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ALTERNATIVE RULES FOR MONETARY POLICY AND FISCAL POLICY IN NEW ZEALAND: A PRELIMINARY ASSESSMENT OF STABILIZATION PROPERTIES

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<u>ABSTRACT</u>

ALTERNATIVE RULES FOR MONETARY POLICY AND FISCAL POLICY IN NEW ZEALAND: A PRELIMINARY ASSESSMENT OF STABILIZATION PROPERTIES

Ralph C. Bryant

In this paper, I focus on the stabilization properties of alternative simplified approaches to the conduct of monetary policy and fiscal policy. The paper is motivated by questions of topical interest in New Zealand, for example what the costs might be in terms of lost credibility if the Reserve Bank of New Zealand were to have multiple goals rather than the exclusive goal of price stability, and whether output smoothing might significantly reduce the costs of the economy adjusting to shocks without compromising the long-run goals of a low rate of inflation and sustainable, prudent long-run evolution in the government's budget. The paper uses an illustrative model of a small open economy with features like New Zealand's, developed while the author was visiting New Zealand in the spring of 1966. The analysis evaluates several alternative combinations of monetary and fiscal rules by subjecting model variants in which these rules are embedded to representative shocks. Simulation results are presented primarily in graphical form. The paper shows that a highly open economy cannot be insulated from shocks regardless of how macroeconomic stabilization policy is conducted. But the paper also suggests that monetary-policy rules permitting output smoothing in addition to the primary goal of inflation avoidance can foster marginally improved economic performance.

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Introduction: Credibility and Stabilization Properties of Alternative Rules

The credibility and time consistency of macroeconomic policies in New Zealand can, in principle, be enhanced by mandating that the Reserve Bank and the Government completely abstain from shorter-run macroeconomic stabilization. Such abstinence would in any case insure against public policies themselves being a source of destabilization (which did occur in New Zealand during the Muldoon period in the first half of the 1980s). Yet the New Zealand economy might be more vulnerable to fluctuations caused by nonpolicy disturbances if neither the Reserve Bank nor the Government were to pay any attention to macroeconomic stabilization. Abstinence from stabilization means forswearing policy flexibility, which could expose the economy to avoidable costs and risks.[1]

The tradeoff between credibility and time-consistency advantages on the one hand and potential gains from stabilization flexibility on the other is infrequently discussed in New Zealand. I have recently argued that the tradeoff deserves more attention than it typically receives (Bryant, 1996). Such attention could strengthen further the commendable reforms in macroeconomic policies introduced in New Zealand by the Reserve Bank Act of 1989 and the Fiscal Responsibility Act of 1994.

In fact, the tradeoff between credibility and stabilization is already at the heart of the accepted

[1] "Macroeconomic stabilization," defined for the purposes of this paper, entails attempts by policymakers -- using monetary policy, fiscal policy, or both -- to cushion the consequences of nonpolicy disturbances that buffet an economy, thereby to improve the short- and medium-run performance of the economy relative to what it would otherwise be. Such stabilization efforts are concerned with effects on real variables such as output and employment, not merely with effects on the rate of inflation.

procedures for implementing New Zealand monetary policy. The decisions in the current Policy Targets Agreement between the Minister of Finance and the Governor of the Reserve Bank about the 0-2 percent range within which the underlying CPI inflation rate may fluctuate reflect a collective judgment about how to weigh credibility and stabilization considerations against each other. Narrower band widths and band midpoints closer to zero would be favorable for influencing inflation expectations and for establishing credibility; but the narrower band or closer-to-zero midpoint would leave even less flexibility for stabilization. Conversely, wider band widths and a band midpoint further from zero would provide greater scope for stabilization flexibility; but the wider band or further-from-zero midpoint would risk undercutting credibility. The existing 0-2 percent band is clearly a compromise choice.

The "caveat" provisions in the Policy Targets Agreement are another example. The fundamental rationale for these provisions is that, in certain specified circumstances, the Reserve Bank should be paying attention to consequences for variables such as output and employment rather than concentrating singlemindedly on the inflation rate.[2] Because of the caveats, the issue of whether and when to try to smooth the paths of output and employment is already on the table, despite a widespread impression to the contrary.

What might be the costs in terms of lost credibility if the Reserve Bank were to have multiple goals rather than the exclusive goal of price stability? How great might the risks be if the Cabinet and Treasury were to give greater explicit weight to output stabilization? And what might be the gains from stabilization flexibility? Could some output smoothing significantly reduce the costs of

[2] For a discussion of the caveat provisions in the Policy Targets Agreement and a clear statement of this rationale, see Reserve Bank of New Zealand (1993, pp. 22-23).

the economy adjusting to shocks without compromising the long-run goals of a low rate of inflation and sustainable, prudent long-run evolution in the government's budget? To have summary labels for talking about these tradeoff questions, it is helpful to use the expressions "credibility properties" and "stabilization properties" to indicate the two types of considerations at stake.

Ultimately, the credibility properties and stabilization properties of alternative approaches to the conduct of policy have to be evaluated together. In the preliminary assessment in this paper, I concentrate exclusively on stabilization properties.

The reader should not forget that my assessment here is only partial. It is <u>not</u> my position -- nor should it be the reader's -- that the credibility properties of alternative policy rules are less important, or less in need of empirical evaluation, than their stabilization properties.

<u>Research Strategy for Assessing Stabilization Properties</u>

How can analysts make progress in evaluating the stabilization properties of alternative approaches to the conduct of monetary policy and fiscal policy in New Zealand?

The first step is to locate, and make arrangements to use, a macroeconomic model that captures the most important features of the behavior of the New Zealand economy. If an already existing model is not available, one will need to be created from scratch. Ideally, the researcher should be able to use several alternative models. If the models were to differ in their conceptual treatment of key issues in modeling the New Zealand economy, so much the better.

All existing models of any national economy, and New Zealand's economy in particular, are seriously inadequate. A newly created model will also be seriously inadequate. Worse, any conclusions of one's analysis will certainly be model-dependent. Notwithstanding those daunting facts, some sort of a model is a necessary condition for carrying out analysis. The best one can do is to select the least inadequate model currently available and proceed with due caution. That way at least lies the hope of progress. It will never be possible to examine the stabilization properties of alternative rules merely by sucking the eraser on the end of a pencil.

The second step in a research strategy is to specify carefully the different approaches to monetary policy and fiscal policy that potentially interest policymakers. For practical purposes, the alternatives will have to be specified fairly simply. The specifications must capture the essential differences among the alternatives, but leave out (from each of them) second-order bells and whistles. In effect, the research evaluates alternative “rules" and can most accurately be characterized as "rule analysis."[3]

The selected rules then get embedded in the model (or models) as different “reaction functions” for monetary policy or fiscal policy. Speaking loosely, a different variant of the model is constructed for each alternative combination of monetary and fiscal rules.

Third, the research strategy must identify different policy shocks, or packages of shocks, that are germane for the New Zealand economy. This identification can be based on past history, judgments about potential future shocks, or both.

Next, the analysis passes the shocks through the variants of the model and studies how a variety of key variables respond to the shocks in model simulations, over both short and longer horizons. Although this task requires sizable computation resources for all but the smallest theoretical models and threatens the analyst with indigestion, the task is straightforward once the

[3] For further discussion of differences between “rule” and “discretionary” approaches, and the main features of rule analysis, see Bryant (1995, chaps. 2 and 4) and Bryant, Hooper, and Mann (1993, chap. 1).

model variants are working properly and the shocks have been defined.[4]

In principle, the final step in the research is to form judgments about the likely performance of the alternative rules, based on the results coming out of the model simulations. If a consensus were to exist about the "social welfare function" (loss function) that is appropriate for evaluating policy, the research could even go so far as to make welfare calculations based on the model simulations. Typically, however, consensus will not exist about the appropriate welfare function, neither about the variables that should appear in the function (as surrogates for the "true" utility of New Zealand residents), about the weights attached to the variables, nor about the discount factor to be used to calculate welfare in present value terms.

When the consumers of rule-analysis research have quite different judgments about the appropriate welfare function and different degrees of suspicion about model inadequacies, therefore, the first step in appraisal of the research results is merely to report the simulated outcomes for a variety of key variables. This information constitutes the raw material for welfare assessments. This raw material gives the consumers scope for exercising their own preliminary judgment about how the outcomes for particular variables should be weighted against each other. It also gives the consumers information that can help them form their own judgments about the plausibility and adequacy of the model on which the research results are contingent. That, at any rate, is the procedure followed in this paper.[5]

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[4] This basic methodology for evaluating alternative approaches to the conduct of policy goes back at least as far as Poole (1970).

[5] When simulation results are obtained that are agreed to be of significant interest, one can further advance the comparison of the rules by computing, for the key variables of greatest interest, the sums of squared deviations from baseline over the whole simulation period (or some chosen subperiod). For illustrations of such calculations, see for example Henderson and

The research strategy just described relies on "deterministic" simulations of particular shocks. This type of research with the model is the place to start the analysis of alternative rules. Analysts have to learn how to walk before it is feasible to run. Eventually, however, research should proceed to stochastic simulation analysis -- first for particular categories of shocks, and eventually for the entire range of shocks that hit the economy. Stochastic simulation techniques will ultimately prove to be the most valuable and robust approach for evaluating the stabilization properties of alternative rules.[6]

Key Characteristics of the Illustrative Model Used in This Study

For the results reported in this preliminary study, I use an illustrative model newly created during my visit to New Zealand in the spring of 1996. The model builds on earlier research conducted on the United States and other countries.

This illustrative model is not a genuine macroeconomic model of the New Zealand economy. I have structured the model to mimic many salient features of the New Zealand economy. But I have no illusions that the model is an adequate representation. My hope is that the preliminary results reported here may stimulate further research along these lines, making use of a model or models that have benefited from more careful empirical calibration to New Zealand data.

McKibbin (1993). This type of calculation falls well short of actual welfare calculations, but again can be a useful input into them. I do not present such calculations in this paper because of the preliminary nature of the simulation results.

[6] For an extensive discussion of deterministic and stochastic simulation techniques for evaluating alternative policy regimes, see Bryant, Hooper, and Mann (1993).

My illustrative model is in the same genre as the MULTIMOD model of the IMF staff,[7] the QPM (Quarterly Projection Model) of the Bank of Canada,[8] the MSG (McKibbin-Sachs Global) model maintained by Warwick McKibbin,[9] the MX3 model of the International Division staff at the Federal Reserve Board (Gagnon, 1991), John Taylor's multicountry model (Taylor, 1993), and a model currently under construction at the Reserve Bank of New Zealand, to be known as the FPS (Forecasting and Policy System) model. To construct my illustrative model, I started with a two-region model of a hypothetical "world" economy built by Long Zhang and myself in 1994. That model in turn was an abridgement of the IMF staff's MULTIMOD. Our abridgment took adapted versions of MULTIMOD's equations for the United States for one of the two regions; the other region was a mirror image of the United States. All the "world" income-accounting and balance-of-payments identities for the two regions were worked out carefully. The result was an internally consistent and relatively transparent model within which one could study many issues about the macroeconomic behavior of open economies.[10]

To prepare an illustrative model for the analysis of alternative policy rules in New Zealand, I first cut this two-region world economy in half (figuratively speaking). I then focused on one of the two regions, treating any variables as exogenous that were associated with the other region (the

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[7] References to the literature on MULTIMOD include Masson, Symansky, Haas, and Dooley (1988); Masson, Symansky, and Meredith (1990, 1991); and Meredith (1991).

[8] Bank of Canada Staff (1994); Black, Laxton, and others (1994); Coletti, Hunt and others (1994).

[9] McKibbin and Sachs (1991), McKibbin (1992), McKibbin and Bok (1995).

[10] The model in the first instance was constructed primarily to study the intertemporal and international aspects of fiscal policy; see Bryant and Zhang (1996a, 1996b, 1996c).

"rest of the world"). The resulting model had the features of a small, open economy in the sense that any developments in that economy could not influence events in the rest of the world.

Finally, I re-calibrated this small, open-economy model to give it some of the key features of New Zealand's economy. For example, I adjusted the baseline trade-openness ratios so that real exports and real imports were proportions of real GDP similar to those in New Zealand (the figures I chose were 33 percent for exports and 34 percent for imports). Analogously, the ratio of net foreign assets to nominal GDP was set to -80 percent, the ratio of government debt to nominal GDP to 30 percent, the capital-output ratio to 2.5, real government expenditures as a proportion of real GDP to 20 percent, and so on.

As a reminder of the illustrative nature of this model for purposes of analyzing New Zealand, I will label the outcomes as referring to the ZZ economy, not the N.Z. economy.

It would be inappropriate to describe the model of the ZZ economy in detail in this paper. Instead, I merely identify a few of its main characteristics. A technical appendix to the paper provides an equation listing for one of the model variants.

As with other models in this genre, my illustrative model is an empirical implementation of the Solow-Swan growth theory. Thus the growth rate of the labor force and the growth rate of productivity (technical progress) are exogenous constants. No thoughtful empirical modeler believes that these growth rates are given constants in real life. However, even with the explosion of the theoretical literature on "endogenous growth" (theories that in one fashion or another determine productivity growth endogenously), there is not yet a discernible consensus on how to incorporate the endogenous-growth theories in empirical models. For the time being (but only for the time being), therefore, most empirical modelers are continuing to rely on the workhorse Solow-Swan growth assumptions.

When preparing the steady-state baselines for the model variants, I assumed that population in the ZZ economy grows at ½ percent and productivity at 1- ½ percent per year. The steady-state inflation rate for the economy was assumed to be 2 percent per year. In the steady-state baselines, therefore, the levels of real variables grow at 2 percent and the levels of nominal variables at 4 percent per year. Along the steady-state paths, of course, the ratios of two real variables, or the ratios of two nominal variables, remain at constant values.

The key foreign (rest-of-world) exogenous variables in the model are foreign real interest rates, foreign prices, and foreign real demand (real absorption). The foreign real interest rate is set at .0425 (4-1/4 percent). Foreign real absorption is assumed to grow at the rate of 2 percent per year (the same steady-state rate of growth as for the home economy's real variables). In size, the rest of world is assumed to be a large multiple of the home economy.

The model incorporates forward-looking expectations in its modeling of the exchange rate, long-term interest rates (the domestic term structure), consumption and wealth, the market value of the capital stock, and the formation of the domestic price level. The behavior of the monetary authority, the ZZ Reserve Bank, and the fiscal authority, the ZZ Treasury, can also be forward-looking (see below). The model is always solved by enforcing the assumption of model-consistent (rational) expectations.

This assumption of model-consistent expectations is undoubtedly superior to the older treatment of expectations as adaptive and merely backward-looking. But in its own way, the assumption of model-consistent expectations is also inadequate. The assumption is too much of a mechanical straitjacket; it presumes that all agents have more information and understanding than most agents in real life actually have. It is a great advantage of the assumption that private-sector behavior does adjust endogenously to the different rules embedded in the variants of the model. The problem is that it adjusts too well. The analysis pretends that all agents are completely informed about what the rule in operation is, and that they know with certainty what the consequences of the use of the rule will be for the model's variables.

Another important feature of the model is that stock-flow identities are carefully enforced. Investment adds to the capital stock; deficits or surpluses in the government's budget lead to changes in the stock of government debt and/or central-bank money; a nonzero current-account balance leads to accumulation or decumulation of net foreign assets.

Each variant of the model has a carefully worked out steady state. The steady-state paths for the variables are used as the baseline paths in dynamic simulations. The values reported for variables in the shock simulations are calculated as deviations of the variables from their steady-state baseline paths.

The model behaves as the neoclassical Solow-Swan model in the long-run, but displays Keynesian-like properties in the shorter run. It has about 100 equations, but over half of these are identities. Many of the equation specifications still resemble those used in MULTIMOD. In a few major respects, I have departed from the MULTIMOD treatment.

The private consumption choices of households are derived by building on the long-run model of consumption in Blanchard (1985). The key determining variables are total wealth, disposable income, the real long-term interest rate, and demographic change. In the steady state, the dynamic consumption equation collapses to a fairly simple relationship in which consumption is a fraction of wealth; the fraction, the marginal propensity to consume out of wealth, MPC, is given by:

$$(1) \qquad MPC = RLR * (1 - EIS) + RTP * EIS + PROBD$$

where RLR is the real long-term interest rate, EIS is the elasticity of intertemporal substitution (the value to consumers of consumption today versus consumption in the next period), RTP is the consumers' rate of time preference, and PROBD is the probability of death. Total wealth is the sum of human wealth (modeled as the present value of the entire forward-looking stream of labor income), the market value of the capital stock, government bonds, money, and net foreign assets (negative in the case of the ZZ economy because of its net foreign liability position). EIS, RTP, and PROBD are assumed to have constant values (0.5, .019, and .021, respectively).

Although consumption in the long run varies with wealth according to the interest-sensitive MPC defined in (1) above, in the shorter run it is influenced by movements in disposable income. A fraction of households (calibrated at 40 percent in the simulations reported in this paper) are assumed to be "liquidity-constrained"; that is, their consumption is limited by an inability to borrow fully against their expected long-run wealth position, so that their consumption is determined by changes in their disposable income. I follow Faruqee, Laxton, and Symansky (1995) in the way that these liquidity constraints are imposed, and I also follow them by incorporating life-cycle profiles for labor income into the specification. These features, together with the assumption of an EIS significantly less than unity, play important roles in giving the shorter-run consumption function its Keynesian-like properties and the longer-run behavior of the model its significant departures from Ricardian equivalence.

Investment behavior in the model is a variant of Tobin's q theory. Net investment is determined by the gap between the market value of existing capital and its replacement cost. The higher the market value of the capital stock relative to replacement cost, the greater is the incentive to undertake new investment. In the steady state, the ratio of the market value to replacement cost is a constant; some amount of investment is always undertaken, even in the steady state, because the steady-state gap between market value and replacement cost is not zero. Capacity output is determined by a CES production function of capital and effective labor supply, with the elasticity of substitution between capital and labor set well below unity (0.5 in these simulations). Capacity output and aggregate demand can differ from each other in the short to medium run; the price level adjusts gradually to close any gap between the two. In the long-run steady state, capacity utilization is always 100 percent.

Real imports into the ZZ economy depend on real domestic absorption, relative prices, and exports (the generic specification used in the IMF's MULTIMOD). The equation is in the form of an error-correction specification. In the long run, the elasticity with respect to domestic absorption is constrained to unity so that a 1 percent rise in absorption eventually produces a rise of 1 percent in import volume.

Assets denominated in the ZZ currency and in the foreign (rest-of-world) currency are assumed to be perfect substitutes, except for the possibility of a risk-premium wedge. This risk-premium wedge is taken as exogenous rather than modeled endogenously. Thus the exchange rate, net capital flows in the ZZ balance of payments, the volumes of exports and imports, import and export prices, and ZZ domestic interest rates are simultaneously determined in the model as endogenous variables. A key behavioral equation imposes the uncovered interest parity condition subject to the exogenous risk-premium wedge. Thus the differential between the ZZ nominal short interest rate and the foreign nominal short rate is equal to the expected nominal depreciation of the

ZZ currency. Although equations exist in the model for the volume of ZZ exports, ZZ import prices, and the ZZ short-term real interest rate, in effect those variables are determined exogenously because of the assumption that foreign real demand, foreign prices, and the foreign short-term real interest rate are exogenously given to the small, open ZZ economy.

Real money demand depends on domestic real absorption and the short-term nominal interest rate. Money is neutral in the long run.

The behavior of the ZZ Reserve Bank is summarized by some variant of a monetary-policy rule in which the nominal short interest rate is taken to be the monetary-policy instrument. The ZZ fiscal authority's intertemporal behavior is summarized by a rule in which the average tax rate is taken to be the instrument. The fiscal rule always enforces the intertemporal budget constraint by making the ratio of government debt to nominal GDP eventually return to a target path for the ratio, set by the fiscal authority. The monetary rule and the fiscal rule are incorporated in the model endogenously, as additional equations -- "reaction functions" -- in the model.

A Matrix of Alternative Rules for Monetary Policy and Fiscal Policy

Figure 1 is a matrix identifying a range of alternative rule combinations for monetary policy and fiscal policy. The columns, labeled with a letter A through F, indicate alternative possibilities for the monetary reaction function. The rows, labeled 1 or 2, identify two possibilities for the fiscal reaction function.

All the different reaction functions take a common form, which can be summarized in its most simplified specification as:

$$X_t = X_{t-1} + \beta(Zgap_t^{adj}) \tag{2}$$

$$Zgap_t^{adj} = w_{fwd}Zgap_{t+1}^u + (1 - w_{fwd} - w_{bwd})Zgap_t^u + w_{bwd}Zgap_{t-1}^u \tag{3}$$

$$Zgap_t^u = Z_t - Z_t^* \quad . \tag{4}$$

Here X is the policy instrument in the function, Z is a target variable, 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 a nonzero value of $Zgap^{adj}$. The unadjusted, contemporaneous value of the gap between actual and targeted values, the deviation of Z from Z^* in the current period, is defined in (4). The reaction function itself in (2) actually focuses on an adjusted value of the gap, defined in (3), which is a weighted average of the next period's, the current period's, and the previous period's unadjusted gap. The weights w_{fwd} and w_{bwd} can be chosen so as to vary the degree to which the policymakers are assumed to look forward or

Figure 1

ALTERNATIVE REACTION FUNCTIONS FOR MONETARY POLICY AND FISCAL POLICY IN THE ZZ ECONOMY: KEY TARGETED VARIABLE(S)

		Key Targeted Variable(s) in Monetary-Policy Reaction Function					
		(A) **Key Monetary Aggregate, Level** [*Money Targeting*]	(B) **Key Price Index, Inflation Rate** [*Inflation-Rate Targeting*]	(C) **Key Price Index Level,** [*Price-Level Targeting*]	(D) **Nominal Value of GDP, Level** [*Nominal-GDP-Level Targeting*]	(E) **Nominal Value of GDP, Growth Rate** [*Nominal-GDP-Growth-Rate Targeting*]	(F) **Price Index, Inflation Rate** plus **Real Output Gap, Level** [*Inflation-plus-Real-GDP Targeting*]
Key Targeted Variable(s) in Fiscal-Policy Reaction Function	(1) **Nominal Debt Stock, Level, Scaled by Nominal GDP** [*Debt-Stock Targeting Alone* (Focus solely on intertemporal budget consistency)]	✔	✔	✔	✔		✔
	(2) **Real Output Gap, Level; and Nominal Debt Stock, Level, Scaled by Nominal GDP** [*Debt-Stock Targeting combined with Smoothing of Output Gap*]		✔		✔		✔

backward when choosing how to vary their instrument.[11]

In all the reaction functions here, instead of (2) I use a more flexible specification that includes a so-called "derivative" term as well as a "proportional" term:

$$X_t = X_{t-1} + \beta(Zgap_t^{adj}) + \gamma\,\Delta(Zgap_t^{adj}) \quad . \qquad (5)$$

The derivative term, the final term on the right-hand side of (5), focuses on the change in the (adjusted) gap rather than on the size of the gap itself. If the actual value of *Z* is above its target path and the gap is widening further, the derivative term causes the instrument *X* to be raised even further. If the gap is narrowing, the derivative term reduces the increment to *X*. The existence of the derivative term can be justified in part as a mechanism for smoothing the adjustment of the instrument (in effect, imposing penalty costs on excessive instrument variation).

The instrument *X* in the monetary-policy reaction functions is assumed to be the short-term nominal interest rate. *X* in the fiscal reaction functions is the average tax rate.

The shaded cell in Figure 1, B1, is the combination that comes closest to representing the current status of macroeconomic policies in New Zealand. Broadly speaking, the Reserve Bank of New Zealand engages in inflation-rate targeting and the Government focuses on intertemporal budget consistency. The checkmarks in that cell and a majority of the other cells indicate the

[11] In principle, policymakers may look forward and prepare forecasts for several periods into the future rather than merely one period. It is straightforward to amend the reaction functions to embody such behavior.

regime combinations for which I have generated preliminary simulation results.[12]

The $Zgap^u$ variable in the B1 regime for the model economy is the simple difference between the inflation rate and the target inflation rate. The ZZ economy does not have a price variable for the consumer price index (and hence a CPI inflation rate). I use the closest analogue, labeled here *PADOT*, which is the inflation rate for *PA*, the price deflator for absorption (consumption plus investment plus government spending).

Column C represents an alternative interpretation of "price stability" under the Reserve Bank Act of 1989, namely, targeting an unchanged <u>level</u> of prices (literal price stability) instead of a constant inflation <u>rate</u>. The $Zgap^u$ variable for the C regimes is defined as $log(PA/PA^*)$, where *PA* is the absorption deflator and PA^* is the target path for *PA*.[13]

As is well known, mandating a target for the level of prices (possibly growing over time but with no changes permitted from the target path) has rather different implications for the long-run price level from mandating a target of an unchanged inflation rate. If some unexpected event causes the price level and hence the inflation rate to change, the target of literal price stability requires a central bank to induce a further change in the price level that reverses the initial change, thus bringing the price level back to its original stable path. In contrast, when the central bank targets the rate of inflation, the inflation rate must be brought back to the initial rate; but

[12] The monetary-policy rule A, money targeting, has not attracted significant interest in New Zealand. I have included it in my research (mostly as a diagnostic aid to facilitate interpretation of the other monetary-policy rules shown in Figure 1) but I do not discuss it in this paper.

[13] The target path for the price level is the baseline steady-state growth path for *PA*. The target inflation rate for the B regimes, $PADOT^*$, is the steady-state (constant) inflation rate associated with the steady-state path for *PA*.

"bygones are bygones" in the sense that the consequences of the unexpected event for the price level do not have to be reversed. The price level can "drift" over time when the inflation rate is targeted. The Government and the Reserve Bank in New Zealand tend to target an unchanged low inflation rate, not literal stability of the price level.

Column D indicates the rule in which monetary policy targets the level of nominal GDP, in effect the product of the price level (as measured by the GDP deflator) and the level of real output. The $Zgap^u$ variable for the D regimes is defined as $log[Py/(Py)^*]$ where *Py* is nominal GDP and $(Py)^*$ is the target path for *Py*; this target path is taken to be identical with the steady-state growth path in the baseline. This rule for nominal-GDP-level targeting has been often suggested and studied in the academic literature on monetary-policy regimes. Prominent proponents include McCallum (1988, 1993, 1995, 1996). The D regime introduces a form of output smoothing into monetary policy.

The column-E rule for monetary policy, not yet implemented in the ZZ model and therefore not analyzed in this paper, would target the growth rate of nominal GDP rather than its level. Such growth-rate targeting would bear an analogous relationship to the level targeting of nominal GDP that inflation-rate targeting (column B) bears to price-level targeting (column C).

The column-F rule also introduces output smoothing into monetary policy, but in a different way from regimes D and E. Instead of a single *Zgap* variable in the reaction function, there are two *Zgap* variables. The inflation-rate component is the same as the inflation-rate *Zgap* used in regime B. The other component is an output-smoothing part, defined as $log[y/ycap^*]$, where *y* is real GDP and $ycap^*$ is capacity output in the steady-state baseline. The F monetary-policy regime may be labeled "inflation-plus-real-GDP targeting."

The essential difference between the D and F regimes is again related to the issue of "drift" in the price level. Under nominal-GDP-level targeting, deviations of the price level from the targeted price level in the $(Py)^*$ path receive the same weight as deviations of real GDP from the targeted level for real output in the $(Py)^*$ path. The rule causes any incipient sustained movement of the price level away from its targeted path to be resisted by policy action. Under inflation-plus-real-GDP targeting, in contrast, the rule requires policymakers to focus on the path of the level of real output and the path of the inflation rate, not the price level. Rule F thus treats past episodes of upward or downward adjustment in the price level as bygones, not subject to correction; ex ante, rule F is designed only to move the rate of change of prices to a target rate.

The debt-stock targeting in the fiscal reaction functions takes the form:

$$\Delta\tau_t = \alpha_1 \frac{(B_t - B_t^T)}{P_t y_t} + \alpha_2 \frac{\Delta(B_t - B_t^T)}{P_t y_t} \quad . \tag{6}$$

τ_t denotes the fiscal instrument, the average tax rate, and B_t and B_t^T are the actual and targeted stock of government debt. The deflation of the feedback coefficients by nominal GDP has the effect of scaling the coefficients.[14] The targeted stock of debt, B^T, is determined as the product of an exogenous target ratio for debt-to-nominal-GDP and the steady-state baseline path for nominal GDP.

[14] The scaling of the feedback coefficients is necessary because for the same size of gap between actual and targeted debt, the required change in 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. See Bryant and Zhang (1996a, 1996b) for an extensive discussion of different variants of debt-stock targeting and other modeling approaches for enforcing intertemporal budget consistency.

When the fiscal rule is allowed to have an output-smoothing component in addition to debt-stock targeting (row 2 in Figure 1), that component takes the same form as the output-smoothing component in the F monetary-policy regime. In other words, the fiscal reaction function has proportional and derivative terms in a second *Zgap* component, $log[y/ycap^{*}]$.

The behavior of any one of the monetary or fiscal rules is of course sensitive to the particular values chosen for the feedback coefficients. When choosing these coefficients, I did not want to favor or penalize any of the rules relative to the others, thereby prejudicing the horse race in advance. Figure 2 reports the coefficients -- the values of β and γ in equation (5) -- used in the initial simulation experiments. In general, I adhere to the rule of thumb that the opening up of a 1 percentage point $Zgap^{adj}$ in a monetary reaction function should lead to a 100-basis-point change in the interest-rate instrument from the proportional term, with a change in the $Zgap^{adj}$ of 1 percentage point leading to a 50-basis-point change in the interest rate (the derivative term). When output smoothing is introduced into the monetary reaction function as a separate *Zgap* variable, it gets only two-thirds of the weight given to the inflation-rate component. This choice was made to acknowledge in a rough way that the inflation goal has primacy for monetary policy.

In the simulations reported here, the ZZ Reserve Bank is assumed to look forward to the next period, make forecasts of the value of $Zgap^{u}$ for that period, and to choose its instrument setting by giving equal weights to that forecast and the value of $Zgap^{u}$ in the current period. It is assumed to attach a zero weight to last period's $Zgap^{u}$. In terms of equation (3), in other words, $w_{fwd} = 0.5$ and $w_{bwd} = 0$. The fiscal authority looks ahead in a comparable way, setting $w_{fwd} = 0.5$ and $w_{bwd} = 0$, with regard to the output-smoothing component of its reaction function in the F2

Figure 2

Values Chosen for Feedback Coefficients in Monetary and Fiscal Regimes

Reaction Function and Component	Coefficient on Proportional Term (β)	Coefficient on Derivative Term (γ)
Money Targeting (A)	100	50
Inflation-Rate Targeting (B)	100	50
Price-Level Targeting (C)	100	50
Nominal-GDP-Level Targeting (D)	100	50
Inflation-plus-Real-GDP Targeting (F):		
Inflation-Rate Component	100	50
Output-Smoothing Component	67	33
Debt-Stock Targeting Alone (1)	0.04	0.30
Debt-Stock Targeting combined with Smoothing of Output Gap (2):		
Debt-stock component	0.04	0.30
Output Smoothing Component	1.00	0.50

case. For its debt-stock targeting behavior, on the other hand, the fiscal authority is assumed not to look ahead, but rather to give equal weights to last period's and the contemporaneous gap (w_{fwd} = 0 and w_{bwd} = 0.5). These assumptions about the degree of "forward-lookingness" in policy behavior are of course illustrative. Sensitivity tests should be carried out to determine whether or not inferences about the ranking of the rules are dependent on these assumptions.

Three Illustrative Shocks

Many types of shocks can be imposed on the model ZZ economy. For this preliminary report, I concentrate on only three: a major foreign recession, an exogenous change in export prices that changes the terms of trade, and a shock that destroys a significant fraction of the capital stock in the ZZ economy. I have deliberately chosen shocks that are relatively large so as to highlight the potential differences in outcomes across the different policy rules.[15]

The experiment illustrating a major foreign recession is a composite shock. Foreign real absorption is assumed to fall below baseline by 2 percent in the first year of the simulation, and then starts to recover; but it is still 1 percent below baseline in the second year, and ½ percent below baseline in the third year. By the fourth year and thereafter, foreign absorption is back on the baseline path. The foreign price level is assumed to fall below baseline by 2-1/2 percent in the first year, to fall further to 4 percent below in the second year, then start to recover; in the third year it is assumed to be 2-1/2 percent below baseline, in the fourth year only 1 percent below, and then in the fifth year and thereafter back on baseline. The foreign real interest rate

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[15] The terms-of-trade and the capital-destruction shocks as defined in this revised version of the paper differ in detail from the definitions used in the May 1996 preliminary draft.

falls 100 basis points below baseline in the first year; falls further to 150 basis points below in the second year, rises back to 100 basis points below in the third year, to 50 basis points below in the fourth year, and in the fifth year and thereafter is back at baseline. This composite shock is labeled “FR” in the legends to the graphs illustrating the simulations.

The FR shock provides a more realistic sense of what would happen in response to a foreign recession than an analysis assuming only a single foreign exogenous variable is altered. In an actual recession, one would expect all of the aggregate-demand, price, and interest-rate variables in the rest of the world to change in a typical pattern somewhat like that assumed in the FR shock.[16]

The terms-of-trade shock, labeled “TT” in the graph legends, is implemented by altering the initial conditions for the variable representing ZZ’s export prices and by making an adjustment in that equation’s residual for the first two years of the simulation. The change in initial conditions reduces the export-price variable immediately prior to the start of the simulations by 10 percent below baseline. The residual adjustment adds an additional downward pressure on export prices in the first year of the simulation which is then exactly reversed by a positive adjustment in year 2. The combined effect of these exogenous changes is to drop ZZ’s export prices (denominated in the ZZ currency) by about 18 percent below baseline in the first year of the simulation. Export prices recover sharply in year 2 to about 10 percent below baseline and then gradually move back toward baseline over the subsequent years of the simulation.

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[16] See Hunt (Bank of Canada Research Department, 1995) for the rationale for a composite shock of this type and an example for Canada using the Bank of Canada’s QPM model. My illustration for the ZZ economy is less carefully worked out than Hunt’s analysis.

The final illustrative shock, labeled “KD,” assumes a destruction of the capital stock in the ZZ economy. For example, assume that an earthquake destroys buildings and machines that cannot be rebuilt quickly or, alternatively, imagine the sudden onset of an epidemic that kills a significant fraction of the country's dairy herds. To implement the shock, I reduce the size of the real capital stock at the outset of the simulation by 7 percent below baseline. In addition I introduce a one-time negative adjustment (in year 1 only) into the residual in the equation in which the actual stock of capital adjusts to bring the market value of the capital stock back into line with replacement costs. The real capital stock thus falls below baseline by a bit more than 9 percent in the first year of the simulation and then begins a slow, gradual recovery back toward baseline.[17]

A Comparison of Inflation-Rate Targeting with Price-Level Targeting

In a first set of simulations using the three illustrative shocks, I contrast the performance of the B1 and C1 regime combinations. Fiscal policy is assumed to be engaged only in debt-stock targeting to maintain intertemporal budget consistency. The hypothetical horse race is between the two different interpretations -- inflation-rate targeting or price-level targeting -- that the ZZ Reserve Bank could give to its exclusive target of "price stability."

The simulation results are presented in chart form. The effects of the foreign recession shock are shown in the two pages of Figure 3. Corresponding pages are shown for the terms-of-

[17] The ratio of the market value of the capital stock to the physical stock rises sharply in year 1. Hence, after an initial fall in year 1, investment also recovers sharply. However, although the capital stock rises continuously back toward baseline in subsequent years, it still remains some 2-3 percent below baseline even after 20 years have elapsed.

trade shock in Figure 4, and the capital destruction shock in Figure 5. Each page of charts has four numbered panels, with each panel pertaining to a single key variable in the model. For example, effects on the nominal exchange rate are shown in panels 3-2, 4-2, and 5-2 and on the real exchange rate in 3-4, 4-4, and 5-4.

Two curves are shown in each panel, one for each of the regimes. The curve for the B1 regime, inflation-rate targeting for monetary policy, is always shown with the open-circle symbol attached to it. The symbol used for the C1 regime, price-level targeting for monetary policy, is always an open square. The horizontal axis always measures time in periods (notional years). Many of the panels report the results for the first 20 periods. When the longer-run outcomes are especially relevant, the length of the period shown is sometimes extended to 30 or 40 periods.

The vertical axes in the panels measure deviation of the variable from a baseline simulation (represented in the charts as a dotted horizontal line at the value zero). The results for nominal and real exchange rates, real output, real consumption, and the price level are calculated as percent deviations from baseline.[18] Results for the nominal short interest rate are shown as absolute deviations in percentage points (e.g., a value of -0.8 indicates a fall below baseline of 80 basis points). Results for the inflation rate and the real long-term interest rate are also shown as absolute deviations in percentage points (e.g., a rate of inflation 6 tenths of a percentage point below the baseline rate -- 1.4 percent relative to the baseline rate of 2.0 percent -- will appear on the vertical axis of the inflation-rate panels as the number -.60).

Consider first the effects on the ZZ economy of the foreign recession shock (Figure 3).

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[18] In all the graphs, depreciations of the nominal or real exchange rate relative to baseline are shown as negative values (appreciations as positive values).

The immediate consequences are to depreciate the nominal value of the ZZ currency (panel 3-2) but to appreciate it in real, inflation-adjusted terms (3-4). The Reserve Bank must sharply lower its interest-rate instrument (3-1) under either the B or the C rule because of the downward pressure on the ZZ inflation rate (3-8) and price level (3-7). Real interest rates initially fall by some 60-80 basis points (see the long real rate in 3-3). Real exports fall very sharply at first; imports change little initially. Hence the current-account balance shifts toward a substantial initial deficit. Real consumption declines slightly (3-6); real investment rises marginally, offsetting the fall in consumption enough to keep real absorption about unchanged relative to baseline but not nearly enough to offset the large swing in exports. Real GDP thus falls sharply in the first year, before beginning a sharp recovery thereafter (3-5). By the third, fourth, and fifth year, real GDP has moved somewhat above baseline; it then gradually returns to baseline, reversing this overshoot.

For most variables, the initial differences between the B and C rules are noticeable but not large. Regardless of which monetary rule is in effect, the foreign recession has sizable and qualitatively similar effects on the ZZ economy. The expected exceptions pertain to nominal variables. The first-year fall in the inflation rate (3-8) is twice as large for inflation-rate targeting as price-level targeting. The central bank's B rule requires the bigger initial instrument adjustment (3-1), which in turn is associated with a smaller fall in the nominal exchange rate, a larger appreciation in the real exchange rate, and a smaller decline in real interest rates. As the financial effects feed through to real variables, the consequence is a somewhat sharper decline in output under inflation-rate targeting than under price-level targeting (3-5).

The most important conceptual difference between the two rules is readily seen in the panels for the price level (3-7) and the nominal exchange rate (3-2). As the shock passes away, the preoccupation of the B rule is merely to get the inflation rate back to its target rate (assumed to be equal to the steady-state baseline rate of 2 percent). The C rule, however, has to return the price level to its target path (also characterized by a steady-state inflation rate of 2 percent). In the C-rule bounceback from the initial recession, the price level actually rises back above baseline in the fourth and fifth years (3-7). Hence the C rule also requires another interval (years 6 through 9) in which the inflation rate must be negative (3-8), with the real exchange rate and real interest rates correspondingly being modestly above baseline. By the time the economy has settled down to a post-shock steady-state evolution, the C rule has brought the price level and nominal exchange rate exactly back to their pre-shock paths. The B rule, which lets bygones be bygones, produces a new steady-state path for the price level that is about 3/4 of a percent lower and a nominal exchange rate that is over ½ percent higher than the original baseline. To state the matter starkly, a transitory shock produces a permanent steady-state change in nominal variables under inflation-rate targeting.

The terms-of-trade shock -- Figure 4 -- affects the ZZ economy in quite different ways from the foreign recession. The fall in export prices leads to a sharp net reduction in the nominal value of exports even though the real volume of exports rises. For many other variables, too, the real values move in the opposite direction from their prices. The incipient pressures on both the nominal and real exchange rates are upwards, though more pronounced for price-level than for inflation-rate targeting (4-2 and 4-4). As private-sector agents look ahead, they see that the shock will reduce their real human wealth and the market value of the capital stock for many periods ahead; accordingly they sharply reduce their consumption (4-6). Real investment also declines below baseline, so real absorption in the ZZ economy plummets. The real trade balance (export volume less import volume) increases, though not by enough to offset the steep decline in real absorption. Real GDP thus falls sharply in the first year, especially so under price-level targeting (4-5).

The ZZ Reserve Bank, foreseeing that the price level and the inflation rate will rise above baseline (4-7 and 4-8), must engineer an initial rise in short-term interest rates (4-1). The upward pressure on prices occurs despite the fact that the real exchange rate (4-4) and real interest rates (4-3) have risen and despite the declines below baseline in real variables. This upward pressure on prices is at least partly explained by the sharp falls in investment, the capital stock, and capacity output, which after several years will generate excess capacity utilization. Forward-looking expectations of this process puts upward pressures on prices (and more so for the absorption deflator than for the GNP deflator).

The terms-of-trade shock, like the foreign recession shock, affects the ZZ economy in qualitatively similar ways regardless of which monetary rule is being implemented by the Reserve Bank. But the differences in outcomes under the B and C rules are significant. Differences between the two rules for private consumption are relatively small (4-6) but pronounced for real output (4-5). The primary differences are again observed in nominal variables. The inflation-rate rule permits the exchange rate to drift down below baseline by, eventually and permanently, nearly 3 percent (4-2); the price level itself (absorption deflator) stays permanently above baseline by a corresponding percentage amount (4-7). Under price-level targeting, these variables are eventually forced to return to their baseline paths.

The capital destruction shock -- Figure 5 -- sharply lowers capacity output as well as the capital stock. Although such a shock would place incipient upward pressure on the prices of goods most directly affected by the destruction of capital, the model is of course not disaggregated enough to capture differences among types of goods. The initial pressure on the general price level (5-7) and the inflation rate (5-8) is downwards as the economy absorbs the inevitable initial loss in output (5-5). The downward pressure is greater when the ZZ Reserve Bank is known to be pursuing inflation-rate targeting, and accordingly the Reserve Bank lowers the monetary-policy instrument somewhat further under inflation-rate targeting than under price-level targeting (5-1). Real interest rates and the real exchange rate thus fall less under the B than the C rule. The fall in real GDP and real consumption are slightly, but only slightly, smaller under price-level targeting than under inflation-rate targeting.

By far the most pronounced difference between the two regimes is again the drift in nominal variables permitted under inflation-rate targeting. The nominal exchange rate, the price level, and the levels of other nominal variables all eventually return to baseline under price-level targeting. Under inflation-rate targeting, however, the nominal exchange rate (5-2) and the price level (5-7) eventually settle on new steady-state paths 3/4 percent above and 3/4 percent below baseline.

The simulations summarized in Figures 3, 4, and 5 do not reveal anything about the differences between the B and C monetary-policy rules that is not already known from theoretical articles and other empirical research. But the simulations do help to drive home the essential difference between the two approaches. The choice between the two rules turns primarily on whether or not it is preferable to treat the consequences of past shocks as bygones, returning promptly to target rates of inflation without trying to reverse the price-level effects of the shocks.

Eric Hansen (1996) addresses this issue in an interesting way. He works with a two-sector model in which one sector has flexible prices (tradeables) and the other sticky prices (nontradeables). In his model, if shocks to the flexible-price sector are larger and more frequent than shocks to the sticky-price sector, the central bank should prefer price-level rather than inflation-rate targeting.

Writing about the difference between the two rules, Stanley Fischer has observed that inflation-rate targeting "tends to produce more certainty about the price level in the near future, at the expense of greater uncertainty about the price level in the distant future. Equivalently, the inflation rate would fluctuate more in the short-run under price-level targeting, as policy strives to come back to the chosen price path."[19]

The simulation results for the foreign-recession shock in the ZZ model do make rule C look somewhat better than rule B. If I were to calculate the sums of squared deviations from baseline for both real output in panel 3-5 and the inflation rate in panel 3-8, for example, price-level targeting would appear to perform better for both variables. And of course, price-level targeting would do much better in minimizing deviations of the price level from baseline (panel 3-7). For the terms-of-trade and the capital-destruction shocks, on the other hand, choosing between the two rules on the grounds of minimizing the sums of squared deviations for output and inflation appears to be a closer call.

The choice between inflation-rate targeting and price-level targeting ultimately has to turn on welfare judgments that model simulations cannot settle. Such considerations, for example, lie behind the following comments by Stanley Fischer:

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[19] Fischer (1995, p. 281). See also Fischer (1994).

> If the goal is to encourage long-term nominal contracting, then price-level targeting would be preferable. However, since the great bulk of nominal contracts are short-term, since the task of monetary policy would be made much more demanding under price-level targeting, and since the benefits of long-term nominal contracting are equivalently obtained by permitting indexation, inflation targeting is preferable to price-level targeting (1995, p. 281)

My own leaning between the two rules is also toward inflation-rate targeting. But policymakers need research that is much more conclusive before this judgment can be confidently held.

Permit Output Smoothing as Part of the Monetary-Policy Rule?

The preceding section, even though it focuses just on the B1 and C1 regimes, will have familiarized the reader with the general nature of the ZZ economy's reactions to the three illustrative shocks. With that background, I now turn to the controversial questions about stabilization flexibility identified in the introduction to the paper.

Specifically, given the analytical framework of the ZZ model economy, we want to ask how much difference it might make for real variables if the central bank were to use a nominal-GDP-level targeting rule or an inflation-plus-real-GDP targeting rule rather than inflation targeting alone. We also want to ask whether, if the ZZ Reserve Bank were to pay some attention to output smoothing in addition to the primary goal of inflation avoidance, a cost would have to be paid in terms of a poorer performance in minimizing deviations of the inflation rate from baseline. These questions are studied by contrasting the simulation results obtained from the D1 and F1 regime combinations with those from the B1 regime. In effect, the B monetary-policy rule is used as a benchmark against which to evaluate the other two rules.[20]

[20] Throughout the comparison in this section, the assumption is made that fiscal policy is implemented with debt-stock targeting alone (rule 1).

The simulation results are presented in a series of charts, structured similarly to the preceding charts. Outcomes for the foreign recession shock are summarized in Figure 6, for the terms-of-trade shock in Figure 7, and for the capital destruction shock in Figure 8. Each panel in these charts now reports three curves. The D1 curve (nominal-GDP-level targeting for monetary policy) is always plotted with an open-triangle symbol. The curve for F1 (inflation-plus-real-GDP targeting for monetary policy) is shown with an open-diamond symbol. The third curve in each panel is exactly the same B1 open-circle curve already shown in the corresponding earlier figure.

Consider first the foreign recession shock (Figure 6). Not surprisingly, many of the ZZ economy's qualitative responses tend not to be changed by permitting monetary policy to keep one eye on output while keeping the other eye on inflation. The nominal exchange rate and the real exchange rate move in opposite directions. Real interest rates fall. ZZ's exports take a big initial hit. Output falls sharply in the first year but then begins to recover sharply.

But the quantitative differences among rules become noticeable. The D and F rules require the central bank to reduce its interest-rate instrument somewhat further than under the B rule. The resulting nominal depreciation of the currency is greater (panel 6-2), the appreciation of the real exchange rate is correspondingly dampened (6-4), and the fall in real interest rates is somewhat larger (6-3). Hence the first-year and second-year declines in real output (6-5) and real consumption (6-6) are marginally cushioned relative to the outcome under inflation targeting. Interestingly, nominal-GDP-level targeting also dampens significantly the dip of the price level (6-7) and the inflation rate (6-8). For example, the first-year dip below baseline in the inflation rate under the D rule is less than half that under the benchmark B rule.

The price-level drift that occurs under inflation-rate targeting tends to be somewhat larger when inflation-rate targeting is combined in rule F with output smoothing. Though the F1 price level in the first three years deviates from baseline a bit less than under B1, over the longer run the F1 price level drifts away from baseline by another half percentage point more than the B1 price level. Similarly, the long-run nominal exchange rate under F1 ends up a half percentage point further above baseline (6-2).

Analogous observations can be made about the effects of the terms-of-trade shock (Figure 7). The output-smoothing components of the D and F rules do not radically change the qualitative outcomes relative to inflation-rate targeting. But they do lead to significant quantitative differences. In the first two years after the shock has hit, the ZZ Reserve Bank raises its interest-rate instrument very much less under the D rule, and slightly less under the F rule, than under the B rule (7-1). Under the D and F rules, the nominal and real exchange rates appreciate somewhat less (7-2, 7-4) and the real interest rate rises slightly less (7-3). Prices initially rise a bit more under the F rule (7-7, 7-8).[21]

The terms-of-trade shock causes declines in real GDP under all three rules, but the initial declines are smaller under the D and F rules (7-5) because of their output-smoothing components. In the second and third periods during which output is recovering, the pace of recovery is faster under the F and B rules than under rule D. The sharp fall in real consumption

[21] The central bank must raise its interest-rate instrument under the F rule by nearly as much as under the B rule (7-1), despite the fact that the output-smoothing component of the F rule (7-5) calls for a decrease in interest rates, because the initial F1 increase in prices is greater than the B1 increase (7-7, 7-8)..

is very similar under all three rules (7-6).[22]

For the F1 regime under this terms-of-trade shock, the drift of nominal variables such as the exchange rate and price level is pronounced and substantially greater than the drift under the B1 regime (7-2, 7-7). It also continues to occur gradually over a long period. As can be seen by comparing the deviations from baseline of the inflation rate (7-8) and the price level (7-7), the continuing drift in the price level under the F rule results in only a small increment to the inflation rate; but the F-rule inflation rate does remain some 0.10 to 0.15 percentage points higher for several decades after the shock has passed.

Now consider the third illustrative shock, a destruction of the capital stock (Figure 8). `The output-smoothing rules for monetary policy lead the central bank to ease policy more aggressively after the onset of the shock (8-1). The easing is especially large under the D rule. The nominal and real exchange rates, and real interest rates, thus fall more sharply (8-2, 8-4, 8-3). The falls in real output and real consumption are accordingly mitigated, marginally but not negligibly (8-5, 8-6). The price level initially rises under the D and F rules rather than falling as under inflation targeting (8-7, 8-8).

The tendency for the F-rule nominal variables to drift is especially strong for this capital destruction shock. Whereas the shock under inflation-rate targeting in the absence of output smoothing leads to a small permanent appreciation of the nominal exchange rate and a small permanent fall in the price level, the addition of output smoothing to the rule causes a large permanent depreciation of the nominal exchange rate and a large permanent increase in the price

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[22] Under all three rules, both real output and real consumption eventually converge back to their baseline paths.

level (8-2, 8-7). These effects under the F rule occur gradually over a protracted period of several decades, with consequences for the inflation rate (8-8). The output smoothing under the D rule, as seen also for the foreign-recession and the terms-of-trade shocks, does not have any such longer-run drift effects for nominal variables.

Permit Output Smoothing into the Rules for Both Monetary Policy and Fiscal Policy?

Before commenting further on the consequences of permitting monetary policy to try to smooth the path of output, I present a final set of charts. These charts extend the analysis to the regime combinations -- B2, D2, and F2 -- in which both monetary policy and fiscal policy are presumed to pay some attention to output smoothing.

The charts will now show panels for additional variables, for example the tax rate used as the fiscal instrument and the ratio of government debt to nominal GDP. Deviations from baseline of the tax rate, the debt ratio, or the ratio of the current-account balance to nominal GDP are reported as absolute changes in hundredths of a percentage point. For example, a simulation tax rate of .234 (23.4 percent) in comparison with a baseline rate of .240 shows on the vertical axis as a deviation of -.006 (0.6 percentage points).

As before, the B1 curve with open circles is repeated, serving as a benchmark for the other simulations. The simulation results for the B2 regime are reported as curves with solid-circle symbols. The D2 results are plotted with solid triangles. The F2 results are shown with solid diamonds. Outcomes under the foreign recession shock are pictured in the three pages of Figure 9. Outcomes under the terms-of-trade shock are in Figure 10, and for the capital destruction shock in Figure 11.

For the foreign-recession shock, the qualitative story for many variables remains as before. With fiscal policy as well as monetary policy engaging in output smoothing, however, the differing consequences for financial variables such as the nominal and real exchange rates and real interest rates are somewhat more pronounced (9-2, 9-4, 9-3). The D2 regime in particular produces a bigger nominal exchange-rate depreciation, a smaller real exchange-rate appreciation, and a larger fall in real interest rates.

The cushioning effects for output are thus also somewhat greater (9-5). The smallest first-period output reduction occurs under the D2 regime.[23]

The biggest differences between Figures 6 and 9, of course, are seen in variables strongly influenced by fiscal policy. The fiscal reaction function 2, interacting with either the B, the D, or the F monetary-policy rule, inhibits real consumption from falling immediately in response to the shock. Indeed, consumption rises above baseline at first if fiscal policy is used to smooth the decline in output. But later on consumption does have to fall below baseline for an extended period during a time in which consumption under the B1 regime would otherwise be above baseline (9-6). The fiscal-policy rule 2 is thus capable of dramatically changing the intertemporal pattern of consumption and saving.

The endogenous adjustments in the fiscal instrument, the average tax rate, are shown in panel 9-9. The tax rate under rule 2 is lowered in response to the shock, by the largest amount when monetary policy uses rule B, the least when monetary policy uses rule D. These differences can be understood by remembering the results shown in Figure 6. For this foreign

[23] Appendix A to the paper is a table giving the numerical values of the deviations of output from baseline, for the initial periods of the simulations, for all seven regime combinations.

recession shock, as monetary policy works to smooth output, the largest nominal exchange-rate depreciation, the smallest real exchange-rate appreciation, and the largest decline in real interest rates occur under rule D (6-2, 6-4, and 6-3). When fiscal policy works at output smoothing at the same time, therefore, fiscal policy has to work less hard in reducing the tax rate when monetary policy is using rule D. The magnitude of the first-period tax-rate reduction is 0.28 percentage points in the D2 simulation (from .241 to .238) and 0.54 percentage points in the B2 case. Notice that in the benchmark B1 simulation, where fiscal policy is concerned only with enforcing the intertemporal budget constraint through debt-stock targeting, the tax rate changes little (even rises slightly above baseline in the first two years rather than falling).

Because rule 2 for fiscal policy lowers the tax rate initially, which causes a budget deficit relative to baseline and hence raises the debt stock, the fiscal authority must subsequently raise the tax rate, moving it above baseline for an extended period. The ratio of the debt stock to nominal GDP rises above baseline but then falls below in a long cycle which eventually returns it to baseline (9-10). The initial rise above baseline is smallest and the subsequent fall below baseline is largest in the D2 case where the monetary authority is targeting the level of nominal GDP.

Now consider the outcomes after the terms-of-trade shock (Figure 10). The use of rule 2 for fiscal policy in conjunction with output-smoothing by monetary policy has effects somewhat analogous to those for the foreign recession shock, but with interesting differences. Under the B2 and D2 regimes, the appreciations of the nominal and the real exchange rates are a bit larger than in the benchmark B1 case (10-2, 10-4), which in turn causes somewhat larger declines in the current-account balance (10-12). The pronounced drifts in nominal variables associated with the

F rule for monetary policy -- substantially larger than under the B rule -- are augmented slightly further by the output-smoothing efforts of fiscal policy (10-2, 10-7).

When both fiscal and monetary policies rather than monetary policy alone are engaged in output smoothing, the falls in real GDP are, as expected, somewhat smaller (10-5). The differences for this shock across the regimes, however, are relatively modest. Moreover, the differences between the D2 and D1 simulations, or between the F1 and F2 simulations, are quite small.[24]

The output smoothing in fiscal rule 2 does lead to reductions and subsequent increases in the average tax rate (10-9). The behavior of the debt stock is affected significantly (10-10). And as with the foreign-recession shock, the fiscal rule 2 changes the intertemporal allocation of consumption. Real consumption initially falls less for all three of the B2, D2, and F2 simulations (10-6). But later on, during the long period when consumption is recovering back toward baseline, the paths of consumption fall below the B1 path.

Finally, consider again the capital destruction shock, shown in Figure 11. Alterations to the intertemporal allocation of consumption are more striking in this case. As seen before in Figures 5 and 8, the capital destruction necessitates a very sharp initial drop in real consumption in the B1 regime (11-6), mirroring the sharp drop in output (11-5). However, when fiscal policy in rule 2 lowers the tax rate in response to the capital destruction, which happens (albeit to a varying degree) under each of the B, D, and F rules for monetary policy (11-9), the initial fall in

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[24] Numerical values for the output deviations for all the simulations are given in Appendix A. The marginal contributions of adding output smoothing <u>by monetary policy</u> to the output smoothing being done by fiscal policy are given by the differences between the D2 and B2, or the differences between the F2 and B2, paths.

real consumption is dramatically mitigated. Furthermore, consumption rises above baseline in the years immediately after the shock has passed away. But the price for this near-term cushioning of consumption is an extended period in the second and third decades of the simulations in which consumption is below baseline. The consumption time paths for the B2, D2, and F2 simulations are thus entirely different from the B1 path.

The cushioning effects on output for the capital destruction shock are modest but not trivial (11-5). For this shock, furthermore, the differences between the D1 and D2 simulations are more consequential than for the terms-of-trade or the foreign-recession shocks. The same is true for a comparison between the F1 and F2 simulations. The addition of output-smoothing efforts by fiscal policy to the output-smoothing efforts of monetary policy results in non-negligible further cushioning of the initial fall in output.[25]

Some Preliminary Conclusions about Output Smoothing

The empirical analysis in this paper is preliminary. The inferences I have drawn are contingent on an illustrative model of a hypothetical ZZ economy. Although this model has been constructed bearing very much in mind the macroeconomic features and policy concerns of contemporary New Zealand, the model is not a legitimate model of the actual New Zealand economy. Even as an illustrative analytical framework, moreover, the model is unproven and in need of further refinement and diagnostic evaluation.

Notwithstanding the preliminary nature of the evidence, some tentative conclusions can

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[25] These comparisons are most easily made by examining Appendix A or chart 14-2 below.

be drawn about the merits and demerits of efforts to engage in shorter-run macroeconomic stabilization. These conclusions are shaped with the New Zealand economy foremost in mind, but may apply generally to most other OECD nations as well (indeed, may be even more applicable, since most of the other OECD nations already engage in some form of output smoothing with their macroeconomic policies).

The first point to emphasize is that macroeconomic outcomes following the occurrence of a particular shock are likely to exhibit many similarities regardless of the specific reaction functions chosen by the monetary authority and the fiscal authority. The differences across policy regimes in the three shocks studied here, for example, are often less noteworthy than the similarities. This point, already observable in the earlier charts, is brought home forcefully in Figures 12, 13, and 14. These figures repeat data for real output and the inflation rate from earlier figures, but with all seven simulations (deviations from baseline) placed on the same graph. Results for the foreign recession, the terms-of-trade, and the capital destruction shocks are plotted in, respectively, Figures 12, 13, and 14.

A foreign recession will produce substantial output losses and price declines in the ZZ economy no matter what is done with the instruments of monetary and fiscal policy (Figure 12). An adverse terms-of-trade shock will depress output and temporarily increase the rate of inflation regardless of macroeconomic stabilization efforts (Figure 13). A capital destruction shock will unavoidably have large immediate damaging effects on output and play havoc with price stability (Figure 14).

No matter how skillful, in other words, neither discretionary stabilization policy nor the selection of alternative nondiscretionary rules for policy can work miracles. A highly open economy cannot be insulated from shocks originating abroad. Adverse welfare consequences are inevitable when bad things occur at home.

One of the risks associated with trying to use macroeconomic stabilization policy to mitigate the consequences of shocks is that the general public may expect, if not miracles, at least powerfully beneficial effects. Unrealistic expectations are bound to be disappointed. Unwarranted expectations can also be a problem themselves. When an economy experiences shocks that are likely to be persistent rather than transitory, the best response will often be a prompt rather than a cushioned adjustment. In such circumstances, unwarranted expectations about the efficacy of policy actions can put troublesome pressures on policymakers to misuse macroeconomic stabilization. These risks are a compelling reason why macroeconomic stabilization efforts in the form of output-smoothing rules should be adopted only cautiously and with explicit attention drawn to their limitations.

Given that miracles are impossible, can output smoothing play any role at all? My illustrative simulations suggest that rules for monetary policy that permit output smoothing in addition to the primary goal of inflation avoidance can foster marginally improved economic performance. Fiscal rules that permit output smoothing may also be able, in conjunction with monetary policy or acting alone, to make marginally helpful contributions. Judged from the perspective of stabilization properties, in other words, output-cushioning effects of the magnitude observed in Figures 12-1, 13-1, and 14-1 are important enough to command attention and to contemplate as possible short-run policy objectives.

Note also that the simulations in this paper do not provide support for the proposition that any form of output smoothing in a monetary-policy rule is bound, from a stabilization perspective, to undercut achievement of the central bank's long-run inflation target. On the contrary. Especially if the output smoothing were to take the form of a rule targeting the level of nominal GDP, there would be no less assurance than with either inflation-rate targeting or price-level targeting of keeping inflation firmly under long-run control.

The shorter run could be another matter. Monetary or fiscal rules that succeed in mitigating the variability of output could conceivably, at least for some types of shocks, produce more variability in inflation than would otherwise be observed. The simulations studied in this paper do not shed clear light on this possibility. The possible tradeoff between output variability and inflation variability is an important issue for further research.

The evidence in this paper about the pros and cons of including output smoothing in a rule for fiscal policy is especially preliminary. Such as it is, the evidence suggests that incorporating output smoothing into a fiscal rule requires even more caution than doing so for monetary policy. Adjustments in tax rates or in expenditures consequent on output smoothing might be fairly large, and would entail costs in the form of distortions from stable long-run tax rates. The intertemporal shifting of consumption and saving caused by adjustments in a fiscal rule could also pose complex questions of intergenerational transfers, complicating further any welfare judgments.

One feature of the graphical evidence in this paper is persistently striking. “Drift” in the price level or in other nominal variables can be significant, even highly problematic, with any monetary-policy rule that targets the rate of growth of a nominal variable rather than its level. This issue of drift, known to be important for inflation-rate targeting, becomes still more of an issue for a rule that combines inflation-rate targeting with output smoothing.

Figures 15, 16, and 17 collect together all the simulation results for the price level (deviation from baseline) for, respectively, the foreign recession, the terms-of-trade, and the capital destruction shocks. As discussed earlier but seen especially clearly in these last figures, the simulations for rule F -- regime F1 and even more so regime F2 -- are highly prone to drift. The terms-of-trade shock and the capital destruction shock cause especially pronounced and persistent drift in the price level (and nominal exchange rate). Future research needs to conduct careful analysis of the costs associated with such drift. This topic is part of the broader study required of the relative merits of targeting levels of growing variables versus targeting their rates of change.[26]

As a last set of points, consider the similarities and differences between nominal-GDP targeting (monetary rule D) and price-level targeting (rule C).[27] These two rules can often perform relatively similarly for a variety of shocks, especially when shocks originate from demand disturbances and thus cause prices and outputs initially to move in same direction. The foreign recession shock in this study is an example. If shocks occur that initially move prices and outputs in opposite directions, however, the differences can become much more important. The terms-of-trade shock in this study, and to a lesser degree the capital destruction shock, offer examples.

Bennett McCallum has argued that nominal-GDP targeting is likely to be preferable to

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[26] Bennett McCallum (1993, 1996) has led the way in emphasizing the importance of this study.

[27] This comparison is more straightforward than a comparison between nominal-GDP targeting (D) and inflation-rate targeting (B), since both rules D and C focus on the (growing) <u>level</u> of the respective targeted variables, whereas rule B focuses on a targeted <u>rate of change</u>.

price-level or inflation-rate targeting.[28] He emphasizes the evidence that the prices of goods and services tend to react more slowly than output. He also believes that the economics profession has a smaller degree of uncertainty about the determination of changes in nominal GDP than about the the split of changes in nominal GDP into their separate inflation and real growth components. These considerations lead him to believe that instrument instability problems will prove less difficult and that the design of a policy rule can be more successful with nominal-GDP targeting than with price-level or inflation-rate targeting. McCallum also downplays the often-expressed objection to nominal-GDP targeting that national income statistics are prepared with insufficient frequency, with too great a lag, and are revised by unacceptably large amounts. The evidence in this paper, particularly for the terms-of-trade shock, gives some support to the McCallum preference for nominal-GDP targeting over price-level targeting.

In his arguments for nominal-GDP targeting, McCallum tends not to highlight output smoothing as an additional explicit goal of monetary policy to supplement inflation control. But he of course recognizes that nominal-GDP targeting does entail this objective.

After further research with the ZZ model, I hope to report results comparing inflation-rate targeting (monetary rule B) with one or more variants of a rule targeting the growth rate of nominal GDP (rule E -- see Figure 1). This comparison would be the rates-of-change analog (because both rules focus on a targeted rate of change) to the levels comparison between rules C and D. My conjecture is that this comparison between rules B and E will also give some support to McCallum's preference for nominal GDP as a target variable over prices alone (both expressed as growth rates).

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[28] McCallum (1988, 1993, 1996); see, for example, section VI in the 1996 paper.

The Information Requirements of Alternative Rules

To put the preceding conclusons in perspective, I want to stress again that this paper focuses only on the stabilization properties of alternative rules. The credibility properties of rules, issues about transparency in the conduct of policies, the need to insulate policy decisions from political pressures that could lead to abuse of macroeconomic stabilization -- all these aspects need equal attention before general conclusions can be drawn about the appropriate conduct of macroeconomic policies.

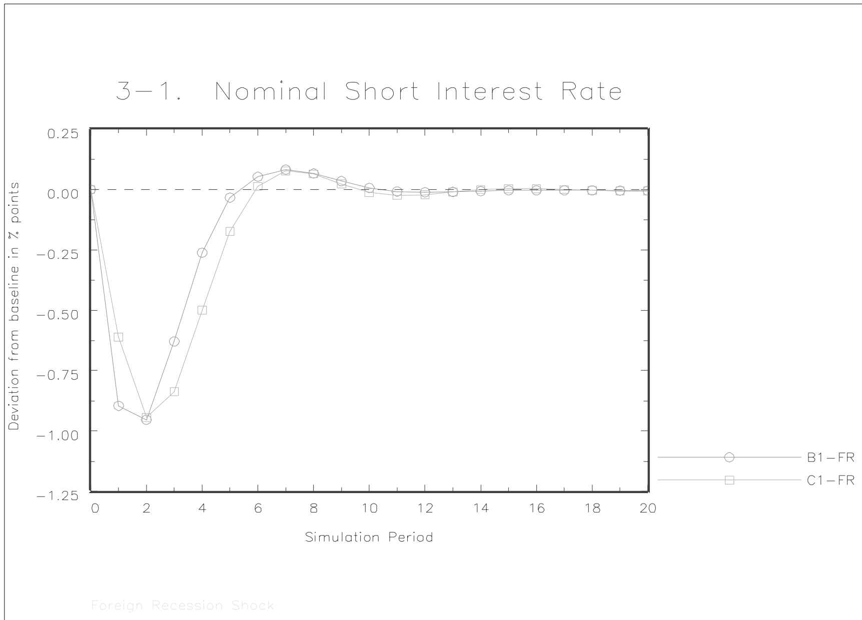
This paper also does not discuss the issues of uncertainty about the functioning of the economy ("model uncertainty") and the information requirements for a successful macroeconomic stabilization policy. My hope is that these important issues will not stand in the way of a thoughtful examination of what the paper does suggest about the stabilization properties of alternative rules.

Are policymakers very uncertain about how the New Zealand economy or any other national economy really functions? The answer is of course yes. Does anyone have a genuinely reliable model of the New Zealand economy or the economy of any other OECD nation? The answer: of course not. When various types of nonpolicy shocks hit an economy, is it possible promptly and accurately to identify them? The answer is, again, of course not. Only well after the fact, and sometimes not even then, can analysis be reasonably sure what the disturbances have been.

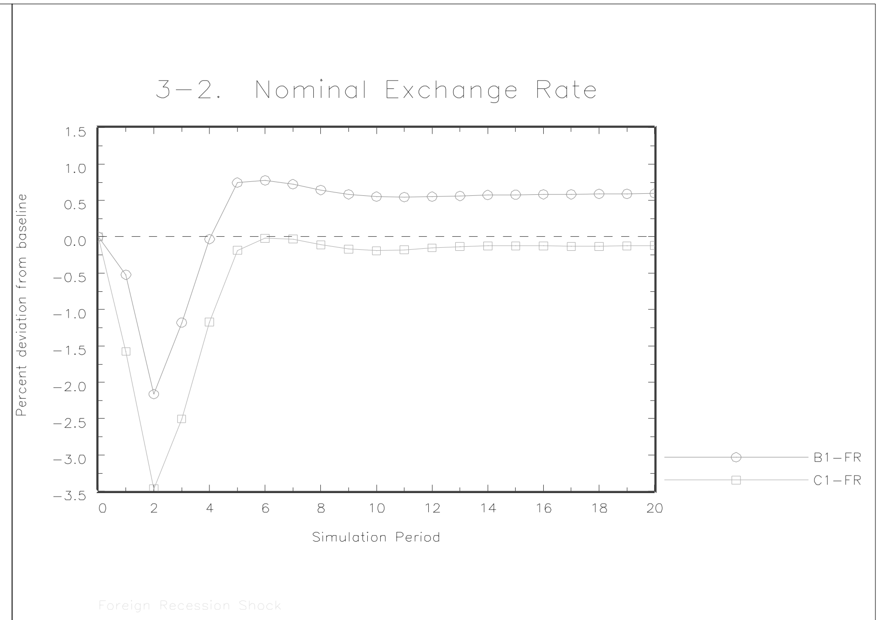
The information requirements for a successful stabilization policy are thus incredibly demanding. And policymakers do not begin to have the amounts and types of information ideally required.

Once these points are acknowledged, it is also pertinent to observe that things were ever thus. For the foreseeable future, furthermore, they will continue to be thus -- for ANY possible approach to conducting monetary policy and fiscal policy. I am always amused by the way that many people stress model uncertainty and the incredibly demanding information requirements of stabilization policy as a reason for rejecting somebody's else's approach to conducting policy , but never the one that they happen to favor.

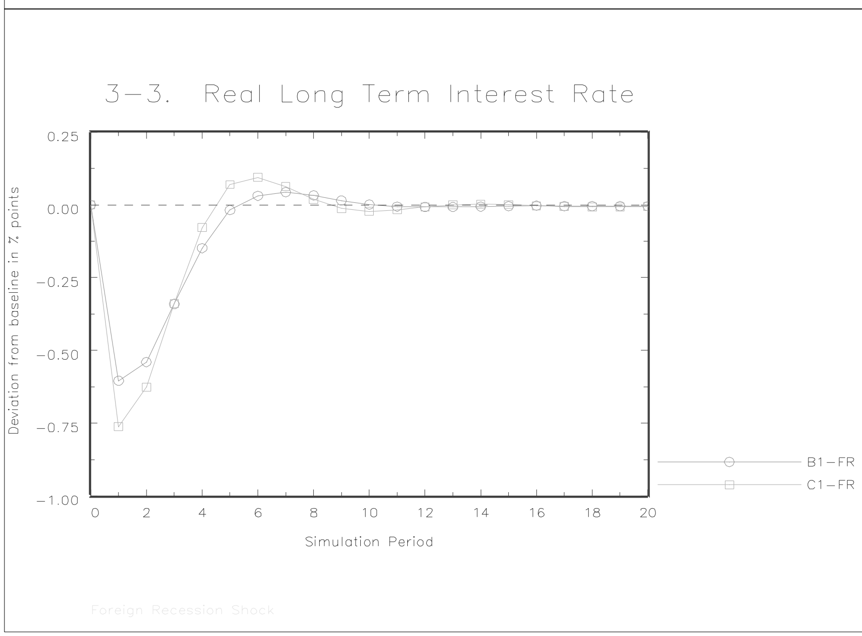
As an example, take the inflation-targeting procedures currently favored by the Reserve Bank of New Zealand. As every member of the forecasting and analysis team at the Reserve Bank knows well, these procedures pose highly demanding information requirements and are bedevilled by model uncertainty. Real-life variants of the alternative rules studied in this paper would have somewhat different information requirements than the current procedures. Data on nominal GDP, real output, and potential real output are not fully reliable; they are reported with a substantial lag; they are often significantly revised; and so on. But in some degree the same points are valid for the data on general price indexes. It is difficult for me to believe that the information requirements of any of the alternative rules studied here are an order of magnitude so much greater than the requirements of the existing inflation-targeting procedure that the alternative rules fail to warrant serious comparison with inflation-rate targeting.



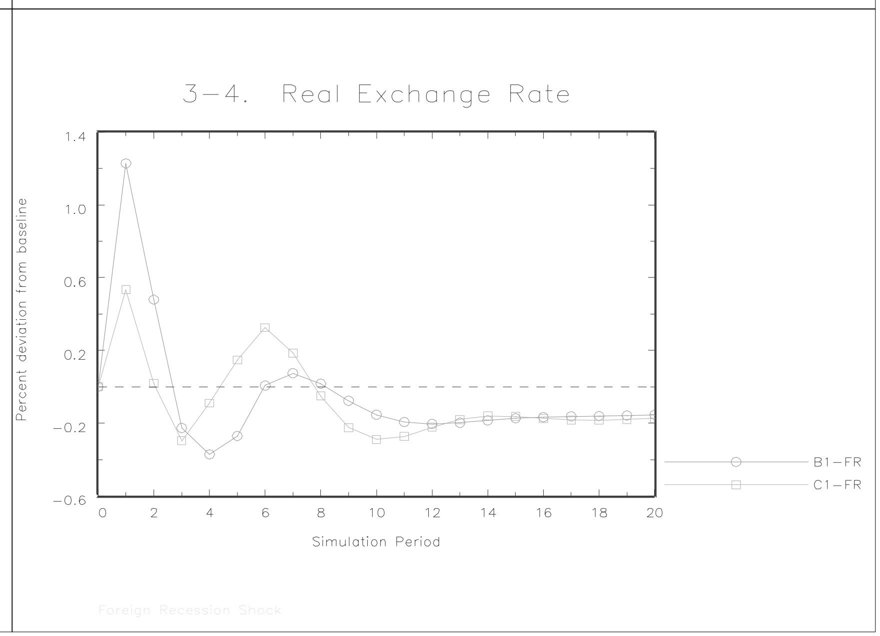
3−1. Nominal Short Interest Rate
Deviation from baseline in % points
Simulation Period
B1−FR
C1−FR
Foreign Recession Shock



3−2. Nominal Exchange Rate
Percent deviation from baseline
Simulation Period
B1−FR
C1−FR
Foreign Recession Shock

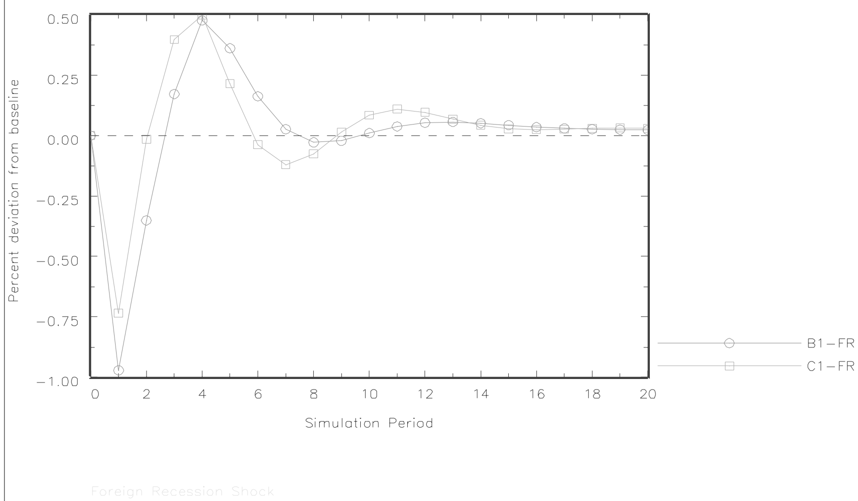


3−3. Real Long Term Interest Rate
Deviation from baseline in % points
Simulation Period
B1−FR
C1−FR
Foreign Recession Shock

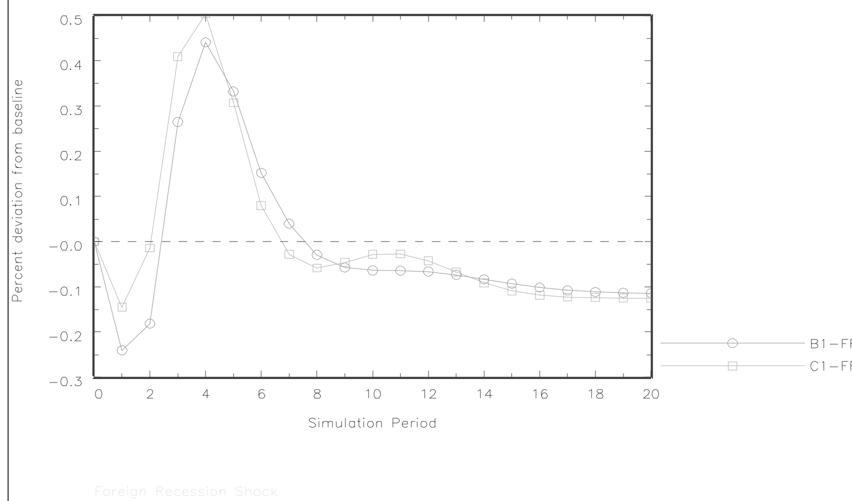


3−4. Real Exchange Rate
Percent deviation from baseline
Simulation Period
B1−FR
C1−FR
Foreign Recession Shock

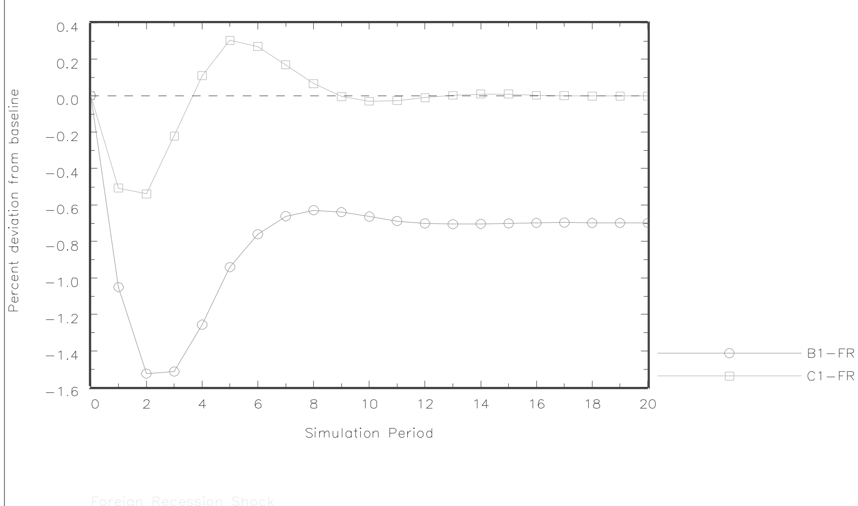
3-5. Real Output (GDP)



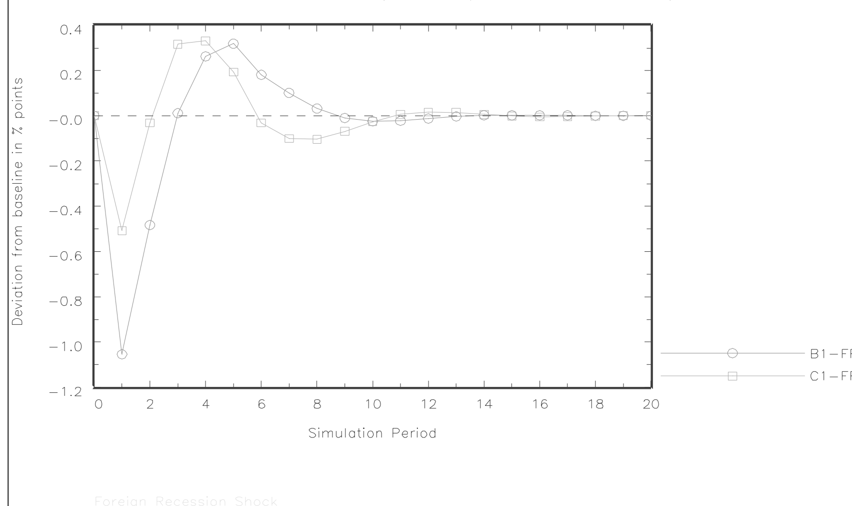
3-6. Real Private Consumption

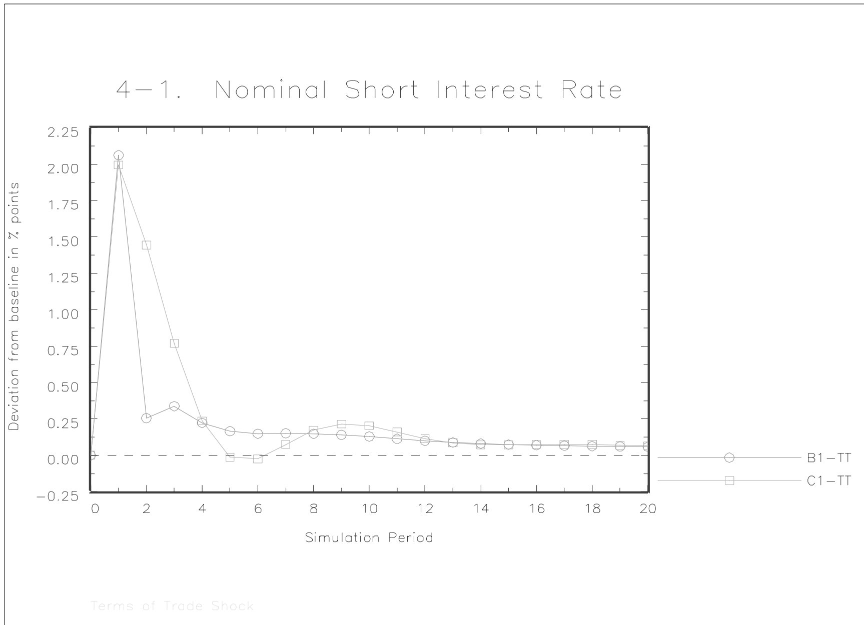


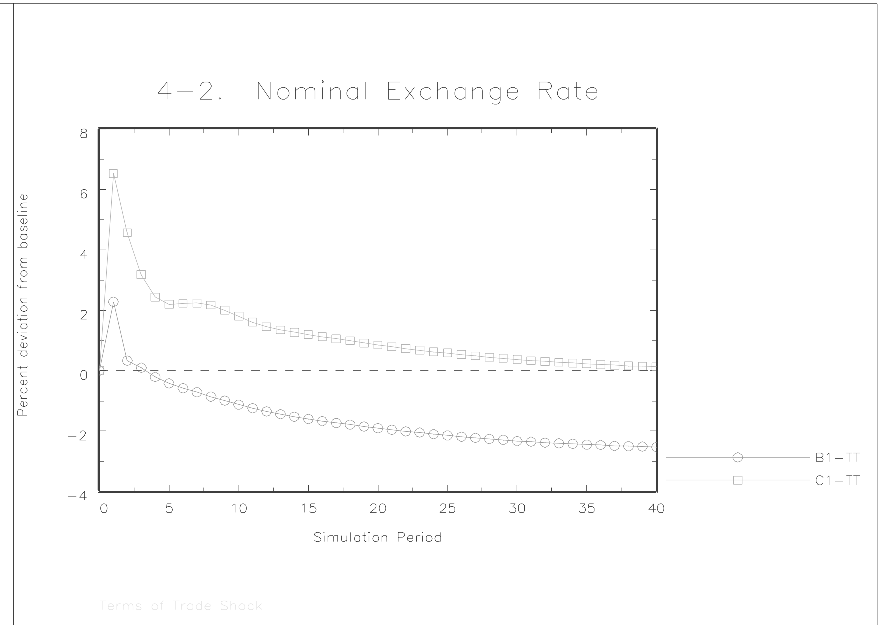
3-7. Price Level (Absorption Deflator)

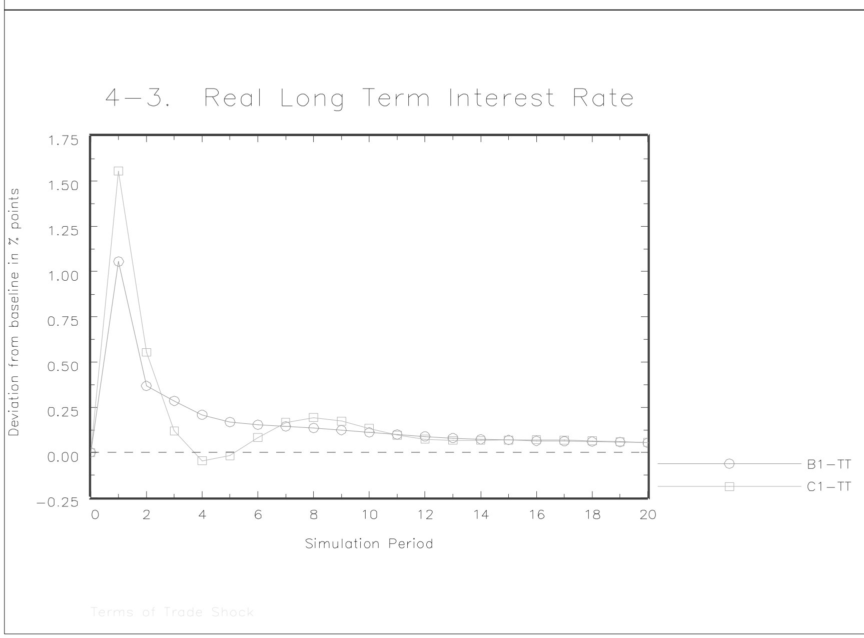


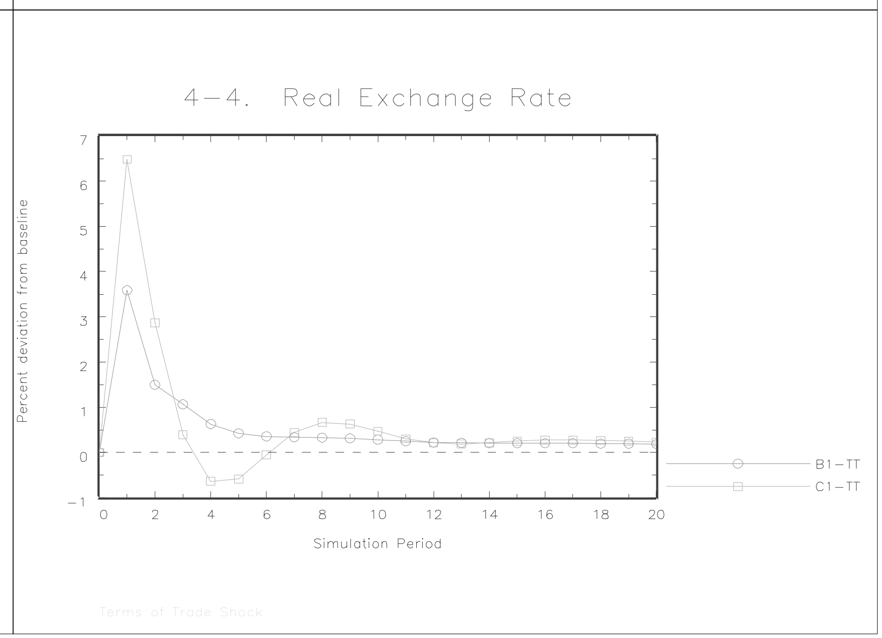
3-8. Inflation Rate (Absorption Deflator)



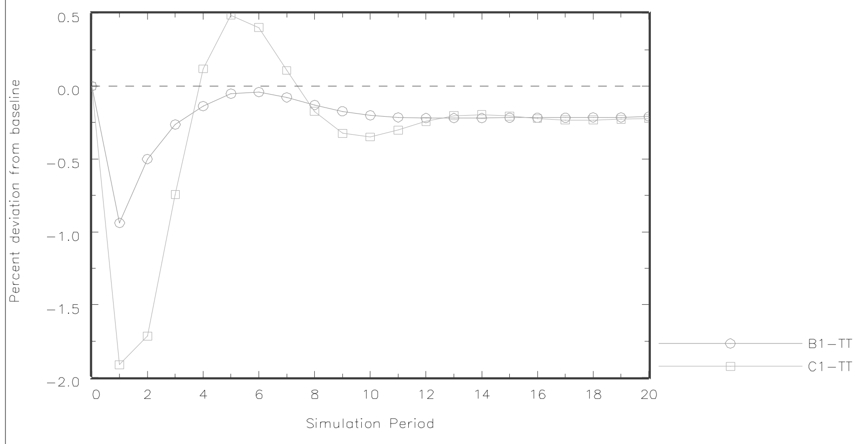

4−1. Nominal Short Interest Rate
Deviation from baseline in % points
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
0
2
4
6
8
10
12
14
16
18
20
Simulation Period
B1−TT
C1−TT
Terms of Trade Shock


4−2. Nominal Exchange Rate
Percent deviation from baseline
8
6
4
2
0
−2
−4
0
5
10
15
20
25
30
35
40
Simulation Period
B1−TT
C1−TT
Terms of Trade Shock

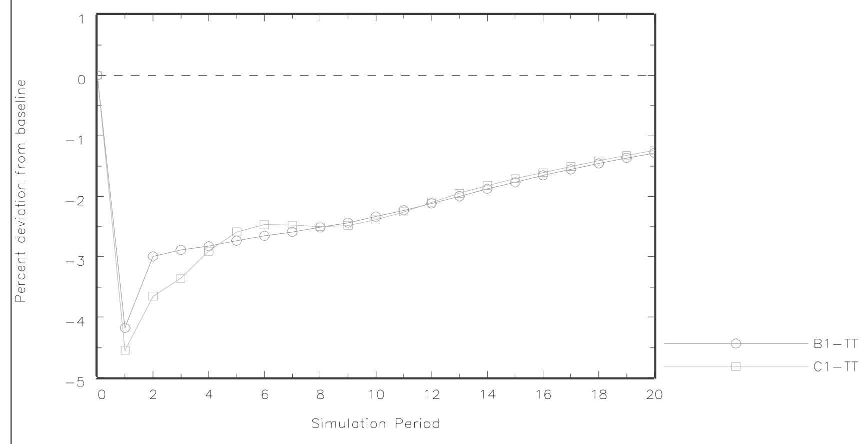

4−3. Real Long Term Interest Rate
Deviation from baseline in % points
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
0
2
4
6
8
10
12
14
16
18
20
Simulation Period
B1−TT
C1−TT
Terms of Trade Shock


4−4. Real Exchange Rate
Percent deviation from baseline
7
6
5
4
3
2
1
0
−1
0
2
4
6
8
10
12
14
16
18
20
Simulation Period
B1−TT
C1−TT
Terms of Trade Shock

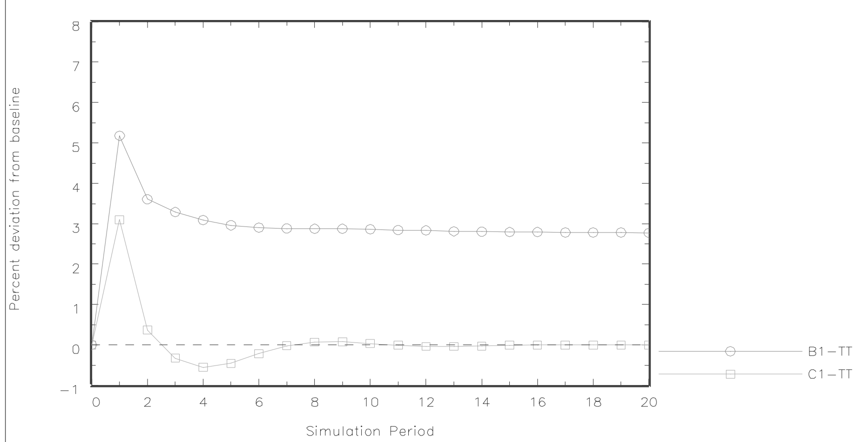
4–5. Real Output (GDP)



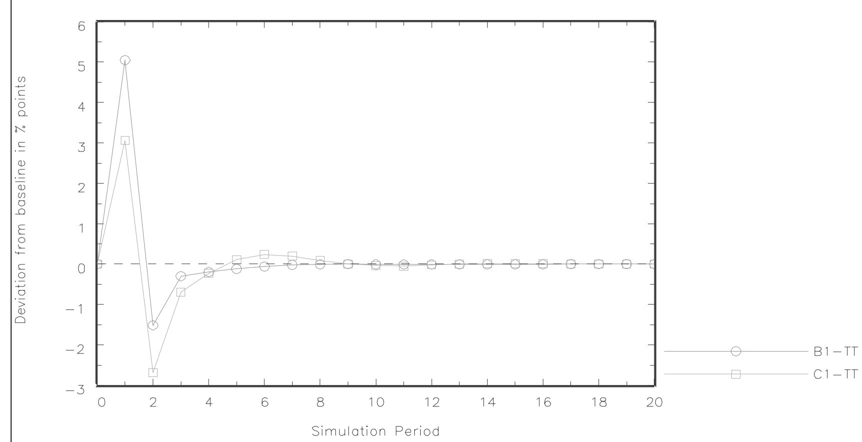
4–6. Real Private Consumption

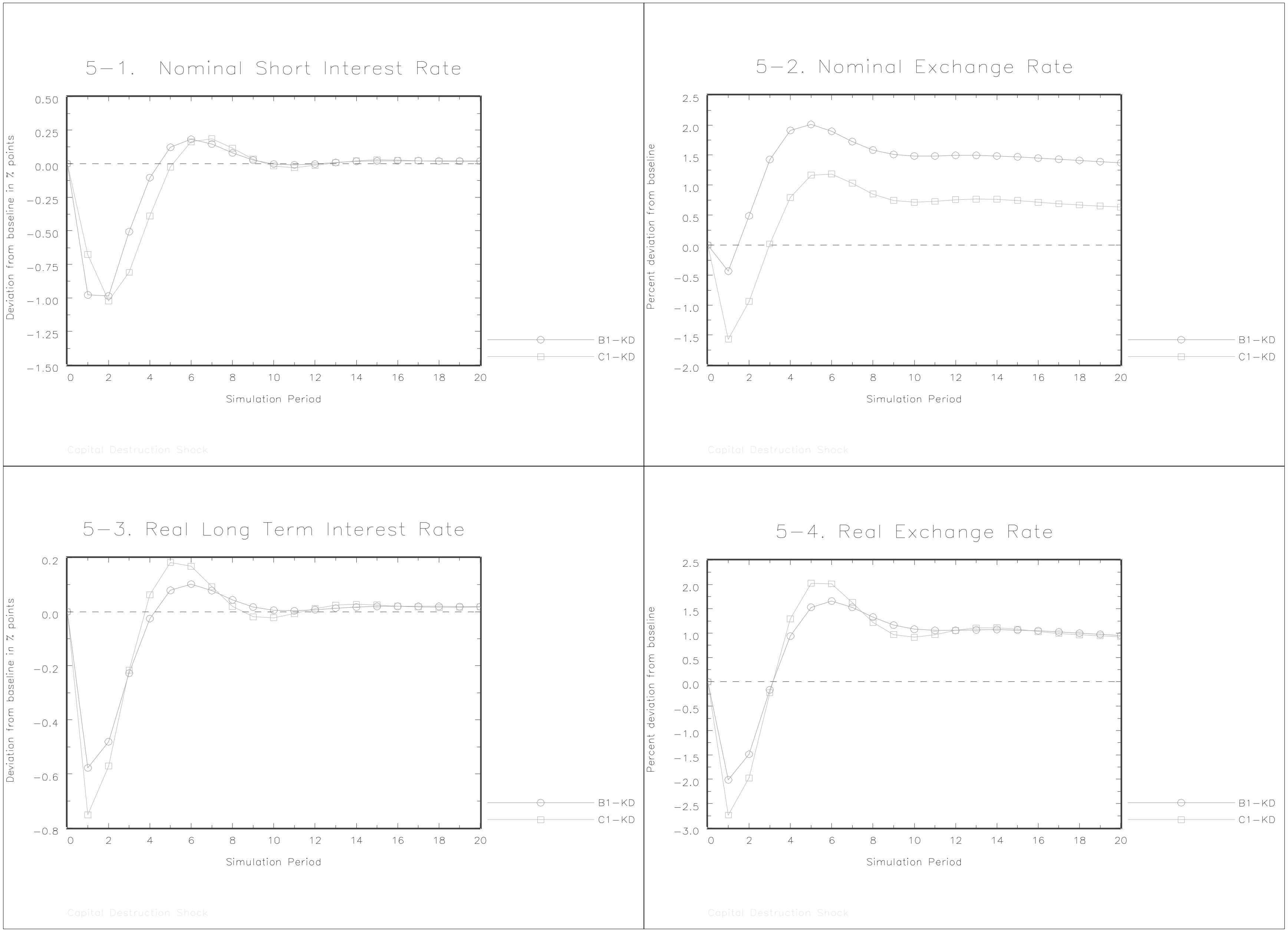


4–7. Price Level (Absorption Deflator)

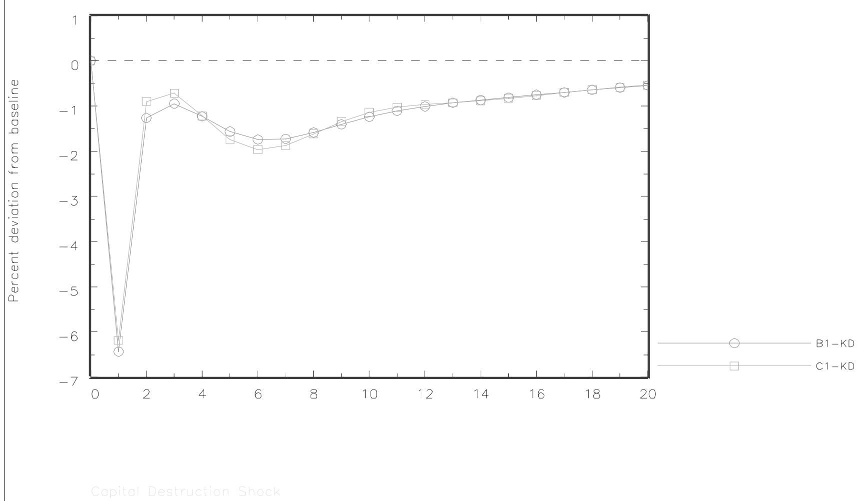


4–8. Inflation Rate (Absorption Deflator)

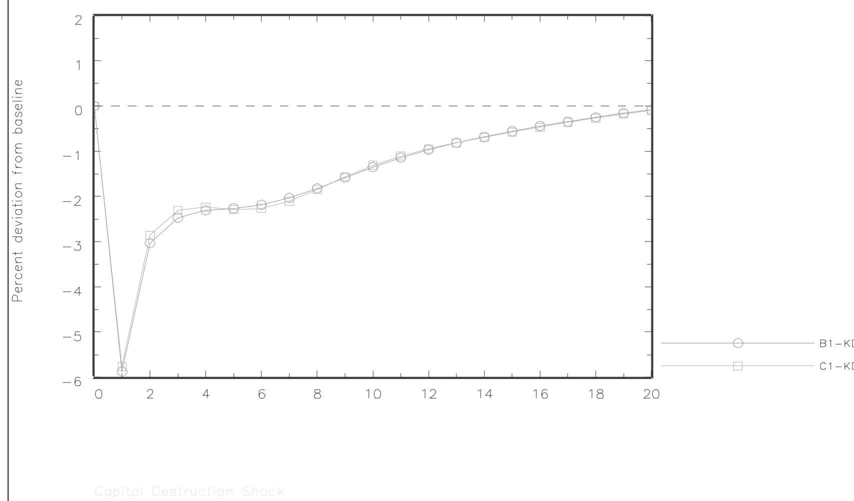



5−1. Nominal Short Interest Rate
Deviation from baseline in % points
Simulation Period
B1−KD
C1−KD
5−2. Nominal Exchange Rate
Percent deviation from baseline
Simulation Period
B1−KD
C1−KD
5−3. Real Long Term Interest Rate
Deviation from baseline in % points
Simulation Period
B1−KD
C1−KD
5−4. Real Exchange Rate
Percent deviation from baseline
Simulation Period
B1−KD
C1−KD

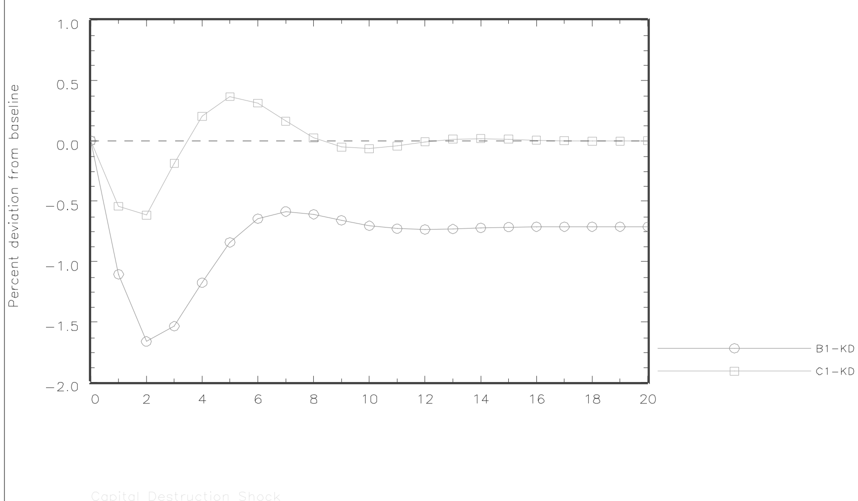
5-5. Real Output (GDP)



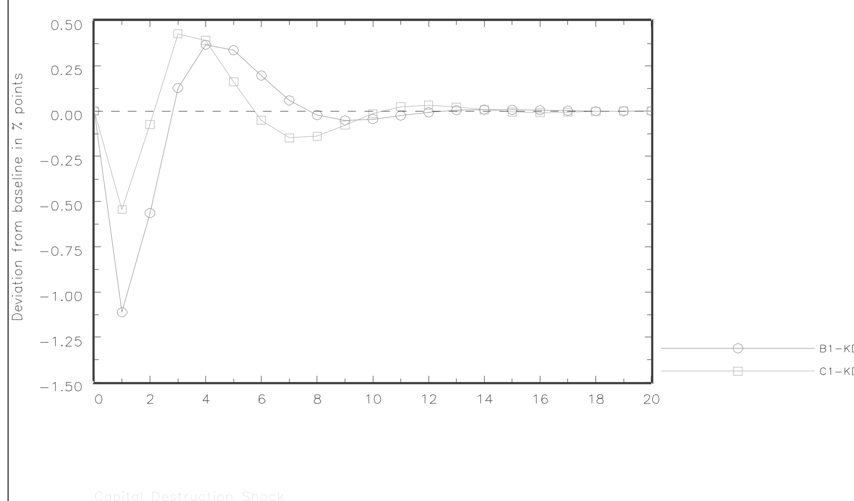
5-6. Real Consumption



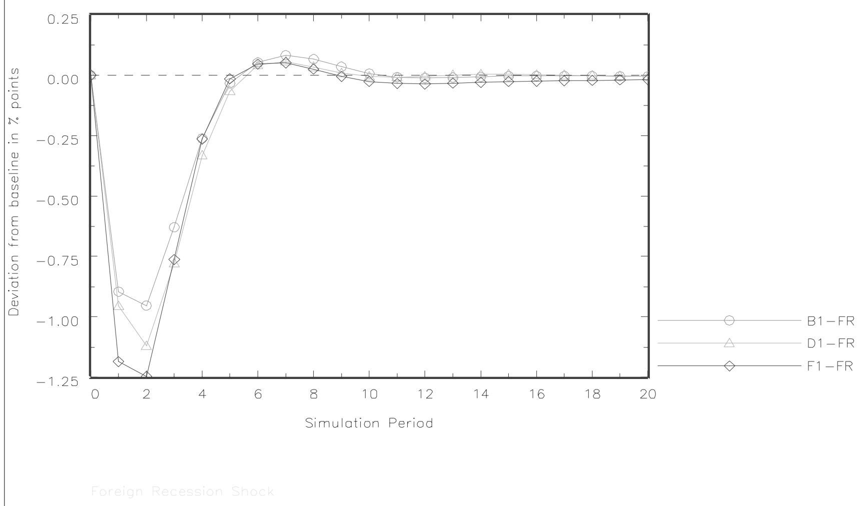
5-7. Price Level (Absorption Deflator)



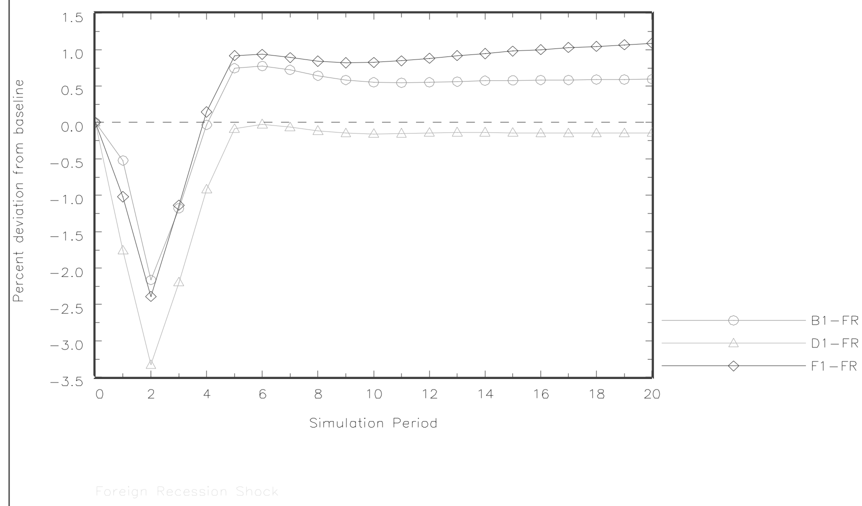
5-8. Inflation Rate (Absorption Deflator)



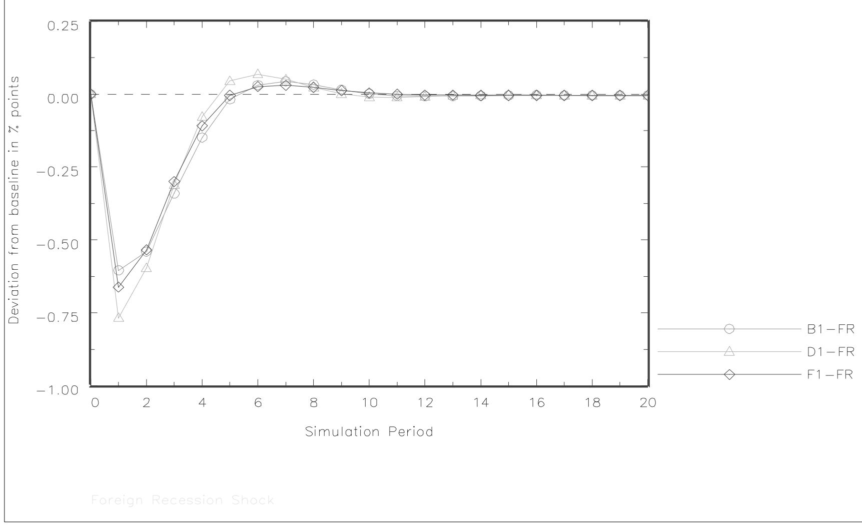
6-1. Nominal Short Interest Rate



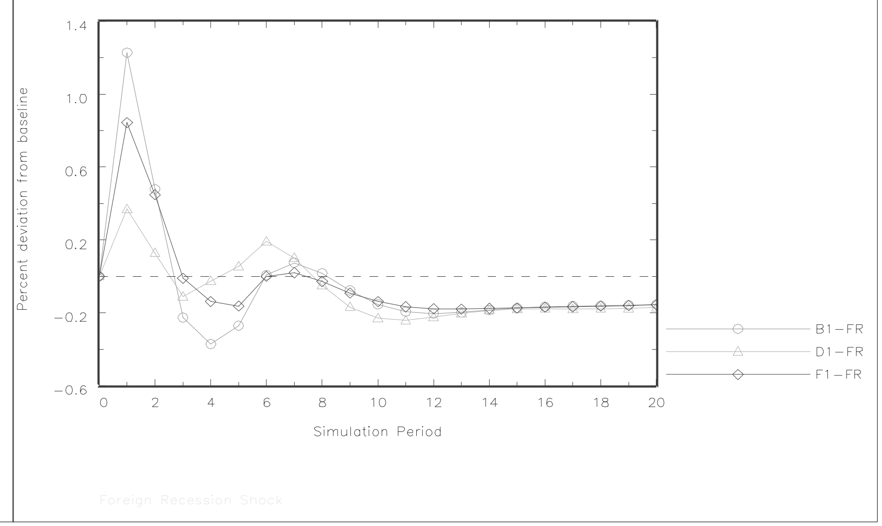
6-2. Nominal Exchange Rate



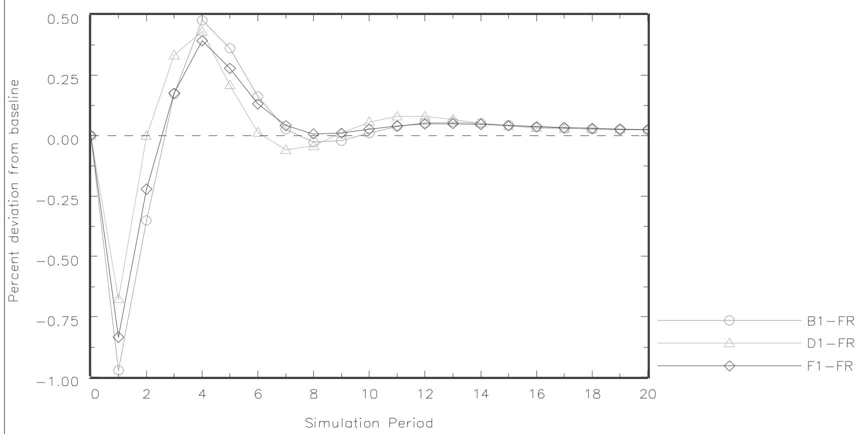
6-3. Real Long Term Interest Rate



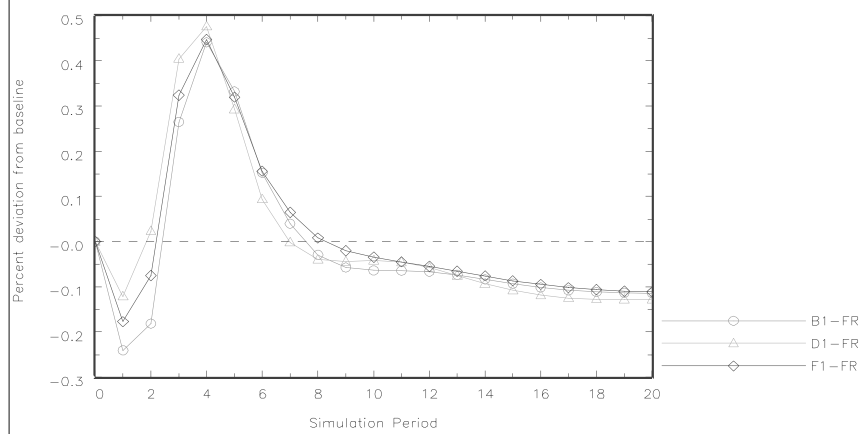
6-4. Real Exchange Rate



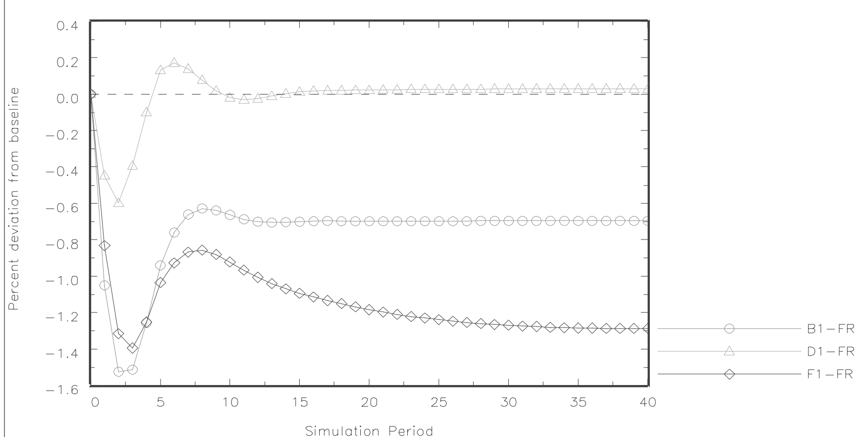
6–5. Real Output (GDP)



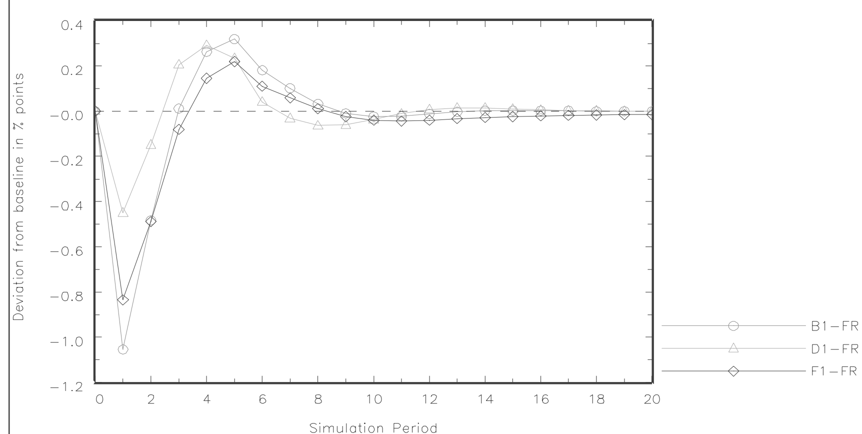
6–6. Real Private Consumption



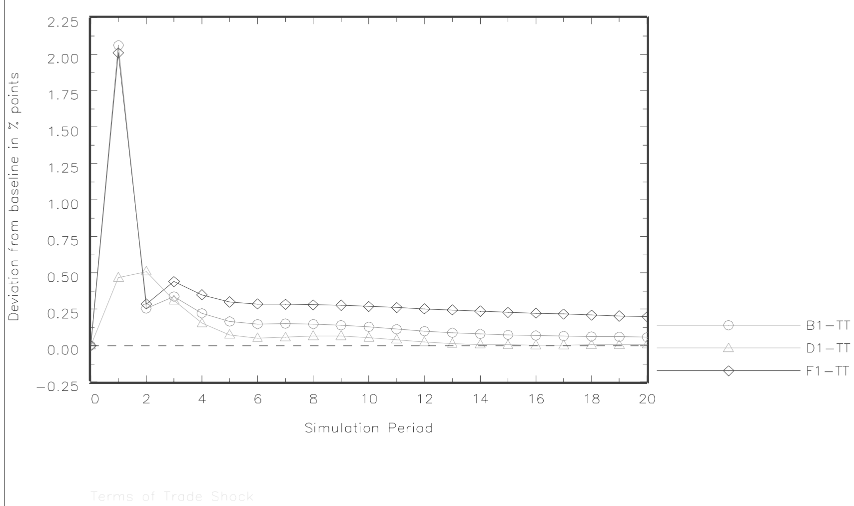
6–7. Price Level (Absorption Deflator)



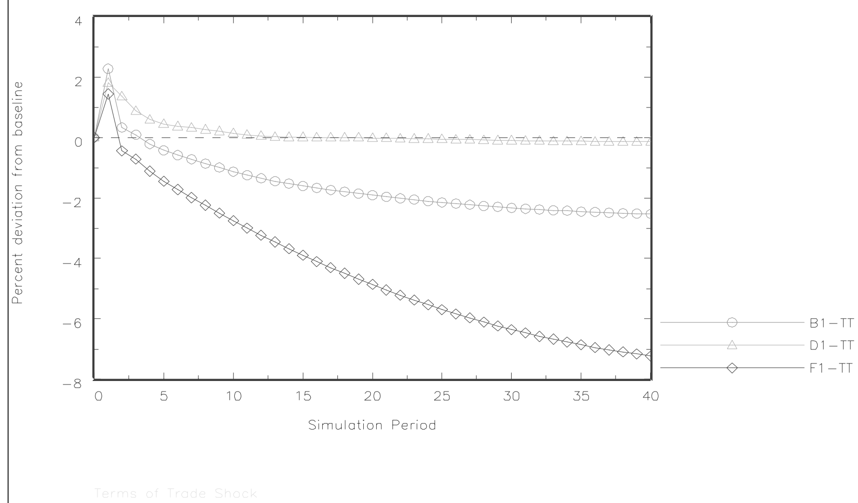
6–8. Inflation Rate (Absorption Deflator)



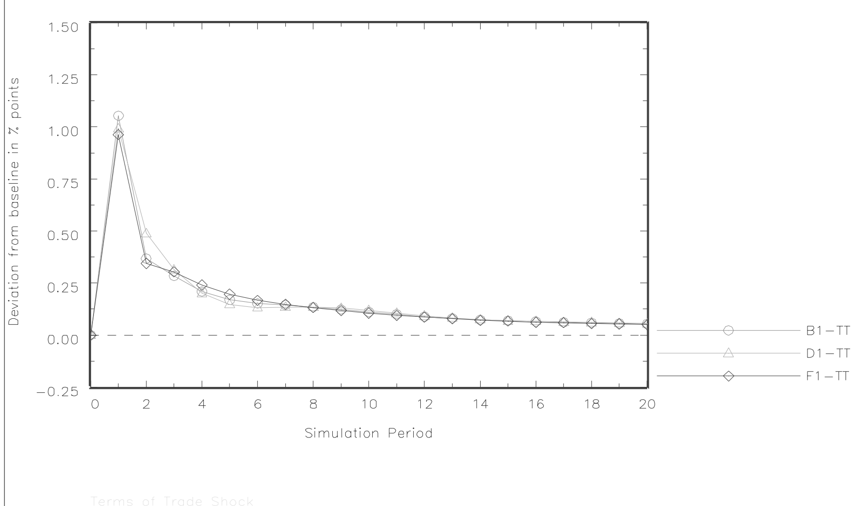
7–1. Nominal Short Interest Rate



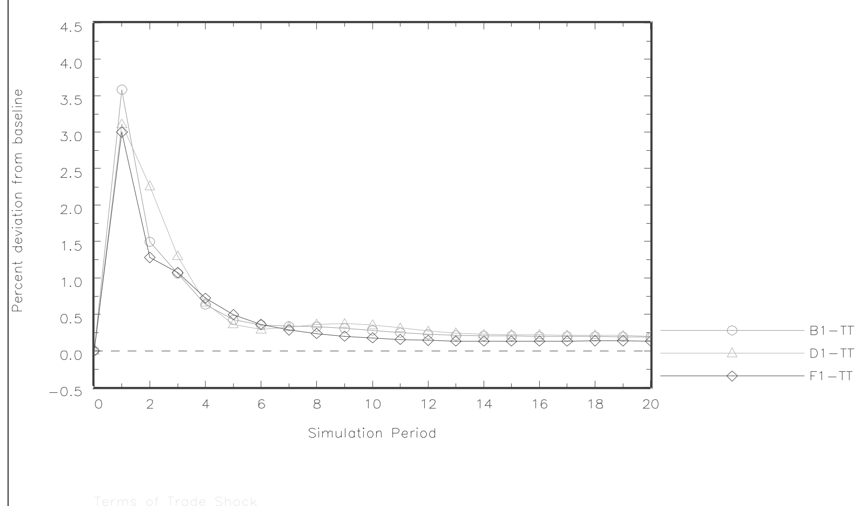
7–2. Nominal Exchange Rate



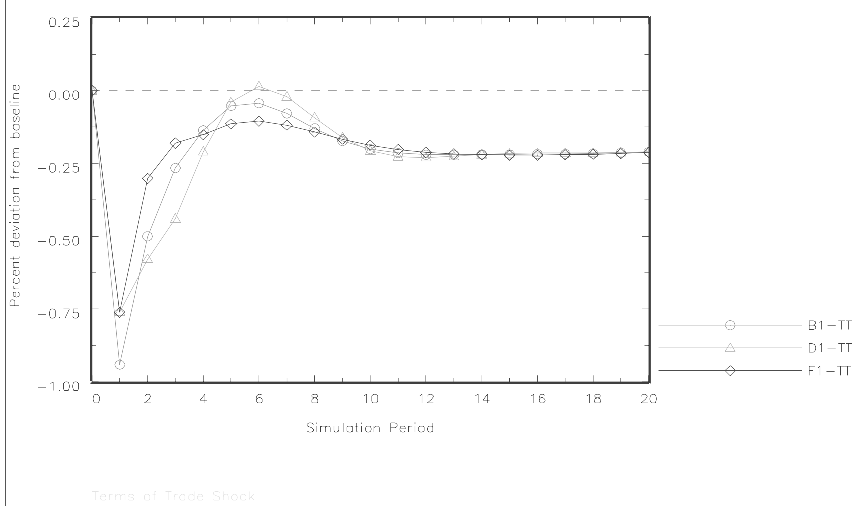
7–3. Real Long Term Interest Rate



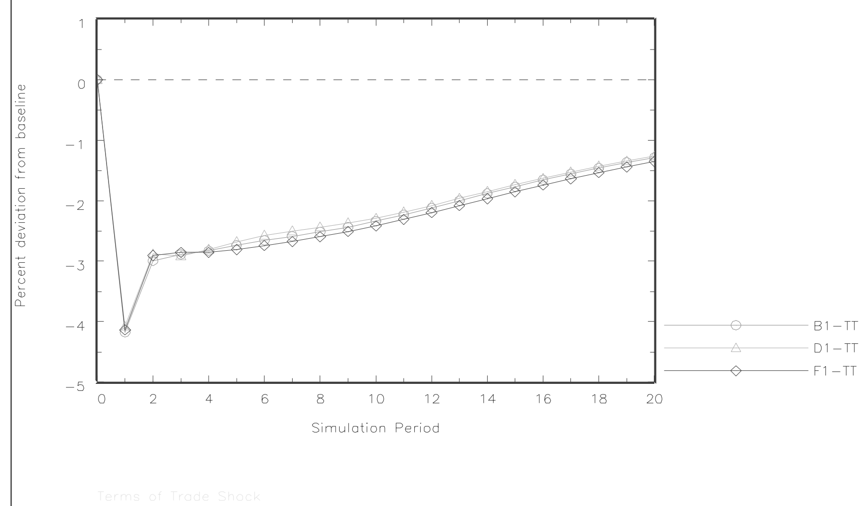
7–4. Real Exchange Rate



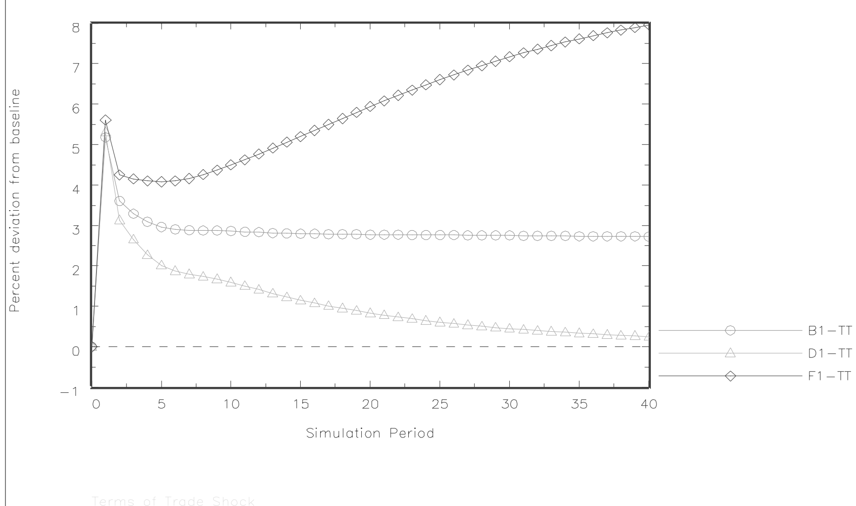
7–5. Real Output (GDP)



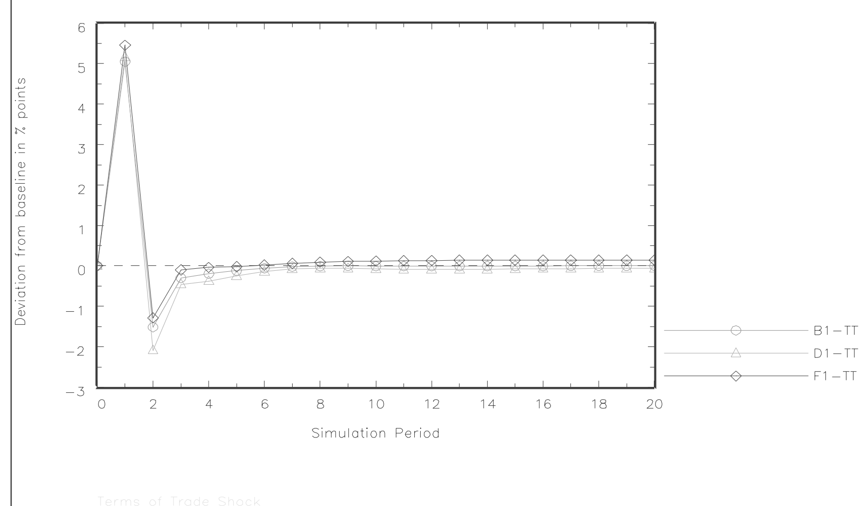
7–6. Real Private Consumption

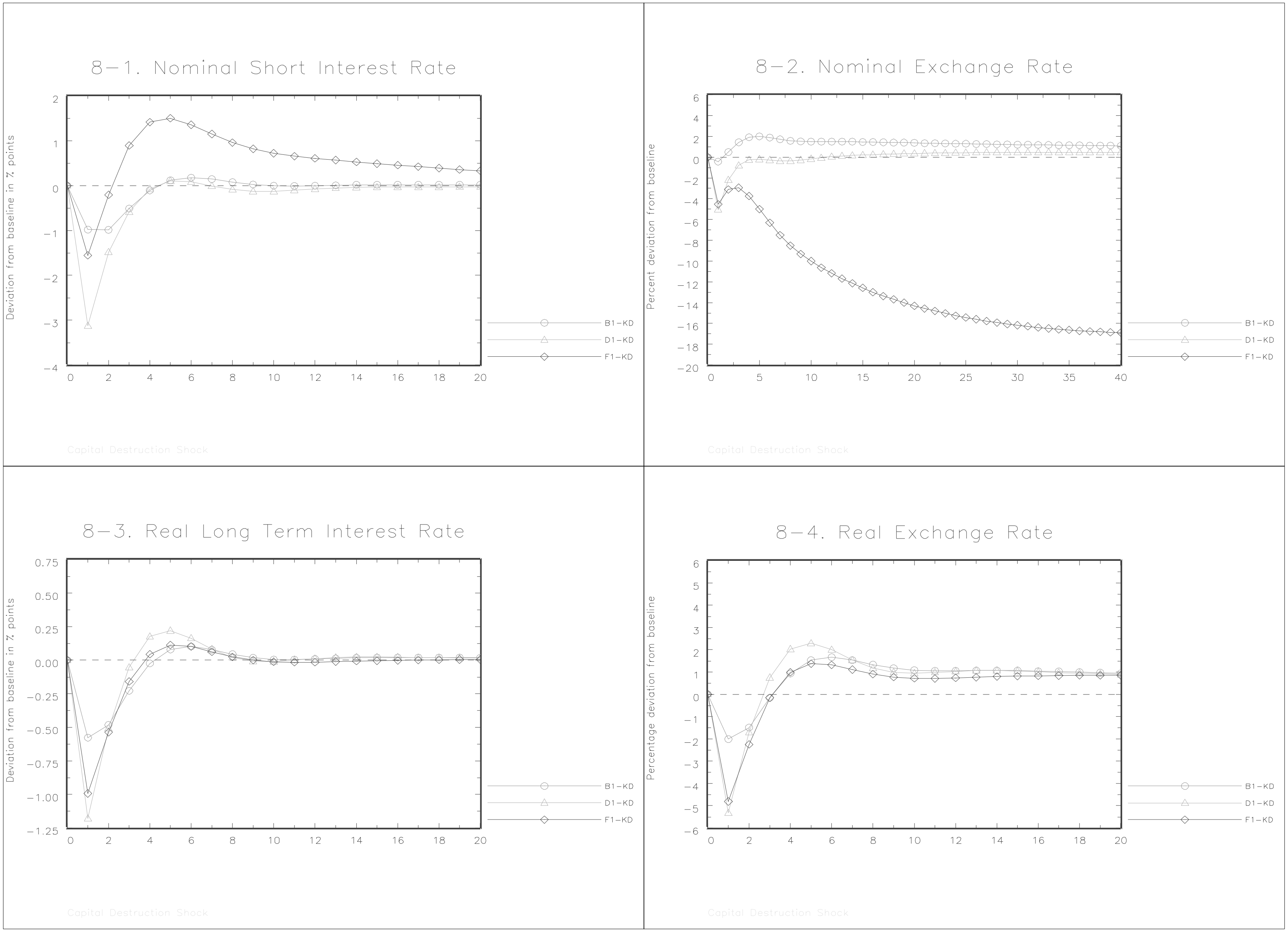


7–7. Price Level (Absorption Deflator)



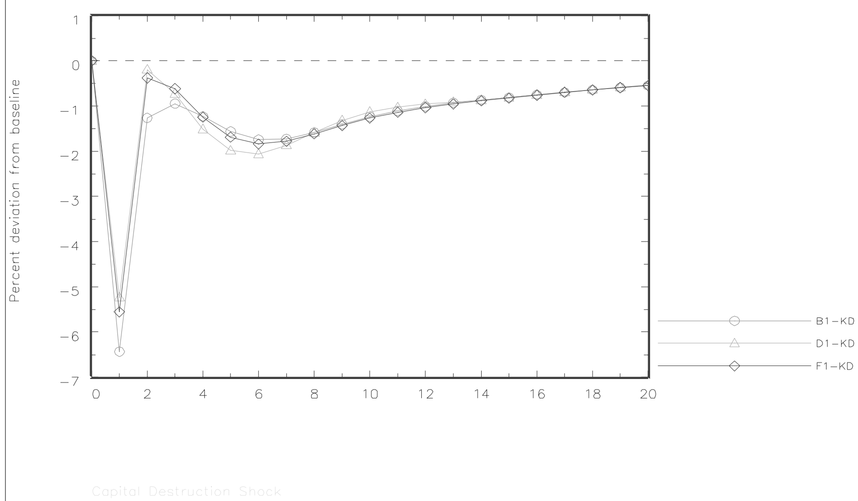
7–8. Inflation Rate (Absorption Deflator)



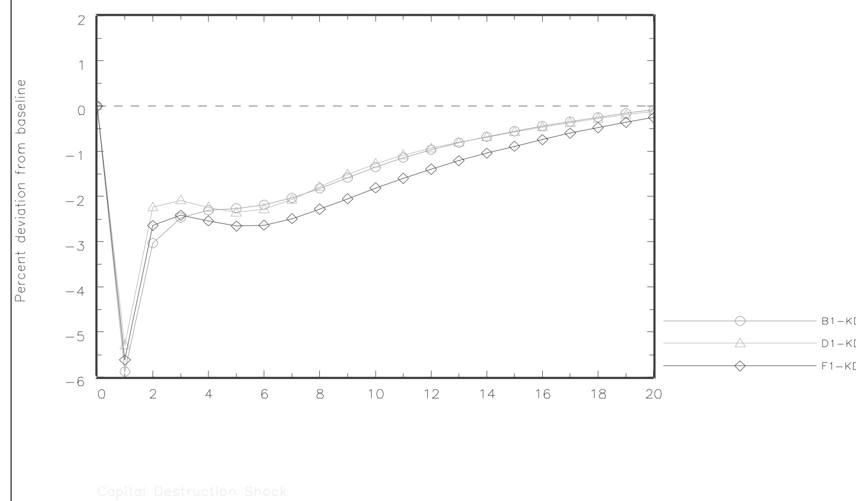


8−1. Nominal Short Interest Rate
Deviation from baseline in % points
8−2. Nominal Exchange Rate
Percent deviation from baseline
8−3. Real Long Term Interest Rate
Deviation from baseline in % points
8−4. Real Exchange Rate
Percentage deviation from baseline
B1−KD
D1−KD
F1−KD
Capital Destruction Shock

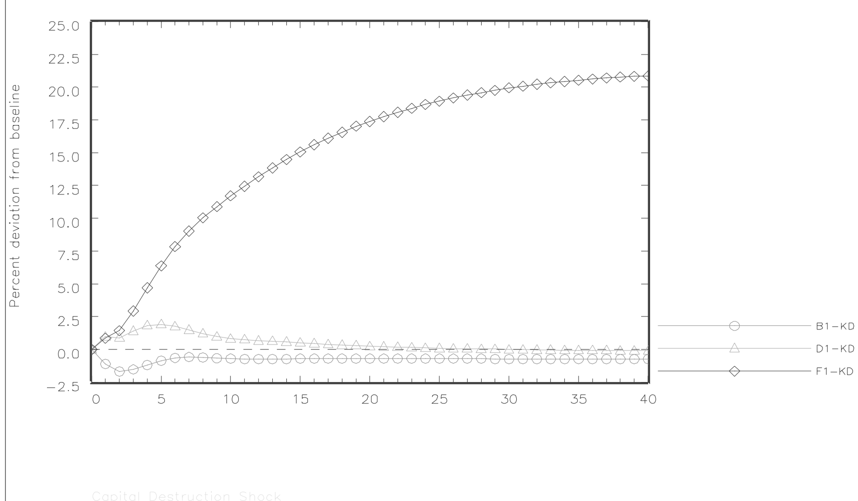
8–5. Real Output (GDP)



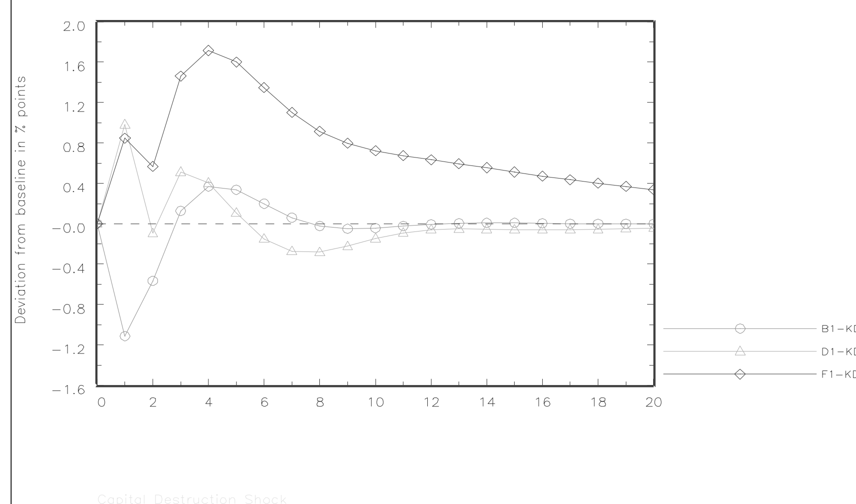
8–6. Real Consumption



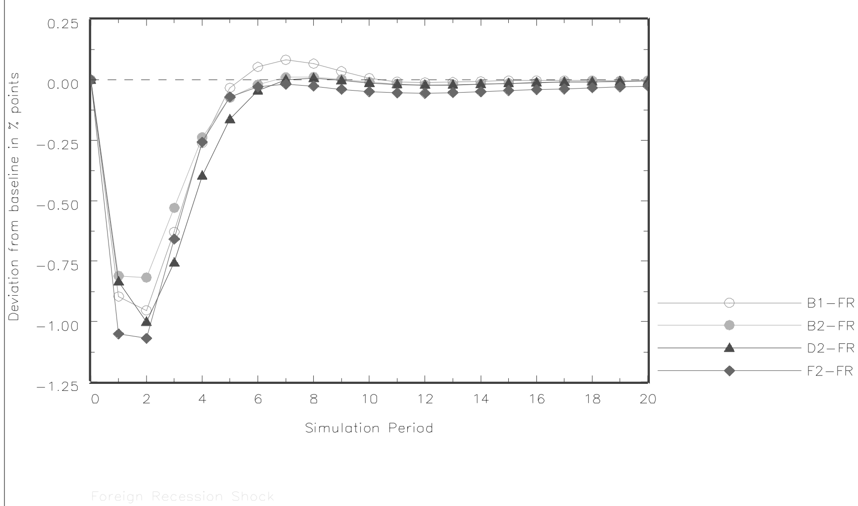
8–7. Price Level (Absorption Deflator)



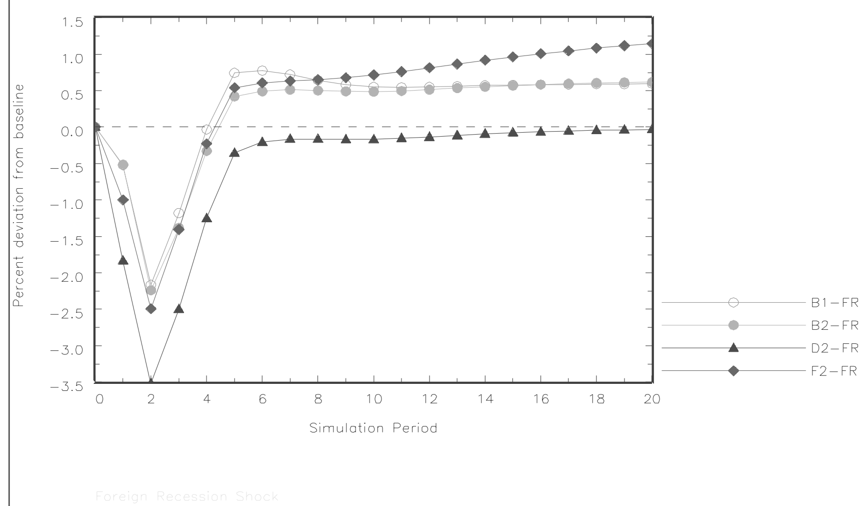
8–8. Inflation Rate (Absorption Deflator)



9−1. Nominal Short Interest Rate



9−2. Nominal Exchange Rate



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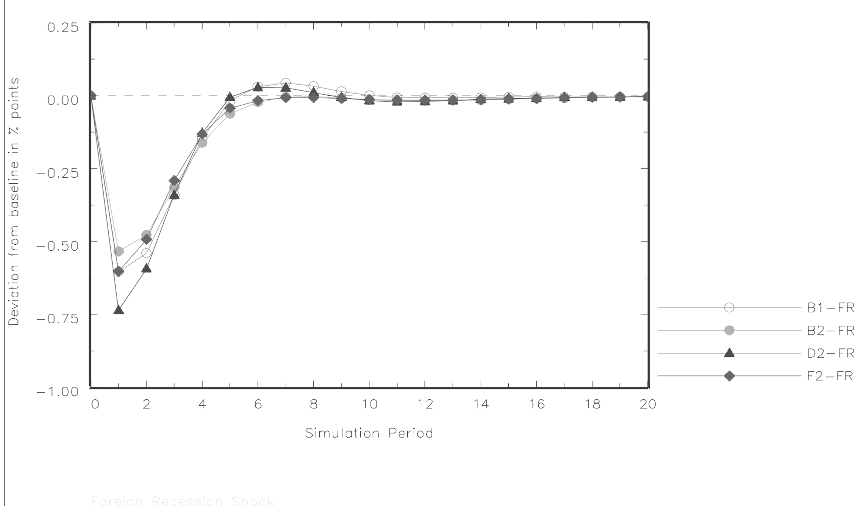
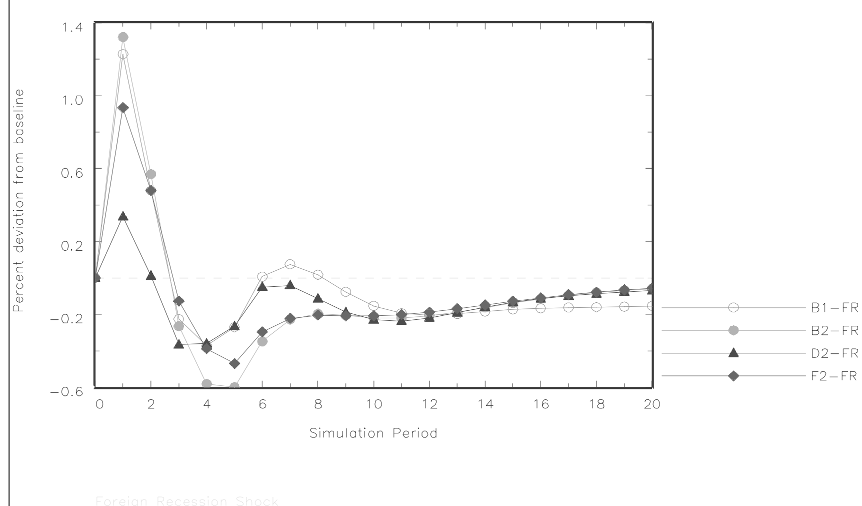
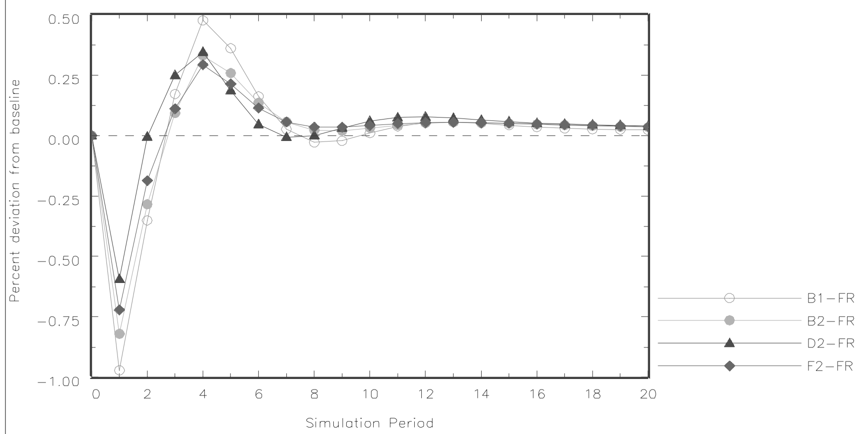


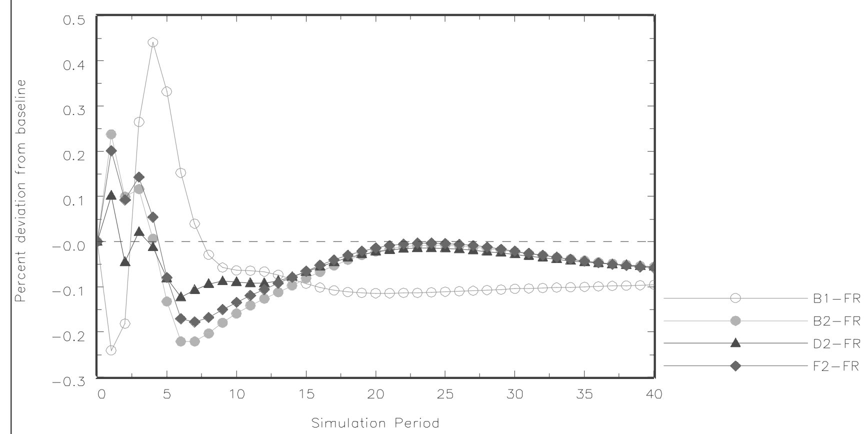
9−4. Real Exchange Rate



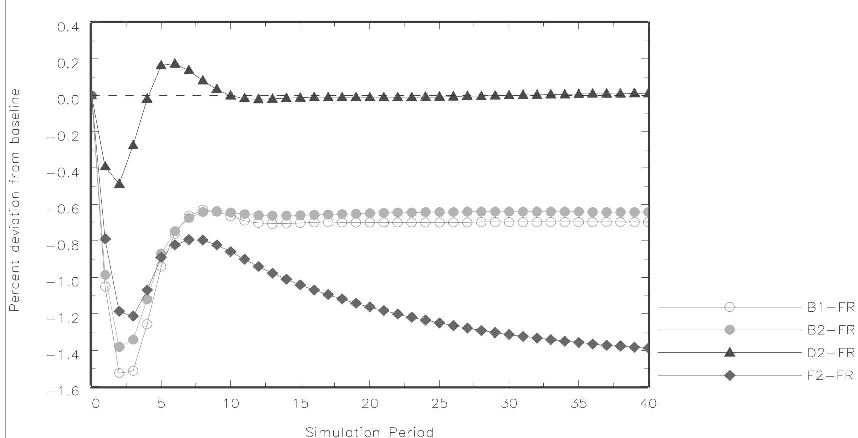
9–5. Real Output (GDP)



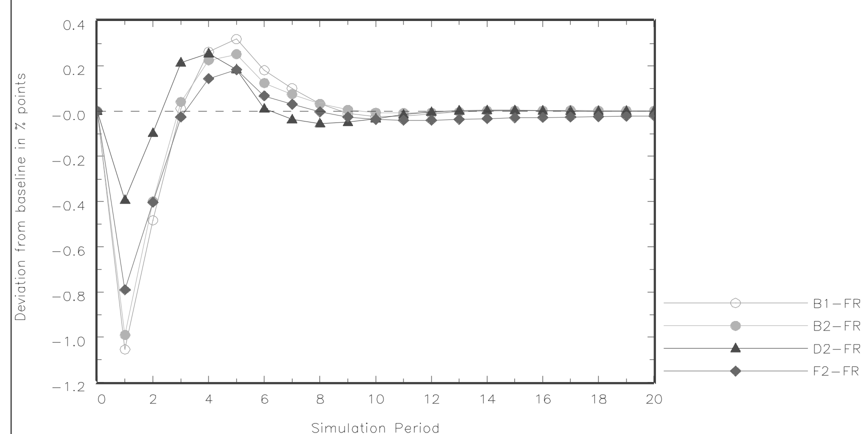
9–6. Real Private Consumption



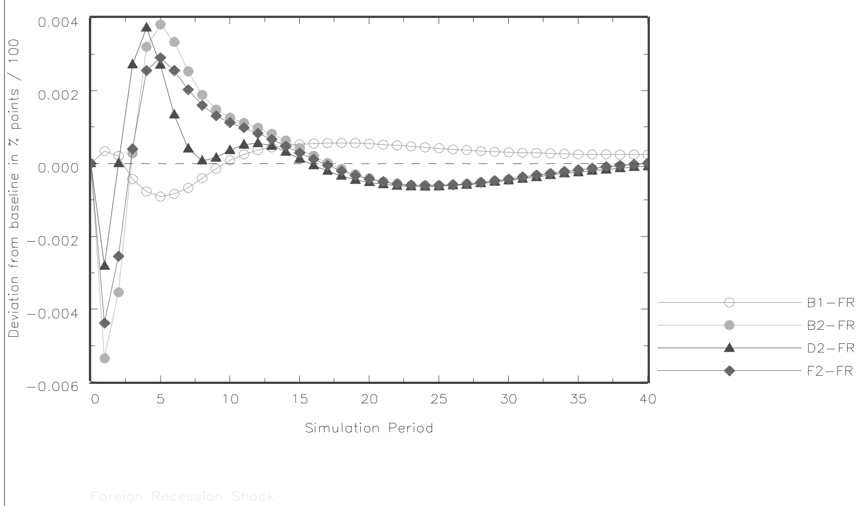
9–7. Price Level (Absorption Deflator)



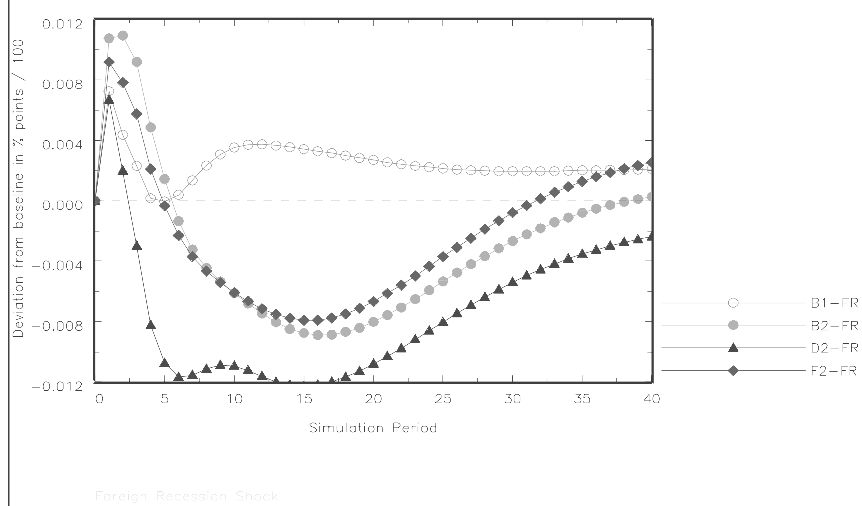
9–8. Inflation Rate (Absorption Deflator)



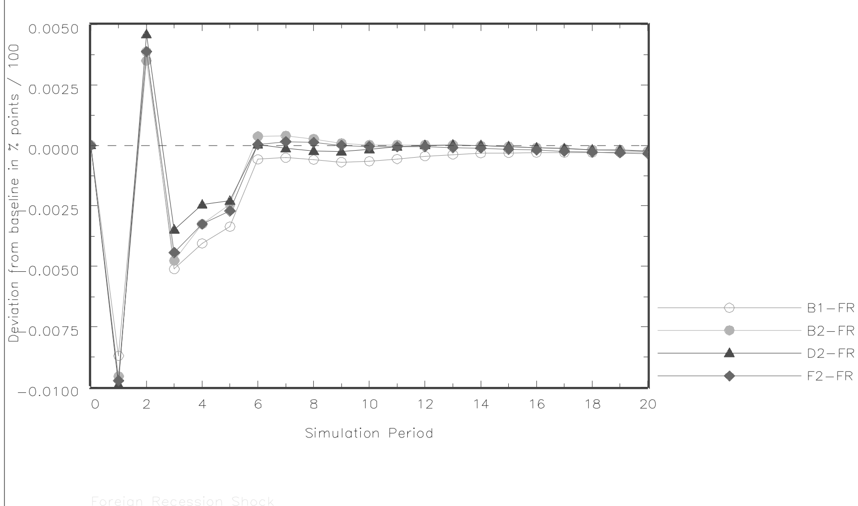
9–9. Tax Rate (Fiscal Instrument)



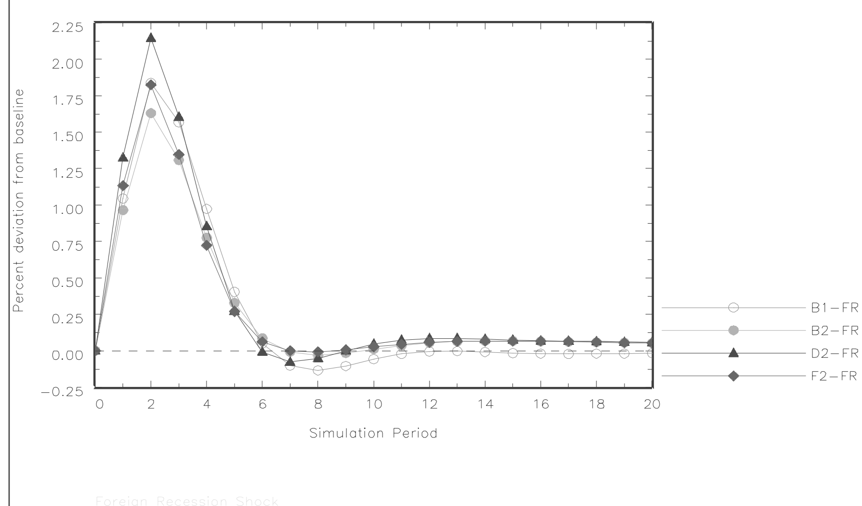
9–10. Ratio of Govt. Debt to Nominal GDP



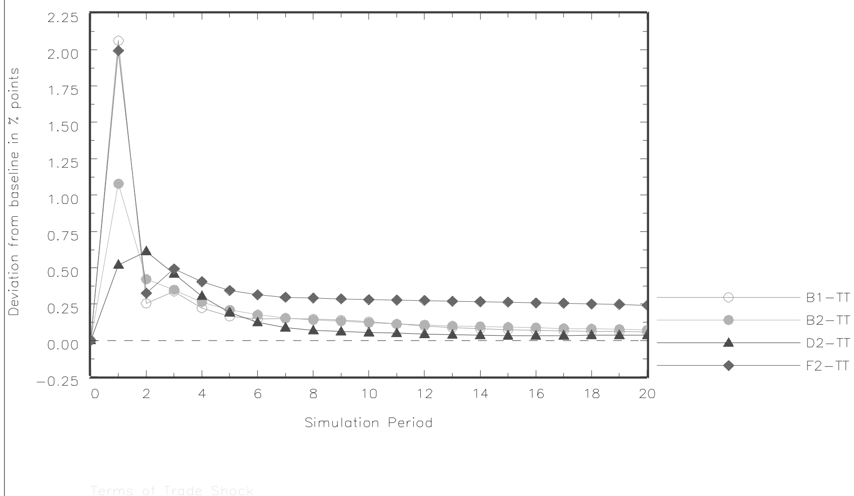
9–11. Ratio of Current Balance to Nominal GDP



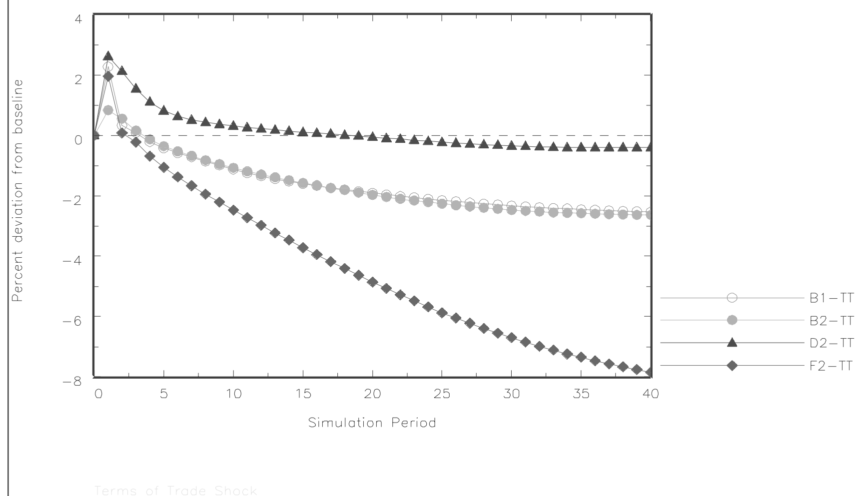
9–12. Real Domestic Investment



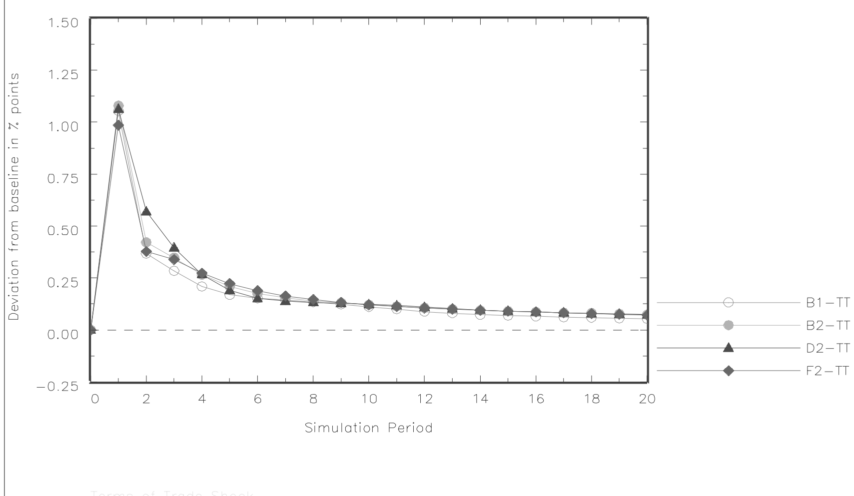
10−1. Nominal Short Interest Rate



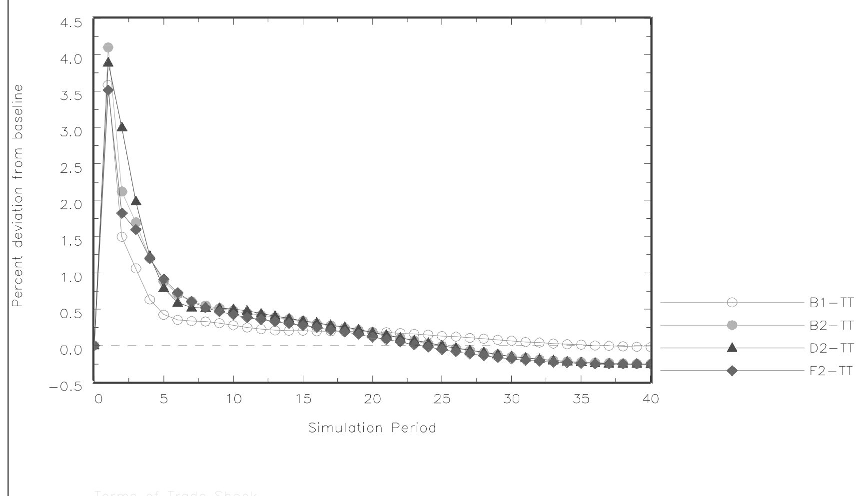
10−2. Nominal Exchange Rate



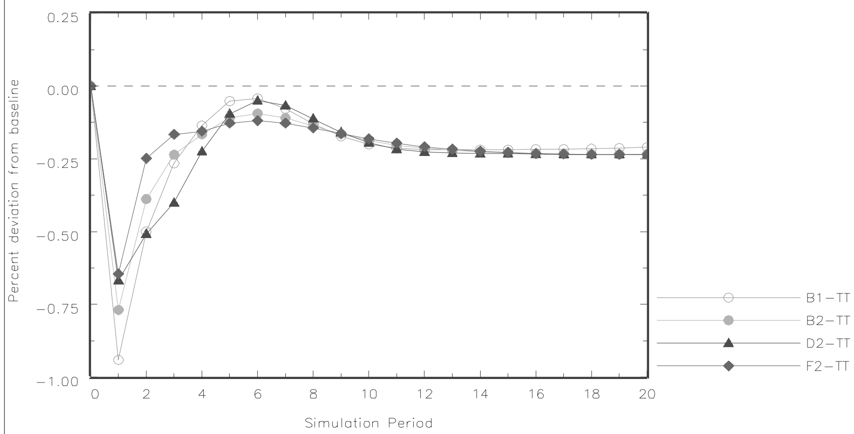
10−3. Real Long Term Interest Rate



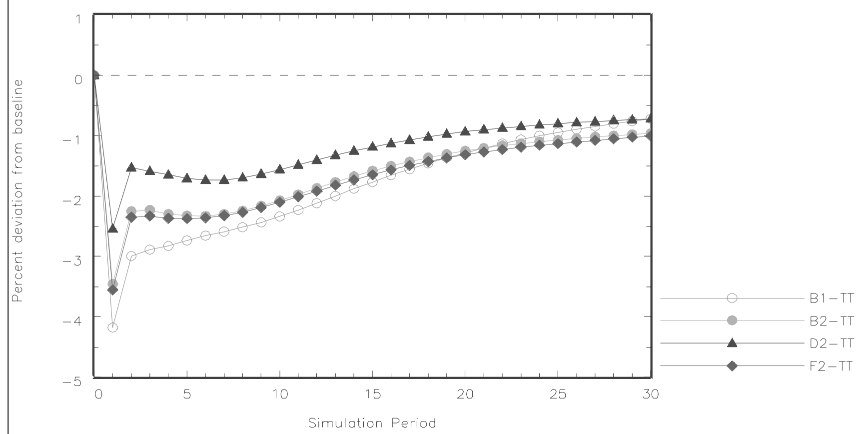
10−4. Real Exchange Rate



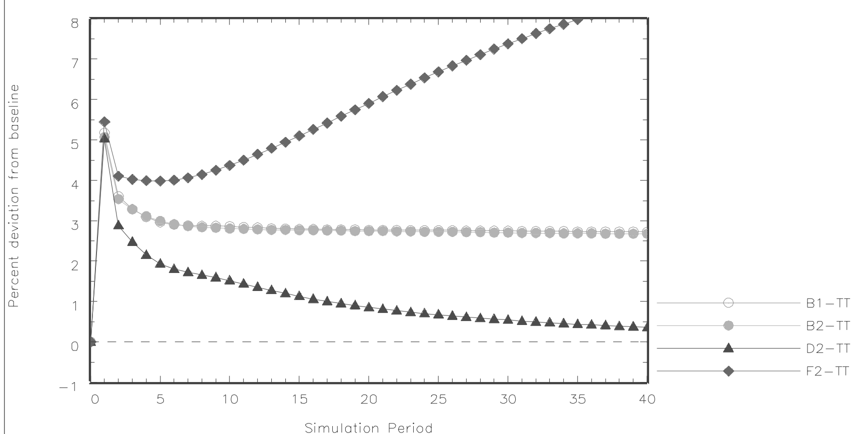
10–5. Real Output (GDP)



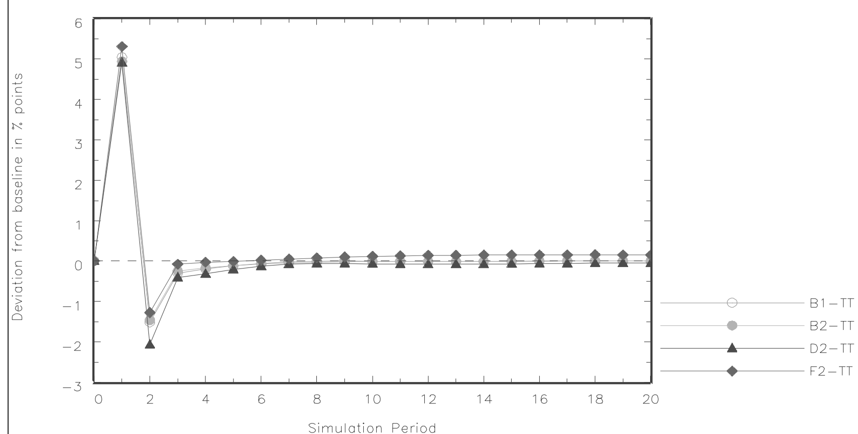
10–6. Real Private Consumption



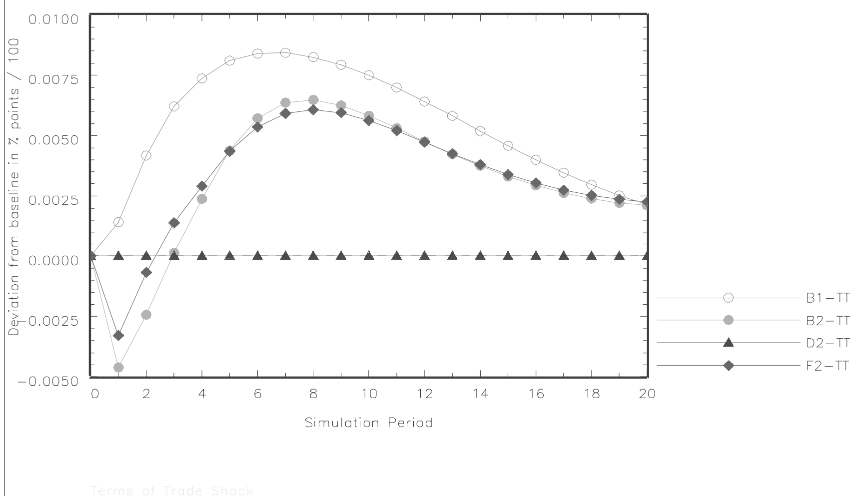
10–7. Price Level (Absorption Deflator)



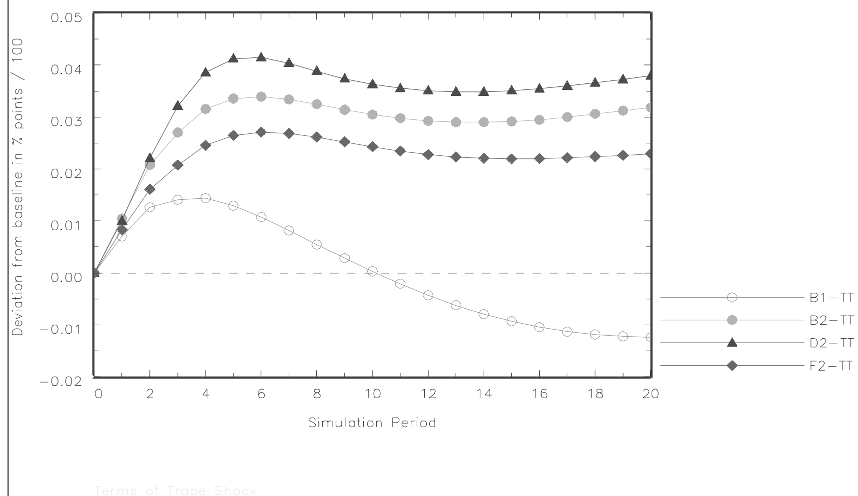
10–8. Inflation Rate (Absorption Deflator)



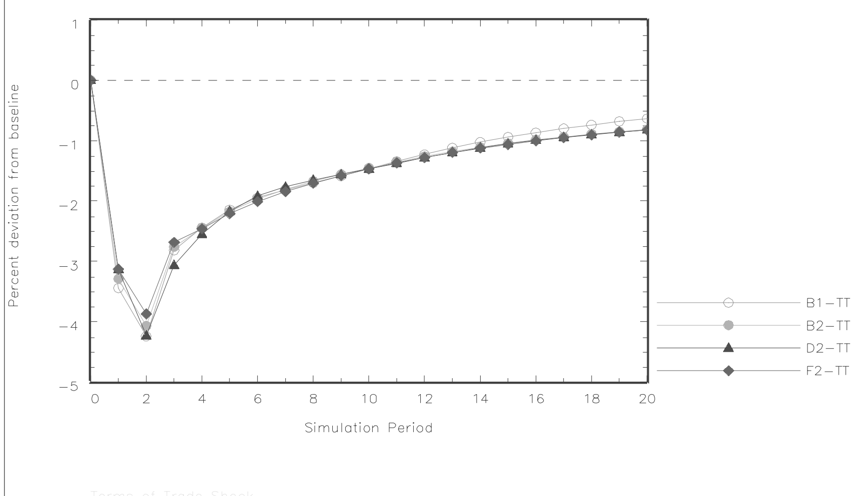
10–9. Tax Rate (Fiscal Instrument)



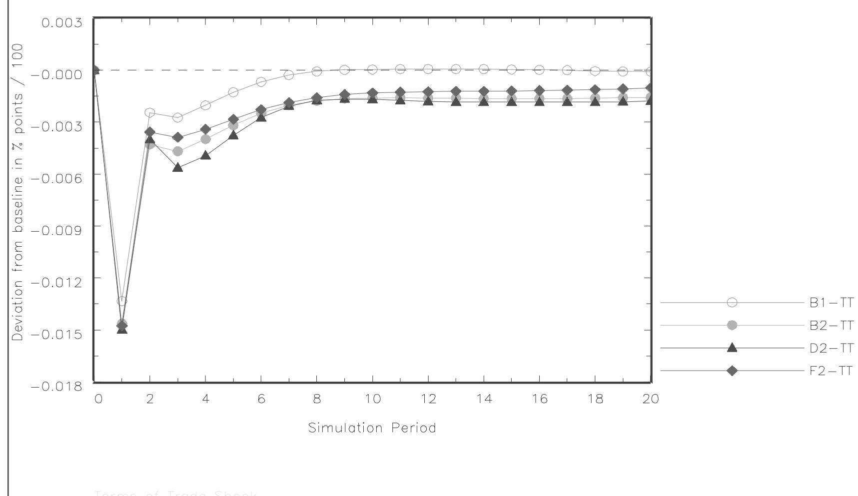
10–10. Ratio of Govt. Debt to Nominal GDP



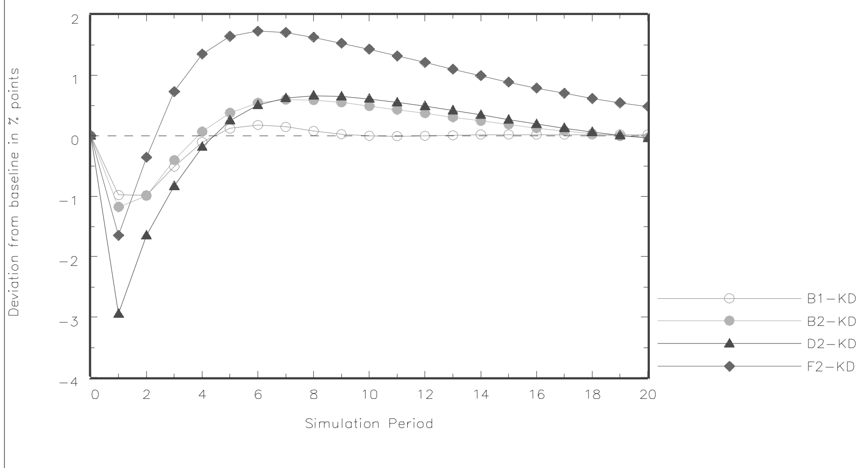
10–11. Real Domestic Investment



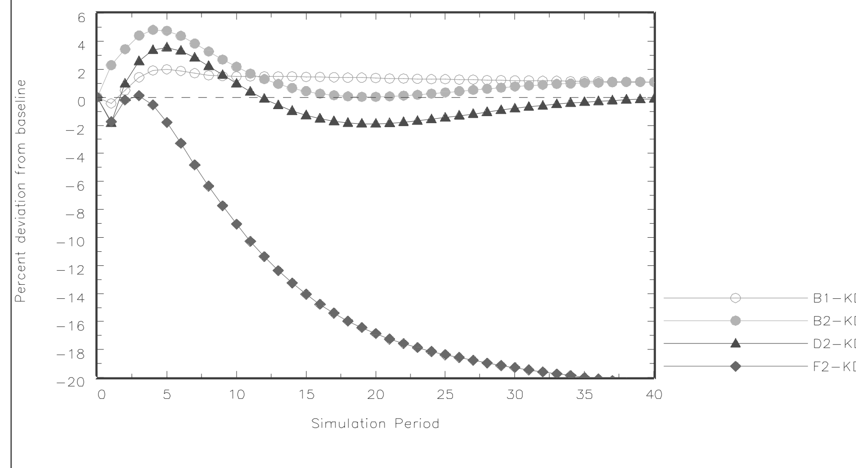
10–12. Ratio, Current Balance to Nominal GDP



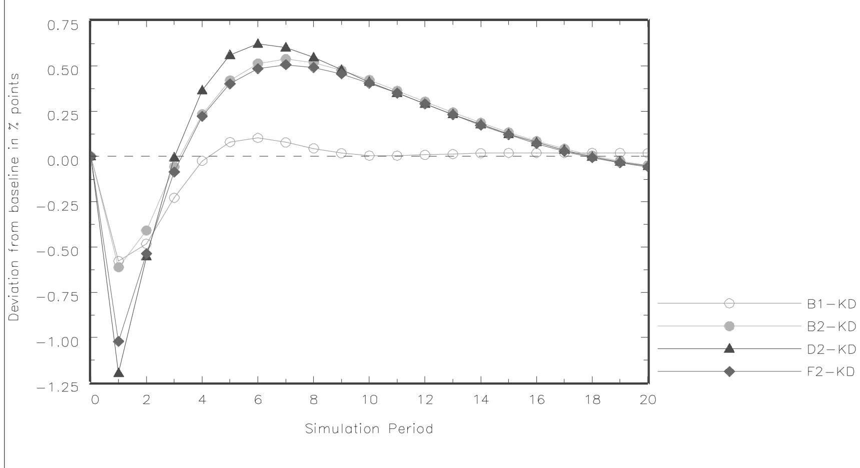
11−1. Nominal Short Term Interest Rate



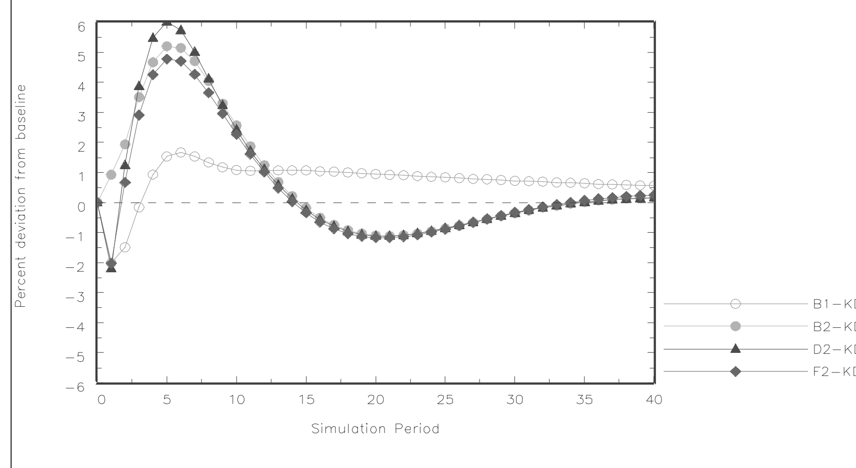
11−2. Nominal Exchange Rate



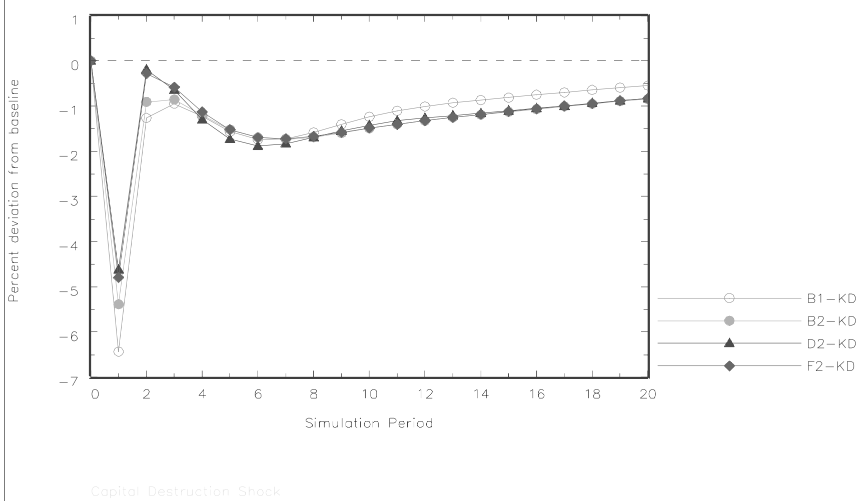
11−3. Real Long Term Interest Rate



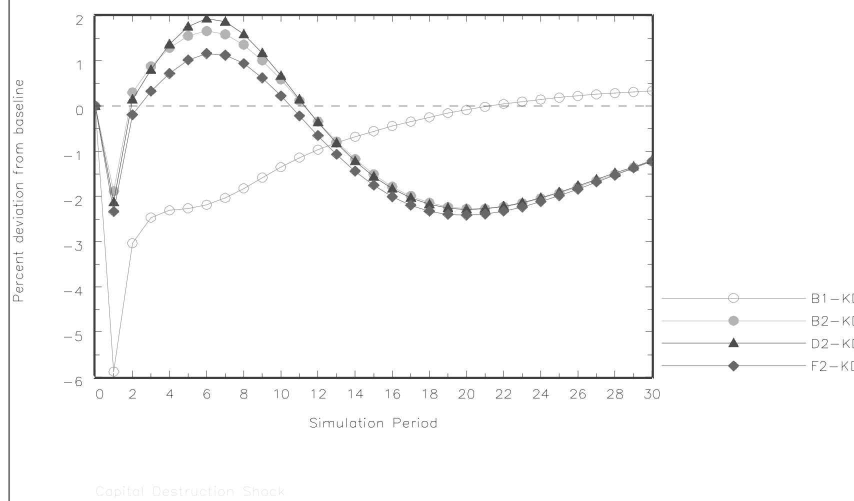
11−4. Real Exchange Rate



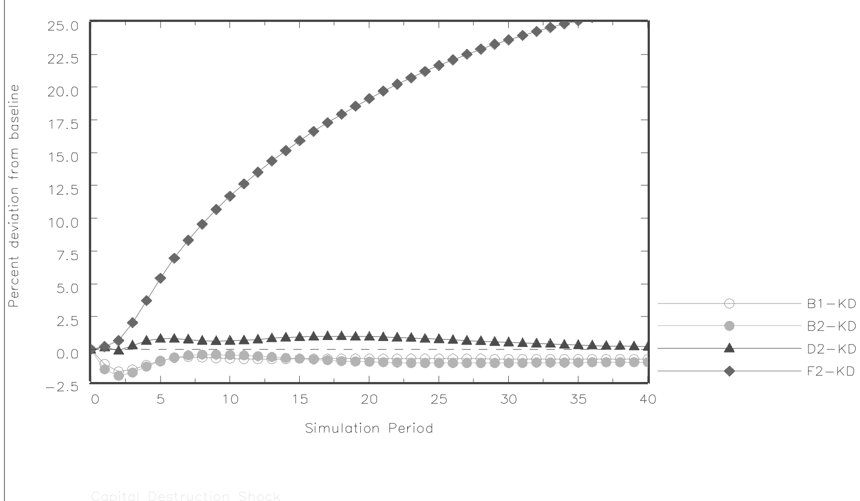
11–5. Real Output (GDP)



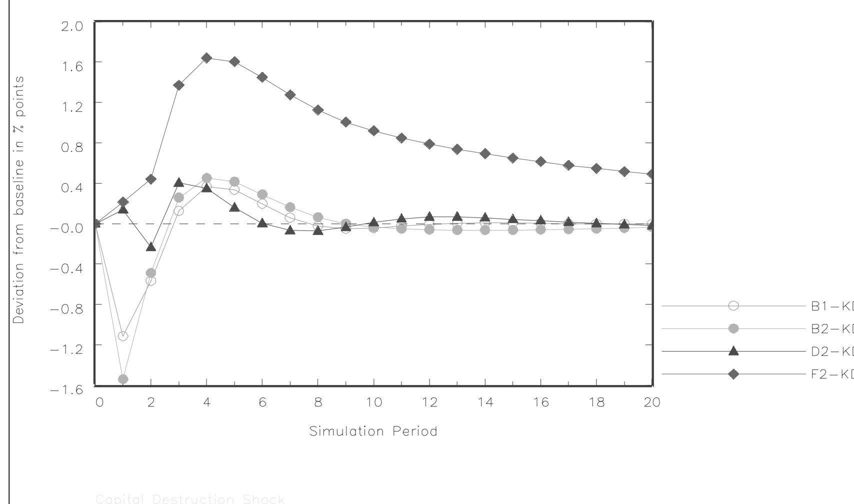
11–6. Real Consumption



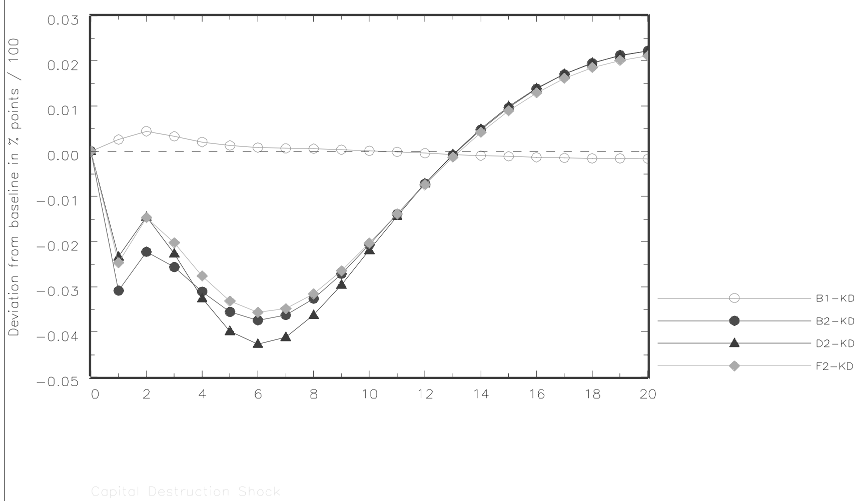
11–7. Price Level (Absorption Deflator)



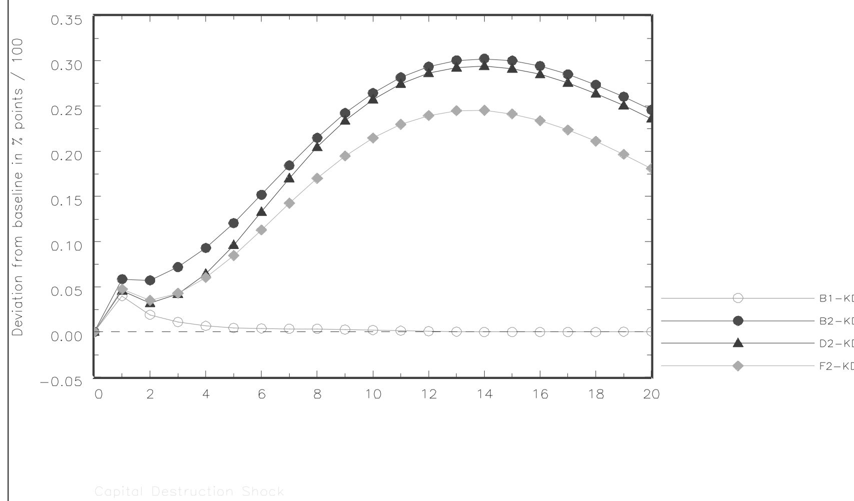
11–8. Inflation Rate (Absorption Deflator)



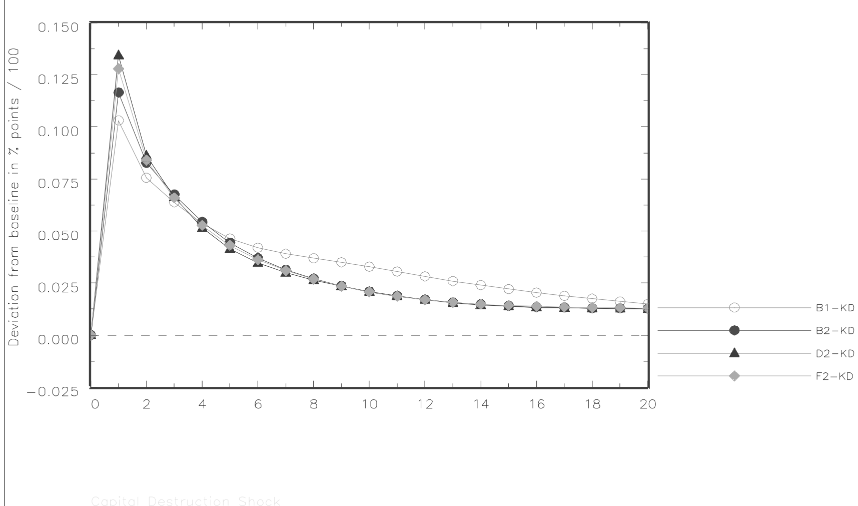
11–9. Tax Rate (Fiscal Instrument)



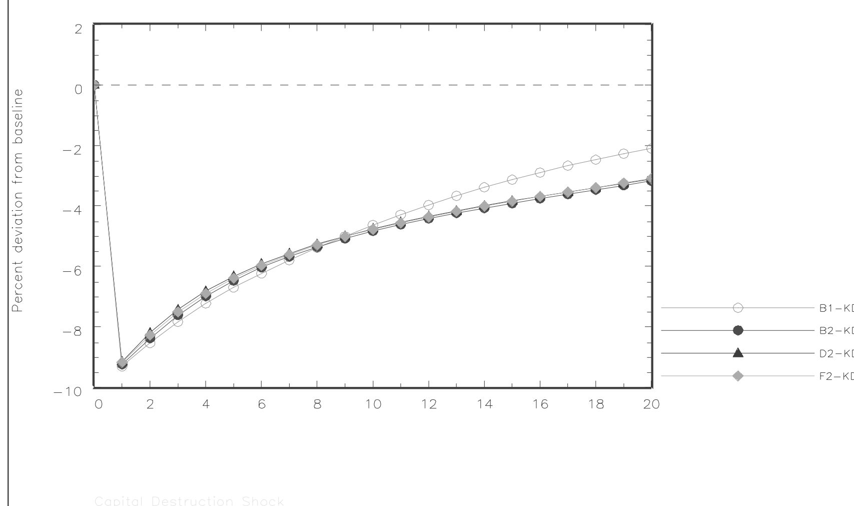
11–10. Ratio of Govt. Debt to Nominal GDP



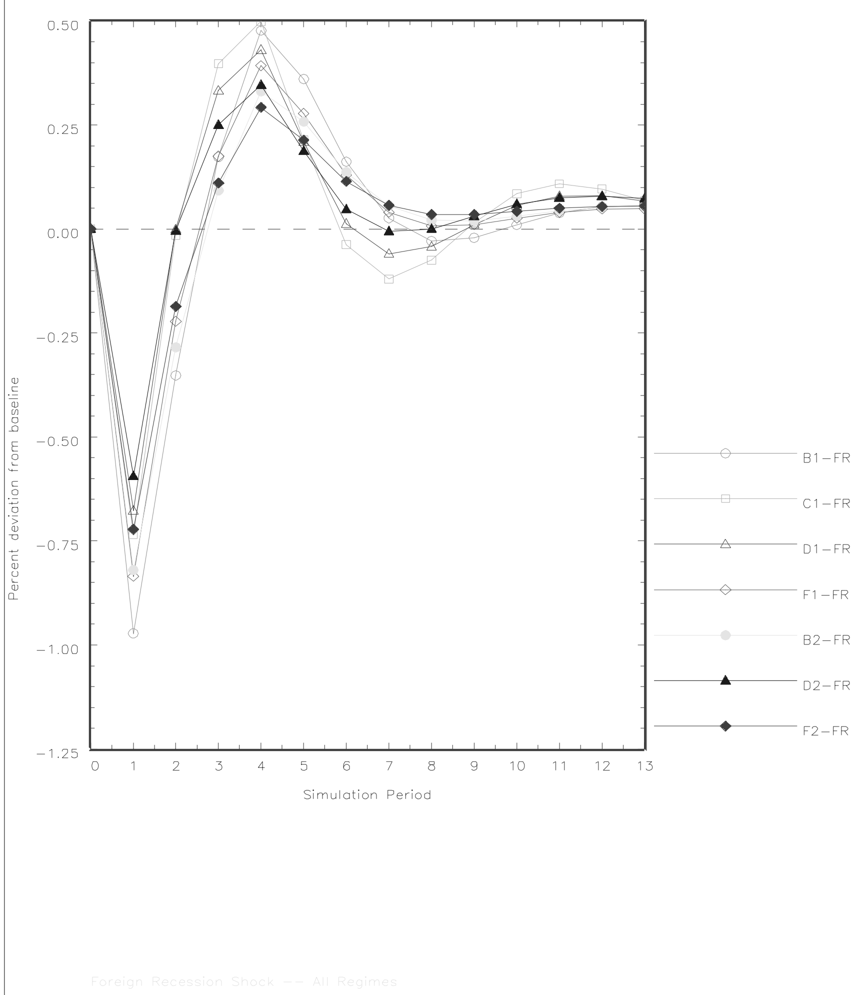
11–11. Ratio, Market Value of K to Real K Stock



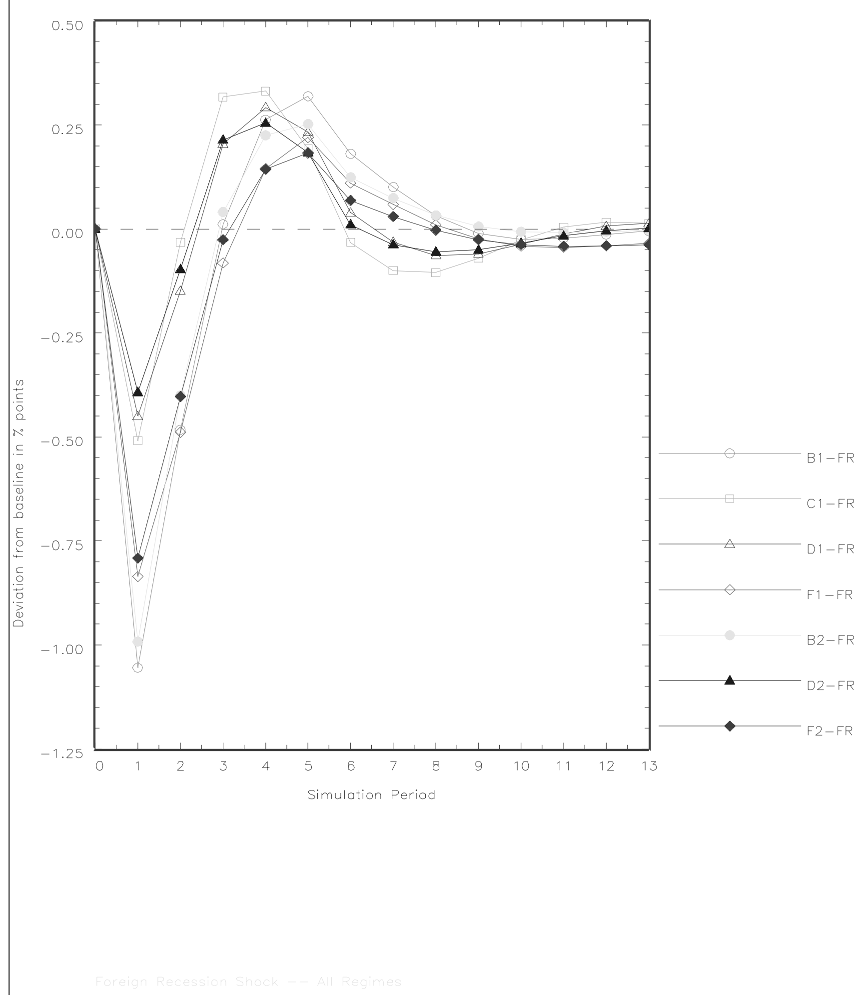
11–12. Real Capital Stock



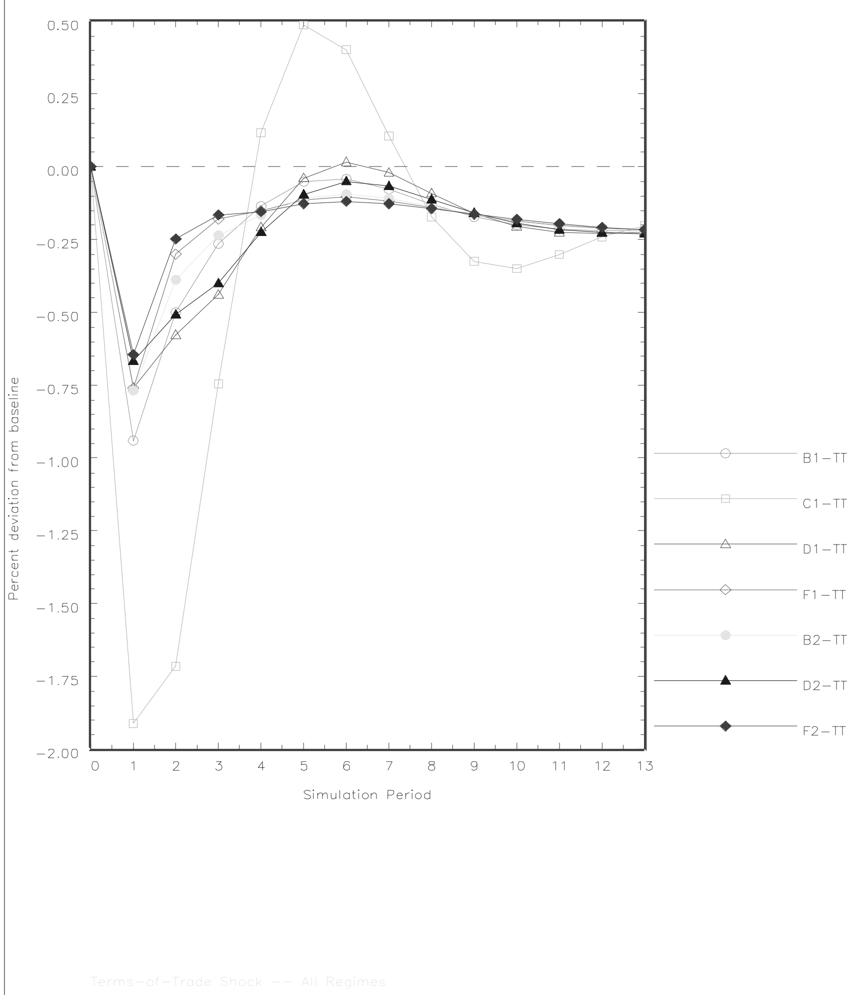
12–1. Real Output –– Foreign Recession Shock



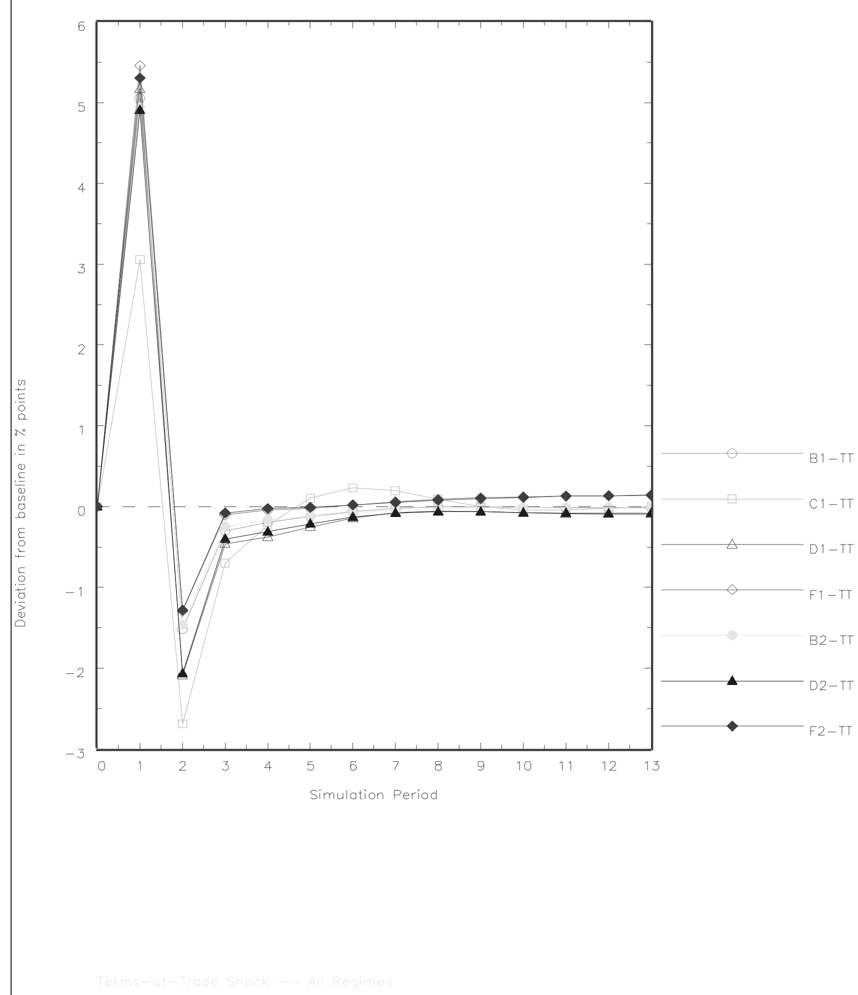
12–2. Inflation Rate –– Foreign Recession Shock



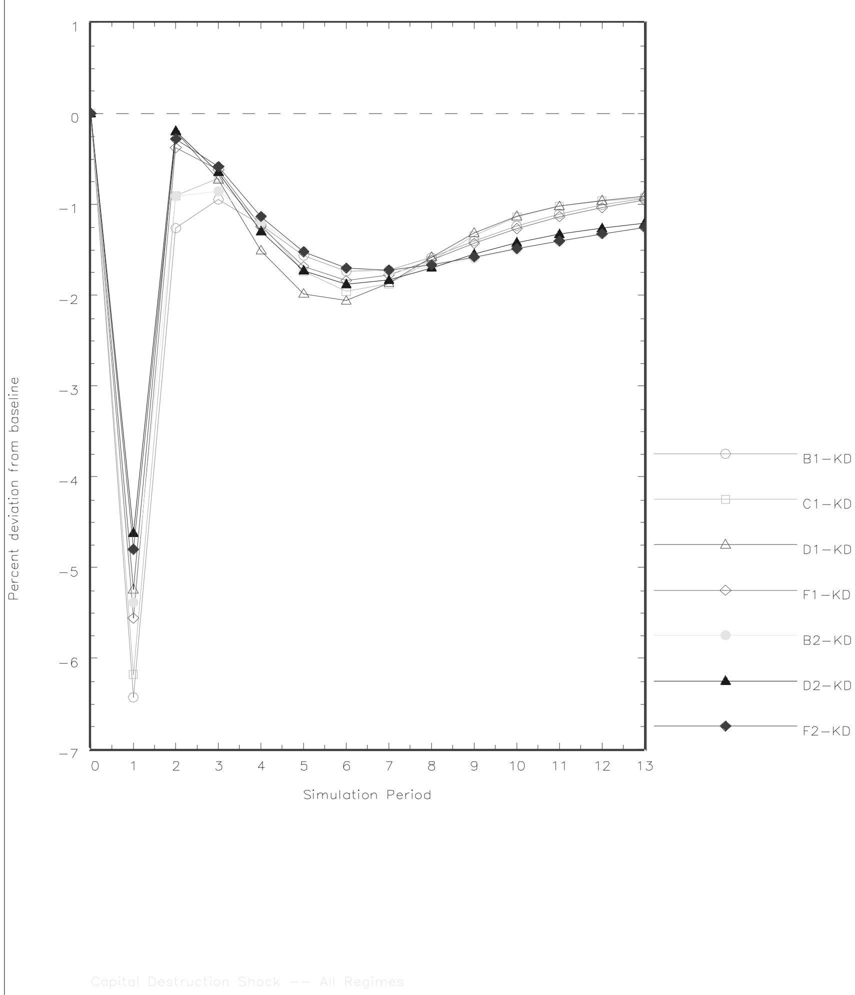
13–1. Real Output –– Terms–of–Trade Shock



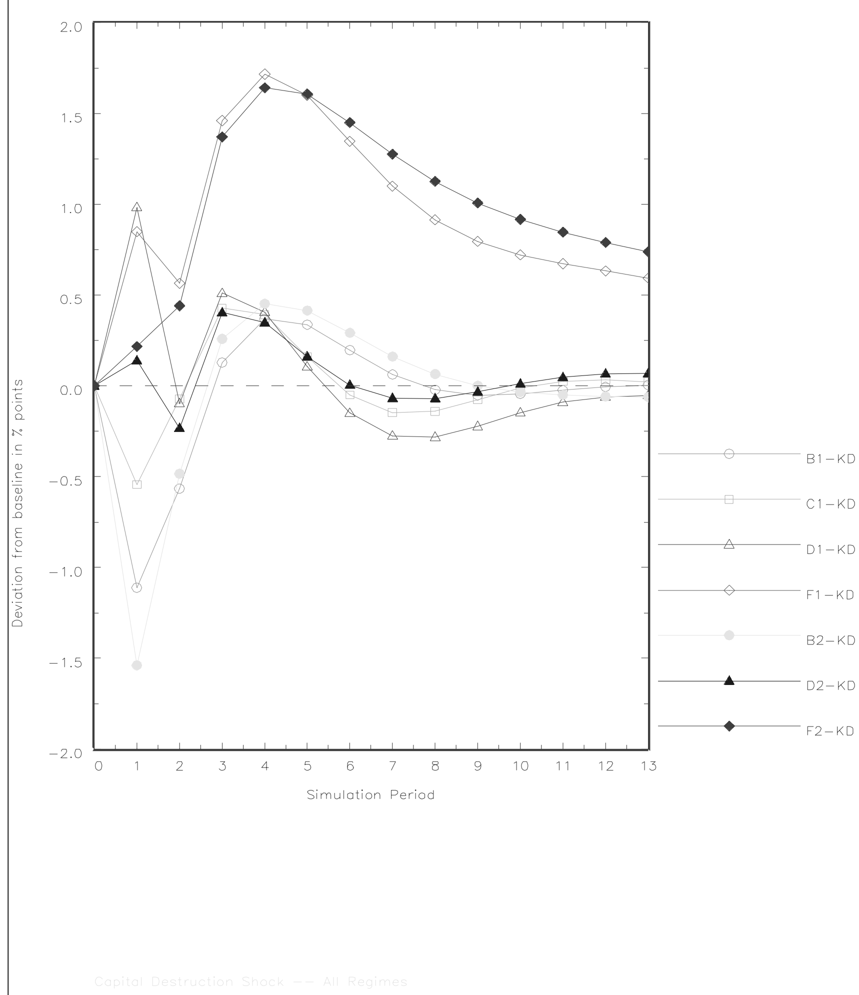
13–2. Inflation Rate –– Terms–of–Trade Shock



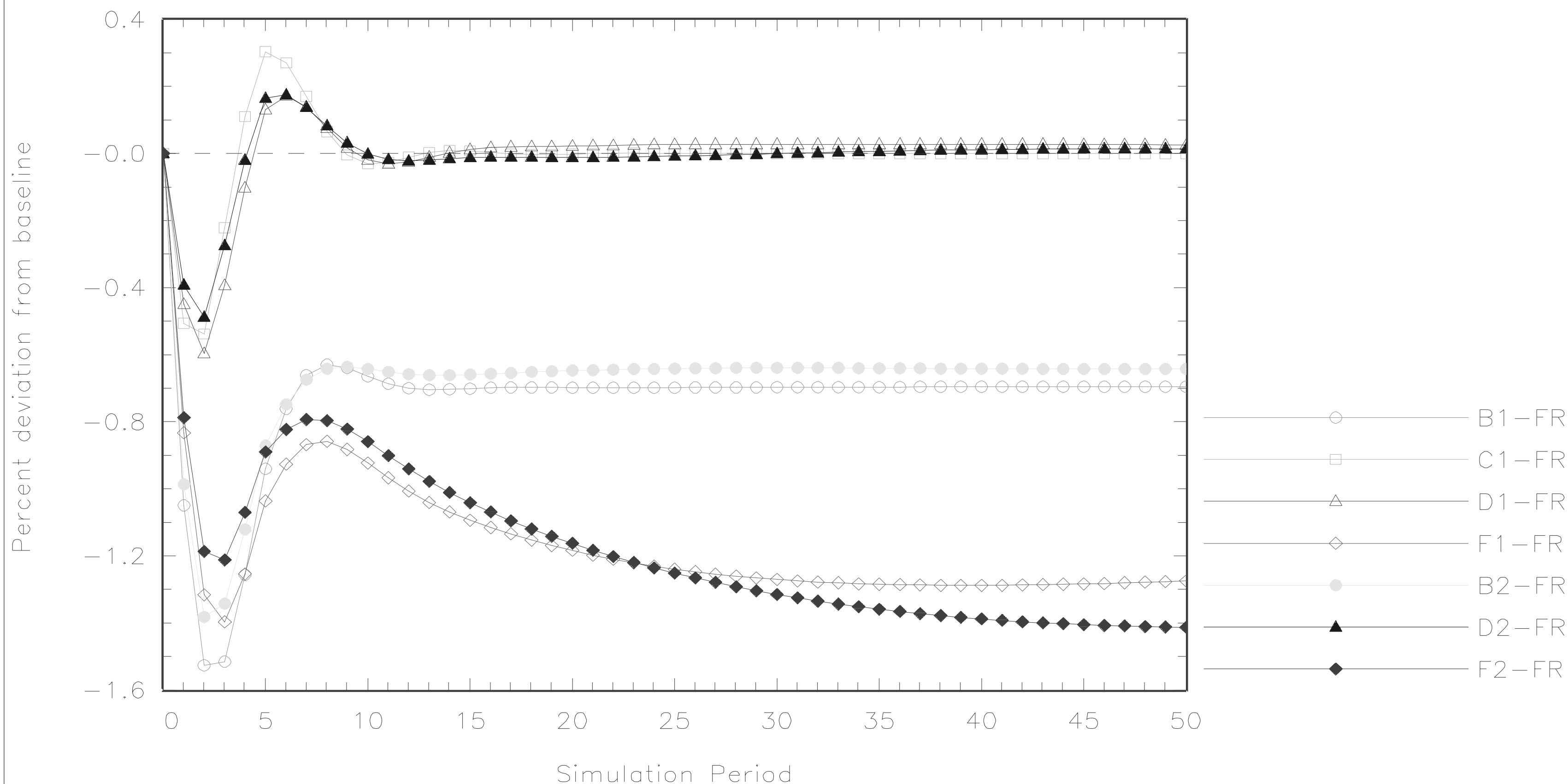
14–1. Real Output –– Capital Destruction Shock



14–2. Inflation Rate –– Capital Destruction Shock

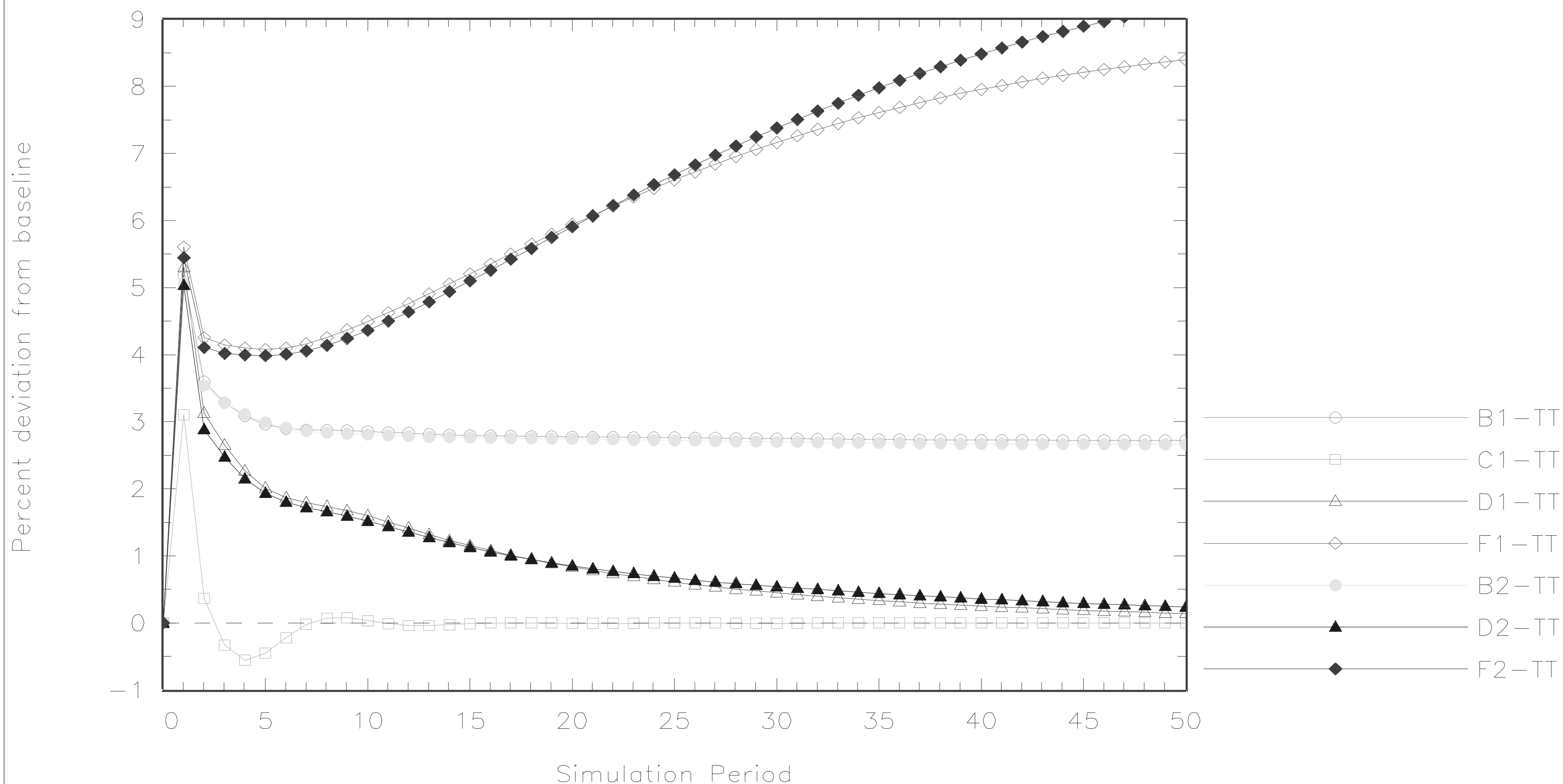


15. Price Level -- Foreign Recession Shock



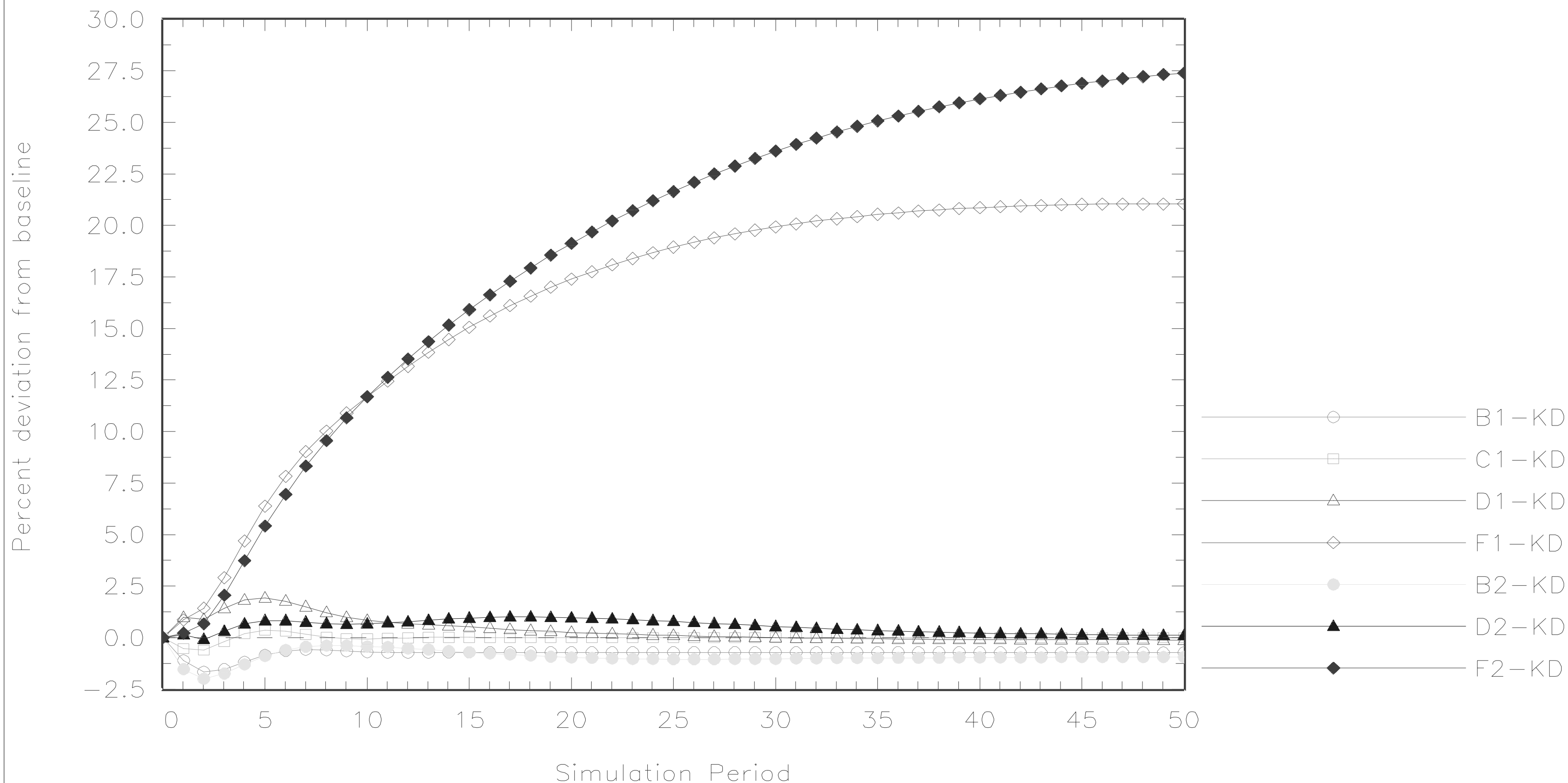
Foreign Recession Shock -- All Regimes

16. Price Level -- Terms-of-Trade Shock



Terms-of-Trade Shock -- All Regimes

17. Price Level -- Capital Destruction Shock



Capital Destruction Shock -- All Regimes

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Appendix A

Declines in Output (Real GDP) Under Alternative Reaction Functions[29]

(measured as percent deviation from baseline)

Foreign Recession Shock (FR)

Period	B1	C1	B2	D1	D2	F1	F2
1	-0.97	-0.73	-0.82	-0.68	-0.59	-0.83	-0.72
2	-0.35	-0.02	-0.28	-0.00	-0.00	-0.22	-0.19
3	+0.17	+0.40	+0.09	+0.33	+0.25	+0.17	+0.11
4	+0.48	+0.50	+0.33	+0.43	+0.35	+0.39	+0.29
5	+0.36	+0.21	+0.26	+0.21	+0.19	+0.28	+0.21
6	+0.16	-0.04	+0.14	+0.01	+0.05	+0.13	+0.11
7	+0.03	-0.12	+0.06	-0.06	-0.01	+0.04	+0.06

Terms-of-Trade Shock (TT)

Period	B1	C1	B2	D1	D2	F1	F2
1	-0.94	-1.91	-0.77	-0.76	-0.67	-0.76	-0.65
2	-0.50	-1.72	-0.39	-0.58	-0.51	-0.30	-0.25
3	-0.26	-0.75	-0.24	-0.44	-0.40	-0.18	-0.17
4	-0.14	+0.12	-0.17	-0.21	-0.23	-0.15	-0.15
5	-0.05	+0.49	-0.11	-0.04	-0.10	-0.11	-0.13
6	-0.04	+0.40	-0.09	+0.01	-0.05	-0.10	-0.12

Capital Destruction Shock (KD)

Period	B1	C1	B2	D1	D2	F1	F2
1	-6.43	-6.18	-5.38	-5.24	-4.62	-5.56	-4.80
2	-1.27	-0.91	-0.91	-0.20	-0.19	-0.38	-0.28
3	-0.95	-0.71	-0.86	-0.72	-0.65	-0.62	-0.59
4	-1.23	-1.22	-1.20	-1.51	-1.30	-1.25	-1.14
5	-1.57	-1.74	-1.52	-1.99	-1.73	-1.69	-1.52
6	-1.74	-1.96	-1.70	-2.06	-1.88	-1.84	-1.70

[29] Refer to the text of the paper for descriptions of the alternative regime combinations and the three illustrative shocks.

Appendix B

“B1" VARIANT OF ILLUSTRATIVE MODEL OF ZZ ECONOMY

This appendix provides further information about the illustrative model. The variable names and equation descriptions in this appendix are taken directly from the Portable TROLL software in which the model is coded. Readers wishing information about parameter/coefficient values, about baseline data, or further details about the equation specifications may contact the author at the Economic Studies Program, Brookings Institution, 1775 Massachusetts Avenue NW, Washington, DC USA (Email address: RBRYANT@BROOK.EDU).

Equation Listing:

Labor force:
1: ZZ_LF = ZZ_POP*ZZ_PART/(1+ZZ_DEM3)

Identity for birth rate:
2: ZZ_BIRTH = ZZ_DLLF + ZZ_PROBD

Definition of Lambda1:
3: ZZ_LAMBDA1 = 1 - EXP((ZZ_ALPHA1+ZZ_PROBD)/ZZ_PROBD*LOG(1-ZLAMBDA))

Definition of Lambda2:
4: ZZ_LAMBDA2 = 1 - EXP((ZZ_ALPHA2+ZZ_PROBD)/ZZ_PROBD*LOG(1-ZLAMBDA))

Definition for BCHI variable:
5: ZZ_BCHI = AONE*ZZ_BIRTH/(ZZ_BIRTH+ZZ_ALPHA1)

Total real consumption:
6: ZZ_C = ZZ_CYP + ZZ_CYD

Definition for MPC, marginal propensity to consume out of wealth:
7: ZZ_MPC = 1/ZZ_MPCINV

Dynamic equation for inverse of MPC:
8: ZZ_MPCINV(1) = ZZ_MPCINV-1-((1-ZZ_SIGMA)*(ZZ_RLR+ZZ_PROBD)-(
ZZ_RTP+ZZ_PROBD))*ZZ_MPCINV/ZZ_SIGMA

Real consumption by forward-looking consumers:
9: ZZ_CYP = ZZ_MPC*(ZZ_FW+ZZ_BCHI*(1-ZZ_LAMBDA1)*ZZ_WH1+(1-ZZ_BCHI)*
(1-ZZ_LAMBDA2)*ZZ_WH2)

Real consumption by liquidity-constrained consumers:
10: ZZ_CYD = (ZZ_LAMBDA1*ZZ_BCHI+ZZ_LAMBDA2*(1-ZZ_BCHI))*((1-ZZ_BETA)
*ZZ_GDP*ZZ_PGNP-ZZ_TAXH)/ZZ_P

ZWH1, first component of human wealth:
11: ZZ_WH1 = ZZ_WH1(1)/(1+ZZ_RLR+ZZ_ALPHA1+ZZ_PROBD+EXP(ZZ_DLLF)-1)+(
(1-ZZ_BETA)*ZZ_GDP*ZZ_PGNP-ZZ_TAXH)/ZZ_P+ZZ_RPREM*ZZ_WK

ZWH2, second component of human wealth:
12: ZZ_WH2 = ZZ_WH2(1)/(1+ZZ_RLR+ZZ_ALPHA2+ZZ_PROBD+EXP(ZZ_DLLF)-1)+(
(1-ZZ_BETA)*ZZ_GDP*ZZ_PGNP-ZZ_TAXH)/ZZ_P+ZZ_RPREM*ZZ_WK

Weighted average of two components of human wealth:
13: ZZ_WH = ZZ_BCHI*ZZ_WH1+(1-ZZ_BCHI)*ZZ_WH2

Market value of capital stock (forward looking, real):
14: ZZ_WK = ZZ_WK(1)/(1+ZZ_RSR+ZZ_K/ZZ_K(-1)-1)+(ZZ_BETA*ZZ_GDP*
ZZ_PGNP-ZZ_TAXK)/ZZ_P-(ZZ_DELTA+ZZ_RPREM)*ZZ_WK

Definition of real financial wealth:
15: ZZ_FW = ZZ_WK+(ZZ_M+ZZ_B+ZZ_NFA/ZZ_ER)/ZZ_P

Total real wealth, human plus financial:
16: ZZ_W = ZZ_WH+ZZ_FW

Real disposable income:
17: ZZ_YD = (ZZ_GDP*ZZ_PGNP-ZZ_TAX)/ZZ_P-ZZ_DELTA*ZZ_K(-1)

Real capital stock (adjusting to market value of capital stock):
18: DEL(1: LOG(ZZ_K)) = ZK0+ZK1*LOG(ZZ_WK/ZZ_K(-1))+ZK2*LOG(ZZ_WK(-1)
/ZZ_K(-2))+RES_ZZ_K

Real gross investment:
19: ZZ_INVEST = DEL(1: ZZ_K)+ZZ_DELTA*ZZ_K(-1)

Definition of domestic absorption:
20: ZZ_A = ZZ_C+ZZ_INVEST+ZZ_G

Identity for real GDP:
21: ZZ_GDP = ZZ_A+ZZ_XM-ZZ_IM

Identity for real GNP:
22: ZZ_GNP = ZZ_GDP+ROW_R*ZZ_NFA(-1)/ZZ_ER/ZZ_PGNP

Behavioral equation for price level (PGNP):
23: DEL(1: LOG(ZZ_PGNP)) = DEL(1: LOG(ZZ_PGNP(-1)))-ZP3*DEL(1: LOG(
ZZ_PGNP(-1)/ZZ_PGNP(1)))+ZP1*(ZZ_CU/100-1)+ZP2*DEL(1: LOG(ZZ_P/
ZZ_PGNP))

Identity for nominal GDP (can be thought of as determining ZZ_P):
24: ZZ_PGNP = (ZZ_P*ZZ_A+ZZ_XM*ZZ_PXM-ZZ_IM*ZZ_PIM)/ZZ_GDP

Definition of nominal GDP:
25: ZZ_NOMGDP = ZZ_GDP*ZZ_PGNP

Production function (determining capacity output):
26: ZZ_YCAP = ZZ_PRODINDEX1*ZY87*(ZBETA*(ZZ_K/ZK87)**(-ZRHO)+(1-ZBETA
)*ZZ_PRODINDEX2*(EXP(ZZ_PRODRG*(T-21))*(1+RES_ZZ_YCAP/(1-ZBETA))
*ZZ_LF/ZL87)**(-ZRHO))**(-1/ZRHO)

Share of returns to capital in income:
27: ZZ_BETA = ZBETA*(ZZ_YCAP/ZZ_K/(ZY87/ZK87))**ZRHO

Definition of capacity utilization:
28: ZZ_CU = 100*ZZ_GDP/ZZ_YCAP

Definition of total nominal government expenditures:
29: ZZ_GE = ZZ_P*ZZ_G+ZZ_R*ZZ_B(-1)+ZZ_GEXOG

Government tax receipts:
30: ZZ_TAX = ZZ_TRATE*(ZZ_PGNP*ZZ_GNP-ZZ_DELTA*ZZ_K(-1)*ZZ_P+ZZ_R*
ZZ_B(-1))

Corporate tax share of total tax receipts:
31: ZZ_TAXK = ZDUMCT*ZZ_BETA*ZZ_TAX+(1-ZDUMCT)*ZZ_CTREFF*ZZ_BETA*
ZZ_GDP*ZZ_PGNP

Labor tax share of total tax receipts:
32: ZZ_TAXH = ZZ_TAX-ZZ_TAXK

Target debt stock, determined by target ratio of debt to baseline nominal GDP:
33: ZZ_BT = ZZ_BRATIOT*ZZ_NOMGDP_SS

Definition of "debt gap" for fiscal reaction function:
34: ZZ_BTGAP = ZZ_B-ZZ_BT

Definition of "adjusted debt gap" for fiscal reaction function:
35: ZZ_BTGAPADJ = FFWD*ZZ_BTGAP(1)+(1-FFWD-FBWD)*ZZ_BTGAP+FBWD*
ZZ_BTGAP(-1)

Tax-rate reaction function for fiscal policy:
36: DEL(1: ZZ_TRATE) = ZZ_FRXDUM*(TAU1*ZZ_BTGAPADJ/(ZZ_GNP*ZZ_PGNP)+
TAU2*DEL(1: ZZ_BTGAPADJ)/(ZZ_GNP*ZZ_PGNP)+ZZ_FRXDUM2)+(1-
ZZ_FRXDUM)*TAU3*(ZZ_TRATE_SS(-1)-ZZ_TRATE(-1))

Government balance sheet identity:
37: DEL(1: ZZ_B)+DEL(1: ZZ_M) = ZZ_R*ZZ_B(-1)+ZZ_P*ZZ_G-ZZ_TAX+
ZZ_GEXOG

Definition of nominal government budget deficit:
38: ZZ_GDEF = DEL(1: ZZ_B+ZZ_M)

Money demand function (high-powered money):
39: LOG(ZZ_M/ZZ_P) = ZM0+(1-ZM4)*LOG(ZZ_A)+ZM2*ZZ_RS+ZM4*LOG(ZZ_M(-1)
/ZZ_P(-1))+RES_ZZ_M

Inflation gap for monetary-policy reaction function:
40: ZZ_PADOTGAP = ZZ_PADOT-ZZ_PADOTT

Adjusted inflation gap for monetary-policy reaction function:
41: ZZ_PADOTGAPADJ = MFWD*ZZ_PADOTGAP(1)+(1-MFWD-MBWD)*
ZZ_PADOTGAP+MBWD*ZZ_PADOTGAP(-1)

Inflation-rate targeting reaction function for monetary policy
(uses absorption deflator as price series):
42: ZZ_RS-ZZ_RS(-1) = ZZ_MRXPDOT1*ZZ_PADOTGAPADJ+ZZ_MRXPDOT2*DEL(1:
ZZ_PADOTGAPADJ)+RES_ZZ_RS

Term structure of interest rates:
43: ZZ_RL/100 = ((1+ZZ_RS/100)*(1+ZZ_RS(1)/100)*(1+ZZ_RS(2)/100)*(1+
ZZ_RS(3)/100)*(1+ZZ_RS(4)/100))**0.2-1

Average interest rate payable on government debt (short and long):
44: ZZ_R = 0.5*ZZ_RS(-1)/100+0.5*SUM(I = -3 TO -1: ZZ_RL(I)/100)/3

Real ex ante long-term interest rate:

45: ZZ_RLR = (1+ZZ_RL/100)/(ZZ_P(5)/ZZ_P)**0.2-1

Real ex ante short-term interest rate:
46: ZZ_RSR = (1+ZZ_RS/100)/(ZZ_P(1)/ZZ_P)-1

Total exports, real (determined as ROW imports):
47: ZZ_XM = ROW_IM/ZE87

Total imports, real:
48: DEL(1: LOG(ZZ_IM)) = ZIM0+ZIM1*DEL(1: ZIM7*LOG(ZZ_A)+(1-ZIM7)*LOG (ZZ_XM))+ZIM2*DEL(1: LOG(ZZ_PIM/ZZ_PGNP))+ZIM3*LOG(ZZ_PIM(-1)/ ZZ_PGNP(-1))+ZIM4*(ZIM7*LOG(ZZ_A(-1))+(1-ZIM7)*LOG(ZZ_XM(-1))- LOG(ZZ_IM(-1)))+ZIM5*TT+ZIM6*TT**2+RES_ZZ_IM

Weighted average of prices in foreign (ROW) markets:
49: LOG(ZZ_PFM) = 0.5*(W21*LOG(ROW_PXM*ROW_ER/UE87)+L21*LOG(ROW_PGNP* ROW_ER/UE87)+W22*LOG(ZZ_ER/ZE87)+-1*LOG(ZZ_ER/ZE87))

Price of ZZ exports:
50: DEL(1: LOG(ZZ_PXM)) = ZPXM0+ZPXM1*DEL(1: LOG(ZZ_PGNP))+(1-ZPXM1)* DEL(1: LOG(ZZ_PFM))+ZPXM2*LOG(ZZ_PGNP(-1)/ZZ_PXM(-1))+RES_ZZ_PXM

Import prices paid by ZZ economy (in ZZ currency):
51: ZZ_PIM = (S12*ROW_PXM+S22*ZZ_PXM*ZZ_ER/ZE87)/(ZZ_ER/ZE87)

Definition of terms of trade as in MULTIMOD:
52: ZZ_RTTLOG = LOG(ZZ_PXM)-LOG(ZZ_PFM)

Definition of terms of trade as ratio of ZZ_PXM to ZZ_PFM:
53: ZZ_RTTRAT = ZZ_PXM/ZZ_PFM

Definition of ZZ real exchange rate:
54: ZZ_RER = ZZ_ER*ZZ_PGNP/ROW_PGNP

Trade balance in local currency:
55: ZZ_TB = ZZ_XM*ZZ_PXM-ZZ_IM*ZZ_PIM

Trade balance expressed in foreign-currency units:
56: ZZ_TBR = (ZZ_XM*ZZ_PXM-ZZ_IM*ZZ_PIM)*ZZ_ER

Net investment income flows in the balance of payments:
57: ZZ_NINVYFLOW = ROW_R*ZZ_NFA(-1)

Change in net foreign assets (in foreign currency units):
58: DEL(1: ZZ_NFA) = ZZ_TBR+ZZ_NINVYFLOW

Current-account balance (in foreign currency units):
59: ZZ_CURBAL = DEL(1: ZZ_NFA)

Uncovered interest parity condition (determining contemporaneous nominal exchange rate):
60: 1+ROW_RS/100 = (1+ZZ_RS/100)*EREXP1/ZZ_ER*RES_ZZ_ER

Model-consistent expectation of next period's exchange rate:
61: EREXP1 = ZZ_ER(+1)

Normalization for ROW exchange rate:
62: ROW_ER = 1

ROW real exports (ZZ imports):
63: ROW_XM = ZZ_IM*ZE87

ROW real imports (ZZ exports):
64: DEL(1: LOG(ROW_IM)) = UIM0+UIM1*DEL(1: UIM7*LOG(ROW_A)+(1-UIM7)*LOG(ROW_XM))+UIM2*DEL(1: LOG(ROW_PIM/ROW_PGNP))+UIM3*LOG(ROW_PIM(-1)/ROW_PGNP(-1))+UIM4*(UIM7*LOG(ROW_A(-1))+(1-UIM7)*LOG(ROW_XM(-1))-LOG(ROW_IM(-1)))+UIM5*TT+UIM6*TT**2+RES_ROW_IM

Prices in ROW's foreign markets:
65: LOG(ROW_PFM) = 0.5*(W11*LOG(ROW_ER/UE87)+-1*LOG(ROW_ER/UE87)+W12*LOG(ZZ_PXM*ZZ_ER/ZE87)+L12*LOG(ZZ_PGNP*ZZ_ER/ZE87))

Price of ROW exports (to ZZ economy):
66: DEL(1: LOG(ROW_PXM)) = UPXM0+UPXM1*DEL(1: LOG(ROW_PGNP))+(1-UPXM1)*DEL(1: LOG(ROW_PFM))+UPXM2*LOG(ROW_PGNP(-1)/ROW_PXM(-1))+RES_ROW_PXM

Import prices facing ROW (ZZ export prices):
67: ROW_PIM = (S11*ROW_PXM+S21*ZZ_PXM*ZZ_ER/ZE87)/(ROW_ER/UE87)

ROW nominal short-term interest rate:
68: ROW_RSR = (1+ROW_RS/100)/(ROW_PGNP(1)/ROW_PGNP)-1

ROW nominal long-term interest rate:
69: ROW_RL/100 = ((1+ROW_RS/100)*(1+ROW_RS(1)/100)*(1+ROW_RS(2)/100)*(1+ROW_RS(3)/100)*(1+ROW_RS(4)/100))**0.2-1

Average of ROW short-term and long-term interest rates:
70: ROW_R = 0.5*ROW_RS(-1)/100+0.5*SUM(I = -3 TO -1: ROW_RL(I)/100)/3

Growth rate of labor force:
71: ZZ_DLLF = LOG(ZZ_LF/ZZ_LF(-1))

Ratio of real consumption expenditures to real wealth:
72: ZZ_CWRATIO = ZZ_C/ZZ_W

Ratio of real consumption expenditures to real GNP:
73: ZZ_CYRATIO = ZZ_C/ZZ_GNP

Ratio of real market value of K stock to real actual stock:
74: ZZ_WKKRATIO = ZZ_WK/ZZ_K

Ratio of real capital stock to real GDP:
75: ZZ_KYRATIO = ZZ_K/ZZ_GDP

Growth rate of real GDP:
76: ZZ_DLGDP = LOG(ZZ_GDP/ZZ_GDP(-1))

Growth rate of real GNP:
77: ZZ_DLGNP = LOG(ZZ_GNP/ZZ_GNP(-1))

Growth rate of nominal GDP:
78: ZZ_DLNOMGDP = LOG(ZZ_NOMGDP/ZZ_NOMGDP(-1))

Definition of inflation rate for PGNP:
79: ZZ_PDOT = LOG(ZZ_PGNP/ZZ_PGNP(-1))

Definition of inflation rate for absorption deflator:
80: ZZ_PADOT = LOG(ZZ_P/ZZ_P(-1))

Ratio of tax revenues to nominal GDP:
81: ZZ_TAXYRATIO = ZZ_TAX/ZZ_NOMGDP

Ratio of real government expenditures to real GDP:
82: ZZ_GYRATIO = ZZ_G/ZZ_GDP

Ratio of ZZ export prices to ZZ absorption deflator:
83: ZZ_PXMRATIO = ZZ_PXM/ZZ_P

Ratio of ZZ real exports to real GDP:
84: ZZ_XMRATIO = ZZ_XM/ZZ_GDP

Ratio of ZZ real imports to real GDP:
85: ZZ_IMRATIO = ZZ_IM/ZZ_GDP

Identity for nominal value of domestic investment:
86: ZZ_INVESTNOM = ZZ_INVEST*ZZ_P

Identity for nominal value of private saving:
87: ZZ_SAVP = ZZ_INVESTNOM+ZZ_GDEF+ZZ_CURBAL

Identity for ZZ national saving:
88: ZZ_SAVN = ZZ_SAVP-ZZ_GDEF

Identity for "primary" government budget deficit:
89: ZZ_GPDEF = ZZ_GE-ZZ_R*ZZ_B(-1)-ZZ_TAX

Ratio of government debt to nominal GDP:
90: ZZ_BRATIO = ZZ_B/(ZZ_GDP*ZZ_PGNP)

Identity for total real consumption (private plus government):
91: ZZ_CTOT = ZZ_C+ZZ_G

Ratio of net investment income flows to nominal GDP:
92: ZZ_NINVYRATIO = ZZ_NINVYFLOW/ZZ_ER/(ZZ_GDP*ZZ_PGNP)

Ratio of current-account balance to nominal GDP:
93: ZZ_CABRATIO = ZZ_CURBAL/ZZ_ER/(ZZ_GDP*ZZ_PGNP)

Ratio of net foreign assets to nominal GDP:
94: ZZ_NFARATIO = ZZ_NFA/ZZ_ER/(ZZ_GDP*ZZ_PGNP)

Ratio of overall government budget deficit to nominal GDP:
95: ZZ_GDEFRATIO = ZZ_GDEF/(ZZ_GDP*ZZ_PGNP)

Ratio of primary government budget deficit to nominal GDP:
96: ZZ_GPDEFRATIO = ZZ_GPDEF/(ZZ_GDP*ZZ_PGNP)

Endogenous Variables (Listed Alphabetically):

EREXP1 ROW_ER ROW_IM ROW_PFM ROW_PIM ROW_PXM
ROW_R ROW_RL ROW_RS ROW_XM
ZZ_A ZZ_B ZZ_BCHI ZZ_BETA ZZ_BIRTH ZZ_BRATIO ZZ_BT
ZZ_BTGAP ZZ_BTGAPADJ ZZ_C ZZ_CABRATIO ZZ_CTOT ZZ_CU
ZZ_CURBAL ZZ_CWRATIO ZZ_CYD ZZ_CYP ZZ_CYRATIO
ZZ_DLGDP ZZ_DLGNP ZZ_DLLF ZZ_DLNOMGDP ZZ_ER ZZ_FW
ZZ_GDEF ZZ_GDEFRATIO ZZ_GDP ZZ_GE ZZ_GNP ZZ_GPDEF
ZZ_GPDEFRATIO ZZ_GYRATIO ZZ_IM ZZ_IMRATIO ZZ_INVEST
ZZ_INVESTNOM ZZ_K ZZ_KYRATIO ZZ_LAMBDA1 ZZ_LAMBDA2
ZZ_LF ZZ_M ZZ_MPC ZZ_MPCINV ZZ_NFA ZZ_NFARATIO
ZZ_NINVYFLOW ZZ_NINVYRATIO ZZ_NOMGDP ZZ_P ZZ_PADOT
ZZ_PADOTGAP ZZ_PADOTGAPADJ ZZ_PDOT ZZ_PFM ZZ_PGNP
ZZ_PIM ZZ_PXM ZZ_PXMRATIO ZZ_R ZZ_RER ZZ_RL ZZ_RLR
ZZ_RS ZZ_RSR ZZ_RTTLOG ZZ_RTTRAT ZZ_SAVN ZZ_SAVP
ZZ_TAX ZZ_TAXH ZZ_TAXK ZZ_TAXYRATIO ZZ_TB ZZ_TBR
ZZ_TRATE ZZ_W ZZ_WH ZZ_WH1 ZZ_WH2 ZZ_WK ZZ_WKKRATIO
ZZ_XM ZZ_XMRATIO ZZ_YCAP ZZ_YD

Exogenous Variables (Listed Alphabetically):

AONE RES_ROW_IM RES_ROW_PXM RES_ZZ_ER RES_ZZ_IM
RES_ZZ_K RES_ZZ_M RES_ZZ_PXM RES_ZZ_RS RES_ZZ_YCAP
ROW_A ROW_PGNP ROW_RSR T TT
ZLAMBDA ZRHO ZZ_ALPHA1 ZZ_ALPHA2 ZZ_BRATIOT ZZ_CTREFF
ZZ_DELTA ZZ_DEM3 ZZ_FRXDUM ZZ_FRXDUM2 ZZ_G ZZ_GEXOG
ZZ_MRXPDOT1 ZZ_MRXPDOT2 ZZ_NOMGDP_SS ZZ_PADOTT ZZ_PART
ZZ_POP ZZ_PROBD ZZ_PRODINDEX1 ZZ_PRODINDEX2 ZZ_PRODRG
ZZ_RPREM ZZ_RTP ZZ_SIGMA ZZ_TRATE_SS

Coefficients/Parameters:

L12 L21 S11 S12 S21 S22
UIM0 UIM1 UIM2 UIM3 UIM4 UIM5 UIM6 UIM7
UPXM0 UPXM1 UPXM2 W11 W12 W21 W22
ZIM0 ZIM1 ZIM2 ZIM3 ZIM4 ZIM5 ZIM6 ZIM7
ZK0 ZK1 ZK2 ZM0 ZM2 ZM4 ZP1 ZP2 ZP3
ZPXM0 ZPXM1 ZPXM2
FBWD FFWD MBWD MFWD
TAU1 TAU2 TAU3
UE87 ZBETA ZDUMCT ZE87 ZK87 ZL87 ZY87