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How Small Should an Economy's Fiscal Deficit Be?

A Monetary Programming Approach

A spreadsheet planning model to help determine the government deficit consistent with a specified vector of country macroeconomic objectives.

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Summary findings

Beckerman describes a spreadsheet planning model to help determine the government deficit consistent with a policymaker's "vector" of principal macroeconomic objectives (including real GDP growth, inflation, exchange rate, and international reserve accumulation). The model focuses on the monetary accounts, applying balance-of-payments forecasts formulated separately but based on the same macroeconomic objectives.

The model is a consistency exercise, intended as part of a broader consistency exercise for a given macroeconomy. It offers one more perspective on the question of how large a government deficit should be — a perspective that can be used in conjunction with others.

For each forecast period, the model determines consistent period-end and period-average stocks for the economy's outstanding central bank assets and liabilities and government obligations. It applies forecasting assumptions about interest rates to forecast central bank profit-and-loss flows, and takes account of these in determining the overall flow of resources that would be available to finance the government deficit.

An annex describes a (purely illustrative) simulation carried out during 1999 for Ecuador.

This paper — a product of the Poverty Reduction and Economic Management Sector Unit, Latin America and the Caribbean Region — is part of a larger effort in the region to strengthen the tools for macroeconomic policy analysis and planning in the region's economies. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Hazel Vargas, room I8-138, telephone 202-473-8546, fax 202-522-2119, email address hvargas@worldbank.org. Policy Research Working Papers are also posted on the Web at www.worldbank.org/research/workingpapers. The author may be contacted at pbeckerman@worldbank.org. March 2000. (34 pages)

HOW SMALL SHOULD AN ECONOMY'S FISCAL DEFICIT BE?

A MONETARY-PROGRAMMING APPROACH

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Introduction

In policy advice for developing economies, macroeconomic analysts often recommend tightened fiscal control. Some observers, especially weary residents of adjustment-fatigued developing economies, suspect that fiscal control has become a matter of dogma rather than practical policy imperative, and that no amount of fiscal tightening is ever quite enough for most macroeconomic analysts. This paper discusses one short-term analytical approach to the question of how far a fiscal deficit must be reduced (or surplus increased) to meet a government's macroeconomic objectives.

Section 1 discusses the basic approach and features of the exercise. Section 2 provides a summary exposition of the model's core procedure. Section 3 sets out the variables used in the detailed forecasting model. Section 4 lists the forecasting assumptions. Section 5 sets out the model. Section 6 discusses the interpretation of the forecasting results. Section 7 discusses the appropriate capital level for a central bank to maintain. Section 8 provides some concluding remarks. An Annex reports results of a spreadsheet application to the case of Ecuador in mid-1999.

1. The basic approach and features of the exercise

This paper describes a spreadsheet model that estimates the government deficit consistent with quantitative settings of a typical "vector" of macroeconomic objectives, including (i) year-over-year real-GDP growth; (ii) price-level growth; (iii) exchange-rate evolution; and (iv) international-reserve accumulation. For any given future year, if these variables took on their programmed values, the economy would be willing to hold certain stocks of government and central-bank obligations, according to the model's asset-demand functions. In principle, the changes in these stocks summed together would indicate the (maximum) flow of financing instruments the government and central bank could issue into the domestic financial system. The net government borrowing flow consistent with the macroeconomic objectives then follows from summing this flow with the flow of net external financing to the government (taken here to be exogenously given). ("Government" may be defined narrowly as just the "central government" or broadly to encompass the entire non-financial public sector, so long as the exercise maintains a consistent definition.)

The core of the exercise is a monetary-programming calculation of the (maximum allowable) increase in the central bank's net balance-sheet position *vis-a-vis* the government. In the process, the exercise determines the associated central-bank profit-and-loss flow and shows its effect on the maximum allowable government deficit. The net increase in government external debt outstanding and the increase in the central bank's net international-reserve position are taken to be exogenously given (either taken from an external-accounts forecasting exercise based on the same macroeconomic programming objectives, or simply set as assumptions). The government is assumed to borrow from (i) external financing sources, (ii) the central bank (in net terms, i.e., including any reduction in the government's deposit account at the central bank), and (iii) domestic financial markets (including commercial banks, excluding the central bank). The exercise determines the amounts these sources together could provide the government, consistent with the macroeconomic programming objectives, external-accounts conditions, supplementary policy instruments, and other behavioral assumptions.

The model presented here should be thought of as part of a broader macroeconomic framework for an economy, one fundamental purpose of which is to determine whether a specified government expenditure program would be fully financed if its economy's performance were to turn out according to the vector of programming objectives. The narrower purpose of the present model is to determine the financing flows that would be available to finance the public deficit if the vector of programming assumptions were to occur. That is, the present model is part of a macroeconomic "consistency" analysis. Economists sometimes disparage consistency exercises of this kind as "just simple adding-up exercises," noting, fairly enough, that they represent no general- or partial-equilibration processes and incorporate only limited assumptions about behavioral responses to incentives. Consistency models can be useful, however, when used appropriately. It would be methodologically inappropriate, for example, to use the present model for prediction: the fact that the model indicates that a given public deficit would be consistent with a given assumption vector by no means implies that the deficit and assumption vector are likely to occur. It would also be inappropriate to claim that the present model simulates the actual macroeconomic processes leading to the outcomes represented by the programming vector. The most appropriate applications of the model described here would undoubtedly be macroeconomic resource-planning exercises. It would be helpful to a policy analyst, for example, to determine that a particular programmed government deficit would require a larger flow of saving and credit resources than the assumption vector would imply. A claim of consistency is a claim of one kind of feasibility—i.e., in this model, resource adequacy. An inconsistent deficit and assumption vector would presumably not both be possible, and so such models can be used to reject unfeasible deficit-vector pairings. While this may seem unexciting for analysts aiming to predict the future, in many contexts this kind of determination can be useful for policy planning exercises.

Consistency exercises of this kind are carried out daily by national macroeconomic policy-makers, with varying degrees of detail and variations in methodology. The International Monetary Fund's basic monetary programming analysis is a consistency exercise, as is the World Bank's RMSM-X model. (The familiar Leontiev "input-output" model is another kind of consistency exercise: one way of describing its purpose is that it determines whether an economy's resource base is consistent with programmed output.)

Several particular features of the present model should be noted at the outset. It takes account not only of the central bank's balance sheet (stock and flow), but also of the central bank's own profit flow. (This is often called "the quasi-fiscal" surplus, although in some countries the expression also refers to other public-sector surpluses or deficits not counted in the main government accounts.) In itself, a central-bank profit flow is a source of monetary absorption, while a loss flow is a source of monetary expansion. This can significantly affect an economy's monetary aggregates, and may thereby significantly increase or reduce the maximum allowable net government borrowing flow. For example, interest earned on international reserves is part of a central bank's international-reserve inflow. Since in most cases this interest is capitalized into the international-reserve accounts, it has no direct monetary consequence. When calculating the sources of base-money expansion, however, the reserve inflow corresponding to the interest inflow may be taken to generate expansion, while the corresponding profit inflow presumably generates a precisely offsetting contraction. A similar example is revaluation of international reserves as a consequence of exchange-rate depreciation. Again, this has no monetary consequence: in the accounting of base-money expansion, the reserve "inflow" corresponding to the appreciation of the reserve stock in domestic-currency terms presumably generates expansion, while the corresponding profit inflow generates a precisely offsetting contraction. For a given maximum monetary expansion under a monetary program, where a central bank's profits or losses are significant, failure to take them into account can produce a corresponding over- or under-estimate of the maximum net financing a central bank can provide to its government.

Another important aspect of the present model is its way of taking account of year-end and year-average values. The model uses year-average values for the price level, exchange rate, and demand functions for money and government obligations. These are taken to be averages of the respective year-end values for the current and preceding years. The averages are taken to be weighted geometric averages, with weighting to take account of "seasonality." Thus, for example, as discussed below, the model takes the year-average domestic price level $\bar{p}$ to be given by

$$\bar{p} = p_{-1}^{[1 - z(p)]} p^{z(p)},$$

where p is the year-end price level and z(p) the exchange-rate "seasonality" coefficient. The "neutral" value of the seasonality coefficient, i.e., the value representing absence of seasonality, would be 0.5. A value of z(p) exceeding 0.5 would indicate more rapid inflation earlier in the year; that is, the year-end value would weigh more heavily than the previous year-end value in determining the year-average value. (In actual spreadsheet exercises, these seasonality assumptions can also be used to help "fudge" near-term forecasts of price-level and exchange-rate variables following a base year in which their actual evolution followed a highly irregular pattern.)

The present exposition takes the array of real interest rates to be exogenous. This is a simplifying approach, intended partly to avoid overloading the present exposition, partly to simplify the basic spreadsheet analysis. Being presented as exogenous in this way, there is no assurance, of course, that any array chosen is consistent with asset-demand functions, nor even with indebtedness ratios. This problem can be addressed by adding in the appropriate asset-demand functions and assumptions about their main parameters. The interest rate on government obligations could, for example, be incorporated in demand functions for money, government and central-bank non-monetary obligations, and these then solved simultaneously for mutually consistent real interest rates. A demand function for central-bank non-monetary obligations could also be set out explicitly (instead of assuming, as described below, that the central bank issues its obligations into a financial market indifferent between them and government obligations).

The approach described here is, of course, just one way of thinking about one aspect of the problem of determining appropriate fiscal policy. Its perspective is fundamentally short-term (at most, medium-term), whereas in many contexts policy-makers may be best advised to set their policy according to longer-term criteria. It focuses on "below-the-line" fiscal constraints, without considering the composition of revenue and expenditure, much less their effects on real output growth (which is taken here as a programming assumption). In sum (as always), the analytical tools described here are best used along with, and in the proper balance, with others.

2. A summary exposition of the model

The core of the exercise is a calculation of how much a central bank's net lending to a government could increase over a period in which it issues a given amount of base money. Consider a simple central bank whose period-end balance sheet consists of (i) net government obligations (F), (ii) other assets (represented *for this section only* by A), (iii) the monetary base (B), and (iv) the central bank's net worth (V). The average interest rates over the year on government obligations and on other assets are given, respectively, *for this section only*, by "f" and "a" (the monetary base is assumed to pay no interest). Since the flow balance sheet over any time period is given by

$$\Delta B + \Delta V = \Delta F + \Delta A,$$

the (maximum) increase in ΔF should be given by

$$\Delta F = \Delta B - \Delta A + \Delta V.$$

Suppose that ΔB, the flow increase in the monetary base B, is consistent, through a money multiplier and a demand-for-money function, with a programming vector of macroeconomic objectives, and assume that ΔA, the flow increase in the central bank's assets other than net government obligations, is exogenously given. Assuming there is no other source of new capital over the course of the year, the value of ΔV would be given by the interest earnings on the year-average stocks of the central bank's asset holdings,

$$\Delta V = f(F_{-1} + F)/2 + a(A_{-1} + A)/2,$$

where F_{-1} and A_{-1} are the previous period-end stocks (the period-average stock being taken to equal the average of the stocks at the beginning and end of the year). Since

$$F_{-1} + F = F_{-1} + (\Delta F/2)$$

and

$$A_{-1} + A = A_{-1} + (\Delta A/2),$$

$$\Delta V = f[F_{-1} + (\Delta F/2)] + a[A_{-1} + (\Delta A/2)].$$

Substituting this last expression into the balance-sheet identity and solving for ΔF gives the net increase in the financing the central bank could provide the government, consistent with ΔB, ΔA, "f" and "a":

$$\Delta F = \{\Delta B - \Delta A + [a A_{-1} + (a \Delta A/2) + f F_{-1}]\}/\{1 - (f/2)\}.$$

The meaning of this expression can be seen by first setting the interest rates "f" and "a" to zero. In this case, the net increase in net financing the central bank could provide the government would simply be the monetary base less ΔA. Suppose next that "a" and ΔA are greater than zero, but that "f" is still zero. In this case, since the central bank would earn a profit of

$$a A_{-1} + (a \Delta A/2),$$

it would have additional resources it could provide the government, all other things being equal (if ΔA is very much less than zero, of course, the central bank would have fewer resources to provide the government). Finally, since "f" is greater than zero, the central bank would have still more resources it could provide the government. Not only would it have the interest earnings from the stock of government obligations at the end of the previous year, $f F_{-1}$, it would also have the intra-year interest earnings on the government obligations the central bank would acquire during the present year (represented by the expression in the denominator of the right-hand side of the formula above for ΔF). In effect, of course, the central bank would lend these resources to the government to finance the interest due to the central bank. To the extent the central bank earns interest from the government, of course, its financing goes in part for this use.

The model presented in the three sections following is a more thorough (although, unfortunately, more complicated) version of this simple monetary-programming exercise.

3. The model's variables

The model's notation conventions are as follows. A bar over the variable indicates a period-average value, while absence of a bar indicates a period-end value. The symbol Δx is read "change in x over the preceding period," and g_X is read "growth rate of x" (i.e., $\Delta x/x_{-1}$). In general, upper case letters indicate asset or liability stocks, except for Y which represents nominal GDP. Asterisks denote values denominated in foreign exchange (U.S. dollars). Real interest rates are denoted by "r," with subscripts indicating the asset or liability stock to which the rate applies. Nominal interest rates are denoted by "n". An asterisk indicates an international U.S. dollar rate. Thus, for example, $\bar{r}_T$ represents the period-average real interest rate on government domestic obligations; $\bar{n}_T$ the corresponding nominal interest rate; and $\bar{n}_E^*$ represents the nominal period-average international U.S. dollar interest rate on external government obligations.

The variables used in the model are as follows:

Y	Nominal gross domestic product (GDP);
Y	Real GDP;
Y^*	Nominal GDP measured in U.S. dollars;
$\overline{p}$	Period-average domestic price level;
P	The period-end domestic price level;
$\overline{p}^*$	Period-average (U.S.-dollar) world price level;
p^*	Period-end world price level;
$\overline{e}$	Period-average (domestic currency per U.S. dollar);
E	Period-end exchange rate;
$\overline{M}$	Period-average broad money supply;
M	Period-end broad money supply;
$\overline{C}$	Period-average currency in circulation;
C	Period-end currency in circulation;
B	Period-end monetary base;
$\overline{A}^*$	Period-average gross central-bank external assets;
A^*	Period-end gross central-bank external assets;
$\overline{L}^*$	Period-average central-bank external liabilities;
L^*	Period-end central-bank external liabilities;
$\overline{R}$	Period-average commercial-bank reserves (central-bank obligations);
R	Period-end commercial-bank reserves;
$\overline{H}$	Period-average central-bank credit to commercial banks;
H	Period-end central-bank credit to commercial banks;
$\overline{Q}$	Period-average government deposit balance at the central bank;

Q	Period-end government deposit balance at the central bank;
$\overline{U}$	Period-average central-bank non-monetary obligations;
U	Period-end central-bank non-monetary obligations;
$\overline{F}$	Period-average central-bank credit to the government;
F	Period-end central-bank credit to the government;
$\overline{T}$	The sum of period-average net central government obligations and central-bank non-monetary obligations to domestic financial markets;
T	The sum of period-end net central government obligations and central-bank non-monetary obligations to domestic financial markets;
$\overline{E}^*$	Period-average net central government foreign currency obligations to external creditors;
E^*	Period-end net central government foreign currency obligations to external creditors;
K	The government's period-end capital position in the central bank; and
Z	The government deficit (in domestic currency).

Also, $\overline{n}_A^*$, $\overline{n}_L^*$, $\overline{n}_E^*$, $\overline{n}_H$, $\overline{n}_Q$, $\overline{n}_F$, $\overline{n}_R$, $\overline{n}_U$, and $\overline{n}_T$ represent the respective nominal interest rates on the central-bank assets, central-bank liabilities, and government obligations A^*, L^*, E^*, H, Q, F, R, U, and (T-U). In addition, x(M) and x(T) represent the elasticities of money demand and government and central-bank domestic obligations, respectively, with respect to real GDP. As noted above, the model uses "seasonality coefficients": the coefficient for the exchange rate e is given by z(e), the coefficient for the price level p is given by z(p), and so on. Finally, v_H represents the percentage value increase in the central bank's holdings of commercial-bank obligations. (A negative value of v_H, for example, could represent a credit loss on a liquidity loan by the central bank to a commercial bank.)

4. Forecasting assumptions

For each forecast year the model requires seven groups of assumptions, (A) basic macroeconomic programming objectives, (B) certain external-accounts flows, (C) flow changes in components of the central bank's domestic credit, (D) nominal interest rates, (E) behavioral parameters, and (F) seasonality coefficients, and (G) the valuation change in the central bank's assets and liabilities. For each forecast year, the ***basic macroeconomic programming objectives*** are as follows:

(A.1) g_y year-over-year growth rate of real GDP;

(A.2) $g_{\bar{p}}$ year-over-year growth rate of the average price level;

and

(A.3) $g_{\bar{e}}$ year-over-year growth rate of the average exchange rate.

These values may be assumed directly or calculated from other assumptions. For example, the growth rate of the average price level can be calculated from an assumed year-end to year-end price-level growth rate. Since

$$\bar{p} = p_{-1}^{[1 - z(p)]} \, p^{z(p)},$$

$$\bar{p} = \bar{p}_{-1} (1 + g_{\bar{p}}) = p_{-1}^{[1 - z(p)]} \, [p_{-1} (1 + g_p)]^{z(p)},$$

so that

$$(1 + g_{\bar{p}}) = [p_{-1}/\bar{p}_{-1}] \, [1 + g_p)]^{z(p)}.$$

Next, for each forecast year, several assumptions are required regarding the ***external accounts***:

(B.1) A^* U.S. dollar value of the central bank's gross external assets;

(B.2) L^* U.S. dollar value of the central bank's external liabilities;

(B.3) E^* U.S. dollar value of the government's external debt;

(B.4) $\bar{n}^*_A$ average interest rate on gross international assets;

(B.5) $\bar{n}^*_L$ average interest rate on the central bank's external debt;

and

(B.6) $\bar{n}^*_E$ average interest rate on the government's external debt.

These values may be assumed directly or calculated from other assumptions. Thus, for example, the increase in the central bank's gross external assets can be calculated by assuming that the central bank will aim to end the period with a reserve stock equal to some number of months of imports of goods and non-factor services.

Next, the model requires assumptions regarding ***flow changes in components of the central bank's domestic credit***:

(C.1) ΔH the increase in commercial-bank obligations to the central bank;

(C.2) ΔU the increase in central-bank non-monetary obligations (including open-market intervention instruments);

(C.3) $\Delta' F$ the programmed minimum increase in the central bank's claims on the government;

(C.4) $\Delta' Q$ the programmed minimum increase in the government's deposit account at the central bank; and

(C.5) ΔK the net increase in the government's capital position in the central bank.

The flow value ΔK is positive to the extent the government increases its equity holding and negative to the extent it withdraws capital, e.g., receives a dividend payment. These assumptions may be derived from assumptions about their real or nominal growth rates, or from other relationships. For example, the government may be assumed to end each period with a deposit balance at the central bank equal to some given percentage of the preceding year's GDP.

An important point to note here is that the flow increases in the balance-sheet values are taken to incorporate capitalized interest and valuation increases. Thus, for example, ΔH, the change in the central bank's outstanding credit to commercial banks, includes (i) net new lending to commercial banks, (ii) interest accrued on such lending, and (iii) any valuation change in the credit stocks that may have occurred. Thus, for example, in setting the assumption for ΔH for any particular year, the accrued interest and valuation change assumptions (D.1) and (G.1) should be taken into account accordingly.

Nominal period-average interest rates on the central-bank assets and liabilities H, F, R, Q, and U are given, respectively, by

(D.1) $\bar{n}_H$,

(D.2) $\bar{n}_F$,

(D.3) $\bar{n}_R$,

(D.4) $\bar{n}_Q$, and

(D.5) $\bar{n}_U$.

Government obligations are assumed to yield nominal interest of

(D.6) $\bar{n}_T$.

The respective period-average real interest rates are $\bar{r}_H$, $\bar{r}_F$, $\bar{r}_R$, $\bar{r}_Q$, $\bar{r}_U$, and $\bar{r}_T$. The nominal interest rates may be assumed directly, or instead the real values may be assumed, and the inflation rate then used to calculate the nominal rate. For example, if $\bar{r}_H$ represents the real interest rate on H, the corresponding period-average nominal interest rate could be taken to be given by

$$\bar{n}_H = [(1 + \bar{r}_H)(1 + g_p)] - 1.$$

(In a spreadsheet, setting out the interest-rate assumptions in real terms and calculating the nominal rate using this formula has the advantage of permitting automatic changes in nominal interest rates when the inflation assumption is changed.)

Assumptions regarding ***behavioral parameters*** comprise the following:

(E.1) k commercial banks' marginal reserve ratio;

(E.2) m the marginal money multiplier;

(E.3) x(M) the elasticity of money demand with respect to real GDP; and

(E.4) x(T) the elasticity of demand for government and central-bank domestic obligations with respect to real GDP.

In the formula for the marginal money multiplier, the values of k and m are taken to be behavioral parameters rather than policy variables. If k exceeds the minimum reserve ratio it may be considered a behavioral parameter; if it equals the minimum reserve ratio when bank managements would prefer to operate with a lower reserve ratio, k would be a policy setting. The value of m is taken to be a behavioral parameter. If z represents the public's marginal currency-deposit ratio, then m = (1 + z)/(k + z)).

Next, there are the ***"seasonality" coefficients*** for the variables p, e, A^*, L^*, E^*, M, T, H, R, and U respectively:

(F.1) z(p)

(F.2) $z(e)$,

(F.3) $z(M)$,

(F.4) $z(R)$,

(F.5) $z(U)$.

(F.6) $z(H)$

(F.7) $z(A^*)$,

(F.8) $z(L^*)$, and

(F.9) $z(T)$,

For simplicity, the seasonality coefficients for F and Q are assumed to be 0.5.

A final assumption introduces ***valuation change*** in the central bank's assets:

(G.1) v_H represents the growth in the valuation of the central bank's holdings of commercial-bank obligations over the period. Thus, for example, a negative value of v_H could represent a credit loss taken by the central bank on liquidity credit to commercial banks.

5. The forecasting model

For each forecast year, the model determines the (maximum) net government borrowing requirement consistent with the programmed macroeconomic and forecast external accounts as the sum of (i) net external borrowing, (ii) net central-bank lending to the government, and (iii) the flow change in domestic government obligations outstanding to financial markets excluding the central bank, as follows. First, (i) the government's net external borrowing is calculated from the exogenous assumptions. Next, (ii) the monetary programming exercise is applied to calculate net central-bank lending to the government. Finally, (iii) the flow change in domestic non-central bank government obligations outstanding is calculated from the year-average and the preceding year-end stock.

The monetary programming exercise begins by applying the money-demand function to calculate year-average money demand. The flow change in the money supply is then calculated from the year-average and the preceding year-end stocks. The assumed money multiplier is then applied to forecast the change in the monetary base. The flow changes in the central bank's gross external assets and liabilities, domestic non-monetary liabilities, and loans to financial institutions, along with the average stocks and the interest flows deriving from them, are brought in from the assumptions. The central bank's flow balance-sheet identity is then used simultaneously to calculate the increase in net central-bank lending to the government and the flow increase in the central bank's capital position through profit. Net central-bank lending to the government is the difference between the increase in central-bank loans to the government and the increase in the government's deposit balance at the central bank. The (maximum) net government borrowing flow consistent with the programmed macroeconomic objectives and the forecast external accounts is then obtained, as noted, by summing net external borrowing, the flow change in domestic non-central bank government obligations outstanding, and net central-bank lending to the government.

The model's equations are as follows. First, forecasts of (1) the year-average price level and (2) exchange rate, (3) the year-end exchange rate, (4) nominal and (5) real GDP, and (6) GDP in U.S. dollars are calculated from the previous year's values and the assumed growth rates, as follows. First, the year-average price level and exchange rate:

$$\bar{p} = \bar{p}_{-1} (1 + g_{\bar{p}}); \qquad (1)$$

$$\bar{e} = \bar{e}_{-1} (1 + g_{\bar{e}}). \qquad (2)$$

Next, assuming that the period-average exchange rate is the weighted geometric mean of the current and previous year's period-end values, the forecast period-end exchange rate may then be calculated using the formula

$$e = e_{-1} (1 + g_e), \text{ where}$$

$$1 + g_e = [(e_{-1}/\bar{e}_{-1}) (1 + g_{\bar{e}})]^{1/z(e)}. \qquad (3)$$

For the domestic-currency, real, and U.S.-dollar values of GDP,

$$Y = Y_{-1} (1 + g_Y), \text{ where}$$

$$(1 + g_Y) = (1 + g_y) (1 + g_{\bar{p}}); \qquad (4)$$

$$y = y_{-1} (1 + g_y); \qquad (5)$$

and

$$Y^* = Y^*_{-1} (1 + g_y)/(1 + g_{\bar{e}}); \qquad (6)$$

The monetary programming exercise determines the maximum net borrowing the government could obtain from the central bank given the policy objectives. The basic approach is to forecast the flow increases in the central bank's assets and liabilities and then calculate the available increase in central-bank lending to the government by subtraction, using the flow balance-sheet identity. The basic approach can be understood from the central bank's balance sheet:

CENTRAL-BANK BALANCE SHEET

Assets		Liabilities	
Gross external assets	(A)	External liabilities	(L)
Domestic assets:		**Domestic liabilities:**	
Government obligations	(F)	Monetary base:	(B)
Commercial-bank obligations	(H)	Currency in circulation	(C)
		Bank reserves	(R)
		Government deposit account	(Q)
		Non-monetary domestic liabilities	(U)
		Net worth:	(V)
		of which, government capital	(K)

The model determines the flow changes in the values of L, B, Q, U, H, and A, then solves simultaneously for the flow changes in the values of F and V.

The model sets out by calculating the economy's average holding of broad money over the year, and from this computes the change in broad money outstanding over the year:

$$\overline{M} = \overline{M}_{-1}\,(1 + g_{\overline{p}})\,(1 + g_y)^{x(M)} \qquad (7)$$

and

$$\Delta M = M_{-1}\,\{[(\overline{M}/M_{-1})]^{[1/z(M)]} - 1\}. \qquad (8)$$

The period-end value of M is then calculated as

$$M = M_{-1} + \Delta M. \qquad (9)$$

The flow increases in the monetary base and its components are given by

$$\Delta B = \Delta M/m, \qquad (10)$$

$$\Delta R = k\,\Delta M\,[1 - (1/m)]/[1-k], \qquad (11)$$

and

$$\Delta C = [\Delta B - \Delta R], \qquad (12)$$

with "m" representing the marginal money multiplier and "k" the reserve ratio maintained by banks (either the minimum required by the monetary authority or a higher amount according to bank managers' preferences). (The formula for ΔR follows from noting that $M = C + D$, $B = C + R$, so that $C = M - D = B - R$; since $B = \Delta M/m$ and $R = k\,\Delta D$,

$$\Delta M\,[1 - (1/m)]/[1-k] = D - kD,$$

and

$$\Delta R = k\,\Delta D,$$

the formula follows directly.) The period-end stocks of B, R and C are given by

$$B = B_{-1} + \Delta B; \qquad (13)$$

$$R = R_{-1} + \Delta R; \qquad (14)$$

$$C = C_{-1} + \Delta C. \qquad (15)$$

The flow increases in central-bank non-government domestic lending, ΔH, and in central-bank non-monetary liabilities, ΔU, are assumptions. The period-end stocks are given by

$$H = H_{-1} + \Delta H \qquad (16)$$

and

$$U = U_{-1} + \Delta U. \qquad (17)$$

As noted above, the flow increases incorporate capitalized interest and valuation change. In an actual modeling exercise an analyst who introduces a forecast of, say, a valuation loss on commercial-bank obligations to the central bank would need to change both assumptions C-1 (ΔH) and G-1 (v_H).

Some intricacies arise in the formulas for the increase in the foreign-exchange value of the central bank's external asset and liability holdings. The overall increases in their respective U.S.-dollar values, ΔA^* and ΔL^*, are assumptions. The difference $\Delta A^* - \Delta L^*$ is the change in the central bank's net external asset position in U.S. dollars. In domestic-currency terms this difference is given by

$$\Delta A - \Delta L = e\,(A^* - L^*) - e_{-1}\,(A^*_{-1} - L^*_{-1}). \qquad (18)$$

The "revaluation" component of the increase in the domestic-currency equivalent of the central bank's net external asset position (comprising both the cross-currency and the exchange-rate valuation increases) is given then by

$$(\Delta A - \Delta L) - \bar{e}\,(\Delta A^* - \Delta L^*). \tag{19}$$

This formula also gives the net foreign-assets revaluation component of the central bank's profit flow and hence, as explained below, of the increase in the central bank's capitalization position. The period-end value of the central bank's foreign-exchange net asset position is given by

$$A - L = (A_{-1} - L_{-1}) + (\Delta A - \Delta L). \tag{20}$$

The period-average stocks of these assets and liabilities (which are used below in the calculation of the central bank's profit and loss account) are given by[1]

$$\bar{R} = R_{-1}^{[1 - z(R)]} R^{z(R)}, \tag{21}$$

$$\bar{U} = U_{-1}^{[1 - z(U)]} U^{z(U)}, \tag{22}$$

$$\bar{H} = H_{-1}^{[1 - z(H)]} H^{z(H)}, \tag{23}$$

$$\bar{A}^* = A^{*\,[1 - z(A^*)]}_{-1} A^{*z(A^*)}, \tag{24}$$

and

$$\bar{L}^* = L^{*\,[1 - z(L^*)]}_{-1} L^{*z(L^*)}. \tag{25}$$

The most intricate part of the solution procedure is the calculation of the government's net borrowing from the central bank. This is a two-step procedure to determine ΔF and ΔQ: either ΔQ takes on its minimum value $\Delta' Q$ and equation 26a below gives ΔF, or ΔF takes on its minimum value $\Delta' F$ and equation 26b gives ΔQ. The central bank's flow balance-sheet identity implies that

$$\Delta F - \Delta Q = \Delta B - (\Delta A - \Delta L) - (\Delta H - \Delta U) + \Delta V.$$

The change in the central bank's net worth is given by the sum of (i) the central bank's net interest bill and (ii) the valuation increase in its external assets:

[1] The writer is grateful to Luís Serven for suggesting the weighting used in the following formulas.

$$\Delta V = \bar{e}\,(\bar{n}^*_A\,\bar{A}^* - \bar{n}^*_L\,\bar{L}^*) - \bar{n}_R\,\bar{R} + (\bar{n}_H\,\bar{H} - \bar{n}_U\,\bar{U})$$

$$+ (\bar{n}_F\,\bar{F} - \bar{n}_Q\,\bar{Q}) + [(\Delta A - \Delta L) - \bar{e}\,(\Delta A^* - \Delta L^*)] - v_H H_{-1} + \Delta K.$$

A formula for the government's net borrowing from the central bank net of interest can be obtained by substituting this last expression into the preceding expression and rearranging:

$$(\Delta F - \bar{n}_F\,\bar{F}) - (\Delta Q - \bar{n}_Q\,\bar{Q}) = \Delta K - v_H H_{-1} + (\Delta B - \bar{n}_R\,\bar{R})$$

$$+ (\Delta U - \bar{n}_U\,\bar{U}) - (\Delta H - \bar{n}_H\,\bar{H}) - \bar{e}\,[\Delta A^* - \bar{n}^*_A\,\bar{A}^*)$$

$$- (\Delta L^* - \bar{n}^*_L\,\bar{L}^*)].$$

Note that

$$\bar{F} = F_{-1}\,[1 + (\Delta F/F_{-1})]^{0.5} = F_{-1}\,(1 + g_F)^{0.5}$$

and

$$\bar{Q} = Q_{-1}\,[1 + (\Delta Q/Q_{-1})]^{0.5} = Q_{-1}\,(1 + g_Q)^{0.5}.$$

The procedure for calculating ΔF and ΔQ uses the assumptions regarding the minimum increases in their values, $\Delta' F$ and $\Delta' Q$, as follows. Assume that F_{-1} and Q_{-1} are greater than zero.

(a) To begin, set $\Delta Q = \Delta' Q$ and solve

$$\Delta F - \bar{n}_F\,\bar{F} = -(1 + \alpha)\,F_{-1},$$

for ΔF, where

$$\alpha = -\{(\Delta B - \bar{n}_R\,\bar{R}) + (\Delta U - \bar{n}_U\,\bar{U}) - (\Delta H - \bar{n}_H\,\bar{H})$$

$$- \bar{e}\,[\Delta A^* - \bar{n}^*_A\,\bar{A}^*) - (\Delta L^* - \bar{n}^*_L\,\bar{L}^*)] + (\Delta Q - \bar{n}_Q\,\bar{Q})$$

$$- F_{-1} + v_H H_{-1} + \Delta K\}/F_{-1},$$

with $\Delta Q = \Delta' Q$ and $\bar{Q} = [Q_{-1}\,(Q_{-1} + \Delta' Q)]^{0.5}$.

The result is

$$\Delta F/F_{-1} = \{(\bar{n}_F/2) \pm [(\bar{n}_F{}^2/4) - \alpha]^{0.5}\}^2 - 1. \qquad (26a)$$

This solution may be computed as follows. Since

$$\Delta F - \bar{n}_F \bar{F} = -(1+\alpha) F_{-1},$$

$$F_{-1} \Delta F/F_{-1} - \bar{n}_F F_{-1} (1+g_F)^{0.5} = -(1+\alpha) F_{-1},$$

or

$$g_F - \bar{n}_F (1+g_F)^{0.5} = -(1+\alpha).$$

Adding $(1+\alpha)$ to both sides,

$$(1+g_F) - \bar{n}_F (1+g_F)^{0.5} + \alpha = 0.$$

This equation may be solved for $(1+g_F)^{0.5}$ using the quadratic formula, and then for $(1+g_F)$ to obtain the formula (26a). (The quadratic solution arises from the use of geometric averaging. The larger of the two roots would be the appropriate solution.) If the value of ΔF given by formula (26a) exceeds $-F_{-1}$, it is the solution, with $\Delta Q = \Delta' Q$.

(b) If the value of ΔF given by formula (26a) is less than $-\Delta' F_{-1}$, the solution is then found by setting $\Delta F = -\Delta' F_{-1}$ and solving

$$\Delta Q - \bar{n}_Q \bar{Q} = -(1+\beta) Q_{-1}$$

for ΔQ, where

$$\beta = \{(\Delta B - \bar{n}_R \bar{R}) + (\Delta U - \bar{n}_U \bar{U}) - (\Delta H - \bar{n}_H \bar{H})$$
$$- \bar{e} [\Delta A^* - \bar{n}^*_A \bar{A}^*) - (\Delta L^* - \bar{n}^*_L \bar{L}^*)] - (\Delta F - \bar{n}_F \bar{F})$$
$$+ Q_{-1} + v_H H_{-1} + \Delta K\}/Q_{-1},$$

with $\Delta F = \Delta' F$ and $\bar{F} = [F_{-1} (F_{-1} + \Delta' F)]^{0.5}$.

In this case the result is

$$\Delta Q/Q_{-1} = \{(\bar{n}_Q/2) \pm [(\bar{n}_Q{}^2/4) - \beta]^{0.5}\}^2 - 1. \qquad (26b)$$

The solution calculation for ΔQ is essentially the same as for formula (26a).

It is helpful to calculate ΔF even for economies where the government is not permitted to borrow from the central bank. In fact, for such economies it is particularly useful to determine whether the model calculates a value for ΔF greater than zero, precisely because in such economies the macroeconomic programming values leading to this result must on this account be considered infeasible.[2]

The economy's period-average holding of government and central-bank obligations together is given by

$$\bar{T} = \bar{T}_{-1}\,(1 + g_{\bar{p}})\,(1 + g_y)^{x(T)} \qquad (27)$$

The change over the year in the demand for domestic government bills and bonds is given then by

$$\Delta T = T_{-1}\,\{[(\bar{T} + \bar{U})/(\bar{T}_{-1} + \bar{U}_{-1})]^{[1/z(T)]} - 1\} - \Delta U. \qquad (28)$$

The period-end stock of domestic government debt excluding the central bank's holdings is given by

$$T - U = T_{-1} - U_{-1} + \Delta T - \Delta U. \qquad (29)$$

Intricacies similar to those involving the central bank's external asset and liability holdings arise in the formulas for the domestic-currency value of the government's external debt. The assumed overall increase in its outstanding value is ΔE^*, and the period-end value is given by

$$E^* = E^*_{-1} + \Delta E^*.$$

The period-average stock of the U.S.-dollar value of the government's external debt is given by

$$\bar{E}^* = E^*_{-1}{}^{[1 - z(E^*)]}\, E^{*z(E^*)}. \qquad (30)$$

[2] The writer is grateful to Antonio Velandia for raising this question.

In domestic-currency terms the overall increase in its outstanding value is given by

$$\Delta E = e E^* - e_{-1} E^*_{-1}. \quad (31)$$

The flow of new government external borrowing less repayment in domestic-currency terms is given by

$$\bar{e} \Delta E^*, \quad (32)$$

and the overall "revaluation" component of the increase in the domestic-currency equivalent of the government's outstanding external debt (comprising both the cross-currency and the exchange-rate valuation increases) is given by

$$\Delta E - \bar{e} \Delta E^*. \quad (33)$$

The (maximum) net government borrowing flow consistent with the policy assumptions is given then by

$$Z = (\Delta F - \Delta Q) + \Delta T + \bar{e} \Delta E^*. \quad (34)$$

Since the government's net interest bill is given by

$$(\bar{n}_F \bar{F} - \bar{n}_Q \bar{Q}) + \bar{n}_T (\bar{T} - \bar{U}) + (\bar{e} \bar{n}^*_E \bar{E}^*), \quad (35)$$

$$Z - [(\bar{n}_F \bar{F} - \bar{n}_Q \bar{Q}) + \bar{n}_T (\bar{T} - \bar{U}) + (\bar{e} \bar{n}^*_E \bar{E}^*)] \quad (36)$$

gives the (maximum) primary (non-interest) net government borrowing flow consistent with the macroeconomic programming assumptions.

6. Analyzing forecasting results

It is not always obvious *a priori* just how particular changes in the vector of macroeconomic objectives would affect the maximum allowable net government borrowing (which is, of course, one of the reasons to use a model like this). For example, in general, for any given year, one would expect higher targeted values for real GDP growth or inflation to imply a higher maximum allowable borrowing requirement in domestic-currency terms. These changes would imply a higher demand for money, which would translate into a larger allowable monetary-base growth, and so, all other things being equal, a larger allowable amount that the central bank could lend to the government (or a larger allowable amount that the government could draw down from its deposit account). It is important to remember, however, that these effects would be in domestic-currency terms. Higher GDP growth and inflation would also imply higher nominal GDP. The effects of increases in the assumed values of real GDP growth and inflation on the maximum allowable net government borrowing *as a percentage of GDP* depend on the parameter assumptions and their inter-relationships, and could, in principle, go either way. The model and its details should be helpful precisely in showing these consequences and helping to understand them.

It is important also to remember that changes in the values of the macroeconomic objectives would also affect the external accounts, and this should be taken into account when using the present model. For example, all other things being equal, higher targeted values for real GDP growth or inflation should increase imports, thus reducing the international-reserve inflow. Since this would imply a smaller increase in the central-bank asset stock, the consequence should be a larger maximum amount that the central bank could lend to the government (or a larger maximum amount that the government could draw down from its deposit account). This would reinforce the probable positive consequence of the increased demand for money for the maximum net borrowing requirement.

An increase in the targeted exchange-rate depreciation could affect the maximum net government borrowing requirement in different ways. It is worth noting, however, that the effect of such an increase on the maximum government deficit should not depend on whether the central bank's initial net foreign-exchange asset position is positive or negative. While a faster rate of currency depreciation would imply a larger increase in the central bank's net foreign-exchange asset position if the position is initially positive—a source of monetary expansion—the full amount of this change would go into the central bank's profit flow—a source of monetary absorption. The overall monetary consequence, hence the effect on the maximum net borrowing requirement, would be entirely neutralized. Again, the consequences for currency depreciation on international-reserve accumulation would need to be taken into account. Since it is presumably positive, all other things being equal, a higher rate of currency depreciation should generally imply a smaller maximum net government borrowing requirement.

Once the maximum net government borrowing flow has been computed for any given vector of macroeconomic objectives and set of parameter assumptions, the next step is to determine whether it is consistent with the government's plans and possibilities—i.e., whether the government is able, given political and contractual constraints, to run a net borrowing flow as low as this maximum. This step is beyond the scope of the model discussed here, which focuses on the "below-the-line" fiscal accounts (but no less essential for that). The analyst would want to apply the same vector of macroeconomic objectives to forecast the "above-the-line" accounts, to determine whether the overall fiscal surplus or deficit would then fall within the below-the-line constraint. In some instances, changed assumptions can lead to complicated consequences. In general, for example, a reduction in the assumed real-GDP growth rate may be expected to imply a lower maximum net borrowing requirement. The same change would imply a higher above-the-line net borrowing requirement, however, because it would imply lower tax revenue.

The analyst may also wish to determine whether the banking system is capable of supporting the macroeconomic programming vector. The model as set out here does not incorporate the banking system explicitly, but since the model does include monetary deposit stocks and the money multiplier, a maximum bank-credit stock could be computed on the basis of a few additional assumptions. Some of this credit would presumably go to the government and the central bank, in the form of commercial-bank purchases of government and central-bank obligations. The remainder could be assumed to be credit going for the economy's productive and commercial systems. One rapid consistency check would be a comparison of the growth rates of this kind of credit and of GDP. If the growth rate of banking-system "productive" credit is significantly less than the programmed GDP growth rate, the analyst might conclude that the GDP growth rate is, at least from this standpoint, unlikely to prove feasible.

As noted at the outset, the model described here is conceived as forming part of a broader macroeconomic consistency analysis, encompassing the full range of an economy's external, fiscal and monetary relationships. A given set of macroeconomic objectives may imply a particular maximum net government borrowing requirement, i.e., a particular below-the-line maximum government deficit. If the same set of macroeconomic objectives implies a higher above-the-line deficit, then, of course, either the analyst would want to change the macroeconomic objectives or propose policy measures to reduce the above-the-line deficit.

7. The central bank's capital position

The model's calculated forecasts include the central bank's own period-end and period-average net worth. For any year, a given vector of macroeconomic objectives may imply a significant increase or decrease in this variable, in real terms, as a percentage of GDP, or as a percentage of the central bank's asset position. If the central bank's capital position is growing at a rate significantly below that of GDP (not to mention below zero), the analyst may wish to consider what this implies for the programming assumptions.

The significance of a central bank's capitalization is a matter of some controversy (see Stella 1997, Beckerman 1997). In a simple sense, a central bank's net worth measures the extent to which the monetary base is quantitatively "backed" by the central bank's net international and domestic assets. To be sure, this measure is a limited indicator of "backing," since it takes no account of the liquidity of the central bank's net asset position—that is, it takes no account of the extent to which the central bank really could deploy its asset base if need be to absorb its outstanding liquidity issue. Nevertheless, at the present level of analysis, it seems reasonable enough to take the view that, all other things being equal, *changes* in the central bank's net worth correspond to *changes* in the backing of the monetary base.

It is unclear how much such changes matter in practical terms for macroeconomic performance. It is unclear to what extent economic agents take account of changes in the backing of the monetary base in determining their behavior—in the way, for example, that their views regarding international-reserve levels often influence exchange rates. In most nations, at most times, most people are simply oblivious to movements in their central bank's net worth. Where such changes are large, persistent and negative, however, they can matter, in at least two ways. First, to the extent a central bank's net worth diminishes, its quantitative capacity to carry out monetary policy diminishes. (Again, it cannot be too strongly emphasized that the liquidity of the central bank's net asset position is at least as important as its quantitative size.) Second, at some point, economic agents may perceive that the "backing" of their money has diminished significantly, and this change in perception may produce a "step" decline in the demand for money.

In several instances, the stocks and flows of central-bank net worth have become significant in these ways. The experiences of Chile and Argentina are well-known examples. Chile's quasi-fiscal deficit, which originated mainly in the Central Bank's loans to commercial banks that had become decapitalized in the crisis of the early 1980s, has never been sufficiently large to prevent the country from stabilizing and growing impressively, but has been a standing problem for the monetary authority's full effectiveness (see Eyzaguirre and Larrañaga 1990). The quasi-fiscal losses *per se* have been a source of money creation, and that nation's Central Bank therefore had to run tighter monetary policy than would otherwise have been required. The Argentine Central Bank's so-called quasi-fiscal deficit became the engine of the hyperinflation in the late 1980s (see Giorgio 1989 and Beckerman 1995). It arose mainly from an attempt to tighten monetary control using high reserve requirements and sales of Central Bank obligations. In the mid-1980s, tightened monetary policy and the unusually high inflationary uncertainty then prevailing forced commercial banks to pay high rates to maintain their deposit base. The Central Bank began paying high rates on its obligations to the banks to enable them to maintain positive operating spreads. Since the Central Bank's earnings on its asset position were inadequate to cover its interest bill, it ran a high deficit, which it financed with further issues of obligations (including capitalization of interest into the stocks of remunerated reserves). By the end of 1989 these obligations and their interest bill had accumulated so massively that the Central Bank found itself in acute distress, with interest rates rising sharply and the price level surging. Over the New Year's weekend of 1990, the authorities carried out the "BONEX conversion," paying out these obligations once and for all to commercial banks, and ultimately to the banks' depositors, in dollar-denominated External Bonds yielding LIBOR. Commercial banks who held the Central Bank's obligations were required to pass the BONEX on to their depositors. The BONEX immediately took a deep market discount (which was the form in which the Central Bank effectively "liquidated" its debt). In April 1991, the authorities fixed the exchange rate and introduced a partial currency board through the "Convertibility Law." This policy proved successful in reducing inflation, and—among its other consequences—gradually increased BONEX valuations to normal levels for external debt. (Argentina's Central Bank has resumed the practice of remunerating bank reserves, but does so from a solid asset base now consisting mainly of international reserves.)

As these examples show, central banks can earn profits and take losses on various accounts (see Beckerman 1997). These include interest receipts and payments generally, foreign-exchange operations, and treasury operations in foreign and domestic financial markets. Some central banks carry out operations more appropriately carried out as fiscal operations; for example, governments have sometimes used central banks to pay subsidies. Some central banks have been decapitalized by contingent liabilities. For example, some central banks had to honor costly exchange-rate guarantees. (See Polackova 1998 for a discussion of the dangers of public-sector contingent liabilities generally.)

For present purposes, one point of including the central bank's capital position in the model is to determine whether the macroeconomic program settings would imply a sharp or continuing reduction in the central bank's capital position. A forecast of a rapidly declining capital position would suggest that the macroeconomic program settings might ultimately prove infeasible. A higher inflation rate, a different structure of central-bank interest rates, or higher exchange-rate depreciation might be required to ensure that the central bank maintains an adequate capital position. In fact, the problem may simply be that the central bank is under-capitalized from the outset: with a larger initial capital position (and the corresponding assets), the central bank would earn a higher profit flow from the outset, and this capital position may therefore be more likely to prove sustainable.

Just as for public deficits generally, for certain purposes it is appropriate to calculate a central bank's profit-and-loss account adjusted for inflation. That is, the central bank's profit-and-loss flow may be decomposed into "inflation" and "real" components. The inflation component reflects the real-value losses sustained by the central bank's assets and liabilities as a consequence of inflation: the losses on the assets subtract from and the losses on the liabilities add to the central bank's profit. The profit or loss resulting from inflation may be estimated both for past and future by multiplying the difference between the period-average domestic-currency values of the central bank's assets and liabilities by $-g_p/(1+g_p)$, where g_p represents the inflation rate over the period. The "real" component of the central bank's profit flow may be calculated by subtracting the "inflation" component from the overall profit flow.

It is difficult to say how large a net-worth position a central bank ought to maintain—just as, in fact, it has proven difficult to provide analytical foundations for the "Basel" capital-adequacy norms for commercial banks, which set the appropriate capital position as a percentage of "risk-weighted" assets. For a central bank, it may be conjectured that the appropriate capital position would be that which, over time, can be held stable in relation to the institution's asset base, with the growth of the capital base coming entirely from the central bank's own profit flow. *For the discussion following only*, let A represent the central bank's total net-asset base (incorporating the monetary base as a negative item), V its net worth, and ΔV its annual profit flow. The ratio V/A would remain constant if

$$\Delta V/V = \Delta A/A$$

$$= g_A$$

or, rearranging, if

$$V/A = (\Delta V/A)/g_A$$

—that is, if the net worth as a percentage of the asset stock were equal to the ratio of (i) the central bank's return on its assets to (ii) the asset growth rate. The long-term asset-growth rate would presumably be the same as the real-GDP growth rate. The appropriate long-term central-bank net worth as a percentage of its asset base, V/A, to be maintained over time would then be that value for which the resulting ΔV would maintain this last equality. This would depend in turn on the central bank's asset and liability structure and also on its interest-rate structure.

8. Concluding remarks

It cannot be emphasized strongly enough that the model presented here is a consistency framework, not a behavioral model, and much less a prediction exercise. The model's purpose is only to determine the government deficit consistent with a particular vector of macroeconomic objectives. In particular country contexts, demonstration of such consistency may be a particularly important selling point for a particular macroeconomic program: consistency and feasibility are obviously essential attributes of any practical macroeconomic program. All the same, the fact that a macroeconomic program can be shown to be consistent, even feasible cannot be taken to imply that the program would be technically straightforward for policy-makers to implement, nor that the deficit would even be appropriate from a longer-term perspective.

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Annex. An illustrative forecast for Ecuador

Ecuador's economy in mid-1999 provides a test case for the methodology proposed in this paper. ***The figures and forecasts presented here are intended exclusively to illustrate the model described in this paper, and do not necessarily indicate the views of the writer, much less the World Bank, regarding Ecuador's likely economic performance in 1999 and 2000.***

Table 1 below summarizes Ecuador's recent macroeconomic performance, and provides balance-of-payments forecasts and base-case programming forecasts for 1999 and 2000. These calculations were made in mid-1999. Even after nearly two decades of unsatisfactory economic performance—1998 per-capita GDP and private consumption were at virtually the same levels as in 1981—Ecuador was expected to suffer a severe recession in 1999, as a consequence of a confluence of external shocks that took place during 1998 and problematic implementation of stabilization policies. In the "base scenario," real GDP would decline by 5.5 per cent and the price level would rise 55 per cent (December to December), while the exchange rate would undergo a year-average-on-year-average depreciation of about 28 per cent. As a consequence, the performance of the external accounts would improve sharply, with the current-account deficit declining from more than 11 per cent in 1998 to around 2 per cent (this was determined using an external-accounts spreadsheet forecasting model).

For present purposes, Ecuador's central-government deficit is taken to be the appropriate "government" concept rather than the overall public-sector financing requirement. The public-sector financing requirement encompasses not only the central government, but also the provincial and municipal governments and the operating losses of publicly-owned enterprises. None of these entities is permitted to borrow directly from the Central Bank.

Table 2a gives the basic results for an estimate of the central-government deficit that would be consistent with based on the same assumptions. It also gives the summary of the central-bank profit flow that would be implied. The base data for the calculation were from the International Monetary Fund's International Monetary Statistics (IFS), as given in the "Monetary Survey" section for Ecuador. The assumptions underlying the calculation are given in Table 2b, corresponding to the assumptions listed in Section 3 of the main text. The assumptions in Table 2b are set out in the seven categories (letters A-G) given in Section 3 of the main text. The assumption category A comprises the general macroeconomic programming assumptions, including real GDP growth, inflation, the real-effective exchange rate. Category B comprises the assumptions drawn from the external-accounts forecasting exercise (carried out separately by the writer). Category C comprises assumptions regarding the increases over each year in the Central Bank's domestic assets and liabilities. Category D comprises assumptions regarding nominal interest rates applying to the Central Bank's domestic assets and liabilities. These are set in the spreadsheet as formulas with real interest rates (r) adjusted for each year's assumed December-December inflation rate (x) using the formula (r-x)/(1+x). Assumption category E comprises the key behavioral assumptions for money demand and supply, including the base-money multiplier and the elasticities of money demand with respect to real GDP and December-December inflation. Category F comprises the seasonality coefficients (all set in the present exercise to 0.5). Finally, assumption category G gives the assumed valuation change in the Central Bank's stock of commercial-bank assets (taken here to be zero).

The forecasting results in Table 2a suggest that in order to achieve the programmed macroeconomic values Ecuador's central government would have had to hold to fairly tight limits on its central-government deficit, not exceeding 2.3 per cent of GDP in 1999 and 1.7 per cent in 2000. With the public interest bill forecast to run between 6 and 8 per cent of GDP during the two years, the non-interest (primary) surplus would have had to remain at austerity levels in order to achieve the programmed targets. For comparison, Ecuador's central-government budget deficit reached 1.9, 1.5 and 2.8 per cent in 1996, 1997, and 1998, respectively, as shown in Table 1. The central bank would run a fairly substantial nominal profit, but this would mainly result from exchange-rate depreciation. Under the assumptions given, the nominal profit deriving from net interest income would be only about 0.8 per cent of GDP.

Table 3 shows the results of varying the assumed macroeconomic objectives. In the sensitivity analysis, assumed real GDP growth for 1999 is varied between –4, -5.5, and -7 per cent, while the inflation rate for the year is varied between 40, 55, and 70 per cent. For all the first nine simulations, the real-effective exchange rate is assumed to depreciate about 28 per cent year over year, corresponding to a December-December real-effective depreciation of 20 per cent. For 2000, real GDP is assumed to grow at 1 per cent in all scenarios while the inflation rate is assumed to be one half that of 1999. The results of different simulations are shown in the rows, with two rows per simulation for each year. The results given in the first nine simulations indicate that the central bank's profitability is quite sensitive to the assumed inflation rate, but the maximum government deficit is fairly robust, coming out around 2 to 2.5 per cent for all the scenarios. In the last three scenarios, the real-effective exchange rate is assumed to depreciate about 24.8 per cent, corresponding to a December-December real-effective depreciation of 10 per cent. The maximum government deficit is slightly higher than in the first three simulations, while the central-bank profit is considerably lower.

The present model offers a wide range of opportunities for "scenario-testing," to determine the fiscal and monetary stance most appropriate to meet policy-makers' macroeconomic objectives.

Annex Table 1. Ecuador: Selected annual macroeconomic indicators

	1991	1992	1993	1994	1995	1996	1997	1998	1999 (forecast)	2000 (forecast)
Growth rates (per cent):										
Gross domestic product (GDP) at market prices	5.0	3.6	2.0	4.4	2.3	2.9	3.3	0.4	-5.5	1.0
Per-capita GDP	2.6	1.2	-0.3	2.0	0.0	0.6	1.0	-1.9	-7.6	-1.3
Consumer prices	48.8	54.3	45.0	27.4	22.9	24.4	30.6	43.4	55.0	27.5
Real-effective exch. rate (1990 = 100; + = appreciation)	106.5	109.0	124.8	133.5	132.3	130.7	134.2	135.4	145.7	145.7
National accounts (per cent of current GDP):										
Gross fixed capital formation	19.7	19.5	19.9	18.8	18.6	17.8	19.0	21.0	18.5	19.5
National saving	16.1	20.2	16.3	14.9	14.6	17.9	16.4	13.6	15.6	17.2
Foreign saving (current-account deficit)	6.0	1.0	4.7	4.1	4.1	-0.6	3.8	11.0	2.9	2.3
Domestic saving	23.8	25.0	21.7	22.0	20.7	24.4	21.2	18.5	21.6	22.8
Resource gap	-1.7	-3.8	-0.6	-3.0	-2.0	-7.1	-1.0	6.2	-3.1	-3.3
Central-government surplus (per cent of GDP):		**0.1**	**0.5**	**-0.1**	**-1.3**	**-1.9**	**-1.5**	**-2.8**		
Total revenue:	**14.7**	**16.1**	**15.7**	**15.5**	**17.5**	**17.5**	**17.1**	**14.1**		
Petroleum	6.9	7.9	7.5	6.4	6.6	8.2	5.9	4.5		
Non-petroleum	7.9	8.2	8.2	9.1	10.8	9.3	11.2	9.6		
Total expenditure:		**-16.0**	**-15.2**	**-15.6**	**-18.8**	**-19.4**	**-18.6**	**-16.8**		
Current expenditure:		**-13.3**	**-12.8**	**-12.2**	**-14.8**	**-14.8**	**-14.6**	**-10.7**		
Staff remuneration						-6.3	-6.2	-7.5		
Interest:	-2.7	-2.4	-1.8	-2.5	-4.5	-3.2	-4.0	-3.5		
External	-2.2	-1.9	-1.4	-2.1	-4.0	-2.6	-3.0	-2.7		
Domestic	-0.5	-0.5	-0.4	-0.4	-0.5	-0.6	-0.9	-0.8		
Other current expenditure						-5.3	-4.5	0.2		
Capital expenditure:		**-2.7**	**-2.4**	**-3.5**	**-4.0**	**-4.6**	**-3.9**	**-6.1**		
Primary balance (total revenue less non-int. exp.)		**2.5**	**2.4**	**2.3**	**3.2**	**1.3**	**2.5**	**0.7**		
Saving (total revenue less current expenditure)		**2.8**	**2.9**	**3.3**	**2.7**	**2.7**	**2.5**	**3.3**		
External accounts (US$ million):										
Current-account balance:	**-708.0**	**-122.0**	**-678.0**	**-679.0**	**-735.0**	**111.0**	**-743.0**	**-2165.2**	**-431.0**	**-361.4**
Merchandise trade:	643.0	1018.0	592.0	563.0	354.0	1220.0	598.0	-1028.6	512.6	573.2
Merchandise exports	2851.0	3101.0	3066.0	3843.0	4411.0	4900.0	5264.0	4133.2	4386.6	4712.8
Merchandise imports (F. O. B.)	-2208.0	-2083.0	-2474.0	-3280.0	-4057.0	-3680.0	-4666.0	-5161.8	-3874.1	-4139.5
Other current account	-1351.0	-1140.0	-1270.0	-1242.0	-1089.0	-1109.0	-1341.0	-1136.6	-943.6	-934.6
Change in net international reserves	**-1010.3**	**-966.2**	**-623.7**	**-766.3**	**-519.0**	**-84.0**	**43.0**	**-246.3**	**-43.4**	**339.8**
Total external debt (US$ million):	**12468.0**	**12280.0**	**14150.0**	**15074.0**	**13992.0**	**14495.0**	**14918.0**	**14756.1**	**14367.2**	**14270.5**
Public and publicly guaranteed (US$ million)	9951.0	9831.0	9974.0	10552.0	12067.0	12444.0	12376.0	12628.0	12506.0	12308.2
(per cent of GDP)	84.7	77.7	69.7	63.5	67.3	65.4	62.6	64.4	84.2	77.1
Service on term debt (US$ million)	954.0	859.4	789.6	912.0	1333.0	1229.0	1791.0	1240.2	1271.4	1338.9
(per cent of exports of goods, non-factor service)	28.0	23.1	21.2	19.9	25.3	21.3	29.9	30.0	29.0	28.4
Gross domestic product (US$ million)	**11752.4**	**12655.9**	**14304.2**	**16605.8**	**17939.4**	**19039.8**	**19768.6**	**19615.7**	**14859.7**	**15960.8**

Data source: Central Bank of Ecuador: projections by the writer.

Annex Table 2a. Ecuador: Results for the forecasting model (base scenario).

	1999	2000
Maximum net government borrowing:		
Per cent of GDP:	**2.3**	**1.7**
Excluding interest	-5.4	-4.6
Interest:	7.8	6.3
External interest	4.5	4.1
"Real" component of domestic interest	0.7	0.4
"Inflation" component of domestic interest	2.6	1.8
US$ million:	**345**	**269**
Excluding interest	-809	-740
Interest:	1154	1010
External interest	666	652
"Real" component of domestic interest	106	71
"Inflation" component of domestic interest	382	286
Central-bank net profit:		
Per cent of GDP:	**6.0**	**2.8**
Net interest:	**0.7**	**1.2**
Interest earnings on assets:	**2.6**	**2.3**
External interest	0.5	0.5
"Real" component of domestic interest	-0.6	-0.2
"Inflation" component of domestic interest	2.8	1.9
Interest payments on liabilities:	**-1.9**	**-1.1**
External interest	-0.1	-0.1
"Real" component of domestic interest	-5.6	-3.4
"Inflation" component of domestic interest	2.7	1.7
Real reduction in value of the currency issue	1.1	0.7
Net earnings on exch.-rate depreciation	**5.3**	**1.6**
Valuation incr. in central-bank claims on comm. Banks	**0.0**	**0.0**
Growth rates:		
GDP at 1975 prices	**-5.5**	**1.0**
Year-end consumer prices	**55.0**	**27.5**
GDP deflator	**52.2**	**35.2**
Yr.-avg. real-effective. exchange rate (+ = depreciation)	**28.0**	**-3.3**
Gross intl. reserves, (mos. of imps. of goods, non-factor services)	**4.0**	**4.5**

Source: Calculation by the writer using the spreadsheet forecasting model.

Annex Table 2b. Ecuador: Assumptions for the forecasting model (base scenario).

		1994	1995	1996	1997	1998	1999	2000
Growth rates:								
GDP at current prices:			26.1	32.0	30.2	35.9	43.9	36.5
GDP at 1975 prices	A-1		2.3	2.9	3.3	0.4	-5.5	1.0
GDP deflator	A-2		23.3	28.2	26.0	35.4	52.2	35.2
Year-end consumer prices			22.8	25.5	30.7	43.4	55.0	27.5
Year-average exchange rate (S./US$)	A-3		16.7	24.4	25.3	37.0	89.9	27.1
Year-end exchange rate (S./US$)			28.8	24.3	21.8	50.8	81.3	17.6
Year-average world prices			9.2	-2.5	1.7	2.2	2.6	2.8
Year-end world prices							2.6	3.0
Yr.-avg. real-effective. exchange rate (+ = depreciation)			3.5	-5.5	1.3	3.5	28.0	-3.3
Yr.-end real-effective. exchange rate (+ = depreciation)			0.0	-0.9	-6.8	5.2	20.0	-5.0
Period-end stocks (US$ million):								
Central-bank (gross) external assets	B-1	2010	1794	2025	2259	1835	1779	2107
Central-bank external liabilities	B-2	4276	417	356	286	298	310	323
Government external debt	B-3	10552	12067	12444	12376	12628	12506	12308
U.S.-dollar interest rates (percent/year):								
Central-bank (gross) external assets	B-4		5.1	4.6	4.8	4.5	4.0	4.5
Central-bank external liabilities	B-5		5.6	5.8	5.7	5.6	5.2	5.2
Government external debt	B-6		5.1	5.1	5.9	5.6	5.3	5.3
Flow increases (S./ billion):								
Central-bank claims on commercial banks	C-1		478	441	-780	3223	3091	2388
(percent of GDP)			1.0	0.7	-1.0	3.0	2.0	1.1
Central-bank non-monetary domestic liabilities	C-2		-43	37	24	3223	3091	2491
(percent of GDP)			-0.1	0.1	0.0	3.0	2.0	1.2
Minimum flow increases:								
Central-bank claims on government	C-3		-8555	35	-33	0	0	0
(percent of GDP)			-18.6	0.1	0.0	0.0	0.0	0.0
Government deposit acct. at the central bank	C-4		0	659	121	0	0	0
(percent of GDP)			0.0	1.1	0.2	0.0	0.0	0.0
Incr. in the government capital position in the central bank	C-5					0	0	0
(percent of GDP)						0.0	0.0	0.0
Sucre interest rates (per cent per year):								
Central-bank claims on:								
Commercial banks	D-1					43.4	38.5	19.3
Government	D-2					20.0	20.0	20.0
Claims on the central bank:								
Commercial banks (reserve accounts)	D-3					0.0	0.0	0.0
Government deposit account	D-4					0.0	0.0	0.0
Central-bank non-monetary domestic liabilities	D-5					43.4	55.0	27.5
Government domestic debt	D-6					43.4	55.0	27.5
Ratios:								
Commercial banks' marginal reserve ratio	E-1		7.1	8.9	8.1	12.0	12.0	12.0
Marginal money multiplier	E-2		8.2	5.7	5.0	5.0	5.0	5.0
Implicit marginal currency-deposit ratio			22.1	32.0	35.2	40.0	40.0	40.0
Asset-demand elasticities								
With respect to real GDP:								
Broad money supply	E-3					1.2	1.2	1.0
Government and central-bank domestic debt	E-4					1.2	1.2	1.0
Seasonality coefficients:								
Price level	F-1		0.5	0.5	0.5	0.5	0.5	0.5
Exchange rate (sucres/U.S. dollar)	F-2		0.5	0.5	0.5	0.5	0.5	0.5
Broad money supply	F-3		0.5	0.5	0.5	0.5	0.5	0.5
Commercial banks' central-bank reserve accounts	F-4		0.5	0.5	0.5	0.5	0.5	0.5
Central-bank non-monetary domestic liabilities	F-5		0.5	0.5	0.5	0.5	0.5	0.5
Central-bank claims on commercial banks	F-6		0.5	0.5	0.5	0.5	0.5	0.5
Central-bank (gross) external assets	F-7		0.5	0.5	0.5	0.5	0.5	0.5
Central-bank external liabilities	F-8		0.5	0.5	0.5	0.5	0.5	0.5
Government and central-bank domestic non-monetary debt	F-9		0.5	0.5	0.5	0.5	0.5	0.5
Valuation change (per cent of previous period-end stock):								
Central-bank claims on commercial banks	G-1					0.0	0.0	0.0

Annex Table 3. Ecuador: Sensitivity analysis for the forecasting model.

		Assumed growth rates:			Per cent of GDP:	Increase as a percentage of GDP:			Per cent of GDP:	
		Real GDP	Consumer prices (Dec./Dec.)	Real-effective exchange rate (yr./yr.)	Current-account surplus	Monetary base	Central-bank net international assets	Central-bank net non-government domestic assets	Central-bank profit	Maximum central-government deficit
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1)	1999	-7.0	70.0	28.0	-1.8	1.9	6.1	0.0	7.0	2.0
	2000	1.0	35.0	-3.3	-1.1	2.3	4.6	-0.1	3.3	1.3
(2)	1999	-7.0	55.0	28.0	-1.8	1.8	5.1	0.0	6.2	2.1
	2000	1.0	27.5	-3.3	-1.1	2.0	4.0	0.0	2.8	1.1
(3)	1999	-7.0	40.0	28.0	-1.8	1.8	4.1	0.0	5.3	2.2
	2000	1.0	20.0	-3.3	-1.1	1.7	3.4	0.0	2.4	1.1
(4)	1999	-5.5	70.0	28.0	-2.9	1.9	5.8	0.0	6.8	2.2
	2000	1.0	35.0	-3.3	-2.3	2.4	4.2	-0.1	3.2	1.8
(5)	1999	-5.5	55.0	28.0	-2.9	1.9	4.9	0.0	6.0	2.3
	2000	1.0	27.5	-3.3	-2.3	2.0	3.6	0.0	2.8	1.7
(6)	1999	-5.5	40.0	28.0	-2.9	1.8	3.9	0.0	5.2	2.4
	2000	1.0	20.0	-3.3	-2.3	1.7	3.0	0.0	2.4	1.7
(7)	1999	-4.0	70.0	28.0	-3.9	2.0	6.2	0.0	6.8	2.0
	2000	1.0	35.0	-3.3	-3.4	2.5	4.3	-0.1	3.2	2.0
(8)	1999	-4.0	55.0	28.0	-3.9	1.9	5.2	0.0	6.0	2.1
	2000	1.0	27.5	-3.3	-3.4	2.1	3.7	0.0	2.8	1.8
(9)	1999	-4.0	40.0	28.0	-3.9	1.9	4.2	0.0	5.2	2.2
	2000	1.0	20.0	-3.3	-3.4	1.8	3.1	0.0	2.4	1.8
(10)	1999	-5.5	70.0	24.8	-3.0	1.9	4.9	0.0	5.8	2.2
	2000	1.0	35.0	-9.1	-3.1	2.4	4.0	-0.1	3.0	1.9
(11)	1999	-5.5	55.0	24.8	-3.0	1.9	4.0	0.0	5.1	2.3
	2000	1.0	27.5	-9.1	-3.1	2.0	3.5	0.0	2.7	1.7
(12)	1999	-5.5	40.0	24.8	-3.0	1.8	3.0	0.0	4.3	2.4
	2000	1.0	20.0	-9.1	-3.1	1.7	2.9	0.0	2.3	1.7

Source: Calculation by the writer using the spreadsheet forecasting model.

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