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INTERTEMPORAL FISCAL POLICY IN MACRO-ECONOMIC MODELS: INTRODUCTION AND MAJOR ALTERNATIVES

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ABSTRACT

INTERTEMPORAL FISCAL POLICY IN MACROECONOMIC MODELS: INTRODUCTION AND MAJOR ALTERNATIVES

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The research reported in this set of three working papers focuses on different assumptions about the intertemporal behavior of government policymakers. In particular, we carefully study alternative specifications of intertemporal fiscal closure rules and their impacts on the effectiveness of macroeconomic policies. In this first paper, we introduce the subject, make general observations about policy reaction functions, and then identify the main possibilities for intertemporal fiscal closure rules. We concentrate on the alternative types of fiscal rule that have so far been introduced into existing empirical macroeconomic models. The second paper in the series uses a small growth model to study the theoretical implications of these intertemporal rules. A third paper describes a two-region empirical macroeconomic model based on the equations for the United States in the IMF staff's multicountry model, MULTIMOD, and reports simulation results of the alternative fiscal closure rules implemented in that abridgement of MULTIMOD. The research highlights the conclusion that, in a macroeconomic model of any type, the consequences for national economies of a shock or policy action can be significantly conditioned by the intertemporal fiscal reaction function used in the model. The point applies to all time horizons -- the short and medium runs as well as the long-run steady state. Builders and users of macroeconomic models thus need to pay more careful attention to fiscal reaction functions than they typically have in the past.

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I. Introduction

The conduct of fiscal policy is widely believed to have important consequences for economic and financial activity. But debates about the appropriate stance for fiscal policy are bedeviled by a lack of analytical agreement on what the consequences of any given stance will be. Throughout the developed industrial economies, the disagreement is widespread within the economics profession itself, and is even more characteristic of the wider public debate.

For example, if a national government runs large budget deficits for a prolonged period of many years, how will this fiscal policy affect interest rates and exchange rates, and how severe will be the adverse future consequences for the nation's capital stock and consumption? If a government sharply reduces a longstanding budget deficit, to what degree will the reduction in government dissaving be offset by a decrease in private saving, and to what extent will an achieved increase in national saving result in increased net investment abroad (a strengthening of the current-account balance) rather than an increase in domestic investment? When action is taken to reduce a budget deficit, how large are the future welfare gains eventually accruing to the nation (increasing its ability to consume), and how long a period elapses before a significant part of those gains begin to be experienced? What size of deficit or surplus in the government's budget can be sustained for the indefinite future? Questions such as these, for which consensus answers are not available, are representative of the basic policy issues about which analytical disagreement is pervasive.

To provide answers to such questions, one must have some type of analytical framework -- a macroeconomic "model" -- that is capable of replicating key features of the government's and the economy's behavior. If consensus answers to the questions are ultimately to be attained, it will have to be shown that similar conclusions are obtained when the common questions are studied in the context of a variety of macroeconomic models.

Plausible analytical models must be able to summarize the behavior not only of the fiscal authority but also of firms, households, and the monetary authority. Since economic behavior is forward-looking, models must somehow deal with forward-looking expectations. Because all national economies have significant cross-border links with other economies, models must be "international" in nature, allowing for changes in exchange rates, in trade and capital flows, and in nations' net foreign asset or liability positions.

Plausible models capable of analyzing fiscal-policy issues must have another characteristic: the models must be specified so that the government's budget constraint is satisfied, in any given year and across the whole sequence of future years. That condition in turn means that the models must incorporate some form of "intertemporal fiscal closure rule." An intertemporal fiscal closure rule in a macroeconomic model is a reaction function for the behavior of a key instrument variable under the control of the fiscal authority. The reaction function -- "rule" for short -- summarizes key features of how the paths of government taxes, spending, and public debt will be determined and indicates the intertemporal relationships among them.[1]

To be internally consistent, a macroeconomic model with forward-looking agents must include an intertemporal fiscal closure rule, for at least two reasons. First, the intertemporal allocation of resources, and hence the division of output into consumption and

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[1] Hereafter, we treat as synonyms the expressions "fiscal reaction function" and "intertemporal fiscal closure rule." Sometimes for brevity we speak simply of a "fiscal rule." "Rule" as used here is merely a shorthand expression; we deliberately do not take a position one way or the other on any of the controversial issues in the debate about the relative merits of simple policy rules versus activist discretion.

saving/investment, will depend on private agents' expectations of the future time paths of government expenditures and taxes. Current consumption in such models is a function of future taxes and government spending. Unless the model explicitly specifies the entire future path of government spending and taxes, it is impossible to solve correctly for current-period values of consumption and investment.[2]

Second, an analytically consistent model must ensure that the government satisfies its intertemporal budget constraint. Any shortfall (excess) of tax revenues below (above) expenditures, including interest payments on the government's debt, must be financed by an increase (decrease) in consolidated government net liabilities. But those liabilities cannot plausibly rise (fall) without limit. Asset holders will only hold the government's debt if they believe it has positive value. Expectations of a spiraling rise in debt, for example, will induce sales of the debt and continuing sharp rises in its interest rate. Imagine, for example, a baseline situation in which the government satisfies its intertemporal budget constraint. Now suppose that a shock, permanent or transitory, is introduced to the economic system, which in turn leads to changes in the stock of outstanding government debt; the debt might change as a result of changes in the real interest rate, or government spending, or taxes, or some combination of all these factors. In these circumstances, the future path of government expenditures or tax revenues must be altered, reflecting the effects of the shock, if the government is to continue satisfying its intertemporal budget constraint. Without a fiscal reaction function operating in a

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[2] We are here assuming that the so-called Ricardian-equivalence proposition does not hold, which is generally true for almost all empirical simulation models. If a model were specified so that the Ricardian-equivalence proposition did apply strictly, then of course the time profiles of private consumption and investment in the model would be invariant to the time profile of government taxes (for a given path of government expenditures).

macroeconomic model (describing, for example, how government taxes will be altered in the presence of the shock), the model will be unable to generate simulation output that abides by the fundamental identities underpinning economic theory and behavior.

II. Cross-Model Diversity in Simulated Consequences of Fiscal Actions

Different macroeconomic models yield quite different estimates of the consequences of fiscal actions. The widespread analytical disagreements about fiscal policy can be traced in large part to this cause.

This diversity of model estimates has been documented in a series of studies sponsored by the Brookings Institution.[3] Model groups participating in these studies were asked to run various standardized simulations with their models. Despite the efforts at standardizing the experiments, the model estimates exhibited considerable divergence.

Take the short-run effects of a fiscal shock as an example. Table A-1 and Figure A-1 show the great divergence of the predictions from different models in the presence of a fiscal contraction of the size of 1% of US baseline GDP in the United States.[4] In accordance with

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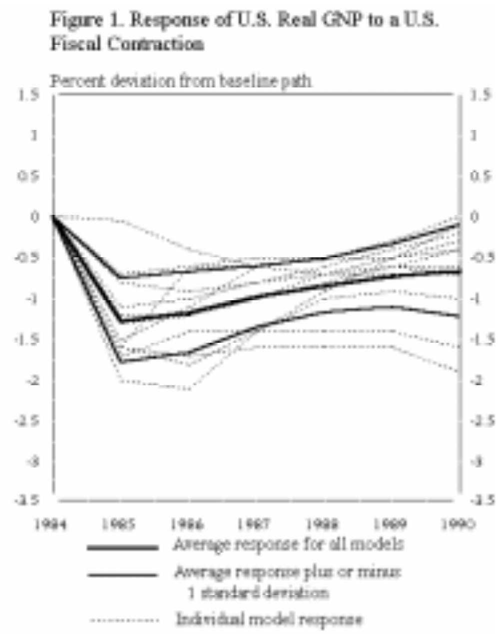
[3] See, for example, Bryant, Henderson, and others (1988); Bryant, Helliwell, and Hooper (1989); Bryant, Hooper, and Mann (1993); and Bryant and McKibbin (1995).

[4] The reported figures are in effect the fiscal output multiplier, that is, the percent deviation from baseline of real U.S. GNP in response to a 1-%-of-baseline reduction in U.S. real government expenditures ("simulation D" for the project). Source: Bryant et al eds., *Empirical Macroeconomics for Interdependent Economies*, 1988 (Supplementary Volume); see also Annex A, C. Sims, *Identifying Policy Effects*, Table A-1. The models and the mnemonics used to refer to them are: DRI: an international model developed by Data Resources Inc.; EEC: the COMPACT model of the staff of the Commission of the European Communities in Brussels; EPA: the World Econometric Model of the Japanese Economic Planning Agency; LINK: the

Table A-1 and Figure A-1

Fiscal Multipliers from Various Multicountry Empirical Models

Model	Year		
	1	2	3
DRI	2.05	2.08	1.86
EEC	1.18	1.16	1.10
EPA	1.57	1.64	1.63
LINK	1.24	1.23	1.14
Liverpool	0.65	0.61	0.58
MCM	1.56	1.70	1.61
Minimod	1.11	1.03	0.94
MSG	0.97	0.95	0.85
OECD	1.53	1.30	1.07
Taylor	1.64	1.10	0.93
Wharton	1.78	1.61	1.56



Source: The figures in the table are the cumulative response of real GNP divided by the cumulative change in real government expenditures (“simulation D” for the Bookings EMIE project). See Bryant et al eds., *Empirical Macroeconomics for Interdependent Economies*, 1988 (Supplementary Volume); see also Annex A, Christopher Sims, *Identifying Policy Effects*, Table A-1.

theoretical presumptions, the models generally predict an initial fall in output and a subsequent recovering trend due to "crowding-in" effects from lower interest rates and a depreciated dollar. But the magnitudes of the effects differ widely across the models.

Subsequent comparisons of simulated fiscal actions from later vintages of these and other models typically show a similar pattern of marked divergence in the sizes of the predicted effects. As a second illustration, Figure A-2 shows two charts taken from a model comparison exercise focused on U.S. fiscal policy conducted in 1993. The simulation experiment was a sharp, suddenly implemented (not previously announced) cutback in real U.S. government expenditures equivalent to 3 % of real US GDP. Six different models participated in the comparative exercise. Four of the models are multicountry: the IMF staff model, MULTIMOD; the large model of the Federal Reserve Board International Division staff, MCM; the McKibbin-Sachs global model, MSG; and the small multicountry model of the Federal Reserve Board International Division staff, MX3. Two are the more traditional "domestic" U.S. models: the domestic model of Data Resources Inc., DRI; and the domestic macroeconomic model of Washington University, WUMM. Two of the models (MULTIMOD and MSG) are annual; the others are quarterly (with the results shown in the charts the annual averages of the quarterly data). Three of the six (MCM, DRI, and WUMM) use adaptive, backward-looking expectations; the other three

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Project LINK world model; LIVERPOOL: the model developed by Patrick Minford and associates at the University of Liverpool; MCM: the Multicountry Model developed by the staff of the Federal Reserve Board; MINIMOD: the small simulation model developed by Richard Haas and Paul Masson at the International Monetary Fund (the precursor model to the IMF staff's MULTIMOD); MSG: the global simulation model developed by Warwick McKibbin and Jeffrey Sachs; OECD: the INTERLINK model of the Economics and Statistics Department at the OECD; TAYLOR: the multicountry model developed by John Taylor and associates at Stanford University: and WHARTON: the world model of Wharton Econometric Forecasting Associates.

(MULTIMOD, MSG, and MX3) impose model-consistent expectations. Each of the model groups reported "pure" model results (so that the simulations were not doctored by add factors or judgmental corrections).

The two panels in Figure A-2 show deviations of the model simulations from a shock-free, baseline simulation. The short-term nominal interest rate in the United States is plotted in the left panel. US real output (gross domestic product) is shown in the right panel. Both for the initial effects in the first two years and for the medium-run and longer-run effects, the predicted outcomes are greatly different.

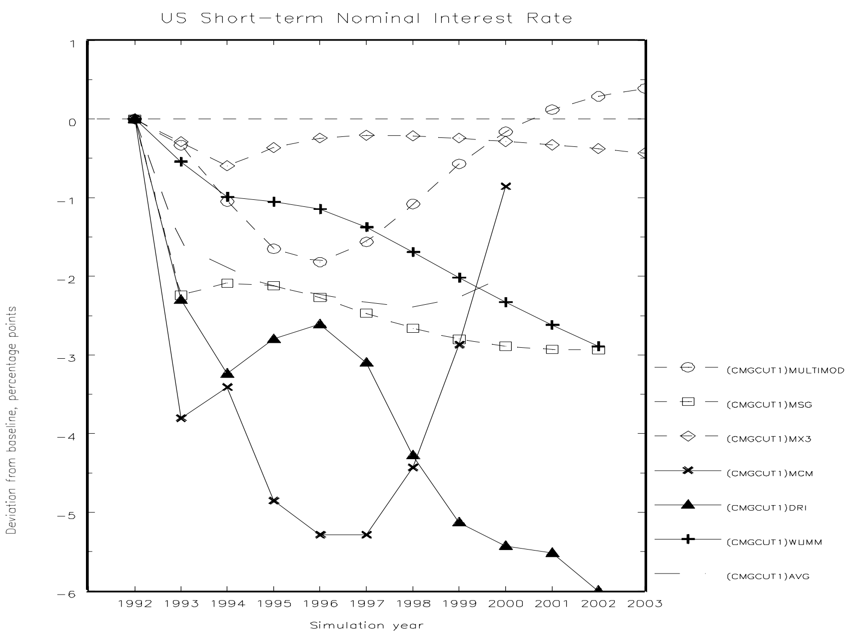
These examples vividly illustrate the typical diversity in simulation outcomes across macroeconomic models. The awkward, unhappy fact is that economists have a very imprecise understanding of how economies actually function and respond to various types of shocks and policy actions, fiscal-policy actions in particular.

The structures and individual-equation specifications of macroeconomic models differ in a variety of ways, all of which probably contribute to the divergent predictions of the consequences of fiscal actions. Alternative theories of macroeconomic behavior and alternative assumptions about the degree of market clearing and price flexibility are an important cause of differences. Differences in the empirical values of key coefficients and parameters, traceable in part to different econometric techniques and different data sources as well as different theoretical specifications, are another important category of differences. Models differ from each other in their treatment of expectations, some relying exclusively or mainly on adaptive, backward-looking expectations whereas newer models have tended to enforce rational, model-consistent expectations.

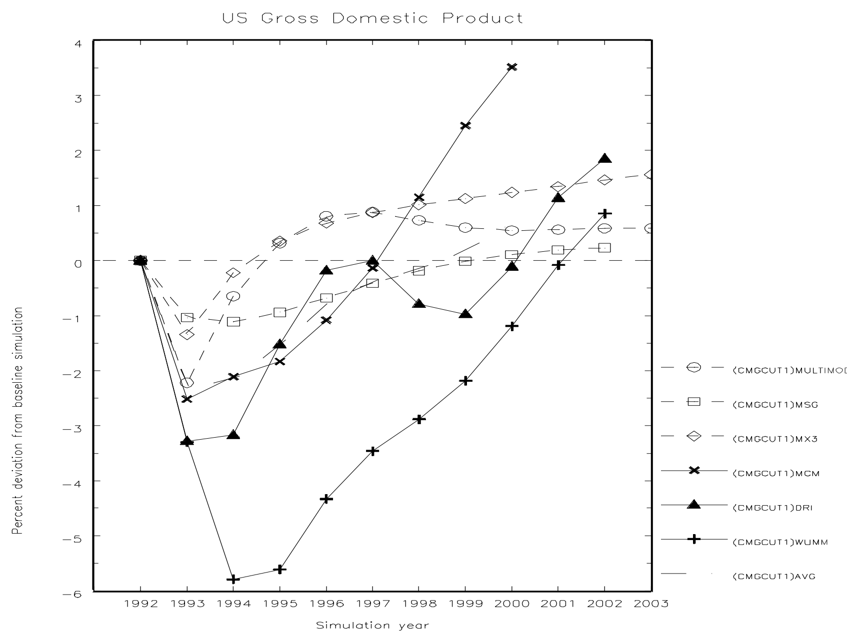
Figure A-2

<u>Illustration of Diversity in Simulation Results for U.S. Variables Across Six Models:</u>

<u>Shpart Cut (3% of GDP) in U.S. Government Expenditures, No Pre-Ammouncement and No Phasing-In</u>



GCUT1, immediate cut in govt. expenditures with no phasing in and no pre-announcement



GCUT1, immediate cut in govt. expenditures with no phasing in and no pre-announcement

MULTIMOD: Multicountry model of IMF Staff (annual)

MCM: Large multicountry model of FRB staff (quarterly)

MSG: Multicountry McKibbin-Sachs Global model (annual)

DRI: US domestic model of Data Resources Inc. (quarterly)

MX3: Small multicountry model of FRB staff (quarterly)

WUMM: US Macroeconomic Model of Washington Univ. (quarterly)

We are concerned in this set of working papers with still another potential source of differences across models, namely, different assumptions about the intertemporal behavior of government policymakers. Little systematic study of these different assumptions has been attempted prior to the research here.[5] Yet the organizers of the Brookings model-comparison exercises have long suspected that differences in the fiscal closure rules used by participating model groups could be a significant source of the diversity in cross-model simulation results.[6]

The research reported in this set of working papers thus focuses narrowly on alternative specifications of intertemporal fiscal closure rules and their impacts on the effectiveness of macroeconomic policies. In the remainder of this first paper, we make some general observations about policy reaction functions and then identify the main possibilities for intertemporal fiscal closure rules. We concentrate on the alternative types of fiscal rule that have so far been introduced into existing empirical macroeconomic models.

The second working paper in this series, Bryant and Zhang (1996b), uses a small growth model to study the theoretical implications of these intertemporal rules. Many of the key research implications emerge clearly in the context of this model even though the model is highly simplified and merely illustrative.[7]

A third paper, Bryant and Zhang (1996c), describes a two-region empirical

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[5] The main pre-1994 exception of which we are aware is a paper by Smith and Wallis (1994). The authors of that paper highlight the issue but make only small progress in exploring the implications of different assumptions. Other relevant papers include Leeper (1991).

[6] For a brief discussion, see Bryant, Hooper, and Mann (1993), especially pp. 37, 237-39, and the comments by Christopher Sims on pp. 430-33.

[7] Zhang (1996) contains a more detailed description and analysis of this model.

macroeconomic model based on the equations for the United States in the IMF staff's multicountry model, MULTIMOD, and then reports simulation results of the alternative fiscal closure rules implemented in the context of that abridgement of MULTIMOD.

Throughout these working papers, we take it for granted without discussion that macroeconomic simulation models are a useful and powerful analytical device for asking questions of policy interest. As already foreshadowed, we also take it for granted that it is necessary for the analysis of fiscal policy to model endogenously not only the behavior of private economic agents but also the behavior of policymakers. If private-sector behavior is modeled as forward looking, then it may be especially important to model policy endogenously -- to specify reaction functions for policy. Finally, we further presume that a macroeconomic model that tries to capture the behavior of the economy as a whole, and a fortiori its interdependence with other economies, will necessarily have to include reaction functions for both monetary policy and fiscal policy, and to pay close attention to how the two interact with each other. These presumptions could not be taken for granted when communicating with some types of audiences. For most of those interested in the details of the economic research reported here, however, we believe that there is no need to debate these presumptions.

III. Policy Reaction Functions: Some General Observations

When specifying a reaction function to describe either monetary-policy or fiscal-policy behavior, an analyst confronts choices about many issues. These fall into three groups: the appropriate policy instrument whose behavior is being represented (“instrument choice”); the variable(s) that the policymakers aim at as proximate or ultimate targets ("target choice"); and the dynamics of how the instrument responds through time to deviations of the targeted variable(s) from desired path(s) ("instrument variation"). We begin with some background observations about these dimensions of choice before turning specifically to fiscal reaction functions. For reference, Figure A-3 provides a checklist of the most important issues.

[Figure A-3 about here]

Both fiscal and monetary authorities have some discretion about instrument choice. That is, they have alternative possibilities for the particular operating instrument whose value they will control precisely at each point in time. With monetary policy, for example, the central bank faces a basic choice for its primary instrument between a price (e.g., a short-term market interest rate) or a quantity (e.g., the amount of some central-bank liability such as the aggregate deposits of commercial banks at the central bank). Both variables are potential instruments. Once one of the two is selected as the primary actual instrument, however, the other cannot be controlled precisely. As discussed below, instrument choice for fiscal policy has analogous possibilities and constraints.

Target choice raises numerous issues. Should policy, as approximated in the reaction function, be assumed to focus exclusively on a single target variable or instead on multiple targets? If the function includes multiple targets, what relative weights should be associated with them (reflecting how the policymakers are assumed to trade the several targets off against each other)? Specification of a reaction function may also require grappling with the controversial question of whether policymakers select some particular intermediate variable to serve as a surrogate target for the ultimate-target variables that are the genuine, final goals of policy. Still

Figure A-3

REACTION FUNCTIONS: DIMENSIONS OF CHOICE

Instrument Choice:

1. What is the appropriate policy instrument(s) whose behavior is to be represented?

Target Choice:

2. How many, and which, variable(s) should be targeted?

3. Should an “intermediate-target” variable be used as a surrogate for ultimate-target variables?

4. What exogenously specified values should be used for the desired paths for the targeted variables?

5. What is the time horizon over which targeting occurs (how far ahead should the policymaker be deemed to forecast expected deviations of the targeted variable(s) from their desired paths)?

6. Should “bands” be specified around the paths of targeted variables? If so, how narrow or wide should the bands be?

Instrument Variation:

7. How should the reaction function represent the dynamics of instrument responses through time (“partial instrument adjustment”)? For example, should the function include “derivative” or “integral” as well as "proportional" terms? How should the values for the feedback coefficients be chosen?

8. Should the reaction function include "penalty costs" for excessive instrument variation?

9. Are there circumstances in which the reaction function can be temporarily abrogated? If so, how should such “caveats” be specified? If relevant, how can the reaction function represent "shock absorption" or "policy delinquency" ?

other target-choice issues include the manner in which the analyst selects the exogenous, desired paths for the targeted variables and the time horizon over which the targeting occurs.

Instrument variation -- the intertemporal dynamics of instrument response -- can be modeled in a variety of ways. Theoretical analysis, and standard textbook macroeconomic models, typically employ the simplifying assumption of "full" instrument adjustment, sometimes also called "exact targeting." Almost all empirical analysis, on the other hand, assumes "partial" instrument adjustment ("inexact targeting"). Exact targeting is impractical in the real world. The assumption of partial rather than full instrument adjustment is common in research with empirical models both because it is thought to correspond better to the actual behavior of policymakers and because an attempt to impose full instrument adjustment leads in many models to problems of instrument instability.

The most simplified specification for a reaction function takes the form:

$$X_t = X_{t-1} + \beta(Z_t - Z_t^*) \quad \text{(A1)}$$

where X is a policy instrument, Z is the target variable in the function, Z^* denotes the desired target value for Z, and β is the policymakers' feedback or response parameter, summarizing the strength of the responsiveness of X to deviations of Z from Z^*. If the feedback coefficient β is set at a very high (in the limit, infinite) value and if the model behaves stably under this assumption, simulations with the model will result in nearly exact targeting of Z (virtually full instrument adjustment). Alternatively, with β set at a finite value, Z will be targeted inexactly. The smaller in absolute size is β, the more partial will be the extent of instrument adjustment.

Specification of the value(s) of the feedback coefficient(s) in a reaction function is a major issue whose resolution has significant implications. As we show with illustrative simulations in the second and third working papers in this series, the magnitudes of feedback coefficient(s) in a fiscal reaction function not only influence the short-run and long-run impacts of shocks to an economic system but also have important implications for its dynamic stability.

How to represent, if relevant, such phenomena as “caveats,” "shock absorption," and "policy delinquency" are the most difficult issues about policy reaction functions. The general question is whether a model's reaction functions should always operate continuously (be implemented immediately at the beginning of all model simulations and remain in force for all time periods), or alternatively can under some circumstances be suspended or implemented with a delay.

In real life, the behavior that is analytically approximated in a reaction function -- the supposedly normal behavior -- can and occasionally does change. For one thing, policymakers may temporarily abandon their normal behavior because an unusual event -- say, an earthquake or a Middle East oil crisis -- occurs in the face of which that behavior is no longer appropriate. Policymakers might even, in advance, have identified some such eventualities as “caveats,” thereby signalling that the unusual events would lead to the abrogation of the normal behavior. A tendency of policymakers to postpone policy changes until they have identified the nature of shocks buffeting the economy (a wait-and-see attitude captured in the phrase “shock absorption”) is another reason why a reaction function might need to be implemented only with a delay. Even more problematic, how should an analyst specify the behavior of policymakers who are initially delinquent and only subsequently implement “normal” behavior, perhaps only after a market-generated crisis forces their hand? Such “policy delinquency” has often been observed for fiscal policy. Fiscal policymakers for long periods have appeared to be altogether ignoring the intertemporal budget constraint that supposedly restrains their behavior.

Attempting to specify reaction functions embodying caveats or delays leads directly into problems not yet treated in the technical literature. For example, should a “caveat” be treated by resetting the predetermined targeted paths for the target variables or in some other way? Once the analyst puts a reaction function into force (or back into force if it has been temporarily abrogated), should it kick in with full strength, or should it be phased in gradually? Should the analyst define a "flashpoint" (in effect, a threshold) which, if or when reached, triggers a shift in policy behavior away from short-run preoccupations or short-run delinquency toward policy paths that are sustainable over the long-run? Should the flashpoint be set exogenously, or, alternatively, defined as a function of the evolution of some endogenous variables?

In terms of equation (A1) above, some of these ideas can be crudely captured by amending the basic reaction function as follows:

$$X_t = X_{t-1} + DELAY_t \, [\beta(Z_t - Z_t^*)] \tag{A2}$$

where $0 \le DELAY_t \le 1$ is a threshold variable that governs when the operative part of the reaction function is implemented. If $DELAY_t$ is equal to unity in each time period, as implicitly in equation (A1), the reaction function is always in operation. The threshold variable might be set equal to zero for the first N periods of a simulation and then to unity in all subsequent periods; this case would crudely capture the idea of delayed response with sudden implementation after a fixed period. The $DELAY_t$ variable could initially take on a value of zero but then could be raised in gradual increments up to unity, representing a case in which policymakers phase in their response over time. Numerous variations can be imagined. In less crude applications of the basic concepts, the $DELAY_t$ variable rather than being specified exogenously by the analyst could be made to depend endogenously on the evolution of other model variables.[8]

The matrix in Figure A-4 gives an indication of the varied combinations of target variables that can appear in simplified reaction functions for fiscal policy and monetary policy. The columns in the matrix classify a few options for monetary rules. Several classes of options for fiscal policy are shown in the rows. As the final column and final row of the matrix suggest, realistic reaction functions -- and therefore the functions likely to be of greatest practical interest to policymakers -- would be less simplified than the options identified in the figure.

[Figure A-4 about here]

Most of the research on policy rules and reaction functions has concentrated on monetary policy. For example, several of the simplified regimes for monetary policy identified in Figure A-4 were the focus of the Brookings-sponsored comparative study, *Evaluating Policy Regimes*, published in 1993.[9]

Fiscal reaction functions have received much less attention. As indicated by the classification of the rows in Figure A-4, it is helpful to distinguish between fiscal rules emphasizing only the intertemporal consistency of the government's budget and those rules emphasizing other objectives as well as intertemporal budget consistency. The five types of

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[8] We report simulations that illustrate simplified uses of a threshold variable in the second working paper of this series (Bryant and Zhang, 1996b).

[9] See Bryant, Hooper, and Mann (1993). Chapters 1-4 of that volume give references to the earlier literature. For recent contributions, see Taylor (1993, 1995].

Figure A-4

MODEL "REACTION FUNCTIONS" FOR FISCAL POLICY AND MONETARY POLICY: KEY TARGETED VARIABLE(S)

			Key Targeted Variable(s) in Monetary-Policy Reaction Function							
			(A) **Key Price Index, Level**	(B) **Key Price Index, Inflation Rate**	(C) **Nominal Income** (Nominal value of GDP or GNP), **Level**	(D) **Nominal Income, Growth Rate**	(E) **Real Output, Level, plus Price Index, Inflation Rate**	(F) **Key Monetary Aggregate, Level**	(G) **Exchange Rate Index, Level**	**[Complex multiple-target reaction functions for monetary policy]**
Key Targeted Variable(s) in Fiscal-Policy Reaction Function	Emphasis on Intertemporal Consistency of Government's Budget	1. **Nominal Debt Stock, Level**								
		2. **Ratio of Nominal Debt to Nominal GDP**								
		3. **Incremental Interest Payments**								
		4. **Balanced Budget Benchmark**								
		5. **Nonzero Flow Deficit** (e.g., ratio of total budget balance / nominal GDP)								
	Emphasis on Intertemporal Budget Consistency and Other Objectives	6. **Output Smoothing combined with Targeting the Nominal Debt Stock**								
	[Complex multiple-target reaction functions for fiscal policy]									

target variables that have been considered as candidates for inclusion in fiscal rules that enforce intertemporal budget consistency are identified in the first five rows of the matrix. Each of these aspects of fiscal reaction functions is addressed in section IV below.

IV. **Alternative Specifications of a Fiscal Reaction Function**

The observations in section III identify numerous problem areas for reaction functions for fiscal policy. Though all the problem areas deserve attention, we do not try to address all of them in these working papers. Our primary purpose is to present an overview of the main options for intertemporal fiscal rules, identifying those meriting further research and rejecting those that appear unpromising. We clarify conceptual points that have been neglected in earlier discussions and stress some key empirical implications of the fiscal closure rules used in previous model simulations by other researchers.

4.1 Instrument Choice for Fiscal Policy

In principle, any variable that can be closely controlled by the fiscal authority could be chosen as the key actual instrument variable for a fiscal reaction function. That instrument variable will be determined endogenously in the model. Typically (though not necessarily), a particular equation in the model -- the fiscal reaction function -- will have its left-hand side (LHS) expressed as the level or the first difference of the key fiscal instrument variable.

One conceivable class of fiscal rules specifies how the time path of government spending would be discretionarily varied over time in order to be consistent with desired dynamic paths for the target variables in the reaction function. For example, the analyst might select the real value of discretionary government expenditures as the LHS variable in the fiscal rule. In the resulting model, the average tax rate and the amount of the government's transfer payments could be specified as exogenous variables -- that is, as aspects of fiscal-policy behavior not modeled explicitly.

Alternatively, the real value or the nominal value of discretionary transfer payments could be selected as the LHS variable for the fiscal reaction function. In such models, the average tax rate and the real or nominal value of government expenditures could be represented in the model as exogenously determined.

The final class of possibilities is to treat tax revenues or the average tax rate as the key instrument of fiscal policy and hence as the LHS variable in the fiscal rule. In this class of models, discretionary government expenditures (and, if they appear in the model, discretionary transfer payments) can be treated by the modeler as exogenous variables. The dynamics of intertemporal fiscal adjustment are then focused on movements through time of the average tax rate. (Closely related alternatives treat some amount of tax revenues, for example some measure of "lump-sum" tax revenues, as the key fiscal-instrument variable that moves intertemporally to ensure achievement of the targeted variables.)

Models with more disaggregation of the government sector could of course contain more than one fiscal reaction function (for example, functions for several different categories of expenditures or functions for several types of tax rates). Notably, however, those few empirical macroeconomic models that have emphasized forward-looking expectations and hence that have had to grapple explicitly with the issue of intertemporal consistency for the government's budget have been aggregative and have incorporated only a single fiscal reaction function per country.

In our research, we have used macroeconomic models that contain only a simplified, aggregative representation of the government sector. And we have restricted attention to the class of fiscal rules in which either tax revenues or an average tax rate is the key fiscal instrument variable. In our working papers, therefore, tax revenues or the average tax rate always move endogenously to satisfy the reaction-function equation whereas the time path of real government expenditures is always specified exogenously.

Our choice of this class of fiscal rule is arbitrary. For some countries, it would probably be preferable to choose some category of government expenditures or some category of transfer payments as the key fiscal instrument. We choose the tax rate or tax revenues as the fiscal instrument primarily because the small amount of existing research on this subject has made that choice and because we wanted our results to be directly comparable with the earlier work. We conjecture that most if not all of our general conclusions are applicable with equal force to cases in which government spending is chosen as the key fiscal instrument.

4.2 Intertemporal Budget Consistency, or Other Objectives Too?

Because a model with forward-looking expectations cannot be solved appropriately unless the model incorporates some form of intertemporal fiscal closure rule, existing research efforts have emphasized the analytical need for intertemporal consistency in the government's budget transactions. We also focus primarily on alternative methods of enforcing intertemporal budget consistency.

Many other issues, however, may be equally relevant for the specification of a fiscal reaction function. That is why Figure A-4 makes a distinction between specifications designed to deal only with intertemporal budget consistency versus specifications designed to achieve other policy objectives as well.

Most notably, a fiscal authority may have goals for stabilizing economic fluctuations and will therefore focus on ultimate-target variables such as the rate of inflation, the amount of unemployment, or the deviation of actual from potential output. Hence the reaction function approximating the authority's behavior is likely to incorporate terms in such variables, typically the "gaps" between the actual values of such variables and their targeted ("preferred") paths. The example suggested in row 6 of Figure A-4 is a fiscal rule aimed both at intertemporal consistency and at the stabilization goal of smoothing fluctuations in the economy's real output.

In this series of working papers, we have not studied the class of complex, more realistic reaction functions that combine the objectives of intertemporal budget consistency and medium-run stabilization of the economy. Nor have we studied the interaction between fiscal reaction functions and alternative monetary regimes. The issues of how to deal with intertemporal budget consistency need to be clarified first before the other complexities can be tackled successfully.

But such topics are self evidently important and are obvious candidates for the next steps in research.

4.3 Reaction Functions Focused on a Target for the Stock of Debt

Because government debt must be kept from exploding (moving toward positive or negative infinity) if the government's intertemporal budget constraint is to be satisfied, it has seemed natural to identify the stock of government debt as the key target variable in an intertemporal closure rule. The intuition behind this choice is, at least at first blush, straightforward. Given an exogenous path for government spending, if the debt stock would otherwise rise progressively above a target level, the government must raise taxes to prevent a cumulative upward spiraling of debt (and vice versa, lower taxes to prevent a cumulative fall of debt below the target level).

Much of the limited research so far carried out on fiscal reaction functions has emphasized the stock of debt, or some transformation of the debt stock, as a key target. For example, this approach was taken in the early work by Haas and Masson on MINIMOD (1986) and it is the approach used in the IMF staff's MULTIMOD[10] and in the Quarterly Projection Model (QPM) of the Bank of Canada's staff.[11]

Let B_t^T denote a target path for the debt stock, B_t the actual debt level, and T_t the value of tax revenue. The simplest possible form of a tax reaction function focused on the debt stock can

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[10] See Masson, Symansky, Haas and Dooley (1988); Masson, Symansky, and Meredith (1990, 1991).

[11] See Bank of Canada staff (1994); Black, Laxton, Rose and Tetlow (1994); and Colletti, Hunt, Rose and Tetlow (1994).

be written as:

$$\text{(A3)} \qquad \Delta T_t = \alpha_1(B_t - B_t^T)$$

where Δ is the first difference operator and α_1 is a "feedback coefficient" (adjustment parameter). The value of α_1 is assumed positive; thus when actual debt is above its target level, tax revenue is raised to bring the stock of debt back down toward the target path. If α_1 approaches the value of positive infinity, the behavior of the policy authority is characterized as full instrument adjustment. Finite values of α_1 represent partial instrument adjustment.

The left hand side of (A3) is a first-difference term in tax revenue. The new value of taxes, T_t, brought about by the operation of this simple rule persists in future periods (unless further changes are made). This rule can thus easily lead to an overshooting of the debt stock in relation to its target level, thereby causing unstable cyclical fluctuation in tax revenues and other variables. Such fluctuations are in effect an example of "instrument instability."

To mitigate the cyclical instability that can be generated by this simplest form of debt-stock targeting, a second term can be added to the right-hand side of the function:

$$\text{(A4)} \qquad \Delta T_t = \alpha_1^1(B_t - B_t^T) + \alpha_2^1\Delta(B_t - B_t^T)$$

Here α_2^1 is a second feedback coefficient, also positive. The first term on the right side of (A4) can be labeled the "proportional term" and the second term the "derivative term." The derivative term focuses on the <u>change</u> in the gap between actual and targeted debt rather than on the size of the gap itself. If actual debt is above its target path and the gap is widening further, the derivative term causes taxes to be raised even further. If the gap is narrowing, the derivative term reduces the increment to taxes. The existence of the derivative term can be justified in part as a mechanism for smoothing the adjustment of the tax instrument (in effect, imposing penalty costs on excessive instrument variation).

One could make the tax rule even more complex by adding an "integral term" to the function. Such a term would focus on the <u>cumulative</u> gap between actual debt and its target path (on the integral of the proportional term). In effect, the proportional component of a fiscal rule makes tax collection react to the current-period "control error"; the derivative component makes tax collection react to the change in this "control error"; and the integral component makes tax collection react to the cumulative sum of "control errors" in all previous periods. For expositional simplicity, we do not include integral terms in the simplified fiscal rules studied in our illustrative simulations. We will discuss and illustrate the benefits of including a derivative term.

The fiscal instrument in functions (A3) and (A4) is the quantity -- nominal value -- of tax revenue. In real life, taxes are not lump sum. If policymakers wish to raise or lower tax revenue, they must do so by raising or lowering tax rates. For all but the most simplified of empirical models, therefore, model constructors are led to select an average tax rate rather than the nominal value of revenue as the left-hand instrument variable in a fiscal reaction function.

Let τ_t denote the average tax rate pertinent for a model, and let P_t and y_t denote, respectively, the GDP deflator and real GDP. Dividing the right hand side of (A4) by the nominal value of output, $P_t\, y_t$, and replacing T_t with τ_t leads to the following variant of simple debt-stock targeting:

(A5) $$\Delta\tau_t \;=\; \alpha_1^2 \frac{(B_t - B_t^{\,T})}{P_t y_t} \;+\; \alpha_2^2 \frac{\Delta(B_t - B_t^{\,T})}{P_t y_t} \quad .$$

The deflation of the feedback coefficients by the nominal value of output has the effect of scaling the coefficients. This scaling is necessary because for the same size of control error the required change in average tax rate is smaller the larger is the size of the economy. Thus, as the absolute size of the economy changes, the required change in the tax rate is correspondingly adjusted.

Equation (A5) is one of the fiscal rules we use in reporting simulations with our illustrative models. It is the variant of debt-stock targeting used by the IMF staff for recent versions of their MULTIMOD model.

Suppose that fiscal policymakers postulate a desired target path not for the debt stock itself but rather for the ratio of the debt stock to nominal GDP. The fiscal reaction function might then be written as follows, where $BRAT^T$ denotes the time path for the target ratio chosen by the policy authority:

(A6) $$\Delta\tau_t \;=\; \alpha_1^3 \left(\frac{B_t}{P_t y_t} - BRAT_t^{\,T}\right) \;+\; \alpha_2^3 \Delta\left(\frac{B_t}{P_t y_t} - BRAT_t^{\,T}\right)$$

This variant of debt-stock targeting causes the tax rate to be increased if the actual debt-GDP ratio is above the path for the target ratio, with additional adjustments from the derivative term depending on whether that gap is widening or shrinking.

One problematic feature of (A6) is its tendency to generate procyclical short-run movements of the tax rate. Such movements are economically implausible, and could even cause the model to be dynamically unstable. Consider, for example, a shock that initially causes a decrease in output and in the aggregate price level. The ratio of debt to nominal GDP will initially rise, and the reaction function (A6) will require an increase in the tax rate, thereby exacerbating the deflationary effects of the initial shock. The fiscal rule (A5) is also affected to some extent by short-run cyclical fluctuations. But (A6) is more procyclical than (A5) because $BRAT^T$ rather than B^T is the exogenous target variable and because $P_t y_t$ in the derivative term in (A6) is inside the first-difference operator instead of outside. The early versions of the IMF staff's MULTIMOD used fiscal reaction functions of the form (A6); because of the procyclicality and instability problems, later versions of the model shifted to the form (A5).[12]

In models focusing on long-run growth, still other variants of debt-stock targeting might be considered. For example, fiscal policymakers could be assumed to define a target path for the real per capita stock of government debt, or for the real stock of debt per unit of effective labor. To illustrate, denote the real stock of debt per effective labor unit as $beff_t$; and let $beff_t^T$ represent the policymakers' target path for the real stock of debt per unit of effective labor. This variant of a debt-targeting rule would then be specified as:

$$\text{(A7)} \qquad \Delta\tau_t = \alpha_1^4(beff_t - beff_t^T) + \alpha_2^4\Delta(beff_t - beff_t^T)$$

In most empirical macroeconomic models, growth in the labor force and growth in productivity (technical progress) are specified exogenously. Neither prices nor output appear in equation (A7). Thus fiscal rule (A7) does not exhibit the kind of procyclical or counter-cyclical behavior that can be generated by rules (A5) and (A6).

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[12] For discussion, see Masson, Symansky, and Meredith (1990, pp.11-12).

4.4 Reaction Functions Focused on Incremental Interest Payments

For the fiscal rules discussed in section 4.3, policymakers are presumed to define an explicit target path either for the debt stock itself or for some transformation of the debt stock. But the fiscal authority can be imagined to maintain its intertemporal budget constraint in a second manner that does not require it to focus explicitly on the stock of debt. The essence of this second type of fiscal rule is that the fiscal authority adjusts its tax revenues through time by an amount just sufficient to offset increases or decreases in its interest payments on government debt. The implicit target variable may be termed "incremental interest payments" (IIP).

To illustrate this type of rule, suppose analysis starts from a baseline case in which the variables of the dynamic economic system in the model settle down to long-run, steady-state paths. Now suppose that a shock occurs in the economy that raises the government's expenditures and hence causes government debt to increase above its baseline level. If the government were to fail altogether to alter its tax revenues in response, the incremental interest payments on the higher debt would lead to still further issuance of debt, and the debt stock would eventually accumulate without bound. With an IIP rule, the fiscal authority is assumed to raise lump-sum taxes by just enough to cover the increased interest costs, but not enough to prevent a permanent increase in debt. In effect, although the overall deficit caused by the shock is permanently higher and although the debt stock rises substantially above its baseline path, an explosive growth of debt is averted and the debt stock eventually converges to a new steady-state path.

One variant of this type of fiscal rule can be represented as follows. Denote the steady-state baseline paths of variables with an overbar. For example, let $\bar{i}_t$ represent the level of the nominal interest rate and $\bar{B}_t$ the level of the debt stock in the steady-state baseline. Now define, for each period, a nominal quantity of tax revenues equivalent to the incremental interest payments:

$$\text{(A8)} \qquad T_t^{adj} = i_t(B_t) - \bar{i}_t(\bar{B}_t)$$

where i_t and B_t denote the period-t actual values of the nominal interest rate and nominal debt. Assume that the government can levy this change in taxes period by period. The total amount of nominal tax revenue collected will then be:

$$\text{(A9)} \qquad T_t = \bar{\tau}_t(P_t y_t) + T_t^{adj} \quad .$$

where $\bar{\tau}_t$ is the baseline tax rate, taken to be exogenous for the purposes of implementing this fiscal rule. The lump-sum tax-adjustment term defined by (A8) could be imposed in the economy of the model as an incremental tax burden on labor or on capital, or shared between them.

The IIP rule of (A8) and (A9) is formulated in terms of nominal magnitudes. But it could also be written, perhaps even preferably, in real terms. Denote $t_t = T_t / P_t$ as the real value of tax revenue, $b_t = B_t / P_t$ the real value of the debt stock, and $r_t = i_t - \dot{P}_t / P_t$ as the real rate of interest on government debt. Policymakers might then define a tax-adjustment shift variable, in real terms, as:

$$\text{(A10)} \qquad t_t^{adj} = r_t(b_t) - \bar{r}_t(\bar{b}_t)$$

where $\bar{r}_t$, $\bar{b}_t$ are the baseline real interest rate and real debt level. Total nominal tax revenue for this rule is given by:

$$\text{(A11)} \qquad T_t = \bar{\tau}_t (P_t y_t) \; + \; t_t^{adj} (P_t)$$

In the MSG model developed by McKibbin and Sachs (1991) and extended further in recent years by McKibbin,[13] a slightly different variant of (A10) and (A11) have been used as the intertemporal fiscal closure rule. McKibbin defines a tax-adjustment term for lump-sum revenues that is equivalent to real incremental interest payments expressed as a percent of real output. This variant of equation (A10) is then used in a variant of equation (A11) where tax revenues are written in real terms as a percent of real output.[14]

The incremental-interest-payments rules defined above differ fundamentally from the debt-targeting rules in section 4.3. Hence, for example, the fiscal rule used by McKibbin for the MSG model produces significantly different results than the rule used by the IMF staff in MULTIMOD. First, the change in taxes in each period in the incremental-interest-payments rules are specified in the form of a shift term for lump-sum taxes. Any change in taxes due to this shift term is simply added to other tax revenue. With this type of rule, there is no danger of overshooting the permanently required level of taxes and hence this rule does not give rise to secondary cyclical fluctuations in the model. Second, the fiscal authority using an IIP rule makes

[13] See, for example, McKibbin (1992), Manchester and McKibbin (1994), McKibbin and Bok (1995).

[14] In its initial comparison of three multicountry models, the Macroeconomic Modelling Bureau at the University of Warwick chose to focus on McKibbin's form of incremental interest payments rule; see Mitchell, Sault, Smith, and Wallis (1995).

its adjustment in tax collections without paying attention to the debt stock itself. Implicitly, the authority treats past deviations of the debt stock from baseline as "bygones" and does not try to correct the past deviations.

Because of the preceding differences, an IIP rule is typically more permissive ("weaker") than a debt-targeting rule in the sense that shocks or policy actions cause greater deviations of debt from baseline. This permissiveness in turn means that the short-run multipliers for traditional expansionary fiscal-policy actions are larger under an incremental-interest-payments rule. The estimated long-run losses from such actions are likewise bigger.[15]

The variants of IIP rules identified here appear to behave in qualitatively similar ways. That at least is the preliminary conclusion of our research on some illustrative types of real shocks. We have not investigated the consequences of nominal shocks under IIP rules. We conjecture that in the presence of nominal shocks the variants of IIP rules would probably exhibit larger differences.

Note that IIP rules have a revenue-quantity term as the (implicit) fiscal instrument, not a tax rate. Such rules thus seem most natural for models in which analysts postulate lump-sum government taxes. IIP rules can be formally implemented in models without lump-sum taxes, but the resulting fiscal reaction function is open to the criticism that it is a particularly unrealistic

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[15] To state the same points more precisely: the expansions in real output over short-run horizons resulting from an increase in discretionary government expendtures or a discretionary reduction in tax revenues are larger under an incremental-interest payments rule than when the fiscal authority implements a debt-stock-targeting rule with the target debt stock unchanged. Correspondingly, the unfavorable consequences relative to baseline over longer runs -- for example, the crowding out of private investment, reductions in the capital stock, and lower future standards of living (diminished consumption) -- are also larger. Analogously, traditional contractionary fiscal actions cause larger short-run decreases in output and bigger longer-run gains in standards of living.

representation of real-life tax collection.

4.5 Balanced-Budget Reaction Functions: An Analytical Benchmark

A simple example of a balanced-budget fiscal rule is a mandate requiring that the total government budget, including interest payments on the existing public debt, be balanced in each and every year. If in any period the sum of government spending and interest payments on existing debt would otherwise threaten to exceed tax revenue, the fiscal authority would be obligated to raise more tax revenue to cover the extra expenses. The government would be prohibited, except possibly for short transitory periods, from either issuing new debt or retiring old debt.[16] Thus, one or the other of the following equations would be required to hold for every period:

(A12) $$T_t = G_t + i_t B_t$$

(A13) $$T_t - \bar{T}_t = G_t - \bar{G}_t + i B_t - \bar{i}_t \bar{B}_t \quad .$$

where again an overbar indicates the baseline value of a variable.

This type of balanced-budget rule is highly restrictive and thus not realistic. But it can serve a useful purpose as an analytical benchmark. Moreover, in countries such as the United States where the public debt is accumulating rapidly and support for a balanced-budget amendment from both the public and Congress is non-negligible, it is not inconceivable to

[16] On a net basis. Any new debt on a gross basis would merely replace existing debt as the existing debt expires.

imagine governments being constrained with some variant of this type of rule in the future.

Consider a simulation scenario in which, initially, a balanced-budget rule is not operational but is then, after a delay, subsequently implemented. For example, suppose that government expenditures are permanently increased, so that the public debt starts to accumulate rapidly. Suppose that the government does not do anything to control the debt accumulation for a few years but that political pressure gradually builds up, eventually leading to the passage of a balanced-budget amendment. Following the passage of the amendment, the fiscal authority is obligated to raise enough tax revenue to balance its total budget each year.

The threshold triggering the implementation of a balanced-budget rule could take many different forms (recall the discussion of equation (A2) above). For example, following the occurrence of a shock one might assume that the government does not alter its spending or tax policies for the first 10 years, but then is forced to alter policies so that the total budget is balanced starting from the 11th year. Alternatively, the time of implementation could be endogenously determined depending on the evolution of the debt stock; for example, the balanced-budget rule might only be triggered after the debt-GDP ratio rose above 100%. For different countries with different starting (or baseline) debt-GDP ratios, the threshold could be defined in terms of the change in the debt-GDP ratio; for example, the balanced-budget rule could be triggered when the debt-GDP ratio doubles.

The short-run expansionary effects and long-run, steady-state implications of a fiscal stimulus would of course depend on the timing of the implementation of the balanced-budget rule. In a continuous-time overlapping-generation model in which Ricardian equivalence does not hold, the longer the implementation time is delayed, the larger will be the short-run impacts.

Similarly, the adverse long-run effects as a result of the fiscal stimulus will be more evident. Thus we predict that a macroeconomic model with a balanced-budget rule always operational will show the smallest short-run (positive) and long-run (negative) effects from fiscal stimulus if that model is compared with models incorporating any other of the fiscal rules discussed above. For analogous reasons, a model with a balanced-budget rule whose implementation is delayed long enough will demonstrate the largest short-run and long-run effects.

As an analytical benchmark, we include examples of the operation of a balanced-budget rule in the illustrative simulations reported in the second and third working papers in this series.

4.6 Reaction Functions Focused on Flow Deficit Targets

We now consider a final conceivable class of fiscal reaction functions in which the key target variable is a flow definition of the budget balance. For example, it may seem natural to postulate that policymakers set a target path for the ratio of the total budget balance to nominal GDP and then react to deviations of the actual ratio from that target path.[17] Alternatively, suppose that policymakers define a target path for the ratio of the primary budget balance to nominal GDP and focus on deviations between the actual and targeted paths of that ratio.[18]

A stock-flow identity, of course, links the government's budget deficit to its outstanding

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[17] A flow-deficit fiscal rule has been implemented in the NIGEM model in the United Kingdom (Barrell et al, 1993); see Smith and Wallis (1994).

[18] The primary budget balance is defined as total government tax revenue minus total government expenditures excluding interest payments on outstanding public debt. The total or overall budget balance is defined as total government revenue minus total government expenditures including interest payments on outstanding public debt.

debt. Given this identity, one might think that it is natural to specify a flow deficit target for a fiscal reaction function. Such a flow target appears simple and readily understood. It might be argued, for example, that the fiscal authority, and even more so the general public, would find it easier to comprehend a deficit target than a target level for the stock of debt.

In our research so far, however, we have come to the view that fiscal rules focused on flow deficit targets are, in general, analytically unsound. Even for a subset of cases where it may be feasible to implement such rules for short horizons, we believe that a rule incorporating the stock of debt will be preferable. Typically, flow deficit targeting is analytically incorrect and infeasible over the long run. We are led to these generalizations by focusing carefully on the long-term, steady-state implications of targeting a flow deficit.

An initial point to observe about targeting a budget flow is that one special case of such targeting is possible. If the reaction function specifies that the overall budget balance should be kept continuously at a value of zero, no special analytical difficulties occur. We have already identified this special case in section 4.5 as the analytical benchmark of a balanced-budget reaction function. A model incorporating a balanced-budget rule as its mechanism for enforcing intertemporal budget consistency does have a well-defined steady state.

But the special case of a balanced-budget rule with the overall balance targeted at zero is deceptive. The issue that requires careful analysis is whether it is feasible and appropriate for the reaction function to target a nonzero path for either the primary or the overall budget balance.

An essentially semantic confusion exists about this issue, and it is helpful to dispense with that confusion first. Consider the variant of debt-stock targeting presented above as (A5), repeated here for convenience:

(A14) $$\Delta\tau_t \;=\; \alpha_1^2 \frac{(B_t - B_t^T)}{P_t y_t} \;+\; \alpha_2^2 \frac{\Delta(B_t - B_t^T)}{P_t y_t} \quad .$$

The second, derivative term in this reaction function could be interpreted as tantamount to targeting the flow budget deficit.[19] The derivative term, apart from the feedback coefficient α_2^2 and the scaling of the coefficient by nominal GDP, is the change in the gap between the debt stock and its target path, which in turn is identically equal to the change in the stock of debt minus the change in the target path for the debt stock. In other words,

(A15) $$\begin{aligned} \Delta(B - B^T) &\equiv (B - B^T) - (B_{-1} - B_{-1}^T) \\ &\equiv (B - B_{-1}) - (B^T - B_{-1}^T) \\ &\equiv \Delta B - \Delta B^T \quad . \end{aligned}$$

If, but only if, there is no change in the target path for the debt stock (if B^T remains unchanged from the baseline B^T path), then the derivative term may be almost equivalent to the flow overall deficit.[20]

The point in the preceding paragraph, though a useful expositional reminder, does not really constitute support for the idea of flow deficit targeting. The critical issue is whether it is feasible and appropriate to specify a fiscal reaction function containing only a flow budget imbalance, omitting altogether any reference to the stock of debt. To put the issue in the narrow context of equation (A14): could an analyst safely drop out the proportional term entirely (set the

[19] The proportional term, of course, unambiguously targets the stock of debt.

[20] We say "almost," because the government's overall budget imbalance might be partly financed by ΔM, a change in reserve money (liabilities of the central bank). The overall budget imbalance is only exactly equal to ΔB if ΔM is zero.

feedback coefficient α_1^2 in that function to zero)?

To see the difficulties with focusing an intertemporal closure rule exclusively on a flow deficit, consider the implications of trying to target only the primary budget balance. In a steady-state position of an economy, if the government is a net debtor, it must have a primary budget surplus large enough to service its outstanding debt. In the presence of permanent real shocks, the steady-state levels of the debt stock and the real interest rate are likely to change; hence the steady-state value of the primary budget balance will also have to change. It can thus be analytically unsound or misleading to postulate that policymakers can specify an exogenous target path for the primary budget balance that remains unchanged in the face of all types of shock.

The point can be explained by examination of the identities for the government's budget.[21] With the primary budget deficit defined as nominal expenditures less nominal tax revenues, $PDEF_t \equiv G_t - T_t$, B_t as the nominal stock of debt, and i_t as the nominal interest rate on debt, the government budget identity can be written:[22]

$$(A16) \qquad PDEF_t + i_t B_{t-1} \equiv B_t - B_{t-1} \quad .$$

Define Y_t as nominal GDP, g_t as the real growth rate of the economy, and π_t as the inflation rate. Dividing both sides of the identity by Y_t and transforming terms gives

[21] We re indebted to David Rose for suggesting this exposition of the point.

[22] For simplicity of exposition, this statement of the identity ignores changes in reserve money.

$$\text{(A17)} \qquad \frac{PDEF_t}{Y_t} \equiv \frac{B_t}{Y_t} - \frac{(1+i_t)B_{t-1}}{Y_{t-1}(1+g_t)(1+\pi_t)} \quad .$$

The nominal interest rate and the real interest rate, r_t, are linked by the identity

$$\text{(A18)} \qquad (1 + i_t) \equiv (1 + r_t)(1 + \pi_t) \quad .$$

Combination of (A17) and (A18) produces

$$\text{(A19)} \qquad \frac{PDEF_t}{Y_t} \equiv \frac{B_t}{Y_t} - \frac{(1+r_t)B_{t-1}}{(1+g_t)Y_{t-1}} \quad .$$

Define the ratios $b_t = B_t / Y_t$ and $d_t = PDEF_t / Y_t$. The preceding equation can then be written as

$$\text{(A20)} \qquad b_t - \frac{(1+r_t)}{(1+g_t)} b_{t-1} \equiv d_t \quad .$$

This last equation is a straightforward first-order difference equation. For the case where $r_t > g_t$, which is presumably the normal situation, (A20) will be dynamically unstable; b_t will diverge over time except for the special case in which $d_t = 0$. Note that this result stems just from the budget identities; it is not dependent on any particular model structure.

The reason that a rule targeting only the flow primary budget imbalance is unstable can be intuitively understood by focusing on the fact that such a rule only tries to "correct" any gap between an actual deficit and the target deficit, but pays no attention to ensuing changes in the stock of debt. With respect to debt, the rule implements the principle of "bygones are bygones."

For example, suppose the fiscal rule were

$$\text{(A21)} \qquad \Delta T_t = \delta(PDEF_t - PDEF_t^*)$$

with $PDEF_t^*$ as the target path. With a finite value of δ (only partial adjustment), then each period only part of the gap between the primary budget deficit and its target path is corrected by raising taxes. Imagine that an increase in government expenditure occurs. The primary deficit and the debt stock will both increase as a result. With the hypothesized fiscal rule, the primary budget deficit will eventually be brought back to its target path, but the debt stock will be allowed to increase monotonically without bound. Even for an artificially restricted case in which partial adjustment is allowed only in the first period whereas full adjustment is rigidly enforced thereafter, the debt stock will still be above its target/baseline level in the first period. This incremental debt will eventually generate an explosive growth in the debt stock because no additional revenue is raised thereafter even to pay for its interest service, much less to provide assurance that the incremental debt could be eventually retired.

To the preceding line of reasoning, which emphasizes long-run implications, some analysts might be tempted to counter that they do not care about very long-run implications and that they merely wish to use a macroeconomic model for generating simulations of outcomes for the shorter run. Does long-run instability in the model prevent its use for short-run predictions? We are inclined to answer yes to this question. When a dynamic simulation model with forward-looking agents does not have a well-defined long-run steady state, the entire solution paths for variables in the model, short-run values as well as long-run, may be seriously incorrect.

We can also intuitively illustrate the long-run problems of this type of fiscal rule by examining directly the relationships that must hold in a long-run steady state. For simplicity of exposition, assume that there is no money, no population growth and no productivity growth in an economy (so that the economy is in a no-growth stationary state). The government budget identity in every period when the economy is in a steady state must then satisfy (with the superscript "ss" denoting steady-state values):

$$\text{(A23)} \qquad PDEF^{ss} = G^{ss} - T^{ss} = -r^{ss}B^{ss} \quad .$$

In other words, in the steady state the government must have a primary budget surplus just large enough to cover interest payments on its existing debt (for this hypothesized case the total budget balance must equal zero). Suppose a model analyst starts from a steady state in which this identity holds and he attempts to enforce a fiscal closure rule that targets on the primary budget deficit. Now consider what happens when there is a permanent increase in government expenditure. As before, the government debt stock will increase (nothing prevents it from doing so), and the interest rate will probably increase as well. The primary budget deficit will initially rise above its baseline/target path, and the fiscal rule will eventually bring it back to that path. However, with a higher real interest rate, a larger government debt stock, but the same target primary budget balance, the total budget will always be in deficit; and the dynamic system will never converge to a steady state in which the debt stock does not change over time.

The conclusions summarized here can be demonstrated with model simulations. For example, if one embeds a fiscal rule targeting the primary budget deficit in illustrative models with forward-looking simulations, the algorithms used to solve such models can appear to find solution paths for the variables provided that one chooses sufficiently large values for the feedback coefficients. The primary budget deficit in such simulations can be brought under control fairly quickly after an upward shock to government expenditures is inserted in the model. But the debt stock increases monotonically. The movements of other key variables, such as consumption and investment, are not so clear cut as the movement of the debt stock; but such simulations show that, contrary to the theory used to build the model's equations, these variables too are still not converging to a steady state after many years (for example, three or four decades).[23]

What if, one might ask, the feedback coefficients in a flow-deficit-target rule were large enough such that each period the induced change in taxes were sufficient to cover the incremental deficits? We are inclined to say that this kind of rule would probably not be interesting practically, and might well lead to excessive fluctuations in the economic system that would not converge to a meaningful steady state. Might it be appropriate to target on the primary budget balance rather than on the total (overall) budget balance and concurrently ensure that a government with outstanding debt chooses surplus values for the target path of its primary balance? Even with those assumptions, we would recommend against an intertemporal rule exclusively focusing on a flow budget balance.

The general points we are stressing do not depend on whether policymakers choose deficit or surplus values for their flow target, or whether they focus on the primary or total budget balance. The basic problem arises from trying to target a flow without giving any weight to the

[23] The initial 1994 draft paper describing this research reported such simulations. To save space, we omit them from this series of working papers.

corresponding stock.[24]

From experience in discussions with other researchers, we know that our conclusions about flow deficit targeting to achieve intertemporal budget consistency can be controversial. We readily acknowledge that it would be helpful to present a more rigorous theoretical analysis for the case in which the flow target is the overall rather than the primary imbalance. Further empirical simulations will also be helpful in generating consensus on this issue.

This topic has an obvious bearing on actual policy decisions. Many practical policymakers, if they worry at all about the analytical questions of intertemporal budget consistency, tend to find it more natural to focus on a flow measure of budget imbalance rather than on the stock of government debt. In Europe, the Maastricht treaty concerned with monetary union stipulates targets for both budget deficits and ratios of government debt, yet more of the popular discussion seems to focus on deficits than debt ratios.

V. Concluding Remarks

This series of working papers stresses a general point of major importance. In a macroeconomic model of any type, the consequences for national economies of a shock or policy action can be significantly conditioned by the intertemporal fiscal reaction function used in the

[24] Could the fiscal authority calculate a path for a flow target where the values of the flow target changed over time to be consistent with long-run, steady-state equilibrium? For example, suppose the primary budget balance were the target variable. Following a decision to increase government expenditures, suppose the fiscal authority targeted larger deficits for the shorter run but then moved the target primary balance into the surplus region for the medium and longer runs. Even this sort of "careful" design of a target path for a flow could still be analytically incorrect for a long-run steady state. The fiscal authority would not know how correctly to calculate what the (changing) size of the primary surplus should be.

model. The point applies to all time horizons -- the short and medium runs as well as the long-run steady state. Unhappily, differing analytical treatments of intertemporal fiscal closure rules by different researchers may lead to substantially different research conclusions, even when the topic has little to do with fiscal policy itself.

Builders and users of macroeconomic models thus need to pay more careful attention to fiscal reaction functions than they typically have in the past. A perfectly analogous point applies to differing implications of different regimes for monetary policy. Somehow, however, researchers have shown greater sensitivity to the importance of the point when incorporating monetary-policy regimes in their models than when they have specified fiscal-policy regimes.

We observed in section II that cross-model differences in fiscal closure rules might be a significant source of the diversity observed in cross-model simulation results. The illustrative simulations presented in Bryant and Zhang (1996b, 1996c) reinforce this suspicion. Much further research is required, however, before it is possible to disentangle this reason for diversity in model results relative to the other reasons identified in section II.

Most of our specific conclusions about individual fiscal reaction functions will be summarized in the subsequent papers in this series. To foreshadow those conclusions, however, we include here several guideposts for what is to follow.

First, the class of incremental-interest-payments (IIP) rules, though at first sight attractive on several grounds, probably is not a promising approach around which future research should converge. We believe that variants of debt-stock targeting are likely to prove a better foundation for future analysis and for comparison across heterogeneous models.

Second, researchers should eschew fiscal rules that focus solely on flow concepts of budget imbalance and instead should be sure that the stock of government debt is included in the fiscal behavior that is assumed to generate intertemporal budget consistency.

Third, future research should pay special attention to the implications of different fiscal closure rules for external-sector variables, and probably also for financial variables and price variables.

Fourth, analysis of fiscal rules that achieve intertemporal budget consistency badly needs to be expanded to cover rules that aim not only at intertemporal consistency but also at medium-run macroeconomic stabilization of national economies.

Fifth, analysts need to focus on the interaction between fiscal rules and the modeling of private-sector consumption and wealth-accumulation behavior. The consequences of alternative fiscal rules are conditioned significantly by a model's treatment of consumers' intertemporal elasticity of substitution (their trading off of consumption today for consumption in future periods) and by the degree to which the model assumes constraints on the ability of agents to borrow in capital markets today for the purpose of smoothing consumption over time. Alternative paths for the stock of government debt, both actual and targeted, can have large or only small consequences for future output and consumption depending on how far away from, or close to, the model's behavior is to Ricardian equivalence.

Finally, systematic consideration needs to be devoted to alternative ways of capturing the delayed implementation of fiscal reaction functions, attributable either to policy delinquency or to deliberate abrogations of an otherwise normal fiscal rule. These phenomena are patently important in real life but have scarcely been considered, much less treated adequately, in macroeconomic models.

These points are illustrated and elaborated in Bryant and Zhang (1996b, 1996c), the subsequent working papers in this series.

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