many positive residuals during the 1970s, which it does because of the sustained period of rapid growth in real GDP from 1960 to 1973.

To emphasize this last point, Figure 3 gives results for the same type of exercise but with the sample period limited to 1985.1-1995.4. Here it will be noted that the hgap values are quite different from those for 1985-1995 in Figure 2, solely because the y_t trend line is estimated differently and yields a significantly different residual pattern.[28] Now there are no major discrepancies that persist as long as in Figure 2, although the two measures give quite different policy signals over most of 1990 and 1992, the Δx_t target calling for a relatively more expansionary monetary stance in the former year and a more restrictive stance in the latter year.

Figure 3 -- Gap measures for hybrid and nominal GDP targets, 1985-1995



The sizable difference between the hgap figures shown in Figures 2 and 3 illustrates the main weakness of the hybrid target variable, namely, its sensitivity to alternative calculations of $\bar{y}_t$ reference values. Proponents of the hybrid variable might argue that more sophisticated measures of $\bar{y}_t$ should be used, and it is certainly true that our linear trends are not conceptually attractive. But neither are, say, Hodrick-Prescott (HP) filtered series, for reasons emphasized by Cogley and Nason (1995) plus a recognition of what the HP filter would imply about U.S. GNP for the period 1929 - 1939.[29] Other measures exist, but have attracted little professional support. In sum, there is no widely accepted and conceptually sound measure for $\bar{y}_t$, but use of the hybrid target variable requires such a measure and its value is rather sensitive to the particular measure adopted.

5. Choice of Instrument Variable

In this section we consider the choice of a variable to serve as the instrument through which a central bank's policy rule will be implemented. It is well-known that, although a substantial number of academic economists have favored use of a monetary base or reserve aggregate instrument, almost all actual central banks utilize some short-term interest rate in that capacity. Before turning to a review of their relative desirability, however, it will be appropriate to consider the sheer feasibility of interest rate and monetary base instruments, since there are a few scholars who have contended that one or the other would be infeasible in some sense.

In this category the most well-known argument is that of Sargent and Wallace (1975). That paper put forth the claim that, in a model in which all private agents are free of money illusion and form their expectations rationally, the economy's price level would be indeterminate if the central bank were to use an interest rate as its instrument. Specifically, the Sargent-Wallace (1975) paper included a result suggesting that if the interest rate R_t were set each period by means of a policy feedback rule that specifies R_t as a linear function of data from previous periods, then all nominal variables would be formally indeterminate. Sargent (1979, p. 362) summarized this conclusion as follows: "There is no interest rate rule that is associated with a determinate price level."[30] Subsequently, however, McCallum (1981, 1986 p. 148) showed that the Sargent-Wallace claim was actually incorrect in such a model; instead, all nominal variables are fully determinate provided that the policy rule utilized for the interest rate instrument involves some nominal variable, as suggested previously by Parkin (1978) and in the classic static discussion of Patinkin (1961). The problem with the alleged proof of Sargent and Wallace is that it showed that the model at hand imposed no terminal condition on the price level, but did not consider the possibility of an initial condition.

In the present context it is important to distinguish between two quite different types of price level behavior that have been referred to in the literature as involving "indeterminacy." Both involve aberrational price level behavior, but they are nevertheless very different both analytically and economically. Consequently, McCallum (1986, p.137) proposed that they be referred to by terms that would recognize the distinction and thereby add precision to the discussion. The proposed terms are "nominal indeterminacy" and "solution multiplicity (or nonuniqueness)."[31] The former refers to a situation in which the model at hand fails for all nominal variables (i.e., variables measured in monetary units) to pin down their values. Thus money stock values and values of (say) nominal income, as well as the price level, would not be defined by the model's conditions. Paths of all real variables are nevertheless typically well defined. In terms of real-world behavior, such a situation could conceivably obtain if the monetary authority failed entirely to provide a nominal anchor.[32] This type of phenomenon has been discussed by Gurley and Shaw (1960), Patinkin (1949, 1961), Sargent (1979, pp. 360-363), Sargent and Wallace (1975), McCallum (1981, 1986), and Canzoneri, Henderson, and Rogoff (1983), among others.

Solution multiplicity, by contrast, refers to aberrational behavior usually described as involving "bubbles" or "sunspots" that affect the price level. In these situations it is typically the case that the path of the money stock—or some other nominal instrument controlled by the monetary authority—is perfectly well specified. Nevertheless, more than one path for the price level—often an infinity of such paths—will satisfy all the conditions of the model. In terms of real world behavior arbitrary yet self-justifying expectations is the source of this type of aberration. It has been discussed by a vast number of writers including Taylor (1977), Sargent and Wallace (1973), McCallum (1983), Brock (1975), Black (1974), Obstfeld and Rogoff (1983), and Flood and Hodrick (1990).

An important application of this distinction is to the "indeterminacy" results of Brock (1975, p. 144-147) and Woodford (1990, pp. 1119-1122). These results pertain to cases in which (base) money is manipulated by the central bank and involve non-uniqueness of rational expectations equilibria when the imposed money growth rates are low, close to the Chicago Rule rate that satiates agents with the transaction-facilitating services of money. But since these equilibria involve well-specified paths of nominal money holdings, the non-uniqueness is clearly not of the nominal indeterminacy type. Instead, it is of the solution multiplicity type, involving price level bubbles or sunspots. Such model multiplicities may or may not be of practical significance,[33] but in any event are not examples of "price level indeterminacy" in the sense of Gurley and Shaw (1960), Patinkin (1949, 1961), Sargent (1979, pp. 360-363), or Sargent and Wallace (1975).

Let us now return to the issue of instrument feasibility, switching to the extreme opposite side of the debate. In a recent article, Goodhart (1994) has argued not just that monetary base control by a modern central bank (CB) is undesirable, but that it is essentially infeasible. In particular, Goodhart states that "virtually every [academic?] monetary economist believes that the CB can control the monetary base..." so that if the CB does not do so, then "it must be because it has chosen some alternative operational guide for its open market operations" (p. 1424). But, he asserts, "almost all those who have worked in a CB believe that this view is totally mistaken; in particular it ignores the implications of several of the crucial institutional features of a modern commercial banking system, notably the need for unchallengeable convertibility, at par, between currency and deposits, and secondly that commercial bank reserves at the CB receive a zero, or below-market, rate of interest" (Goodhart, 1994, p. 1424). Then as the discussion proceeds it becomes clear that Goodhart is himself taking a position that is predominately, if not entirely, supportive of the opinions of those who have worked in a CB. Thus he asserts, on his own account, that "if the CB tried to run a system of monetary base control, it would fail" (p. 1425). And he goes on to outline the putative flaws in logic or factual knowledge that invalidate the cited views of academic economists (pp. 1424-1426).

In fact, however, although Goodhart's discussion is apparently intended to be concerned with feasibility, the actual argumentation presented pertains to desirability. Specifically, the main analytical points are those made in the first three complete paragraphs of p. 1425, which argue that tight base control would lead in practice to overnight interest rates that at the end of most days would equal either the CB's penal rate or a value "near zero."[34] Having developed that point, Goodhart concludes as follows: "Some economists might prefer such a staccato pattern of interest rates, but it would not seem sensible to practitioners" (p. 1425). But clearly this is an argument that pertains to the desirability, not the feasibility, of tight base control.

Having concluded, then, that neither interest rate nor monetary base instruments are infeasible,[35] we turn to the task of considering their relative desirability.[36] In that regard, most proponents of a base instrument do not deny that such a regime would involve more variability of short-term interest rates than is experienced under today's typical procedures, which involve interest-rate instruments and short-term interest rate smoothing.[37] Base proponents would contend, however, that with a base instrument it is possible to design simple policy rules that are more effective from a macroeconomic perspective than are comparable rules with interest rate instruments.

In order to illustrate the plausibility of that contention, let us consider some counterfactual historical simulations of the general type used by McCallum (1988, 1993a, 1995a) with quarterly U.S. data. In order to keep the model specification from biasing the results,[38] the macroeconometric model in these simulations will be an unconstrained VAR with four lags included for each of the four variables Δy_t, Δp_t, Δb_t, and R_t. Here R_t is the three-month treasury bill rate, b_t is the log of the St. Louis Fed adjusted monetary base, and GNP data is utilized for y_t and p_t. The estimation and simulation period is 1954.1-1991.4.

We have seen above that there has not been a large discrepancy, historically, between signals provided by Δx_t and Δp_t targets, when the target values are gauged so as to imply the same average inflation rate. Accordingly, let us concentrate our attention on rules for Δb_t and R_t designed to keep x_t close to three target paths, all of which provide expected Δx_t values of 0.01125 (i.e., approximately 4.5 nominal GNP growth per year, designed to yield 2.0 percent inflation). These three paths will be of the growth-rate, growing level, and weighted average types. For the monetary base instrument, the rule to be considered[39] is

(2) $\Delta b_t = 0.01125 - (1/16)(x_{t-1} - b_{t-1} - x_{t-17} + b_{t-17}) + \lambda(x^*_{t-1} - x_{t-1})$

where $\lambda > 0$ is a policy adjustment parameter and the target variable x^*_t can be defined in various ways. To yield a growing-levels target, we would have $x^{*1}_t = x^{*1}_{t-1} + 0.01125$ whereas a growth-rate version would use instead $x^{*3}_t = x_{t-1} + 0.01125$. Besides these, we will consider $x^{*2}_t = 0.2x^{*1}_t + 0.8x^{*3}_t$, where the weights are chosen semi-arbitrarily but so as to give more importance to the growth-rate target.

According to the policy rule (2), monetary base growth is set in each quarter so as to equal the target value for nominal GNP growth minus average base velocity growth over the past four years,[40] plus a cyclical correction term that reacts to past target misses. Note that $x^{*3}_{t-1} - x_{t-1} = (x_{t-2} + 0.01125) - x_{t-1} = 0.01125 - \Delta x_{t-1}$ and that $x^{*2}_{t-1} - x_{t-1} = 0.2(x^{*1}_{t-1} - x_{t-1}) + 0.8(0.01125 - \Delta x_{t-1}) = 0.2(x^{*1}_{t-1} - x_{t-1}) + 0.8(\Delta x^{*1}_t - \Delta x_{t-1})$ so that use of x^{*2}_t is equivalent to having a growing-levels target but using derivative as well as proportional feedback in the terminology of Phillips (1954). So as to obtain some indication of robustness to rule specification, a range of λ values from 0 to 1 will be examined.

For the interest instrument rule, no velocity growth term is needed so the comparable rule can be expressed as

(3) $R_t = R_{t-1} - 100\,\lambda(x^*_{t-1} - x_{t-1})$.

Thus, the value of the interest rate instrument is lowered relative to the previous quarter when target spending x^*_t exceeds the actual level in the previous quarter. The -100 factor is inserted so as to make the same range of λ values as in (2) appropriate again.[41] The same trio of x^*_t definitions is employed as with the base instrument.

Table 1 reports results of counterfactual historical simulations each using rule (2) or (3) with VAR equations for Δy_t, Δp_t, and either R_t or Δb_t. In these, estimated residuals for Δy_t, Δp_t, and either R_t or Δb_t are fed into the system as estimates of shocks that occurred historically, with the simulations beginning with initial conditions as of 1954.1 and running for 152 periods.[42] The table's entries are RMS errors, i.e., deviations of x_t from target values x^*_t, with the left-hand figure in each pair pertaining to the Δb_t instrument and the right-hand figure to the R_t instrument. The three panels A,B, and C refer to simulations with the three target values (x^{*1}_t, x^{*2}_t, x^{*3}_t) and for each simulation the RMS error performance is reported relative to each of the three target paths. Thus, we are able to see if performance relative to alternative <u>criteria</u> is sensitive to the target utilized, for each of the targets.

Comparing the three panels we see that when the levels target is used (with only proportional feedback) performance is very bad with the R_t instrument, explosive fluctuations in x_t resulting with $\lambda = 0.25$, 0.5, and 1.0. Even with the base instrument, the levels target does not perform too well and leads to instability when $\lambda = 1.0$. With $\lambda = 0.25$, somewhat better performance relative to the x^{*1}_t target path obtains than when x^{*2}_t or x^{*3}_t is the target, but the difference is not large. Panel C, by contrast, shows that when the pure growth rate target x^{*3}_t is adopted, successful stabilization of x_t is achieved for all

Table 1
RMS Errors with Base/Interest Instruments
Rules (2) and (3), VAR Model, U.S. Data 1954.1-1991.4

RMS Error relative to:	$\lambda = 0.00$	$\lambda = 0.25$	$\lambda = 0.50$	$\lambda = 1.00$
		Panel A: x^{*1}_t target		
x^{*1}_t	.0503/1.153	.0235/expl	.0376/expl	expl/expl
x^{*2}_t	.0133/.2415	.0113/expl	.0184/expl	expl/expl
x^{*3}_t	.0097/.0184	.0112/expl	.0188/expl	expl/expl
		Panel B: x^{*2}_t target		
x^{*1}_t	.0503/1.153	.0284/.0619	.0232/.0381	.0201/.0254
x^{*2}_t	.0133/.2415	.0109/.0155	.0106/.0123	.0114/.0147
x^{*3}_t	.0097/.0184	.0100/.0105	.0105/.0107	.0118/.0142
		Panel C: x^{*3}_t target		
x^{*1}_t	.0503/1.153	.0418/.3321	.0361/.1825	.0292/.0959
x^{*2}_t	.0133/.2415	.0123/.0680	.0117/.0378	.0116/.0217
x^{*3}_t	.0097/.0184	.0099/.0104	.0102/.0100	.0111/.0123

Note: expl denotes explosive oscillations.

λ values with both instruments. Performance relative to the growing levels path x^{*1}_t is much better in Panel B with the x^{*2}_t target, however, and brings about very little deterioration in performance relative to the pure growth rate criterion (i.e., the x^{*3}_t path). Accordingly, the weighted average criterion x^{*2}_t seems quite attractive, as was noted for Japan in McCallum (1993a). Equivalently, application of a limited amount of proportional as well as derivative feedback is evidently desirable.[43]

As for the comparison between monetary base and interest rate instruments, the results in Table 1 are distinctly more favorable to the former. In only one of 30 separate comparisons is the RMS error value smaller with the R_t instrument.[44] And, more significantly, the number of cases in which explosive oscillations result is larger with the interest instrument. These cases, should be noted, all involve the growing-levels target, x^{*1}_t.

Some proponents of an interest instrument might argue that it is important that R_t be adjusted relative to a reference level, rather than to the previous quarter's value. Following the practice of Taylor (1993b), therefore, let us also consider performance of a rule of the following type:

(4) $R_t = 100[0.029 + (p_{t-1} - p_{t-5})] - 100\,\lambda(x^{*}_{t-1} - x_{t-1})$.

Here the $(p_{t-1} - p_{t-5})$ term uses the past year's inflation rate as a forecast of the next quarter's so as to make the rule one that sets a real interest rate in relation to the (annualized) target value of 0.029, which is designed to be consistent with a long-run real interest rate of 2.9 percent, equal to the sample average rate of growth of real output. The feedback term is as before.

Results are presented in Table 2 for cases using rule (4) that are exactly analogous to those in Table 1. It will be seen that the performance is better than with interest instrument rule (3) for all 12 comparisons when x^{*1}_t is the target, i.e., when a levels target is utilized. Among the 18 remaining comparisons, however, rule (4) outperforms (3) in only a single case. So, it is unclear whether the levels form of interest instrument rule is superior to the form that calls for adjustment of R_t relative to the previous quarter's value. In comparison to the base instrument, rule (4) avoids the explosive outcome in the case in which $\lambda = 1$ and the levels target x^{*1}_t is used, and also does better relative to the x^{*3}_t path in two more cases (with the levels target). But for all cases in which the growth rate target x^{*3}_t or the weighted average target x^{*2}_t is used, the RMS error is larger with rule (4) than with (2)—and is substantially larger when the criterion path is either x^{*1}_t or x^{*2}_t.

The apparent superiority of the base instrument in studies such as this leads to the question of why it is that, in actual practice, almost all central banks utilize operating procedures that are akin to use of an interest rate instrument. It is almost certainly the case that use of a base instrument would entail more short-term interest rate variability, but it is unclear that this would have any substantial social costs.[45] One hypothesis is that interest rate instruments and interest rate smoothing are practiced because financial communities dislike interest variability and many central banks cater to the wishes of financial institutions with which they have to work in the course of their central-banking duties. The extent of interest-instrument preference by CBs suggests, however, that there are additional reasons. Accordingly, Goodfriend (1991) and Poole (1991) have made interesting efforts to understand the Fed's attachment to an interest rate instrument.

Table 2

RMS Errors with Level-Style Interest Instruments
Rule (4), VAR Model, U.S. Data 1954.1-1991.4

RMS Error relative to:	$\lambda = 0.00$	$\lambda = 0.25$	$\lambda = 0.50$	$\lambda = 1.00$
		Panel A: x^{*1}_t target		
x^{*1}_t	.3825	.1541	.0915	.0551
x^{*2}_t	.0809	.0326	.0208	.0169
x^{*3}_t	.0118	.0104	.0108	.0143
		Panel B: x^{*2}_t target		
x^{*1}_t	.3825	.2996	.2416	.1702
x^{*2}_t	.0809	.0630	.0507	.0366
x^{*3}_t	.0118	.0111	.0110	.0129
		Panel C: x^{*3}_t target		
x^{*1}_t	.3825	.3687	.3559	.3328
x^{*2}_t	.0809	.0780	.0754	.0711
x^{*3}_t	.0118	.0118	.0120	.0153

Despite their contribution of various insights, however, the question remains unanswered.[46]

My own thoughts on the subject suggest two intelligible reasons for a CB to prefer a R_t instrument, one having to do with beliefs concerning possible instrument instability and the other involving the CB's role as a lender of last resort. Regarding the former, consider a grossly simplified base money demand function that includes lagged as well as current interest rates:

(5) $$b_t = \alpha_0 + \alpha_1 R_t + \alpha_2 R_{t-1} + \eta_t \qquad \alpha_1 < 0$$

Here the absence of price level and income/transaction variables reflects the presumption that their movements are slow in comparison to those of b_t and R_t.[47] Now suppose that the CB were to manage b_t exogenously.[48] Then R_t will behave as in

(6) $$R_t = \beta_0 + \beta_1 R_{t-1} + \beta_2 \eta_t + \beta_3 \text{ (}b_t\text{ determinants)}$$

where $\beta_1 = -\alpha_2/\alpha_1$. Thus, if $\alpha_2 < 0$, there will be oscillations in R_t. More importantly, if $|\alpha_2| > |\alpha_1|$, then the system will be explosive.

Belief that market demand for the monetary base is such that $|\alpha_2| > |\alpha_1|$ represents the actual state of affairs would then lead one to believe that use of a base instrument would be disastrous, as suggested by Goodhart. And, in fact, there is some reason to think that such beliefs might be held by central bankers. In particular, econometric estimates of base money demand functions (direct or indirect) tend to indicate that $|\alpha_2| > |\alpha_1|$ in fact. Central bank analysts would be aware of these estimates. My own belief is that it is not true that $|\alpha_2| > |\alpha_1|$ holds in reality, for time periods of one month or longer, so that the posited CB attitude is unjustified.[49] But it could be prevalent, nevertheless.

A second intelligible reason for CB interest instrument preference concerns the lender-of-last-resort (LLR) role. That role is to prevent financial crises that involve sharply increased demands for base money (Schwartz (1986), Goodfriend and King (1988)). To prevent such crises, the CB needs to supply base money abundantly in times of stress (Bagehot, 1873). This is usually conceived of as occurring by the route of discount-window lending. But Goodfriend and King pointed out that a policy involving interest rate smoothing—i.e., not allowing R_t to change much relative to R_{t-1}—would automatically provide base money in times of high demand.[50] Then if a CB is going to practice R_t smoothing it is quite natural for it to use a R_t instrument.[51]

This last discussion leads one to consider the possibility of using an interest rate instrument—and smoothing its movements at a high frequency (e.g., weekly)—so as to keep monetary base values close to target levels implied by a policy role such as (2). The motivation, of course, is that quarterly base rules seem to function better macroeconomically than interest rules. The preliminary investigation in McCallum (1995a) attempts to study this question while accounting realistically and in quantitative terms for shock variances and market responses in the U.S. economy. The results suggest that the federal funds rate could be manipulated weekly to approximate monetary base values that are designed to hit desired quarterly-average nominal GNP targets, with considerable smoothing of the funds rate on a weekly basis (only about twice as much weekly variability as now obtains).

6. Issues Concerning Research Procedures

In this section consideration will be given to a number of issues concerning procedures used in investigations of the properties of monetary policy rules. One set of issues has to do with the operationality of various rule specifications while another set focuses on the types of simulations used to generate model outcomes. Regarding the latter, a weakness of the simulation results reported above in Section 5, and also those in McCallum (1988, 1993a, 1995a), is that they are based on simulation exercises with a single set of shock values, i.e., shocks estimated to have occurred historically. As explained by Taylor (1988) and Bryant et.al. (1993), there are several advantages to be obtained by using true stochastic simulations with a large number of shock realizations generated by random selection from (multivariate) distributions that have covariance properties like those of the historical shock estimates. The studies of Judd and Motley (1991, 1992) for example, improve upon those of McCallum (1988) by conducting "experiments" each of which consists of 500 stochastic simulations with a given model, policy rule, and policy parameter value, rather than a single simulation with the historical residuals used as shocks.

One obvious advantage of stochastic simulations over historical counterfactuals is that they avoid the possibility that the historical residuals happen to possess some particular quirk that makes performance unrepresentative for the shock moments being utilized. Another advantage is that sample-mean values of shocks may not equal zero, as they must by construction in the case of historical residuals. This feature is especially important in considering the consequences of rules that feature difference stationarity (rather than trend-stationarity) of nominal variables. The residual values used as shocks in the simulations in Tables 1-3, for example, sum to zero for each equation's shock term. Thus the extent of a tendency for x_t (say) to drift away from a levels target path such as

x^{*1}_t is understated by the results in those tables.[52] Bryant et.al. (1993, pp. 373-5) suggests that, in addition, stochastic simulations are helpful from a robustness perspective.

Perhaps the most ambitious project undertaken to date on the characteristics of alternative monetary policy rules is the Brookings-sponsored study reported in Bryant et.al. (1993). In this study, which is a follow-up to Bryant et. al (1988), eight prominent modeling groups (or individuals) reported on policy rule simulation exercises conducted with the following multicountry models: GEM, INTERMOD, MSG, MX3, MULTIMOD, MPS, LIVERPOOL, and TAYLOR. These studies were designed to explore the macroeconomic consequences of adopting different target variables for monetary policy, with contenders including nominal GDP (in levels form) and the hybrid variable discussed above in Section 4, as well as monetary aggregates and the exchange rate. Most impressively, the conference organizers took pains to arrange for the various modeling groups all to consider the same range of policy alternatives, thereby creating the possibility of obtaining results that would gain in credibility as a consequence of being relatively robust to model specification. At the strategic level of research design, therefore, this Brookings project possessed the potential for contributing greatly to knowledge concerning the design of monetary and fiscal policy rules (despite any potential weaknesses of the models' specifications).

It is argued in McCallum (1993b) (1994), however, that this potential was significantly undermined by the generic form of policy rule specified for use by all the modeling groups. The alleged problem is that the rule form permits rule specifications that are not operational and, in addition, suggests performance measures that can be seriously misleading. The rule form in question, which has also been used in several other studies, may be written as

(7) $R_t - R^b_t = \lambda(z_t - z^b_t)$,

where R_t is an interest rate instrument and z_t is a target variable such as nominal GDP. Here the "b" superscripts designate baseline reference paths for the variables, baseline paths that may be defined differently by different investigators. Also, the performance of various targets is evaluated by measures such as $E[(z_t - z^b_t)^2]$, which pertain to target variable(s) for the rule and perhaps also other criterion variables.

In terms of operationality there are two problems with this rule form (7).[53] The more obvious is that it is unrealistic to pretend that monetary policymakers can respond to the true value of current-period realizations of z_t for several leading specifications of the latter. It is reasonable to assume that contemporaneous observations are available for interest rates, exchange rates, or other asset-market prices. It would be unreasonable, however, to make such an assumption for nominal or real GDP (or GNP) or the price level. One could make arguments pro and con in the case of monetary aggregates such as M1 or M2, but in the case of national-income values data is not produced promptly enough for actual central bankers to respond to movements without an appreciable lag. Ignoring that lag, as is done throughout the Bryant et.al. (1993) studies, clearly makes it possible for the simulated performance to be significantly better than could be obtained in reality. Furthermore, simulations that ignore this lag also intend to understate the danger of instrument-induced instability, a bias that is quite important because instrument instability is one of the most serious dangers to be avoided in the design of a policy rule.

The second and less obvious way in which rules like (7) are not operational involves the baseline values R^b_t and z^b_t. Here the problem is that an actual policymaker could not implement any rule of form (7) without knowledge of these reference paths. But by definition these paths may be related to each other by the <u>model</u> being investigated, so the policy rule is model-specific and therefore of reduced interest to a practical policymaker.

In terms of misleading performance measures, the problem is that the instrument variable under consideration may be one that can be used to smooth out fluctuations in z_t but not to control the long-term growth of z_t. Then by using fluctuations in z_t relative to the baseline path z^b_t in a performance measure like $E[(z_t - z^b_t)^2]$, the investigator may conclude that R_t is a desirable instrument when in fact it is highly unsuitable.[54]

Another type of nonoperationality involves the specification of instrument variables that would, in actual practice, be infeasible in this capacity. Broad monetary aggregates such as M2 or M3 would seem clearly to fall into this category and, under typical current institutional arrangements, probably the same applies to variants of M1. Studies that pretend that such variables are feasible instrument have declined in frequency in recent years, as the practice of specifying an interest instrument has gained in popularity (e.g., Taylor (1993a), Bryant et.al. (1993), Fuhrer and Moore (1995)).

Objections based on the operationality criterion have been directed at rules that use nominal GDP or GNP targets, even when these rules refer only to values lagged by one quarter (or more). The point is that national income statistics are not produced often enough or quickly enough, and are significantly revised after their first release. But this criticism seems misguided since the essence of nominal income targeting is to utilize some rather comprehensive measure of aggregate (nominal) spending; the variable does not need to be GDP or GNP per se. Other measures could readily be developed on the basis of price and quantity indices that are reported more often and more promptly—in the United States, for example, one could in principle use the product of the CPI and the Fed's industrial production index (both of which are published monthly). It might even be possible to develop a monthly measure that is more attractive conceptually than GDP, by making the price index more closely tailored to public perceptions of inflation and/or by using a quantity measure that treats government activity more appropriately.

7. Interactions with Fiscal Policy

The relationship between monetary and fiscal policy has been quite an active topic recently, possibly in part as a response to the magnitude and duration of fiscal deficits experienced in many developed countries and/or to controversies concerning proposed fiscal rules for the planned European monetary union. It is obviously impossible to discuss in this paper all of the many ramifications of monetary/fiscal policy interactions, but it seems important to recognize some recent arguments which suggest that it is necessary, or at least desirable, for the monetary authority to take account of fiscal policy behavior when designing its monetary policy rule.[55] Such a recommendation is implicitly critical of the policy rules discussed in previous sections and runs counter to the spirit of much current central bank thinking, as expressed for example in the practice of inflation targeting. Consequently, three strands of literature will be considered.

An early paper on the subject that has received a great deal of attention is the Sargent and Wallace (1981) piece entitled "Some Unpleasant Monetarist Arithmetic." As most readers will be aware, that paper's principal contention was that an economy's monetary authority cannot prevent inflation by its own control of base money creation if an uncooperative or irresponsible fiscal authority behaves so as to generate a continuing stream of primary fiscal deficits.[56] Whether the central bank has control over inflation is viewed as depending upon, in the words of Sargent and Wallace (1981, p.7), "which authority moves first, the monetary authority or the fiscal authority. In other words, who imposes discipline on whom?" Having posed the problem in that way, the Sargent-Wallace paper then goes on to suggest that it might well be the fiscal authority that dominates the outcome. In fact, however, the paper's analysis proceeds by simply assuming that the fiscal authority dominates, an assumption that is implicit in the procedure of conducting analysis with an exogenously given path of primary deficits. By proceeding in that fashion, the Sargent-Wallace paper seems to show that even a determined central bank could be forced by a fiscal authority to create base money along a path that is inflationary when a non-inflationary path is intended.

It is argued by McCallum (1990, pp. 984-5), however, that this suggestion is unwarranted. It is of course true that fiscal authorities may be able to bring political pressure to bear on central banks in ways that are difficult to resist. But the Sargent-Wallace analysis is not developed along political lines; instead it seems to invite the reader to conclude that a politically independent central bank could be dominated in some technical sense by a stubborn fiscal authority. The basis for disputing this is that an independent central bank is technically able to control its own path of base money creation, but fiscal authorities cannot directly control their own primary deficit magnitudes. The reason is that deficits are measure of spending in excess of tax collections, so if a fiscal authority embarks on a tax and spending plan that is inconsistent with the central bank's (perhaps non-inflationary) creation of base money, it is the fiscal authority that will have to yield. Why? Simply because in this circumstance, it will not have the purchasing power to carry out its planned actions. [57] In other words, the fiscal authority does not actually have control over the instrument variable—the deficit—that it is presumed to control in the Sargent-Wallace experiment. Thus a truly determined and independent monetary authority can always have its way, technically speaking, in monetary versus fiscal conflicts. This simple point is one that seems to the author to be of great importance in the design of central bank institutions.

The point is also intimately related to a quite recently developed body of theorizing that takes a strongly "fiscalist" stance, leading examples of which include Woodford (1994, 1995), Sims (1994, 1995), and Leeper (1991). Perhaps the most dramatic theme in this literature is the presentation of a "fiscal theory of the price level" (Woodford, 1995, pp. 5-13; Sims, 1994). For an introductory exposition and analysis, let us consider the simplest case, which involves a Sidrauski-Brock[58] model with constant output y and utility function $u(c_t, m_t) + \beta u(c_{t+1}, m_{t+1}) + \ldots$ with $u(c,m) = (1-\sigma)^{-1}A_1c^{1-\sigma} + (1-\eta)^{-1}A_2m^{1-\eta}$, where $\sigma, \eta > 0$. In this setup, the households' first order conditions include

(8) $M_t/P_t = A\,[R_t/(1+R_t)]^{-1/\eta}$ $\qquad A = [A_1y^{-\sigma}/A_2]^{-1/\eta}$

(9) $1 + R_t = (1/\beta)\,P_{t+1}/P_t$ $\qquad R_t \geq 0$

for all $t = 1,2,\ldots$ Here P_t is the money price of output, M_t is nominal money at the end of period t, $m_t = M_t/P_t$, c_t is consumption during t, and R_t is the rate of interest on government bonds, the household's budget constraint being

(10) $P_t(y - v_t) = P_t c_t + M_t - M_{t-1} + B_t - (1 + R_{t-1})\,B_{t-1}$

where v_t is lump-sum taxes and B_t is the nominal stock of bonds at the end of t. In per-household terms, the government budget constraint with zero purchases is

(11) $-P_t v_t = M_t - M_{t-1} + B_t - (1 + R_{t-1}) B_{t-1}$,

so v_t is the per-household value of the fiscal surplus. If the government chooses time paths for M_t and v_t (or B_t), then (8) - (11) give equilibrium values for c_t, P_t, R_t, and B_t (or v_t) provided that two transverality conditions are satisfied, these requiring that $\beta^t M_t/P_t$ and $\beta^t B_t/P_t$ approach zero as $t \rightarrow \infty$. Note that (10) and (11) imply $c_t = y$, the constancy of which are utilized in formulations (8) and (9).

Following the fiscalist argument,[59] now suppose that the value of M_t is kept constant at M and that $v_t = v > 0$ for all $t = 1,2,\ldots$. Then the price level is determined as follows. The GBR can be written as

(12) $b_t = (1+R_{t-1}) (P_{t-1}/P_t) b_{t-1} - v_t = (1/\beta) b_{t-1} - v$,

implying that $b_t = B_t/P_t$ will explode as $t \rightarrow \infty$, since $1/\beta > 1$, unless it is the case that $b_0 = B_0/P_0 = v\beta/(1-\beta)$, which would induce b_t to remain constant at the level $b_t = v\beta/(1-\beta)$. Therefore, so the theory says, $P_0 = B_0(1-\beta)/\beta v$ is determined by the fiscal surplus magnitude v and the initial stock of debt B_0. At the same time, (8) and (9) imply a difference equation relating P_{t+1} to P_t in an unambiguously explosive fashion, starting from P_0, provided that P_0 exceeds a critical value P_c. That explosion in P_t makes M/P_t approach zero and so, with b_t constant, both transversality conditions are satisfied although B_t is exploding. Thus the fiscal theory of the price level asserts that with a constant money stock and constant fiscal surplus, the price level explodes as time passes, starting from a level that is directly related to the size of the pre-existing nominal bond stock and to the magnitude of the maintained surplus. No other path could be an equilibrium because it would imply an exploding b_t, which would violate a transversality condition.

The foregoing is an ingenious argument but, in the opinion of the writer, is open to two objections. First, since the model's equations are supposed to hold for all $t = 1,2,\ldots$, the model cannot be used to determine P_0. The latter is an historically given initial condition—albeit an irrelevant one—as are B_0 and M_0, not something that the model can determine. That objection would be overcome by positing that it is start-of-period money balances that facilitate transactions, but the second objection would remain. It is that there is another equilibrium—typically ignored by fiscalist writers—that does not rely upon explosive-bubble behavior of the price level. This more fundamental "monetarist" equilibrium features $P_{t+1} = P_t = M(1-\beta)^{1/\eta}/A_2$, i.e., a constant price level, together with values $B_t = 0$ for all $t = 1,2,\ldots$. With these paths for P_t and B_t it is clear that (8), (9), (10), and both transversality conditions are satisfied. It might be objected that this solution does not satisfy the budget constraint (11) for the values of $v_t = v$ specified by the fiscalist writers, but as argued above the fiscal surplus is actually not a variable that can legitimately be specified as exogenous. What the monetarist solution says is that if the fiscal authority tried to keep $v_t = v$ as in the fiscalist solution, then households would refuse to purchase the bonds that are required to be sold by the fiscal authority. It would be necessary to distinguish between bonds supplied in (11) and bonds demanded in (10), with $B_t = 0$ in the latter. If there were an initial stock of bonds outstanding, $B_0 \neq 0$, then they would be retired in period 1 with a resulting real primary surplus of $(1 + R_0)\, B_0/P_1$.

In sum, a formally-correct and arguably more plausible solution than the fiscalist candidate is one in which the price level remains constant, with a magnitude that is proportional to the money stock. At the same time, the stock of bonds offered for sale by the fiscal authority may be explosive but if so these bonds will not be purchased by optimizing households. The fiscal authority's realized surplus will then be zero after the initial period leaving us with a traditional non-fiscalist result. There are, of course, other results and more complex models featured in the recent fiscalist literature, but it would appear to be the case that the striking fiscalist outcomes typically result from emphasizing a bubble solution while ignoring the existence of a non-bubble or fundamentals solution that would deliver an entirely traditional policy message.[60]

One other feature of the recent fiscalist literature is its contention that pegging the nominal interest rate at a low value will result in a correspondingly low inflation rate and in no indeterminacy problem, implying that such a policy would be preferable to the maintenance of a low growth rate of the (base) money supply. The analytical key to this argument is that explosive price level (bubble) solutions, which are possible with a low money stock growth rate, would be precluded by a constant interest rate in models with a well-behaved (possibly constant) real rate of interest—see, e.g., eq. (9) above. It has been established above, however, that when money growth is exogenous, the possible aberration reflects multiple (bubble) solutions, not nominal indeterminacy. But the empirical relevance of bubble solutions for macroeconomic variables is quite dubious, some analysts would contend, and if such solutions are not relevant then the theoretical disadvantage for the low money growth policy is itself irrelevant.

Regarding the recommended policy of pegging a short term interest rate, the absence of nominal indeterminacy was established by Canzoneri, Henderson, and Rogoff (1983) under the assumption that the peg is a limiting version of a money supply rule designed to reduce interest rate fluctuations. McCallum (1986) explored this result further and also considered the case of a pure peg, i.e., a central bank policy of offering to buy or sell bonds at the stated interest rate. His finding was that determinacy would prevail in the absence of stochastic shocks.[61] It is not entirely clear whether this result has been extended to a stochastic setting by the analyses of Woodward, Leeper, and Sims.

The other strand of the monetary-fiscal interaction literature to be discussed is represented by papers by Alesina and Tabellini (1987) and Debelle and Fischer (1995). In the former, the workhorse Barro-Gordon model is extended by assuming that real government purchases are controlled by a fiscal authority (FA) that may have different objectives—concerning the level of these purchases as well as inflation and output—than those of the central bank (CB). The FA's revenues come from non-lump-sum (distorting) taxes and money growth, government debt being excluded from the model. In this setting, Alesina and Tabellini derive outcomes pertaining to both discretionary and rule-like behavior by the CB.[62] Their most striking result is that when preferences of the CB and the FA are sufficiently different,[63] equilibrium outcomes with monetary policy commitment can be inferior[64] to those obtained under discretion. This result is with independent behavior by the CB and FA, so the message is that monetary-fiscal policy cooperation is needed.

In a more recent paper, Debelle and Fischer (1995) have modified the Alesina-Tabellini framework by also including a social objective function, one that can be different from those of the CB and fiscal authorities. Only the latter cares, in their setup, about the level of government purchases. In this model, Debelle and Fischer conduct analysis always assuming discretionary behavior by the CB but under different assumptions regarding the Stockelberg leadership positions of the CB and FA. A major aim of the analysis is to determine the optimal value, in terms of society's preferences, of the "conservativeness" of the CB, i.e., the relative importance that it assigns to inflation. It is not optimal, they find, for the CB's preferences to match those of society—i.e., the private sector. And they find that it is undesirable socially for the FA to dominate (in a Stackelberg sense) the CB, requiring the CB bank to finance FA deficits.[65]

An objection to this last strand of analysis stems from its reliance on the presumption that an economy's CB and FA will have preferences that differ from each other's and from social (i.e., household) preferences. While such might be the case in some nations, one would expect that in democratic societies, CBs and FAs will be aware of and tend to reflect the basic preferences of the population. That tendency might be combatted by various devices, but it seems likely that (e.g.) attempts to appoint CB governors with tastes more anti-inflationary than society's would often result in ex-post surprises regarding these tastes. Also, one might expect that fiscal or monetary legislation would be overturned fairly promptly if it were truly inconsistent with the preferences of the society's voters. In any event, it would seem that designing institutions under the presumption that CB and/or FA preferences differ from those of the society at large is unlikely to be fruitful.

8. Concluding Remarks

This final section will consist of a brief and perhaps opinionated recapitulation of conclusions obtained for the main topics of discussion. First, in actual practice the defining characteristics of rule-like behavior are that the central bank conducts policy in a systematic fashion, and while doing so systematically abstains from attempts to exploit existing expectations for temporary gains in output. Central banks can behave in this committed manner if they choose; there are dynamic-inconsistency pressures on them to act in a more discretionary fashion, but there is nothing tangible to prevent committed behavior. Indeed, the adoption of a monetary policy rule is one technique for overcoming discretionary pressures.

In terms of research strategy, the paper's discussion has promoted the robustness approach—i.e., searching for a rule that works reasonably well in a variety of models—rather than the more straightforward approach of deriving an optimal rule relative to a particular model. No strong claims are made in this regard, however, and the value of the optimal design approach is recognized. The importance of operationality of any proposed rule is also emphasized, as well as the merits of stochastic simulations as opposed to simpler historical counterfactual simulations.

Regarding the choice of a target variable, the paper suggests that in practice the difference between an inflation target and one that aims for nominal spending growth, at a rate designed to yield the same target inflation rate on average, is unlikely to be large. More dissimilar is the hybrid target variable that adds together inflation and output relative to capacity. This hybrid variable is probably more closely related to actual central bank objectives, but the absence of any reliable and agreed-upon method of measuring capacity or trend output creates a major drawback for this variable. Also, it is argued that the magnitude of future price-level uncertainty, introduced by the unit root component that results from a growth-rate type of target, is probably rather small. Thus growth rate targets appear somewhat more desirable than growing-level targets as the latter requires stringent actions to drive any nominal target variable back toward its predetermined path after shocks have led to target misses.

Turning to the choice of an instrument variable, the paper presents a small bit of evidence designed to illustrate why it is that a number of academic economists are inclined to prefer quantity instruments, such as the monetary base, rather than short-term interest rates. The exposition includes arguments against some literature claims that either short-term nominal interest rates or the monetary base are infeasible as instruments. In this discussion, particular emphasis is given to the distinction between two quite different types of abberational price level behavior, namely, nominal indeterminacy and multiple solutions. The former has to do with the distinction between real and nominal variables while the latter concerns self-fulfilling dynamic expectational phenomena—i.e., bubbles. Also, the former pertains to all nominal variables whereas the latter involves real variables.

Finally, with regard to prominent fiscalist positions two points are made. First, the recently-developed fiscal theory of price level determination typically leads to a solution that is not unique; there also exists a less exotic bubble-free solution that has a much more traditional (indeed, monetarist) flavor. This conclusion stems from recognition that central banks can dominate in any conflicts with fiscal authorities. Also, there are some results in the literature that suggest that monetary/fiscal cooperation is important, but these depend upon the assumption that central banks and fiscal authorities have fundamentally different objective function. It is debatable whether such an assumption can play a fruitful role in the design of desirable central bank institutions and behavior patterns.

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[1] For other early rule proposals, see Laidler (1996) and Humphrey (1992).

[2] Including proposals of Meltzer (1984, 1987) Hall (1984), Hall and Mankiw (1994), Feldstein and Stock (1994), and Gavin and Stockman (1990).

[3] An incomplete list of notable studies would include those mentioned above plus Hess, Small, and Brayton (1993), Clark (1994), Croushore and Stark (1995), Dueker (1993), Dueker and Fischer (1996), Estrella and Mishkin (1996), Judd and Motley (1991, 1992), Haldane and Salmon (1995), and King (1996).

[4] There is a sizable and growing literature on inflation targeting that will be mentioned below.

[5] Taylor, like Judd and Motley (1992), envisions the genuine possibility that central bank policy committees would enrich their considerations by referring to the instrument settings suggested by a numerical rule, taking them as a starting point for their policy deliverations.

[6] A particularly striking example of the importance of this assumption is provided by Svensson (1996b), which argues that in the workhorse model, extended to include persistence of output or unemployment in the surprise Phillips relationship, price level targeting will lead to less inflation variability (as well as less price level variability) than will inflation targeting. This dramatic result depends, however, upon the presence of discretionary behavior on the part of the monetary authority. It does not obtain if the central bank is behaving in a rule-like fashion. Svensson (1996b) recognizes this point but strongly emphasizes the discretionary case.

[7] This exposition does not explicitly refer to the reputational models pioneered by Barro and Gordon (1983b), the reason being that the author finds these models implausible. Of

course the argument here advanced relies upon reputational effects, but does not utilize the type of equilibria featured in the reputation literature.

[8] Empirically it is—unlike the usual position—consistent with the "free lunch" finding that increased CB independence provides improved inflation performance without increased output employment variability. On this finding, see Fischer (1995) or Debelle and Fischer (1995, p. 201). It should be noted, incidentally, that my hypothesis is quite different from that of Mervyn King ((1996), who suggests that CBs do not aim for output in excess of the natural rate value.

[9] In the workhorse model, policy settings of both the committed and discretionary type may be expressed as resulting from policy feedback equation of the form $\pi_t = a_0 + a_1 E_{t-1}\pi_t + a_2 u_t$, with different coefficient values. Here $E_{t-1}\pi_t$ represents prevailing expectations and u_t is a current macroeconomic shock.

[10] The absence of any truly necessary tradeoff is implicit in the central bank contracting approach pioneered by Walsh (1995) and Persson and Tabellini (1993).

[11] Taylor (1979) conducted an optimal policy exercise in the context of a dynamic macro model with rational expectations almost 20 years ago.

[12] This viewpoint will be expanded upon below, in Section 5.

[13] For the optimal-design point of view, see Fair and Howrey (1996).

[14] The magnitude of inflation rates depends upon the length of a single time period whereas the percentage (or fractional) deviation of output from its reference path does not. The usual convention with this hybrid variable is to add percentage inflation rates measured for <u>annual</u> periods to percentage output derivations. It would be equivalent to

use inflation over a quarter plus one-fourth of the relative output deviation. Use of fractional units for both variables would also be equivalent, with appropriate adjustments in the response coefficient. This last convention will be utilized below.

[15] If a set of countries is to have permanently fixed exchange rates, it would seem that from a purely economic perspective there are extra benefits (reduced transaction costs) with no extra costs of having a common currency. As for rates that are fixed, but not permanently, the European experiences of 1992 and 1993 supports Friedman's (1953) classic argument that such an arrangement is undesirable because of the self-destructive speculative impulses that are implied.

[16] From the monetary policy perspective, a moving peg or narrow band falls into the same category as a fixed exchange rate, since it entails the dedication of monetary policy to its maintenance.

[17] This statement is applicable to much of the literature relating to the planned European monetary union, of course.

[18] relatively clear-cut example is provided by Luxembourg, which has had a monetary union with Belgium since 1921 (except for an interruption during World War II), Belgian francs serving as a legal tender in both nations. Luxembourg also issues franc notes and coins, but has kept these interchangeable with their Belgian counterparts.

[19] Here and below the language will often be stated in terms of nominal variables such as nominal GDP or a price index when it is the natural logarithm of that variable that is actually meant.

[20] For alternative arguments that reach this conclusion, which is taken for granted by Feldstein and Stock (1994), see Fischer (1995) and Fillion and Tetlow (1994). The opposing position is taken by Hall and Mankiw (1994) and Svensson (1996b) [but see fn. 5 above].

[21] Thus it is being tentatively assumed that the control error, if inflation targeting were adopted, would have a mean of zero and a variance equal to that of the currently-prevailing one-step-ahead forecast error, which might be taken as an approximation of the minimum feasible control error variance.

[22] I am taking the control error to be serially uncorrelated. Then the 80-period ahead error would have variance (80) (0.0045^2) = 0.00162 whose square root is 0.040. Thus two standard deviations is 0.08 so a 95% confidence interval will have width roughly ±0.08 or ±8 percent.

[23] If used in a rule of form (1), this sort of weighted-average target would be equivalent to a pure growing-levels target with both "proportional" and "derivative" feedback.

[24] This proposition, often termed the "natural rate hypothesis," is subscribed to by a large fraction of macroeconomic researchers.

[25] This position is explicitly expressed by McCallum (1997) and by Reserve Bank of New Zealand (1993).

[26] Of course the same sort of averaging could be applied to the Δx_t and h_t variables.

[27] On this subject, see Reserve Bank of New Zealand (1993).

[28] It also has a reduced slope, which changes the definition of Δxgap to Δx_t - 0.010336.

[29] If the HP filter were applied to U.S. real GNP over a period including 1929-1939, the HP "trend" series would turn down fairly sharply during the early 1930s. If this series were used as one's measure of trend or capacity output, it would then be concluded that the Great Depression was not very serious—i.e., that output was low over 1932-1938 largely because capacity was low. But measured unemployment figures suggest strongly that this conclusion would be misleading.

[30] Sargent and Wallace (1982) advanced arguments quite different from those of their 1975 paper, and attributed this difference to their use in (1982) of a model with agents who solve explicit dynamic optimization problems, in contrast to the linear IS-LM model with a Lucas supply function in (1975). In fact, however, the main relevant difference is that the 1982 analysis is based on a model in which monetary and nonmonetary assets can not be distinguished—and indeterminacy does not actually prevail in any case. On this, see McCallum (1986, pp. 144-154)

[31] Actually, McCallum (1986) proposed "indeterminacy" for the former, but the addition of the adjective is clearly desirable.

[32] And the system lacked sufficient inertia or money illusion to make the nominal paths determinate—requirements that are actually almost inconceivable.

[33] It is unclear whether there is any compelling evidence in support of the notion that macroeconomic bubbles or sunspots are empirically relevant (Flood and Hodrick, 1990). In any event, it is a plausible hypothesis that, in cases with an infinity of solutions, there is a single bubble-free or fundamentals solution that obtains in practice.

[34] If required-reserve averaging is practiced, then the statements referred to pertain only to days near the end of reserve maintenance periods.

[35] A different objection to use of a base instrument is that central banks do not literally control the sum of currency and reserves, since currency is demand determined and only the non-borrowed component of total reserves is directly controlled, since banks can use the discount window to add to or subtract from reserve holdings. But there are three flaws with this position. First, since the base can be read from the CB's own balance sheet, it can observe it frequently and make whatever adjustments are needed to keep the magnitude closer to its target. Second, the CB could, if it chose, close the discount window. Third, it would be possible to consider the non-borrowed base as the instrument under discussion.

[36] Brief mention should be made of a study by Howitt (1992), who finds that an interest rate peg would lead to dynamic instability in a model that includes a sticky-price Phillips curve and a generalized adaptive form of dynamic "learning behavior" rather than rational expectations. Whether or not one finds the latter feature appealing, Howitt's results do not pertain to the issue at hand since the type of "pegging" that he is concerned with involves keeping R_t at some preset value indefinitely, not varying R_t period by period in an instrument capacity.

[37] The concept of interest rate smoothing that I have in mind is keeping R_t close to R_{t-1}, but there is no major conflict here with concepts such as a tendency to minimize $E(R_t - E_{t-1}R_t)^2$ (Goodfriend, 1987).

[38] The small "structural models" used in McCallum (1988) are biased in favor of the base instrument because the real monetary base (and no interest rate) appears as an explanatory variable in these models' common aggregate demand relation. In Hess, Small, and Brayton (1993), by contrast, the small macro model discussed on pp. 14-21 might be considered to be biased in favor of an interest rate instrument.

[39] As in McCallum (1995a).

[40] The velocity connection term serves implicity as a forecast of the average growth rate of base velocity over the indefinite future, i.e., the long-lasting component of velocity growth that is due to institutional change (not growth due to cyclical effects, which are accounted for in the third term). More sophisticated methods of forecasting the permanent component of both velocity growth and real output growth would be used in practice by actual central banks.

[41] The factor 100 is needed because R_t is expressed in terms of percentage points whereas Δb_t is in logarithmic (i.e., fractional) units. Comparability is not complete, however, because R_t is measured as percentage points on a per annum basis. Use of -400 as the scale factor would, however, result in dynamically unstable behavior for most λ values over 0.25.

[42] Stochastic simulations, with shocks generated randomly, have been conducted by Judd and Motley (1992) in a related study mentioned below in Section 6.

[43] Judd and Motley's (1992) findings with regard to the use of some proportional control are less encouraging, evidently because their mixture is more heavily weighted toward

proportional control. Also, they do not consider performance relative to the x^{*1}_t path when x^{*2}_t is the target utilized.

[44] Note that the first-column cases are the same with the three different targets, since with $\lambda = 0$ there is no feedback from target misses.

[45] Between 1975 and 1987 the Swiss National Bank used procedures that were akin to use of a base instrument. (See Rich (1987, pp. 11-13).) Short-term interest rate variability in Switzerland was much greater than in other economies, but macroeconomic performance was excellent. (In 1987 there were two major institutional changes, involving new required-reserve structures and a new clearing system, that seriously disrupted monetary control and resulted in altered operating procedures.)

[46] It is possible that Goodhart's (1994) belief, that a base instrument would be infeasible, is shared by many central bankers. But why? One possible reason is developed in the next two paragraphs.

[47] This simplification should not be misleading for the purposes at hand, although it would be fatal for many other issues. In (5), η_t is a stochastic disturbance term.

[48] Here I do not literally mean exogenous, but rather that b_t is varied for macroeconomic reasons, not so as to smooth R_t values.

[49] In part my belief stems from the fact that for base demand in period t the value of R_{t-1} is an irrelevant bygone, so R_{t-1} does not belong in a properly specified demand function. There are reasons, involving omission of expectational variables, why econometric studies would nevertheless tend to find strong R_{t-1} effects. On this, see McCallum (1985, pp. 583-5).

[50] As would a practice of keeping R_t from rising above some preset penal rate.

[51] Goodfriend (1991, p. 15) and Poole (1991, p. 37-39) observe, however, that this is not a strict logical necessity. Also, many actual CBs apparently do not accept the Goodfriend-King argument that the LLR role can be fulfilled by R_t smoothing without discount-window lending.

[52] Understated, but not entirely absent; time plots of x_t indicate the absence of any path-restoring behavior except toward the end of the 152-quarter simulation (and sample) period.

[53] It should be noted favorably that the instrument variable is operational and realistic.

[54] Some examples are described in McCallum (1994).

[55] Among these contributions are papers by Alesina and Tabellini (1987), Debelle and Fischer (1995), Leeper (1991), Sims (1994, 1995), and Woodford (1994, 1995).

[56] The result pertains to primary deficits, i.e., deficits exclusive of interest payments, but not to deficits measured in the conventional interest-inclusive way.

[57] This is directly implied by the government's budget constraint—which limits purchases to revenue raised by taxes, net bond sales, and base money creation. In this regard it should be recognized that the government cannot compel private agents to buy its bonds (i.e., lend to it), since such would represent taxation.

[58] That is, a model in which infinite-lived households with time-separable preferences make their decisions in a optimizing fashion and interact with each other and the government (monetary authority and fiscal authority) on competitive markets.

Woodford's (1995) version of the model, and ours, does not include capital goods but that feature of the setup is not relevant to the issues at hand.

59 I am indebted to Michael Woodford for special efforts to explain the argument to me, but he is certainly not responsible for the point of view expressed here.

60 Dotsey (1996) shows that a realistic specification of parameter values gives rise to a more traditional policy message than one promoted in the fiscalist literature, for an issue concerning the responsiveness of the CB to fiscal variables under the assumption that the fiscal authority's policy rule tends to prevent debt explosions.

61 Woodford's (1995) paper shows that monetary policy behavior that involves a pure interest-rate peg will not involve nominal indeterminacy. It suggests that this result obtains because its model is of the Sidrauski-Brock type, rather than the IS-LM-AS type used by Sargent and Wallace (1975) and McCallum (1981, 1986), and that this type implies an equilibrium condition not present in IS-LM-AS models. The discussion correctly points out that the determinacy argument is "somewhat different" from the one in McCallum (1981), but does not recognize that determinacy is obtained in McCallum (1986) for non-stochastic setting.

62 In the absence of debt, the FA has no incentive for dynamic inconsistency, i.e., no commitment problem.

63 The CB is assumed to assign at least as much weight to the inflation rate (relative to each of the other goal variables) as does the FA.

64 Inferior in terms of both authorities' preferences; the private sector is assumed to care only about real wages.

[65] Of course, it is argued above that the FA will not be able to dominate if the CB has independence (i.e., can choose its own base money creation rates).