INTERNATIONAL MONETARY FUND

STAFF PAPERS

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VOL. 30 No. 2 JUNE 1983

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From the Foreword to the first issue:

> **"Among the responsibilities of the International Monetary Fund, as set forth in the Articles of Agreement, is the obligation to 'act as a center for the collection and exchange of information on monetary and financial problems,' and thereby to facilitate 'the preparation of studies designed to assist members in developing policies which further the purposes of the Fund.' The publications of the Fund are one way in which this responsibility is discharged.**
>
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The authors of the papers in this issue have received considerable assistance from their colleagues on the staff of the Fund. This general statement of indebtedness may be accepted in place of a detailed list of acknowledgments.

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Publications Unit
International Monetary Fund
Washington, D.C. 20431 U.S.A.

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Vol. 30 No. 2 JUNE 1983

EDITOR'S NOTE

The Editor invites from contributors outside the Fund brief comments (not more than 1,000 words) on published articles in *Staff Papers*. These comments should be addressed to the Editor, who will forward them to the author of the original article for reply. Both the comments and the reply will be published in the same issue of *Staff Papers*.

International Standard Serial Number: ISSN 0020-8027

The Macroeconomic Effects of Changes in Barriers to Trade and Capital Flows: A Simulation Analysis

MOHSIN S. KHAN and ROBERTO ZAHLER*

THE ISSUE OF OPENING UP domestic economies to the world economy through the liberalization of trade and capital movements—either across the board or selectively—has been of perennial concern to policymakers in the developing world. Recently there has been a renewal of interest in this subject in these countries, including many in Latin America. While the reasons for this heightened interest are varied, three are of principal importance.

First, there is the "demonstration effect" imparted by the economic performance of a select group of developing countries, particularly in Southeast Asia, where the growth of trade has

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This study is the output of a joint project undertaken by the Economic Commission for Latin America (CEPAL) and the International Monetary Fund. The CEPAL participation was conducted within the framework of UNDP Project RLA/77/021, Implications for Latin America of the Situation of the International Monetary System, directed by Carlos Massad. The authors are grateful to Ricardo Arriazu, Reynaldo E. Bajraj, Andres Bianchi, Kenneth W. Clements, Jacob A. Frenkel, Ernesto Gaba, Norberto Gonzalez, Carlos Massad, and Daniel Schydlowsky, as well as some of Mr. Khan's colleagues in the Fund, whose many comments and suggestions at various stages of the work were extremely valuable. Nicolas Eyzaguirre not only provided excellent research assistance but also contributed to the development of the model.

The United Nations has published this study under the title, *Efectos Macroeconómicos de Cambios en las Barreras al Comercio y al Movimiento de Capitales: un Modelo de Simulación* (Sales No. S.83.II.G.12, Santiago de Chile, December 1982).

played a major role. A number of recently completed studies of individual-country experiences (i.e., Bhagwati and Srinivasan (1979), Keesing (1979), Balassa (1980), Krueger and others (1981)) have shown that, at the broadest level, the countries adopting outward-looking development strategies have fared far better in terms of economic growth, employment, economic efficiency, and adjustment to external shocks than those that have engaged in more inward-looking strategies. The outward-oriented strategies have been typically characterized, inter alia, by the provision of incentives for export production, the encouragement of import competition for most domestically produced goods, and the use of the nominal exchange rate for the maintenance of realistic real exchange rates. At the same time, various developing countries have experienced a relative loss of dynamism in their industrialization processes that are based on import substitution; thus, they have had to consider designing new strategies for the external sector much along the lines adopted by the outward-looking developing economies.

Second, in certain countries there has been a move toward greater stress on the role of market forces in the functioning of the economic system, and this has led to a revival of the propositions associated with the well-known theory of the gains from trade. Briefly, according to this theory, international trade is believed to contribute to the development process in the following ways: trade allows a country to follow the route indicated by the theory of comparative advantage; it offers greater opportunities to exploit economies of scale; it increases the supply capacity of the economy through imports of capital goods, raw materials, and other inputs in the production process; and finally, by providing competition for tradable goods, it is a source of both stimulus and pressure for domestic production and, depending on the exchange rate policy being pursued, can set limits to the domestic inflation rate. In a similar vein, insofar as liberalization of capital movements is concerned, proponents argue that capital flows can increase the supply of financial savings, augment the stock of capital, and induce competition and efficiency in the domestic financial system.

Third, the generally increasing integration of the world economy, in both goods and capital markets, has meant that countries have been drawn into closer international relationships, whether expressly desired or not. This growing interdependence has also contributed to a reorientation of thinking and policies in these

countries so that they can adjust to international developments.[1]

It can clearly be argued that a combination of these theoretical and empirical factors prompted several Latin American countries to move in the direction of opening up their economies to international competition. The most dramatic shifts in policy occurred in the Southern Cone countries—Argentina, Chile, and Uruguay—although other countries in the region also followed this path, albeit in a more restrained and selective fashion. Uruguay started the process about 1974, and the liberalization reforms were instituted in Argentina and Chile during the years 1975–77. Venezuela moved to rationalize its protection system in 1978–79, and Colombia, Mexico, and Peru also took steps toward freer trade and the liberalizing of capital movements. Moreover, it appears that other countries, both within and outside Latin America, are closely watching and judging these experiments.

Nevertheless, a majority of developing countries are reluctant to embark on a program of liberalizing their trade and exchange systems. If such policies seem so attractive on economic grounds, then it is certainly relevant to ask what the reasons are that underlie this supposed reluctance. The answers, of course, are not clear cut by any means, but several factors bear on this issue.[2] At the outset it should be recognized that many government policies, including controls on trade and capital flows, may have been implemented with full knowledge of their likely adverse effects on resource allocation and efficiency, as measured by market prices. These policies are, however, regarded as having strong implications from the point of view of equity so that welfare considerations can play a fundamental, if not overriding, role in any decision to alter existing distortions and controls in the foreign sector. The arguments based on externalities that are created by offering incentives to produce domestically rather than to import, and achieving a minimum stage of industrialization, are of no less importance, particularly if it is not known where a country's dynamic comparative advantage lies. Broadly speaking, there may be both long-run economic and social costs that have to be balanced against the long-run economic benefits to be expected from opening up.

[1]For a detailed study on the effects of the changing international environment on developing countries, see Goldstein and Khan (1982 a).

[2]Some of these factors have been covered in the studies by Ayza and others (1975), Villanueva (1978), and Ffrench-Davis (1979).

The longer-term factors just discussed can clearly inhibit the opening up of an economy, but perhaps equally important in this context are the short-run and medium-run effects that occur when such a strategy is adopted. Simple casual observation shows that there are serious, even if transitory, costs as a country moves from a relatively closed economy to a more open one. These costs can include losses in output and employment, current account deficits, a fall in fiscal revenues, and increases in external debt. Whatever the long-term effects are in net terms, these short-run costs can provide an effective barrier to a country's desire to open up its economy. Some consideration has to be given to these potential shorter-term problems as well. The identification of such costs, at both macroeconomic and microeconomic levels, and to determine if the costs are general or country specific, is therefore of utmost importance; the available evidence on this is extremely scanty. Furthermore, if these costs are general in nature, and thus are to be expected whenever a policy of liberalization is adopted, do they depend on the specific type of liberalization strategy chosen? Opening up has not, of course, been uniform with respect to the trade and capital accounts, nor has the speed with which these reforms have been implemented in various countries. For example, Argentina and Uruguay eliminated capital controls first and then proceeded slowly toward goods-market liberalization. On the other hand, Chile chose the opposite sequence of moving first toward the more rapid removal of trade restrictions and then allowing a greater degree of capital mobility. Mexico and Venezuela had had no capital controls to speak of for some time and, therefore, their concentration was exclusively on the trade side. Finally, can the negative aspects associated with opening up be mitigated or minimized by an appropriate mix of different policies? To our knowledge, these issues have not been dealt with in the literature in any generalized and systematic fashion.

Analyzing this latter set of questions—namely, relating to the shorter-term aspects of liberalization policy—is the focus of this study. Such an examination would make it possible to shed some light on whether these short-run effects are significant enough to warrant concern. It should be stressed that no explicit attempt is made here to consider the long-run aspects of liberalization but simply to determine the process of adjustment of the economic system after the new policy has been initiated. While this type of approach does exclude a number of interesting and important issues, it is believed that the exercise does provide useful insights

in an area where information is lacking. Furthermore, restricting the analysis to the short term enables one to stay clear of difficult welfare-related issues, which naturally arise when one looks into the long-term consequences of opening up an economy. It was also the express intention to concentrate on the effects of changes in policy on such variables as overall economic activity, prices, the balance of payments, external indebtedness, and interest rates. As such, the exercise is exclusively macroeconomic in nature. It is considered that studying the simultaneous interaction of the main macroeconomic variables and their initial response to policy stimuli generated in the context of removal of restrictions on trade and capital flows is a necessary first step in properly ascertaining the response of the economic system.

The various short-term aspects of opening up are handled within the framework of a dynamic general-equilibrium model constructed for this specific purpose. This approach is more systematic than analyzing the liberalization experiences of individual countries, as, for example, has been done by Wonsewer and Sarachaga (1980), Zahler (1980), Diaz-Alejandro (1981), Gaba (1981), and Mezzera (1981). This model has the capability of explaining the more important macroeconomic variables, and the structure is based on well-grounded economic theory. It has its roots in a variety of theoretical and empirical general-equilibrium models that have been formulated to deal with issues similar to the ones that are of interest here; [3] the model also has strong links to monetary-oriented models that have been proposed to analyze short-term stabilization policies.[4] The model does go well beyond the standard monetary models and contains an explicit, albeit simplified, treatment of the real sector and the interaction of this sector with the monetary sector. Nevertheless, the crucial role played by monetary disequilibrium in the behavior of major macroeconomic variables is stressed in the model, and in principle it remains consistent with the basic long-run tenets of the monetary approach to the balance of payments.[5] In fact, even though

[3]See, for example, the models of Clements (1977; 1980) and Feltenstein (1980).

[4]These models include those developed by Blejer (1977), Knight and Wymer (1978), Aghevli and Khan (1980), Blejer and Fernandez (1980), and Khan and Knight (1981).

[5]See Frenkel and Johnson (1976) and IMF (1977). For a more recent discussion of the relationship between the monetary and the absorption approaches, see Massad (1980).

attention is focused exclusively on the short-run path of the economy, considerable care is taken throughout to ensure that long-term conditions that are consistent with general-equilibrium theory are satisfied. However, the dynamic aspects are considered crucial, since the trajectories of the variables are of great interest to policymakers, and it is precisely in this area that there is a serious gap in the literature.[6]

The model is taken to be representative of a typical Latin American economy, and thus does not pretend to be exactly applicable to any single country. For this reason, its structure is quite general in form and aims at covering only the essential features of a broad group of countries. It does not seek to incorporate institutional or other characteristics that would necessarily have to be taken into account to apply the model to any particular country. The economy represented by this model is assumed to be small in relation to the world and to operate under a fixed exchange rate regime.[7] It is also assumed that the domestic markets are relatively free of direct government control. This last assumption implies that prices are essentially market determined and that financial reforms to liberalize the domestic financial system have already been implemented.

Nevertheless, even though highly aggregated, the model is sufficiently rich and complex to yield the necessary answers to the relevant questions. It is also, as mentioned previously, dynamic in that it allows for delayed response of variables and can trace out the path of adjustment from one equilibrium position to another. It is obvious that questions of transition definitionally imply the study of the time path of the variables after there has been some type of shock to the system. The complex and dynamic structure of the model precludes its solution in any simple analytical fashion. Numerical values for the parameters are required, and these can be either obtained through econometric estimation or imposed from outside the system. The latter approach was taken here for two reasons. First, econometric estimation of such a model is quite difficult; further, it was not the intention to apply this model in its present stage to any single country or group of countries. Second, a considerable amount of information was already available in the literature for a number of relevant param-

[6]Both Clements (1980) and Feltenstein (1980), for example, deal with models in continuous equilibrium.

[7]The choices could include pegging the nominal exchange rate, crawling peg regimes, and preannounced exchange rate schedules.

eters, and this could be readily utilized. As such, the model is properly described as a "simulation" model, and naturally all the results are conditional on the values of the parameters chosen.[8] Some sensitivity analysis through the variation of certain key parameters was performed to determine if the basic results were significantly different.

The initial equilibrium—namely, the closed economy—was defined as one in which there was a uniform tariff on imports,[9] and capital inflows and outflows were completely restricted. Trade liberalization was defined then as a reduction in the tariff rate to zero, and, correspondingly, capital account liberalization as the complete removal of the existing restrictions. With the properties of the initial equilibrium defined, and using a ceteris paribus assumption regarding the international picture and with respect to other domestic policies,[10] the following simulation experiments were conducted: (a) gradual and sudden reduction in tariffs; (b) gradual and sudden removal of restrictions on capital flows; (c) simultaneous gradual removal of restrictions on trade and capital flows; and (d) sequential gradual removal of restrictions on trade and capital flows. The results from these simulations allow one to evaluate the effects of "gradual versus shock" types of policy, as well as the effects of a combination of alternative policies implemented both simultaneously and with differing speeds. The last simulation is particularly interesting, since there has been a lively discussion in the literature on whether a country should liberalize its trade account first or its capital account.[11] Together these four sets of simulations are reasonably comprehensive and are believed to cover most of the actual types of liberalization strategy.

While the model is utilized here only for the study of the effects of opening up, it can easily be extended to analyze a variety of other issues. For example, it can be used to simulate the effects of other domestic policy actions, as well as changes in foreign variables. Furthermore, within the model it is possible to design com-

[8]This is the type of approach taken in the larger computational general-equilibrium models. See Feltenstein (1980).

[9]The assumption of a uniform tariff does not involve any loss of generality and has been made only for simplicity.

[10]This assumption was made solely for the simulation experiments. The model is able to simultaneously handle both domestic policy changes and alternative international scenarios.

[11]See McKinnon (1982) and Frenkel (1982) for a discussion of some of these issues.

pensatory stabilization-type policies that operate in conjunction with the opening-up policies. One such experiment is undertaken here to demonstrate this particular capability of the model. Also, even though growth is not explicitly allowed for in the present version of the model, it can easily be introduced exogenously without radically altering the basic structure. What the model is not able to do is handle growth endogenously so that it cannot deal with the longer-term aspects of opening up. Capital formation, labor force participation, transfer of factors, wealth accumulation, etc., have to be introduced if such long-term effects are to be covered adequately. To do so, however, was not the intention in this present study.

The remainder of the paper proceeds as follows. Section I describes the basic structure of the model. Section II considers the various simulation experiments, and Section III contains the principal conclusions of the study.

I. Specification of the Model

The model consists of 37 equations, of which 17 are behavioral, while the remaining are definitions or identities. In a sense, the size of this model represents a compromise between the much larger computational general-equilibrium models developed by Feltenstein (1980) and Dervişand others (1981) among others, on the one hand, and the more aggregated models of Clements (1980), Blejer and Fernandez (1980), and Khan and Knight (1981), on the other hand. There are basically two reasons for the level of aggregation chosen. First, as it is sought to evaluate the behavior of the main macroeconomic variables of a general rather than a specific economy, it is necessary to restrict the complexity of the model and to limit it to its essential features. In other words, country-specific institutional details are excluded from consideration. Second, since this is a simulation exercise, numerical values are required for the parameters; the more the model is expanded, the greater is the degree of arbitrariness in the selection of parameters, thereby possibly increasing the danger of making the results less general.

Essentially, this model describes an economy that is "small" in the sense that it takes prices and interest rates in the world markets as given parameters. It assumes a fixed nominal exchange rate or, more strictly, one that is not subject to market forces but

that can be altered by the authorities in whatever manner they choose. Foreign trade, while permitted, is subject to a relatively high tariff on imports that creates a wedge between domestic prices and the domestic-currency price of importable goods. Capital movements, however, are restricted completely. In contrast to the restrictions on trade and capital flows, domestic prices and interest rates are assumed to respond to market forces, implying that reforms affecting the operation of the domestic money and credit markets are assumed to have been carried out.[12]

Potential output, which can be identified as the "transformation curve" of the economy, is assumed to be determined exogenously, that is to say, it is independent of the endogenous evolution of the variables in the system. This assumption means that the productive capacity of the economy is unaffected by the opening up, even though it could, in principle, be allowed to increase over time. This is a serious assumption and warrants comment, since it implies that—in the short run—capital formation, technical progress, etc., are unaffected by any liberalization policy. While one can legitimately assume the growth of the labor force to be exogenous, determined, for example, by population growth, the assumption of no increase in net investment is not as easy to justify, since it necessarily implies zero net additional national savings. However, it is well known that policies of opening up are usually accompanied to a greater or lesser extent by current account deficits, which constitute external savings. To assume that net savings (and therefore net investment) are constant, it is necessary to impose the condition that changes in external savings are exactly offset by changes in domestic savings. While this is possibly an extreme assumption, some empirical evidence does point to partial offsetting in developing countries, in the sense that part of external savings goes into financing consumption.[13] Basically, this assumption of a given transformation curve was made to avoid consideration of sectoral production functions, which would have greatly complicated the structure of the model.

Actual real output is, of course, endogenously determined so

[12]Such financial reforms, taking into account the complex interactions between the money and credit markets, distinctions between lending and borrowing rates, and differential reserve requirements, etc., have been analyzed in detail for various countries by Mathieson (1979; 1980), Wonsewer and Saráchaga (1980), Zahler (1980), Fry (1981; 1982), and Gaba (1981).

[13]See, for example, Weisskopf (1972), Mikesell and Zinser (1973), and Fry (1980).

that the model attempts to capture the short-term deviations of output from potential output. The gap between potential and actual output measures unemployment of resources, which, with limitations and in an indirect manner, can be interpreted as unemployment of labor.[14] The long-run equilibrium for output is therefore defined as a point on the transformation curve—namely, where actual and potential output are equal, allowing for some small level of permanent unemployment of resources.

In line with the current theory of international trade, the model contains three types of goods—importables, exportables, and nontradables. These categories are based essentially on the relative degree of substitution between domestic and foreign goods in consumption and production (reflected basically though price differentials, including transport costs, tariffs and other trade distortions, and any other adjustments). This classification, which is useful for the present purpose (directed as it is toward analysis of the foreign sector), does not incorporate any distinction between consumption goods and investment goods. This omission does constitute a further limitation, since one of the most frequently discussed issues in the process of opening up is the impact of such a policy on the rate of capital formation.[15] Neither, for that matter, is there any consideration of intermediate inputs so that all goods are "final" goods.

Finally, the model has three important general-equilibrium characteristics. First, the quantities produced of each good are limited by the aggregate transformation curve, the position and shape of which is in turn determined by the resource endowment and technology of the economy; in the long term, the vector of quantities produced satisfy this restriction. Second, the demand equations for these goods satisfy the theoretical conditions of homogeneity, symmetry of substitution effects, and additivity. The last general characteristic of the model is the explicit intro-

[14]This interpretation requires assuming that, at the aggregate level, a reasonably stable relationship exists between unemployment and total real output. However, as the productivity of labor in different sectors is usually heterogeneous, changes in the level and structure of production may be quite different with respect to their impact on employment.

[15]This discussion usually involves considerations that are not easy to handle in a model such as the one used here. These considerations include the uneven structure of the protection given to consumption and investment goods, possible initial situations of disequilibrium with respect to stocks of consumption goods (usually associated with an excess demand for such goods), the impact of opening up on the demand for domestic credit and, in a more general sense, on the evolution of the capital market.

duction of budget constraints, both for the government and for the economy as a whole.[16] The government budget constraint makes it possible to link the balance of payments and the fiscal and monetary sectors to domestic expenditures and income. These links are modeled explicitly and, together with the first two elements referred to earlier, ensure the global and sectoral consistency of the model.

The model contains the following six sectors: (1) production and supply; (2) expenditures; (3) prices and unemployment; (4) money and credit; (5) the balance of payments; and (6) the government.

PRODUCTION AND SUPPLY

The system of equations determining "desired" aggregate supply for the three types of goods—importables (I^{s*}), exportables (X^{s*}), and nontradables (N^{s*})—is derived in a manner outlined by Clements (1980) in the framework of a multiproduct supply model. This involves the maximization of the value of the national product subject to the restriction represented by the transformation curve and the respective prices of the three goods—*Pi*, *Px*, and *Pn*. The shape of the transformation curve describes the technological possibilities of transformation of one good into another, and the distance of the transformation surface from the origin represents the available resource endowment, given by the potential real output (y^*). Assuming that the technology is characterized by a quadratic transformation function, the producers' problem can be formally described as

$$\text{Maximize } P'Z$$
$$\text{Subject to } Z'\Lambda Z = y^{*2}$$

where P is a price vector $[Pi, Px, Pn]$, Z is the quantity vector $[I^{s*}, X^{s*}, N^{s*}]$, and Λ = diagonal $[\gamma_1, \gamma_2, \gamma_3]$.[17] The γ_1, γ_2, and γ_3 are the price parameters of supply of importables, exportables, and nontradables, respectively. Also, y^* is a positive scalar that determines the distance of the transformation surface from the origin and represents the total endowment of resources. For the

[16]Namely, that government spending is constrained by fiscal revenues and borrowing, and the current account of the balance of payments is equal to the excess of absorption over income (Alexander (1952)).

[17]In general, Λ is a positive definite symmetrical matrix of parameters, but for simplicity it has been assumed to be diagonal.

present study, it has been assumed to be constant, that is,

$$y^* = \bar{y}^* \tag{1}$$

The solution to the maximization problem is given by

$$Z = \frac{y^*}{(P' \Lambda^{-1P})^{1/2}} \Lambda^{-1P} \tag{2}$$

so that the desired supplies of importable, exportable, and nontradable goods depend exclusively on the relative prices of the three goods, the technical conditions of transformation of one good into another, and the resource endowment. The system of equations (Z) is homogeneous of degree zero in prices, the cross-price effects are symmetrical, and the weighted sum of the price effects across equations is zero.[18] The specific desired supply equations for the three goods are as follows:

$$I_t^{s*} = \left[\frac{\gamma_2\gamma_3 y_t^{*2} Pi_t^2}{D}\right]^{1/2} \tag{2'}$$

$$X_t^{s*} = \left[\frac{(\gamma_1^2\gamma_3/\gamma_2) y_t^{*2} Px_t^2}{D}\right]^{1/2} \tag{2''}$$

and

$$N_t^{s*} = \left[\frac{(\gamma_1^2\gamma_2/\gamma_3) y_t^{*2} Pn_t^2}{D}\right]^{1/2} \tag{2'''}$$

where

$$D = \gamma_1\gamma_2\gamma_3 Pi_t^2 + \gamma_1^2\gamma_3 Px_t^2 + \gamma_1^2\gamma_2 Pn_t^2$$

Dynamics in the supply of tradable goods are introduced by allowing for the actual supplies of importables and exportables to respond gradually to any changes in relative prices or the resource endowment. The dynamics are modeled in a simple way by specifying partial-adjustment mechanisms, whereby actual supplies adjust to the difference between current desired supply and the supply in the previous period, in the following manner:

$$\Delta I_t^s = \lambda_1 [I_t^{s*} - I_{t-1}^s] \qquad 0 \leq \lambda_1 \leq 1 \tag{3'}$$

$$\Delta X_t^s = \lambda_2 [X_t^{s*} - X_{t-1}^s] \qquad 0 \leq \lambda_2 \leq 1 \tag{3''}$$

The λ_1 and λ_2 are coefficients of adjustment, and Δ is a first-difference operator, $\Delta I_t^s = I_t^s - I_{t-1}^s$. Substituting from equa-

[18]Gross substitutability has been assumed.

tions (2′) and (2″), one obtains the actual supply equations for importable and exportable goods

$$I_t^s = \lambda_1 \left[\frac{\gamma_2 \gamma_3 y_t^{*2} Pi_t^2}{D} \right]^{1/2} + (1 - \lambda_1) I_{t-1}^s \tag{4'}$$

$$X_t^s = \lambda_2 \left[\frac{(\gamma_1^2 \gamma_3 / \gamma_2) y_t^{*2} Px_t^2}{D} \right]^{1/2} + (1 - \lambda_2) X_{t-1}^s \tag{4''}$$

The supply of nontradable goods is determined in a somewhat different manner, on the grounds that disequilibrium in this market leads to changes in both prices and quantities.[19] The specification is as follows:

$$\log N_t^s = \log N_t^{s*} + \lambda_3 [\log N_t^d - \log N_t^{s*}] \tag{5}$$

Equation (5) states that supply will equal the desired supply only if the demand for nontradables (N^d) is equal to the desired supply. If at the prevailing price there is excess demand (supply) with respect to desired supply, the supply of nontradables will be larger (smaller) than desired supply. The second term, therefore, can be viewed as representing variations in inventories. The purpose of formulating this type of equation was to have a direct link between the demand for and the supply of nontradable goods, other than through variations in the price of such goods.[20] With $\lambda_3 = 0$, the aggregate supply of nontradable goods is totally independent of aggregate demand in quantity terms, and with $\lambda_3 = 1$, the adjustment of supply takes place along the demand function.[21]

Given the values of I^s, X^s, and N^s, one can obtain real output (y) by the equation[22]

$$y_t = [\gamma_1 I_t^{s2} + \gamma_2 X_t^{s2} + \gamma_3 N_t^{s2}]^{1/2} \tag{6}$$

The level of nominal income in turn is given by the identity

$$Y_t = Pi_t I_t^s + Px_t X_t^s + Pn_t N_t^s + \epsilon_t \cdot \tau_t \cdot Pf_t \cdot I_t \tag{7}$$

where Y is national income, ϵ is the exchange rate (defined in terms of units of domestic currency per unit of foreign currency), τ is the uniform tariff rate on imports, and I is the level of imports

[19]For tradable goods, quantity adjustments take place via the foreign sector.
[20]The link via prices is discussed later in this paper.
[21]In a sense, allowing for both price and quantity adjustments is a generalization of the Clements (1980) model in which prices clear instantaneously to keep supply of and demand for nontradable goods in continuous equilibrium.
[22]The assumption of a quadratic form of the transformation function yields the equation for real output in this form.

in foreign currency. In nominal income, one must add tariff revenues, because this corresponds to income generated, although it accrues in this case to the government rather than to producers. Disposable nominal income (YD) is calculated simply by deducting tax revenues (T) and tariff revenues from equation (7), that is,

$$YD_t = Y_t - T_t - \epsilon_t \cdot \tau_t \cdot Pf_t \cdot I_t \tag{8}$$

EXPENDITURES

The desired level of private nominal expenditures (including consumption and investment expenditures) are specified following the approach outlined by Dornbusch and Mussa (1975) with respect to savings. Here private expenditures are related to disposable nominal income, the nominal excess supply of money, and the rate of interest[23]

$$\log EPRD_t^d = \gamma_4 \log YD_t + \gamma_5 (\log M_t - \log M_t^d) - \gamma_6 rd_t \tag{9}$$

where $EPRD^d$ is the desired level of private expenditures, YD is disposable income, M and M^d are the stock of money and the nominal demand for money, respectively, and rd is the domestic interest rate.

Residents of the country are assumed to be able to spend more or less than their disposable income depending on whether they are running down or accumulating cash balances. This latter term represents, in other words, a "hoarding" effect that is related to the wealth effect on private expenditures. A rise in the domestic interest rate is assumed to have a depressing effect on private nominal expenditures through, presumably, the reduction of the investment component of such expenditures.[24]

Actual private expenditures are assumed to adjust to the difference between the current desired level and the actual level in the previous period

$$\Delta \log EPRD_t = \lambda_4 [\log EPRD_t^d - \log EPRD_{t-1}]$$
$$0 \leq \lambda_4 \leq 1 \tag{10}$$

Substituting for $EPRD^d$ from equation (9), one obtains the dy-

[23]See Aghevli and Khan (1980), Clements (1980), and Knight and Mathieson (1983) for similar formulations.

[24]In fact, consumption expenditures could very well decline as well. However, here, as mentioned before, no distinction is made between the two types of expenditure.

namic version of the nominal private expenditures equation

$$\log EPRD_t = \lambda_4[\gamma_4 \log YD_t + \gamma_5(\log M_t - \log M_t^d) - \gamma_6 rd_t] + (1 - \lambda_4) \log EPRD_{t-1} \quad (11)$$

Equation (11) represents total private expenditures (including spending on both goods and nonfinancial services) and expenditures associated with interest payments on foreign debt. Private expenditures on goods alone require the latter to be subtracted from *EPRD*, that is,

$$EP_t = EPRD_t - rd_t \cdot Bf_t \quad (12)$$

where *EP* is private expenditures on goods and *Bf* is the stock of foreign debt. Obviously, in an economy with total restrictions on capital movements in the past, private foreign debt would be zero, but this variable is bound to become quantitatively important as the opening-up policy is instituted.[25]

Total expenditures (E) in the economy are the sum of private expenditures (EP) and government expenditures (G)

$$E_t = EP_t + G_t \quad (13)$$

Once total expenditures are given, the distribution between importable, exportable, and nontradable goods is determined by a process of maximization, subject to the budget constraint represented by total nominal expenditures. Such an approach assumes strict separability, implying a unidirectional causal relationship running from total expenditures toward its components.[26] Since one is dealing with total expenditures, one is also (for the sake of simplicity) making the explicit assumption that government expenditures are allocated among the three goods on the same basis as are private expenditures.

Consequently, the problem consists of maximizing the utility function $f(Q)$ subject to the constraint that

$$P'Q = E$$

where $P = [Pi, Px, Pn]$ and Q is the vector of quantities demanded of the three goods $[I^d, X^d, N^d]$. E corresponds to the nominal expenditure on goods ($E = PiI^d + PxX^d + PnN^d$), and

[25]It does not make any important difference to assume either a zero or a positive initial stock of foreign debt.

[26]This assumption is standard in studies of demand systems. See, for example, the survey by Brown and Deaton (1972).

$f(Q)$ represents a general utility function.[27] The solution to the maximization problem yields the demand equations for importable, exportable, and nontradable goods, respectively[28]

$$\Delta\log(PiI^d)_t = \Delta\log E_t + \Delta\log Pi_t + (1/w_i^d)[-\gamma_7\Delta\log Pi_t + (w_n^d + (\gamma_7 + \gamma_8 - \gamma_9 - 1)/2)\Delta\log Px_t + (w_x^d + (\gamma_7 - \gamma_8 + \gamma_9 - 1)/2)\Delta\log Pn_t] \quad (14')$$

$$\Delta\log(PxX^d)_t = \Delta\log E_t + \Delta\log Px_t + (1/w_x^d)[w_n^d + (\gamma_7 + \gamma_8 - \gamma_9 - 1)/2)\Delta\log Pi_t - \gamma_8\Delta\log Px_t + (w_n^d + (-\gamma_7 + \gamma_8 + \gamma_9 - 1)/2)\Delta\log Pn_t] \quad (14'')$$

$$\Delta\log(PnN^d)_t = \Delta\log E_t + \Delta\log Pn_t + (1/w_n^d)[w_x^d + (\gamma_7 - \gamma_8 + \gamma_9 - 1)/2)\Delta\log Pi_t + (w_i^d + (-\gamma_7 + \gamma_8 + \gamma_9 - 1)/2)\Delta\log Px_t - \gamma_9\Delta\log Pn_t] \quad (14''')$$

where γ_7, γ_8, and γ_9 are the respective price parameters of demand for importable, exportable, and nontradable goods, and the proportion of total expenditures on each type of good is given by the (variable) weights w_i^d, w_x^d, and w_n^d. The corresponding price elasticities, therefore, are γ_7/w_i^d, γ_8/w_x^d, and γ_9/w_n^d. The demand equations are homogeneous of degree zero in prices, the matrix $(\partial Q/\partial P')$ is symmetrical, and the property of additivity is satisfied.

PRICES AND UNEMPLOYMENT

In equilibrium, the price of importable goods is defined as equal to an index of foreign prices (Pf),[29] adjusted by the exchange rate

[27]The use of this function was considered to be more general than the specific forms associated with the linear-expenditure system (Stone (1954)). This was possible because one is not actually estimating the system and does not have to be overly concerned with the complexity of the form.

[28]Because one is working with a general utility function, unlike the supply equations, the variables are in rates of change rather than in levels.

[29]It is assumed that a single index of foreign prices is relevant to importables and exportables alike. This assumption does not introduce any loss of generality, since, if it were desired to study, for example, the impact of variations in the terms of trade, two different foreign price indices could be employed.

(ϵ) and the level of tariff protection (τ).[30] In log-linear terms, this can be expressed as

$$\log \bar{P}i_t = \log Pf_t + \log \epsilon_t + \log(1 + \tau_t) \tag{15}$$

where the $\bar{P}i$ represents the equilibrium price of importables. Since it is often observed that the actual price of importables does not adjust immediately to changes in the variables on the right-hand side,[31] a partial-adjustment function is specified for the actual price of importables

$$\Delta \log Pi_t = \lambda_5 [\log \bar{P}i_t - \log Pi_{t-1}] \qquad 0 \leq \lambda_5 \leq 1 \tag{16}$$

Substituting equation (15) in equation (16) and solving for the price of importable goods yields

$$\log Pi_t = \lambda_5[\log Pf_t + \log \epsilon_t + \log(1 + \tau_t)] + (1 - \lambda_5)\log Pi_{t-1} \tag{17}$$

The price of exportable goods is definitionally equal to the product of the foreign price level and the exchange rate

$$\log Px_t = \log Pf_t + \log \epsilon_t \tag{18}$$

Prices of nontradable goods are assumed to be essentially demand determined, and therefore the specification abstracts from all types of cost factors. In other words, these prices respond to excess real demand for nontradable goods and, in the absence of any disequilibrium, will be changing according to the variation in the price of tradable (importable) goods. The influence of the prices of tradable goods can be rationalized on two basic grounds. First, it can be argued that this term captures expectations of future inflation, and, second, for long-run consistency it is necessary to ensure that all prices move in line in the steady state.[32] This yields the equation

$$\Delta \log Pn_t = \lambda_6 [\log N_t^d - \log N_t^s] + \lambda_7 \Delta \log Pi_t \tag{19}$$

One would generally expect both λ_6 and λ_7 to be positive. A small

[30]Actually, the variable τ is assumed to include all types of imperfections and distortions (such as transport costs) that keep the domestic price of importables different from the foreign price index adjusted for the exchange rate.

[31]Indeed, it is frequently argued that opening up by lowering tariffs does not lead to an immediate fall in Pi, thus allowing importers to obtain as profits the revenues that previously accrued to the government.

[32]For a rationale of this formulation, see Khan and Knight (1981), Appendix II.

value of λ_6 would imply slow clearance of the nontradable goods market, and continuous equilibrium would require $\lambda_6 \to \infty$.[33] The movements in quantity and prices of nontradable goods when there is disequilibrium in this market would obviously depend on the relative values of λ_6 and λ_3, the parameter in the nontradable goods supply equation. Also, in the long run, one would expect the parameter λ_7 to tend to unity.

The general price index is specified as a Divisia index, where the percentage change in prices is a weighted average of the percentage changes in the prices of importable, exportable, and nontradable goods, with the weights being the shares of the expenditures on each of the three goods

$$\Delta \log P_t = w_i^d \Delta \log Pi_t + w_x^d \Delta \log Px_t + w_n^d \Delta \log Pn_t \qquad (20)$$

As a measure of expected inflation is required, the adaptive-expectations model of Cagan (1956) is used to generate it. In this context, expectations are revised proportionally according to the difference between the actual rate of inflation and the rate that was expected in the previous period

$$\Delta \Pi_t = \lambda_8 [\Delta \log P_t - \Pi_{t-1}] \qquad (21)$$

where Π is the expected rate of inflation, and λ_8 measures the extent to which the revision of expectations responds to the error, $0 \leq \lambda_8 \leq 1$.

The unemployment of resources is modeled as a simple function of the difference between potential and actual output—namely, the so-called output gap

$$U_t = U_0 + \gamma_{10} (\log y_t^* - \log y_t) \qquad (22)$$

where U is the level of unemployment and U_0 represents some level of "normal" underutilization of resources. If the relation between the labor force and the level of aggregate output is stable, then equation (22) can be interpreted as an equation for labor unemployment.[34] In general, however, one has to exercise caution when dealing with distinct sectors, which may, for example, have differing factor intensities, to make such an assumption.

[33]A large value for λ_6 yields instantaneous equilibrium, as in the model of Clements (1980).

[34]It should be stressed that resources engaged in reallocation between sectors are also viewed here as unemployment.

MONEY AND CREDIT

The monetary sector, which is crucial to the operation of the model, is formulated in a fairly straightforward manner. The nominal demand for money is specified as a function of a scale variable, in this case nominal income, and the opportunity costs of holding financial assets in monetary form. Since the public can hold real assets (goods) as well as financial assets, these opportunity costs are the expected rate of inflation (Π) and the domestic interest rate (rd). Formally, the function for nominal demand for broad money can be written in log-linear terms as[35]

$$\log M^d = \alpha_1 + \gamma_{11} \log Y_t - \gamma_{12} \Pi_t - \gamma_{13} rd_t \tag{23}$$

Obviously, more general formulations can be considered that could include, among other variables, the "own" rate of interest or, if residents hold wealth in the form of foreign financial assets, the foreign interest rate and the expected change in the exchange rate. For the moment, it is assumed that money pays no interest[36] and that residents hold only domestic financial assets.

The supply of money (equal to the actual stock)—broadly defined to include currency, demand deposits, and time and savings deposits—is equal to the stock of international reserves (in domestic currency terms) and the level of domestic credit extended by the banking system. This definition allows changes in the money supply to be brought about by variations in the balance of payments; this phenomenon is the central element of the monetary approach to the balance of payments (Frenkel and Johnson (1976) and IMF (1977)). Domestic credit, which is the basic monetary tool, is made up of credit to the government and credit to the private sector. In the absence of sterilization, monetary policy in this framework is essentially passive. Using these distinctions, the identity for the money supply can be expressed as

$$M_t = CRG_t + CRP_t + R_t \tag{24}$$

where CRG and CRP are credit to the government and to the private sector, respectively, and R is the stock of net international reserves (in terms of domestic currency).

[35]As long as γ_{11} is unity, this function is exactly the same as an equation specified in real terms.

[36]Or, alternatively, the net effect of a change in, say, deposit interest rates on broad money is zero, as some components of the money stock rise while others fall. For a discussion of this issue, see Mathieson (1981; 1983).

Since it has been assumed that the domestic financial system has already been liberalized, the domestic interest is free to adjust to market forces. The formulation chosen here relates the changes in the interest rate to monetary disequilibrium as follows:

$$\Delta rd_t = \gamma_{14}[\log M_t^d - \log M_t] \tag{25}$$

An excess demand for money can be expected to raise the interest rate, and vice versa, so that the parameter γ_{14} would be positive. Its size would naturally determine the speed at which the interest rate moves to equilibrate the money market.[37] The nominal rate, as determined from equation (25), feeds back into the rest of the model, although the real interest rate, however defined, does not.

BALANCE OF PAYMENTS

Imports (I), valued in foreign currency terms, are defined as the difference between domestic demand and domestic supply for importables[38]

$$I_t = Pf_t[I_t^d - I_t^s] \tag{26}$$

Similarly, exports (X) are equal to domestic excess supply of exportables

$$X_t = Pf_t[X_t^s - X_t^d] \tag{27}$$

and the current account (in domestic currency terms) is equal to the difference between exports and imports *less* the interest payments on foreign debt

$$CA_t = \epsilon_t[X_t - I_t] - rd_t \cdot Bf_t \tag{28}$$

The equation for capital movements is derived on the basis that, apart from some autonomous components, capital flows respond to the differential between domestic and foreign interest rates, adjusted for expected exchange rate changes and other factors, such as country risk and differences in bank reserve requirements. In the absence of controls, the function determining capital movements could be specified as

[37]Strictly speaking, it is the combination of γ_{14} and the interest elasticity of the demand for money, γ_{13}, that determines how quickly the interest rate moves to eliminate disequilibrium in the monetary sector.

[38]This formulation corresponds to the so-called perfect-substitutes model of import behavior. See Goldstein and Khan (1982 b).

$$DK_t = \lambda_9 \epsilon_t + \gamma_{15}(rd_t - rf_t - \rho_t - \Delta\log \epsilon_t) \quad (29)$$

where DK is the flow of capital, rf is the foreign interest rate, and ρ is the risk premium.[39] The first term simply gives the domestic currency value of autonomous capital flows, and it is assumed that the expected change in the exchange rate can be represented by the percentage change in the actual rate, $\Delta\log \epsilon_t$.

The value of γ_{15} measures the degree of response of capital flows to interest rate differentials, and to the extent that there are controls or restrictions on capital mobility, this parameter will be smaller. Equation (29) is redefined in the following way to take into account various degrees of opening up of the capital account

$$DK_t = \lambda_9 \epsilon_t + \beta[\gamma_{15}(rd_t - rf_t - \rho_t - \Delta\log \epsilon_t)] \quad (29')$$

In this formulation, by varying β one can control the degree of restrictions on movements of capital. If $\beta = 0$, then the economy is totally closed to international capital flows, whereas $\beta = 1$ implies complete liberalization. Values between zero and unity do not necessarily reflect varying degrees of restriction but mainly whether the response of capital flows is slow or rapid. Gradual opening up of the capital account can be represented in two alternative ways. First, β can be allowed to go from zero to unity gradually, or, second, it can be fixed at some positive value. Both methods, although not strictly equivalent, yield broadly similar results in the simulations performed. For the purpose of the exercise here, it was decided to work with the second of the alternatives.[40]

The overall balance of payments (BP) is given by the identity

$$BP_t = CA_t + DK_t \quad (30)$$

and the stock of international reserves (in domestic currency terms) by

$$R_t = R_{t-1} + BP_t \quad (31)$$

It is worth noting the way in which foreign indebtedness is incorporated in the model. It is assumed that foreign residents acquire (sell), in the home country, domestic financial assets issued only by the private sector and that there are no government

[39]Equation (29) corresponds to what has been termed in the literature the stock specification for international capital flows.

[40]To be precise, gradual opening up in the simulation experiments is defined as changing β from zero to one half.

bonds.[41] There is an initial stock of private bonds, and no new issues are assumed to take place.[42] External debt is therefore given by

$$Bf_t = \sum_{j=0}^{\infty} DK_{t-j} \tag{32}$$

The risk premium is assumed to have a constant component (ρ_0) and a variable component related to the ratio of foreign debt to total income, that is,

$$\rho_t = \rho_0 + \gamma_{16}(Bf/Y)_t \tag{33}$$

This function basically assumes that the supply curve of international capital to the country is not infinity elastic, and the relevant cost—that is, the foreign interest rate adjusted for exchange rate changes and the risk premium—rises as more external debt is contracted. It is arbitrarily assumed here that when the ratio of foreign debt to income reaches a certain level, domestic and foreign interest rates (including the now larger risk premium) will be equalized.[43] As foreign debt rises beyond this point, capital outflows will be generated and the domestic interest rate will have to rise to compensate for the increase in the risk premium.

GOVERNMENT SECTOR

The model incorporates the fiscal sector in a rudimentary fashion, since the purpose is solely to introduce an explicit government budget constraint into the framework. Government ex-

[41]For the present, the issue of government bonds has not been taken into consideration because of the complexities involved in the possible "net wealth effects," the effects that this would have on the government budget constraint, and the problems involved in modeling market segmentation of private and government bonds.

[42]Relaxing these rather restrictive assumptions greatly complicates the structure of the model. To properly handle these issues, one would have to formulate a complete portfolio model.

[43]This approach has been adopted because the equilibrium properties of the model related to the fixed transformation curve require that the rate of interest return to its original level eventually. Therefore, any capital account liberalization will lower the domestic interest rate, but as ρ rises, this rate is pushed back up. Note that in the original equilibrium, one has

$$rd > rf + \rho + \Delta \log \epsilon$$

but in the final equilibrium, because ρ has increased, one has interest parity

$$rd = rf + \rho + \Delta \log \epsilon$$

penditure in nominal terms (G) is defined as the sum of taxes, tariff revenues, and the public sector deficit

$$G_t = T_t + \epsilon_t \cdot \tau_t \cdot Pf_t \cdot I_t + GD_t \tag{34}$$

where GD is the government deficit.

Taxes are related in a linear fashion to the level of nominal income

$$T_t = t_0 + \gamma_{17} Y_t \tag{35}$$

where γ_{17} is the marginal tax rate.

Finally, it is assumed that all public sector deficits are financed by the issuance of money, namely, through variations in credit to the government, that is,

$$\Delta CRG_t = GD_t \tag{36}$$

The linkage between fiscal policy, as represented by GD, and monetary policy is immediate and stems from the fact that no other forms of financing public expenditure, in particular, borrowing from the nonbank public, have been modeled.[44]

For purposes of convenience, the complete model, including the behavioral equations as well as identities and definitional equations, are presented in Appendix I.

II. Simulation Experiments

Utilizing the values for the parameters (shown in Appendix II), the complete model can be simulated for various types of change related to the opening-up process. To begin with, following conventional analysis, the economy was assumed to be in initial equilibrium; this may appear to be a rather arbitrary starting point, given that the implementation of a liberalization strategy generally presupposes the existence of some disequilibria in the economy. Nevertheless, any attempt to begin the analysis from a disequilibrium position would pose three problems. First, the main features of the disequilibrium cannot be chosen arbitrarily, since this would probably violate the internal consistency of the model. In other words, if one starts from a position of a particular current account deficit, this implies specific values for other variables in the system so that all of these must be taken into consideration.

[44]For a model of this type, see Aghevli and Khan (1978).

Second, if the analysis were begun from a position of disequilibrium, it would be quite difficult to distinguish those changes that occurred as a result of discretionary policy actions from those that would have occurred in any case, owing to the automatic processes that tend to adjust, for example, the balance of payments and the domestic inflation rate in a small open economy. Finally, the time path of the variables during the transition period, and indeed the transition period itself, is not independent of the initial conditions. Consequently, it would be hard to determine whether the behavior of a variable during transition was due to the policy or simply to the position from which it started. For these reasons, the simulations are begun in full equilibrium, not with any intention of realism but to be exactly aware of how the adjustment process operates within the context of the model.

The initial equilibrium was defined as one in which the economy is protected by a uniform tariff of 100 percent ($\tau = 1.0$) on all imports and is closed to international capital movements ($\beta = 0$). The economy is assumed to be on its transformation curve (assuming 5 percent normal unemployment) so that actual and potential output are the same and all desired quantities are equal to their actual levels. Prices are assumed to be in equilibrium for a fixed exchange rate ($\epsilon = 1.0$); the current account, capital account, and overall balance of payments are in balance; and the level of international reserves and the stock of money are constant. In the context of the simulations, trade liberalization corresponds to a lowering of the tariff rate (τ) to zero, and opening up the capital account means increasing the value of β.[45]

Given these initial conditions, and the further assumptions of an unchanging international environment[46] and no variation in other policies,[47] the following simulation experiments were conducted: (1) gradual and sudden reduction in tariffs; (2) gradual and sudden removal of restrictions on capital movements; (3) simultaneous gradual removal of restrictions on trade and capital flows; and (4) sequential gradual removal of restrictions on trade and capital flows. These four sets of experiments are believed to cover most of the liberalization scenarios that one has observed.

[45]See Section I.

[46]This amounts to assuming that the foreign price level and foreign interest rate are constant.

[47]This is a strong simplifying assumption, since in fact most liberalization policies have typically been accompanied by stabilization programs. See, for example, Diaz-Alejandro (1981).

In addition, for purely illustrative purposes, a "compensatory" policy simulation was conducted in which monetary policy was used to keep the current account from deteriorating when tariffs were lowered. The purpose of this particular simulation is to demonstrate the capability of the model to handle this type of question and further to highlight the kind of trade-offs that emerge when it is desired to stabilize certain variables in the context of opening up.

The effects of the policy changes were naturally traced out for all the endogenous variables, although the results are reported and discussed for only a select few that are regarded as of central interest.

GRADUAL AND SUDDEN REDUCTION IN TARIFFS

Assume that the level of restrictions on capital flows is maintained ($\beta = 0$) but the tariff rate is lowered from 100 percent to zero in two specific ways. In the first case the reduction takes place gradually over four periods starting in period 3, and in the second case in a sudden fashion, also in period 3.[48] The effects of these two types of policy change on the level of prices (in logarithms), the domestic interest rate, the current account and the level of international reserves, and the gap between potential output and actual output (unemployment of resources), are shown in Chart 1, A–D.

Considering the gradual tariff reductions first, one can observe that the overall price index falls (Chart 1-A). This fall is a consequence of both the direct effect of the drop in the price of importable goods and the effect of the decline in the price of nontradables. The price of nontradable goods faces downward pressure on two counts. First, the percentage change in the price of importables enters the equation for the percentage change in the price of nontradable goods, measured by the parameter λ_7; second, the change in relative prices leads to a transfer of resources toward the production of nontradable (and exportable) goods and, at the same time, diverts demand from these two sectors toward the market for importables.[49] As a result of this

[48]Although the unit of observation is not defined explicitly, the parameters utilized are either independent of time or correspond to yearly data. The first two periods in all the simulations correspond to the initial equilibrium so that all policy changes are assumed to occur in the third period.

[49]These effects indicate that the reduction in tariffs would lead to an increase in imports *and* exports.

CHART 1. GRADUAL AND SUDDEN REDUCTION IN TARIFFS

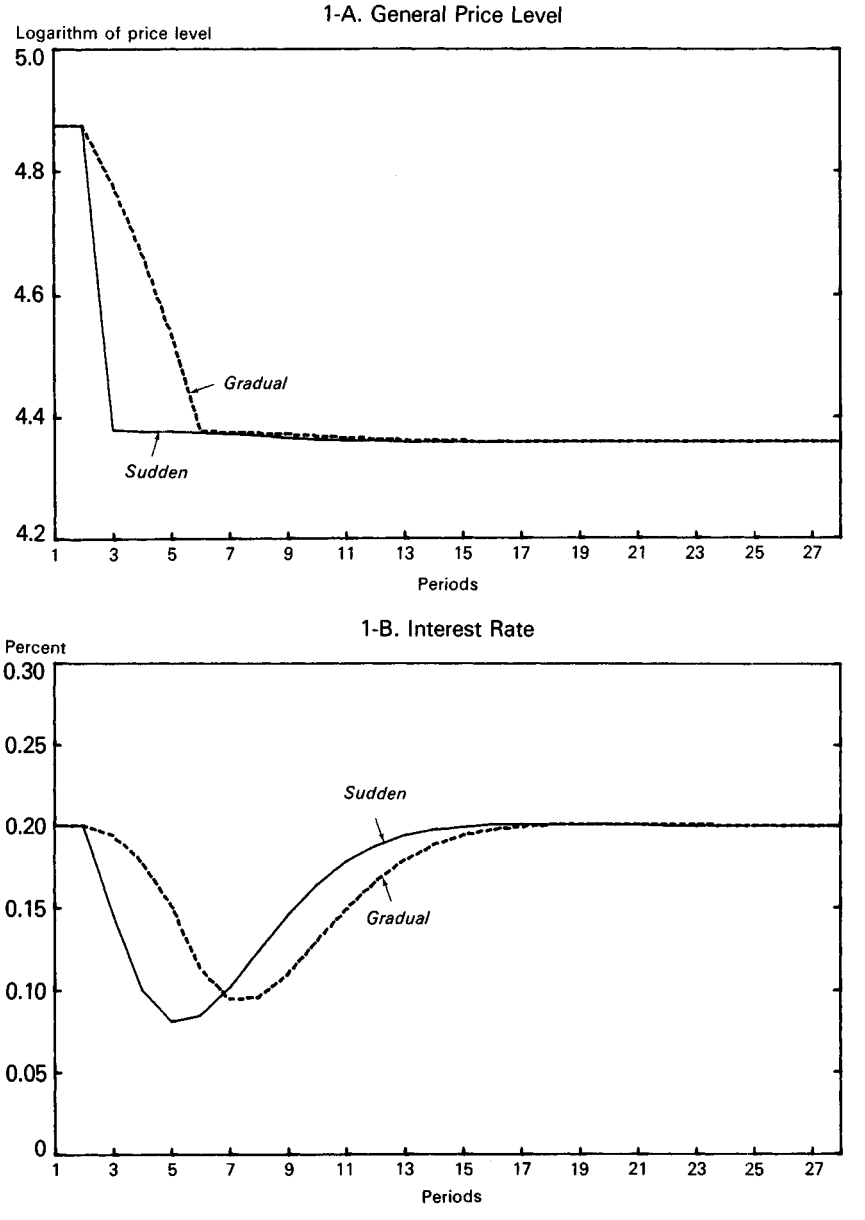
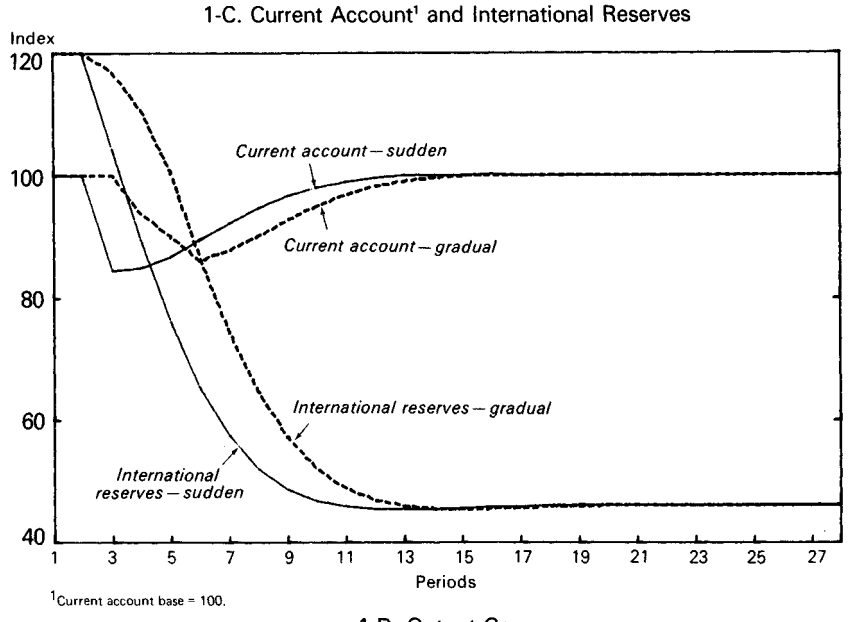
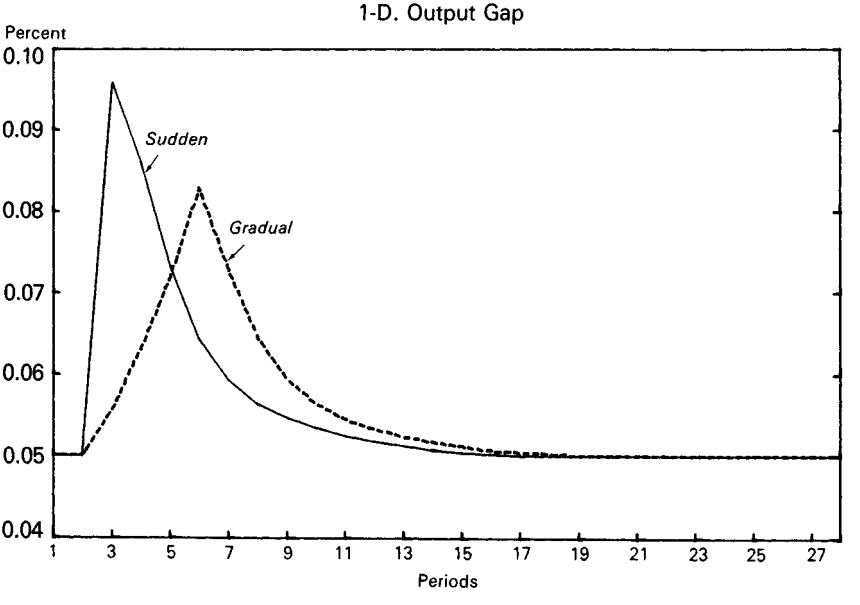


CHART 1 *(concluded)*. GRADUAL AND SUDDEN REDUCTION IN TARIFFS



[1]Current account base = 100.



transfer, an excess supply of nontradable goods is created, which causes a decline in the price of nontradables and the overall price level.

The fall in prices, by lowering the nominal demand for money, creates an excess supply of money that manifests itself both in the financial sector and in expenditures. The rate of interest drops temporarily (the "liquidity effect") for about six periods after the policy of tariff reduction is initiated[50] and then starts to rise as the monetary disequilibrium is steadily eliminated (Chart 1-B). After approximately 14 periods, the rate of interest stabilizes at its original level.

The combination of the excess supply of money and the change in relative prices results in a current account deficit that persists for 14 periods or so (Chart 1-C). There is a steady loss of international reserves until they reach about one third of their original level. In fact, it is this loss of reserves, together with the initial decline in the rate of interest, that eventually brings about equilibrium in the money market.

Finally, as adjustment in the tradable goods market is not instantaneous, and, more specifically, importable goods are assumed to adjust more rapidly than exportable goods ($\lambda_1 > \lambda_2$), the resources released by the importables sector are not absorbed by the other sectors, thereby resulting in unemployment (Chart 1-D).[51] The gap between potential and actual real output rises by more than 3 percentage points and then declines to the original 5 percent level of "normal" unemployment. It can be observed that the unemployment created by the policy of tariff reduction tends to persist for a considerable period.[52] Both the extent and duration of this unemployment depend crucially on the relative values of the adjustment parameters in the supply equations (λ_1, λ_2, and λ_3). When adjustment is instantaneous in both the importable and exportable goods markets, and $\lambda_3 = 0$, one would observe that trade liberalization has basically the same effects on the time paths of the other variables in the system but that the resource gap turns out to be zero. However, instanta-

[50]While the nominal interest rate declines, as the decline in expected inflation is greater, the real interest rate actually rises during the process.

[51]One is working with the assumption that the demand for nontradable goods does not have a direct impact on the supply ($\lambda_3 = 0$). If λ_3 were positive, then, as there is initially an excess supply in the nontradables market, the magnitude of the unemployment of resources would be greater.

[52]The creation and duration of unemployment is one of the main aspects of a trade liberalization strategy that has been the subject of criticism.

neous adjustment is clearly an extreme assumption, and our choice of parameters appears more realistic.

When tariffs are reduced in a "shock" fashion, that is, they are immediately reduced to zero in the first period, there is essentially no qualitative difference in the results; see Chart 1, A–D. Clearly, the effects of such a policy result in a more pronounced movement in the initial periods and the transition path is generally less "smooth." Given the different time paths of the excess supply of money in this simulation, the initial fall in prices and the interest rate is sharper, but it can be seen that the latter variable starts to rise back to its original level earlier. It is interesting that the accumulated current account deficit (loss of international reserves) does not differ according to whether the opening up is gradual or sudden. What is evident is that when the policy is implemented suddenly these deficits are larger originally and then smaller later (Chart 1-C).

A similar pattern is evident in the behavior of the gap between potential and actual output, but to properly compare the areas under the curves in Chart 1-D, one would have to calculate the present values using some type of social rate of discount. The difference observed between the cases of the sudden and the gradual opening up is related not so much to the time during which output remains below "full" employment, but rather to the fact that in the former the peak of unemployment is higher and the distribution of the resource gap is more asymmetrical than in the scenario for the gradual opening up.

GRADUAL AND SUDDEN REMOVAL OF RESTRICTIONS ON CAPITAL FLOWS

These experiments start with the assumption that there is a 100 percent tariff on imports and capital movements are completely restricted. Maintaining the tariff and eliminating the restrictions on capital flows both gradually and suddenly—that is, by varying β—gives a picture of what would be expected if only the capital account were liberalized. The results of this experiment on the various important macroeconomic variables are shown in Chart 2, A–E.[53]

The immediate effect of removing restrictions on the capital account is an inflow of capital as the domestic interest rate is

[53]Recall that the change in policy is always assumed to take place in the third period.

CHART 2. GRADUAL AND SUDDEN REMOVAL OF RESTRICTIONS ON CAPITAL FLOWS

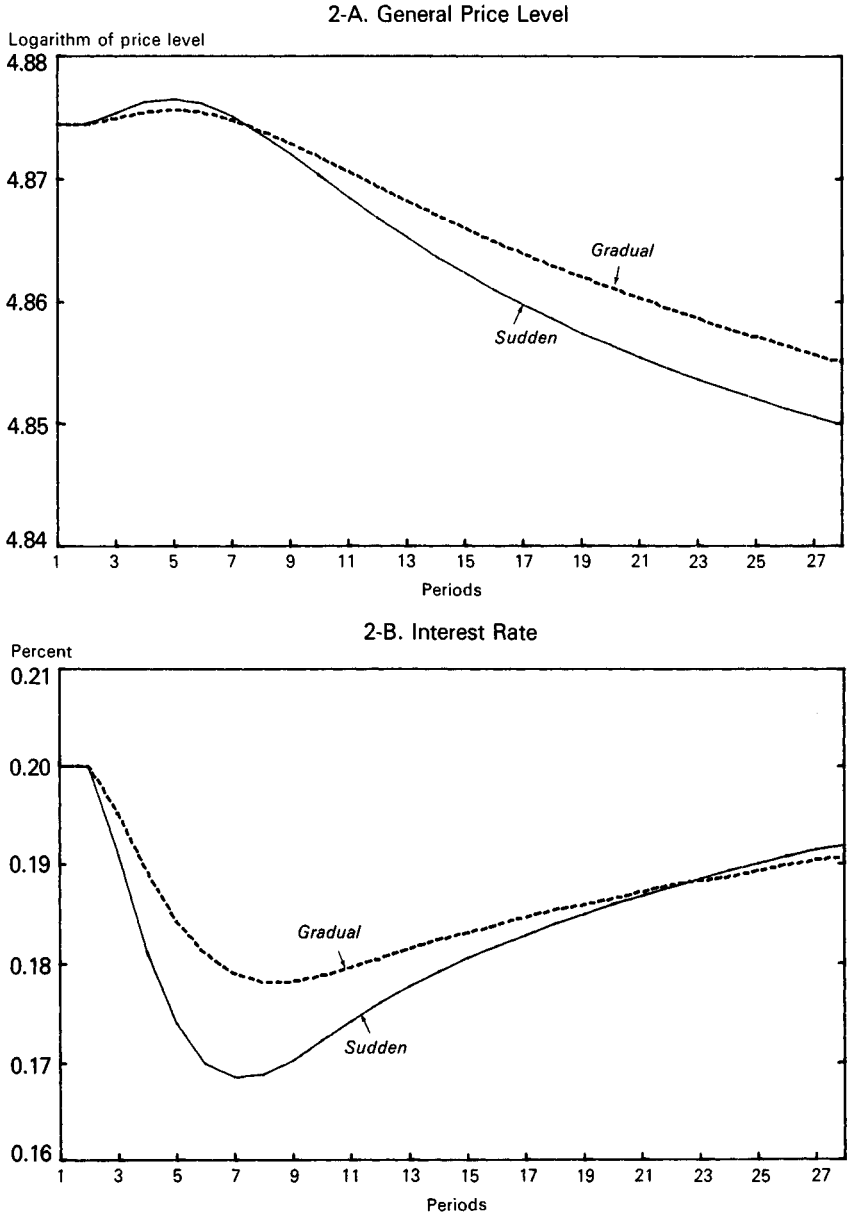
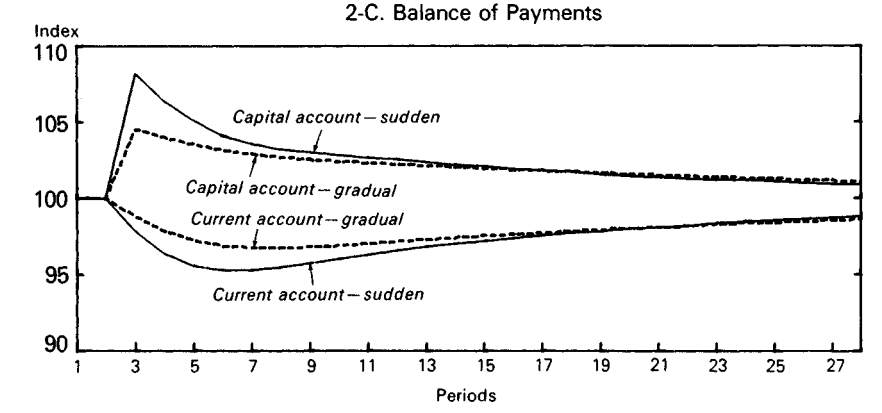
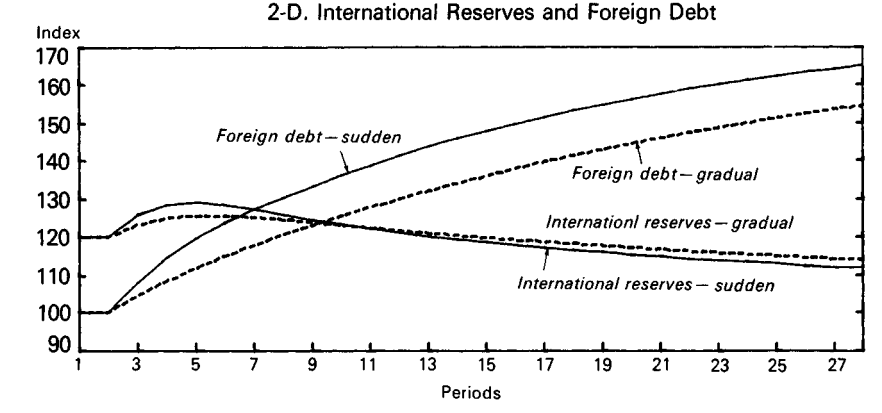
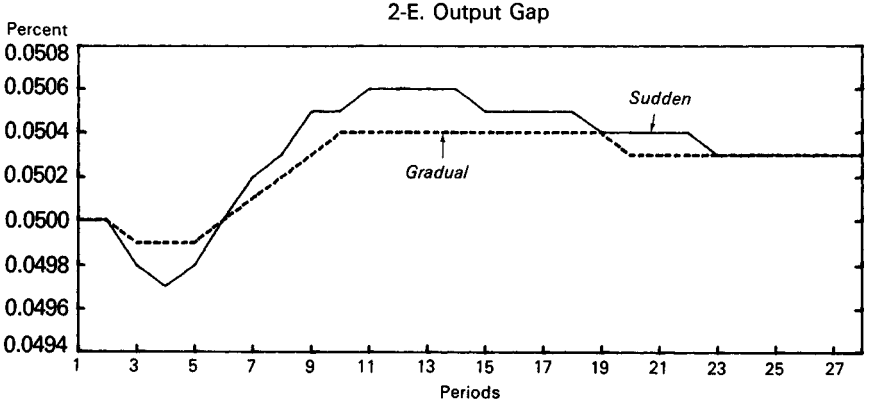


CHART 2 *(concluded)*. GRADUAL AND SUDDEN REMOVAL OF RESTRICTIONS ON CAPITAL FLOWS







above the corresponding foreign interest rate. This positive differential in favor of the domestic economy is a phenomenon typically observed in a number of developing countries that have liberalized their domestic financial markets and removed capital controls. (See Mathieson (1979; 1980) and Zahler (1980).) The inflow of capital creates an excess supply of money that, in turn, has an expansionary effect on aggregate demand, which is reflected in an initial rise in prices (Chart 2-A) and a worsening of the current account (Chart 2-C). The excess supply of money, as expected, also lowers the domestic interest rate (Chart 2-B). In theory, the interest rate move should persist until interest parity is established, which in this specific case implies that the rate should fall initially and then rise to its equilibrium level.[54] How fast this occurs depends on the size of the response of capital flows to the interest rate differential (γ_{15}) and the effect on the rate of interest of monetary disequilibrium, measured by γ_{14}. The values chosen for these parameters imply fairly slow adjustment of the interest rate so that even though it initially falls, it nevertheless starts to rise slowly as the stock of external debt increases and pushes up the risk premium. This slow adjustment would seem to accord with actual experience, and it has been hypothesized that such factors as market segmentation, nontradable assets, and other rigidities prevent the emergence of instantaneous interest parity.[55] While these factors have not been modeled explicitly, the choice of parameters here does yield a rough approximation to this type of behavior.

Moreover, as long as equality between interest rates does not exist, foreign debt will continue to increase (Chart 2-D); this means that the economy must generate a trade surplus in order to cover the rising interest payments.[56] In this process, there is a slight increase in the share of tradable goods and a corresponding fall in the proportion of nontradable goods in total output because of the need to depress aggregate demand so as to generate the resources for paying interest on external debt. This fall causes a small decline in the price of nontradable goods, and the general price level, after the temporary rise that occurred owing to the initial excess money supply (Chart 2-A).

Despite the surplus on the trade account, a sustained deficit in

[54]That is, the foreign interest rate *plus* the increased risk premium.

[55]See, for example, Blejer (1982).

[56]It is assumed that interest payments on foreign debt begin immediately and that international reserves earn no interest so that one can abstract from the concept of "net" interest payments.

the current account can be noted, although its size decreases gradually as the economy moves toward equilibrium. Given the values of the parameters, the current account deficit is, however, more than compensated for by the inflow of capital (Chart 2-C) so that there is an increase in international reserves in the beginning. The higher initial level of reserves reflects the increased demand for money that results from the decline in the interest rate; of course, at the same time, the stock of foreign debt is also larger (Chart 2-D).

In contrast to the simulations related to trade liberalization, the opening up of the capital account has only a small impact on the resource gap. After a slight increase in output owing to the initial excess money supply, the gap between potential and actual output reaches a peak that is only about 0.4 percentage point above the equilibrium level of full employment (Chart 2-E).

The main differences between the gradual and sudden policies with respect to the opening up of the capital account lie in the distribution of the variables in question. The time path of the variables in the scenario for the gradual opening up are generally smoother than when β is set to unity in one period. In the shock case, external indebtedness toward the end is larger, and, while the initial decline in the resource gap is greater, the eventual rise in unemployment is somewhat higher.

In short, capital account liberalization, unlike trade liberalization, does not significantly affect relative prices, the level of domestic prices, or resource unemployment,[57] nor is there a significant loss of international reserves, but rather an initial gain. There is associated with this policy, however, a process of growing external indebtedness that involves a continuing current account deficit that is due to the need to make interest payments on the foreign debt. Finally, there is a temporary decline in both the nominal and the real rates of interest.

SIMULTANEOUS GRADUAL REMOVAL OF RESTRICTIONS ON TRADE AND CAPITAL FLOWS

Assume that the authorities undertake to liberalize the trade and capital accounts simultaneously, rather than separately. In this case, the tariff rate (τ) is reduced to zero and the coefficient measuring the degree of restrictions (β) is raised to one half, and

[57]This neutrality no doubt reflects the relative speeds at which the goods and financial markets clear.

both policies are implemented gradually.[58] That is, τ is reduced to zero in four periods and β is set at equal to 0.5 in the third period. The results of this simulation experiment are shown in Chart 3, A–E.

In the first place, the combined effect of such policies is to bring about a greater degree of monetary disequilibrium in the economy, compared with the consideration of the two policies separately. The nominal demand for money falls because of the drop in the price level resulting from the tariff reduction and the money supply increases owing to the inflow of international capital. In net terms, there would appear to be a larger excess supply of money initially; this causes the price level and the interest rate to fall relatively more than was observed in the two previous simulations (Charts 3-A and 3-B). The interest rate falls rather sharply in the beginning; even when it begins to rise again, it remains below the time path followed when only the capital account was opened up.

The initial excess money supply creates a current account deficit that is also larger than when the two policies were undertaken individually. The deterioration caused by the tariff reduction is reinforced by the further small worsening that results from opening up the capital account (Chart 3-C). The time path of the trade balance lies between the corresponding paths of the two previous simulations, initially following (for about 10 periods) the direction of the trade balance picture emerging from trade liberalization but later beginning to mimic the behavior of the trade balance that resulted from the capital account liberalization. This is so because a surplus must be generated continually to finance the interest payments on the growing external debt.

The final level of international reserves is about the same as was observed with the trade liberalization, although during the transition the paths of reserves do deviate from one another (Chart 3-D). It is readily apparent that the capital inflows generated by the policy of removing the relevant restrictions are not sufficient to cover the current account deficits so that the country will lose reserves. The stock of external debt has a somewhat different path from the simulation experiments related to capital account liberalization (Chart 3-D). There is an initial rise but then a fall for a few periods and later a smooth increase. This gyration

[58]Since the results for the shock scenario are similar, only the results for the gradual opening up are reported here.

CHART 3. SIMULTANEOUS GRADUAL REDUCTION IN TARIFFS AND REMOVAL OF RESTRICTIONS ON CAPITAL FLOWS

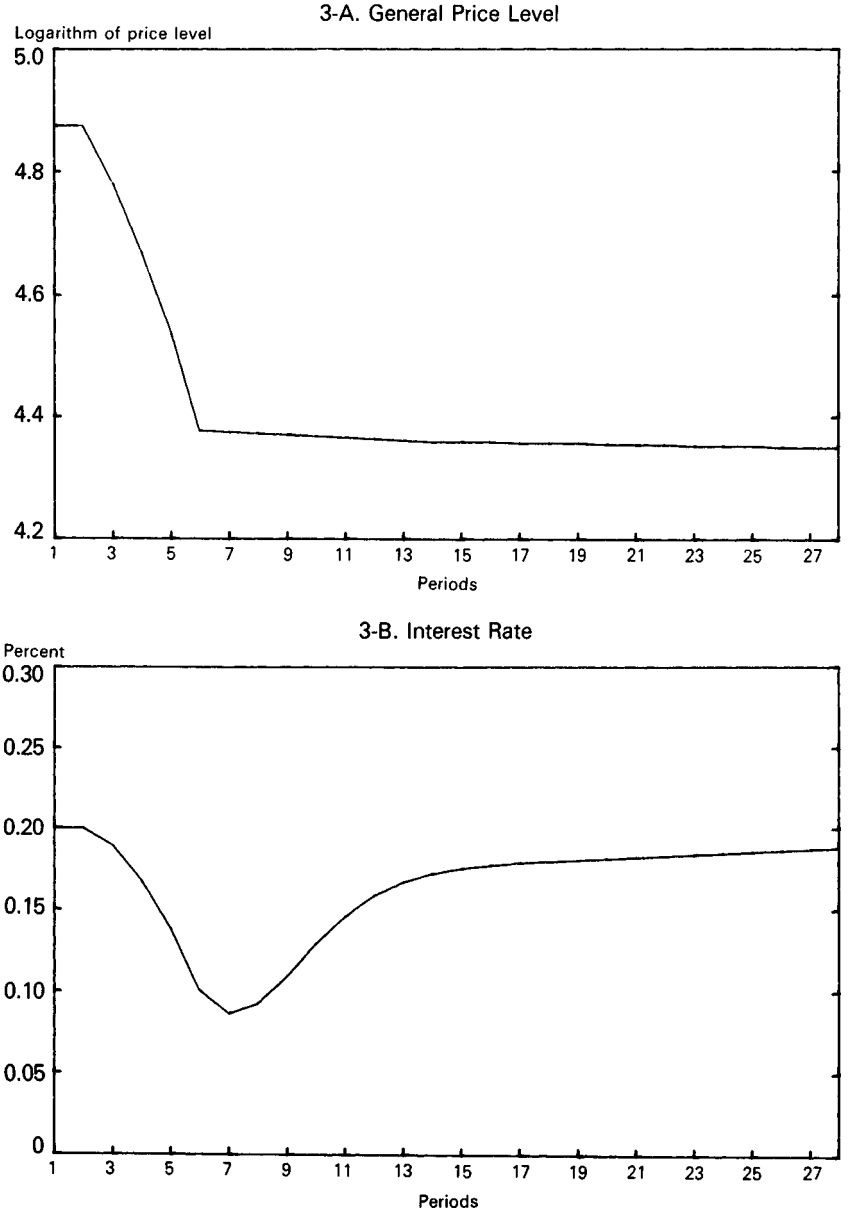
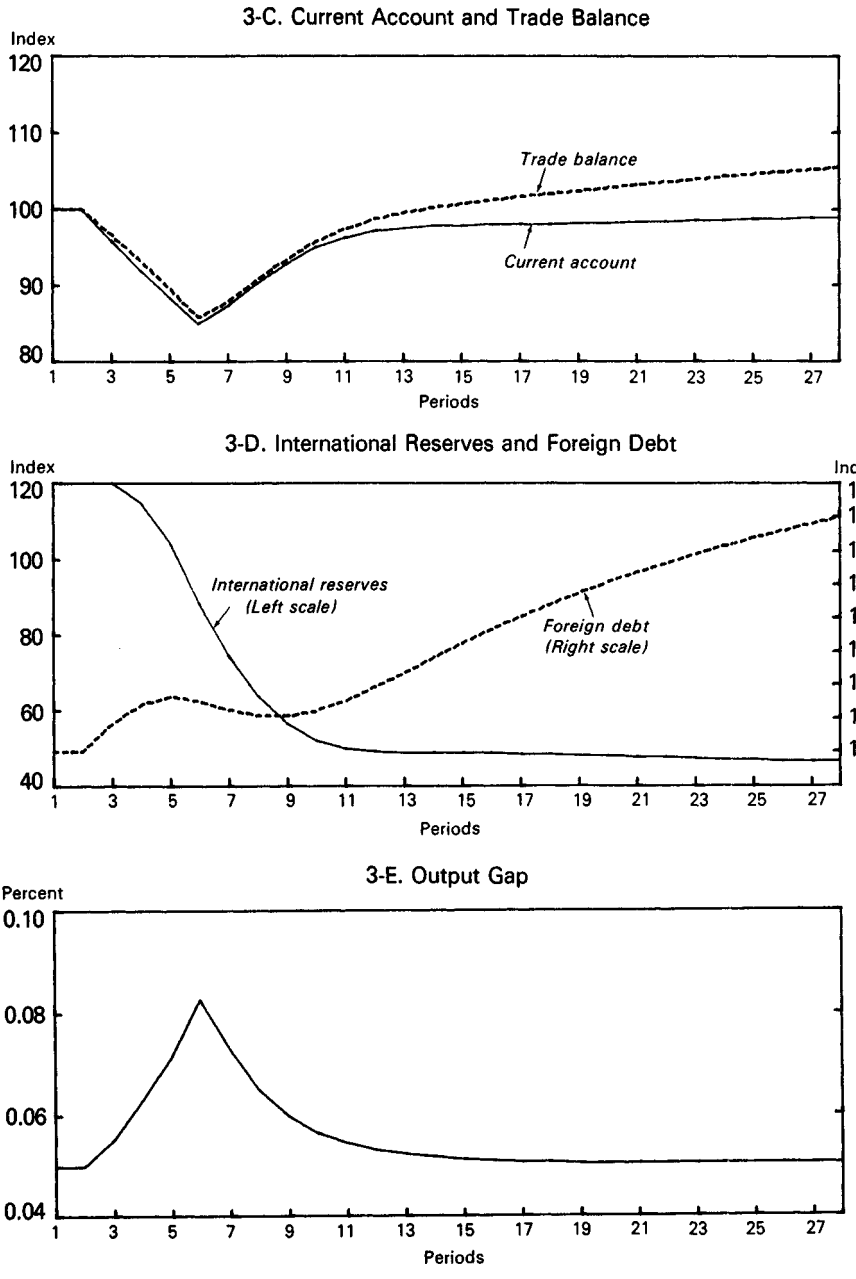


CHART 3 *(concluded)*. SIMULTANEOUS GRADUAL REDUCTION IN TARIFFS AND REMOVAL OF RESTRICTIONS ON CAPITAL FLOWS



is a direct consequence of the cyclical way in which the interest rate behaves in this particular simulation.

Finally, the structure of production and the resource gap behave in a way that is similar to the trade liberalization, which can be explained by the small impact of capital account liberalization on relative prices (Chart 3-E). Even though there is initially a greater excess money supply, this appears to be reflected in a current account deficit rather than affecting the real sector through a change in relative prices. Unemployment rises by a little more than 3 percentage points above its long-run equilibrium level.

To sum up, the simultaneous application of the two types of opening-up policy is not simply the same as the sum of each of them considered separately. Although the structure of production and resource unemployment, together with prices, tends to broadly reproduce the situation observed for the reduction in tariffs, the financial and foreign sector variables behave in a different manner from that resulting from the two policies considered individually. This shows up, in particular, in a lower level of external indebtedness, a smaller surplus in the trade balance (but with larger imports than in the initial situation), and a different time path of the interest rate in comparison with capital account liberalization alone.

SEQUENTIAL GRADUAL REMOVAL OF RESTRICTIONS ON TRADE AND CAPITAL FLOWS

Much of the recent discussion regarding opening-up strategies has focused on the sequence in which these reforms ought to be implemented, namely, whether the trade account should be liberalized first and then the capital account, or vice versa. (See McKinnon (1982) and Frenkel (1982).) Since theory provides limited guidance on the issue of sequencing, the arguments have been based on essentially casual empiricism. Without going into the discussion of which sequence is better or more likely to be successful, one can, in the context of this model, outline the consequences of two alternative types of strategy. First, the trade account is liberalized (gradually) in period 3 and then, after the subsequent four periods, the restrictions on capital account are removed (also gradually).[59] In the second stage, the sequence is

[59]The four periods correspond to the complete implementation of the gradual tariff reduction.

reversed, with the capital restrictions removed first and then, again after four periods have elapsed, the tariff rate is gradually lowered to zero. The results of this particular experiment are reported in Chart 4, A–F.

It appears to be a matter of indifference as to the sequence of policies adopted insofar as the price level is concerned (Chart 4-A). Prices decline by approximately the same amount in the two cases, except that when the trade account is liberalized first, the effect occurs earlier. Since it has been shown in the previous experiments that the effect on prices of the opening up of the capital account is negligible, this result is not too surprising.

The effect on the interest rate is slightly different, depending on the chosen sequence. When the capital account is liberalized first, the rate of interest initially declines more slowly, but then the fall is accelerated as tariffs are removed (Chart 4-B). This is so because the excess supply of money generated by the fall in prices owing to the reduction in tariffs is greater than the excess supply of money created by the capital inflow. The overall decline in the interest rate also turns out to be somewhat greater in this particular sequence of reforms.

The trade balance and current account pictures are, however, quite different. If the capital account is liberalized initially, for a few periods there is a slight worsening of the trade balance (Chart 4-D). The tariff adjustment pushes the trade balance further into deficit, but the cumulative deficit turns out to be smaller than if tariff reductions had been introduced first. The payment of interest on foreign debt also makes the path of the current account somewhat different (Chart 4-C). For this variable, the deficit is smaller in the beginning when the capital account is liberalized first, but later the deficit turns out to be larger than when the opposite sequence is implemented.

The behavior of international reserves and the foreign debt is also interesting. As capital restrictions are removed, there is an immediate inflow of capital, and both reserves and the stock of foreign debt rise (Chart 4-E). However, as the tariff reduction lowers the demand for money, which further reduces the interest rate, this process is temporarily reversed and both the stock of foreign reserves and debt fall. Eventually, as the system stabilizes, the level of international reserves is approximately the same in both scenarios, and the level of external indebtedness is slightly higher when the capital account is opened up initially.

CHART 4. SEQUENTIAL GRADUAL REDUCTION IN TARIFFS AND REMOVAL OF RESTRICTIONS ON CAPITAL FLOWS

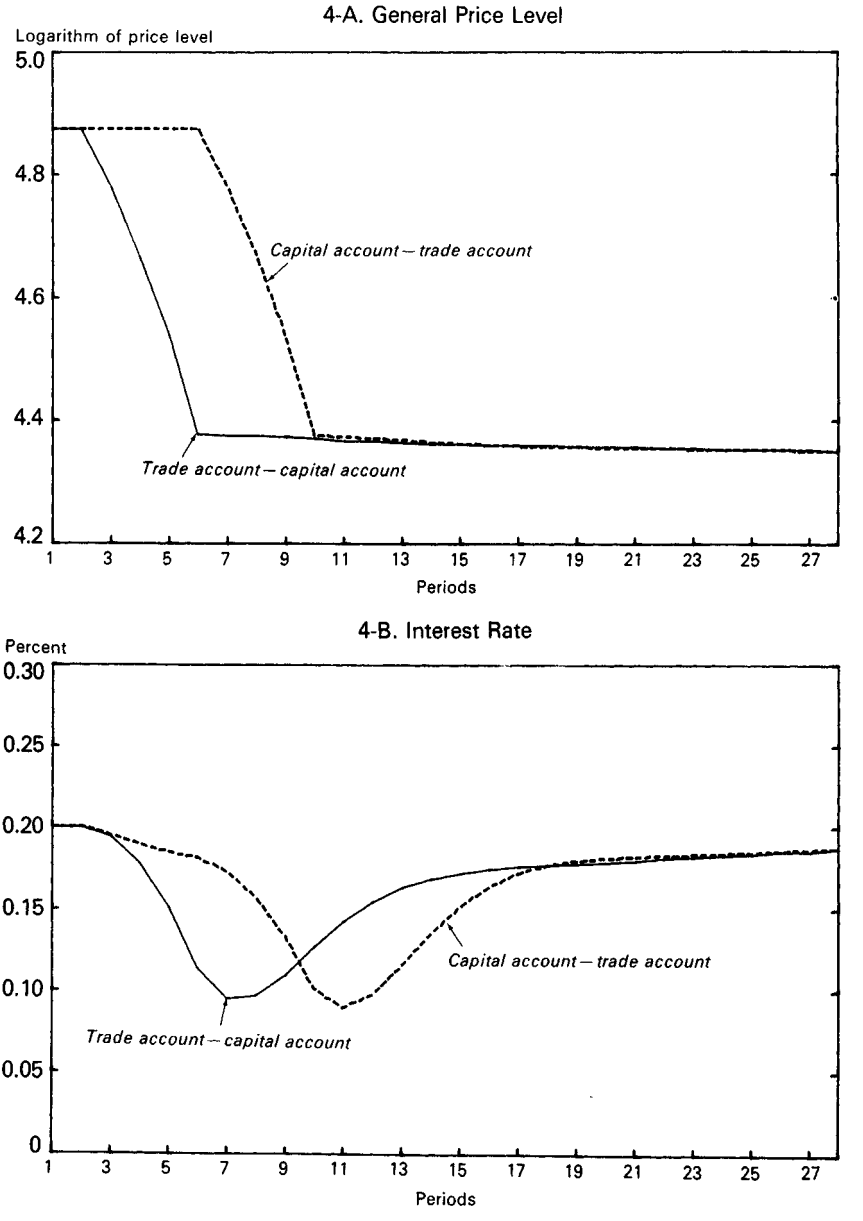
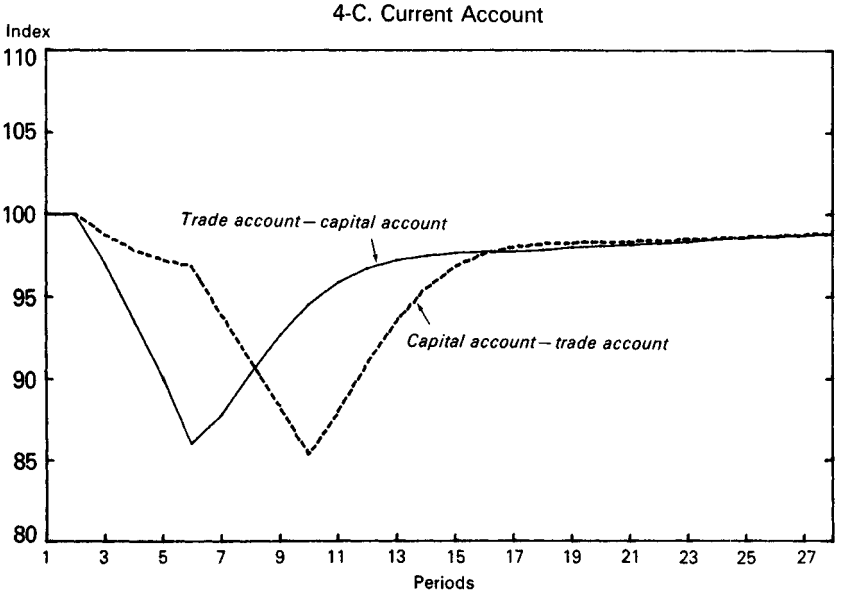


CHART 4 *(continued)*. SEQUENTIAL GRADUAL REDUCTION IN TARIFFS AND REMOVAL OF RESTRICTIONS ON CAPITAL FLOWS



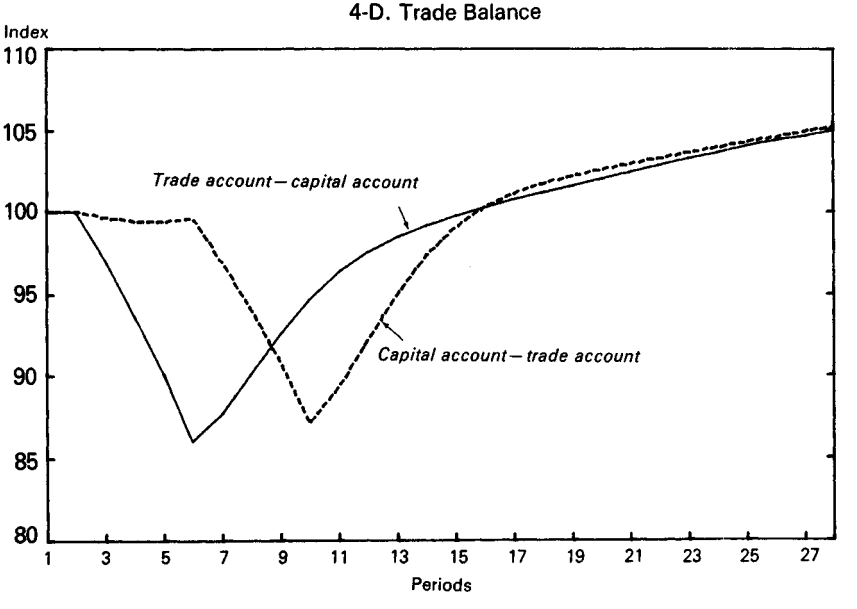
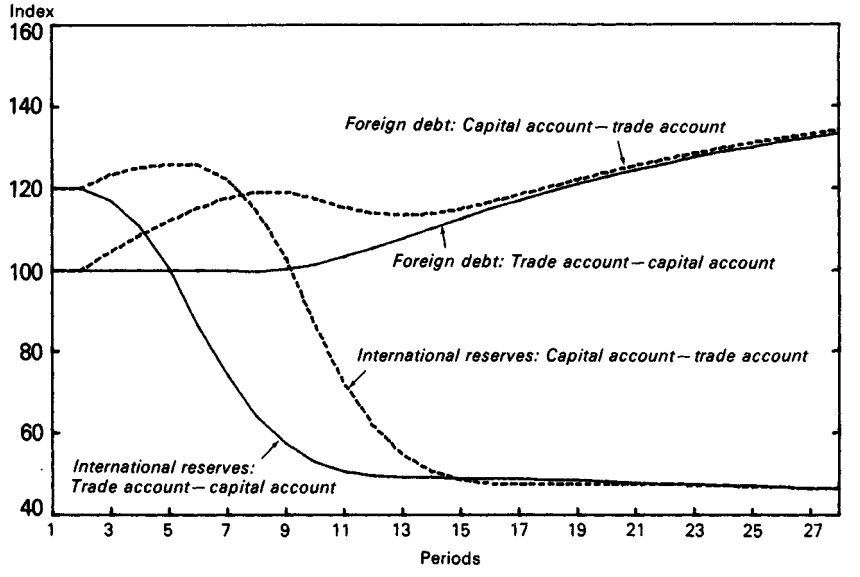
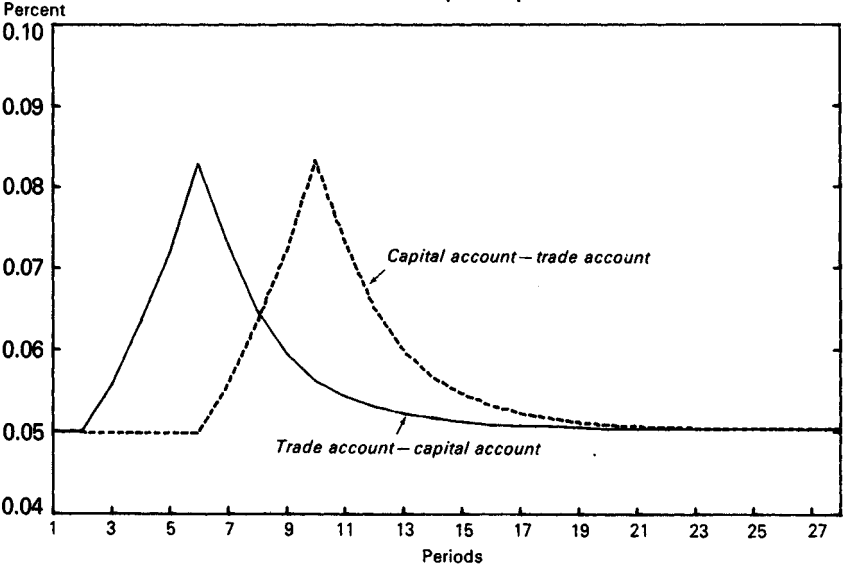


CHART 4 *(concluded)*. SEQUENTIAL GRADUAL REDUCTION IN TARIFFS AND REMOVAL OF RESTRICTIONS ON CAPITAL FLOWS

4-E. International Reserves and Foreign Debt



4-F. Output Gap



As the liberalization of the capital account has a negligible effect on the output gap, there is no noticeable difference when the different sequences of policies are adopted (Chart 4-F). All that one observes is that the unemployment is generated later when the opening up of the capital account is instituted first. Other than that, the time paths of unemployment are exactly the same.

In summary, as with the simultaneous liberalization experiments, little difference is found in the effects on prices and the real sector. The only question that can be raised in relation to the latter is whether unemployment is preferred now or later. The main differences arise in the financial and foreign sectors, where the decline in the interest rates, the deterioration in the current account, and the loss of international reserves is initially less if capital flows are liberalized before any trade reforms are initiated than if the opposite sequence is followed. At the same time, however, the stock of external debt will be smaller in the long run if the trade account is liberalized first. Therefore, these results do not indicate clear-cut support for the propositions made by McKinnon (1982) and Frenkel (1982) that tariff reforms should necessarily take place prior to policy changes that affect capital movements. Explicit trade-offs are evident, and the issue cannot be resolved on theoretical grounds.

COMPENSATORY POLICIES

It is evident from the analysis of the various simulations that opening-up policies are generally accompanied by transitory effects (of varying duration) that may be considered undesirable by the policymakers. The effects can include current account deficits, loss of international reserves and/or greater external indebtedness, increases in the real interest rate, and resource unemployment. Each of the strategies tends to yield some combination of these "costs." Of course, the authorities could in principle use compensatory demand management policies, such as monetary and fiscal or exchange rate policy, to minimize some of these costs. The present model allows one to design such policies; purely for illustrative purposes, one such experiment is described here.

In the context of trade liberalization alone, it is clear from all these experiments that the current account deteriorates in the short run. Suppose that the authorities wish to prevent this and are prepared to use monetary policy to this end. To avoid a cur-

rent account deficit and, given that capital movements are not allowed, a consequent loss of international reserves, it would be necessary to implement a restrictive monetary policy consisting of reducing domestic credit—in this case, credit to the private sector (*CRP*)—so as not to generate the excess money supply that typically emerges when tariffs are reduced.[60] Chart 5-A describes the magnitude and the time path that domestic credit must follow in the attempt to secure permanent equilibrium in the monetary sector when trade is opened up gradually. For purposes of comparison, the (constant) path of domestic credit has been plotted when trade was liberalized gradually without any change in monetary policy. It can be seen that a strong contraction in domestic credit would be necessary, being more pronounced in the initial periods and subsequently less marked.

The paths of the international reserves and current account as a consequence of this restrictive monetary policy are shown in Charts 5-B and 5-C, where again the results have been plotted in the absence of changes in monetary policy. International reserves fall slightly; they do not remain unchanged because guaranteeing equilibrium in the monetary sector alone is not sufficient for this. In addition, as the adjustment in the exportable goods market is slower than in the importable goods market, the change in relative prices creates an asymmetrical response in the two markets, thereby generating a current account deficit in the first few periods—even though there is no excess aggregate demand.

While the level of international reserves can be stabilized by a suitable tightening of monetary policy, this policy can itself have obvious adverse effects on other variables in the system. For example, Chart 5-D shows what happens to private expenditures as a consequence of such a policy. For several periods, private expenditures are lower than the rate witnessed when tariffs were reduced without any variation in monetary policy. Although not shown here, a relatively larger rise in the real interest rate and some further lowering of inflation and growth were also observed.

The basic exercise here has pointed out that designing an "optimal" mix of policies necessarily involves trade-offs, and it is up to the authorities to decide the weights that they assign to the various effects. It appears quite evident that there is no easy escape from having to choose among alternative combinations of transitory effects.

[60]For experiments of a similar nature, see Khan and Knight (1981).

CHART 5. COMPENSATORY MONETARY POLICY FOR GRADUAL REDUCTION IN TARIFFS

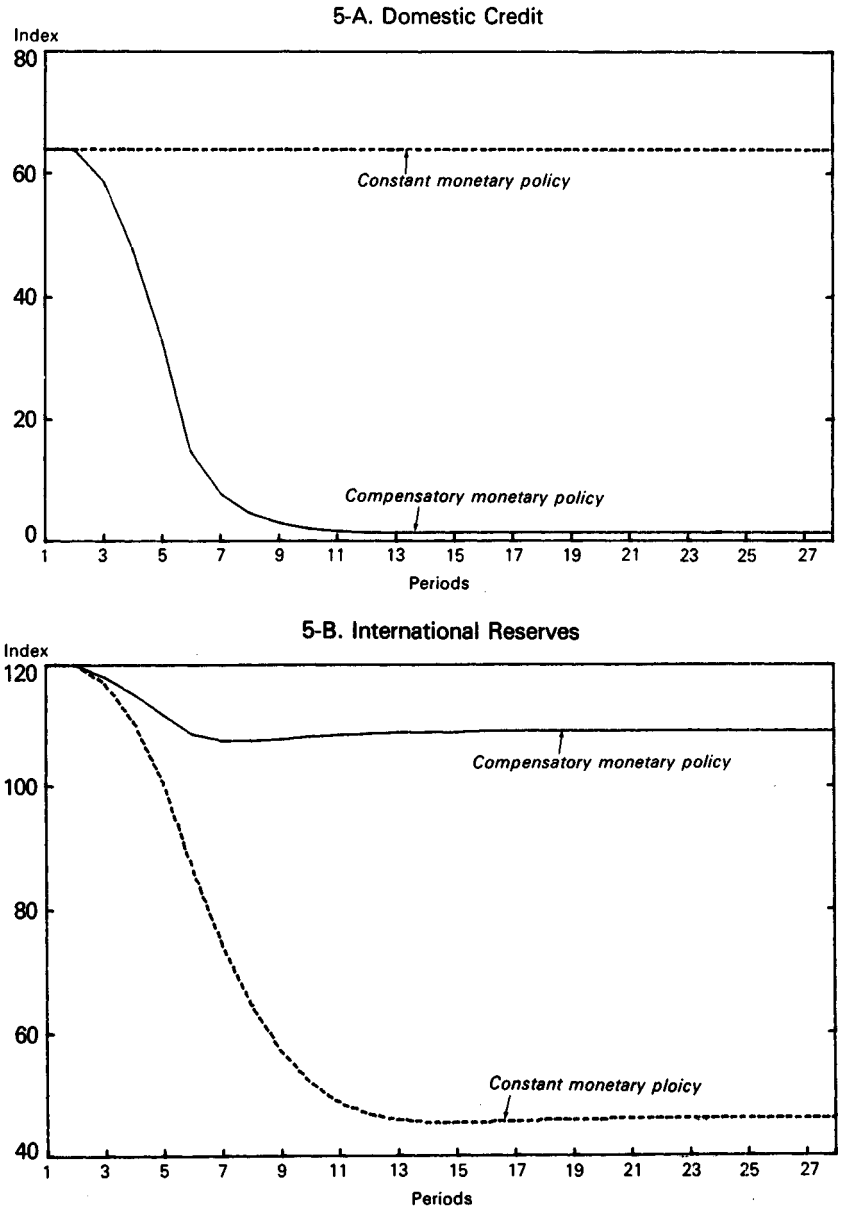
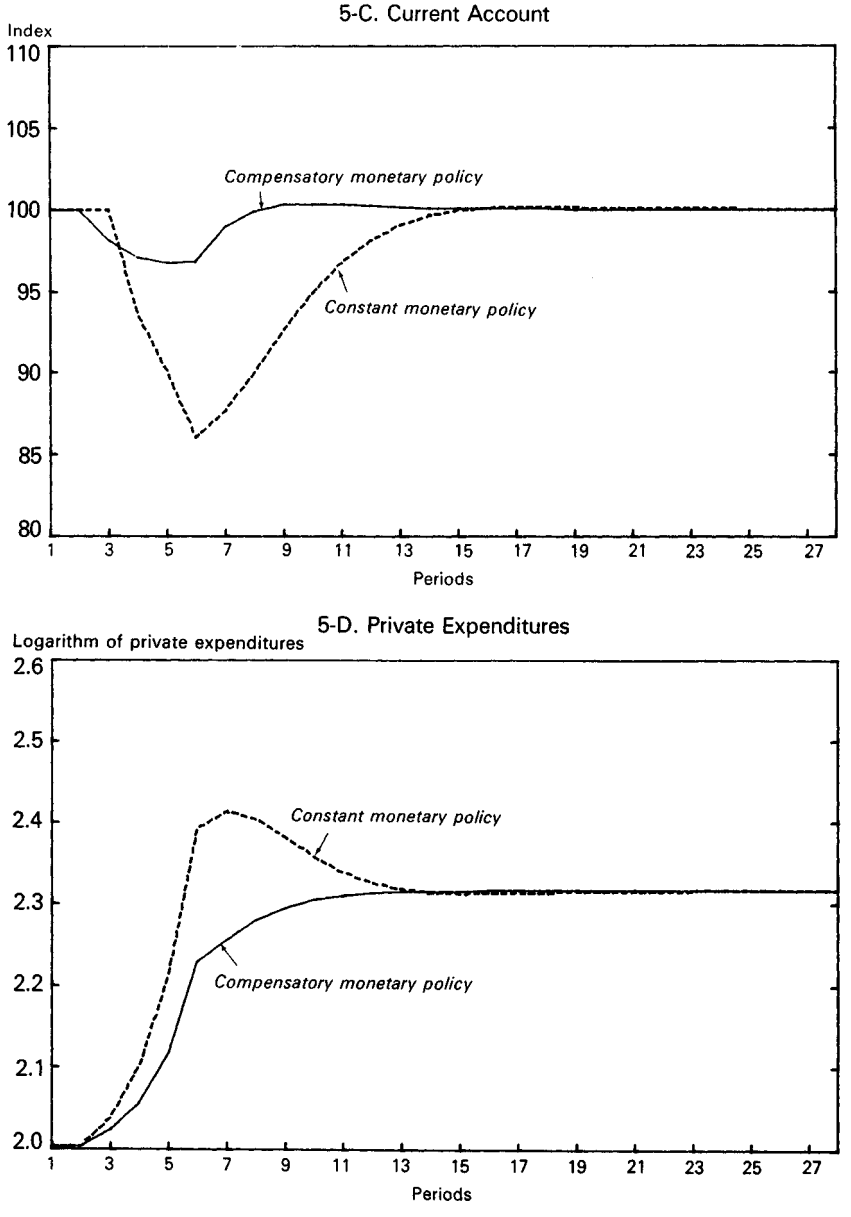


CHART 5 *(concluded)*. COMPENSATORY MONETARY POLICY FOR GRADUAL REDUCTION IN TARIFFS



III. Conclusions

This study, while focusing on the narrow issue of the characteristics of the short-run and medium-run adjustment path of some main macroeconomic variables as a consequence of opening up the economy to the free flow of goods and financial capital, has yielded, nonetheless, some important insights that can now be summarized. The main results are presented for convenience in Table 1. The simulation exercises produced a number of interesting and plausible results, based—it should be stressed—on a representative set of parameters. Certain combinations of parameters, of course, could produce somewhat counterintuitive results, but it seems that the values needed for the coefficients would be fairly unrealistic and of only possible academic interest.

Briefly, the principal results are as follows:

(1) It was demonstrated that the effects of trade liberalization are quite different from those resulting from the opening up of the capital account. The former type of policy results in significant changes in resource allocation and in both relative and absolute prices, in current account deficits, in loss in international reserves, and in a relatively large fall in aggregate production. The impact of capital account liberalization, on the other hand, results in greater external indebtedness and current account deficits, although international reserves rise initially and then fall. The effects on the structure of production, prices, and the resource gap, however, are small.

(2) Another interesting result is that the speed with which reforms are instituted also matters. As would be expected, a shock-type approach, whether in the trade sector or on the capital account side, has a more pronounced impact at the beginning, but the adjustment to equilibrium is faster. If the policy is implemented more gradually, the time paths of the variables are smoother, but naturally the adjustment process is more delayed. While, on the face of it, this would seem to suggest that a more gradualist approach would reduce the cost of the opening-up policy, it should be noted that making an adequate comparison of the effects of alternative strategies requires the introduction of an appropriate social rate of discount. This is something that is not done here, since it would involve a fair degree of speculation.

(3) If a choice must be made as to which type of liberalization policy to implement first, it is clear that different policy sequences yield different results from the point of view of the time paths of

TABLE 1. SUMMARY OF SHORT-RUN EFFECTS OF LIBERALIZATION OF TRADE AND CAPITAL MOVEMENTS ON SELECTED ECONOMIC VARIABLES

Policy	Price Level	Current Account	International Reserves	Real Output	External Debt
Trade liberalization[1]	Lowered	Deficit	Lowered	Lowered	—
Capital account liberalization[2]	Unchanged	Deficit	Initially increased	Unchanged	Increased
Simultaneous liberalization	Lowered	Deficit	Lowered	Lowered	Increased
Sequential liberalization[3]	Lowered	Deficit	Lowered	Lowered	Increased

[1]Capital controls retained.
[2]Tariff barriers retained.
[3]This simulation corresponds to the gradual removal of tariff barriers and then the elimination of capital controls, and vice versa. While the overall effects of the two sequences are similar, as reported in this table, the time paths of the variables do differ.

the principal macroeconomic variables, and it is not immediately obvious which pattern would be preferable. Also, it appears that the effects of the simultaneous liberalization of trade and the capital account is not simply a linear combination of the policies implemented separately.

It may, therefore, be concluded from the simulations that the economic authorities cannot be indifferent about sequences, magnitudes, and relative speeds of alternative opening-up strategies.

The basic time paths of the variables in the system, which are in a sense the focus of the exercise, depend on a variety of factors; it may be useful to discuss some of these factors:

(1) In general terms, the study indicates that even when there is rapid opening up, it takes a number of periods to secure general macroeconomic equilibrium. In particular, even for a sudden liberalization of the capital account, it takes a while for the domestic interest rate to converge to the international rate, appropriately defined. The sensitivity of the speed of convergence of domestic and international interest rates depends on the interest elasticity of the flow of international capital to the country, the proportion of the monetary disequilibrium that spills into the domestic fi-

nancial market, and the effect on the country-risk premium of changes in the external debt situation of the country.

(2) A further element that plays an important role in determining the time path of the various macroeconomic variables is the adjustment of prices and quantities in the nontradable goods market. It is observed that the slower the adjustment of this market and the more important the direct role of effective demand in the supply of such goods, the costlier the process of trade liberalization tends to be in terms of production losses. Likewise, the speed with which domestic and foreign prices tend to equalize when there is removal of trade barriers depends strongly on the importance of the production of nontradable goods within total supply and on the speed of adjustment of prices to disequilibrium in the nontradables market.

(3) A final element that stands out in defining the time path of the macroeconomic variables in a process of opening up is that associated with the speed of response of the production of exportable and importable goods to changes in relative prices. The greater the intersectoral mobility of resources and the smaller the differences between the lags in the desired and effective supplies of exportable and importable goods, the smaller will be the transition costs related to unemployment of resources arising from the opening up.

Some other specific interesting results that emerge from the exercise are as follows:

(1) When the domestic economy is opened up to the world economy, the global balance of payments position may improve, even though the current account deteriorates and external indebtedness grows.

(2) Real output temporarily falls when tariffs are reduced. The duration of the resource unemployment is independent of the speed of trade liberalization, but, as mentioned, the resource gap is greater at the beginning for "shock" policy, although later its magnitude is less than that corresponding to the "gradual" scenario. This result is sensitive to the relative speed of adjustment of quantity and prices in the nontradable goods market.

(3) As expected, the rate of inflation falls when tariffs are reduced, and the domestic interest rate moves toward the value of the international rate, appropriately defined, when the economy is opened up to capital flows. However, these two variables do not converge instantaneously toward their international levels, and

the time that it takes depends, to some extent, on the speed of the respective processes of opening up.

(4) Although the production of importable goods falls with tariff reductions as its price falls, the production of exportable goods rises. The proportion of nontradable goods in the final equilibrium, compared with the initial equilibrium, depends on the own and cross-price elasticities of substitution of production and expenditure. In general, there is a change in the structure of production even though the level may remain constant.

(5) If initially the domestic nominal interest rate is above the relevant (adjusted) foreign rate, it will tend to fall when the economy is initially opened up, but the real rate may rise substantially above its initial value for some time. This case is frequently observed in sudden opening-up strategies in the trade sector and is explained by the (relatively) sharp drop in the domestic (actual and expected) rate of inflation, which results from the reduction in the price of importable goods.

(6) Compensatory policies can be designed that tend to reduce some of the undesirable transitory effects of the process of opening up. The model makes it possible to devise such policies and to evaluate the trade-offs implicit in their application.

Before ending, it is important to list certain caveats. The analysis was conducted in a nongrowth framework, and it was assumed that potential output is exogenous. In the opening-up process, when a current account deficit occurs, to preclude net capital accumulation (a necessary condition for maintaining real potential output as exogenous), it has been assumed that foreign savings are a perfect substitute for domestic savings. Furthermore, the assumption of exogenous real potential output implies that the model does not incorporate the possibility that, in the process of opening up, some part of the existing capital stock can become economically (but not necessarily technically) obsolete, and that there may be an improvement in efficiency owing to inputs of new modern capital goods.

Some further caveats, which do not necessarily limit the relevance of this study, should also be pointed out. For example, even though the results here have obvious implications regarding the behavior of factor markets and changes in the distribution of income, property, or wealth, which may be quite important in some experiences of economic opening up, no explicit analysis of such phenomena has been conducted. Also, all goods in the mod-

el are final goods, and, as such, there is no allowance for intermediate inputs; therefore, there is no direct analysis of costs of production, the level and composition of which may change in the process of opening up. The model also makes no distinction between consumption and investment goods. This omission may be important, particularly as one of the most frequently discussed topics in processes of opening up is that of their impact on the rate of accumulation. Finally, expectations have been modeled in a fairly simplified fashion, and it is possible that the introduction of more sophisticated expectations-generating schemes could alter some of the results. In this context, one should also be aware that a model such as that developed here is vulnerable to the so-called Lucas critique. In other words, it is quite likely that certain structural parameters that have been assumed to be constant, particularly those relating to expectations, could be altered as a consequence of the change in the policy regime. Unfortunately, to our knowledge, there is no obvious way to take account of such a criticism.

Also, note that the various simulations upon which these conclusions are based were conducted using the strong assumption that other domestic policies, as well as international factors, remained unchanged. It is obvious that the results could be significantly altered if, for example, the government ran large fiscal deficits, engaged in excessive monetary expansion, or maintained an unrealistic exchange rate at the same time that it was engaged in a liberalization process. Furthermore, changes in the international environment, as have been witnessed recently—namely, the high foreign real interest rates, declining growth in the industrial world, rising protectionism in the export markets of developing countries, and sharp changes in commodity prices that have generally worsened the terms of trade of these countries—would also be expected to change the outcome of the liberalization experiments. Although such factors have not been dealt with here explicitly, the model is quite capable of handling them.

Finally, further development of this model will make it possible to facilitate the analysis of real cases. The next stage would undoubtedly involve, apart from some theoretical refinements, the actual estimation of structural parameters, lags, and coefficients of adjustment, either for individual countries or using cross-country data. The expectation is that the basic model designed and studied here will serve as a foundation on which more detailed structures can be built, taking due care to incorporate institutional

and other characteristics of the particular case at hand. Such models would help to evaluate more precisely the economic policy options related to the liberalization process. In addition, it would be quite informative to compare the short-term results from this model with the longer-term results emerging from static general-equilibrium models that incorporate some type of welfare function. However, in conclusion, it should be reiterated that even in its current stage, the model has provided systematic general information on the macroeconomic effects associated with the liberalizing of trade and capital flows.

APPENDICES

I. Simulation Model

A. Equations

PRODUCTION AND SUPPLY

Factor endowment

$$y_t^* = \bar{y}_t^* \tag{1}$$

Supply of importable goods

$$I_t^s = \lambda_1 \left[\frac{\gamma_2\gamma_3 y_t^{*2} Pi_t^2}{\gamma_1\gamma_2\gamma_3 Pi_t^2 + \gamma_1^2\gamma_3 Px_t^2 + \gamma_1^2\gamma_2 Pn_t^2} \right]^{1/2} + (1-\lambda_1) I_{t-1}^S \tag{2}$$

Supply of exportable goods

$$X_t^s = \lambda_2 \left[\frac{(\gamma_1^2\gamma_2) y_t^{*2} Px_t^2}{\gamma_1\gamma_2\gamma_3 Pi_t^2 + \gamma_1^2\gamma_3 Px_t^2 + \gamma_1^2\gamma_2 Pn_t^2} \right]^{1/2} + (1-\lambda_2) X_{t-1}^s \tag{3}$$

Desired supply of nontradable goods

$$N_t^{s*} = \left[\frac{(\gamma_1^2\gamma_2/\gamma_3) y_t^{*2} Pn_t^2}{\gamma_1\gamma_2\gamma_3 Pi_t^2 + \gamma_1^2\gamma_3 Px_t^2 + \gamma_1^2\gamma_2 Pn_t^2} \right]^{1/2} \tag{4}$$

Supply of nontradable goods

$$\log N_t^s = \log N_t^{s*} + \lambda_3 [\log N_t^d - \log N_t^{s*}] \tag{5}$$

Real output

$$y_t = [\gamma_1 I_t^{s2} + \gamma_2 X_t^{s2} + \gamma_3 N_t^{s2}]^{1/2} \tag{6}$$

Nominal income

$$Y_t = Pi_t I_t^s + Px_t X_t^s + Pn_t N_t^s + \epsilon_t \cdot \tau_t \cdot I_t \tag{7}$$

Disposable income

$$YD_t = Y_t - T_t - \epsilon_t \cdot \tau_t \cdot Pf_t \cdot I_t \tag{8}$$

EXPENDITURES

Total private expenditures

$$\log EPRD_t = \lambda_4[\gamma_4 \log YD_t + \gamma_5(\log M_t - \log M_t^d) - \gamma_6 rd_t] + (1 - \lambda_4) \log EPRD_{t-1} \tag{9}$$

Private expenditures on goods

$$EP_t = EPRD_t - rd_t \cdot Bf_t \tag{10}$$

Total expenditures

$$E_t = EP_t + G_t \tag{11}$$

Total expenditures on importable goods

$$\Delta\log (PiI^d)_t = \Delta\log E_t + \Delta\log Pi_t + (1/w_i^d)\,[-\gamma_7 \Delta\log Pi_t + (w_x^d + (\gamma_7 + \gamma_8 - \gamma_9 - 1)/2)\Delta\log Px_t + (w_n^d + (\gamma_7 - \gamma_8 + \gamma_9 - 1)/2)\Delta\log Pn_t] \tag{12}$$

Total expenditures on exportable goods

$$\Delta\log (PxX^d)_t = \Delta\log E_t + \Delta\log Px_t + (1/w_x^d)\,[w_n^d + (\gamma_7 + \gamma_8 - \gamma_9 - 1)/2)\Delta\log Pi_t - \gamma_8 \Delta\log Px_t + (w_i^d + (-\gamma_7 + \gamma_8 + \gamma_9 - 1)/2)\Delta\log Pn_t] \tag{13}$$

Total expenditures on nontradable goods

$$\Delta\log (PnN^d)_t = \Delta\log E_t + \Delta\log PN_t + (1/w_n^d)\,[\,(w_x^d + (\gamma_7 - \gamma_8 + \gamma_9 - 1)/2)\Delta\log Pi_t + (w_i^d + (-\gamma_7 + \gamma_8 + \gamma_9 - 1)/2)\Delta\log Pn_t] \tag{14}$$

PRICES AND UNEMPLOYMENT

Prices of importable goods

$$\log Pi_t = \lambda_5[\log Pf_t + \log \epsilon_t + \log (1 + \tau_t)\ ] + (1 - \lambda_5)\log Pi_{t-1} \tag{15}$$

Prices of exportable goods

$$\log Px_t = \log Pf_t + \log \epsilon_t \tag{16}$$

Prices of nontradable goods

$$\Delta\log Pn_t = \lambda_6[\log N_t^d - \log N_t^s] + \lambda_7 \Delta\log Pi_t \tag{17}$$

General price index

$$\Delta\log P_t = w_i^d \Delta\log Pi_t + w_x^d \Delta\log Px_t + w_n^d \Delta\log Pn_t \tag{18}$$

Expected inflation

$$\Delta\Pi_t = \lambda_8[\Delta\log P_t - \Pi_{t-1}] \tag{19}$$

Resource unemployment

$$U_t = U_0 + \gamma_{10} (\log y_t^* - \log y_t) \tag{20}$$

MONEY AND CREDIT

Nominal demand for money

$$\log M^d = \alpha_1 + \gamma_{11} \log Y_t - \gamma_{12}\Pi_t - \gamma_{13} rd_t \tag{21}$$

Nominal money supply

$$M_t = CRG_t + CRP_t + R_t \tag{22}$$

Domestic interest rate

$$\Delta rd_t = \gamma_{14}[\log M_t^d - \log M_t] \tag{23}$$

BALANCE OF PAYMENTS

Imports (in foreign currency)

$$I_t = Pf_t[I_t^d - I_t^s] \tag{24}$$

Exports (in foreign currency)

$$X_t = Pf_t[X_t^s - X_t^d] \tag{25}$$

Current account

$$CA_t = \epsilon_t[X_t - I_t] - rd_t \cdot Bf_t \tag{26}$$

Capital flows

$$DK_t = \lambda_9 \epsilon_t + \beta[\gamma_{15}(rd_t - rf_t - \rho_t - \Delta\log \epsilon_t)] \tag{27}$$

Balance of payments

$$BP_t = CA_t + DK_t \tag{28}$$

Stock of international reserves

$$R_t = R_{t-1} + BP_t \tag{29}$$

Foreign debt

$$Bf_t = Bf_{t-1} + DK_t \tag{30}$$

Risk premium

$$\rho_t = \rho_0 + \gamma_{16}(Bf/Y)_t \tag{31}$$

GOVERNMENT SECTOR

Government expenditures

$$G_t = T_t + \epsilon_t \cdot \tau_t \cdot Pf_t \cdot I_t + GD_t \tag{32}$$

Taxes

$$T_t = t_0 + \gamma_{17} Y_t \tag{33}$$

Credit to government

$$\Delta CRG_t = GD_t \tag{34}$$

DEFINITIONAL EQUATIONS

Proportion of expenditures on importable goods

$$w_{it}^d = (PiI^d)_t/E_t \tag{35}$$

Proportion of expenditures on exportable goods

$$w_{xt}^d = (PxX^d)_t/E_t \tag{36}$$

Proportion of expenditures on nontradable goods

$$w_{nt}^{d} = (PnN^{d})_t/E_t \tag{37}$$

B. Exogenous Variables

$\bar{y}^*$ = potential real output

ϵ = exchange rate (index of units of domestic currency per unit of foreign currency), set equal to unity

τ = uniform nominal tariff on imports

Pf = index of foreign prices, equals 100

rf = foreign rate of interest, set equal to 0.1

β = index of restrictions on capital movements

CRP = credit to private sector

GD = government fiscal deficit

II. Values of Parameters Used in Simulations

Despite the seemingly large size of the model, it contains only 17 structural and 9 adjustment parameters and 4 constants. In choosing the values for these various coefficients, we were guided by two basic principles. First, the parameters should be consistent, in that the various theoretical restrictions implicit in the model, particularly relating to the supply and demand elasticities, be satisfied. Second, the combination of parameters should be such as to ensure that the model be dynamically stable and that it settle down to a steady state, which may or may not necessarily be equal to the original equilibrium. The specific values of the parameters used in the simulations reported in the text are given in Table 2.

Structural parameters

Little information is available on the price elasticities of the demand for and supply of importables, exportables, and nontradable goods, other than those for the United States contained in the study by Clements (1980). Other general-equilibrium models either use arbitrary values themselves or do not deal with sectors at the level of aggregation used in this study. For the supply side, therefore, we arbitrarily chose a value for the price parameter of importable goods (2.0) that was twice as large as the corresponding price coefficient of the supply of exportable goods. Developing countries in general, because of the type of goods that they export (primary and semimanufactured), are characterized as having a relatively low supply response of export goods, while the supply response of importables is considered to be larger. After these two coefficients were determined, the price coefficient of the supply of nontradable goods was readily obtained from the restriction that the weighted sum of the three must

TABLE 2. VALUES OF PARAMETERS

Equation	Variable	Parameter Values		
		Structural	Adjustment	Constant
(2''')	N^{s*} = desired supply of nontradable goods	$\gamma_3 = 0.3591$	—	—
(4')	I^s = supply of importable goods	$\gamma_1 = 2.0$	$\lambda_1 = 0.8$	—
(4'')	X^s = supply of exportable goods	$\gamma_2 = 1.0$	$\lambda_2 = 0.4$	—
(5)	N^s = supply of nontradable goods	—	$\lambda_3 = 0$	—
(11)	$EPRD$ = private expenditures	$\gamma_4 = 1.0$	$\lambda_4 = 1.0$	—
		$\gamma_5 = 0.3$	—	—
		$\gamma_6 = 0.5$	—	—
(14')	I^d = demand for importable goods	$\gamma_7 = 0.4721$	—	—
(14'')	X^d = demand for exportable goods	$\gamma_8 = 0.0833$	—	—
(14''')	N^d = demand for nontradable goods	$\gamma_9 = 0.4446$	—	—
(17)	Pi = price of importable goods	—	$\lambda_5 = 1.0$	—
(19)	Pn = price of nontradable goods	—	$\lambda_6 = 0.6$	—
		—	$\lambda_7 = 0.7$	—
(21)	Π = expected inflation	—	$\lambda_8 = 0.5$	—
(22)	U = resource unemployment	$\gamma_{10} = 1.0$	—	$U_0 = 0.05$
(23)	M^d = nominal demand for money	$\gamma_{11} = 1.0$	—	$\alpha_1 = 0.2924$
		$\gamma_{12} = 1.0$	—	—
		$\gamma_{13} = 1.0$	—	—
(25)	rd = domestic interest rate	$\gamma_{14} = 0.5$	—	—
(29')	DK = capital flows	$\gamma_{15} = 100.0$	$\lambda_9 = 0.0$	—
(32)	ρ = risk premium	$\gamma_{16} = 0.2$	—	$\rho_0 = 0.05$
(35)	T = taxes	$\gamma_{17} = 0.1222$	—	$t_0 = 0.0$

equal zero. The relevant weights themselves were calculated from national accounts data for six Latin American countries—Argentina, Brazil, Chile, Colombia, Mexico, and Uruguay—using the methodology outlined by Clements (1977) and Goldstein and Officer (1979). The production and expenditure weights obtained are shown in Table 3.

The price elasticities of demand for importables (γ_7) and exportables (γ_8) were calculated as an average of the price elasticities of demand for imports and exports, respectively, as reported by Khan (1974). Again, the use of the weights for expenditures (Table 3) yielded the estimate of the price elasticity of demand for nontradable goods.

TABLE 3. SIX LATIN AMERICAN COUNTRIES: WEIGHTS OF IMPORTABLE, EXPORTABLE, AND NONTRADABLE GOODS IN TOTAL INCOME AND EXPENDITURE, 1970–79[1]

Goods	Proportion of	
	Income	Expenditure
Importables	0.35	0.47
Exportables	0.17	0.08
Nontradables	0.48	0.45

[1]Calculated as averages of the data for Argentina, Brazil, Chile, Colombia, Mexico, and Uruguay.

The parameters in the private expenditures equation are based on the empirical results of Aghevli and Khan (1980) and Knight and Mathieson (1983), and the money demand coefficients correspond to those obtained for developing countries by Khan (1980), Mathieson (1981; 1983), and others. The risk premium parameter (γ_{16}) is selected so that when the ratio of the stock of external debt to nominal income is 0.25, and the constant risk premium is 0.05, the total risk premium should be 0.1. The tax parameter (γ_{17}) is also set so as to maintain equality between tax revenues and nominal income, assuming the constant to be zero. The remaining parameters were imposed to guarantee a consistent initial equilibrium.

Adjustment parameters

The adjustment parameters were selected for the most part to ensure noninstantaneous adjustment to equilibrium, in keeping with the intention of tracing out the transition path of certain important variables. The main distinctions were made in the supply sector and the determination of the price of nontradable goods. Basically, it was assumed that the supply of importables would generally respond faster than the supply of exportable goods, implying thus that $\lambda_1 > \lambda_2$. On the nontradable goods side, λ_3 was set equal to zero in the simulations reported in the text, meaning that adjustment of the quantity of nontradables responded to changes in demand through variations in prices rather than directly. The parameter λ_3 was, however, allowed to vary so as to permit a degree

of direct demand effects on the behavior of nontradable goods. The price of nontradable goods was assumed to adjust slowly to excess demand because of "stickiness," and in the long run was expected to grow at a rate somewhat less than the rate of increase of the price of importables.[61] For the present analysis it was assumed (although it is not necessary to do so) that the price of importables adjusted immediately to a change in tariffs, that is, that $\lambda_5 = 1$. The coefficient of expectations (λ_8) is an approximate average of the values obtained by Khan (1980) in the context of a study of the demand for money function for a group of developing countries. No autonomous capital flows were permitted so that λ_9 was initially set to zero.

To allow for some permanent or "normal" level of underemployment, U_0 was fixed at 5 percent. The constant in the money demand equation was chosen simply to ensure equilibrium in the money market, given the initial values of the variables involved and the relevant parameters. The constant risk premium is assumed to be 5 percent, and the average tax rate zero.

While there is no doubt that the choice of parameters for the simulation experiments is, in the final analysis, essentially arbitrary, the exercise was repeated by varying certain key parameters. The sensitivity analysis, while yielding different transition patterns for some of the variables, did not qualitatively change the results or the main conclusions of the study.[62]

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[61]As the period of analysis does not correspond strictly to a full long-run situation, it was not deemed necessary to set $\lambda_7 = 1$.

[62]The results of these additional exercises are available from Mr. Khan, whose address is Research Department, International Monetary Fund, Washington, D.C. 20431.

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The Underground Economy in the United States: Annual Estimates, 1930–80

VITO TANZI*

DURING THE PAST two or three years, the center of attention on the underground economy has gradually moved from the pages of newspapers into the pages of scholarly reviews. Reflecting this scholarly interest, several books have been published[1] and conferences have been organized. The reason for studying the underground economy is self-evident because of the possible influence on economic policies of the distortion of official estimates of such macroeconomic variables as the national accounts, the employment rate, and the rate of inflation if the underground economy is large.[2]

There is still disagreement on the definition of the underground economy—and, perhaps even more, on its measurement—but progress is being made. As the present article is not intended to be a survey, it does not review that progress. Rather, using a method developed by the author a few years ago (and by now applied to a large number of countries), it presents yearly estimates for the underground economy in the United States for the period 1930–80.

Researchers have shown their resourcefulness by developing several alternative approaches to the measurement of the under-

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[1]See Ray (1981); Bawly (1982); Burkett and Proctor (1982); Simon and Witte (1982); and Tanzi (1982).

[2]International organizations have also started paying attention to the underground economy—obviously an important phenomenon. See, for example, De Grazia (1980), Tanzi (1980 a), Smith (1981), and Blades (1982).

ground economy. Some have attempted a direct measurement of the various activities that make up this phenomenon (Internal Revenue Service (1979); Simon and Witte (1980)). Some have used questionnaires to elicit answers from persons interviewed as to whether they had participated in these activities either as buyers or as sellers (Isachsen, Klovland, and Strøm (1982); Hansson (1982)). Some have used employment statistics to attempt to estimate the number of those who were officially or unofficially unemployed, while they were actually working "underground" (Pettenati (1979); Contini (1982)). Others have attempted to estimate the underground economy from the differences between the consumption and the income side of the national accounts (Macafee (1980)); still others have utilized the information on income and consumption contained in household budget studies (Dilnot and Morris (1982)). Finally, there has been the monetary approach, of which the method used in this article is a variant.

I. The Monetary Approach: A Brief Review

The monetary approach can itself be distinguished by (a) the fixed-ratio variant; (b) the currency-denomination variant; and (c) the currency-equation variant.

The fixed-ratio variant relies on two key assumptions. First, it assumes basically that there is a monetary ratio that, except for the effect of the underground economy, would have remained constant over time. Second, it assumes that there was a golden period in the past when no underground economy existed. This monetary ratio is C/D for Guttman (1977) and MV/GNP for Feige (1979), where C is currency in circulation, D is demand deposits, M is money supply (made up of currency and demand deposits), V is transactions (not income) velocity of money,[3] and GNP is the officially estimated gross national product. Through the changes over time in these ratios, Guttman and Feige estimate the size of the underground economy. In Guttman's method the estimation is indirect, in the sense that he first calculates "excessive" currency in circulation (induced by the existence of underground activities) and then, by making assumptions about its in-

[3]In the actual calculations, the velocity of currency and of demand deposits are determined separately.

come velocity, estimates the underground economy. In Feige's method the estimation is direct, as the change in the *MV/GNP* ratio over time allows a direct estimation of underground *GNP*. The golden period, when the underground economy was zero, is the late 1930s for Guttman and is either the late 1930s or the mid-1960s for Feige.

The currency-denomination variant is based on the assumption that underground economic activities are associated mainly with the use of bills of certain denominations. In the United States, bills of $100 and above have been considered to be used mainly, and serious proposals have been made to withdraw them from circulation (Henry (1976)). Thus, by analyzing the change in the composition of total currency holdings in circulation, some analysts have attempted to measure the underground economy (Henry (1975)).

The fixed-ratio approach, regardless of whether it is used in Guttman's version or in Feige's (more sophisticated) version, is open to the criticism that there is no obvious reason why those ratios should remain constant over long periods. Although, at least for the United States, there may be "great ratios" in the economy that, for some poorly understood reasons, remain relatively unchanged (Klein and Kosobud (1961)), it is not clear why Guttman's and Feige's ratios should be among them. Another criticism is that the results are sensitive to the choice of the initial period. For these two reasons, there has been considerable reluctance to accept the high estimates of the underground economy that have been derived by Guttman (1977) and the even higher ones that have been derived by Feige (1979).

The currency-denomination approach is open to the criticism that—with real growth and relatively high rates of inflation—it would be expected that the composition of currency holdings would change over the years. Over time, large bills do not appear to be as large as they once were. When the normal daily wage was a few dollars, a $100 bill was a small fortune; but today, when the wage of many workers exceeds $100 a day, $100 no longer reflects a large purchasing power. Furthermore, as the author has argued elsewhere, many $100 bills are probably being used for transactions or for storing wealth in foreign countries. An unknown but probably high amount of currency substitution (with U.S. currency replacing the currencies of many countries) has certainly been taking place over the years. This substitution, or "dollariza-

tion," is likely to have been particularly significant in countries that are experiencing high rates of inflation.[4]

Before moving to the more substantive part of this paper, the author has provided, in a summary fashion, some of the basic data that have been utilized in the monetary approach.

Chart 1 depicts the behavior of total currency on a per capita basis for the period 1933–80. It shows that a remarkable increase took place over the period and that, by 1980, there was almost $700 of currency outstanding for each person living in the United States. The increase was particularly significant in the years 1941–45 and the period after the mid-1960s. Chart 1 also shows the behavior of currency in denominations smaller than $100, equal to $100, and greater than $100. The remarkable increase in per capita currency, combined with the high per capita figure of currency in circulation and the large increase in $100 bills, has given credence to claims about a phenomenal growth in underground economic activities.

Chart 2, however, gives a somewhat modified picture simply by adjusting for changes in prices. In fact, when per capita currency in circulation is expressed in 1972 prices, it appears that, despite the substantial growth in real income since World War II, per capita currency was much higher during World War II than it was in 1980. Between that early period and the early 1960s, real per capita holdings of currency fell by almost one half. The holdings then started rising again, with the increase attributed mostly to $100 bills. But as a proportion of per capita income in real terms, the holdings have continued to fall up to the present time.

In addition to total currency per capita and to total $100-denominated currency per capita, the ratio that has attracted most attention in connection with underground economic activity is that of currency to demand deposits. That ratio, shown as *C/D* in Chart 3, has fluctuated considerably over the years. It rose sharply during the Great Depression, when eroding confidence in the banking system induced individuals to substitute currency for demand deposits, and it increased sharply during World War II for a variety of reasons detailed in Cagan's well-known study (1958). From 1945 to the early 1960s, the *C/D* ratio fell but it then rose again. The behavior of the *C/D* ratio indicates that (a) this ratio

[4]For a more detailed discussion of this point, see the author's paper, "A Second (and More Skeptical) Look at the Underground Economy in the United States," Ch. 6 in Tanzi (1982), pp. 103–18.

CHART 1. U.S. PER CAPITA CURRENCY IN CIRCULATION, EXPRESSED IN CURRENT PRICES, 1933–80

(In U.S. dollars)

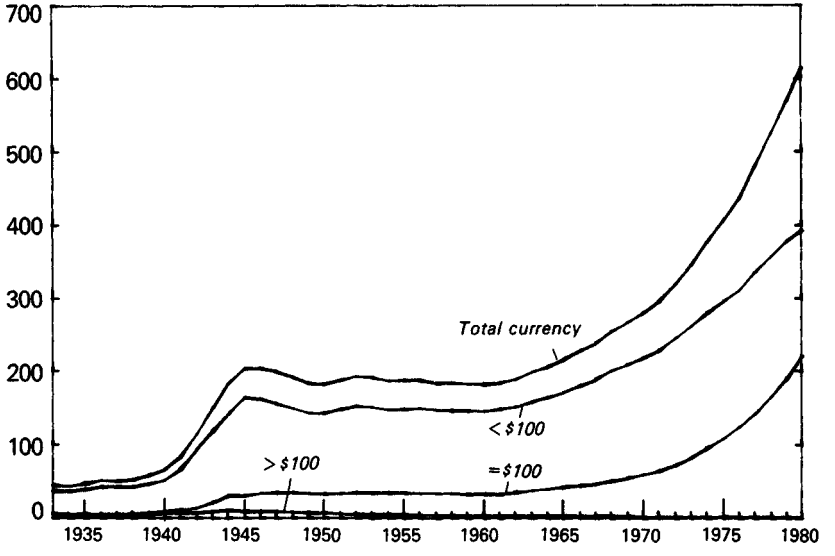
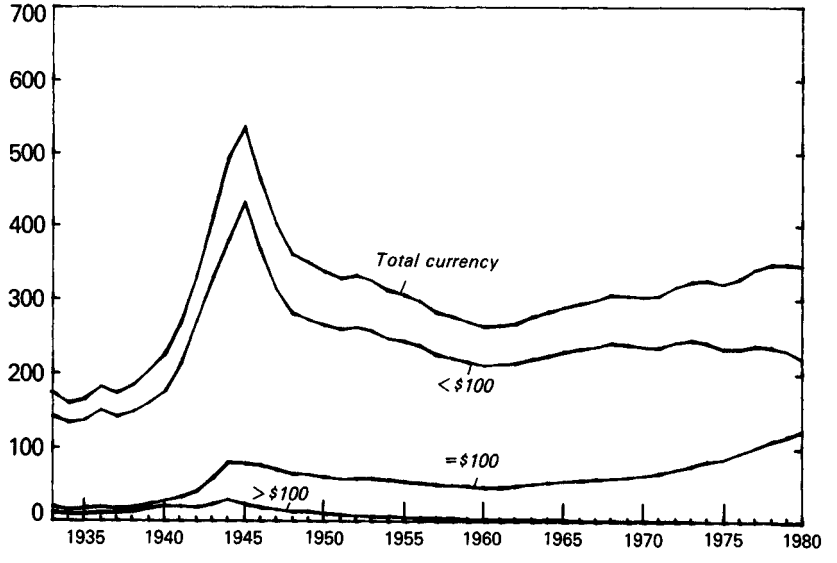


CHART 2. U.S. PER CAPITA CURRENCY IN CIRCULATION, EXPRESSED IN 1972 PRICES, 1933–80

(In U.S. dollars)



can hardly be taken as constant and (b) if one bases estimates of the underground economy on that ratio, the results obtained will be highly influenced by the beginning period.

CHART 3. RATIO OF U.S. CURRENCY IN CIRCULATION TO DEMAND DEPOSITS AND TO M_1 AND M_2, 1930–80

(In percent)

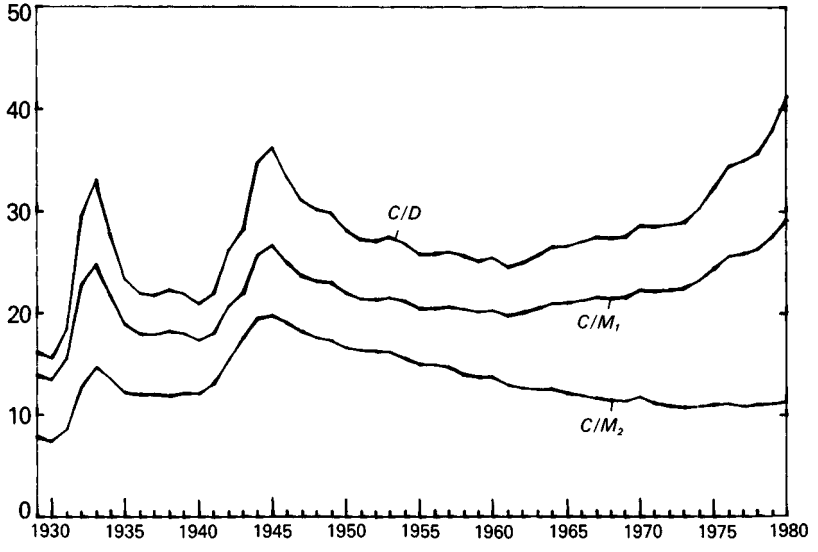
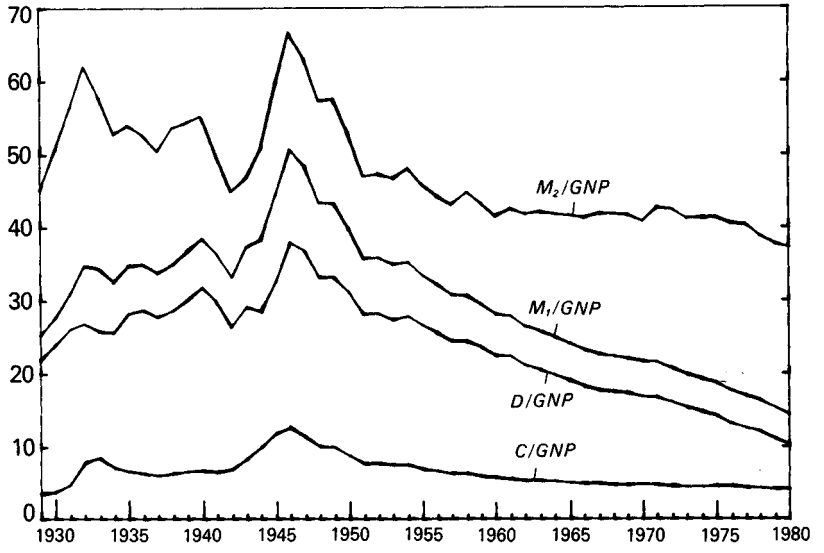


Chart 3 also shows that, while the C/D ratio fell between 1945 and 1961 and then rose, the C/M_2 ratio fell continuously from 1945 to the early 1970s and then remained roughly constant. This pattern seems to indicate that the increase in the C/D ratio during the past two decades may be due to shifts by individuals from checking accounts into other financial assets (included in M_2) that paid interest rather than to sharp increases in currency holdings. In other words, the C/D ratio may have risen because of a fall in D rather than an increase in C. (See also Garcia and Pak (1979).) This conclusion is strongly supported by Chart 4, in which various measures of the money supply are shown as percentages of GNP. This figure shows a substantial fall in D/GNP, while the fall in C/GNP appears to be quite gradual over the post-World War II period.

CHART 4. VARIOUS MEASURES OF U.S. MONEY SUPPLY AS PROPORTION OF GROSS NATIONAL PRODUCT, 1930–80

(In percent)



II. Description of Method and Data

The method that is used here to derive the yearly estimates of the underground economy in the United States has been explained in detail in an earlier study in which estimates for 1976 were derived.[5] The approach consists in specifying a demand-for-currency equation to be able to infer the effect of a change in the tax level on that demand. The key assumptions are, first, that underground economic activities are the direct consequence of high taxes,[6] and, second, that currency is used mainly for carrying out such transactions or for storing wealth. In the equation, the

[5]That method was first suggested and utilized in an unpublished paper (Tanzi (1979)); a substantially revised version was published in Tanzi (1980 b). Of related interest are also Cagan (1958) and Henry (1975). Henry's paper was written while he was a graduate student at Harvard University; appreciation is due to him for bringing the paper to the author's attention.

[6]Obviously, some underground activities are not the result of taxes; therefore, estimates will not capture these activities. Convention, however, excludes the income generated from illegal activities from national accounts; it is likely that this income would vanish if it could be discovered and taxed. It should also be realized that the opportunity cost of the resources used for these activities is likely to be very low.

ratio of currency holdings (C) to money (defined as M_2) is the dependent variable. The independent variables are real per capita income (Y), the rate of interest paid on time deposits (R), the ratio of wages and salaries in national income (WS/NI), and an income tax variable (T). Thus,

$$\ln C/M_2 = a_0 + a_1 \ln T + a_2 \ln WS/NI + a_3 \ln R + a_4 \ln Y + \epsilon \quad (1)$$

where ϵ is an error term.

Once equation (1) has been estimated for the period 1930–80, it can be utilized to estimate currency holdings by making the assumption that the tax variable assumes a value of zero. Once currency holdings at zero taxes are estimated, they can be used to determine the extent of the underground economy by multiplying excessive currency by the income velocity of money, as discussed later in more detail.

The expected sign for both per capita income and the interest rate is negative, while the expected sign for both taxes and the ratio of wages and salaries in national income is positive.

A detailed discussion of why these signs are expected can be found in Tanzi (1980 b). Briefly, as the level of taxation rises, individuals are encouraged to engage in tax-evading activities that are facilitated by the use of currency, as this practice leaves no traces; therefore, the use of currency rises. Because wages are often paid in currency, especially for daily workers, and other types of income (interest, dividends, etc.) are almost always paid by check, an increase in the ratio of wages in total income paid will require more currency. On the other hand, economic development, as proxied by per capita real income, is assumed to lead to the replacement of currency by checks, thus leading to a fall in C/M_2. Equally, as an increase in the rate of interest increases the opportunity cost of currency holdings, C/M_2 and R can be expected to be negatively correlated because M_2 includes time deposits.

The data used are presented in Table 1, which covers the period 1929–80, with currency and M_2 based on June 30 of each year. R is the interest rate paid on time and savings deposits. TW and T are two alternative measures of the tax variable: TW is a weighted average tax rate on interest income and is described in detail in Tanzi (1980 b); T is the ratio of total income tax payments after credit to adjusted gross income.

TABLE 1. UNITED STATES: BASIC DATA, 1929–80

Year	Currency[1]	M_2[1]	$\frac{Y}{\text{1972 dollars per capita}}$	Wage and Salary/ National Income	R^2	TW[3]	T[4]
	Billion U.S. dollars		*Thousand U.S. dollars*	← *Percent* →			
1929	3.64	46.60	2.58	59.50	3.34	5.00	4.04
1930	3.37	45.70	2.31	62.62	3.31	3.54	2.63
1931	3.65	42.70	2.11	66.83	2.99	2.71	1.81
1932	4.62	36.10	1.81	71.96	2.80	5.01	2.83
1933	4.76	32.20	1.76	72.76	2.56	4.82	3.40
1934	4.65	34.40	1.89	69.26	2.37	7.34	4.00
1935	4.78	39.10	2.04	64.99	1.93	7.60	4.41
1936	5.22	43.50	2.30	65.24	1.64	8.85	6.31
1937	5.49	45.70	2.39	63.82	1.55	10.29	5.38
1938	5.42	45.50	2.28	65.17	1.48	7.38	4.05
1939	6.01	49.30	2.43	64.52	1.36	8.55	4.00
1940	6.70	55.20	2.59	62.56	1.22	8.90	4.09
1941	8.20	62.50	2.98	60.52	1.12	18.58	6.63
1942	10.94	71.20	3.40	60.50	1.03	27.22	11.32
1943	15.81	89.90	3.87	62.44	0.87	28.78	14.65
1944	20.88	106.80	4.10	64.29	0.84	47.35	13.89
1945	25.10	126.60	3.99	65.05	0.85	48.61	14.17
1946	26.52	139.00	3.36	62.84	0.82	40.70	11.97
1947	26.60	146.00	3.23	63.25	0.85	39.95	12.03
1948	26.00	147.80	3.31	61.87	0.87	43.27	9.41
1949	25.60	147.70	3.27	63.36	0.90	40.92	9.01
1950	25.10	151.00	3.49	62.24	0.92	43.61	10.22
1951	25.40	155.50	3.72	62.90	1.02	43.79	11.93
1952	26.70	164.50	3.80	64.86	1.14	46.46	12.87
1953	27.70	171.10	3.88	66.27	1.30	45.17	12.80
1954	27.50	176.70	3.76	65.80	1.30	42.98	11.58
1955	27.60	183.60	3.95	64.54	1.36	33.61	11.87
1956	27.90	186.70	3.96	65.83	1.58	33.89	12.19
1957	28.30	191.70	3.96	66.04	2.08	33.76	12.23
1958	28.30	201.60	3.89	66.07	2.20	33.56	12.17
1959	29.00	211.00	4.05	64.61	2.36	33.75	12.60
1960	29.00	210.80	4.08	65.41	2.58	33.04	12.47
1961	28.90	223.40	4.11	65.17	2.73	32.99	12.76
1962	30.00	236.60	4.28	64.51	3.23	32.51	12.83
1963	31.50	251.40	4.39	64.15	3.34	31.85	13.02
1964	33.50	266.40	4.56	64.04	3.47	29.89	11.84
1965	35.00	287.40	4.77	63.24	3.73	28.23	11.50
1966	37.40	312.10	4.99	63.43	4.12	28.23	11.93
1967	39.20	335.10	5.07	64.48	4.32	28.91	12.42
1968	41.80	364.00	5.24	65.00	4.36	28.84	13.78
1969	44.70	391.80	5.32	66.17	4.57	29.25	14.30
1970	47.60	402.40	5.25	67.68	4.98	30.01	13.26
1971	51.00	454.80	5.35	66.66	4.77	30.53	12.65
1972	54.30	498.00	5.61	65.92	4.62	31.30	12.52
1973	59.20	548.10	5.96	64.69	5.82	32.10	13.04

TABLE 1 *(concluded)*. UNITED STATES: BASIC DATA, 1929–80

Year	Currency[1]	M_2[1]	$\frac{Y}{\text{1972 dollars per capita}}$	Wage and Salary/ National Income	R[2]	TW[3]	T[4]
	Billion U.S. dollars		*Thousand U.S. dollars*	← *Percent* →			
1974	64.50	594.20	5.89	65.97	7.14	33.03	13.64
1975	71.00	642.20	5.78	65.06	5.96	32.87	13.13
1976	77.70	698.20	6.04	64.52	5.32	34.16	13.36
1977	84.30	775.50	6.32	63.61	5.24	33.36	13.68
1978	92.80	840.60	6.57	63.32	5.87	33.87	14.33
1979	101.80	915.50	6.72	62.96	7.41	34.24	14.56
1980	111.00	982.60	6.65	63.34	8.52	35.47	15.51

[1]Currency and M_2 are based on June 30 each year.
[2]R = interest rate paid on time and savings deposits.
[3]TW = weighted average tax rate.
[4]T = income tax after credit over adjusted gross income.

III. Results

Using the data shown in Table 1, equation (1) was solved alternatively with both measures of the tax variable. A logarithmic specification has been used; given that specification, to solve the equations for a situation in which the tax variable is assumed to be zero, that variable has been replaced in each case by the yearly figure shown in the table *plus* one. In other words, T and TW have been replaced for each year by $1 + T$ and $1 + TW$, respectively.

The estimated equations are as follows:[7]

$$\ln C/M_2 = \underset{(3.61)^{**}}{-5.0262} + \underset{(5.81)^{**}}{0.2479} \ln (1 + TW) + \underset{(5.33)^{**}}{1.7303} \ln (WS/NI) - \underset{(3.66)^{**}}{0.1554} \ln (R) - \underset{(1.90)}{0.2026} \ln (Y) \qquad \bar{R}^2 = 0.950 \quad D\text{-}W = 1.576 \quad (1')$$

[7]The equations have been corrected with a first-order Cochrane-Orcutt correction for serial correlation. The coefficients in parentheses are t-values. Two asterisks indicate significance at the 1 percent level; one asterisk indicates significance at the 5 percent level.

$$\ln C/M_2 = \underset{(2.93)^{**}}{-4.2005} + \underset{(5.26)^{**}}{0.3096 \ln (1+T)} + \underset{(4.76)^{**}}{1.5791 \ln (WS/NI)} - \underset{(3.37)^{**}}{0.1603 \ln (R)} - \underset{(2.22)^{*}}{0.2804 \ln (Y)} \quad \bar{R}^2 = 0.947 \quad D\text{-}W = 1.677 \quad (1'')$$

In both cases, the $\bar{R}^2$ is high, implying that most of the variation in ln C/M_2 is explained by the estimated equation. In all cases except two, the t-values for the coefficients are significant at the 1 percent level. The exception is the coefficient of Y, which in one case is significant at the 5 percent level and in the other case, at the 6 percent level. The signs are as expected—positive for the tax variable and the WS/NI variable, and negative for the rate of interest and per capita income.

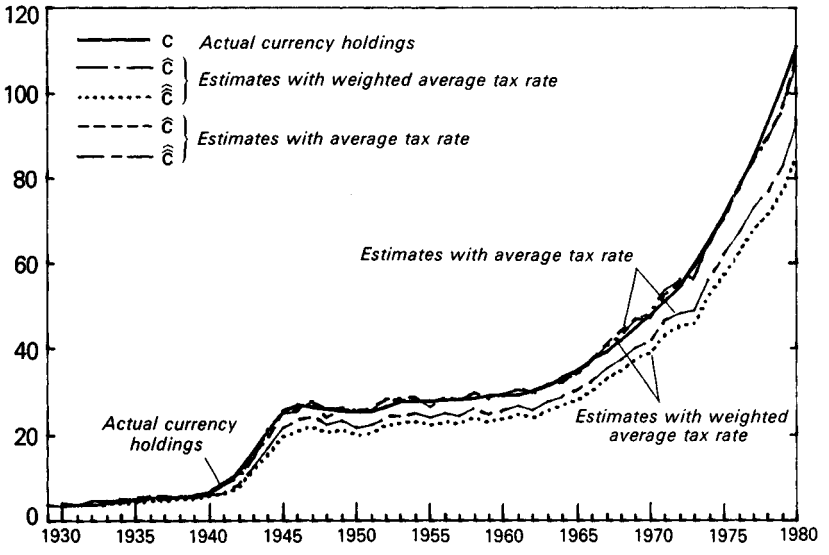
The estimates of the underground economy are derived as follows. For each year, the predicted level of the currency ratio C/M_2 can be calculated by using the preceding regression equations. Then, given the actual figure of the M_2 for that year, the predicted level of currency holdings ($\hat{C}$) can be calculated.[8] Next, the equations are solved in the same way, assuming that the tax variable is zero while the coefficients of the other variables remain unchanged. The resulting value of currency is then defined as $\hat{\hat{C}}$. The difference between C and $\hat{C}$ gives an indication of the accuracy of fit of the equations. The difference between $\hat{C}$ and $\hat{\hat{C}}$ gives the estimation of how much currency holding is tax induced; in other words, it indicates by how much taxes induce people to hold larger amounts of currency—presumably because of their attempt to evade the taxes.

The difference between predicted currency holdings ($\hat{C}$) and the currency holdings predicted from the equation under the assumption of zero taxes ($\hat{\hat{C}}$) yields an estimation of "illegal money." The difference between the total of currency and demand deposits in circulation (i.e., total M_1) and the estimated illegal money yields "legal money" used for transactions purposes. Dividing GNP by legal money gives an estimate of the income velocity of legal money. Assuming that the velocity of illegal

[8]See Tanzi (1980 b) for the detailed procedure.

CHART 5. ACTUAL AND PREDICTED VALUES OF U.S. CURRENCY HOLDINGS UNDER ALTERNATIVE AVERAGE TAX RATES, 1930–80

(In billions of U.S. dollars)



money is the same as that of legal money,[9] an estimate of the underground economy can be obtained by multiplying illegal money by the velocity of money. Because two alternative measures of taxes have been used, two alternative values are derived for $\hat{C}$ and $\hat{\hat{C}}$.

Chart 5 shows (a) actual currency holdings for the period 1930–80, C; (b) currency holdings predicted by equations (1′) and (1″), $\hat{C}_1$ and $\hat{C}_2$, respectively; (c) currency holdings, when taxes are assumed to fall to zero, predicted by equations (1′) and (1″), $\hat{\hat{C}}_1$ and $\hat{\hat{C}}_2$, respectively. The data on which Chart 5 is based are shown in Tables 2 and 3. Table 2 presents the estimates via use of the weighted average tax rate; Table 3 presents the estimates via use of the average tax rate. In both tables, the last column contains the estimates of illegal money. Thus, in 1980 illegal money—that is, money used to fuel the activities of the underground economy —was $21.75 billion, according to Table 2 or $16.35 billion according to Table 3.

The yearly estimates of the underground economy are shown in

[9]This is clearly a key and controversial assumption. See Tanzi (1980 b) for more details.

TABLE 2. UNITED STATES: ACTUAL AND PREDICTED VALUES OF CURRENCY HOLDINGS, USING WEIGHTED AVERAGE TAX RATE, 1929–80

(In billions of U.S. dollars)

	Currency				
	Actual	Predicted with tax	Predicted without tax	Differences	
Year	C	$\hat{C}$	$\hat{\hat{C}}$	$C-\hat{C}$	$\hat{C}-\hat{\hat{C}}$
1929	3.64	—	—	—	—
1930	3.37	3.78	3.62	−0.41	0.15
1931	3.65	3.60	3.45	0.05	0.15
1932	4.62	4.23	3.46	0.39	0.77
1933	4.76	4.24	3.83	0.52	0.41
1934	4.65	4.94	4.05	−0.29	0.88
1935	4.78	4.81	4.19	−0.03	0.62
1936	5.22	5.51	4.67	−0.29	0.84
1937	5.49	5.52	4.64	−0.03	0.88
1938	5.42	5.40	5.01	0.02	0.39
1939	6.01	6.00	5.10	0.01	0.90
1940	6.70	6.49	5.60	0.21	0.89
1941	8.20	8.31	6.10	−0.11	2.21
1942	10.94	10.07	7.67	0.87	2.41
1943	15.81	14.48	11.64	1.33	2.84
1944	20.88	21.33	15.36	−0.45	5.97
1945	25.10	24.93	19.53	0.17	5.41
1946	26.52	25.42	20.88	1.10	4.54
1947	26.60	27.42	21.91	−0.82	5.51
1948	26.00	25.91	20.24	0.09	5.68
1949	25.60	26.39	21.20	−0.79	5.19
1950	25.10	25.36	19.86	−0.26	5.51
1951	25.40	25.67	20.31	−0.27	5.36
1952	26.70	28.27	22.07	−1.57	6.20
1953	27.70	28.43	22.59	−0.73	5.85
1954	27.50	28.65	22.92	−1.15	5.73
1955	27.60	26.27	22.10	1.33	4.17
1956	27.90	28.60	22.96	−0.70	5.64
1957	28.30	27.88	22.44	0.42	5.44
1958	28.30	29.74	23.95	−1.44	5.79
1959	29.00	28.43	22.84	0.57	5.59
1960	29.00	29.21	23.62	−0.21	5.60
1961	28.90	30.42	24.51	−1.52	5.91
1962	30.00	29.48	23.82	0.52	5.65
1963	31.50	31.39	25.43	0.11	5.96
1964	33.50	32.53	26.66	0.97	5.87
1965	35.00	34.09	28.00	0.91	6.09
1966	37.40	36.95	30.03	0.45	6.91
1967	39.20	40.73	32.92	−1.53	7.81
1968	41.80	42.90	34.84	−1.10	8.06
1969	44.70	46.47	37.60	−1.77	8.87
1970	47.60	48.28	38.92	−0.68	9.36
1971	51.00	53.58	43.22	−2.58	10.36
1972	54.30	56.17	45.18	−1.87	11.00
1973	59.20	56.94	45.72	2.26	11.22

TABLE 2 *(concluded)*. UNITED STATES: ACTUAL AND PREDICTED VALUES OF CURRENCY HOLDINGS, USING WEIGHTED AVERAGE TAX RATE, 1929–80

(In billions of U.S. dollars)

	Currency			Differences	
Year	Actual C	Predicted with tax $\hat{C}$	Predicted without tax $\hat{\hat{C}}$	$C-\hat{C}$	$\hat{C}-\hat{\hat{C}}$
1974	64.50	65.58	52.54	−1.08	13.04
1975	71.00	71.02	57.26	−0.02	13.76
1976	77.70	78.14	62.37	−0.44	15.78
1977	84.30	83.84	67.77	0.46	16.07
1978	92.80	89.13	71.47	3.67	17.66
1979	101.80	95.70	76.75	6.10	18.95
1980	111.00	107.03	85.28	3.97	21.75

TABLE 3. UNITED STATES: ACTUAL AND PREDICTED VALUES OF CURRENCY HOLDINGS, USING AVERAGE TAX RATE, 1929–80

(In billions of U.S. dollars)

	Currency			Differences	
Year	Actual C	Predicted with tax $\hat{C}$	Predicted without tax $\hat{\hat{C}}$	$C-\hat{C}$	$\hat{C}-\hat{\hat{C}}$
1929	3.64	—	—	—	—
1930	3.37	3.76	3.82	−0.39	−0.06
1931	3.65	3.54	3.58	0.11	−0.04
1932	4.62	4.19	3.60	0.43	0.58
1933	4.76	4.54	4.06	0.22	0.49
1934	4.65	4.88	4.34	−0.23	0.54
1935	4.78	5.01	4.49	−0.23	0.52
1936	5.22	5.93	4.94	−0.71	0.99
1937	5.49	5.26	4.94	0.23	0.32
1938	5.42	5.49	5.36	−0.07	0.14
1939	6.01	5.86	5.40	0.15	0.46
1940	6.70	6.53	5.96	0.17	0.56
1941	8.20	8.01	6.49	0.19	1.53
1942	10.94	10.59	8.20	0.35	2.38
1943	15.81	15.43	12.55	0.38	2.88
1944	20.88	19.02	16.71	1.86	2.31
1945	25.10	24.94	21.51	0.16	3.43
1946	26.52	25.74	23.42	0.78	2.32
1947	26.60	27.73	24.20	−1.13	3.53
1948	26.00	23.75	22.25	2.25	1.51
1949	25.60	25.96	23.23	−0.36	2.73
1950	25.10	25.34	21.67	−0.24	3.67
1951	25.40	26.18	22.06	−0.78	4.12
1952	26.70	27.99	23.94	−1.29	4.05
1953	27.70	28.02	24.43	−0.32	3.59
1954	27.50	27.85	24.96	−0.35	2.89
1955	27.60	27.52	23.91	0.08	3.60

TABLE 3 *(concluded)*. UNITED STATES: ACTUAL AND PREDICTED VALUES OF CURRENCY HOLDINGS, USING AVERAGE TAX RATE, 1929–80

(In billions of U.S. dollars)

	Currency				
	Actual	Predicted with tax	Predicted without tax	Differences	
Year	C	$\hat{C}$	$\hat{\hat{C}}$	$C-\hat{C}$	$\hat{C}-\hat{\hat{C}}$
1956	27.90	28.58	24.80	−0.68	3.78
1957	28.30	27.79	24.24	0.51	3.55
1958	28.30	29.74	25.99	−1.44	3.74
1959	29.00	28.54	24.67	0.46	3.87
1960	29.00	29.18	25.51	−0.18	3.67
1961	28.90	30.61	26.52	−1.71	4.09
1962	30.00	29.47	25.63	0.53	3.84
1963	31.50	31.65	27.45	−0.15	4.20
1964	33.50	32.14	28.74	1.36	3.40
1965	35.00	34.31	30.25	0.69	4.06
1966	37.40	37.37	32.38	0.03	4.99
1967	39.20	41.08	34.49	−1.88	5.59
1968	41.80	44.20	37.42	−2.40	6.78
1969	44.70	46.89	40.26	−2.19	6.63
1970	47.60	47.03	41.63	0.57	5.40
1971	51.00	52.65	46.40	−1.65	6.25
1972	54.30	55.20	48.26	−0.90	6.94
1973	59.20	56.58	48.75	2.62	7.83
1974	64.50	65.55	56.31	−1.05	9.24
1975	71.00	70.39	61.80	0.61	8.59
1976	77.70	77.41	67.00	0.29	10.41
1977	84.30	84.42	72.88	−0.12	11.55
1978	92.80	89.63	76.77	3.17	12.86
1979	101.80	96.00	82.78	5.80	13.22
1980	111.00	108.85	92.49	2.15	16.35

Tables 4 and 5. These two tables again use the weighted average tax rate (Table 4) and the average tax rate (Table 5). The first column of these tables is equivalent to the last column of Tables 2 and 3 (the estimates of illegal money). Multiplying column (1) by column (3), which yields the income velocity of money, produces the estimates of the underground economy, shown in column (4). These estimates are also given as proportions of GNP in column (5).

Table 4 shows that the underground economy grew from about $45 billion in 1970 to more than $159 billion in 1980. The figure for 1976 is remarkably close to the well-known estimate of $100 billion by the Internal Revenue Service (1979). Column (5) shows that, as a porportion of GNP, the underground economy exceeded 6 percent in 1980. The estimate for 1974 ($71 billion) is in the range of the other direct estimate made by Simon and Witte (1980, p. 74) of between $70 billion and $75 billion of income from

TABLE 4. UNITED STATES: ESTIMATES OF UNDERGROUND ECONOMY AND TAX EVASION, USING WEIGHTED AVERAGE TAX RATE, 1930–80

(In billions of U.S. dollars)

Year	Illegal Money (1)	Legal Money (2)	Income Velocity of Legal Money (3)	Underground Economy (4)	Underground Economy as Percentage of GNP (5)	Tax Evasion (6)
1930	0.15	24.93	3.63	0.55	0.61	0
1931	0.15	23.33	3.25	0.49	0.65	0
1932	0.77	19.48	2.98	2.28	3.93	0.01
1933	0.41	18.76	2.96	1.22	2.19	0.01
1934	0.88	20.46	3.18	2.81	4.32	0.02
1935	0.62	24.59	2.94	1.82	2.52	0.02
1936	0.84	28.16	2.93	2.47	2.99	0.04
1937	0.88	29.81	3.03	2.68	2.96	0.03
1938	0.39	29.34	2.89	1.13	1.33	0.01
1939	0.90	32.47	2.79	2.51	2.78	0.02
1940	0.89	37.77	2.64	2.35	2.35	0.03
1941	2.21	43.31	2.87	6.37	5.11	0.20
1942	2.41	50.40	3.13	7.54	4.78	0.42
1943	2.84	69.01	2.78	7.89	4.12	0.59
1944	5.97	74.98	2.80	16.74	7.96	1.29
1945	5.41	88.74	2.39	12.91	6.09	1.04
1946	4.54	101.46	2.05	9.32	4.47	0.72
1947	5.51	106.59	2.17	11.96	5.17	0.94
1948	5.68	106.32	2.42	13.75	5.34	0.82
1949	5.19	106.11	2.42	12.55	4.89	0.71
1950	5.51	108.59	2.62	14.44	5.07	0.93
1951	5.36	113.24	2.92	15.62	4.73	1.15
1952	6.20	118.90	2.92	18.12	5.22	1.45
1953	5.85	122.55	2.99	17.46	4.77	1.40
1954	5.73	124.07	2.95	16.92	4.62	1.23
1955	4.17	130.23	3.07	12.79	3.20	0.95
1956	5.64	130.36	3.23	18.19	4.32	1.42
1957	5.44	131.46	3.37	18.33	4.14	1.42
1958	5.79	132.61	3.39	19.59	4.36	1.50
1959	5.59	138.51	3.51	19.63	4.03	1.56
1960	5.60	137.20	3.69	20.64	4.08	1.61
1961	5.91	140.39	3.73	22.05	4.21	1.78
1962	5.65	144.15	3.91	22.11	3.92	1.80
1963	5.96	148.04	4.02	23.95	4.03	1.94
1964	5.87	153.63	4.14	24.30	3.82	1.80
1965	6.09	160.31	4.29	26.16	3.80	1.88
1966	6.91	168.79	4.46	30.85	4.10	2.30
1967	7.81	173.49	4.59	35.85	4.50	2.83
1968	8.06	186.34	4.66	37.55	4.32	3.31
1969	8.87	197.93	4.73	41.93	4.48	3.88
1970	9.36	204.24	4.81	45.01	4.58	3.84
1971	10.36	219.44	4.85	50.22	4.72	4.03
1972	11.00	232.20	5.04	55.45	4.74	4.42
1973	11.22	252.68	5.25	58.88	4.44	4.79
1974	13.04	264.46	5.42	70.72	4.93	6.10
1975	13.76	277.14	5.59	76.92	4.97	6.19

TABLE 4 *(concluded)*. UNITED STATES: ESTIMATES OF UNDERGROUND ECONOMY AND TAX EVASION, USING WEIGHTED AVERAGE TAX RATE, 1930–80

(In billions of U.S. dollars)

Year	Illegal Money (1)	Legal Money (2)	Income Velocity of Legal Money (3)	Underground Economy (4)	Underground Economy as Percentage of GNP (5)	Tax Evasion (6)
1976	15.78	287.52	5.98	94.26	5.49	7.73
1977	16.07	309.63	6.19	99.56	5.19	8.23
1978	17.66	335.04	6.44	113.62	5.27	9.84
1979	18.95	351.05	6.88	130.29	5.40	11.51
1980	21.75	358.55	7.32	159.31	6.07	15.01

legal sources. Perhaps even more significant is the fact that a clear upward trend has been noticeable since the mid-1960s, when the underground economy averaged about 3.8 percent of GNP. This trend, while not as dramatic as that reported by some news accounts or as estimated by Feige (1979), is nevertheless disturbing, especially as it seems to have accelerated in recent years. As a proportion of GNP, the underground economy reached its peak in 1944, when it was close to 8 percent. This figure is consistent with results reported by other researchers (for example, Cagan (1958) and Molefsky (1982)). From 1944 to the mid-1960s, the share of the underground economy in GNP fell by one half. Table 5 presents the same categories of results but is calculated by using the average tax rate rather than the weighted average tax rate.

The results from Tables 4 and 5 are presented in Chart 6, which shows that the estimates based on the average tax rate are somewhat lower than the others. In 1980 the two estimates varied by about 1½ percent of GNP. In general, the behavior of the two lines in Chart 6 is quite similar, except that one is consistently above the other. The only period when the two lines diverge in behavior is during World War II. In fact, while the use of the weighted average tax rate gives the highest figure for the underground economy in 1944, the use of the average tax rate gives the highest figure in 1942.

Tables 4 and 5 also show estimates of income tax evasion—column (6). For 1980, income tax evasion was estimated at about $15 billion in Table 4 and at about $11 billion in Table 5. These figures were derived by assuming that incomes in the underground economy would have been taxed at the same *average* rate as

TABLE 5. UNITED STATES: ESTIMATES OF UNDERGROUND ECONOMY AND TAX EVASION, USING AVERAGE TAX RATE, 1930–80

(In billions of U.S. dollars)

Year	Illegal Money (1)	Legal Money (2)	Income Velocity of Legal Money (3)	Underground Economy (4)	Underground Economy as Percentage of GNP (5)	Tax Evasion (6)
1930	−0.06	25.14	3.60	−0.22	−0.25	0
1931	−0.04	23.52	3.22	−0.13	−0.18	0
1932	0.58	19.67	2.95	1.73	2.97	0.01
1933	0.49	18.68	2.98	1.45	2.61	0.01
1934	0.54	20.80	3.13	1.69	2.60	0.01
1935	0.52	24.69	2.92	1.52	2.10	0.01
1936	0.99	28.01	2.95	2.91	3.52	0.04
1937	0.32	30.37	2.98	0.95	1.05	0.01
1938	0.14	29.59	2.86	0.39	0.46	0
1939	0.46	32.91	2.75	1.28	1.41	0.01
1940	0.56	38.10	2.62	1.47	1.47	0.02
1941	1.53	43.99	2.83	4.32	3.47	0.13
1942	2.38	50.43	3.13	7.46	4.73	0.42
1943	2.88	68.97	2.78	7.99	4.17	0.60
1944	2.31	78.64	2.67	6.17	2.94	0.48
1945	3.43	90.72	2.34	8.01	3.78	0.64
1946	2.32	103.68	2.01	4.67	2.24	0.36
1947	3.53	108.57	2.13	7.52	3.25	0.59
1948	1.51	110.49	2.33	3.51	1.36	0.21
1949	2.73	108.57	2.36	6.46	2.52	0.37
1950	3.67	110.43	2.58	9.47	3.32	0.61
1951	4.12	114.48	2.88	11.89	3.60	0.87
1952	4.05	121.05	2.87	11.62	3.35	0.93
1953	3.59	124.81	2.93	10.52	2.87	0.85
1954	2.89	126.91	2.89	8.33	2.28	0.61
1955	3.60	130.80	3.05	11.00	2.75	0.82
1956	3.78	132.22	3.18	12.03	2.86	0.94
1957	3.55	133.35	3.32	11.79	2.66	0.92
1958	3.74	134.66	3.33	12.48	2.78	0.95
1959	3.87	140.23	3.47	13.43	2.76	1.07
1960	3.67	139.13	3.64	13.33	2.63	1.04
1961	4.09	142.21	3.68	15.06	2.88	1.22
1962	3.84	145.96	3.86	14.84	2.63	1.21
1963	4.20	149.80	3.97	16.67	2.80	1.35
1964	3.40	156.10	4.07	13.85	2.18	1.03
1965	4.06	162.34	4.24	17.22	2.50	1.24
1966	4.99	170.71	4.41	22.00	2.92	1.64
1967	5.59	175.71	4.53	25.33	3.18	2.00
1968	6.78	187.62	4.63	31.38	3.61	2.77
1969	6.63	200.17	4.67	30.98	3.31	2.87
1970	5.40	208.20	4.72	25.47	2.59	2.17
1971	6.25	223.55	4.76	29.73	2.80	2.38
1972	6.94	236.26	4.96	34.42	2.94	2.74
1973	7.83	256.07	5.18	40.56	3.06	3.30
1974	9.24	268.26	5.35	49.38	3.44	4.26
1975	8.59	282.31	5.49	47.16	3.04	3.79

TABLE 5 *(concluded)*. UNITED STATES: ESTIMATES OF UNDERGROUND ECONOMY AND TAX EVASION, USING AVERAGE TAX RATE, 1930–80

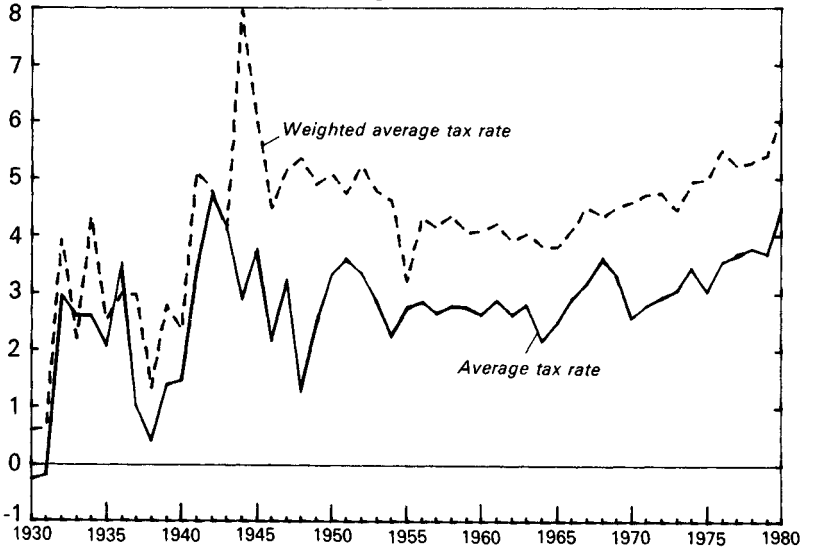
(In billions of U.S. dollars)

Year	Illegal Money (1)	Legal Money (2)	Income Velocity of Legal Money (3)	Underground Economy (4)	Underground Economy as Percentage of GNP (5)	Tax Evasion (6)
1976	10.41	292.89	5.87	61.08	3.56	5.01
1977	11.55	314.15	6.11	70.50	3.68	5.83
1978	12.86	339.84	6.34	81.59	3.78	7.07
1979	13.22	356.78	6.77	89.44	3.71	7.90
1980	16.35	363.95	7.22	117.99	4.49	11.12

incomes in the regular economy. This is, of course, a strong assumption. If incomes in the underground economy had been marginal incomes and thus would have been taxed at *marginal* tax rates, the estimates of tax evasion would have been much higher. This is undoubtedly true for many providers of underground services. They may hold regular jobs, on which they pay normal taxes, and may provide underground services during weekends or evenings. Therefore, if they had declared these additional incomes, they would have paid higher taxes than they actually paid on their reported incomes. However, many of the participants in

CHART 6. SIZE OF U.S. UNDERGROUND ECONOMY UNDER ALTERNATIVE AVERAGE TAX RATES, 1930–80

(In percent)



underground economic activities may not declare any income at all, and some (for example, illegal aliens) might pay taxes that are lower than the average. Furthermore, some of these activities might not take place at all if they could be controlled and taxed. In conclusion, without ascertaining each activity and determining whether the activity would exist if it had to move above ground, it is impossible to establish what the precise loss in tax revenue from the underground activities would be. Therefore, the assumption that has been made probably yields the most reasonable estimates that can be made in view of the information available.[10]

IV. Concluding Remarks

In the present article, yearly estimates for the underground economy for the period 1930–80 have been calculated. The main conclusions can be summarized as follows: (1) In 1980 the underground economy, expressed as a percentage of GNP, was somewhere between 4.5 percent and 6.1 percent. (2) The only other period in which it may have been higher than that was during World War II. (3) It has been increasing since the mid-1960s. (4) Over the period 1965–80, it has grown by more than 2 percentage points of GNP, or by almost 50 percent. The recent trend is disturbing as it seems to have accelerated in recent years, especially since the mid-1970s. This trend was probably influenced by the substantial increase in marginal tax rates over the period 1975–80, caused by inflation and the absence of significant tax cuts.[11] It is not possible at this point to speculate on whether the tax cuts enacted in 1981 have reversed the trend.

The results obtained in this paper should not be taken as precise measures of the underground economy; they are, at best, broad indications of trends and of orders of magnitude because they are sensitive to the assumptions made as well as to data revisions. However, it is comforting to realize that for 1974 and 1976 they are of the same order of magnitude as direct estimates made by Simon and Witte (1980) and by the Internal Revenue Service (1979).

[10]These estimates of tax evasion relate only to tax evasion that is associated with currency use and underground activities. But, obviously, many forms of tax evasion (claiming nonexistent exemptions, exaggerating deductions, nonreporting of interest income received, etc.) have nothing to do with currency usage or underground economic activities. Thus, these estimates do not measure total tax evasion.

[11]For a recent paper on the relation between high marginal tax rates and tax evasion, see Clotfelter (1982).

Perhaps a word on what has been measured here is necessary. The estimates attempt to measure the incomes that were generated through the excessive use of currency and that presumably were not reported to the tax authorities. Whether these incomes were or were not measured by the national accounts authorities cannot be determined. Presumably, part of these incomes not only evaded the tax net but also may have escaped the attention of the national accounts authorities—but, how large this part was cannot be assessed with the information at hand. It should also be emphasized that this measure of the underground economy does not measure "incomes" from criminal activities. But, as noted earlier, if these incomes were discovered, they would vanish and the "legal" incomes that would be generated by the resources so released would probably be small.[12] It is then not clear to what extent those illegal incomes represent a loss to the tax authorities or whether they should be measured in the national accounts.

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[12]For example, a drug smuggler who makes a large gain from his criminal activity would see his "income" dramatically reduced if (a) he were caught and jailed or forced to get a legal job, (b) if he gave up his activity because of improved law enforcement, or (c) if drug consumption were legalized. Therefore, these criminal incomes are totally arbitrary ones. In the author's view, it makes no sense to include them in a definition of underground economy that emphasizes either potentially recoverable tax revenue or the use of resources for activities that should be measured by the national accounts.

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Measurement of the Public Sector Deficit and Its Implications for Policy Evaluation and Design

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THIS PAPER STUDIES budgetary, financial, and monetary policy evaluation and design in a framework of comprehensive wealth and income accounting. Although the focus is on the public sector accounts, inevitably some attention is paid to the private and overseas sectors. Construction of stylized comprehensive balance sheets for the public sector and for its "flow" counterpart (the change in real public sector net worth) forms the basis for a comparison of these balance sheets with the conventionally measured balance sheet and the flow of funds accounts. The conventionally measured public sector balance sheet typically contains only marketable financial assets and liabilities. On the asset side, it omits such items as the value of the stock of social overhead capital, the value of government-owned land and mineral rights, and the present value of planned future tax revenues. On the liability side, it omits the present value of social insurance and other entitlement programs.

The conventionally measured financial surplus of the public sector, even when evaluated at constant prices, presents a potentially misleading picture of the change in the real net worth of the public sector. One reason is that capital gains and losses on outstanding stocks of government assets and liabilities are not included in the flow of funds. For example, the following are omitted: capital gains or losses that are due to changes in relative

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prices (e.g., changes in the real value of mineral rights), changes in the real value of nominally denominated public sector debt that are due to inflation, and changes in the real value of foreign-currency-denominated assets and liabilities that are caused by changes in exchange rates.

A second reason is that changes in tax and entitlement programs, in the future revenue base, and in discount rates, etc., may significantly alter the planned or expected future streams of taxes and benefits and their present value. Capital gains and losses on such implicit nonmarketable assets and liabilities are part of the Hicks-Simon concept of income, but they are excluded from the flow of funds accounts.

The differences between the conventionally measured accounts and the comprehensive accounts can be very large. In inflationary periods, large public sector deficits (conventionally measured) may be more than offset by the inflation-induced reduction in the real value of the government's nominal liabilities. Changes in the current account deficit of the balance of payments (conventionally measured) may be offset or enhanced by changes in the value of external assets and liabilities associated with exchange rate changes. Changes in social security legislation may alter the future flows of benefits and contributions. With efficient forward-looking financial markets, such policy changes will not merely alter *future* rates of return when the financial implications of current legislation become visible and directly measurable—for example, through changes in the amount of public sector borrowing. They will have an effect on *current* financial asset prices and rates of return; larger anticipated future deficits may raise current interest rates.

After presenting the comprehensive and conventionally measured accounts for the public sector, the private sector, and the overseas sector, the paper proposes some general rules for policy design. These rules derive from a reasonable policy norm or objective and from rather minimal and uncontroversial assumptions about private sector behavior. To translate these general (and, indeed, perhaps rather vague) rules into concrete policies is a task that is well beyond the scope of this paper because a wealth of country-specific knowledge would be required in each case.

The essence of the argument is that, in a first-best world, private agents, governments, and international organizations would decide on spending, saving, lending, production, and portfolio allocation programs, constrained only by comprehensive wealth

or permanent income. Single-period or other short-run "budget constraints" would not represent further effective or binding constraints on economic behavior. The perfect internal and external capital markets required to implement the first-best solution, however, do not exist. Private agents are constrained by the illiquidity and nonmarketability of certain assets (e.g., pension rights, human capital, and expected future tax cuts). Dearth of suitable collateral often renders infeasible the borrowing required to spend in line with permanent income. These cash flow constraints, illiquidity, credit rationing, lack of collateral, nonmarketability of certain assets and liabilities, and a host of other capital market imperfections force the actions of private agents and national governments to depart from the behavior that would be optimal if comprehensive net worth or permanent income constraints alone had to be taken into account.

Flow of funds accounting on a cash or transactions basis and the analysis of balance sheets consisting only of marketable claims are useful precisely because they will help to identify the conditions under which the behavior of economic agents is likely to be constrained by factors other than comprehensive net worth.

Within a national economy, conventional accounting helps to decide when and how the national authorities, through appropriate fiscal, financial, and monetary measures, can help private agents to avoid or overcome obstacles to spending and saving in line with permanent income (for households) and impediments to production in pursuit of long-run profit or social net benefit (for enterprises). Within the international economy, conventional accounting serves to identify the conditions under which international organizations should extend or restrict credit to national governments to enable them to develop in line with their long-run potential. Exercises in financial evaluation, such as the Fund's financial programming, should, therefore, start from two sets of accounts. The first set contains the conventional cash-based flow of funds accounts, the income expenditure accounts of the United Nations System of National Accounts (SNA), and the conventional balance sheets of marketable assets and liabilities. The second set contains the comprehensive balance sheets or wealth accounts outlined in the paper and their flow counterparts, describing the changes in real sectoral net worth over time and thus permanent income—that is, the ultimate accrual-based accounts.

Both national governments and international agencies should design fiscal, financial, and monetary policies so as to induce an

evolution of the conventionally measured balance sheet and flow of funds accounts that permits private agents and national economies, respectively, to approximate the behavior that would be adopted if either comprehensive wealth or permanent income were the only binding constraint on economic behavior.

The approach developed in this paper implies that conventional financial planning is an essential input into optimal (or even merely sensible) policy design. It also suggests that a set of comprehensive wealth and permanent income accounts (or the best practicable approximation to them) should complement the conventional data base. Without the conventional accounts, of course, analyses based just on the comprehensive wealth and permanent income accounts will fail to take into account many of the actual binding constraints on economic behavior.

"Stabilization policy," as viewed in this paper, is potentially useful and effective even if goods and factor markets clear continuously. The existence of capital market imperfections that prevent private agents from spending in line with permanent private disposable income and nations from spending in line with national permanent income is necessary before there can be scope for stabilization policy—that is, policy actions or rules designed to permit smoothing of consumption over time by removing or neutralizing constraints on spending other than permanent income. Successful stabilization policy keeps disposable income in line with permanent income and ensures an adequate share of disposable financial wealth in comprehensive wealth. Another necessary condition for potentially desirable stabilization policy is that governments have access to capital markets on terms that are more favorable than those faced by private agents, or, more generally, it is necessary for governments to have financial options that are not available to private agents. Mutatis mutandis, the same condition applies in an international setting for certain international agencies vis-à-vis national governments. The existence of Keynesian effective demand failures that are due to disequilibria in goods and factor markets would, of course, strengthen the case for stabilization policy.

This view of stabilization policy implies that the government's financing policies (changes in its tax, transfer, borrowing, and money creation mix) should be used for stabilization rather than for variations in its spending program on goods and services. The spending program should aim to achieve the best feasible public/private consumption mix based on national permanent income.

I. A Stylized Set of Public Sector Accounts

Table 1 presents a stylized and simplified "comprehensive" balance sheet for the public sector. Many definitional problems are ignored; for example, throughout this paper the terms "government" and "public sector" are used interchangeably. (See Boskin (1982).) It is assumed that an extremely heterogeneous set of assets and liabilities can somehow be expressed in common value terms, despite the fact that some of the assets are not marketable (K^{soc}) or, even if potentially marketable, may lack a current observable market price (K^G). Some assets and liabilities are neither marketable nor tangible and merely represent implicit noncontractual (and reversible) political commitments (T and N).

Referring to T, N, and A^M as present discounted values of

TABLE 1. COMPREHENSIVE CONSOLIDATED PUBLIC SECTOR BALANCE SHEET AT CURRENT MARKET OR IMPLICIT PRICES

Assets		Liabilities	
$p_{K^{soc}}K^{soc}$	Social overhead capital (nonmarketable)	B^H	Net interest-bearing debt denominated in domestic currency, held by residents
$p_G K^G$	Equity in public enterprises (partly potentially marketable)	B^F	Net interest-bearing debt denominated in domestic currency, held by nonresidents
$p_R R^G$	Land and mineral assets (marketable)	eB^{*H}	Net interest-bearing debt denominated in foreign currency, held by residents
eE^*	Net foreign exchange reserves	eB^{*F}	Net interest-bearing debt denominated in foreign currency, held by nonresidents
T	Present value of future tax program, including social security contributions, tariff revenue, etc. (implicit asset)	$p\tilde{B}^H$	Net interest-bearing index-linked debt, held by residents
pA^M	Imputed net value of government's cash monopoly	$p\tilde{B}^F$	Net interest-bearing index-linked debt, held by nonresidents
		H	Stock of high-powered money
		N	Present value of social insurance and other entitlement programs (implicit liability)
		W^G	Public sector net worth

future streams of payments or receipts involves a rather cavalier use of certainty equivalence; the conditional mathematical expectations of the uncertain future revenues or outlays are discounted by using "risk-adjusted" discount rates. If, for example, future tax revenues are highly uncertain, T would be correspondingly small. The relevant horizon is, in principle, infinite.

For many purposes, it is better not to attempt to reduce marketable and nonmarketable, implicit and explicit, claims to a common balance sheet measure of value. Instead, each of the items in the balance sheet would be modeled as having potentially distinct behavioral effects. The proper way of handling this will depend on the specifics of the model and the application under consideration. For a preliminary examination of the problem of comprehensive wealth and income accounting in the public sector, the balance sheet in Table 1 is, however, useful.

Most of the items in the balance sheet are self-explanatory. Public sector overhead capital is assumed to yield an implicit rental $r^{soc}p_{K^{soc}}K^{soc}$, which corresponds to the item pG^{soc} (public sector consumption of social overhead capital services) on the debit side of the public sector current account. The symbol p_GK^G represents the balance sheet counterpart of the operating surplus of the public enterprise sector in the public sector current account. This may well be a negative item for some of the secular public enterprise loss makers, in which case it should be moved to the liability side of the balance sheet. The present value of current and capital grants is not entered separately; it can be viewed as subsumed under N or T. Net foreign exchange reserves (E^*) are entered separately as an asset rather than netting them out against B^{*F} or $B^{*F}+\frac{B^F}{e}+\tilde{B}^F\frac{p}{e}$. For simplicity, only nominal capital-certain bonds and real capital-certain bonds are considered. (See Miller (1982).)

The treatment of money in this exposition of the comprehensive wealth accounting framework is somewhat unusual. The reason for adopting this approach is that it represents the simplest way of introducing a nontrivial role for money. Specifically, it keeps the economy from becoming isomorphic to a barter economy when, in Section V, the accounts of the public and private sectors are consolidated in the investigation of debt neutrality. Money, as a social asset that produces liquidity and convenience services, does not disappear when private and public sector assets and liabilities are netted out. The usefulness of the framework of comprehensive

wealth accounting does not depend on the acceptability of this approach to modeling money.

Money has value to the private sector because it yields a flow of imputed nonpecuniary liquidity and convenience services. Let ρ^M be the nonpecuniary rate of return on money. The value to the private sector of its money holdings is given by V^M in equation (1)

$$V^M(t) = \frac{1}{p(t)} \int_t^\infty H(t)\,\hat{\rho}^M(u,t)\, e^{-\int_t^u \hat{i}(s,t)\,ds}\, du^1 \tag{1}$$

The assumption that the pecuniary and nonpecuniary yields on money and bonds are equalized at the margin yields

$$\rho^M = i = r + \frac{\hat{\dot{p}}}{p} \tag{2}$$

Equations (1) and (2) imply that

$$V^M = \frac{H}{P} \tag{3}$$

Let Π^M be the present discounted value of the expected future flow of profits to the government from operating the printing presses. Assuming that cash can be produced without cost, the result is

$$\Pi^M(t) = \frac{1}{p(t)} \int_t^\infty \hat{\dot{H}}(u,t)\, e^{-\int_t^u \hat{i}(s,t)\,ds}\, du^2 \tag{4}$$

Integrating equation (4) by parts produces

[1]Or, equivalently, by

$$V^M(t) = \int_t^\infty \frac{H(t)}{\hat{p}(u,t)}\, \hat{\rho}^M(u,t) e^{-\int_t^u \hat{r}(s,t)\,ds}\, du$$

For any variable x, $\hat{x}(s,t)$ is the value of x expected at time t to prevail at time s.

[2]Or, equivalently,

$$\Pi^M(t) = \int_t^\infty \frac{\hat{H}(u,t)}{\hat{p}(u,t)}\, e^{-\int_t^u \hat{r}(s,t)\,ds}\, du$$

$$\Pi^M(T) = -\frac{H(t)}{p(t)} + A^M(t)^3 \tag{4'}$$

where

$$A^M(t) = \frac{1}{p(t)} \int_t^{\infty} \hat{i}(u,t)\hat{H}(u,t)e^{-\int_t^u \hat{i}(s,t)ds} du \tag{5}$$

Thus, $A^M(t)$—the net value of the government's cash monopoly—can be interpreted as the present discounted value of the interest income that the central bank expects to earn at each future date on a portfolio of government bonds that is equal in value to the stock of high-powered money at that date.

The conventionally measured public sector balance sheet typically omits from Table 1 all nonmarketable and nonfinancial assets and liabilities—that is, K^{soc}, K^G, R^G, T, N, and A^M.

The current and capital accounts of the public sector whose balance sheet is given in Table 1 are represented in Table 2. (See Ott and Yoo (1980).) They are stylized SNA accounts and have a number of significant shortcomings when used uncritically as a guide to the changes over time in the balance sheet—especially as regards the evolution of the *real* comprehensive net worth of the public sector and its components.

For simplicity, it is assumed that government consumption (G^c) and the imputed rental services from social overhead capital have the same price (p).[4] A uniform depreciation rate (δ) for different types of capital is also imposed. Foreign exchange reserves are assumed to pay the same interest rate as other foreign-currency-denominated financial claims. All of these assumptions serve only illustrative purposes.

The "public sector budget constraint," which was rediscovered by macroeconomic theorists in the early 1970s, is obtained by consolidating the current and capital accounts of Table 2. Imputed income and consumption are netted out. Deflating by the general price level yields the conventionally measured public sector financial surplus (at constant prices) given in equation (6)

[3]It is assumed that for any variable x, $\hat{x}(t_1, t_2) = x(t_1)$ for $t_1 \leq t_2$: the past and present are assumed to be known.

[4]Consumption of the imputed services from social overhead capital can be viewed as a transfer (in kind) from the public sector to the private sector rather than as an item of public sector consumption. Alternatively, the services from the stock of public sector overhead capital could be an input into private production.

TABLE 2. PUBLIC SECTOR INCOME AND EXPENDITURE AND CAPITAL FINANCE ACCOUNTS

(At current market or implicit prices)

Debit		Credit	
CURRENT ACCOUNT			
$p\,(G^c + G^{soc})$	Government consumption including imputed rental from social overhead capital	τ	Tax receipts (including social security contributions)
		$r^G p_G K^G + r^R p_R R^G$	Profits from public enterprises and ownership of natural resources
$\delta(p^{K^{soc}} + K^{soc}\, p_G K^G)$	Capital consumption		
n	Transfer and benefit payments	ei^{*E*}	Interest received
$i\,(B^H + B^F) + ei^*\,(B^{*H} + B^{*F})$ $+ rp\,(\tilde{B}^H + \tilde{B}^F)$	Interest paid	$r^{soc} p_{K^{soc}} K^{soc}$	Imputed return from social overhead capital
S^G	Surplus on current account		
CAPITAL ACCOUNT			
$p^{K^{soc}}(\dot{K}^{soc} + \delta K^{soc})$ $+ p_G\,(K^G + \delta K^G)$	Gross investment in structures	S^G	Surplus on current account
		$\delta(p_{K^{soc}} K^{soc} + p_G K^G)$	Capital consumption
$-[\dot{B}^H + \dot{B}^F + e\,(\dot{B}^{*H} + \dot{B}^{*F} - \dot{E}^*)$ $+ p(\dot{\tilde{B}} + \dot{\tilde{B}}^F) + \dot{H}]$	Net financial investment		
$p_R \dot{R} G$	Net purchases of existing assets		

$$\frac{\tau}{n} - \frac{n}{p} - G^c - \frac{p_{K^{soc}}}{p}\delta K^{soc} - \frac{P_G}{p}\delta K^G - i\left(\frac{B^H + B^F}{p}\right)$$
$$- \frac{e}{p} i^* (B^{*H} + B^{*F} - E^*) - r(\dot{B}^H + \dot{B}^F) + r^G \frac{P_G}{p} K^G$$
$$+ r^R \frac{p_R}{p} R^G \equiv \frac{p_K^{soc}}{p} \dot{K}^{soc} + \frac{P_G}{p}\dot{K}^G + \frac{p_R}{p}\dot{R}^G - \frac{1}{p}(\dot{B}^H + \dot{B}^F)$$
$$- \frac{e}{p}(\dot{B}^{*H} + \dot{B}^{*F} - \dot{E}^*) - (\dot{\tilde{B}}^H + \dot{\tilde{B}}^F) - \frac{\dot{H}}{p} \qquad (6)$$

Even this "real" surplus, however, is likely to be a poor indicator of the change in the real net worth of the public sector, as defined from the balance sheet in Table 1. This change in the real net worth of the government is given in equation (7)

$$\frac{d}{dt}\left(\frac{W^G}{p}\right) \equiv \frac{p_{K^{soc}}}{p}\dot{K}^{soc} + \frac{P_G}{p}\dot{K}^G + \frac{p_R}{p}\dot{R}^G$$
$$- \frac{1}{p}(\dot{B}^H + \dot{B}^F) - \frac{e}{p}(\dot{B}^{*H} + \dot{B}^{*F} - \dot{E}^*)$$
$$- (\dot{\tilde{B}}^H + \dot{\tilde{B}}^F) - \frac{\dot{H}}{p} + \frac{1}{p}(\dot{T} - \dot{N}) + \dot{A}^M$$
$$+ \left(\frac{\dot{p}_{K^{soc}}}{p_{K^{soc}}} - \frac{\dot{p}}{p}\right)\frac{p_{K^{soc}}}{p} K^{soc} + \left(\frac{\dot{P}_G}{P_G} - \frac{\dot{p}}{p}\right)\frac{P_G}{p} K^G$$
$$+ \left(\frac{\dot{p}_R}{p_R} - \frac{\dot{p}}{p}\right)\frac{p_R}{p} R^G + \frac{\dot{p}}{p}\left(\frac{B^H + B^F + H}{p}\right)$$
$$- \left(\frac{\dot{e}}{e} - \frac{\dot{p}}{p}\right)\frac{e}{p}(B^{*H} + B^{*F} - E^*)$$
$$- \frac{\dot{p}}{p}(T - N)^5 \qquad (7)$$

A comparison of the right-hand sides of equations (6) and (7) reveals that the difference between the "real," or constant, price surplus and the change in real net worth is due to capital gains and losses (Ω) and to changes in the value of the implicit assets and liabilities (Δ) where

[5]No behavioral significance should be attached to the specification of T and N in nominal terms.

$$\Omega = \left(\frac{\dot{p}_{K^{soc}}}{p_{K^{soc}}} - \frac{\dot{p}}{p}\right)\frac{p_{K^{soc}}}{p}K^{soc} + \left(\frac{\dot{P}_G}{p_G} - \frac{\dot{p}}{p}\right)\frac{p_G}{p}K^G + \left(\frac{\dot{p}_R}{p_R} - \frac{\dot{p}}{p}\right)\frac{p_R}{p}R^G$$
$$+\frac{\dot{p}}{p}\left(\frac{B^H + B^F + H}{p}\right) - \left(\frac{\dot{e}}{e} - \frac{\dot{p}}{p}\right)\frac{e}{p}(B^{*H} + B^{*F} - E^*)$$
$$-\frac{\dot{p}}{p}(T - N) \qquad (8')$$

and

$$\Delta = \frac{1}{p}(\dot{T} - \dot{N}) + \dot{A}^M \qquad (8'')$$

As regards Ω, the statement that the change in wealth or net worth equals saving *plus* capital gains is not surprising. The importance of fully accounting for capital gains and losses on existing government assets and liabilities to obtain a correct understanding of the short-run and long-run implications of past, present, and prospective budgetary, monetary, and financial policies has not, however, been appreciated universally.

Considerable interest attaches to behavior by an economic agent, sector, or group of sectors that leaves real comprehensive net worth unchanged. Such agents or sectors consume their permanent income, and their behavior is ex ante permanently sustainable. For policy design, policies aimed at keeping total-national (public *plus* private) consumption in line with national permanent income—that is, policies focusing on the consolidated public and private sector comprehensive balance sheet accounts—are of special relevance. These are considered in Section V. While there are certainly valid reasons for optimal consumption to depart from permanent income, such divergences must necessarily be temporary, with overshooting and undershooting of the permanent income benchmark canceling each other in terms of present value. The focus on spending behavior that is consistent with constant real comprehensive net worth should, therefore, come naturally in policy evaluation and design. It is noted that equations (7), (8′), and (8″) represent ex post or realized measures only. For planning, including consumption planning, the ex ante measures are relevant. They are obtained by replacing actual changes in prices with anticipated changes in prices in equations (7) and 8′), and by substituting anticipated changes in the value of implicit assets and liabilities for actual changes in equations (7) and (8″). In what follows, *anticipated* capital gains and

losses replace the ex post measures whenever planned private or public sector behavior is discussed.

II. Amortization of Public Debt Through Inflation and Currency Appreciation

Let us consider, first, changes in the public sector balance sheet that are due to "pure" or general inflation, which is defined as a situation in which all money prices (including the prices of real capital assets) change at the same rate—that is,

$$\frac{\dot{p}_{K^{soc}}}{p_{K^{soc}}} = \frac{\dot{P}_G}{P_G} = \frac{\dot{p}_R}{p_R} = \frac{\dot{p}}{p}$$

For reasons of space, ignore capital gains or losses on the implicit assets and liabilities T and N that are caused by inflation.

Inflation-induced changes in real public sector net worth (Ω') are given by

$$\Omega' = \frac{\dot{p}}{p}\left(\frac{B^H + B^F + H}{p}\right) + \left(\frac{\dot{p}}{p} - \frac{\dot{e}}{e}\right)(B^{*H} + B^{*F} - E^*)\frac{e}{p} \quad (9')$$

THE CLOSED ECONOMY

In a closed economy, the last term on the right-hand side of equation (9′) can be ignored, $B^F = 0$ and the reduction in the real value of the outstanding stock of nominally denominated government liabilities is given by Ω'.

$$\Omega'' = \frac{\dot{p}}{p}\left(\frac{B^H + H}{p}\right) \quad (9'')$$

Proper wealth accounting requires that the amortization of public debt through inflation should be put "below the line" in measuring the financing of the government's net "real" borrowing.[6] Above the line, a higher rate of inflation will (if interest rates are free) swell the measured deficit as nominal interest rates rise with the rate of inflation. If the Fisher hypothesis holds and real interest rates are invariant with respect to the rate of inflation, the increased nominal interest payments associated with a higher rate of inflation will be exactly matched by the reduction in the real

[6]Clear statements of this proposition can be found in Siegel (1979) and in Taylor and Threadgold (1979). See also Buiter and Miller (1981) and Buiter (1982 b).

value of the government's stock of nominally denominated interest-bearing debt (Ω'''), defined by

$$\Omega''' = \frac{\dot{p}}{p}\frac{B^H}{p} \tag{9'''}$$

Subtraction of Ω''' from the conventionally measured deficit yields the deficit "at real interest rates"—what the conventionally measured deficit would have been if all interest-bearing debt had been index linked. In models that do not exhibit "pre-Ricardian" debt neutrality, changes in the real value of the stock of government interest-bearing debt are the major proximate determinant of "financial crowding out"—the displacement of private capital formation by government borrowing, holding constant the size and composition of the government's real spending program. The exact nature (degree, scope, and time pattern) of financial crowding out will, of course, be "model specific." A number of simple examples are analyzed in a sequel to this paper. (See Buiter (1982 c).) The central (and obvious) point is that, ceteris paribus, private agents (whose portfolio demands are for real stocks of assets if agents are free from money illusion) will absorb additional issues of nominal government bonds equal to the erosion in the real value of their existing holdings caused by (anticipated) inflation, without requiring any increase in the real rate of interest. Such government borrowing, therefore, does not raise the degree to which the public sector competes with the private sector for real investible resources.

The ceteris paribus clause of the preceding paragraph includes a given stock of real money balances. Additional monetary financing equal to the inflation tax on existing money balances, $\left(\frac{\dot{p}}{p}\frac{H}{P}\right)$, leaves real money balances unchanged. A conventionally measured deficit equal to Ω'', financed by borrowing an amount, $\frac{\dot{p}}{p}\frac{B^H}{P}$, and by money creation equal to $\frac{\dot{p}}{p}\frac{H}{P}$ is, therefore, consistent with constant real interest rates and a constant degree of aggregate financial crowding-out pressure.[7] Note that subtracting Ω'' from the conventionally measured deficit yields a somewhat wider concept of the deficit at real interest rates, since the real

[7]It is assumed that borrowing and money creation, per se, do not affect determinants of the demand for public debt other than expected real rates of return.

rate of return (ignoring nonpecuniary liquidity and convenience services) on high-powered money bearing a zero nominal interest rate is *minus* the rate of inflation.[8]

The argument for public sector inflation accounting in the closed economy can be summarized succinctly by using a simplified version of equations (1) and (2). Ignoring G^{soc}, K^{soc}, and R^G, let us assume that $P_G = p$ and define $G^I = \dot{K}^G$ (net investment by public sector enterprises) and $\tilde{\tau} = \frac{\tau - n}{p}$ (real taxes net of transfers and other benefits). If it is assumed, in addition, that $r = i - \frac{\dot{p}}{p}$, then the conventionally measured government budget constraint is given by

$$\frac{\dot{H} + \dot{B}^H}{p} + \dot{\tilde{B}}^H \equiv G^c + G^I + \delta K^G - \tilde{\tau} + \left(r + \frac{\dot{p}}{p}\right)\frac{B^H}{p} + r\tilde{B}^H - r^G K^G \tag{10}$$

The change in the real value of the stock of interest-bearing debt is given by

$$\frac{d}{dt}\left(\frac{B^H}{p} + \tilde{B}^H\right) \equiv G^c + G^I + \delta K^G - \tilde{\tau} + r\left(\frac{B^H}{p} + \tilde{B}^H\right) - r^G K^G - \frac{\dot{H}}{p} \tag{11}$$

The deficit measure that is relevant for aggregate financial crowding-out pressure on private capital formation, given in equation (11), will depend on the amount of monetary financing permitted by the authorities. Useful benchmarks are (a) monetary financing sufficient to keep the real money stock constant: $\frac{H}{p} = \frac{\dot{p}}{p}\frac{H}{p}$; and (b) monetary financing consistent with a zero trend rate of inflation: $\frac{\dot{H}}{p} = \gamma\frac{H}{p}$, where γ is the natural rate of growth.[9]

Equation (11) answers the questions as to whether the fiscal stance (defined by G^c, G^I, and $\tilde{\tau}$) and the monetary target (defined by $\frac{\dot{H}}{p}$) imply aggregate financial crowding-out pressure

[8]This is the ex post measure. The ex ante real yields are defined in terms of the expected rate of inflation.

[9]Money demand is assumed to be unit elastic in income and wealth.

$\left(\frac{d}{dt}\left(\frac{B^H}{p}+\tilde{B}^H\right)>0\right)$ or crowding-in pressure $\left(\frac{d}{dt}\left(\frac{B^H}{p}+\tilde{B}^H\right)<0\right)$. This issue can be addressed in the short run (for a single period), in the medium term (by applying equation (11) sequentially for as many periods as one is interested in), or in the steady state. Note that inflation-induced capital gains or losses on nonindexed bonds cancel the inflation premium in the nominal interest payments; in equation (11), all debt service is evaluated at real rates of interest.[10]

For aggregate crowding-out pressure on total national (private *plus* public sector) capital formation, a useful simple measure (noting that $G^I = \dot{K}^G$) is

$$\frac{d}{dt}\left(\frac{B^H}{p}+\tilde{B}^H-K^G\right)=G^c-\tilde{\tau}+r\left(\frac{B^H}{p}+\tilde{B}^H-K^G\right)+(r-(r^G-\delta))\,K^G-\frac{\dot{H}}{p} \tag{12}$$

The conventional deficit measure is further modified in equation (12) by subtracting net investment by public sector enterprises. Interest payments on net nonmonetary liabilities $(B^H+B^H-K^G)$ are evaluated at the real interest rate, r. If the net rate of return on public enterprise capital $(r^G-\delta)$ exceeds the opportunity cost of borrowing (r), the "corrected" deficit is further reduced. If the opposite prevails, the corrected deficit is larger by an amount $(r-(r^G-\delta))\,K^G$.

The decline in the real value of total tangible net worth of the public sector is given by

$$\frac{d}{dt}\left(\frac{H+B^H}{p}+\tilde{B}^H-K^G\right)=G^c-\tilde{\tau}+r\left(\frac{B^H}{p}+\tilde{B}^H-K^G\right)+(r-(r^G-\delta))\,K^G-\frac{\dot{p}}{p}\frac{H}{p} \tag{13}$$

This could be called the inflation-corrected government current account deficit. Debt service payments and receipts on all assets and liabilities (including money) are evaluated at real rates of return.[11]

[10]The accounting framework does not indicate whether or not the real interest rate varies with the inflation rate.

[11]For certain purposes, crowding-out pressure per unit of capacity output or crowding-out pressure per unit of efficient labor is of interest. (See, e.g., Sargent and Wallace (1981).) This would involve replacing equation (11) by the following:

Some idea of the magnitude of the overstatement of the government's true borrowing by the conventionally measured deficit under inflationary circumstances is provided by Table 3 for the United Kingdom and Table 4 for the United States.

In 1981 the public sector borrowing requirement in the United Kingdom was £10.6 billion, and the public sector financial deficit rose to £7.5 billion. The inflation correction in that year amounted to about £11 billion, using a variety of estimates. The inflation-corrected deficit was actually a surplus. If it is noted that during 1981 the U.K. economy was also experiencing the worst recession since the 1930s, there can be no doubt that the inflation-corrected and cyclically adjusted (trend or permanent) deficit was actually a sizable surplus. It is a matter of some practical importance whether that constitutes wise countercyclical fiscal policy. The United States during the period 1979–81 also had an inflation-corrected balanced federal budget. Any reasonable cyclical correction for 1981 produces a large inflation-corrected cyclically adjusted surplus. High U.S. real interest rates in 1981 can be explained by the fiscal stance only if large anticipated future inflation-corrected cyclically adjusted deficits are postulated.

THE OPEN ECONOMY

In an open economy, governments can borrow and lend domestically or abroad. Their financial assets and liabilities can be denominated in foreign or domestic currency or can be index linked. Consider equation (9′). The real value of public sector debt denominated in domestic currency is reduced by domestic inflation whether this debt is owned by the private sector or the rest of the world. While, ceteris paribus, inflation also reduces the real value of foreign-currency-denominated financial claims, exchange rate depreciation increases it. If purchasing power parity holds $\left(\frac{\dot{p}}{p} - \frac{\dot{e}}{e} = \frac{\dot{p}^*}{p^*}\right.$ and through choice of units, $\left.ep^* = p\right)$, equation (9′) becomes

$$\Omega' = \frac{\dot{p}}{p}\left(\frac{B^H + B^F + H}{p}\right) + \frac{\dot{p}^*}{p^*}\left(\frac{B^{*H} + B^{*F} - E^*}{p^*}\right) \qquad (9'')$$

$$\frac{d}{dt}\left(\frac{\tilde{B} + B^H p^{-1}}{Y}\right) = \frac{G^c + G^I + \delta K^G - \tilde{\tau}}{Y} + (r - \gamma)\left(\frac{B^H}{pY} + \frac{\tilde{B}^H}{Y}\right) - \frac{r^G K^G}{Y} - \frac{\dot{H}}{pY}$$

TABLE 3. UNITED KINGDOM: CORRECTING THE PUBLIC SECTOR DEFICIT FOR INFLATION, 1967–81

Year	Public Sector Debt (Market Value) (*percent of GDP*)[1]	Public Sector Borrowing Requirement (*billions of pounds sterling*)	Public Sector Borrowing Requirement (*percent of GDP*)	Public Sector Financial Deficit (*billions of pounds sterling*)	Public Sector Financial Deficit (*percent of GDP*)	Inflation Correction (1)[2] (*billions of pounds sterling*)	Inflation Correction (2)[3] (*billions of pounds sterling*)	Inflation Correction (3)[4] (*billions of pounds sterling*)
1967	81	1.9	4.6	1.5	3.8	0.5	0.6	1.0
1968	77	1.3	3.0	0.9	2.0	1.4	2.0	1.2
1969	70	−0.4	−1.0	−0.5	−1.1	1.2	2.0	1.3
1970	67	0.0	0.0	−0.7	−1.3	2.1	2.7	1.4
1971	59	1.4	2.4	0.3	0.53	3.0	3.2	1.5
1972	58	2.1	3.2	1.5	2.4	3.3	3.2	1.7
1973	49	4.2	5.8	2.8	3.8	3.0	4.0	2.3
1974	43	6.4	7.7	4.7	5.7	7.0	9.3	3.3
1975	41	10.5	9.9	7.7	7.3	10.3	11.9	3.9
1976	43	9.1	7.3	8.3	6.6	7.5	7.4	5.0
1977	47	6.0	4.2	5.9	4.1	10.1	9.3	5.8
1978	44	8.4	5.1	8.1	4.9	6.2	6.4	6.5
1979	42	12.6	6.6	8.1	4.2	12.3	13.8	8.2
1980	36	12.2	5.4	9.7	4.3	9.6	12.1	10.5
1981	38	10.6	4.1	7.5	2.9	10.8	11.7	11.8

Source: Marcus Miller, "Inflation-Adjusting the Public Sector Financial Deficit: Measurement and Implications for Policy," in *The 1982 Budget,* ed. by T. Kay (London, 1982).

[1]GDP = gross domestic product.

[2]Inflation correction (1) = annual rate of inflation *times* market value of public sector debt (midyear).

[3]Inflation correction (2) = annual rate of inflation *times* nominal value of public sector debt.

[4]Inflation correction (3) is based on the assumption of a long-run real interest rate of 2 percent.

TABLE 4. UNITED STATES: FEDERAL DEFICITS AND DEBT, FISCAL YEARS, 1967–81[1]

(Cols. 1–4 in billions of U.S. dollars)

Fiscal Year	Total Federal Budget and Offbudget Deficit for Fiscal Year (1)	Par Value of Public Debt Securities Held by Private Investors, End of Fiscal Year (2)	Par Value of Public Debt Securities Held by Private Investors, End of Fiscal Year (*in 1967 prices*) (3)	Inflation Correction (4)	Inflation Correction (5)
1967	8.7	204.4	204.4	5.9	0.26
1968	25.2	217.0	208.3	9.1	0.25
1969	−3.2	214.0	194.9	11.6	0.23
1970	2.8	217.2	186.8	12.8	0.22
1971	23.0	228.9	188.7	9.8	0.21
1972	23.4	243.6	194.4	8.0	0.21
1973	14.9	258.9	194.5	16.1	0.20
1974	6.1	255.6	173.1	28.1	0.18
1975	53.2	303.2	188.1	27.6	0.20
1976	73.7	376.4	220.8	21.8	0.22
1977	53.6	438.6	241.7	28.5	0.23
1978	59.2	488.3	249.9	37.6	0.23
1979	40.2	523.4	240.8	59.1	0.22
1980	73.8	589.2	238.7	79.5	0.22
1981	78.9	665.4	244.3	69.2	0.23

Source: *Economic Report of the President* (Washington, February 1982).
[1]Col. (3) = col. (2) deflated by consumer price index. Col. (4) = col. (2) *times* proportional rate of change of consumer price index.

With purchasing power parity, reductions in the real value of foreign-currency-denominated public sector debt can be calculated by multiplying the foreign rate of inflation by the real value of net foreign-currency-denominated liabilities.

Consider the following stylized representation of the position of a number of small, open developing countries that lack a significant domestic capital market. Government debt is largely placed abroad and tends to be denominated in foreign currency (typically U.S. dollars). In such countries, $B^H = B^F = \bar{B}^H = \bar{B}^F = B^{*H} = 0$. The conventionally measured public sector deficit is[12]

[12]Simplifying assumptions about the public sector accounts made earlier in this section of the paper are maintained.

$$\frac{\dot{H}}{p} + \frac{e}{p}(\dot{B}^{*F} - \dot{E}^*) = G^c + G^I + \delta K^G - \tilde{\tau} + \frac{e}{p} i^*(B^{*F} - E^*) - r^G K^G \tag{14}$$

If, in addition, only the government borrows overseas, $\frac{d}{dt}(B^{*F} - E^*)$ equals the current account deficit (in terms of foreign currency) of the balance of payments, as shown in equation (15)

$$\frac{e}{p}(\dot{B}^{*F} - \dot{E}^*) = -X + \frac{e}{p} i^*(B^{*F} - E^*) \tag{15}$$

Here, X denotes real net exports of goods and services (excluding debt service) *plus* net transfers and grants from abroad.

Compare the current account balances of two countries, identical in real terms but facing different rates of world inflation. If r^* is the world real rate of interest, $i^* = r^* + \frac{\dot{p}^*}{p^*}$

or

$$\frac{e}{p}(\dot{B}^{*F} - \dot{E}^*) = -X + \frac{e}{p}\left(r^* + \frac{\dot{p}^*}{p^*}\right)(B^{*F} - E^*) \tag{15'}$$

If the world real rate of interest is independent of the inflation rate and if purchasing power parity prevails, the current account deficit of the country facing the higher rate of world inflation $\left(\frac{\dot{p}^*}{p^*}\right)^1$ will exceed that of the country facing the lower rate of world inflation $\left(\frac{\dot{p}^*}{p^*}\right)^2$ by an amount $\left(\left(\frac{\dot{p}^*}{p^*}\right)^1 - \left(\frac{\dot{p}^*}{p^*}\right)^2\right) e\left(\frac{B^{*F} - E^*}{p}\right)$ that is equal to the difference in external debt service payments. This difference in current account balances should, however, have no real consequences, since the higher debt service item above the line is matched below the line by the larger reduction in the real value of its external liabilities; higher world inflation means faster amortization of external indebtedness. Thus, $\frac{d}{dt}\left(\frac{e}{p}(B^{*F} - E^*)\right)$, or the change in net real external liabilities, is the same in the two economies. The country facing the larger current account deficit owing to higher world inflation should be able to borrow to finance its higher external interest payments. (See Sachs (1981).)

What has occurred in recent years is an increase in world real interest rates (r^*). This increase does require adjustment rather than, or in addition to, mere financing, with the relative weights on adjustment versus financing depending on the extent to which the increase in world real interest rates is perceived as permanent rather than transitory. Also, to the extent that countries have borrowed on a long-term rather than a short-term basis (or at variable interest rates), unanticipated changes in interest rates will result in once-and-for-all real capital gains or losses on external debt. Finally, significant departures from purchasing power parity have been the rule, especially since the breakdown of the Bretton Woods system of par values. Thus, even with a given world real interest rate (r^*), a country's real external indebtedness will increase whenever $\frac{\dot{p}^*}{p^*} - \left(\frac{\dot{p}}{p} - \frac{\dot{e}}{e}\right)$—the excess of the world rate of inflation over the domestic rate of inflation *minus* the percentage depreciation of the exchange rate—increases.

Many other kinds of open economy can be analyzed, starting from the general framework of equations (6), (7), and (9′), but the general principles should be clear from the simple example that was just analyzed.

III. Budgetary Policy and Monetary Growth: Eventual Monetization of Deficits

If bond financing of deficits causes concern about the crowding out of private capital formation and, in the open economy, about possible adverse consequences for external indebtedness, monetization of deficits is a source of concern because of its inflationary implications. It has been seen that it was necessary to correct the conventionally measured budget deficit for the effects of inflation and exchange rate appreciation on the real value of outstanding stocks of public sector financial assets and liabilities in order to assess changes in the extent to which the public sector competes with the private and overseas sectors for investible resources.

Similar adjustments are required to understand the monetary implications of the deficit, as is shown in this section.

THE CLOSED ECONOMY

From the simplified government budget constraint in equa-

tion (10), the following expression is derived for the proportional rate of growth of the nominal money stock.[13]

$$\frac{\dot{H}}{H} = V\left[\frac{G^c + G^I + \delta K^G - \tilde{\tau}}{Y} + \left(r + \frac{\dot{p}}{p}\right)\frac{B^H}{pY} + r\frac{\tilde{B}^H}{Y} - r^G\frac{K^G}{Y} - \frac{\dot{B}^H}{pY} - \frac{\dot{\tilde{B}}^H}{Y}\right] \tag{16}$$

$V \equiv \frac{pY}{H}$ is the income velocity of circulation of money. To evaluate the implications of the fiscal stance for monetary growth, it is necessary to specify paths both for public spending and taxation and for nonmoney financing. A particularly useful benchmark for financing policy is one that keeps constant the real values of all government assets and liabilities (other than money) per unit of output. This policy would be one of constant crowding-out pressure per unit of output. These constant liability/output (or asset/output) ratios need not be the historically inherited ones. The exercise can be applied to evaluating the longer-run implications for monetary growth after the debt/output ratios have acquired some desired long-run (or even steady-state) values. Given this rule,

$$\frac{G^I}{K^G} = \frac{\dot{\tilde{B}}^H}{\tilde{B}^H} = \gamma$$

and

$$\frac{\dot{B}^H}{B^H} = \gamma + \frac{\dot{p}}{p}$$

Equation (16) then becomes

$$\frac{\dot{H}}{H} \equiv V\left[\frac{G^c - \tilde{\tau}}{Y} + (r - \gamma)\left[\frac{B^H}{pY} + \frac{\tilde{B}^H}{Y} - \frac{K^G}{Y}\right] + (r - (r^G - \delta))\frac{K^G}{Y}\right] \tag{17}$$

Defining the longer-run fiscal stance by given constant values of $\frac{B^H}{pY}$, $\frac{\tilde{B}^H}{Y}$, and $\frac{K^G}{Y}$ and by given, but not necessarily constant,

[13]The money stock throughout this paper is the high-powered money stock. Addition of a private banking sector will, in general, be required for practical applications but does not significantly alter the conceptual framework outlined here.

paths of $\frac{G^c}{Y}$ and $\frac{\tilde{\tau}}{Y}$, it can be seen from equation (17) that longer-run monetary growth is governed by a deficit concept that differs from the conventionally measured deficit in a number of ways. First, the reduction in the real value of the stock of nominal government bonds owing to inflation is subtracted from the conventional measure. Second, in a growing economy the real stocks of government assets and liabilities can increase at the natural rate γ while leaving the asset/output or debt/output ratios constant. The net debt service term in equation (17), therefore, involves the real growth-adjusted interest rate $(r - \gamma)$. Under inflationary conditions, this rate can be significantly less than $i = r + \frac{\dot{p}}{p}$—the nominal interest rate. To infer the long-term implications for monetary growth (and thus for inflation) of the fiscal stance, a correction for inflation is applied only to the interest-bearing component of the government's nominal liabilities. The conventionally measured deficit should not also be reduced by the erosion of the real value of the nominal stock of high-powered money balances $\left(\frac{\dot{p}}{p}\frac{H}{p}\right)$ because constancy of the real value of all (monetary and nonmonetary) government debt per unit of output is consistent with any deficit and any rate of inflation.

Large conventionally measured deficits (even if cyclically adjusted) that correspond to small inflation-corrected deficits (or even surpluses)[14] reflect *current* high inflation. They do not indicate the inevitability of high crowding-out pressure or high rates of monetary growth in the future. Even without correction for real growth, an inflation-corrected or "trend" surplus means that (a) with zero money financing, there would be (aggregate) crowding in, and (b) with a bond-financing policy of zero (aggregate) crowding in, there would be negative monetary base growth.

Equation (17) alone does not lead to conclusions about the effects of, say, changes in fiscal stance on monetary growth. It is necessary to use positive economic models to incorporate the effect of any parameter changes on endogenous variables, such as velocity (V), real rates of interest (r and r^G), and even the natural rate of growth (γ). Such an analysis is simplest in classical monetarist models, such as that of Sargent and Wallace (1981), in which

[14]That is, deficits corrected for the reduction that is due to inflation in the real value of the stock of nominal government bonds.

velocity, the real interest rate, and the natural rate of growth are constants, but equation (17) can be incorporated in models of any type. (See also Buiter (1982 a and 1982 b).)

THE OPEN ECONOMY

From the budget constraint of the simplified open economy, the expression for the percentage growth rate of the nominal money stock given in equation (18) can be obtained, as follows:

$$\frac{\dot{H}}{H} = V\Big[\frac{G^c + \delta K^G - \tilde{\tau}}{Y} + \Big(r + \frac{\dot{p}}{p}\Big)\Big(\frac{B^H + B^F}{pY}\Big) + r\Big(\frac{\tilde{B}^H + \tilde{B}^F}{Y}\Big) + \frac{i^* e}{pY}(B^{*H} + B^{*F} - E^*) - r^G\frac{K^G}{Y} + \frac{\dot{K}^G}{Y} - \frac{1}{p}\Big(\frac{\dot{B}^H + \dot{B}^F}{Y}\Big) - \Big(\frac{\dot{\tilde{B}}^H + \dot{\tilde{B}}^F}{Y}\Big) - \frac{e}{p}\Big(\frac{\dot{B}^{*H} + \dot{B}^{*F} - \dot{E}^*}{Y}\Big)\Big] \tag{18}$$

To evaluate the longer-run monetary implications of the fiscal stance, it is again assumed that all stock/flow ratios on the right-hand side of equation (18) are kept constant. Equation (18) then reduces to

$$\frac{\dot{H}}{H} = V\Big[\frac{G^c - \tilde{\tau}}{Y} + (r - \gamma)\Big(\frac{B^H + B^F}{pY} + \frac{\tilde{B}^H + \tilde{B}^F}{Y} - \frac{K^G}{Y}\Big) + \Big(i^* - \Big(\frac{\dot{p}}{p} - \frac{\dot{e}}{e}\Big) - \gamma\Big)\Big(\frac{B^{*H} + B^{*F} - E^*}{pY}\Big)e + (r - (r^G - \delta))\frac{K^G}{Y}\Big] \tag{19}$$

With purchasing power parity, this simplifies to

$$\frac{\dot{H}}{H} = V\Big[\frac{G^c - \tilde{\tau}}{Y} + (r - \gamma)\Big(\frac{B^H + B^F}{pY} + \frac{\tilde{B}^H + \tilde{B}^F}{Y} - \frac{K^G}{Y}\Big) + (r^* - \gamma)\Big(\frac{B^{*H} + B^{*F} - E^*}{p^*Y}\Big) + (r - (r^G - \delta))\frac{K^G}{Y}\Big] \tag{19'}$$

The evaluation of the long-term monetization implied by the fiscal stance requires the consideration of a deficit measure that has nominal debt service payments "corrected" for the effects of domestic inflation, exchange rate appreciation, and real growth.

In any particular period, the economy may well be far removed from the long-run trend captured in equations (17) and (19) or (19′). Actual monetary growth in the short run will be given by equations (16) or (18). If current inflation is a function only of

current monetary growth, as would be true, for example, if velocity were constant, the price level were perfectly flexible, and output grew at its exogenously given trend rate γ, then $\frac{\dot{p}}{p} = \frac{\dot{H}}{H} - \gamma$. Authorities concerned with inflation in the short run may not be gratified to know that the long-run rate of inflation implied by their fiscal stance is low, if current monetary growth and inflation are high. If, as seems more likely, current inflation is a function of current and past monetary growth, and a fortiori if current inflation depends also on anticipated future monetary growth (as it does in models with forward-looking rational expectations), then the long-run monetary growth expressions in equations (17), (19), and (19′) become relevant even for short-term and medium-term policy.

IV. Role of Implicit Assets and Liabilities

On the asset side of the public sector balance sheet, there are T, the present value of planned or anticipated future tax revenues, and A^M, the imputed value of the government's cash monopoly. On the liability side is N, the present value of future transfers and benefits under various entitlement programs. This section considers how the value of these implicit assets and liabilities changes over time, with the focus on N. The treatment of T, A^M, and private sector human wealth (in Section V) is analytically identical. The symbol N is defined in equation (20) as[15]

$$N(t) \equiv \int_t^{\infty} e - \int_t^u \hat{i}(s, t)ds \;\; \hat{n}(u, t)du \tag{20}$$

The change in the present discounted value of expected future benefits is given by

$$\frac{d}{dt}N(t) = i(t)\,N(t) - n(t) + \int_t^u e^{-\int_t^u \hat{i}(s,t)ds} \left[\frac{\partial}{\partial t}\hat{n}(u, t) - \hat{n}(u, t)\int_t \frac{\partial}{\partial t}\hat{i}(s, t)\,ds\right] du \tag{21}$$

The first two terms on the right-hand side of equation (21) show

[15]The appropriate discount rate may include a risk premium.

how the present value of future benefits changes if all expectations concerning the future flow of benefits and future interest rates remain the same. The last term shows the effect of changes (at time t) in expectations concerning future benefits $\left(\frac{\partial}{\partial t}\hat{n}(u,t)\right)$ and future interest rates $\left(\frac{\partial}{\partial t}\hat{i}(s,t)\right)$. As expected, upward revisions in future benefit entitlements raise the value of N, while higher future expected interest rates lower its value.

The only item on the right-hand side of equation (21) that appears in the cash-based public sector deficit or flow of funds accounts is $n(t)$, current benefit payments; $i(t)N(t)$ does not appear because future entitlements are not a marketable interest-bearing liability of the authorities. Changes in planned or expected future benefit entitlements appear in the accounts only if and when they actually become payable in the future, yet such "revaluations" of N are of considerable policy interest. Even if financial markets are not forward-looking—even if government borrowing affects market rates of return only when it actually occurs—increases in N unmatched by increases in T (or by cuts in other spending programs) imply increased future borrowing or money issues and thus mean trouble for the future. Financial markets, furthermore, appear to be linked intertemporally (as formalized, for example, by models of efficient asset market equilibrium that incorporate forward-looking rational expectations). A larger anticipated future borrowing requirement therefore affects asset prices and rates of return today. An unanticipated increase in future expected (inflation-corrected) deficits crowds out private spending today. The intangible items in the public sector balance sheet must be taken into account.

V. Public Sector Accounts and Private Behavior

THE PRIVATE AND OVERSEAS SECTORS' ACCOUNTS

Comprehensive balance sheets analogous to the public sector balance sheet of Table 1 are drawn up for the private sector and the overseas sector. (See Tables 5 and 6.) For reasons of space, the private sector balance sheet consolidates the household sector, the corporate sector, and the private financial sector. For practical applications, further sectoral disaggregation is often required. The balance sheets need little further explanation. Consumer durables and private residential housing can be viewed as included in

TABLE 5. PRIVATE SECTOR BALANCE SHEET

(At current prices)

Assets		Liabilities	
B^H	Net interest-bearing government debt denominated in domestic currency, held by residents	T	Present value of future taxes
eB^{*H}	Net interest-bearing government debt denominated in foreign currency, held by residents	W^p	Private sector net worth
$p\tilde{B}^H$	Net interest-bearing index-linked government debt, held by residents		
H	Stock of high-powered money		
N	Present value of social insurance and other entitlement programs		
F^H	Net interest-bearing claims on foreign sector denominated in domestic currency		
eF^{*H}	Net interest-bearing claims on foreign sector denominated in foreign currency		
$p_{K^p}K^p$	Value of claims on real reproducible capital (including inventories)		
$p_R(R - R^G)$	Land and mineral assets		
L	Present value of expected future labor income		

K^p, and their imputed service flows are subsumed under private income and consumption in the budget constraint.

For simplicity, it is assumed that all claims on, or debts to, the

rest of the world take the form of interest-bearing financial claims. Direct foreign ownership of domestic real capital or of domestic resources is not considered but could be added without difficulty. Human wealth (L), the present discounted value of expected future labor income, is a nonmarketable asset in the household balance sheet. The total national stock of land and mineral rights is assumed to be given by $\bar{R}$.[16]

The conventionally measured financial surplus of the private sector (at constant prices) and the change in real private net worth are given in equations (22) and (23), respectively:

$$\frac{\ell}{p} + r^p \frac{p_{Kp}}{p} K^p + r^R \frac{p_R}{p} R^p + \left(r + \frac{\dot{p}}{p}\right)\left(\frac{B^H}{p} + \frac{F^H}{p}\right) + \frac{ei^*}{p} \quad (B^{*H} + F^{*H}) + r\tilde{B}^H + \frac{n}{p} - \frac{\tau}{p} - C - \delta K^p \equiv \left(\frac{\dot{B}^H + \dot{F}^H}{p}\right) + \dot{\tilde{B}}^H + \frac{e}{p}(\dot{B}^{*H} + \dot{F}^{*H}) + \frac{\dot{H}}{p} + \frac{p_{Kp}}{p}\dot{K}^p - \frac{p_R}{p}\dot{R}^G \tag{22}$$

$$\frac{d}{dt}\left(\frac{W^p}{p}\right) \equiv \left(\frac{\dot{B}^H + \dot{F}^H}{p}\right) + \dot{\tilde{B}}^H + \frac{e}{p}(\dot{B}^{*H} + \dot{F}^{*H}) + \frac{\dot{H}}{p} + \frac{p_{Kp}}{p}\dot{K}^p - \frac{p_R}{p}\dot{R}^G + \frac{1}{p}(\dot{L} + \dot{N} - \dot{T}) + \left(\frac{\dot{p}_K \dot{p}}{p_K p} - \frac{\dot{p}}{p}\right) K^p + \left(\frac{\dot{p}_R}{p_R} - \frac{\dot{p}}{p}\right)(\bar{R} - R^G) - \frac{\dot{p}}{p}\left(\frac{B^H + F^H + H}{p}\right) + \left(\frac{\dot{e}}{e} - \frac{\dot{p}}{p}\right)\frac{e}{p}(B^{*H} + F^{*H}) - \frac{\dot{p}}{p}(L + N - T) \tag{23}$$

The conventionally measured financial surplus of the overseas sector (at constant prices) and the change in the real net worth of the overseas sector are given in equations (24) and (25), respectively:

[16]If Table 5 represents the balance sheet of those private agents currently alive, the horizons involved in N, T, and L would be finite if operative intergenerational bequest motives are absent. The symbols N and T in the private balance sheet would, therefore, be smaller than the corresponding items in the public sector balance sheet, even if public sector and private sector discount rates were identical. If there are operative intergenerational bequest motives, or if the private sector is viewed abstractly as containing both current and future generations, an infinite horizon for T, N, and L in Table 5 is appropriate. Even with common horizons, different discount rates for the public and private sectors could lead to changes in private net worth resulting from changes in the public sector balance sheet that leave public sector net worth unchanged. These issues are discussed later in this section.

TABLE 6. OVERSEAS SECTOR BALANCE SHEET

(At current prices)

Assets		Liabilities	
B^F	Overseas holdings of nominal government bonds denominated in domestic currency	eE^*	Net foreign exchange reserves of government
eB^{*F}	Overseas holdings of government bonds denominated in foreign currency	F^H	Net interest-bearing debt to domestic private sector denominated in domestic currency
$p\tilde{B}^F$	Overseas holdings of index-linked government debt	eF^{*H}	Net interest-bearing debt to domestic private sector denominated in foreign currency
		W^F	Overseas sector net worth

$$-X+\frac{e}{p}\,i^*(B^{*F}-F^{*H}-E^*)+\left(r+\frac{\dot{p}}{p}\right)\left(\frac{B^F-F^H}{p}\right)+r\tilde{B}^F$$
$$\equiv\frac{e}{p}\,(\dot{B}^{*F}-\dot{F}^{*H}-\dot{E}^*)+\left(\frac{\dot{B}^F-\dot{F}^H}{p}\right)+\dot{\tilde{B}}^F \tag{24}$$

$$\frac{d}{dt}\left(\frac{W^F}{p}\right)\equiv\frac{e}{p}\,(\dot{B}^{*F}-\dot{F}^{*H}-\dot{E}^*)+\left(\frac{\dot{B}^F-\dot{F}^H}{p}\right)+\dot{\tilde{B}}^F$$
$$-\frac{\dot{p}}{p}\left(\frac{B^F-F^H}{p}\right)+\left(\frac{\dot{e}}{p}-\frac{\dot{p}}{p}\right)\frac{e}{p}\,(B^{*F}-F^{*H}-E^*) \tag{25}$$

These equations require little explanation. For the private sector, the difference between the financial surplus (at constant prices) and the change in real net worth reflects capital gains and losses on existing marketable assets and liabilities (including capital gains and losses that are due to inflation and exchange rate changes) and changes in the value of the intangible and nonmarketable items L, N, and T. On the left-hand side of equation (22), because only cash transactions are included, the implicit liquidity and convenience yield on money balances $\left(\rho^M\frac{H}{p}=i\frac{H}{p}\right)$ as an item of private consumption and of private income is omitted.

POSITIVE IRRELEVANCE AND NORMATIVE RELEVANCE OF DEBT NEUTRALITY

The simplest theory of the interaction of the private and public sectors is based on the so-called pre-Ricardian debt-neutrality hypothesis. (See Barro (1974), Carmichael (1979), Buiter and

TABLE 7. CONSOLIDATED PUBLIC AND PRIVATE SECTOR BALANCE SHEET

Assets	Liabilities
$p_{K^{soc}}K^{soc}$	
$p_G K^G$	
$p_{K^P}K^P$	$W^P + W^G$
$p_R\bar{R}$	
$e\,(E^* + F^{*H} - B^{*F})$	
$+ F^H - B^F - p\bar{B}^F$	
L	
pA^M	

Tobin (1979), Buiter (1980), and Tobin and Buiter (1980).) This hypothesis holds that, given the level and composition of the public sector's real spending on goods and services, private sector behavior is invariant with respect to changes in the taxation/borrowing mix that finances this spending. Most of the formal models dealing with this issue concern closed barter economies, and the formal invariance propositions tend to be stated in terms of borrowing versus taxing without explicit consideration of monetary financing. For all three financing modes, the informal literature on the subject does, however, assert the irrelevance for real outcomes of the way in which governments finance their spending. The argument underlying this Modigliani-Miller theorem for the public sector vis-à-vis the private sector runs as follows. Spending must be financed (in a closed economy) by taxation, by borrowing, or by printing money. Borrowing is merely deferred taxation. A switch between taxation and borrowing should, therefore, not affect the permanent income and consumption behavior of rational well-informed private agents. Monetary financing implies the imposition of an inflation tax, which under restrictive conditions has the same effect on permanent income as explicit taxes.[17]

With debt neutrality, private sector spending behavior (for a given program of public spending on goods and services) is con-

[17]The Modigliani-Miller theorem for money financing has been established formally for models in which money serves only as a store of value. Such "money" has only the name in common with what economists have always meant by money—that is, a means of payment or a medium of exchange. (See Wallace (1981).)

strained only by the consolidated national balance sheet, as shown in Table 7. The distribution of the ownership of the nation's resources between the public and private sectors is irrelevant. The national flow of funds account, including nonmarketable imputed income and consumption streams, is given in equation (26)

$$\begin{aligned}
&\frac{1}{p}\{\ell + r^{soc}p_{K^{soc}}K^{soc} + r^{G}p_{G}K^{G} + r^{p}p_{K^{p}}K^{p} + r^{R}p_{R}\bar{R} \\
&+ i^{*}e(E^{*} + F^{*H} - B^{*F}) \\
&+ i(F^{H} - B^{F}) - rp\tilde{B}^{F} + iH\} - \left\{G^{c} + G^{soc} + C\right. \\
&\left. + \frac{\delta}{p}(p_{K^{soc}}K^{soc} + p_{G}K^{G} + p_{K^{p}}K^{p}) + \rho^{M}\frac{H}{p}\right\} \equiv \frac{1}{p}\{p_{K^{soc}}\dot{K}^{soc} \\
&+ p_{G}\dot{K}^{G} + p_{K^{p}}\dot{K}^{p} + e(\dot{E}^{*} + \dot{F}^{*H} - \dot{B}^{*F}) \\
&+ \dot{F}^{H} - \dot{B}^{F} - p\,\dot{\tilde{B}}^{F}\} \equiv \frac{S}{p}
\end{aligned} \tag{26}$$

The first bracketed term on the left-hand side of equation (26) contains current income, including the imputed return from the government's cash monopoly $i\frac{H}{p}$. This item is matched in the second bracketed term, containing current consumption, by $\rho^{M}\frac{H}{p}$, the imputed value of the nonpecuniary services of money consumed by the private sector. It is possible to omit both items if desired. The change in real national comprehensive net worth is given by

$$\begin{aligned}
\frac{d}{dt}\left(\frac{W}{p}\right) \equiv \frac{d}{dt}\left(\frac{W^{p} + W^{G}}{p}\right) &\equiv \frac{S}{p} + \left(\frac{\dot{p}_{k}^{soc}}{p_{k}^{soc}} - \frac{\dot{p}}{p}\right)\frac{p_{K^{soc}}K^{soc}}{p} \\
&+ \left(\frac{\dot{p}_{G}}{p_{G}} - \frac{\dot{p}}{p}\right)\frac{p_{G}}{p}K^{G} \\
&+ \left(\frac{\dot{p}_{K^{p}}}{p_{K^{p}}} - \frac{\dot{p}}{p}\right)\frac{p_{K^{p}}}{p}K^{p} + \left(\frac{\dot{p}_{R}}{p_{R}} - \frac{\dot{p}}{p}\right)\frac{p_{R}}{p}\bar{R} \\
&+ \left(\frac{\dot{e}}{e} - \frac{\dot{p}}{p}\right)\frac{e}{p}(E^{*} + F^{*H} - B^{*F}) \\
&- \frac{\dot{p}}{p}\{F^{H} - B^{F}\} + (\dot{L}/p) + \dot{A}^{M}
\end{aligned} \tag{27}$$

The change in real net worth equals saving $\left(\frac{S}{p}\right)$ *plus* capital gains on marketable assets *plus* changes in the imputed or implicit value of nonmarketable items of wealth. A program of total national consumption in line with permanent national income means a choice of the value of the second bracketed terms in equation (26) so that the expected value of $\frac{d}{dt}\left(\frac{W}{p}\right) = 0$. Such a consumption program is ex ante indefinitely sustainable and serves as a useful benchmark for consumption planning in this debt-neutral economy.

Debt neutrality is bad positive economics. It requires private agents to be infinite lived or to have operative intergenerational bequest and child-to-parent gift motives in every generation. Perfect capital markets are another necessary condition: future labor income is a source of current spending power on a par with current disposable income and current holdings of government debt.[18]

The economic behavior that would be generated under debt neutrality is, however, a useful guide to what the aims of policy should be in a world in which a variety of capital market imperfections prevent the "unaided" private sector from acting according to permanent income principles.

It is, for example, well known that, in the absence of operative private intergenerational transfer motives, changes in the borrowing/taxation mix can redistribute the burden of financing a given government spending program between generations, even without the existence of capital market imperfections. If government is motivated by a concern for the utility (lifetime consumption patterns) of future generations as well as of the current generation, it can use the budgetary and financial mechanism to induce the current generation to act as if it were constrained by permanent private sector income rather than merely by the present value of its own lifetime resources.

The endowments listed on the asset side of Table 7, the nation's

[18]Debt neutrality—that is, invariance of the solution trajectories of real economic variables under changes in the borrowing/taxation mix of the government—also requires lump-sum taxes. With nonlump-sum (or distortionary) taxes, transfers, and subsidies, public sector claims on the private sector and private sector claims on the public sector still are netted out in the balance sheet. Real behavior is altered when the borrowing/taxation mix changes because the familiar allocative effects of nonlump-sum taxes, etc., will alter equilibrium prices and rates of return.

technology (broadly defined) and the international trading and lending or borrowing conditions that it faces, represent the unavoidable constraints on the nation's intertemporal transformation of resources.[19] The purpose of financing policy—that is, the choice of the tax, transfer, borrowing, and money creation mix for a given real public spending program on goods and services—should be to keep additional constraints, such as cash flow shortfalls, inadequate liquidity, insufficient collateral, nonmarketabil-

[19]While it might, for example, be possible for an individual to consume today by borrowing against the present value of future labor income, a closed economic system cannot effect intertemporal shifts of future labor endowments. In an ideal market economy, these and other technological constraints are reflected in the sequence of demands and supplies over time and thus in equilibrium prices (including the asset prices that enter the balance sheets) at each point in time. In an ideal planned economy, the programming of material balances and the use of shadow prices would ensure the same outcomes.

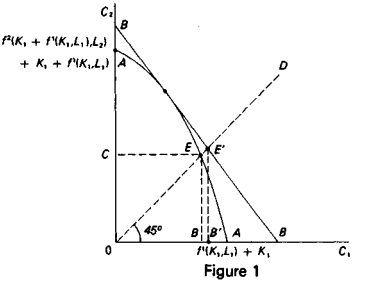

Figure 1

Consider, for example, a simple two-period economy. The trade-off along the intertemporal consumption possibility frontier of c_1 (consumption in period 1) for c_2 (consumption in period 2) is given by AA in Figure 1. It is defined by the initial endowment of capital (K_1), the labor endowments in periods 1 and 2 (L_1 and L_2), the well-behaved production functions in the two periods [$f^1(K_1, L_1)$ and $f^2(K_2, L_2)$] and the constraint [$0 \leq c_1 \leq f^1 + K_1$, $o \leq c_2 \leq f^2 + K^2$, $c_1 = f^1(K_1, L_1) + K_1 - K_2$]. (See Figure 1.)

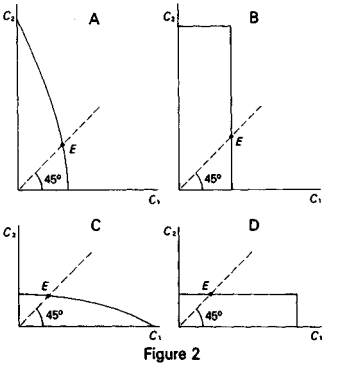

Figure 2

The permanent income in this closed system is given by $0D = 0C$, determined by the intersection of the consumption possibility frontier with the 45° line $0F$. The opportunity for international lending and borrowing at a rate r would raise the permanent income of this system unless the slope of the international capital market constraint BB (given by $-(1 + r)$) equals the slope of the closed economy locus at E. For the figure, it is shown how a low external interest rate raises permanent income to $0D'$. Figure 2 shows when a closed economy should not consume its permanent income in each period. Very favorable intertemporal transformation possibilities (Figure 2(A) and 2(B)) suggest consumption in excess of permanent income in period 2; the opposite applies in Figure 2(C) and 2(D). It is still the comprehensive balance sheet that matters for consumption, but constant net worth is unlikely to be optimal. Even with international lending and borrowing, the presence of nontraded goods, whose production can be augmented only slowly and at considerable cost, can make a program of consumption equal to permanent income infeasible or suboptimal.

ity of assets, and credit rationing, from becoming binding or, failing that, to minimize their incidence and consequences.[20]

Through their budgetary and financing policies, governments (within a national economy) and international organizations (within the international economic system) can act as superior financial intermediaries in changing the composition of private sector portfolios and nation-state portfolios, respectively. Well-designed policy interventions of this kind can minimize the extent to which disposable income, current cash flow, and the portfolio of liquid marketable financial assets become binding constraints on consumption, investment, production, and portfolio allocation, enforcing undesirable departures from behavior according to permanent income principles. Governments, through their unique ability to impose taxes, through their monopoly of legal tender, and through the superior quality of their debts, have a "comparative advantage" over the private sector in borrowing to smooth out income streams.[21] The same holds, although perhaps to a lesser extent, for certain international organizations vis-à-vis nation-states.

In what follows, a few examples are given to illustrate this role of the government as the natural borrower and the unique ability of the government to restructure the conventionally measured sectoral balance sheets, flow of funds accounts, and income expenditure accounts so as to permit the economy as a whole to

[20]The most desirable policy—eliminating capital market imperfections as far as possible—should be pursued to the full. Budgetary policies should aim to neutralize the imperfections that cannot be eliminated.

[21]Because governments have the unique power to impose taxes (unrequited transfers to itself) and because of their ability to declare certain of their liabilities legal tender, the risk of default on government bonds is less than that on private debt. Total current and future natural income is in a sense the collateral for government borrowing. National income tends to be much less variable and uncertain than the income of individual private agents.

Governments effectively pool individual risks and thus eliminate diversifiable risk. An obvious question is why this risk-sharing cannot be done equally well through private insurance markets. One answer is that, even if this were possible, it would be more costly than making minor alterations to a tax structure that is required in any case. A second answer relies on familiar problems of moral hazard in insurance markets. It may be possible to devise efficient private insurance schemes for "bad luck" default. Private insurance markets will operate inefficiently (or may not exist at all) if there is frequent "voluntary" or "dishonest" default and if lenders and insurers cannot differentiate between honest and dishonest borrowers. If it is easier and less costly for the government to levy taxes on reluctant taxpayers than it is for private lenders and insurers to compel performance by dishonest borrowers, then governments have a role as financial intermediaries and government debt is not "neutral." (See Webb (1981; 1982).)

approximate more closely behavior that is constrained only by comprehensive wealth or permanent income.

Fiscal aspects of discovery of a natural resource

Consider the effects of an oil discovery on public sector and private sector balance sheets. This discovery can be represented by an unexpected increase in p_R, the value of property rights in land and mineral assets by, say, $dp_R > 0$. To the extent that these property rights are privately owned and marketable, disposable private net worth increases by $(\bar{R} - R^G)\,dp_R$. Following permanent income principles, private agents would consume the perpetuity equivalent of this capital gain in each period. If spending were constrained by a dearth of marketable financial wealth to begin with, a temporarily larger increase in private consumption spending would result. The value of public sector assets increases by $R^G dp_R$. The government could choose to increase its own consumption spending in line with the permanent income equivalent of this capital gain. If it chooses not to do so, it faces the problem of enabling the private sector to raise its spending by the perpetuity equivalent of $R^G dp_R$.

One way to approach this situation would be to distribute to the private sector (in the form of tax cuts or increased transfer payments) the stream of actual additional oil revenues $r^R(t)\,R^G(t)\,dp_R(t)$ as and when they accrue. The present value of such anticipated future tax cuts or increases in transfer payments is, however, a nonmarketable highly illiquid asset that is singularly poor collateral for private borrowing. If there is a gestation period before the new oil comes on stream and a fortiori if development costs have to be incurred before the oil starts to flow, the additional cash flow to the government, and thus to the private sector, may well be negative for several years.

Private agents whose current spending is constrained by current disposable income or other forms of illiquidity will therefore be unable to raise their spending in line with their permanent income. A superior fiscal option is for the government, as soon as the new oil wealth is discovered, to cut taxes or raise transfers by an amount equal to the perpetuity equivalent or annuity value of the discovery. (See Flemming (1982).) This option will require additional government borrowing until the moment when actual revenues exceed their permanent value, at which time the authorities will be able to retire the temporary debt issues, whose function is merely to relax the spending limits on cash-flow-con-

strained households. With this transformation of future tax cuts into present tax cuts, the nation can consume in line with its new and higher permanent income; the government has transformed future tax cuts into disposable income.

An alternative proposal to handle the same problem has been made by Samuel Brittan of the *Financial Times*. His proposal amounts to a capital gift to the private sector by the public sector—the equity in the newly discovered oil riches is transferred to the private sector. If this newly privatized wealth takes the form of marketable financial claims, private spending in line with permanent income is again likely to be encouraged, relative to a policy of cutting taxes in line with current oil revenues—the government has transformed future tax cuts into disposable financial wealth.

In this paper, the same symbol T is used both for the present value to households of expected future tax payments and for the present value to the government of expected future tax receipts. Similarly, N represents both the household asset and the government liability corresponding to the stream of future benefits (n).

The presence of an impact on private spending of offsetting changes in, say, T, N, and B^H that would prima facie appear to leave household net worth unchanged is then attributed, in a rather ad hoc manner, to differences in the liquidity, marketability, and usefulness as collateral of T, N, and B^H. An alternative (but still ad hoc) way of avoiding the debt-neutrality conundrum is to assume that households discount future taxes and benefits at a higher rate than the market rate of return on bonds (and at a higher rate than the government discounts its tax revenues and benefit payments). To avoid a longer list of symbols and notation, this approach was not adopted here. A truly satisfactory treatment of these issues requires the tools of the new microeconomics of credit rationing, collateral, and other capital market imperfections, whose beginnings can be found, for example, in the work of Jaffee and Russell (1976), Benjamin (1978), Stiglitz and Weiss (1981), and Webb (1981; 1982).

"Cyclical" corrections to public sector deficits

Consider an economy in which the level of economic activity—as measured, for example, by output and employment—cycles around a trend. It is not assumed at this stage that these cycles represent Keynesian departures from full employment and nor-

mal capacity utilization. They could be regular swings in the natural rate of unemployment.

If the economy represented by equation (10) is simplified even further by ignoring public sector capital and index-linked bonds, the government budget constraint becomes

$$\frac{\dot{H}+\dot{B}^H}{p} \equiv G^c - \tilde{\tau} + \left(r + \frac{\dot{p}}{p}\right)\frac{B^H}{p} \tag{28}$$

$\bar{Y}$, the trend level of output, grows at a proportional rate, γ. Actual output (Y) cycles steadily around this trend. If the demand for debt is a demand for real debt *per capita* and if population (in efficiency units) and $\bar{Y}$ grow at the same rate, then government financing tends to exercise upward pressure on the real interest rate when $\frac{d}{dt}\left(\frac{B^H}{p\bar{Y}}\right) > 0$ at the given real interest rate and the given real per capita stock of money balances. From equation (28), it can be seen that

$$\frac{d}{dt}\left(\frac{B^H}{p\bar{Y}}\right) = \frac{G^c - \tilde{\tau}}{\bar{Y}} + (r-\gamma)\frac{B^H}{p\bar{Y}} - \frac{\dot{H}}{p\bar{Y}} \tag{29}$$

It is a stylized empirical fact that, while exhaustive public spending (G^c) tends to grow in line with trend output, taxes net of transfers ($\tilde{\tau}$) tend to vary positively with the current level of economic activity. These two relationships can be summarized by

$$G^c = g^c\bar{Y} \qquad 1 > g^c > 0 \tag{30'}$$

$$\tilde{\tau} = \theta Y \qquad 1 > \theta > 0 \tag{30''}$$

Substituting equations (30′) and (30″) in equation (29) yields

$$\frac{d}{dt}\left(\frac{B^H}{p\bar{Y}}\right) = g^c - \frac{\theta Y}{\bar{Y}} + (r-\delta)\frac{B^H}{p\bar{Y}} - \frac{\dot{H}}{p\bar{Y}} \tag{31}$$

Similarly, the proportional rate of growth of the money stock, assuming that the authorities keep constant the stock of real bonds per capita or per unit of trend output, is given by

$$\frac{\dot{H}}{H} = V\left\{g^c\frac{\bar{Y}}{Y} - \theta + (r-\delta)\frac{B^H}{pY}\right\} \tag{32}$$

Thus, the current change in $\frac{B^H}{p\bar{Y}}$ overstates (understates) its trend or long-run average rate of change, and the current rate of growth of the nominal money stock overstates (understates) its trend or

long-run average rate of growth whenever output is below (above) its trend value.

Even if it is only the current values of $\frac{d}{dt}\left(\frac{B^H}{p\bar{Y}}\right)$ and $\frac{\dot{H}}{H}$ that matter for current crowding out and current inflation, respectively, the trend or long-run behavior of $\frac{d}{dt}\left(\frac{B^H}{p\bar{Y}}\right)$ and $\frac{\dot{H}}{H}$, obtained by evaluating equations (31) and (32) with output at its trend value $\bar{Y}$, will still be of interest to all but the most short-sighted governments.

Furthermore, if current crowding out is a function of anticipated future changes in $\frac{B^H}{p\bar{Y}}$ and current inflation depends on anticipated future monetary growth (as well as possibly on past monetary growth), current $\frac{d}{dt}\left(\frac{B}{p\bar{Y}}\right)$ and $\frac{\dot{H}}{H}$ will be a poor proxy for future developments if there are transitory swings in the deficit. From this perspective, cyclical corrections are a simple, if ad hoc, way of approximating the long-run implications of the fiscal stance for crowding out and monetary growth—that is, a quick method for calculating the permanent deficit.

Evaluation of Y at $\bar{Y}$ in equations (31) and (32) yields a reasonable approximation to the long-run averages only if the positive and negative deviations of Y from $\bar{Y}$ cancel each other out in the long run, as would be true, for example, if output followed a regular sinusoidal motion about trend, such as $\frac{Y(t)}{\bar{Y}(t)} = 1 + A\cos(\omega_t + \epsilon)$. If positive and negative deviations of Y from $\bar{Y}$ do not balance on average, the simple cyclical correction gives a biased estimate of the long-run crowding-out pressure and monetary growth implications of the deficit. Such estimates will have to be replaced by an explicit averaging of equations (31) and (32) over long periods.

There are good reasons for letting taxes net of transfers vary with the current level of economic activity rather than making them functions of long-run or permanent income. It is assumed, as seems reasonable, that during the downswing a significant number of private agents are constrained in their spending by current disposable income.[22] By reducing taxes and increasing borrow-

[22]It may be desirable to replace the phrase "spending constrained by current disposable income" by the following: the effect of current disposable income on spending exceeds that of permanent income multiplied by the share of current

ing during the downswing, public spending during that period will be financed to a larger extent by private agents who are not constrained by current disposable income (the purchasers of the bonds). Total consumption, therefore, declines by less than it would decline if taxes (which are assumed to fall equally on disposable-income-constrained and permanent-income-constrained private agents) had been kept constant. In the upswing, the additional debt incurred during the downswing can be repaid out of higher than normal taxes.[23] The net result is that consumption is smoothed out over the cycle—a desirable result on grounds of intertemporal allocative efficiency even if product and factor markets cleared continuously. If wage or price stickiness exists, Keynesian problems of the failure of effective demand can also occur. Exogenous shocks to demand can set in motion contractionary or expansionary multiplier processes if private agents are constrained in their spending by current disposable income. The usefulness of automatic stabilizers and of countercyclical budget deficits derives from private spending that is constrained by current disposable income and from other capital market imperfections. It is reinforced by output and labor market disequilibrium.

Constraints of current disposable income on private consumption need not be absolute. Regular anticipated cycles in real income do not, of course, imply corresponding cycles in consumption, even for individuals who can borrow only on very unfavorable terms in order to consume in excess of their current disposable income. They have the option of accumulating a stock of liquid savings that can be run down and built up again cyclically. Even with uncertain stochastic swings in the level of economic activity, a buffer stock of liquid financial assets may permit a measure of income smoothing. Such private saving strategies are, however, likely to be inferior substitutes for access to borrowing on the terms available to the government.

A further option available to the government is to choose partial money financing of increases in cyclical deficits rather than borrowing. This option is more attractive the smaller the number and the less the wealth of private agents that are not constrained by current disposable income and liquidity. The more inelastic the

disposable income in permanent income (allowing for the effect of changes in current income on expectations about future income streams).

[23]These higher taxes during the upswing fall on a population that, on average, is likely to be less constrained by current disposable income than it was during the downswing.

demand for government bonds, the larger is the increase in interest rates that is required to unload additional bond issues on the private sector. (Access to international capital markets may make the total demand for domestic government bonds considerably more interest elastic than private domestic demand alone.) Such countercyclical money issues and withdrawals need not imply any increase in the trend rate of growth of the money stock.

It is to be noted that this view of stabilization policy suggests that taxes and transfers, rather than "exhaustive" public spending on goods and services, should be used to dampen fluctuations in economic activity. Public consumption spending, like all consumption spending, should be smoothed over time in line with permanent income. Public sector capital formation should have its time profile determined largely by the optimal public sector consumption program. Public works and other public spending on goods and services can be effective in regulating the overall level of demand and of economic activity, but they are likely to distort the optimal private sector/public sector consumption mix, unlike well-designed changes in the taxation, borrowing, and money financing mix.

Sales of public sector assets and cosmetic changes in PSBR

Sales of existing public sector financial assets do not appear in the SNA public sector financial surplus, but they do appear in the public sector borrowing requirement (PSBR) and similar transactions records. A "stock-shift" sale of government-owned rights to natural resources ($-dR^G$) or of claims to public enterprise capital ($-dK^G$) to the private sector would not in itself alter public sector or private sector net worth. If it is assumed that the government wishes neither to reduce the level of the money stock nor to acquire private sector capital, the counterpart of a reduction in R^G or in K^G would be a reduction in B^H, B^{*H}, or $\tilde{B}^H$ with $P_R dR^G + p_K{}^G dK^G = dB^H + edB^{*H} + pd\tilde{B}^H$.

Nationalizing or denationalizing may, of course, be desirable for reasons of efficiency. Total national net worth is altered by such transfers of ownership if the efficiency with which the resources are managed differs between sectors. The financial consequences, however, are virtually nil, because bonds in private portfolios are replaced by other financial claims. If the government gradually sells its assets to finance a flow of spending $\left(p_R \frac{d}{dt} R^G + p_G \frac{d}{dt} K^G < 0\right)$, the difference between this policy and

one of conventional financing by borrowing is also largely cosmetic.[24] When it borrows, the government incurs an obligation to service the additional debt. When it sells assets, it loses the future income from the assets that it sells. It makes little sense, therefore, to attribute economic significance to the distinction between sales of public debt (below the line) and sales of government financial assets (above the line) as is done with the PSBR in the United Kingdom.

VI. Conclusion

The general conclusions have been stated in the introductory paragraphs. This section contains some more specific and practical remarks.

Comprehensive wealth and permanent income accounting requires explicit judgments concerning expectations about the future because of the need to evaluate nonmarketable, often intangible, and merely implicit assets and liabilities, such as future tax and benefit streams. This requirement is considered to be a salutary aspect of comprehensive wealth accounting. It brings out the distinction between mechanistic bookkeeping and recording of transactions, on the one hand, and accounting for economic policy evaluation and design, on the other hand.

Inflation accounting in the public sector is long overdue. Money illusion in the public sector should cease to be an obstacle to sensible budgetary policy. Taken alone, the public sector financial deficit and the PSBR (at current or constant prices or as a proportion of gross national product) are not very informative statistics. They must be corrected for the change in the real value of the outstanding stocks of interest-bearing public debt to evaluate either the implications of the deficit for financial crowding out or the "eventual monetization" implied by the government's fiscal stance. Analogous corrections should be made to the conventionally measured external current account deficit or surplus; it is necessary to allow for changes in the real value of external assets and liabilities owing to changes in the price level and the nominal exchange rate.

Omission of government-owned capital and public sector property rights in land and natural resources from the public sector

[24]The earlier caveat about differences in the efficiency with which the assets are managed also applies here.

balance sheet can give a misleading picture of the net worth of the public sector and of its present and future fiscal and financial options. This holds true especially for countries where the government owns significant mineral rights (such as Norway, the United Kingdom, the United States, and many of the oil producing nations) and countries in which the nationalized sector accounts for a large share of economic activity (such as the United Kingdom and many developing countries). The sign of the effect on public sector net worth of including publicly owned capital is not self-evident; virtually open-ended commitments to subsidize loss-making public enterprises depress net worth.

The implicit assets and liabilities of the public sector represented by the streams of future tax revenues and of future benefits and transfer payments may well dwarf the marketable financial assets and liabilities in the government balance sheet.

Transitory (e.g., cyclical) deficits and surpluses are mechanisms that enable private agents who are constrained by current disposable income to smooth out consumption and to keep it more closely in line with permanent income. By permitting consumption to be maintained in the face of a transitory decline in income, they also mitigate unemployment and excess capacity if price and wage rigidities prevent an instantaneous market-clearing response to demand shocks. It is sound fiscal management for governments to borrow in the downswing "on behalf of" private agents with less favored access to capital markets and to retire these countercyclical debt increases during the upswing, regardless of the rate of inflation. Alternatively, cyclical increases in the deficit could be partly or wholly financed by money creation, to be reversed during the upswing. The optimal financing mix of cyclical (or transitory and reversible) deficits need not be the same as that of permanent deficits. A consideration of this important issue would require the analysis of specific detailed models, which are well beyond the scope of this paper. The focus here is on general propositions that rely on as few detailed model-specific properties as possible.

APPENDIX

List of Symbols

p_K^{soc} price of social overhead capital

p_G	price of public enterprise capital
p_{Kp}	price of private capital
p_R	price of land and property rights to natural resources
p	domestic general price level
p^*	foreign general price level
e	nominal exchange rate (domestic-currency price of foreign exchange)
i	nominal interest rate on bonds denominated in domestic currency
r	domestic real interest rate
r^G	rate of return on public enterprise capital
ρ^M	nonpecuniary rate of return on money balances
r^R	rate of return from ownership of land and natural resources
r^p	rate of return on private capital
r^{soc}	rate of return on social overhead capital
i^*	nominal interest rate on bonds denominated in foreign currency
r^*	foreign real interest rate
K^{soc}	stock of social overhead capital
K^G	stock of public enterprise capital
R^G	government-owned land and rights to natural resources
R^p	privately owned land and rights to natural resources
$\bar{R}$	total rights to natural resources
B^H	domestically held nominal government bonds
B^F	foreign-held nominal government bonds
B^{*H}	domestically held foreign-currency-denominated government bonds
B^{*F}	foreign-held foreign-currency-denominated government bonds
$\tilde{B}^H$	domestically held index-linked government bonds
$\tilde{B}^F$	foreign-held index-linked government bonds
H	stock of high-powered money
E^*	stock of foreign exchange reserves
N	present value of entitlement programs
T	present value of tax programs
L	present value of expected future labor income
W^G	public sector net worth
W^p	private sector net worth
W^F	overseas sector net worth
W	$W^G + W^p$
F^H	domestic-currency-denominated private claims on overseas sector
F^{*H}	foreign-currency-denominated private claims on overseas sector
K^p	private capital stock
A^M	net value of government's cash monopoly

G^{soc} government consumption of services of social overhead capital

G^c government consumption spending (excluding capital consumption and consumption of imputed services of social overhead capital)

G^I $\frac{d}{dt}K^G$ (net investment in public enterprise capital)

τ current taxes

n current transfer and benefit payments

$\tilde{\tau}$ $(\tau - n)/p$

C private consumption

X trade balance surplus, including net international transfer receipts

Y real output

$\bar{Y}$ capacity or trend output

ℓ current labor income

S total national saving

γ natural rate of growth

δ proportional rate of depreciation

V income velocity of circulation of money

$\dot{x}$ $\frac{d}{dt}x$

$\hat{x}(s, t)$ value of x expected at t to prevail at s

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Estimating Models of Financial Market Behavior During Periods of Extensive Structural Reform: The Experience of Chile

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IN DESIGNING A FINANCIAL PROGRAM, a sample of data taken from the prestabilization program period is often used to obtain empirical estimates of the parameters of a variety of behavioral relationships. Implicit in the use of these estimated empirical relationships is the assumption that, at least in the short run, the financial program will affect the performance of a given economic structure but will not fundamentally alter the structure itself. While this assumption may be quite reasonable for many economies, there is the problem of how to estimate these behavioral relationships for countries that are undergoing extensive structural change over an extended period as a result of sweeping trade, fiscal, and financial market reforms.

For the period 1973–81, Chile provides an example of an economy that underwent extensive trade, fiscal, and financial policy changes designed to open the economy to international influences. The trade policies encompassed the replacement of a system of quotas and high tariffs with a uniform tariff of 10 percent an exchange rate policy that evolved from a crawling peg complemented by occasional discrete adjustments, to a preannounced

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The author has benefited from the comments of Fund colleagues but is naturally responsible for any remaining errors. An earlier version of this paper was presented at the XIX Meeting of Central Bank Technicians of the American Continent at Santiago, Chile in November 1982.

crawl, and, finally, to a fixed exchange rate. In financial markets, the program included the removal of interest rate ceilings, substantial reductions in required reserves in financial institutions, the payment of interest on bank reserves, sustained reductions in the Central Bank's issuance of base money and subsidized lending programs, and opening up the financial system to increased domestic and international competition. Finally, fiscal reforms resulted in expenditures and tax changes that created a substantial fiscal surplus. Table 1 illustrates the sequencing and scope of some of the reforms that took place during 1975–80.

The objective of this analysis is to empirically estimate the response of inflation, the balance of payments, and financial markets to the opening of the economy and other reform elements within a framework that is consistent with the usual financial programming structure. The rest of this paper has four sections. Section I presents a discussion of the financial programming framework used to describe the linkages between inflation, the balance of payments, interest rates, and financial aggregates. Section II analyzes the empirical results for a sample of data from July 1976 to June 1980. Section III contrasts these estimates with those obtained recently for Argentina and also examines the reasons for the persistence of high nominal and real interest rates. Section IV sets forth the conclusions.

I. Basic Model

To describe the channels by which the trade, fiscal, and financial reforms influenced the Chilean domestic economy, it is convenient to first describe the determinants of financial system behavior and then turn to the determinants of domestic inflation and the balance of payments. In the financial markets, this model distinguishes between the behavior of banks, financieras, and the nonfinancial sector. The financieras are financial institutions that accept short-term deposits and make short-term consumer and enterprise loans. The deposits and loans of financieras are viewed to some degree as substitutes for comparable bank assets and liabilities. The nonfinancial sector consists of households and firms. In each sector, it is assumed that wealth holders attempt to achieve some desired stock and composition of wealth or net worth but that adjustment costs make it unlikely that actual and desired portfolio holdings are equal at each instant.

TABLE 1. CHILE: SELECTIVE LISTING OF REFORM MEASURES, 1975–80[1]

Trade Reform	Financial System Reforms	Fiscal Policy
1974–75		
Prior to the trade reform, there was an extensive system of import controls that included (1) a compulsory waiting period of 90 to 120 days for delivery of foreign exchange by central banks, (2) a list of some 2,400 products subject to a 10,000 percent deposit requirement, and (3) an unweighted average import duty of 67 percent at the end of 1974.	Prior to the start of the financial reform in 1974, the principal financial institutions consisted of the Central Bank, the Banco del Estado (a state bank), the commercial banks, and a system of savings and loan institutions (SINAP). This system was characterized by interest rate ceilings, high required reserve ratios, and limited competition between financial institutions.	To improve the consolidated government budget position, the authorities undertook a series of measures in April–May 1975 including (1) a 10 percent surcharge on income and property taxes, (2) the elimination of most exemptions to the value-added tax (VAT) and increases in excise taxes, (3) a 15 percent reduction in real terms in local currency expenditure and a 25 percent real cut in foreign currency expenditure other than debt payments, (4) a hiring freeze, (5) greater control over public enterprises, and (6) accelerated sales of assets of official entities. Despite these measures, there was a consolidated government deficit equal to about 2 percent of gross domestic product (GDP).
In August 1975 a new tariff program designed to establish (by the beginning of 1978) a tariff schedule with no rate higher than 35 percent was put in place. The program provided for a linear tariff reduction schedule composed of five stages with six months between each modification. The first modification was made in February 1976.	In May 1974 short-term ceiling interest rates were increased, full inflation adjustment of principal was authorized on credits with maturities of at least one year, and investment companies (financieras) were allowed to operate beside commercial banks at interest rates up to 50 percent higher than maximum bank rates. In November 1974 interest rates paid by banks on time deposits were freed, and proceeds of such deposits could be used to purchase commercial paper at free rates.	

In 1975 there was rapid growth of the financieras but serious difficulties with the SINAP system, as it lost deposits to the financieras. Throughout 1975 various actions were taken to stem the outflow of deposits from SINAP, including limitations on deposit withdrawals and the extension of Central Bank regulatory policies to include the financieras. To improve the position of banks vis-à-vis the financieras and to further the liberalization process, bank lending rates were freed (in April 1975) and an 8 percent reserve requirement was established on financiera liabilities.

1976

The schedule of tariff reductions was speeded up. Revised schedules were issued for changes to be made in December 1976, January 1977, and April 1977. The unweighted average tariff rate fell to 49 percent at the end of 1975 and to 27 percent at the end of 1976. A compulsory waiting period for delivery of foreign exchange was gradually reduced and then eliminated. A list of products subject to an

In May 1976 the Central Bank began to pay interest on bank reserves against time deposits. Initially this rate was pegged to the treasury bill rate. After November 1976 the rate was linked to the rate offered by banks on their time deposits. At first, the interest rate on reserves was equal to 70 percent of the time deposit rate during the same month. Subsequently, the proportion was raised to 90 percent,

The consolidated government accounts moved into a surplus equal to approximately 4 percent of GDP.

TABLE 1 *(continued)*. CHILE: SELECTIVE LISTING OF REFORM MEASURES, 1975–80[1]

Trade Reform	Financial System Reforms	Fiscal Policy
advance deposit of 10,000 percent was reduced basically to imports of used motor vehicles.	and in June 1977 to 100 percent. During 1976 the authorities began to lower reserve ratios in the financial system on a gradual but continuous basis. Between mid-1976 and mid-1979, for example, these changes lowered the reserve ratio on sight deposits from 85 percent to 52 percent and on 30-day to 89-day time deposits from 55 percent to 16 percent.	
1977		
Tariff reductions in 1977 brought the average tariff to 16 percent by the end of the year. The final stage of the tariff reform consisted of monthly tariff reductions between December 1977 and June 1979. At the end there would be a uniform tariff of 10 percent on all imports (except automobile items).	In November 1977 the payment of interest on bank reserves was extended to 50 percent of excess reserves. The reduction in reserve ratios continued throughout the year.	In January 1977 steps were taken to extend the use of indirect taxes and to reduce the role of direct taxes. The changes in indirect taxes included the elimination of exemptions from the 20 percent VAT and raising the VAT from 8 percent to 20 percent on a set of goods. Changes in direct taxes encompassed reductions in income tax rates and increases in basic nontaxable income allowances (especially on lower-income and middle-income groups) and reduction of

		certain direct business taxes. The consolidated government budget surplus was about 1 percent of GDP.
1978		
Tariff reductions were continued.	The above-mentioned reforms were continued.	The consolidated government budget surplus was roughly 2 percent of GDP.
1979		
Tariff reform (except for automobile products) was completed and the remaining prior import deposits of 10,000 percent were eliminated in June 1979.	Reserve ratios reached 42 percent on sight deposits and 8 percent on time deposits by the end of 1979. As reserve ratios fell, the authorities ended the payment of interest on reserves. In April 1979 the interest rate on reserves fell to 50 percent of the time deposit rate, and all such payments ceased at the end of 1979.	Special emphasis was placed on measures designed to reduce tax evasion. The consolidated government budget surplus was equal to about 5 percent of GDP.
1980		
	The reserve ratio on time deposits was lowered to 4 percent, and the incremental reserve ratio on sight deposits was lowered in steps from 21 percent to 10 percent.	In August 1980 there were further increases in the basic nontaxable allowances, reductions in personal income tax rates, and a revenue-sharing program with the local governments. The consolidated government budget surplus was about 2 percent of GDP.

TABLE 1 *(continued)*. CHILE: SELECTIVE LISTING OF REFORM MEASURES, 1975–80[1]

Exchange Rate Policy	Controls on Capital Inflows	Other Reforms and Measures
1975		
Throughout the year there were small frequent changes in the exchange rate, with a sharp real depreciation of the exchange rate early in 1975.	The most important capital inflows were subject to the conditions imposed by Article 14 of Decree 1272, which stipulated that capital brought into the country in the form of foreign exchange and registered with the Central Bank could be repatriated as long as the capital remained in the country for no less than 24 months from the date of registration. The 24-month period was established in August 1976; prior to that, it had been only 6 months.	This was a period of gradual but continued liberalization of the price system. Prices were classified into three groups: (a) free prices, (b) freely determined prices subject to cost determination, and (3) controlled prices. At the end of 1975 there were less than 30 items in the controlled category, including basic foodstuffs, public utility tariffs, cigarettes, and petroleum derivatives. Price increases for category (2) goods were to be accompanied by the filing of evidence of cost increases. Public enterprise tariffs were increased sharply in April and May to reflect rapid cost increases that had not been reflected fully in utility prices. In September the authorities adopted a new wage-indexing formula based on the rate of increase in the consumer price index during the last two months

		plus an adjustment for the expected price rise in the month of the wage adjustment.
1976 Small adjustments of the exchange rate continued. In addition, on June 30, 1976 there was an 11 percent revaluation of the exchange rate. Until July 1976 the small adjustments in the exchange rate were announced as they occurred, but after that date the changes were announced approximately one month ahead.		There was further liberalization of the price system.
1977 In March 1977 there was an 11 percent discrete appreciation of the peso, followed again by a period of small frequent changes in the exchange rate.		The number of products subject to price controls was reduced to 15.
1978 In February 1978 the authorities published a schedule of daily exchange rates for the peso in terms of the U.S. dollar for the rest of the year. In December 1978 a new schedule was published for 1979.	In January, commercial banks were authorized to contract external credits under Article 14 for relending in domestic currency but with the loan principal indexed to the U.S. dollar/peso exchange rate. Such loans could equal	

TABLE 1 *(continued)*. CHILE: SELECTIVE LISTING OF REFORM MEASURES, 1975–80[1]

Exchange Rate Policy	Controls on Capital Inflows	Other Reforms and Measures
	up to 25 percent of the paid-up capital and reserves of each bank. In addition, no more loans than the equivalent of 5 percent of capital and reserves could be converted into domestic currency in any one month. Finally, the global limit on bank indebtedness to foreign banks was raised from 150 percent to 160 percent of bank capital and reserves. If this limit was exceeded, the entire stock of such liabilities would be subject to an 8 percent reserve requirement. In April, banks were authorized to surpass both the limit on Article 14 borrowings and the global limit on foreign indebtedness by 20 percent, provided that this excess borrowing represented foreign credits having an average maturity of at least 36 months. In December, banks and financial institutions could use Article 14 credits to fund domestic lending in amounts equal to 5 percent of capital and re-	

serves or US$2 million, whichever was larger. Also, the limit on Article 14 borrowings by such institutions was raised from 25 percent to 60 percent of capital and reserves, provided that the excess borrowing represented credits having an average maturity of at least 36 months. The limit on total external indebtedness of banks to other banks was raised from 160 percent to 180 percent of capital and reserves. This limit could be raised to 215 percent if excess borrowing had an average maturity of at least 36 months.

1979

On June 30, 1979 the peso depreciated to 39 Chilean pesos to the U.S. dollar; it was announced that this level would be left in effect until the end of February 1980.

In April, the limit on total foreign indebtedness of banks was raised to 225 percent, and the limit on Article 14 borrowing went up from 60 percent to 70 percent. At the same time, financial institutions that obtained credits under Article 14 were required to deposit at the Central Bank the equivalent of 25 percent of loans with a maturity of 24–36 months and 15 percent for longer maturity. In May, the 15 percent deposit requirement

TABLE 1 *(concluded)*. CHILE: SELECTIVE LISTING OF REFORM MEASURES, 1975–80[1]

Exchange Rate Policy	Controls on Capital Inflows	Other Reforms and Measures
	was made applicable to loans with maturities of three to four years with 10 percent on loans of four to five and a half years and 0 percent for longer maturity. In June 1979 the monthly limit on the rate of utilization of foreign loans was lowered to US$1 million or 5 percent of capital and reserves, whichever was larger. The 225 percent limit on total external debt was abolished.	
1980		
	The ceiling on monthly conversions of Article 14 borrowings was raised to US$2 million or 5 percent of capital and reserves in January. This restriction was eliminated in April. The deposit requirement on loans of 24–48 months was set at 15 percent.	

[1]This listing does not encompass all reforms.

NONFINANCIAL SECTOR

The nonfinancial sector is taken as holding currency, demand deposits, bank time deposits, financiera time deposits, and real capital as assets, and bank, financiera, and foreign loans as liabilities. Since the bank loan rate and the time deposit rate are taken as representative domestic market interest rates, one can begin with the specification of nonfinancial sector demand for bank loans and time deposits.

The nonfinancial sector's demand for bank loans is assumed to be a positive function of the expected real return on capital, the real cost of foreign borrowing, the cost of borrowing from financieras, and the level of permanent income, and a negative function of the real loan rate. At each instant, the nonbank sector will attempt to eliminate any difference between its desired and actual holdings of bank loans. Thus, the desired stock of bank loans equals

$$\ln (B/P)^d = \alpha_1 - \gamma_1(r_B - \pi^e) + \gamma_2(r_F' - \pi^e) + \gamma_3(r_{FL} - \pi^e) + \gamma_4 \ln (Y/Y^T) + \ln Y^T \quad (1)$$

where

B = bank loans
P = general price level
r_B = domestic bank loan rate (in percent a month)
π^e = expected rate of inflation (in percent a month)
r_F' = cost of foreign borrowing (in percent a month)
r_{FL} = cost of financiera loans (in percent a month)
Y^T = permanent income

and the stock adjustment behavior is given by

$$D \ln (B/P) = \beta_1[\ln (B/P)^d - L \ln (B/P)] \quad (2)$$

where

L = lag operator ($LX_t = X_{t-1}$)
$D = 1 - L$

(Appendix I presents a summary of notation.) Since the expected real return on capital is assumed to be fixed in the short run, its effect has been subsumed into the α_1 term. The level of permanent income (as measured by the trend income level) is taken as a proxy for the level of wealth. The $\ln (Y/Y^T)$ reflects the cyclical component of the demand for bank loans associated with financing extra output during an upturn in economic activity. The exact

sign on γ_4 depends on the degree to which firms tend to anticipate cyclical movements. If firms do not anticipate these cyclical movements, they will be forced to obtain bank credit during a cyclical upturn to finance the unanticipated increase in their output. This situation would argue for a positive γ_4. Whenever firms anticipate cyclical movements, they may follow a policy of borrowing when the demand for bank credit is relatively low in order to finance accumulation of inventory during a slack period. In this case, γ_4 would be negative. The actual value of γ_4 is thus an empirical question.[1] The financiera loan rate is included to reflect the fact that firms and households can borrow from financieras as well as from banks.[2] In an economy without controls on capital inflows or outflows, the cost of foreign borrowing (r_F') is composed of three elements: the nominal foreign borrowing rate (r_F), any risk premium (θ) attached to lending to domestic nationals, and the expected rate of depreciation of the exchange rate ($\dot{x}^e$). In Chile, the cost of foreign borrowing has also been affected by the capital controls that the authorities have applied in an attempt to limit capital inflows. These controls have taken a variety of forms, including minimum maturity requirements on foreign loans, required deposits at the Central Bank (at a zero or low interest rate) of up to 25 percent of foreign borrowing, ceilings limiting both total foreign borrowing by banks and loans in foreign currency to a certain percentage of a bank's capital and reserves, and restrictions on the amount of foreign borrowing that could be converted into domestic currency each month. Even though the required deposits on foreign borrowing declined from 25 percent as the maturity of the loan lengthened, the effect of the decline can be approximated by taking the 25 percent deposit requirement as the representative rate during the period April 1979 to June 1980. This deposit requirement was applicable to short-term foreign borrowing. If δ_0 represents a vector that takes on the value one between April 1979 and June 1980 and is zero otherwise, the cost of foreign borrowing would become

[1]It must be stressed that the $\ln[Y/Y^T]$ term is not the only way in which cyclical developments affect the demand for bank credit. The levels of the interest rates are also affected by cyclical changes in economic activity; these effects are transmitted through the γ_1, γ_2, and γ_3 terms.

[2]While the nominal yields on financiera loans and deposits are taken as exogenous, they should be included as endogenous variables in this model of financial system behavior. Unfortunately, the absence of time-series data on the stocks of outstanding financiera loans and deposits makes identification of the appropriate demand and supply functions impossible.

$$\delta_0(r_F + \dot{x}^e + \theta)/0.75 + (1 - \delta_0)\ (r_F + x^e + \theta)$$

ignoring for the moment the effects of all other capital controls.

The impact of the minimum maturity requirements and the changing limits on conversion of foreign currency are much more difficult to capture. To simplify, this analysis uses a series of dummy variables (z_i) to represent changes in these restrictions.[3] The cost of foreign borrowing is thus given by[4]

$$r_F' = (r_F + \theta + \dot{x}^e)\ (1 - \delta_0) + \delta_0(r_F + \dot{x}^e + \theta)/0.75 + \sum_{i=1}^{n} \delta_i z_i \quad (3)$$

The nonfinancial sector's desired stock of bank time deposits is assumed to be positively related to the level of permanent income and the expected real return on bank time deposits, and negatively related to the expected real return on currency and demand deposits, the expected return on financiera deposits, and the ratio of current to permanent income.

$$\ln (T/P)^d = \alpha_2 - \gamma_5(-\pi^e) + \gamma_6(r_T - \pi^e) - \gamma_7(r_{FT} - \pi^e) - \gamma_8 \ln (Y/Y^T) + \ln Y^T \quad (4)$$

where

T = nominal stock of bank time deposits
r_T = nominal yield on bank time deposits (in percent a month)
r_{FT} = nominal yield on time deposits in financieras (in percent a month)
Y = real income

The negative of the expected rate of inflation is taken as a measure of the own rate of return on currency and demand deposits, since interest was not paid on demand deposits during the sample period.[5] The effect of the financiera deposit yield is important, since nonfinancial entities could always hold financiera rather than bank time deposits. The ratio of current to permanent

[3]The exact nature of these dummies is discussed in Section II, Empirical Results.

[4]The true interest rate cost (ignoring capital controls) is given by $(1 + r_F') = (1 + r_F)\ (1 + \theta)\ (1 + \dot{x}^e)$. The linear approximation given in equation (3) has been used in order to have a variable elasticity formulation for the portfolio demands and supplies.

[5]The real return on currency and demand deposits actually equals $r_c - \pi^e$, where r_c is the nominal return paid on currency and demand deposits. For Chile, however, $r_c = 0$.

income represents the fact that a relatively high current level of income may increase the proportion of wealth held as transactions balances, and hence may reduce the proportion held as savings or time deposits.

In attempting to achieve this desired stock of bank time deposits, actual holdings change according to

$$D \ln (T/P) = \beta_2[\ln (T/P)^d - L \ln (T/P)] \tag{5}$$

One portion of the nonfinancial sector's portfolio that is especially important for determining short-run economic behavior is its holdings of highly liquid assets (i.e., currency, demand deposits, and time deposits). While each of these asset demands could be modeled separately (as in equations (4) and (5)), the formulations here for inflation and balance of payments behavior can be simplified if there is a general representation of the excess stock of liquid assets. In addition, this will allow a direct comparison between these results for the demand for money and those obtained in previous studies that generally used ordinary least-squares regression analysis and ignored the endogenous nature of the money supply. Therefore, broad money (M) is defined as the sum of currency (C), bank demand deposits (N), and bank time deposits (T).[6] The desired stock of liquid assets is taken as a positive function of the expected real return on holdings of currency and bank demand deposits, the real yield on bank time deposits, the level of permanent income, and the ratio of current to permanent income, and a negative function of the expected real yield on financiera deposits. Thus,

$$\begin{aligned} \ln (M/P)^d = {} & \alpha_3 + \gamma_9(-\pi^e) + \gamma_{10}(r_T - \pi^e) - \gamma_{11}(r_{FT} - \pi^e) \\ & + \gamma_{12} \ln (Y/Y^T) + \ln Y^T \end{aligned} \tag{6}$$

Since the demand for broad money reflects the underlying demands for currency, demand deposits, and bank time deposits, the signs of γ_9 and γ_{10} are ambiguous. For example, a higher expected real yield on bank time deposits would increase the desired holdings of that asset but depress desired holdings of currency and demand deposits. A rise in the level of transactions will increase the demand for currency and demand deposits but lower that for time deposits. In taking γ_{12} as positive, it is also assumed that the transactions demand for currency and demand

[6]The absence of consistent time series on financiera deposits prevents the inclusion of these holdings.

deposits implicit in γ_{12} outweighs the negative transactions effect associated with time deposits.

The stock adjustment mechanism for liquid assets is given by

$$D \ln (M/P) = \beta_3[\ln (M/P)^d - L \ln (M/P)] \tag{7}$$

BANKING SYSTEM

The banking system holds reserves, loans to domestic residents, and foreign securities as assets, and demand deposits, time deposits, foreign borrowing, borrowing from the Central Bank, and bank capital as liabilities. The banks' willingness to supply loans or accept deposits reflects their decisions regarding what sources of funds they will utilize and what earning assets they will purchase. Since this analysis is concerned with the short run, the owners' commitments of funds are taken as given and the use of other sources of funds is assumed to depend on the relative cost of these funds and any restrictions that the authorities impose on their use. Thus, the use of source S_i as a proportion of total funds (F) will be a function of the vector $[r_B]$ of the relative nominal costs of the various sources of funds and the returns that can be earned on bank assets. Nominal returns are relevant, since bank profits depend on the differential between the cost of bank funds and the returns on the bank's assets. The use of any given source of funds would fall as its cost rises relative to other sources. A bank's use of a given source of funds will also be influenced by any government regulations that affect such portfolio selections (these restrictions being represented by the vector g). These considerations mean that $S_i/F = f_{iB}(r_B, g)$.

These desired sources of funds and holdings of assets are unlikely to be achieved at each instant. Just as for the nonfinancial sector, the cost of adjustment and uncertainties regarding the sustainability of any interest rate structure mean that banks may want to spread their purchases of assets or issuance of liabilities over time. In addition, banks in a less than perfectly competitive industry may have some influence over the level of market interest rates. For example, banks may attempt to establish a loan rate that reflects the cost of bank funds and ensures an "adequate" level of profits. This type of "markup" pricing scheme would imply that banks follow a mixed strategy of changing the quantity of financial instruments supplied or purchased and the yields that banks offer on deposits or charge on loans.

To allow for the possibility of both price and quantity adjustment in the financial system, it is assumed first that the banks'

desired proportion of total bank funds (F) supplied by time deposits is a negative function of the gaps between the cost of time deposits and the rates of return earned on domestic loans and government securities and the cost of foreign funds. Thus,

$$\ln (T/F)^s = \alpha_4 - \gamma_{13}[r_T - r_E K_T - r_B(1 - K_T)] - \gamma_{14}[r_T - r_E K_T - r'_F] - \gamma_{15}[r_T - r_E K_T - r_G] \quad (8)$$

where

F = total bank funds
K_T = required reserve ratio on bank time deposits
r_E = interest paid by the Central Bank on reserves held against time deposits (in percent a month)
r_G = yield on government securities (in percent a month)

The net cost to the bank of utilizing time deposits as a source of funds is the difference between the time deposit rate (r_T) and the interest earned on reserves held against time deposits ($r_E K_T$) where K_T is the required reserve ratio on time deposits. In comparing this net cost with the earnings on domestic loans, the bank recognizes that it can lend only $(1 - K_T)$ pesos of every peso of time deposits. The net addition to bank profits of one or more pesos of time deposits is thus $r_B(1 - K_T) - r_T + r_E K_T$.

Since foreign borrowing is an alternative source of funds, the banks' desired supply of time deposits will be influenced by the differential between the net cost of time deposits $(r_T - r_E K_T)$ and the cost of foreign funds (r'_F). Similarly, sales of domestic government securities can be used as substitutes for additional time deposits as a source of funds so that the differential $r_T - r_E K_T - r_G$ is also included in equation (8).

To reflect the slow adjustment of actual to desired time deposit issuance, one has

$$D \ln (T/F) - \beta_4[\ln (T/F)^s - L \ln (T/F)] \quad (9)$$

The pricing behavior of the banking system can be represented by assuming that the banks always adjust the interest rate on domestic loans to ultimately achieve a constant long-run return on bank equity. In the long run, the loan rate (r_B^*) that will yield a given rate of profit (α_5) is[7]

[7]This relationship can be derived from the banks' profit and loss statement. If E is defined to equal the owners' equity in the bank and r_Q is the yield on that equity, then $r_B B + r_G G = r_T T - r_E K_T T + r'_F F + r_E E$. Thus, $r_B = (r_T - r_E K_T)(T/B) + r'_F(F/B) - r_G(G/B) + r_Q(E/B)$. In equation (10), $\alpha_5 = r_Q(E/B)$.

$$r_B^* = \alpha_5 + (T/B)^*(r_T - r_E K_T) + (F/B)^* r_F' - (G/B)^* r_G \qquad (10)$$

where an asterisk denotes the long-run value. This relationship means that the banks' desired loan rate will be positively related to the net cost of time deposits and foreign funds, and negatively related to the return that can be earned on government securities. Given the uncertainty regarding the sustainability of the current mix of interest rates, each individual bank will want to adjust its lending rate not only to reflect general market adjustments of interest rates (e.g., owing to changes in expected inflation) but also to maintain the bank's share of market activity. While a bank's oligopolistic position would allow it to raise its interest rates relative to other banks without losing all its loan business, its share of total market lending would decline, thereby reducing its level of profits.[8] In such a situation, banks will move the prevailing loan rate only gradually toward the desired level. To reflect this behavior in a simple framework, it is assumed that the adjustment of the loan rate takes the form

$$Dr_B = \beta_5[\alpha_5 + \gamma_{15}(r_T - r_E K_T) + \gamma_{16} r_F' - \gamma_{17} r_G - Lr_B] \qquad (11)$$

where γ_{16}, γ_{17}, and γ_{18} are estimates of $(T/B)^*$, $(F/B)^*$, and $(G/B)^*$

Since portfolio disequilibrium has been allowed in both the bank and nonbank sectors, this model necessarily contains adjustment equations for both its quantities of loans and deposits and the market interest rates on both of these financial instruments. The nonbank sector's flow demands for bank loans and time deposits (equations (2) and (5), respectively) are determined by a number of variables, including the levels of the loan and time deposit rates. These demands thus determine the accumulations of bank loans and time deposits, given the values of the loan and time deposit rates. The time deposit rate is assumed to adjust until such time as the nonfinancial sector's flow demand for bank deposits (equation (5)) is equal to the banks' flow supply of time deposits (equation (9)). The loan rate is determined by the banks' desire to gradually move the rate toward the long-run profit-maximizing level (equation (11)). The banks must therefore supply an amount of loans that is consistent with the nonfinancial sector's flow demand for loans (equation (2)) at the level of the

[8]The bank's profits will decline because it will be in the elastic portion of the kinked demand that it faces in the market. This type of demand curve reflects the assumption that, at any moment, other banks would not match increases in loan rates above some prevailing market interest rate but they would match lower loan rates.

loan rate being quoted by banks. If there are sharp changes in the nonfinancial sector's flow demand for loans, then the bank may have to vary its supply of loans equally sharply to keep the loan rate on its desired path. In this model, the required funds for these loans could be obtained via sales of government securities or increased foreign borrowing.

FINANCIAL MARKETS, BALANCE OF PAYMENTS, AND DOMESTIC MONEY CREATION

The linkage between financial market behavior, domestic money creation, and the balance of payments rests on three relationships. First, increases in the stock of base money (H) are equal to the weighted sum of the growth of central bank domestic credit (CR) and the conversion of international reserves (XR).

$$D \ln H = (1 - XR/H)\, D \ln CR + (XR/H)\, D \ln R \qquad (12)$$

where

X = exchange rate

Second, the stock of base money can be held as currency (C) or bank reserves (CBR). Thus,

$$H = C + CBR \qquad (13)$$

Bank reserves reflect holdings of banks' required and excess reserves. In Chile, there are multiple ratios that vary with the maturity and type of deposit. These ratios have changed frequently in recent years, which makes the identification of required and excess reserves quite difficult. To simplify, an "effective" reserve ratio (ERR) is defined empirically, as follows:

$$CBR = ERR(N + T + FD + GD) \qquad (14)$$

where

N = bank demand deposits
T = bank time deposits
FD = foreign currency bank deposits (converted into domestic currency units)
GD = government bank deposits

ERR is thus the implicit average required reserve ratio in the

Chilean banking system,[9] and it will be taken as exogenous to this analysis.[10]

When the definition of broad money ($M = C + N + T$) is combined with equations (13) and (14), there is a nonlinear link between the overall stock of money and the stock of base via a money multiplier. While this model could be used to forecast values of this money multiplier, the objective here is rather to define the endogenous relationship between M, H, C, and T. Linearizing produces

$$\epsilon_1 \ln M \simeq \epsilon_2 \ln H + \epsilon_3 \ln C + \epsilon_4 \ln ERR + \epsilon_5 \ln FD + \epsilon_6 \ln GD \tag{15}$$

where ϵ_i = constants with $\epsilon_1, \epsilon_2 \geq 0$; $\epsilon_3, \epsilon_4, \epsilon_5, \epsilon_6 \leq 0$. (See Appendix II for a definition of these constants.) This equation implies that the stock of broad money will rise as base money increases but will fall with any increase in holdings of currency, foreign currency deposits, and government deposits or an increase in the ERR.

The preceding definitions can also be used to specify the total stock of funds (F) available to banks.

$$F = (1 - ERR)\,(N + T + FD + GD) + CCB + CA + OI + FL \tag{16}$$

where

CCB = bank borrowing from Central Bank
CA = bank capital
FL = foreign borrowing by banks
OI = other bank sources of funds

The bank funds available for the purchase of assets thus equal the sum of deposits net of reserve holdings, bank borrowing from the Central Bank, bank capital, bank foreign borrowing, and other bank sources of funds. This nonlinear relationship can be linearized (using $M = C + N + T$) to yield

[9]Once again, financiera holdings of reserves are being excluded because of the absence of data.

[10]This simplification means that the effects of shifts between various classes of deposit on ERR are being ignored.

$$\epsilon_7 \ln F = \epsilon_8 \ln M - \epsilon_9 \ln C - \epsilon_{10} \ln ERR - \epsilon_{11} \ln FD - \epsilon_{12} \ln GD + \epsilon_{13} \ln (CCB + CA + OI + FL)^{11} \quad (17)$$

where

$$\epsilon_7, \epsilon_8, \epsilon_9, \epsilon_{10}, \epsilon_{11}, \epsilon_{12}, \epsilon_{13} \geq 0$$

(See Appendix II for the derivation of these constants.)

The relationships represented by equations (1)–(17) imply that financial market developments are strongly influenced by events in international markets and such domestic factors as inflation, output, and banking system regulations. What is described next is how financial market developments in turn influence the balance of payments and inflation.[12]

BALANCE OF PAYMENTS

Since the domestic monetary base can increase as a result of central bank purchases of foreign or domestic assets, the overall state of the balance of payments will necessarily be closely related to monetary and portfolio disequilibrium. It is therefore assumed that the balance of payments is influenced by attempts to arbitrage the prices of goods and securities across countries, by portfolio disequilibrium, and by the state of the domestic business cycle. In the long run, goods and financial market equilibrium require that (i) the prices of domestic goods increase at the same rate as world prices adjusted for any changes in the exchange rate and trade restrictions, and (ii) domestic interest rates not differ from comparable foreign interest rates *plus* the expected rate of depreciation of the exchange rate by more than the risk premium attached to lending to Chilean nationals by foreign financial institutions (i.e., interest rate parity must hold). Short-run departures from either relative purchasing power parity or interest rate parity will result in arbitrage flows that will lead to changes in the authorities' stock of foreign exchange reserves (assuming that the exchange rate is not perfectly flexible).

In addition, any excess flow demand for money implies an excess demand for base money. If this excess demand for base

[11]This last variable is used because $CCB + CA + OI$ has negative elements, since OI is a variable based on a net definition.

[12]Since this model is estimated over a sample of monthly data, the level of domestic output is taken as exogenous.

money is not satisfied by Central Bank creation of domestic credit, then the resulting portfolio adjustments will help to generate a balance of payments surplus. Finally, the balance of payments may be affected by the state of the domestic business cycle. As the level of output expands relative to the economy's capacity output, imports may increase sharply, which will deteriorate the state of the balance of payments. Thus,[13]

$$\begin{aligned}(XR/H)\ D \ln R = \ & \alpha_6 - \gamma_{19}(D \ln P_D - D \ln P_F) \\ & + \gamma_{20}(r_B - r_F') \\ & + \gamma_{21}[\gamma_{22}(\ln M^d - L \ln M) \\ & - D \ln CR] - \gamma_{23} \ln (Y/Y^T) \end{aligned} \tag{18}$$

where

P_D = price vector for domestic goods
P_F = price vector for foreign goods (in terms of domestic currency)

PRICE BEHAVIOR

The overall price level (P) can be defined as a log-linear weighted average of the levels of the prices of domestic (P_D) and foreign (P_F) goods. Thus,

$$\ln P = \alpha_7 + \gamma_{24} \ln P_D + (1 - \gamma_{24}) \ln P_F \tag{19}$$

Domestic goods are those produced locally, and foreign prices equal world prices adjusted for exchange rate and tariff (or quota) effects.

The prices of domestic goods are influenced by international price arbitrage, domestic monetary disequilibrium, and domestic cyclical developments. Thus,

$$\begin{aligned}D \ln (P_D/P_F) = \ & \alpha_8 - \gamma_{25}\ L \ln (P_D \epsilon_{14}/P_F) + \gamma_{26}[L \ln (M/P) \\ & - \ln (M/P)^d] + \gamma_{27} \ln (Y/Y^T) \end{aligned} \tag{20}$$

The rate of increase in the prices of domestic goods rises relative to the foreign rate of inflation whenever the prices of domestic goods are sufficiently (as given by ϵ_{14}) below foreign prices, an excess supply of real money develops, or the level of economic activity rises relative to capacity output. The presence of both

[13]This balance of payments equation reflects the fact that Chile did not have a floating exchange rate during the sample period.

monetary disequilibrium and the effects of international price arbitrage reflects the fact that during the Chilean reform period the Chilean economy was neither completely open nor closed in terms of international transactions.

EXPECTATIONS

In this model, the expected rate of inflation and expected rate of depreciation of the exchange rate have played important roles in determining the expected real returns on financial assets. To simplify, it is assumed that the private sector forms the expectations on the basis of its past experience with actual exchange rate and price movements. Thus,

$$Dx^e = \beta_6 L(x - x^e) \; 0 \leq \beta_6 \leq 1 \tag{21}$$

where

x = actual monthly rate of change of the exchange rate, and

$$D\pi^e = \beta_7 L(\pi - \pi^e) \; 0 \leq \beta_7 \leq 1 \tag{22}$$

where

π = actual monthly rate of change in wholesale price index.

This study attempts to identify the values of β_6 and β_7 that best describe the formation of exchange rate and price expectations.

This type of adaptive-expectations structure is often regarded as "irrational" in the sense that there can be a significant gap between actual and expected price movements for an extended period. Brunner, Cukierman, and Meltzer (1980) and White (1981) have argued, however, that this expectations structure is "rational" (i.e., represents an optimal forecasting technique) whenever economic agents are uncertain about whether observed shocks to the economy are permanent or transitory. In an economy undergoing extensive structural changes, all past observations are useful in identifying the permanency of past shocks. Brunner, Cukierman, and Meltzer (1980) also argued that the size of β_6 and β_7 is positively related to the ratio of the variance of permanent shocks to the variance of temporary shocks. Thus, if the ratio of the variance of permanent shocks to the variance of temporary shocks is low, then the β_i will be low, giving important weight to past history.

II. Empirical Results

PARAMETER ESTIMATES

Table 2 summarizes the empirical results for the model obtained from a sample of monthly data for the period July 1976 to June 1980. The model was estimated using a full-information maximum-likelihood estimator,[14] which allowed for the imposition of the appropriate cross-equation restrictions on parameters. The various behavioral relationships are generally well estimated.

The parameter estimates for the nonfinancial sector indicate a relatively slow adjustment of actual to desired portfolio holdings. The mean time lags involved in the adjustment of actual to desired holdings range from 3 months for the demand for broad money to 6 months for the demand for time deposits and to 16 months for the demand for bank loans. The relatively rapid adjustment of broad money holdings quite likely reflects fast adjustment of currency holdings. These adjustment speeds imply a sharp difference between the short-run and long-run portfolio responses to movements in interest rates, inflation, and income. Table 3 illustrates, for example, that an increase of 1 percent in the loan rate would bring about a fall of 0.16 percent in the demand for bank loans in the short run, versus a decline of 2.48 percent when all portfolio adjustments are complete.

The nonfinancial sector's holdings of bank loans increased whenever there was a higher expected real rate for financiera loans, a higher expected real rate for foreign loans, or an increase in permanent income.[15] In contrast, a higher expected real loan rate depressed real borrowing from banks.[16] As noted earlier, the short-run interest rate elasticity of the demand for bank loans is much smaller than the longer-term elasticities. This evidence provides further support for the McKinnon (1973) hypothesis that the short-run demand for bank funds is dominated by the demand for working capital. As is discussed later, the interest-inelastic nature of the demand for bank loans is one factor in explaining the persistence of high real interest rates in the Chilean reform period.

[14]See Wymer (1978) for a description of the RESIMUL program.

[15]The estimation program was unable to identify γ_4 despite a variety of changes in the specification of the demand for bank loans; thus, γ_4 was set equal to zero.

[16]The demand for domestic bank borrowing was reduced when restrictions on foreign borrowing were loosened somewhat beginning in June 1979.

TABLE 2. CHILE: PARAMETER ESTIMATES, JULY 1976–JUNE 1980[1]

Equations	Dependent Variable	Explanatory Variable	Parameter	Estimate	t-Ratio
(1) and (2)	D ln (B/P)	adjustment parameter	β_1	0.063	7.66
		constant		−0.034	3.00
		$r_B-\pi^e$	γ_1	38.993	7.82
		$r_F'-\pi^e$	γ_2	17.591	4.82
		$r_{FL}-\pi^e$	$\gamma_3=\gamma_2{}^2$		
		$\ln(Y/Y^T)$	$\gamma_4{}^2$	0.00	—
		z_1	λ_1	0.011	2.21
(4) and (5)	D ln (T/P)	adjustment parameter	β_2	0.182	3.50
		constant		−0.311	4.89
		$-\pi^e$	γ_5	2.765	0.35
		$r_T-\pi^e$	γ_6	102.215	2.71
		$r_{FT}-\pi^e$	γ_7	98.394	2.99
		$\ln(Y/Y^T)$	γ_8	1.404	1.86
		z_2	λ_2	0.165	3.12
		z_3	λ_3	−0.011	3.31
		z_4	λ_4	0.033	2.46
(6) and (7)	D ln (M/P)	adjustment parameter	β_3	0.308	9.46
		constant		−0.289	9.98
		$-\pi^e$	γ_9	11.754	26.13
		$r_T-\pi^e$	γ_{10}	−1.124	1.40
		$r_{FT}-\pi^e$	γ_{11}	4.763	4.92
		$\ln(Y/Y^T)$	γ_{12}	−0.091	0.92
(8) and (9)	D ln(T/F)	adjustment parameter	β_4	0.219	5.79
		constant		−0.271	7.10
		$r_T-r_EK_T-r_B(1-K_T)$	γ_{13}	5.516	1.71
		$r_T-r_EK_T-r_F'$	γ_{14}	4.132	2.58
		$r_T-r_EK_T-r_G$	γ_{15}	1.685	0.78
		z_2	λ_5	0.014	1.65
		z_5	λ_6	0.021	3.45
(11)	$D\ r_B$	adjustment parameter	β_5	0.218	5.35
		constant		−0.015	6.00
		$r_T-r_EK_T$	γ_{16}	3.796	4.01
		r_F'	γ_{17}	0.458	1.40
		r_G	γ_{18}	0.867	1.54
(15)	ln C	autocorrelation parameter	ρ_{15}	0.959	92.41
		constant		−0.2384	4.22
		ln M	ϵ_1	0.596	—

TABLE 2 *(concluded)*. CHILE: PARAMETER ESTIMATES, JULY 1976–JUNE 1980[1]

Equations	Dependent Variable	Explanatory Variable	Parameter	Estimate	*t*-Ratio
		$\ln H$	ϵ_2	1.0	—
		$\ln C$	ϵ_3	−0.076	—
		$\ln ERR$	ϵ_4	−0.070	—
		$\ln FD$	ϵ_5	−0.043	—
		$\ln GD$	ϵ_6	−0.187	—
		z_6	λ_7	0.030	3.46
		z_7	λ_8	0.030	4.51
(16)	$\ln F$	autocorrelation parameter	ρ_{16}	1.011	27.88
		constant		0.006	0.27
		$\ln F$	ϵ_7	1.0	—
		$\ln M$	ϵ_8	0.466	—
		$\ln C$	ϵ_9	0.087	—
		$\ln ERR$	ϵ_{10}	0.325	—
		$\ln FD$	ϵ_{11}	0.020	—
		$\ln GD$	ϵ_{12}	0.086	—
		$\ln[FD + GD + CCB + \text{CA} + OI + FL]$	ϵ_{13}	0.752	—
(17)	$(XR/H)D \ln R$	constant		−0.232	9.26
		$D \ln P_D - D \ln P_F$	γ_{19}	0.195	3.29
		$r_B - r_F^e$	γ_{20}	1.579	7.85
		$[\gamma_{21}\{\ln M^d - L \ln M\}$	γ_{21}	0.997	73.08
		$-D \ln CR]$	γ_{22}	0.280	9.88
		$\ln(Y/Y^T)$	γ_{23}	0.49	1.35
		z_2	λ_9	0.005	0.31
		z_3	λ_{10}	−0.002	1.97
		z_8	λ_{11}	0.023	5.15
(18)	$\ln P$	constant		−0.004	6.59
		$\ln P_D$	γ_{24}	0.811	306.58
(19)	$D \ln(P_D/P_F)$	constant		0.481	5.39
		$L \ln(P_D\epsilon_{14}/P_F)$	γ_{25}	0.338	5.46
		$L \ln(M/P)$			
		$-\ln(M/P)$	γ_{26}	0.358	4.85
		$\ln(Y/Y^T)$	γ_{27}	−0.251	2.84
		z_3	λ_{12}	−0.024	7.24
		z_6	λ_{13}	−0.056	2.37
		z_1	λ_{14}	−0.043	5.91
(20)	x^e		β_6	0.1	—
(21)	π^e		β_7	0.1	—

[1]All behavioral parameters are defined to be positive.
[2]Imposed.

TABLE 3. CHILE: SHORT-RUN AND LONG-RUN ELASTICITIES, JULY 1976–JUNE 1980[1]

Equation	Dependent Variable	Explanatory Variable	Short-Run Elasticity[2] (t-ratio)	Long-Run Elasticity (t-ratio)
(2)	$\ln(B/P)$	$-\pi^e$	−0.012 (0.84)	−0.192 (0.83)
		r_B	−0.157 (4.81)	−2.478 (7.82)
		r_F'	0.054 (3.62)	0.853 (4.82)
		r_{FL}	0.073 (3.62)	1.157 (4.82)
		$\ln Y^T$	0.063 (7.66)	1.0[3]
(5)	$\ln(T/P)$	$-\pi^e$	0.010 (0.25)	0.053 (0.27)
		r_T	0.866 (4.96)	4.758 (2.71)
		r_{FT}	−0.881 (5.61)	−4.841 (2.99)
		$\ln Y$	−0.256 (2.31)	−1.404 (1.86)
		$\ln Y^T$	0.438 (3.69)	2.404 (3.18)
(7)	$\ln(M/P)$	$-\pi^e$	0.091 (5.13)	5.867 (8.73)
		r_T	−0.016 (1.30)	−0.052 (1.40)
		r_{FT}	−0.072 (5.40)	−0.234 (4.92)
		$\ln Y$	−0.028 (0.93)	−0.091 (0.92)
		$\ln Y^T$	0.336 (7.74)	1.091 (11.08)
(9)	$\ln(T/F)$	r_T	−0.115 (4.30)	0.528 (4.35)
		$r_E K_T$	0.029 (4.30)	0.132 (4.35)
		$r_B(1-K_T)$	0.114 (1.98)	0.523 (1.71)
		r_F'	0.044 (2.45)	0.200 (2.58)
		r_G	0.013 (0.72)	0.058 (0.78)
(11)	r_B	r_T	0.606 (7.48)	2.781 (4.01)
		$r_E K_T$	0.151 (7.48)	0.694 (4.01)
		r_F'	0.076 (1.21)	0.349 (1.40)
		r_G	0.102 (1.93)	0.474 (1.53)

[1]Evaluated at sample means.
[2]The short-run elasticity is the product of the relevant explanatory variable parameter and the corresponding adjustment parameter evaluated at the sample means.
[3]Imposed.

Nonfinancial sector holdings of real time deposits increased whenever there was an increase in the expected real return on time deposits or in permanent income. A higher real return on currency and demand deposits (given by $-\pi^e$) or financiera deposits worked to reduce real time deposit holdings. As income rose relative to permanent income, holdings of time deposits declined, reflecting the shift toward currency and demand deposit holdings to satisfy the need for transactions balances.

Since the adjustment parameter β_2 implies a mean time lag for the adjustment of actual to desired holdings of real time deposits of slightly over five months, the flow demand for time deposits has interest rate elasticities that are less than unity in the short run and considerably larger in the longer term (Table 3). The results also indicate that time deposits in financieras are viewed as quite close substitutes for time deposits in banks. The demand elasticities for short-run and long-run bank time deposits with respect to the expected real yields on bank time deposits and financiera time deposits are of roughly comparable size, although of opposite sign. And, despite the interest-elastic nature of the long-run demand for bank time deposits, the short-run demand must be characterized as relatively interest inelastic.[17]

The results for the demand for broad money reflect the fact that the estimated interest rate parameters are composite terms that are influenced by the underlying interest rate elasticities for currency, demand deposits, and time deposits. As noted earlier, a higher $r_T - \pi^e$ that raises the demand for time deposits also lowers that for currency and demand deposits, therefore implying an ambiguous sign for the parameter on $r_T - \pi^e$ in the demand for broad money. As shown in Table 2, the demand for broad money responds positively to a fall in the expected rate of inflation, a lower expected real yield on financiera deposits, a higher ratio of current to permanent income, and a higher level of permanent income. In contrast, a higher expected real rate on time deposits does not have a significant effect and is negative in sign. This result suggests that changes in the demand for currency and demand deposits have significantly influenced the demand for broad money.

The contrast between the insignificant and negative coefficient

[17]The nonbank demand for time deposits has also been affected by changes in capital controls and crises in the financiera system. In late 1976 and early 1977 holdings of bank time deposits increased as a result of the failures of some financieras. This shift is represented by two dummy variables—z_2 and z_3: z_2 contains ones for the period July 1976 to April 1977 with zeros elsewhere; and z_3 contains a time trend for the period July 1976 to April 1977 and zeros elsewhere. The estimated parameters (λ_2 and λ_3) indicate that this shift of deposits had its greatest impact during July 1976 and then gradually diminished over time. Between September 1977 and April 1978, z_4 contains ones and zeros elsewhere; it also represents the impact of imposing a limit on commercial bank conversion of foreign loans into domestic currency. This no doubt influenced the willingness of banks to issue time deposits and quite likely resulted in banks improving the characteristics of as well as the yield on time deposits. The effect of the improvement in the characteristics of time deposits on the nonfinancial sector's demand for these assets is represented by z_4.

on the $r_T - \pi^e$ terms and the significant and negative coefficient on $r_{FT} - \pi^e$ in the demand for broad money reflects the type of portfolio substitutions generated by interest rate changes. A rise in the expected real yield on financiera deposits will lead to portfolio substitution away from currency, demand deposits, and time deposits. Since all three substitution effects work in the same direction, it is not surprising that γ_{10} is a significant coefficient. An increase in $r_T - \pi^e$, however, leads to substitution out of currency and demand deposits and into bank time deposits; therefore, its effect on the demand for broad money is ambiguous. The combination of the highly significant coefficient for $r_T - \pi^e$ in the demand for time deposits (γ_6) and the insignificant coefficient for broad money (γ_9) suggests that significant substitution has occurred between the various components of broad money.

Three general conclusions emerge from these equations for nonfinancial sector portfolio adjustment. First, portfolio adjustment generally occurs gradually, with the longer-term assets and liability holdings adjusting most slowly. Second, as a result of these relatively slow speeds of adjustment, the short-run nonbank demand for financial assets or liabilities tends to be highly inelastic even though there is considerable evidence of much higher long-term interest rate elasticity. Third, the demands for bank loans and time deposits both show considerable interest rate elasticity with respect to their own interest rates and to those of close substitutes.

The proportion of bank funds derived via time deposits was most significantly related to the differential between the net cost of time deposits and the cost of foreign funds (γ_{14}). Although the coefficients on the differential between the net cost of time deposits and the return on loans (γ_{13}) and the return on government securities (γ_{15}) are of the correct sign, they are not highly significant. The results also indicate that the banks' adjustment of actual to desired holdings of time deposits has a mean time lag of more than four and one-half months, which is not much faster than the speed of adjustment associated with the nonfinancial sector's demand for time deposits. This relatively slow speed of adjustment implies that the banks' supply of time deposits has been relatively interest inelastic in both the short run and the long run. The slow adjustment speed and low interest rate elasticities may reflect the banks' ability to have some influence over domestic market interest rates, the possibility of credit rationing, or high adjustment cost.[18]

[18]The banks' issuance of time deposits was also affected by two exogenous events. During portions of 1976, the financiera system suffered a number of

Although the results obtained for the loan rate adjustment equation are generally consistent with the hypothesis that banks attempted to achieve a long-term profit-maximizing loan rate, the estimates of certain parameters appear to be biased by the absence of data on key variables that are important for determining the desired loan rate. The estimate of the adjustment parameter β_5 indicates that banks adjusted the loan rate rather slowly to changes in the determinants of the desired loan rate. The mean time lag in this adjustment process is slightly greater than four and one-half months. The coefficients on the net cost of time deposits (γ_{16}), the cost of foreign funds (γ_{17}), and the government securities rate (γ_{18}) are all of the correct sign, although only the net cost of time deposits is statistically significant. In addition, γ_{16} implies an elasticity of the loan rate relative to the net cost of time deposits (2.8) that seems too large. This estimated elasticity quite likely reflects the fact that the specification here of the determinants of the desired loan rate has excluded a number of variables for which the information is not available. For example, the cost of operating the bank or of issuing demand deposits was not included. These excluded variables may have biased the estimate of the γ_{16}, γ_{17}, and γ_{18} parameters (and others as well).

The two linear approximations that were used to define the relationship between base money and broad money (equation (15)) and the determinants of movements in total bank funds (equation (16)) were evaluated at the sample means. Since the sample period witnessed rapid structural change and growth, it was found that the residuals from the original linear approximations exhibited positive serial correlation. To minimize the biases induced by such correlation, it was decided to treat each of the identities as if it were a stochastic equation with error term $\mu_{i,t}$, where i denotes the equation and t, time. It is assumed that $\mu_{i,t} = \rho_i \mu_{i,t-1} + V_i$ where V_i is white noise with mean zero and

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failures by financial institutions. These failures led to a flow of funds from the financieras to the banks that raised the proportion of time deposits to bank total funds. This situation was represented by a dummy variable (z_2), which took on the value one between July 1976 and April 1977 and was zero otherwise. Second, at the end of 1978, the authorities relaxed capital controls in terms of a higher ceiling on borrowing under Article 14 of Chile's foreign investment law, larger monthly conversion of foreign funds, and a shorter minimum maturity on those borrowings. In the period just prior to this relaxation (September 1978–November 1978), banks either found that the existing restrictions severely limited their foreign borrowing or they decided to delay some of their foreign borrowing to the period of lower restrictions. In either case, there was increased reliance on bank time deposits as a source of funds. This is represented by a dummy variable (z_5) that has ones in September 1978–November 1978 and zeros elsewhere.

variance σ_i^2. The identities were then transformed so that the ρ_i could be estimated directly. These resulting estimates for ρ_{15} and ρ_{16} both indicate that obtaining first differences for these identities was the appropriate transformation.[19]

While equations (12) and (15) illustrate the dependence of domestic monetary growth on the Central Bank's accumulation of foreign exchange reserves, equation (17) also indicates that the state of the balance of payments is strongly influenced by domestic monetary disequilibrium. The results for parameters γ_{21} and γ_{22} in equation (17) show that, whenever Central Bank domestic credit creation was in excess of the flow demand for money, it led to a deterioration in the balance of payments. In addition, an increase of 1 percent a month in the domestic inflation rate relative to foreign inflation led, ceteris paribus, to a decline of 0.2 percent a month in the rate of growth of Chile's international reserves. In contrast, an increase of 100 basis points in the differential between domestic and foreign interest rates resulted in an increase of 1.5 percent a month in the growth of international reserves. While the coefficient on the difference between current and trend output is insignificant, it is of the wrong sign. Ordinarily, one would expect a level of current income that is high relative to trend income to lead to a deterioration in the current account and, hence, to the state of the balance of payments.[20]

The results for the price equations (18) and (19) imply that both monetary disequilibrium and international price arbitrage have affected domestic price behavior. Equation (18) indicates that

[19]The linearization for the relationship between broad money and base money was also affected by changes in capital controls that altered the nature of the money multiplier. To capture these shifts, two dummy variables were used: (1) z_6 has a one in July 1976 and zeros elsewhere, representing the effects of the increase in the minimum maturity on foreign borrowing by banks from 6 to 24 months; (2) z_7 has ones in May and June 1980 and zeros elsewhere to represent the effects of the elimination of monthly limits placed on banks' monthly conversion of foreign loans into pesos. The impact of these changes in capital controls on the money multiplier implicit in equation (15) is given by the estimated values of λ_7 and λ_8.

[20]The state of the balance of payments was also affected by both financial system crises and changes in capital inflows. The impact of the financiera system failures in 1976 (described in footnote 17) is represented by z_2 and z_3; z_8 contained ones in the period July 1979–October 1979, which basically represented the period between the end of the ceiling on bank foreign borrowing (in late June 1979) under the afore-mentioned Article 14 and the imposition of the monthly limit on banks' conversion of foreign exchange into pesos (established in mid-September 1979). This relaxation of capital controls naturally resulted in a substantial capital inflow that raised the accumulation of reserves.

domestic prices receive a weight of 81 percent in the overall price index. The rate of increase in domestic prices relative to foreign inflation responded significantly to the lagged ratio of domestic to foreign prices and to the excess demand for money. The size of γ_{25} implies that there was a mean lag of approximately three months between any change in foreign prices and the resulting change in domestic prices. The coefficient on the ratio of current to trend income is significant but of the wrong sign. One would have expected greater price pressure as domestic demand rises relative to trend output. It may be, however, that this variable is more indicative of the availability of domestic goods than of demand pressure; $\ln(Y/Y^T)$ would then be high during periods when the supply of goods is high relative to trend output, thus helping to depress prices.[21]

The likelihood function for this estimator attains its maximum value when the adaptive expectations coefficients for both exchange rate and price expectations are assigned the value 0.1. The mean time lag in the adjustment of actual to expected price and exchange rate changes is thus 11 months. These relatively long lags could imply that the ratio of the variance of permanent shocks to the variance of temporary shocks is low and that important weight has been given to past history in determining underlying trends in inflation and exchange rate movements. This type of behavior could reflect private sector uncertainty about the sustainability of certain reforms.

IN-SAMPLE FORECASTING EFFICIENCY

Table 4 provides the static and dynamic in-sample forecasts of this model. The static forecasts utilize the actual values of the exogenous variables and the lagged endogenous variables, whereas the dynamic forecasts use the lagged endogenous variables generated by the model. The mean-squared errors for the static

[21]The linkages between domestic price and domestic monetary disequilibrium were influenced by domestic financial crises and changes in capital controls. The financiera system crisis of 1976 is represented by z_3 and indicates that the real growth of broad money holdings (especially bank time deposits) that was observed during this period reflected, in addition to the ordinary demand determinant, a shift in the demand for bank deposits relative to financiera deposits. The term λ_{12} provides a rough estimate of the effects of the shift in the demand for broad money on price behavior during this period; z_1 and z_6 are described in footnotes 17 and 19, respectively. These variables represent effects of the establishment of the two-year minimum maturity on foreign borrowing (z_6) and the temporary relaxation of capital controls during mid-1979 (z_1) on the linkage between domestic price formation and monetary disequilibrium.

TABLE 4. CHILE: IN-SAMPLE FORECASTS—MEAN-SQUARED ERRORS, JULY 1976–JUNE 1980

Variable	Mean-Squared Error of Static Forecasts	Mean-Squared Error of Dynamic Forecasts
$\ln B$	0.057	0.643
$\ln T$	0.096	1.053
$\ln M$	0.054	0.298
r_T[1]	0.0003	0.0003
r_B[1]	0.001	0.005
$\ln C$	1.979	6.960
$\ln F$	0.039	0.418
$\ln R$	0.044	0.047
$\ln P$	0.026	0.100
$\ln P_D$	0.040	0.153
$\ln H$	0.044	0.329

[1]Prediction errors on the interest rates are in units of percentage points. Static and dynamic mean-squared errors as a proportion of the average interest rates are 0.020 and 0.082 percent, respectively, for the loan rate and 0.007 and 0.007 percent, respectively, for the time deposit rate.

forecasts are less than 1 percent except for currency (which is derived via the linear approximation of the relationship between broad money and base money) as implied by equation (15). The dynamic forecasts, not surprisingly, suggest somewhat larger errors, ranging up to 7 percent for currency. The relatively large error for currency reflects the fact that the linear approximation of the nonlinear money multiplier relationship is not entirely accurate.

III. Comparisons with Earlier Empirical Results

Before contrasting the results obtained in this study with earlier studies, it is important to stress that the estimates presented in this paper come from the early and middle phases of the Chilean reform period. Owing to breaks in the basic data series used in the model,[22] the analysis cannot be extended directly into the 1981 and 1982 period during which the Chilean financial system and economy experienced some difficulty. It would be interesting to contrast estimates from the period 1976–80 with those for the

[22]This is especially true for the series on banks' external liabilities.

entire period 1976–82. Such a comparison would provide considerable evidence on the stability of portfolio demands and supplies.

There are certain similarities between the results obtained in this study and those from an earlier study, which was of Argentina (Mathieson (1982)). Although the model used in the Argentine study has characteristics quite close to those utilized in the current analysis, the Argentine model did not allow for portfolio disequilibrium in the banking system and did not fully identify the linkages between base money, the balance of payments, and broad money. In both cases, however, the nonfinancial sector exhibited a relatively slow adjustment of actual to desired stockholding for time deposits, broad money, and bank loans. The mean time lags in the adjustment process for time deposits were 6 months for Chile and 16 months for Argentina. For broad money, the mean time lags were 3 months for Chile and 26 for Argentina; for bank loans, the comparable lags were 16 months for Chile and 33 for Argentina. The slower adjustment speeds for Argentina could reflect the fact that, in the Argentine model, banks were assumed to be in continuous portfolio equilibrium. If market adjustments in holdings of these assets really reflected the portfolio disequilibrium of both banks and nonbanks, then misspecifying the portfolio adjustment process for banks could lead to slower estimates of the adjustment process for the nonfinancial sector.

The relatively slow speeds of adjustment for nonbank portfolio holdings imply a sharp difference between short-run and long-run interest rate and income elasticities in both Chile and Argentina. The short-run demands for financial assets and liabilities therefore have been much more interest inelastic than the long-run demands. By far the most interest-inelastic short-run demand curves have been those for bank loans. In Argentina, the short-run interest rate elasticity was only -0.003, which was even lower than the elasticity in Chile (-0.16). As will be discussed shortly, these characteristics of interest rate elasticity have been one factor contributing to the persistence of high real loan rates in both countries.

In these studies, the overall state of the balance of payments was influenced significantly by both monetary disequilibrium and price and interest rate arbitrage. Since the Argentine model did not allow for the full simultaneous relationship between money and the balance of payments, the estimates are not directly compatible with those of the current model. It is interesting, however,

that a greater proportion of any excess supply of money seems to have spilled over into the balance of payments in Chile than in Argentina. This result could reflect the fact that, during the time periods being considered, Chile had proceeded much further in its trade reforms than Argentina. In contrast, the overall state of the balance of payments seems to have been much more responsive to price and interest rate arbitrage in Argentina than in Chile. Argentina's greater responsiveness to interest rate differentials is likely to have been related to the lower level of capital controls in Argentina. The more rapid response to inflation differentials in Argentina is somewhat puzzling because, during the time periods considered, Chile had fewer trade barriers than Argentina. This result could be modified by a more appropriate specification for the Argentine model of the linkages between the balance of payments and domestic monetary equilibrium.

The price equations indicate that, although international price arbitrage had roughly comparable effects on domestic inflation, the effect of any excess money supply was much more inflationary in Argentina than in Chile. These estimation results are again consistent with the view that Chile was a more open economy and, hence, that any excess supply of money would spill over more readily into the balance of payments than into the domestic inflation.

The results for the bank and nonfinancial portfolio demands and supplies also imply that the high level of nominal interest rates have encompassed quite different real interest rate behavior for loans and deposits. During the period July 1976–June 1980, the Chilean nominal loan rate averaged 6.4 percent a month and the nominal time deposit rate, 4.7 percent a month. Given the estimate of the adaptive expectations parameter (β_7), the average expected rate of inflation was 5.0 percent. These averages imply an average real loan rate of 1.4 percent a month and an average real time deposit of −0.3 percent a month. For the period March 1977–December 1979, Argentina experienced an average expected real 30-day loan rate of 0.9 percent a month and an average expected real time deposit rate of −0.5 percent.[23] Thus, for both

[23]Although there is no accurate estimation of the average cost of funds for the banks, in Chile the nominal average cost of funds derived from time deposits (inclusive of interest on reserves) was 3.49 percent a month (−1.51 percent in real terms); from foreign loans (nominal rate *plus* expected rate of depreciation only), 4.85 percent a month (−0.15 percent in real terms); and from sale of government securities, 3.47 percent a month (−1.53 percent in real terms).

countries, there was a relatively high ex ante real loan rate combined with a low or slightly negative expected real time deposit rate.[24] These results raise two related questions: Why was there such a high real loan rate? Why was there such a large spread between the lending and deposit rates?

The high real loan rate seems to have reflected both an interest-inelastic demand for bank loans on the part of nonfinancial sector portfolio owners and a relatively slow adjustment on the part of banks toward increasing the real supply of bank loans. As noted earlier, the Chilean nonfinancial sector's demand for bank loans had a short-run interest elasticity of only −0.16.[25] This elasticity alone would mean that an exogenous increase in the demand for loans or a reduction in the supply of loans would ensure a sharp increase in the loan rate unless the supply of bank loans was quite interest elastic. Given the nature of Chilean controls on capital inflows, any short-run increase in the supply of bank loans would have to come via an increase in the issuance of bank time deposits. As shown in Table 3, however, the bank supply of time deposits had a short-run interest elasticity (with respect to the loan rate) of only 0.11. In the short run, both the nonbank demand for bank loans and the bank supply of such loans were therefore quite interest inelastic. These characteristics of portfolio interest elasticity thus provide some insights into why there might be considerable short-run instability of interest rates; but, by themselves, these characteristics do not explain the sustained high level of the real loan rate.

The combination of a persistent high real loan rate, the need to maintain an extensive system of capital controls (at least in Chile), and rapid real growth in the amount of real credit available can be explained in terms of the financial market conditions that prevailed at the start of the financial reform and the market's response to the reforms undertaken. The Chilean financial system

[24]It must be remembered that these estimates of the real interest rates on loans and deposits are based on the assumption that price expectations are formed on the basis of an adaptive-expectations structure that uses previous experience with inflation to form future expectations about inflation. Since inflation was generally declining over the sample period, a more forward-looking expectations structure might imply somewhat higher real rates of return.

[25]This low-elasticity estimate could also be affected by the fact that many bank loans in Chile are not made at the peso interest rate that has been used here but rather at a variety of other rates that are tied to the cost of borrowing in terms of U.S. dollars. Although an estimate (r_F^t) of the dollar costs has been included here, it may not have captured the full effects of the ability of banks and nonbanks to substitute dollar for peso loans.

started its reform with a small initial real stock of credit and a large excess demand for that stock at the prevailing ceiling for loan and deposit interest rates. The small initial stock reflected the highly variable and negative real returns on financial assets of the pre-reform period. When this small real stock of credit was combined with an interest-inelastic demand for credit, it is not surprising that a high real loan rate prevailed. This excess demand persisted over time because neither capital inflows nor larger real holdings of time deposits grew sufficiently rapidly to eliminate the excess demand for credit.[26] Capital inflows were inhibited by capital controls that had been established to assist monetary control; and, at least in the short run, the supply of bank time deposits was relatively interest inelastic with respect to both the loan and time deposit rates. Thus, to encourage banks to undertake continued issuance of time deposits, a loan rate was needed that was high relative to the cost of time deposits. It was still true in Chile, however, that there was a significant change in the relative real returns on bank loans and time deposits. During the first half of the sample period (July 1976–June 1978), the ex ante real loan rate averaged 2 percent a month, whereas the ex ante real time deposit rate had an average value of −0.6 percent. For the second half of the sample period, the ex ante real loan rate declined to only 0.7 percent a month, while the ex ante real time deposit rate rose to −0.2 percent. Thus, the expected real loan rate fell by two thirds during the two subperiods, but the expected real deposit rate continued to rise.

The actual size of the required spread between the loan and deposit rates also reflected the effects of government regulation and a number of economic factors. First, the deposit and loan rate spread was affected by such government regulations as the required reserve ratio and the payment of interest on reserves. The resulting net spread equaled the loan rate *minus* the time deposit rate adjusted for the payment of interest on required reserves ($r_E K_T$) *divided by* one *minus* the required reserve ratio on time deposits ($r_B - [r_T - r_E K_T]/(1 - K_T)$). The division by $1 - K_T$ reflects the fact that banks could use only $1 - K_T$ percent of each peso of time deposits that they received. The net spread for the period July 1976–June 1980 tended to decline over the sample

[26]An alternative explanation also consistent with this model is that the persistence of the high real loan rate reflects the loan rationing that banks have undertaken to achieve a desired path for the loan rate that maximizes profits over time.

period but still averaged 1.3 percent a month. During the period June 1979–July 1980, however, the mean spread declined to only 0.5 percent a month.

The continued existence of a positive net spread reflected the cost of financial intermediation, the impact of inflation, the desire of banks to earn an adequate return on their equity capital, the risks associated with interest rate and exchange rate variability, and the competitive structure of the financial system. Banks must earn some positive net spread to cover their operating cost. In addition, the required reserve ratio is a means of imposing an inflation tax on both borrowers, whose loan cost is driven up, and lenders, whose return on deposits is driven down as the tax is imposed. The gap between the nominal loan and deposit rates can be shown (McKinnon and Mathieson (1981)) to be related directly to the expected rate of inflation by a factor equal to $K_T/(1 - K_T)$ in this model. While Chilean inflation and required reserves were both quite high at the beginning of this sample, they declined over time. Since banks must bear the risks associated with interest rate and exchange rate variability, the net spread will be larger, the greater are these risks. These factors provide some explanation for the spread between lending and deposit rates being large at the beginning of the period and declining over time. Finally, the spread also could have reflected some element of oligopolistic power on the part of financial institutions. The empirical results here do not allow one to establish the importance of this factor.

IV. Conclusions

This analysis has shown that it is possible to estimate a financial programming model for periods during which an economy is undergoing extensive trade, fiscal, and financial reforms. The current model reflects a modification of earlier models in that it allows specifically for endogenous interest rates and the continuous impact of programs designed to gradually open the economy to international trade and capital flows.

The estimation results for Chile indicate that domestic bank and nonfinancial portfolio owners have adjusted their actual to their desired asset or liability holdings only gradually. There is thus a sharp distinction between the short-run and long-run income and interest rate elasticities of demands for and supplies of financial assets. The nonfinancial sector's demand for bank loans has been

especially interest inelastic. The results indicate that both monetary disequilibrium and international price and interest rate arbitrage played significant roles in explaining the behavior of the domestic rate of inflation and overall balance of payments position. The presence of both monetary and arbitrage effects reflects the fact that the Chilean economy was in a period of transition from a closed to an open economy.

A comparison with earlier results obtained for Argentina suggests that certain common characteristics were found in both the Argentine and Chilean reform periods. In both countries, the reform periods witnessed average ex ante real loan rates of roughly 1 percent a month and an average ex ante real deposit rate that was approximately zero or slightly negative. The high real loan rates encountered during the early stages of the financial reform reflected the low initial stocks of real credit and deposits and the uncertainties created by high and variable inflation rates. While the real loan and time deposit interest rates have declined over time, these real interest rates have shown considerable variability and have remained high as a result of interest-inelastic nonfinancial sector demand for bank loans and banking system supply of time deposits. The short-run interest-inelastic nature of these porfolio demands and supplies reflected in part a rather slow adjustment of actual to desired portfolio holdings. The level of interest rates and the spread between deposit and lending rates has also proved sensitive to such government policy as the level of required reserve ratio, the payment of interest on reserves, controls on capital inflows, and policies governing entry into the financial system.

The characteristics of the price and balance of payments equations for the two countries also show evidence of the effects of both monetary disequilibrium and international price and interest rate arbitrage.

APPENDICES

I. Notation

B = nominal stock of bank loans
P = wholesale price index
r_B = bank loan rate (in percent a month)
π^e = expected rate of inflation (in percent a month)

r_F = nominal interest rate on foreign borrowing (in percent a month)
r_F' = nominal interest rate on foreign borrowing *plus* expected rate of change in exchange rate *plus* any risk premium (in percent a month)
r_{FL} = nominal interest rate on loans from financieras (in percent a month)
Y^T = permanent income
X = exchange rate (pesos per dollar)
$\dot{x}^e$ = expected rate of change in exchange rate (in percent a month)
T = nominal stock of bank time deposits
Y = current output
r_{FT} = nominal yield on time deposits in financieras (in percent a month)
N = nominal stock of bank demand deposits
C = nominal stock of currency
M = nominal stock of broad money ($= C + N + T$)
F = total bank funds
r_E = nominal interest rate paid on bank reserves (in percent a month)
K_T = required reserve ratio on bank time deposits
r_G = return on government securities (in percent a month)
H = nominal stock of base money
R = foreign exchange reserves
CR = Central Bank domestic credit
CBR = commercial bank reserve
ERR = effective reserve ratio
FD = foreign currency bank deposits
GD = government bank deposits
CCB = commercial bank borrowing from Central Bank
CA = commercial bank capital
OI = other bank sources of funds
FL = foreign borrowing by banks
P_D = domestic component of wholesale price index
P_F = foreign component of wholesale price index

II. Sources and Definitions of Variables

IFS = International Monetary Fund, *International Financial Statistics*. The line numbers reported in *Variables* refer to the page containing the Chilean data.
BCC = Banco Central de Chile, *Boletín Mensual*.

Variables

The figures used in the analysis are the monthly averages of the following end-of-month stocks.

Currency	= Line 14a in *IFS*
Demand deposits	= Line 24 in *IFS*
Time and savings deposits	= Line 25a in *IFS*
Broad money	= Sum of lines 14a, 24, and 25a in *IFS*
Bank loans	= Line 22d in *IFS*
Government deposits	= Line 26d in *IFS*
Foreign currency deposits	= Line 25b in *IFS*
Base money	= Line 14 in *IFS*
Foreign exchange reserves	= Difference between lines 11 (Central Bank foreign assets) and 16c (Central Bank foreign liabilities) in *IFS*
Commercial bank reserves	= Line 20 in *IFS*
Commercial bank borrowing from Central Bank	= Line 26g in *IFS*
Commercial bank capital	= Line 27a in *IFS*
Other sources of bank funds	= Line 27r in *IFS*
Foreign borrowing by banks	= Line 26c in *IFS*
Price level (wholesale price index)	= "Indice de precios al por mayor, Indice General" (BCC)
Domestic component of wholesale price index	= "Indice de precios al por mayor, Productos Nacionales" (BCC)
Foreign component of wholesale price index	= "Indice de precios al por mayor, Productos Importados" (BCC)
Income—monthly industrial production index	= "Indice de producción industrial manufacturera, Indice General" (BCC)
Permanent income	= Time trend for monthly industrial production index
Loan rate (in percent a month)	= "Tasas de interés efectivas mensuales cobradas en colocaciones a corto plazo, I. Bancos" (BCC)
Time deposit rate (in percent a month)	= "Tasas de interés efectivas mensuales pagadas en captaciones a corto plazo, I. Bancos" (BCC)
Foreign interest rate (in percent a month)	= Rate paid by domestic nationals under Article 14 borrowing (Source: Central Bank of Chile)
Government security rate (in percent a month)	= Until December 1978, this yield equals the midpoint in the range on "Tasas de interés en el mercado secundario de pagarés de

	tesorería por bancos" (BCC). From January 1980, "Pagarés de tesorería" no longer issued. Then, used midpoint in monthly range on "Pagarés descontables del Banco Central."
Interest paid on required reserves against time deposits (in percent a month)	= Series provided by the Western Hemisphere Department of the International Monetary Fund
Financiera loan rate (in percent a month)	= "Tasas de interés efectivas mensuales cobradas en colocaciones a corto plazo, II. Sociedades Financieras" (BCC)
Financiera time deposit rate (in percent a month)	= "Tasas de interés efectivas mensuales pagadas en captaciones a corto plazo, II. Sociedades Financieras" (BCC)
Required reserve ratio on time deposits	= "Tasas de Encaje del Sistema Financiero, Moneda Nacional, Depósitos y Captaciones de 30 a 89 días plazo" (BCC)
Exchange rate	= Line ae of *IFS*

Dummy variables

z_1 Dummy for loosening of capital controls on foreign borrowing at end of June 1979. Included reduction in the percentage of any loan that was required to be deposited in the Central Bank and removal of ceiling on bank foreign borrowing. (one, June–December 1979)

z_2 Dummy for impact of financiera crises in early and mid-1976 (involving the closure and merger of various financieras). This led to sharp increase in deposits at banks. (one, July 1976–April 1977)

z_3 Dummy representing same event as z_2 but containing time trend between July 1976 and April 1977.

z_4 Dummy representing imposition of limitation on monthly conversion of foreign loans into pesos. An individual bank was initially limited to an amount equal to 5 percent of the bank's capital and reserves. (one in September 1977 and April 1978)

z_5 Dummy representing period prior to relaxation of capital controls at end of 1978. These changes included a higher ceiling on Article 14 borrowing, larger limits on the monthly conversion of foreign exchange, and a shorter minimum maturity on these borrowings. (one, September–November 1978)

z_6 Dummy representing increase in minimum maturity on foreign borrowing to two years. (one in July 1976)

z_7 Dummy representing initial effects of elimination in April 1980 of monthly ceiling on conversion of foreign loans into pesos. (one, May–June 1980)

z_8 Dummy representing period between end of ceiling on total bank foreign borrowing under Article 14 (in late June 1979) and imposition of monthly limit on bank conversion of foreign borrowing into pesos (in mid-September 1979). (one, July–October 1979)

The constants given in equations (15) and (16) will equal (with $m = M/H$):

$$\mu_1 = e^{\overline{\ln m \cdot ERR \cdot c}} - e^{\overline{\ln m \cdot c}} - e^{\overline{\ln m \cdot ERR \cdot M}} - e^{\overline{\ln m \cdot ERR \cdot FD}} - e^{\overline{\ln m \cdot ERR \cdot GD}}$$

$$\epsilon_1 = 1 - e^{\overline{\ln m \cdot ERR \cdot M}}/\mu_1 + e^{\overline{\ln M}}/\mu_1$$

$$\epsilon_2 = 1$$

$$\epsilon_3 = +[e^{\overline{\ln c}} - e^{\overline{\ln m \cdot ERR \cdot c}}]/\mu_1$$

$$\epsilon_4 = [e^{\overline{\ln m \cdot ERR \cdot M}} - e^{\overline{\ln m \cdot ERR \cdot c}} + e^{\overline{\ln m \cdot ERR \cdot FD}} + e^{\overline{\ln m \cdot ERR \cdot GD}}]/\mu_1$$

$$\epsilon_5 = e^{\overline{\ln m \cdot ERR \cdot FD}}/\mu_1$$

$$\epsilon_6 = e^{\overline{\ln m \cdot ERR \cdot GD}}/\mu_1$$

$$\epsilon_7 = e^{\overline{\ln F}}$$

$$\epsilon_8 = e^{\overline{\ln M}} - e^{\overline{\ln ERR \cdot M}}$$

$$\epsilon_9 = e^{\overline{\ln C}} - e^{\overline{\ln ERR \cdot c}}$$

$$\epsilon_{10} = e^{\overline{\ln ERR \cdot M}} - e^{\overline{\ln ERR \cdot C}} - e^{\overline{\ln ERR \cdot FD}} + e^{\overline{\ln ERR \cdot GD}}$$

$$\epsilon_{11} = e^{\overline{\ln ERR \cdot FU}}$$

$$\epsilon_{12} = e^{\overline{\ln ERR \cdot GD}}$$

$$\epsilon_{13} = e^{\overline{\ln[CCB+CA+OI+FL]}}$$

where a bar over a variable denotes the mean, ln is the natural logarithm, and e is the exponential.

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Applied General-Equilibrium Tax Modeling

JOHN B. SHOVEN*

THE GENERAL-EQUILIBRIUM MODEL has long been the centerpiece of economic theory, but its development through this century has been frustratingly slow. Despite its formalization by Leon Walras late in the nineteenth century, a formal proof of the existence of an equilibrium of the model was not established until the 1950s. It is surprising that Marshallian competitive general-equilibrium microeconomics developed so fully in the absence of even a proof that prices existed that simultaneously cleared all markets. The breakthrough of the 1950s was disappointing in one sense—despite demonstrating existence, the proofs did not determine the equilibrium set of prices. It took another decade and breakthrough to develop reliable algorithms for computing equilibria. The work of Herbert E. Scarf and Harold W. Kuhn in the middle to late 1960s provided this capability.

The ability to compute equilibria of relatively complicated general-equilibrium models opened the door to what may be referred to as applied general-equilibrium modeling. It seemed natural to be able to add to these models some features of the real world, such as governments, taxes, tariffs, and transfer payments, specifying them so that they resembled actual economies and performing policy evaluation with them. Before the development of the algorithms, general-equilibrium analysis was limited to the two-by-two analytic or graphic models associated with Harry G.

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The work described was supported by the National Science Foundation and the U.S. Treasury Department. The views are the author's and do not necessarily represent the views of these organizations.

Johnson, James E. Meade, and Arnold C. Harberger. Now, larger and more realistic models were feasible.[1] The purpose of this paper is to describe the models and techniques that have been developed for using applied general-equilibrium analysis for evaluating tax policy. The paper also mentions some of the results to date, the shortcomings of current models, and the expected directions of further developments.

I. Fundamental Structure of Applied General-Equilibrium Models

General-equilibrium models have four essential ingredients. There must be a specification of (1) the endowments of consumers, (2) their preferences, (3) the production technology, and (4) the conditions of equilibrium.

In general, consumers may possess endowments of any or all of the commodities in the economy. Often, in practice, consumers are endowed only with factors of production (capital and labor). The preferences of consumers are specified with the demand function for each commodity. Commodity demands are nonnegative and depend on all prices in a continuous manner. They are homogeneous at degree zero in prices, meaning that only relative prices matter. Market demands are the sum of individual household demands, and they satisfy Walras's law. If some notation is introduced, the consumer side of the model can be specified. Let N be the number of commodities (including factors), W_i be the total endowments of commodity i, and $D_i(\vec{P})$, $i = 1, \ldots, N$ be the market demand functions. With this notation, Walras's law now states

$$\sum_{i=1}^{N} P_i D_i(\vec{P}) = \sum_{i=1}^{N} P_i W_i$$

The value of market demands must equal the value of market endowments at all prices. This condition automatically holds if

[1]It is perhaps ironic that once the applied general-equilibrium models were developed, it was found that they could usually be solved with Newton-type methods that have long been available. Despite this finding, the expanding interest in computational general-equilibrium models is clearly due to the work of Kuhn and Scarf. Improved versions of their algorithms are now competitive with Newton methods in terms of computational speed, even in cases where the Newton algorithms converge.

market demands are simply the sum of individual demands when the individuals are subject to their budget constraints.

On the production side of a general-equilibrium model, technology is usually described by a set of constant-returns-to-scale activities or by production functions that exhibit nonincreasing returns to scale. The advantage of the activity-analysis approach is that the conditions for equilibrium are very simple when production is modeled in this way. On the other hand, production functions are more convenient to use in applied work. They are easily given parameters, since most of the relevant econometric literature involves their estimation.

With the activity-analysis approach, the J activities available to the economy can be listed in an $(N \times J)$ matrix A, where the aij elements are negative for inputs and positive for outputs. The first N columns

$$A = \begin{bmatrix} -1 & \cdots & 0 & a_{1,N+1} & \cdots & a_{1,J} \\ 0 & \cdots & 0 & a_{2,N+1} & \cdots & a_{2,J} \\ \vdots & & & & & \\ 0 & & -1 & a_{N,N+1} & & a_{N,J} \end{bmatrix}$$

of this matrix are disposal activities. Joint products are possible; however, activities are restricted to satisfy the condition of boundedness that $A\vec{X} + \vec{W}$ is bounded from above at any nonnegative set of J activity levels $\vec{X}$. The interpretation of this condition is that the production possibility is finite in all dimensions.[2]

In the activity-analysis modeling of production, equilibrium is characterized by a nonnegative vector of N prices and J activity levels (P^*, X^*) so that

(1) demand equals supplies for all commodities

$$D_i(P^*) = \sum_{j=i}^{J} a_{ij}X_j^* + W_i \text{ for } i = 1, \ldots, N$$

and

[2]Continuous constant-returns-to-scale production functions are similar to an infinite listing of activities to produce each output. For any set of input prices, one can compute the cost-minimizing method of producing a unit output for each output. This is the technique or activity that will be used at those prices (if output prices are sufficient for production to take place).

(2) activities in use break even, with those not used having negative economic profits.

$$\sum_{i=1}^{N} P_i^* a_{ij} \leq 0 \; (= \text{if } X_j^* > 0) \text{ for } j = 1, \ldots, J$$

A simplified numerical example may illustrate the general-equilibrium structure. For expositional purposes, consider a model with two final goods (manufacturing and nonmanufacturing), two factors of production (capital and labor), and two classes of consumer. Consumers have initial endowments of factors but no initial endowments of goods. The "rich" consumer group owns capital, while the "poor" group owns labor. Production of each good takes place according to a constant elasticity of substitution (CES) production function, and each consumer class has demands that are derived from maximizing a CES utility function subject to its budget constraint.

The production functions are given by

$$Q_i = \phi_i \left[\delta_i L_i^{\frac{\sigma_{i-1}}{\sigma_i}} + (1-\delta_i) K_i^{\frac{\sigma_{i-1}}{\sigma_i}} \right]^{\frac{\sigma_{i-1}}{\sigma_i}} \qquad i = 1, 2,$$

where Q_i denotes output of the ith industry, ϕ_i is the scale or units parameter, δ_i is the distribution parameter, K_i and L_i are the factor inputs, and σ_i is the elasticity of factor substitution.

The CES utility functions are given by

$$U^q = \left[(\alpha_1^q)^{\frac{1}{\sigma_q}} (X_1^q)^{\frac{\sigma_{q-1}}{\sigma_q}} + (\alpha_2^q)^{\frac{1}{\sigma_q}} (X_2^q)^{\frac{\sigma_{q-1}}{\sigma_q}} \right]^{\frac{\sigma_q}{\sigma_{q-1}}} \qquad q = 1, 2$$

where X_i^q is the quantity of good i demanded by the qth consumer, α_i^q are share parameters, and σ_q is the substitution elasticity in consumer class q's CES utility function.

If consumers maximize these utility functions subject to the constraint that expenditures not exceed income derived from the sale of endowments, the resulting demand functions are

$$X_i^q = \frac{\alpha_i^q I^q}{P_i^{\sigma_q} (\alpha_1^q P_1^{1-\sigma_q} + \alpha_2^q P_2^{1-\sigma_q})} \qquad i = 1,2 \qquad q = 1,2$$

where I^q is individual q's income level.

With this structure, a "toy" model can be specified, with the following values of the parameters.

	Production		
	ϕ	δ	σ
Manufacturing (1)	1.5	0.6	2.0
Nonmanufacturing (2)	2.0	0.7	0.5

	Consumption				
	Endowments		Preference parameters		
	K	L	α_1	α_2	σ
Rich households	25	0	0.5	0.5	1.5
Poor households	0	60	0.3	0.7	0.75

This model has been solved using Merrill's (1971) algorithm, which is an advanced variant of Scarf's method. The results are shown in Table 1. At the prices computed, total demand for each

TABLE 1. EQUILIBRIUM SOLUTION: GENERAL EQUILIBRIUM FOR ILLUSTRATIVE SIMPLE MODEL

Equilibrium prices	
Manufacturing output	1.399
Nonmanufacturing output	1.093
Capital	1.373
Labor	1.000

PRODUCTION

	Quantity	Revenue	Capital	Capital Cost
Manufacturing	24.992	34.898	6.212	8.532
Nonmanufacturing	54.378	59.439	18.788	25.805
Total		94.337	25.000	34.337

	Labor	Labor Cost	Total Cost	Cost Per Unit of Output
Manufacturing	26.366	26.366	34.898	1.399
Nonmanufacturing	33.634	33.634	59.439	1.093
Total	60.000	60.000	94.337	

DEMAND

	Manufacturing	Nonmanufacturing	Expenditure
Rich households	11.514	16.674	34.337
Poor households	13.428	37.704	60.000
Total	24.942	54.378	94.337

	Labor Income	Capital Income	Total Income
Rich households	0	34.337	34.337
Poor households	60	0	60.000
Total	60	34.337	94.337

output exactly matches the amount produced. It follows that producer revenues equal consumer expenditures. It also is true, to a high degree of approximation, that the labor and capital endowments are fully employed and that consumer factor incomes equal producer factor costs. The cost per unit of output in each sector matches the price, which means that economic profits are zero. The expenditure of each household exhausts its income. Thus, the solution closely approximates all the properties of an equilibrium for this economy. The closeness of the approximation can be enhanced by increasing the amount of computation time allowed for the algorithm used in the solution.

This illustrative example shows the kind of models that can be solved with the relatively new computer-based algorithms. However, it does not indicate how data are collected and incorporated and how taxes and other policy variables are introduced. Also, it is necessary to develop techniques of welfare economics to compare the equilibria that result from alternative policies.

II. Specification of Policy Models

INCLUSION OF TAXES

The first modification that is desirable in the simple model that was outlined in Section I is the inclusion of a system of taxes and government expenditures. Taxes may be imposed on the purchase of goods and services by consumers, the use of factors and intermediate inputs by producers, the receipt of income by consumers, and the final output of the various production sectors. The tax rates may differ for each good, consumer, and producer. The government uses the tax proceeds to finance transfer payments to consumers and to purchase final goods and services. Most of the models that have been developed to date assume a balanced government budget, but recent work by Feltenstein (1983) incorporates a bond and money market into models of this type.

The method of including taxes and governments in the general-equilibrium framework was first shown in Shoven and Whalley (1973) and Shoven (1974). Conditions for equilibrium become demand equals supply for each commodity, firms in operation break even after taxes, and government receipts (including bond sales and money issuance in Feltenstein's formulation) equal government expenditure. Walras's law now states that the gross-of-purchase-tax value of demands equals the value of endowments

less personal taxes *plus* transfer payments. It continues to be the sum of the individual household aftertax budget constraints.

EQUAL-YIELD TAX COMPARISONS

Often, in consideration of replacement of one system of taxes with an alternative system, the relevant policy constraint is that the replacement set of taxes should generate the same real government revenue as the original set. When economic behavior is itself a function of tax rates, the rates required for matching the yields cannot be easily determined. In fact, a full general-equilibrium analysis is required to determine such rates correctly. The computational algorithms used can easily be extended to calculate not only an equilibrium for a new tax system but also a scaler that determines the level of tax rates. The user has some choice as to whether this scaler is additive or multiplicative to the rates in the tax system under examination and whether the adjustments of the equal-yield rate (determined by the scaler) apply to all agents and taxed activities or just to a subset of them. This technique is described in Shoven and Whalley (1977).

PRODUCTION

The specification of production is somewhat more complex in the current computational general-equilibrium models than in the illustrative model presented here. The key difference is that intermediate inputs are incorporated, often with a fixed-coefficient technology. Substitution occurs only between primary factors in the production of value added, and then according to a CES or Cobb-Douglas function. The models in use vary in the level of disaggregation, with the number of production sectors varying between 4 and 33. For fixed coefficients for intermediate inputs, the production function for each sector can be written as

$$Q = \text{Min}\left[\frac{1}{a_0} VA(K, L), \frac{X_N}{a_1}, \ldots, \frac{X_N}{a_N}\right]$$

Most empirical models distinguish between industrial outputs and consumer goods for the simple reason that the data are classified differently. Industrial sectors involve such categories as forestry and fisheries, metal mining, and publishing and printing, while consumers purchase furniture, automobiles, and books. This fact is recognized in the models by incorporating a second stage of production, which converts industrial outputs into

consumer goods. This technology is usually modeled as a fixed-coefficient conversion matrix.

With some exceptions (for example, Derviş, de Melo, and Robinson (1981) and Fullerton (1982)), capital is modeled as fully mobile between production sectors and thus earns the same aftertax rate of return from each sector. Fullerton's model allows full mobility to new investment, which earns the same rate of return in all sectors engaged in new investment, but it fixes the industrial locale of capital, once it has been acquired. Derviş, de Melo, and Robinson have a similar "putty-clay" model of capital, although the allocation of investment may be set by arbitrary policy rules rather than by competitive rent seeking.

CONSUMPTION AND SAVING

Computational or applied general-equilibrium models were initially almost always static in nature, possibly including rather artificial saving and investment behavior. In recent years several of the models have been made dynamic, although this remains an area of active model development. The U.S. model with which the author is associated (along with his coinvestigators John Whalley, Don Fullerton, Charles Ballard, and Larry Goulder) now computes a sequence of essentially static equilibria connected by saving and capital formation.

The 12 consumer classes in the U.S. model act as if they were maximizing the nested utility function

$$U = U\left[H\left(\prod_{i=1}^{N} X_i^{\lambda_i}, l\right), C_F\right]$$

or some monotonic transformation of it, subject to their income constraint. The X's are consumer goods (15 in number in the U.S. model), l is leisure, and C_F is a composite commodity of future consumption. Both H and U are CES functions. The parameters of those functions determine the shares of income devoted to each commodity, to saving (the provision for C_F), and to the "purchase" of leisure. They also determine two key elasticities in the models—the elasticity of labor supply with respect to the real aftertax wage rate, and the elasticity of saving with the real aftertax rate of return to capital.

In the U.S. model, consumers have myopic expectations regarding future prices and, in particular, regarding the future rate of return to capital. Future consumption is "acquired" by buying a fixed composition portfolio of real investments that offer an

infinite annuity of returns. There has been some work on incorporating both perfect foresight and limited foresight into this model (Ballard and Goulder (1982)). Work is also being done to incorporate life-cycle behavior where a utility function such as

$$U = \int_0^T H(X, l)e^{-\delta_t}\, dt$$

is maximized, subject to a lifetime wealth constraint.

FOREIGN TRADE

Applied general-equilibrium modeling is used in the evaluation of customs unions, tariffs, and trade restrictions, and several models focusing on those issues have been developed. (See, for example, Miller and Spencer (1977), Feltenstein (1980; 1982), and Whalley (1982 b).) Here, let us concentrate on the foreign trade specification of models that are designed basically for evaluating domestic tax policies.

International trade is usually modeled extremely simply. In the U.S. model, the standard specification is one that has a constant elasticity of export demand and has import supply equations. Trade balance is imposed, and there is no international mobility of capital. A richer specification of the foreign sector, including international capital markets, was investigated by Goulder, Shoven, and Whalley (1982). The impact of domestic tax policies was shown to be quite sensitive to international capital mobility and to the credit granted in the United States for foreign taxes paid. Other tax models (Ballentine and Thirsk (1979), Keller (1980)) include capital flows, while some (Slemrod (1981) and Auerbach, Kotlikoff, and Skinner (1981)) have no foreign sector at all.

FINANCIAL SECTORS

Current general-equilibrium tax models clearly owe a great deal to the pathfinding work of Arnold Harberger (1959; 1962; 1966). He introduced the two-sector general-equilibrium framework to public finance and was one of the first to investigate the issue of tax incidence as it is known today. In many ways, the proper approach to thinking of the current models is as super-Harberger models.

One severe shortcoming of these models is the total absence of financial markets. They are "real" models solving for relative

prices, but there are no debt instruments, money, financial intermediation, or deficits. Integrating financial and real markets in these models is perhaps the current area of greatest research activity. Feltenstein (1983) has added money and government bonds as well as foreign exchange markets to this general model. Slemrod (1981) has attempted to incorporate modern portfolio behavior on the part of consumers, while Fullerton and Gordon (1981) have begun to deal with issues of corporate financial policy and behavior toward risk.

Given that countries experience large government deficits, current account trade imbalances, and sizable accumulated foreign debts, the inclusion of these features in policy models is clearly important. The general issue of the "crowding out" of private sector investment through government borrowing can also be addressed in this framework.

DATA REQUIREMENTS AND PARAMETER SPECIFICATION

In applying general-equilibrium models, a complete equilibrium data set must be assembled. This includes factor usage by industry, an input/output table, consumer expenditures by commodity and incomes by source, government expenditures and tax collections, and information on foreign trade and investment. The normal practice is to gather this data from available sources for a particular year. In general, such data are inconsistent. For example, total labor payments by employers do not match total labor income. To be useful, the data must be adjusted for consistency. This adjustment requires some judgment as to which data are most reliable and which should be changed so as to be consistent.

The consistent data represents what is often referred to as the "benchmark" equilibrium. The strong assumption is made that the data represent an equilibrium of the economy. The construction of data sets of this type is described in St. Hilaire and Whalley (1980), Piggott and Whalley (1983), and Ballard, Fullerton, Shoven, and Whalley (1983). Since the benchmark data are usually presented in value terms, units must be chosen for goods and factors to obtain separate price and quantity observations. A commonly used type of unit conversion, originally adopted by Harberger, is to choose units for both goods and factors that have a price of unity in the benchmark equilibrium.

With the benchmark observation at hand, parameters are then chosen so that the solution to the model explicitly replicates the benchmark data. This procedure is termed model calibration.

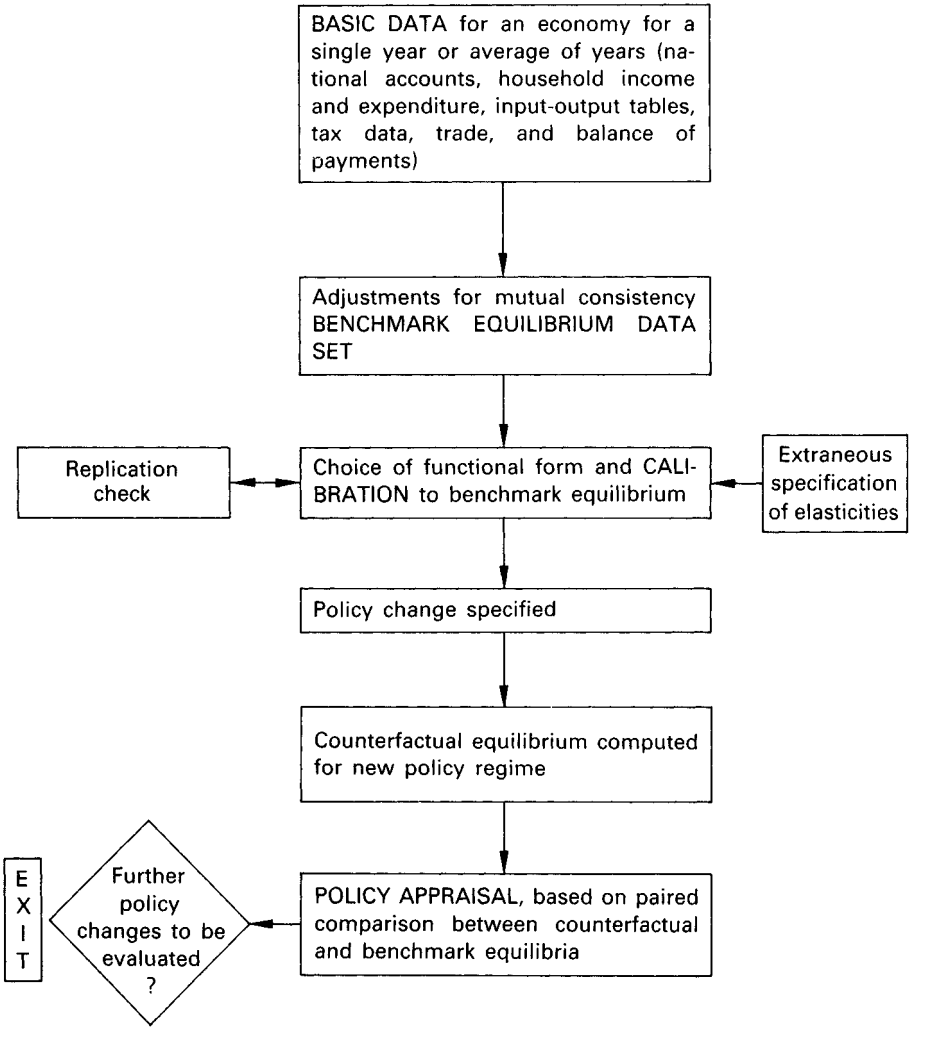
Values of the parameters thus generated can then be used to solve for a different equilibrium under alternative policy regimes. This is usually termed a counterfactual or policy replacement equilibrium.

The typical calibration procedure involves only one year's data or one single observation, which may be an average over a number of years. Depending on the complexity of functional forms used, the data may not uniquely identify the parameters. With Cobb-Douglas functions, a single benchmark observation serves to uniquely identify the values of the parameters, since expenditure and factor shares by sector are known. With other functions, it is typically true that an infinite number of combinations of parameters can replicate the data in the required manner. In such cases, extraneously specified elasticities usually serve as identifying restrictions. Once specified, these allow the other parameters to be determined uniquely from the equilibrium observation.

The extraneous specification of elasticities can be thought of as determining the curvature and position of isoquants and indifferent surfaces. If Cobb-Douglas preference functions are chosen, a single observation of a point and slope at that point of an indifference curve is sufficient to uniquely determine the parameters of the function. If CES functions are used, extraneous values of substitution elasticities are required, since the curvature of indifference curves, described by the single elasticity parameter, is not given by benchmark data. For demand functions of a linear expenditure system, income elasticities are determined, once the origin coordinates for utility measurement are known. The current procedure in setting the additional parameters is to scan empirical literature to select appropriate values of substitution elasticities for the underlying utility and production functions. The primary role of calibration is thus to determine the shares and unit parameters in these functions, once elasticities are known. No statistical test of the chosen model specification is involved, since a deterministic procedure is employed for calculating the values of the parameters from the equilibrium observation. This entire procedure is clearly dependent on both the accuracy of the assembled data and the assumption that it represents an equilibrium. Also, the key role played by elasticities used in these models becomes immediately apparent.

Once the calibration procedure is completed, a full model is available and can be used for policy analysis. As indicated in Figure 1, any policy change can be specified, and a counterfactual

FIGURE 1. FLOW CHART FOR TYPICAL APPLIED GENERAL-EQUILIBRIUM MODEL



equilibrium for a new policy regime can be computed. Policy appraisal then proceeds on the basis of paired comparisons of counterfactual and benchmark equilibria. If further policy changes are to be evaluated, the specification of policy changes is repeated.

There are a number of reasons why this calibration approach, rather than a more direct econometric approach, is so widely used in setting the parameters for applied models. First, in some of the models, many thousands of parameters are involved; to estimate all these parameters of the model simultaneously by using time-series methods would require an unrealistically large number of observations. Second, the way in which benchmark data sets are used to generate the values of the parameters under calibration involves taking an observation in value terms and then decomposing it into separate price and quantity observations. Benchmark equilibrium prices, by construction, represent unity in each benchmark equilibrium, making it difficult to sequence equilibrium observations with consistent units through time, as would be required for time-series estimation. These problems, combined with the difficulty of incorporating equilibrium restrictions into a satisfactory estimation procedure, have thus far largely excluded complete econometric estimation of general-equilibrium systems, although some progress in this direction has been made in recent work by Mansur (1981). Mansur, for instance, notes the difficulties in simply writing down a likelihood function for a maximum-likelihood procedure incorporating full-equilibrium restrictions. He suggests a partitioning approach, using segmented production and demand systems, with a third segment incorporating their equilibrium interdependence. Other attempts at econometric estimation of complete-equilibrium systems occur in the work of Allingham (1973) and Jorgenson (1983).

WELFARE EVALUATIONS

A counterfactual equilibrium is computed and is compared with the observed economy (which is assumed to represent an equilibrium). For a dynamic model, a dynamic path of prices and endowments is computed (the capital endowments being endogenous). This path is compared with the path of the economy when there is no policy change. For the U.S. model, the investigators have assumed that the data for the base year (1973) represent not only a static equilibrium but one that lies on a steady-state growth path. Thus, without any policy change, rela-

tive prices remain constant, and the economy simply gets larger in a completely balanced manner. When an unanticipated policy change is announced, the economy goes through a transition period but eventually resettles into a new steady-state growth path. The model thus computes both the transition path and the long-run comparative steady states.

Without a social welfare function, it is impossible to state unambiguously that one equilibrium or a path of equilibria is better than an alternative, unless the improvement follows Pareto's law—that is, everyone is better off. This is, unfortunately, rarely true. What the investigators do in this model in measuring the change in economic efficiency or the welfare of a policy change is analogous to the measurement of costs and benefits in cost-benefit analysis—that is, apply the Kaldor criterion: a situation is superior if the winners could compensate the losers, even if this compensation does not take place. The criterion has well-known theoretical shortcomings (Tibor Scitovsky showed, for instance, that it need not be transitive), but it is widely used for policy evaluation. In the U.S. model, the investigators calculate the dynamic or static compensating variation for each household and sum these for an overall welfare measure. The government's expenditures do not enter into this calculation—an omission that is less serious owing to the equal revenue-equal expenditure constraint described earlier; that is, the government has the same real resources available to it under both the old and new policy regimes.

The general-equilibrium approach offers a complete description of the economy for alternative policy scenarios. Substantial information is lost in the endeavor to compare the equilibria with a single number. The changes in welfare for each consumer can be computed, and the changes in factor usage, expenditure patterns, and industrial output levels can be examined. It should also be said that, for large policy changes (such as the institution of a new tax regime or the construction of a project such as the Aswan Dam), only a general-equilibrium analysis can capture the interactive effects.

III. Applications

In this section, let us review some of the applications that have been completed using the U.S. model. It should be stated at the outset that a large number of other models have been used for

policy evaluation in other countries. These include Whalley's (1975) evaluation of the major U.K. tax reform package of 1973, Miller and Spencer's (1977) assessment of the United Kingdom's entry into the European Economic Community, Piggott's (1979) evaluation of Australian tax policy, Feltenstein's (1980) analysis of trade restrictions in Argentina, Whalley's (1982 b) examination of the effects of the Tokyo Round trade agreement, and Serra-Puché's (1983) policy model for Mexico. Similar models are being used for energy economics (Hudson and Jorgenson (1978) and Borges and Goulder (1983)), development policy (Dervis, de Melo, and Robinson (1981)), and even economic history (James (1981)).

The U.S. model consists of 19 production sectors, 16 consumer goods, and 12 consumer groups. It is a dynamic model incorporating the complete tax system (federal, state, and local personal income taxes, corporate taxes, sales and excise taxes, social security taxes, etc.). The benchmark data set represents the 1973 economy. The model's development was financed by the U.S. Treasury Department; it is currently in use there, most recently in evaluating flat-tax proposals.

The policy that has received the most attention in the United States from general-equilibrium modelers is the integration of the U.S. corporate and personal income tax, probably because Harberger originally examined the incidence and efficiency consequences of the corporate income tax with his two-sector model. Corporate equity capital is taxed twice in the United States in that the earnings of firms are subject to the 46 percent corporate income tax. Aftertax earnings are either distributed as dividends and taxed at the personal level or retained. If retained, the earnings may lead to partially taxable capital gains. Capital income from other sectors, particularly real estate and to some extent agriculture, is lightly taxed. The result is an inefficient allocation of capital across sectors and, quite possibly, a distortion of the consumption/saving decision.

Another policy that has been evaluated with the U.S. general-equilibrium model is the possibility of taxing consumption rather than income at the personal level. This result could be accomplished by first establishing the household's income and then allowing a deduction for all saving. As the tax would be direct, special exemptions could be granted the blind, the elderly, those with large families, etc., and the tax could have increasing marginal rates. The advocates of a consumption tax argue that it does

not distort the consumption/saving decision, as does an income tax, and that it is better to base taxes on a household's withdrawals from the social product (consumption) than on a rough approximation of their contribution to it (income).

Before evaluating the consumption tax, it is important to recognize that the United States already has a partial consumption tax, since roughly half of saving is not subject to tax: 30 percent through retirement plans and life insurance, where the tax is deferred until withdrawal (as with a consumption tax), and 20 percent in the form of new housing construction. Housing must be purchased with aftertax dollars (i.e., the saving/investment is not deductible), but the return on it, imputed or otherwise, is very lightly taxed. Thus, it is not taxed twice, as with an income tax; its treatment is more nearly analogous to a consumption tax.

Table 2 presents the dynamic efficiency gains for a consumption tax and corporate tax integration. The figures are in 1973 dollars. The key parameters of the model are set at 0.4 for the saving elasticity and 0.15 for the labor supply elasticity. The elasticity for factor substitution in value added varies by industry, but it is generally slightly less than unity. The gain in efficiency depends on how the lost revenue is compensated for. For example, if a consumption tax is instituted by making 80 percent of saving deductible (over and above the 20 percent currently saved through new housing acquisition), row (1) of Table 2 shows the gain to be $686 billion if the revenue shortfall was made up with lump-sum tax increases. However, if marginal tax rates are increased in a multiplicate manner (everyone's ratio is multiplied by a common $X > 1.0$), the gain is $621 billion, while if they increased in an additive manner ($t' = t + X$), the welfare measure increases by $636 billion. These numbers are about 1.25 percent of the present value of future national income, expanded to include the value of leisure. The discount rate used is each consumer's aftertax rate of return to capital before the tax change, which averaged a real rate of return of 4 percent.

Row (2) of Table 2 shows the welfare gains of integrating the two income tax systems. The results are more sensitive to the replacement tax used for maintaining government revenues, both because integration involves the loss of more tax receipts and because it does not stimulate saving, capital formation, and growth as much as does the consumption tax. Row (3) combines the policies of the first two systems and shows that the efficiency improvement is approximately additive.

TABLE 2. UNITED STATES: DYNAMIC WELFARE EFFECTS IN PRESENT VALUE OF COMPENSATING VARIATIONS OVER TIME

(In billions of 1973 dollars)[1]

Tax Replacement	Types of Scaling to Preserve Tax Yield		
	Lump sum	Multiplicative	Additive
(1) Consumption tax (80 percent savings deduction)	686.167 (1.376)	620.652 (1.245)	636.002 (1.275)
(2) Corporate tax integration with indexation of capital gains	731.550 (1.467)	338.858 (0.680)	448.541 (0.889)
(3) Consumption tax with integration	1,429.503 (2.867)	999.813 (2.005)	1,135.083 (2.276)
(4) Pure consumption tax with integration	1,500.881 (3.010)	1,344.423 (2.696)	1,388.410 (2.784)
(5) Partial consumption tax (55 percent savings deduction)	328.268 (0.658)	289.999 (0.582)	298.180 (0.598)
(6) Full savings deduction with housing preference	991.704 (1.989)	962.633 (1.931)	964.370 (1.934)
(7) Pure income tax without integration	−579.177 (−1.162)	−471.653 (−0.946)	−496.861 (−0.996)
(8) Pure income tax with integration	128.298 (0.257)	−22.596 (−0.045)	21.422 (0.043)

[1]The numbers in parentheses represent the gain as a percentage of the present discounted value of consumption *plus* leisure in the base sequence. This number is $49.863 trillion for all comparisons and accounts for only the initial population.

Since 80 percent of total savings is deductible under the plans of rows (1) and (3) and 20 percent of total savings flow into tax-favored housing, these plans capture the intertemporal effects of a full consumption tax. However, since any savings can be used for housing, these plans leave an intersectoral distortion in favor of owner occupancy. The plan of row (4) allows full deductibility of savings and eliminates the preference for housing. Gains are larger, as expected. The efficiency gain of the plan in row (4) relative to the current tax system is roughly $1.5 trillion with lump-sum revenue replacement, $1,350 billion with multiplicative marginal rate surcharges, and $1,390 billion with additive marginal rate surcharges. Row (5) examines a partial move toward a consumption tax—halfway between the current 30 percent shel-

tering of retirement plans and the 80 percent of row (1)—while row (6) exempts all saving from taxation, leaves the housing preference unchanged, and results in a personal income tax subsidy to saving. However, since this subsidy offsets the corporate income tax, which is left in place, total efficiency is enhanced relative to the plan shown in row (1).

The results shown in rows (7) and (8) indicate that the United States could move to a pure income tax and integrate the corporate tax with no loss in efficiency, but that a pure income tax alone would lose efficiency. For row (7), the tax base is increased, since imputed income from housing is included and existing savings deductions are eliminated. Thus, the tax rate can be lowered, rather than raised, to maintain government revenues. Results in row (7) show that moving to a pure income tax alone involves an efficiency loss of $579 billion if marginal tax rates are not lowered—primarily because the intertemporal distortions of the current system are worsened. However, if the marginal rates are reduced, the efficiency loss to the economy is lowered to roughly $470 billion. The improvement in the interindustry allocation of capital (resulting primarily from the taxation of the return to owner-occupied housing) tends to offset the deterioration in the intertemporal efficiency (now reduced by the marginal rate adjustments). Row (8) shows the results from a comprehensive single-level income tax plan involving corporate tax integration as well. Such a tax system lowers revenues and thus necessitates a rate increase to maintain the yield. When the rates are adjusted either multiplicatively or additively, the net efficiency impact of the package is negligible.

The results in Table 2 are sensitive to the elasticities incorporated in the model. For example, the $621 billion from row (1), with a multiplicative scaling of the marginal tax rates, becomes $411 billion if the uncompensated saving elasticity is zero and $1,279 billion if this elasticity is 2.0. A more thorough evaluation of these results appears in Fullerton, Shoven, and Whalley (1983).

Table 3 provides information on how long the economy takes to resettle into a steady-state growth path after a tax change occurs. Once the economy has completely adjusted to the new policy regime, all relative prices will again remain constant. For consumption tax proposals, the new steady state is characterized by a higher capital intensity and a lower relative return to capital. The results of Table 3 indicate that, for the cases with a savings elasticity of 0.4, roughly 40 percent of the adjustment is com-

TABLE 3. UNITED STATES: TIME PATH FOR RATIO OF RENTAL PRICE OF CAPITAL TO WAGE RATE

Plan Number[1]	Savings Elasticity	Revenue Replacement	Prechange	Years					
				0	10	20	30	40	50
				←——— *Factor price ratios* ———→					
(1)	0.4	Lump sum	1.00	1.00	0.93	0.89	0.86	0.84	0.83
(1)	0.4	Additive	1.00	0.99	0.92	0.88	0.85	0.84	0.83
(3)	0.4	Additive	1.00	1.19	1.04	0.96	0.92	0.89	0.88
(1)	0.0	Additive	1.00	0.99	0.94	0.91	0.89	0.87	0.86
(1)	2.0	Additive	1.00	0.99	0.80	0.79	0.79	0.79	0.79
(7)	0.4	Additive	1.00	0.97	1.00	1.02	1.04	1.06	1.07

[1]Refers to the number of the row in Table 2.

pleted after 10 years and 80 percent after 30 years. The economy then asymptotically approaches the new steady-state growth path. The transition is accomplished much more rapidly with a savings elasticity of 2.0, despite the fact that the total adjustment is larger. Adjustments in capital/labor ratios proceed in patterns similar to the adjustments of the price ratios in Table 3.

Interestingly, Ballard and Goulder (1982) find that the adjustment to a new steady state is slightly slower with perfect foresight and the institution of a consumption tax, since consumers are deterred from additional saving by the recognition that future capital deepening will depress the rate of return to capital.

In previous literature, estimates of the length of the long run have varied widely. Sato (1963) finds the adjustment to be extremely long (more than 100 years), while Hall (1968) and Summers (1981) find it to be surprisingly short (about 5 years). It is difficult to reconcile these various findings completely, but it is clear that a prime determinant is the strength of substitution effects in the model used for the analysis.

Ballard, Shoven, and Whalley (1982) made another set of computer runs, asking a question of more theoretical interest: What are the efficiency costs of the entire U.S. tax system? This question is of interest because efficiency issues are often treated as minor ones, relative to those of economic stability. The aim here was also to estimate the marginal cost of a government dollar raised by increasing taxes. In the past, efficiency costs have frequently been quoted as fractions of gross national product or as the deadweight loss relative to the revenue raised. The former measure is ridiculous if the question is whether a tax on automobile tires or restrictions on steel imports are inefficient. The latter measure—the average distortion per dollar raised—does not often give the right answer either (average figures seldom do in economics). What has been computed, therefore, is the marginal distortionary cost per marginal dollar raised for each of the major tax systems in the United States.

The estimate here for the hypothetical experiment of removing the entire tax system and replacing it with a set of lump-sum levies (proportional to income and with sales taxes actually paid so as to minimize income and wealth transfers) is that the present value of welfare would increase by $3.3 trillion, which is roughly 6.7 percent of national income *plus* leisure, or 10 percent of national income. The primary result of removing all marginal taxes is tremendous capital deepening. The net of tax rental/wage ratio

immediately climbs by 113 percent and gradually sinks from there to become 30 percent higher than its present value in the new steady-state growth path. The capital/labor ratio is 50 percent higher after 50 years. The labor supply also grows, being 19 percent higher in the first period, because leisure is no longer the ultimate tax shelter that it is under the current system.

These results are sensitive to the values of the key elasticity parameters, as shown in Table 4, although the general picture is preserved. The standard case is shown in row (2). The total loss represents 3.55 percent of expanded national income, even when both the uncompensated labor supply and saving elasticities are zero.

Table 5 contains the results of computing the marginal distortionary costs of the U.S. tax system. If all marginal tax rates were multiplied by 1.01, the effect would be to raise government receipts by $3.331 billion. Transfers to consumers amount to just under one third of government revenues; the question is whether this fraction of a marginal tax increase would also be returned to households as transfers. Table 5 computes the marginal cost of funds for exhaustive expenditures under the assumptions that

TABLE 4. UNITED STATES: SENSITIVITY ANALYSIS WITH RESPECT TO KEY PARAMETERS OF DEADWEIGHT LOSS OF TOTAL TAX SYSTEM

Labor Supply Elasticity	Saving Elasticity	Welfare Gain[1] *(trillion 1973 dollars)*
(1) 0.15	0.0	2.231 (4.48)
(2) 0.15	0.4	3.338 (6.69)
(3) 0.15	2.0	8.236 (16.52)
(4) 0.0	0.0	1.772 (3.55)
(5) 0.0	0.4	2.709 (5.43)
(6) 0.0	2.0	7.017 (14.07)

[1]The figures in parentheses express the welfare gains as a percentage of the total present value of welfare from consumption and leisure, which is $49.863 trillion.

TABLE 5. UNITED STATES: RELATIONSHIP BETWEEN FIRST-PERIOD MARGINAL TAX REVENUE COLLECTIONS AND MARGINAL CHANGE IN WELFARE (ANNUALIZED TO FIRST PERIOD) FOR VARIOUS PARTS OF TAX SYSTEM

Marginal Rates Increased by 1 Percent (1)	Increase in Total Tax Revenues (2)	Increase in Transfers (3)	Increase in Government Tax Payments on Labor Use (4)	Net Increase in Government Revenue (col. (2)−(3)−(4)) (5)	Decrease in Utility (6)	Marginal Welfare Loss per Dollar of Revenue (col. (6)÷(5)−1) (7)	Marginal Welfare Loss, Holding Transfers Fixed (8)
	←		*Billion dollars*		→		
(1) All marginal rates	3.331	1.101	0.233	1.997	3.520	0.763	0.52
(2) Capital taxes by industry	0.615	0.205	0.021	0.389	0.694	0.784	0.51
(3) Labor taxes by industry	0.767	0.242	0.156	0.369	0.475	0.287	0.19
(4) Consumer purchase taxes	0.330	0.108	0.010	0.212	0.398	0.877	0.63
(5) Output taxes	0.131	0.043	0.004	0.084	0.129	0.536	0.43
(6) Motor vehicle taxes	0.013	0.003	0.000	0.010	0.013	0.300	0.23
(7) Marginal income taxes	1.895	0.633	0.055	1.207	2.209	0.830	0.57

transfers are adjusted when receipts increase and that they are held fixed.

If transfers increase, then \$1.101 billion is returned to households. Further, of the \$3.331 billion raised, the government itself pays \$0.233 billion. Netting out the transfers and the government's own tax payments, the funds available for a public project are \$1.997 billion, shown in column (5). The decrease in consumer welfare is \$3.520 billion, 1.76 times as much as the money available for the government project. Column (7) reflects this distortionary cost (\$0.76) per dollar transferred to the public sector. If transfer payments are not increased, the government ends up with more net revenue and households have a larger decrease in utility, with the net result that consumers lose 1.52 times as much as the government raises. This fact is reflected in column (8).

The implications of these numbers, if accepted, are great. The \$1.76 or \$1.52 private cost of a marginal government dollar means that cost-benefit studies that use unity as the critical benefit/cost ratio support projects that are socially inefficient. They do this by not taking into account the resource waste caused by the distortionary taxes that are used to raise the additional revenues. The correct critical ratio would be 1.76 or 1.52, depending on how transfer payments react to the enlarged government budget. At a more theoretical level, the results indicate that Paul Samuelson's conditions for the optimal provision of public goods should include

$$\sum_{cons} MRS_{X,G} = \lambda \cdot MRT_{X,G}$$

where λ is 1.76 or 1.52. Public goods not only use up resources in their manufacture but also are a cost to economic welfare in the distortionary taxes that they necessitate.

Rows (2)–(7) of Table 5 compute the marginal cost of each major type of tax. If these tax types were used in a third-best optimal manner, they would each have the same marginal distortionary cost per dollar raised. This cost would minimize the total deadweight loss for a given revenue using this given set of instruments. The results of columns (7) and (8) show that the U.S. tax system is far from this condition of optimality. An additional flat tax on labor by industry (payroll tax) could raise one dollar for as little as \$1.19 in private welfare, whereas increasing the 1973 personal income tax rates would result in government dollars that cost \$1.57 each at the margin, even if transfer payments are frozen.

The results of this table are elaborated on in Ballard, Shoven, and Whalley (1982). They illustrate a kind of analysis that cannot be carried out appropriately with partial equilibrium techniques.

IV. Conclusion

General-equilibrium analysis has developed from an abstract economic theory to a computational procedure and now to a tool that can be used for policy purposes. It is not always the appropriate technique; certainly, many issues are best examined at a very fine level of detail by using partial-equilibrium methods. The model also is inappropriate for very short-run forecasting of business and the business cycle and does not yet have the many rigidities (unions, rent controls, monopolies, transactions costs, etc.) that characterize real economies. Nonetheless, for analyzing the likely medium-run to long-run adjustments of an economy to a large policy change, the applied general-equilibrium model seems to be appropriate and to be ready for application.

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On the Monetary Analysis of an Open Economy

CHARLES COLLYNS*

THE ORIGINAL CONTRIBUTION of the monetary approach to the balance of payments was to focus on conditions in the money market in explaining developments in the external sector of the economy. Payments' surpluses or deficits were seen as arising from imbalances between the supply of and demand for money at a given exchange rate. Alternatively, under a free float, the exchange rate was viewed as varying to balance the demand for money with a fixed supply of money. Subsequent elaboration of this approach has broadened its perspective: alternative assets, including bonds and foreign currencies, have been introduced into the analysis together with more complex treatment of the formation of expectations and of differing rates of adjustment in asset and product markets. Using this asset-market approach, it has been possible to model the current and capital accounts separately and to analyze such phenomena as exchange rate overshooting.[1] But money itself is still usually treated as merely cash balances and noninterest-bearing demand deposits. This fact seems curious, as the proportion of such narrow money in total liquidity has declined with the increasing attraction of quasi-money and the widening spectrum of near-money.

Less attention has been paid to improving the analysis of the liability side of the balance sheet. The standard assumption has been that all domestic assets are issued directly by the monetary authorities. The supply of money or bonds varies only if the au-

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[1]Dornbusch (1980) and Frenkel and Mussa (1983) provide useful sources for much of this material.

thorities intervene in bond or foreign exchange markets, or indulge in "helicopter" operations. This view provides no role for the domestic private borrower in generating the basic demand for credit, or for the banking system in intermediating between borrower and lender.

This paper argues for a more sophisticated treatment of the supply of money. The simplifications that all money bears no interest and that all assets are claims on the government clearly limit the richness of the asset-market approach. The approach does not permit the analysis of the joint determination of money interest and exchange rates, or of how shifts in banking behavior or the demand for credit affect equilibrium. Such limitations may perhaps be forgiven at the early stages of development of a theory: some abstraction is, of course, necessary to facilitate the analysis of a complex situation. However, if the simplifications lead to policy conclusions that are seriously misleading or incomplete, the incorporation of a more satisfactory treatment becomes urgent.

The body of this paper has four main sections. Section I discusses ways in which recent institutional changes make the simplified treatment of money increasingly unrealistic and argues in favor of an approach in which the demand for credit is given the same prominence as the demand for monetary assets. Section II develops a Keynesian model of monetary equilibrium in a competitive banking system that provides the basic framework for the subsequent analysis. The following two sections study the behavior of this model from different angles: Section III looks at long-run equilibria in which prices and wages have adjusted to relative values accepted by firms and unions; Section IV focuses on short-run equilibria in which prices and wages are sticky so that relative prices may be disturbed by exchange rate movements. These two sections are not intended to sum to an exhaustive study of the situations considered,[2] but rather to indicate the dangers of the standard approach and to suggest a preferable way of proceeding.

I. Interest Rates, Indeterminacy, and the Demand for Credit

The central point of this section is that standard asset-market

[2]See Collyns (1981, Chs. 6–9) for a more extensive analysis of these and related models.

models of the balance of payments or exchange rate determination cannot easily assimilate quasi-money into their framework. Once a variable rate of interest is paid on domestic liquidity in such models, the degrees of freedom for monetary policy increase; it seems that the authorities may simultaneously achieve two out of exchange rate, liquidity, and interest rate targets. This finding appears to conflict with conventional views on the scope for monetary policy.

The first part of this section argues that recent institutional changes make it essential to include the interest earned on money holdings as a relevant feature of a satisfactory model of exchange rate determination. The second part contests that such a model must then also include treatment of the demand for domestic credit and of the intermediation between borrower and lender in order to provide a realistic framework for the analysis of monetary policy.

RELEVANCE OF QUASI-MONEY

A peculiarity of the asset-market approach is that it does not include any explicit interest payable on money holdings, as if the only types of money available were cash balances and demand deposits (i.e., narrow money) but not time and savings deposits (i.e., quasi-money). This neglect would be justified analytically if (a) the demand for all relevant assets were completely independent of the interest paid on quasi-money, or (b) the nominal rates of interest paid on quasi-money were fixed, or (c) an alternative asset were included in the model whose properties essentially mirrored the properties of quasi-money. In (a), the rates of interest paid on quasi-money would be immaterial to the determination of equilibrium, provided that the distribution effects of shifts in interest rates were of second-order importance. In (b), the nominal rates of interest would become part of the given economic environment and could be treated as implicitly factored into the description of people's behavior. In (c), the omission of quasi-money would be an appropriate simplification without major analytical consequences unless the focus of interest was specifically quasi-money itself.

In many if not most open economies, the first two of these conditions no longer hold, if they ever did. The institutional changes that have occurred in financial markets in recent years have tended to increase both the own-interest elasticity of the

demand for money and the flexibility of the rates of interest paid on quasi-money.

From first principles, one would conjecture that the demand for money would depend on the total demand for financial wealth, on the relative rates of return expected from the various forms of money and alternative assets, and on the variation of such characteristics as convenience, liquidity, security, and the anticipated stochastic distribution of real returns among these assets. These nonpecuniary characteristics of different assets give the wealth holder reason to differentiate between assets bearing the same expected returns so that, in particular, the demand for money would not be perfectly interest elastic. Indeed, the traditional theories of money, such as the quantity theory, go to the other extreme and implicitly see money as having nonpecuniary characteristics so unique that the demand for money can be treated as essentially independent of its own rate of return. But, in most countries, the own-interest elasticity of the demand for money is probably increasing over time as institutional changes occur that make the characteristics of money less special. The precise story will be different in each country, but the general trend seems clear.

First, new types of financial instrument have been introduced and familiar types have been revamped to increase the attraction and the range of alternative forms of money and near-money. Deregulation has permitted commercial banks to offer more flexible and remunerative types of account, while interest-bearing stores of value with reasonable liquidity are also offered now by credit unions, savings and loan associations, building societies, money market mutual funds, and many other institutions. Increasingly, these latter institutions extend check-writing facilities to their accounts to provide means of payment. In addition, credit cards and "easy access" overdraft facilities make available instant lines of credit that may also be used as means of payment.

Second, the progressive removal of domestic exchange controls and the increasing integration of world financial markets have substantially reduced the transactions cost of holding bank accounts and other assets abroad, and hence have made available a range of close foreign substitutes for domestic monetary assets. A monetary asset held in a foreign banking system has liquidity and security characteristics that are similar but not identical to those of a domestic deposit with an equivalent maturity. If denominated in a foreign currency, its pattern of expected real returns might be

strongly differentiated from the domestic alternatives by uncertainty over future exchange rate variations. But the existence of forward currency markets and offshore banking facilities provides the opportunity of holding assets abroad without incurring any concurrent exchange risk.

Third, the growth of multinational operations and the accumulation of financial wealth owned outside the traditional financial centers have provided a substantial pool of highly mobile and professionally managed funds that are seeking attractive short-term investments. As a result, it is no longer true, at least in the major developed countries, that domestic money is held only by domestic residents. By its very nature, this foreign demand is likely to be particularly interest elastic; the international placement of funds will be closely related to comparative returns in different markets.

All in all, there exist many domestic and foreign substitutes for both narrow money and quasi-money except in countries that are at a rudimentary level of financial development and that have effective controls on capital mobility. Outside these cases, the demand for the various types of money and near-money will tend to be sensitive to the rates of interest payable on quasi-money.

Nevertheless, if nominal rates of interest payable on all forms of money were fixed and not subject to policy manipulation, then they would not need to be explicitly included as variables in an economic model, whatever the demand elasticities. However, in most developed countries, while interest still may not be paid on demand deposits, the interest rates paid on time and savings deposits and on other types of liquidity are increasingly flexible. This flexibility reflects in part a new propensity on the part of monetary authorities to relax restrictions and to allow interest rates to be set by the financial institutions concerned. This deregulation is usually accompanied by measures aimed at increasing the degree of competition for funds among banks and between banks and other financial institutions. In consequence, interest rates on at least the less liquid monetary instruments tend to be highly sensitive to market conditions.

The literature does contain, of course, many studies that include narrow money and some other domestic asset (usually bonds) that bears interest at a market-determined rather than a fixed rate. Why is more work needed? One reason is that a narrow money/bond model is inadequate for the analysis of monetary policy using broad money as an explicit target. A second reason

is that the real interest rate on domestic bonds is often assumed to be fixed by a perfectly elastic international demand for bonds, as if domestic and foreign bonds were indistinguishable; this contrasts sharply with the companion assumption that narrow money is held only by domestic residents.[3] Neither assumption captures the intermediate view of quasi-money as an interest-bearing differentiated asset held both for its liquidity and as a store of value. Models that do treat bonds as a differentiated asset,[4] on the other hand, let the supply of bonds and money be determined separately by the authorities. Such analysis would be applicable to a narrow money/quasi-money framework only if the authorities were to develop policy instruments that were capable of controlling these two monetary aggregates separately; it also faces a serious theoretical problem (considered in the next subsection of this paper) if both types of asset earn interest.

PROBLEM OF INDETERMINACY AND POSSIBLE SOLUTIONS

Consider the following simple model of the financial sector. Let the nominal demand for domestic liquid assets, denominated in sterling (DL), be an increasing function only of domestic nominal income (Y) and the nominal interest rate paid on liquid assets (R). Let Y itself be a decreasing function of the exchange rate, e (the price of sterling in terms of special drawing rights—SDRs). Let the supply of liquid assets (L) be controlled by the government. Then the financial market equilibrium condition is written

$$L = DL(Y(e), R) \tag{1}$$

Figure 1 illustrates this condition as the locus AA in L/R space for a given exchange rate. AA slopes up, as increasing the interest rate raises the demand for domestic liquidity; the more interest elastic is the demand for liquidity, the steeper the slope of AA. An exchange rate appreciation reduces nominal income and shifts AA down and to the right, so altering the feasible combinations of L and R. In this situation, the government apparently has two degrees of freedom in selecting its monetary policy: it may choose to set two of L, e, and R. This result is contrary to the conventional wisdom that the government has only one degree of freedom—that (for example) if it chooses to aim for a liquidity target,

[3]See, for example, Mundell (1968) and Dornbusch (1976).
[4]See, for example, Branson (1979), Dornbusch (1980, Chs. 10 and 11), and Kouri (1980).

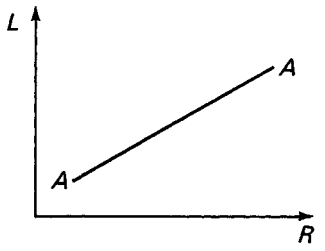

Figure 1

it must allow the exchange rate and interest rates to be market determined. According to the present model, the government could well achieve both liquidity and exchange rate targets, despite shifts in the demand for liquid assets, if it were willing to vary the interest rate as required.

The salient point is that, after considering the rate of interest on liquidity, there are not one but two prices of domestic assets: the interest rate and the exchange rate; this feature leads directly to the extra degree of freedom. The difficulty does not go away if one relaxes assumptions to broaden the picture of the asset market: introducing domestic bonds would lead to an extra market-clearing equilibrium condition and two extra variables—the rate of return on bonds and the aggregate supply of bonds—and so increase rather than reduce the available degrees of freedom. Introducing foreign assets would not alter the relevant equilibrium conditions if the home country were small in world markets; otherwise, it would add one more equation and rate of return per asset. Separating domestic liquidity into narrow money and quasi-money would have no analytical consequence in this context unless the supplies of narrow money and quasi-money could be controlled independently—which would then leave the degrees of freedom unaffected. Nor would it help to hypothesize, on the basis of an infinite willingness by wealth holders to arbitrage between domestic and foreign money markets, that the demand for domestic liquidity was perfectly interest elastic. Not only would this hypothesis be implausible, requiring wealth holders to be utterly indifferent to the currency composition and security of their portfolios, but it would leave the total demand for domestic liquid assets indeterminate. In consequence, equation (1) could not be solved for the exchange rate even if the supply of liquid assets were fixed; that is, e and L may be set independently

although R is now fixed to the rate of return on foreign assets. Finally, allowing for the effect of anticipated movements of the exchange rate on the expected real return to domestic liquidity would give the authorities an additional lever on the present through their pronouncements on future monetary policy.

There are two alternative directions in which to proceed. One is to accept that the authorities may indeed determine two out of the three variables—supply of liquid assets, interest rate, and exchange rate—and to investigate the basis on which policy should then be decided. In developing countries, this approach has in fact received much attention. For example, the literature on the choice of interest rates takes for granted that a stable exchange rate can be achieved simultaneously with controlled interest rates.[5] Implicit in these discussions is the belief that interest and exchange rates are independent policy variables. But, in developed countries, the experience has been that the authorities have limited power to control more than one of the key variables on a permanent basis. Attempts to meet the targets for both money supply and the exchange rate, or interest and exchange rates, have eventually foundered on external disequilibrium. Then it would seem that the asset-market approach is an insufficient theoretical framework for policy analysis in such countries, as its practical implications are ill-founded once it is recognized that money—like other assets—has a variable rate of return. In reacting to this conclusion, it would appear necessary to extend the asset-market approach to include additional factors that would effectively constrain the application of monetary policy.

The solution offered in this paper is to extend the analysis beyond the simplistic assumption that the supply of liquidity is under the direct control of the monetary authorities. Instead, monetary assets are seen as the counterparts of monetary liabilities, consisting of bank loans and advances to the private sector and other debt instruments. Monetary equilibrium in a competitive market is then modeled as requiring that the demands for monetary assets and liabilities be matched. Use of this extra condition reduces the degrees of freedom and provides the desired result that the authorities are able to determine only one of the three key variables.[6]

[5]See Coats and Khatkhate (1980).

[6]An equivalent approach in a model featuring only high-powered money and bonds would be to introduce the government's own demand for credit as a dependent variable rather than as a given.

Clearly, this approach requires an analysis of the demand for monetary liabilities that is compatible with the treatment of the demand for monetary assets. Economists have generally paid far less attention to the study of the demand for credit and its components than they have to asset-portfolio selection. But, on first principles, it would seem plausible to approach the demand for monetary liabilities in a way that is analogous to the demand for monetary assets, that is, as depending on the total demand for finance, the relative rates of interest payable on the various forms of bank credit and alternative sources of funds, and the variation of such characteristics as convenience, liquidity, and the anticipated stochastic distribution of interest costs between these sources. As with the demand for monetary assets, the existence of these other characteristics gives the borrower reason to differentiate between sources requiring the same expected rates of return so that, in particular, the demand for monetary liabilities would not be perfectly interest elastic. In practice, however, this interest elasticity is probably increasing over time, as institutional changes occur that make the characteristics of bank credit less unique. These changes include a widening range of domestic financial institutions and increasing opportunities to raise funds overseas.

A model of monetary equilibrium that matches the demand for monetary assets and liabilities must also inevitably contain a submodel of the means of intermediation between these two, that is, the banking system. This submodel would ideally explain the ratio between bank reserves and lending and the spread between the rates of interest on deposits and lending. Also, this submodel should contain mechanisms by which the monetary authorities would be able to influence bank behavior to affect the position of monetary equilibrium. Of course, the appropriate modeling of the banking system would depend on the degree of competitiveness within the system, conventions of bank behavior, and the instruments of monetary control, and hence would vary between countries. This paper does not attempt a serious model of bank behavior, however, and uses an ad hoc approach that is compatible with both competitive and oligopolistic types of banking system.[7]

One of the messages of this section of the paper is that no single approach to the monetary analysis of an open economy is necessarily appropriate for the study of all countries. In some countries—in particular, developing countries in which interest rates

[7]See Collyns (1981, Ch. 7).

are fixed and credit is allocated by rationing—the conventional monetary approach may indeed be adequate for many purposes. But elsewhere a more elaborate analysis may be necessary to capture the behavior of the system and to delineate the policy options that are open to monetary policy.

II. Analytical Framework

This section develops a model of an industrial economy, open to both trade and financial flows. This model is Keynesian in the sense that relative prices are not perfectly flexible and domestic output depends on demand. To simplify, the real economy is reduced to one sector, and the fiscal branch of the government is omitted. Savings and investment are ignored, as if consumers and firms always held at the start of the period the stocks of wealth and capital that they wished to hold at the period's end. The financial sector consists only of an aggregate banking system that intermediates between the demands for domestic assets and domestic credit, both denominated in sterling.

The rudimentary nature of this model should be recognized—it is intended for illustrative purposes rather than for immediate application. A more useful version for policy studies would need to distinguish the expenditure, taxation, and financial activities of government from the private sector to allow analysis of the impact of, for example, an altered public sector deficit or open market operations. The effects of stock adjustment on the balance of payments and the exchange rate are also important and would need to be considered in determining the impact of shocks to the domestic economy.[8]

THE REAL ECONOMY

The domestic economy produces a single good that is differentiated from the output of the rest of the world. The price of this good is set by markup over costs on domestic and world markets; firms set production to meet the resulting domestic and export demand; employment is determined by the labor required to achieve this level of production. Wages are fixed by trade unions that seek to achieve an appropriate balance between the take-

[8]See Collyns (1981, Ch. 9).

home pay and the employment of their members. The rest of the world is large relative to the domestic economy in the sense that activity levels and prices do not depend on the state of the domestic economy. Imports are in perfectly elastic supply and are priced by arbitrage with world markets.

Let real income be y, and production f (by convention, lowercase letters indicate real values with the price of the domestic good being used as the numeraire); y and f are related by

$$y = f + r^* \cdot (w - k) \tag{2}$$

where w is real domestic wealth, k is the real domestic capital stock, and r^* is the real rate of return on foreign investment.

It is assumed throughout that the economy is in static stock equilibrium: given activity levels and prices, firms and consumers hold just the stocks of physical capital and wealth that they desire. Domestic firms achieve their target capital stock (k), which is an increasing function of the output level

$$k = k(f, .) \tag{3}$$

Domestic consumers achieve their target level of wealth (w), which is an increasing function of y

$$w = w(y, .) \tag{4}$$

Firms sell what they produce, and consumers spend what they earn.

Let α be the price of the domestic good relative to imports, that is, a measure of the competitiveness of the domestic economy; its value depends on the interaction between the price and wage setting mechanisms. Arbitrage sets the domestic price of imports (PM) to the world price (PM^*) adjusted by the exchange rate e (again the price of sterling in terms of SDRs)

$$PM = PM^*/e \tag{5}$$

Then, the domestic price of the domestic good (PD) is given by

$$PD = \alpha \cdot PM \tag{6}$$

The proportion of income allocated to the consumption of the domestic good (λ) is a decreasing function of α. So, demand for the domestic good on the domestic market is given by

$$z = \lambda(\alpha, .) \cdot y \tag{7}$$

Sales of exports are also a decreasing function of α

$$z^* = z^*(\alpha, .) \tag{8}$$

Then, production is given by

$$f = \lambda(\alpha, .) \cdot y + z^*(\alpha, .) \tag{9}$$

Solving equations (2)–(4) and (9) gives output (f) and real income (y) as decreasing functions of α and exogenous variables

$$f = f(\alpha, .) \tag{10}$$

$$y = y(\alpha, .) \tag{11}$$

Foreign firms and consumers are also assumed to hold their target stocks of capital and wealth. These targets are fixed in terms of imported goods and may be expressed as $\alpha \cdot k^*$ and $\alpha \cdot w^*$, respectively, in terms of domestic goods.

In the long run, relative prices and wages reach equilibrium in the sense that firms and unions, knowing the state of the economy and taking the actions of others as given, are content with the prices and wages, respectively, that they set. Movements of the exchange rate affect the overall level of prices and wages, via their effect on the nominal price of imports, but not relative prices. The level of the long-run real domestic lending rate ($\bar{r}$) does, however, affect competitiveness: a rise in the cost of funds will increase firms' markups, and hence raise $\bar{\alpha}$ ($\bar{}$ indicates a long-run value); α may also shift owing to fundamental changes in technology, institutional attitudes, or other structural facets of the economic environment. So,

$$\bar{\alpha} = \bar{\alpha}(\bar{r}, .) \tag{12}$$

In the short run, wage/price equilibrium is not necessarily maintained. In particular, unanticipated exchange rate movements may affect the value of α, as the import price responds faster than wages or the price of the domestic good. At a single point in time, this stickiness may be expressed in the equation

$$\alpha = \alpha(e, .) \tag{13}$$

where $\alpha(.)$ is an increasing function of e. Short-run interest rates are supposed not to affect α on the grounds that firms do not vary the value of their markups over the business cycle.

In the absence of future shocks, α increases over time at rate β toward its long-run equilibrium value, $\bar{\alpha}$; β is a decreasing function of $\alpha - \bar{\alpha}$

$$\beta = \beta(\alpha - \bar{\alpha}, .) \tag{14}$$

The domestic rate of inflation (ρ), which is defined as the rate of change of the domestic price over time, depends on β and on the rate of depreciation of the exchange rate (γ), according to

$$\rho = \beta + \gamma \tag{15}$$

THE FINANCIAL SECTOR

The domestic financial sector consists of a banking system, regulated by a central bank.[9] Domestic monetary assets and liabilities are denominated in the domestic currency, sterling. There are no controls on external financial flows to restrict domestic access to foreign financial markets or foreign access to domestic financial markets. Sterling is, however, differentiated from other currencies by its own particular nonpecuniary characteristics.

Domestic firms finance part of their capital (K) through sterling credit from domestic banks and part through loans from foreign banks; the remainder is provided by the firms' owners. Firms pay a nominal interest rate of R on credit from domestic banks; they expect sterling to depreciate at rate γ and domestic prices to increase at rate ρ. The share of capital financed through sterling credit (c) is a decreasing function of the real interest rate ($R - \rho$) and of a measure of the cost of domestic loans relative to foreign loans ($R - \gamma$).[10]

Foreign firms may also borrow from domestic banks. They raise the share c^* of their capital (K^*) in sterling loans; this share also decreases with $R - \gamma$. So the total demand for sterling loans (DC) is given by

$$DC = c(R-\rho, R - \gamma, .)\cdot K + c^*(R - \gamma, .)\cdot K^* \tag{16}$$

Domestic wealth holders divide their wealth (W) between holdings of noninterest-bearing sterling currency, sterling bank deposits bearing interest at rate $R - \delta$ (δ being the interest rate spread), property rights, and foreign assets. They also expect the domestic currency to depreciate at rate γ and domestic prices to increase at rate ρ. The portfolio share of sterling currency (k_{M_1}) is a decreasing function of the inflation rate and of the real interest paid on deposits ($R - \delta - \rho$); the portfolio share of bank deposits (k_{MQ}) is an increasing function of ρ, $R - \delta - \rho$, and $R - \delta - \gamma$.

[9]There is no stock market; ownership titles to firms are not transferable.

[10]The home country's demand for foreign assets and liabilities is assumed to be negligible in world markets; the foreign interest rate can then be taken as exogenous.

Foreign wealth holders place k^*_{MQ} of their wealth (W^*) in sterling deposits; k^*_{MQ} increases with $R - \delta - \gamma$. So the total demand for domestic broad money (DM_2) is given by

$$\begin{aligned} DM_2 = [&k_{M_1}(\rho, R - \delta - \rho, .) \\ &+ k_{MQ}(\rho, R - \delta - \rho, R - \delta - \gamma, .)] \cdot W \\ &+ k^*_{MQ}(R - \delta - \gamma, .) \cdot W^* \end{aligned} \tag{17}$$

The domestic banking system intermediates between the demand for sterling deposits and that for sterling loans. Commercial banks offer facilities for interest-bearing accounts to depositors and allocate their funds either to loans or to reserve deposits with the central bank. The central bank's liabilities—the monetary base—include these reserve deposits and also its issue of notes and coins; it deploys its assets either in lending to commercial banks or in foreign exchange reserves.

The central bank has various policy instruments at its direct disposal: it sets the required minimum ratio between commercial bank reserves and deposits, the rates of interest that it pays on required and on excess reserves, and the rate of interest that commercial banks pay to borrow from it. With these instruments, it may influence the behavior of commercial banks. A full account of the interactions taking place within the banking system is not attempted here; its details would depend on such factors as the degree of competition between commercial banks and the way in which commercial banks responded to risk. Briefly, the ratio of total sterling broad money to sterling bank credit (η) and the commercial bank interest rate spread (δ) depend on the required reserve ratio and the spread between the interest rates that the central bank pays on deposits and the rate that it charges for loans: increasing either of these will tend to raise both commercial banks' desire for reserves and the cost of intermediation, hence to reduce η and increase δ. To simplify the analytical framework, the general presumption will be that the central bank operates to keep η and δ fixed and invariant to changes in macroeconomic variables. The central bank's main policy instrument is the basic level of its interest rates, which is assumed to have a direct impact on R and hence on other potential macroeconomic variables.

Allocation within the banking system is competitive, in the sense that neither borrowers nor lenders face quantity constraints on their transactions at given prices. The sterling interest rate and/or exchange rate (depending on the government's monetary

policy) adjust to ensure that the money market clears. The authorities are sufficiently knowledgeable to achieve monetary targets by setting appropriate values for the available instruments.

III. Long-Run Monetary Equilibrium

In the long run, domestic competitiveness is expected to remain constant at $\bar{\alpha}$ at a value depending on $\bar{r}(\equiv R - \rho)$; the expected rate of inflation (ρ) and the expected rate of exchange rate depreciation (γ) are then equal. Domestic consumers and firms achieve their stock targets, $\bar{w}$ and $\bar{k}$, respectively, both of which are functions of long-run income, $\bar{y}$. Using equations (3)–(6), (10)–(12), and (16–17), the long-run conditions for money market equilibrium are as follows:

$$M_2 = [k_{M_1}(\rho, R - \delta - \rho, .) + k_{MQ}(\rho, R - \delta - \rho, .)] \cdot \bar{\alpha} \cdot \frac{PM^*}{e} \cdot w(y(\bar{\alpha}, .) + k^*_{MQ}(R - \delta - \rho, .) \cdot \bar{\alpha} \cdot \frac{PM^*}{e} \cdot \bar{w}^* \tag{18}$$

$$M_2 = \eta \cdot [c(R - \rho, .) \cdot \bar{\alpha} \cdot \frac{PM^*}{e} \cdot k(f(\bar{\alpha}, .), .) + c^*(R - \rho, .) \cdot \bar{\alpha} \cdot \frac{PM^*}{e} \cdot \bar{k}^*] \tag{19}$$

$$\bar{\alpha} = \bar{\alpha}(R - \rho, .) \tag{20}$$

Equation (18) is the condition that the demand for sterling assets equal the stock of broad money; equation (19) requires that the demand for sterling loans be compatible with the stock of broad money; equation (20) sets the value of domestic competitiveness.

Provided that the authorities follow a monetary policy that is compatible with stable prices—hence, a stable exchange rate—ρ is set to zero; δ and η are taken as behavioral parameters of the banking system, while PM^*, $\bar{w}^*$, and $\bar{k}^*$ are exogenous variables. Equations (18), (19), and (20) can then be solved for the real interest rate, relative prices, and the stock of real broad money, $m_2(\equiv M_2/[\alpha \cdot (PM^*/e)])$. Domestic prices and other nominal values depend on the authorities' choice of monetary target; they may set either the exchange rate or the broad money stock (or

some other nominal value).[11] Within this framework, the government cannot affect real variables but has one degree of freedom to affect nominal values.

Figure 2 illustrates long-run equilibrium in $\bar{r}/m_2$ space. AA represents equations (18) and (19) in $\bar{r}/m_2$ space; it slopes upward provided that the shift in portfolio composition toward broad money as $\bar{r}$ increases outweighs the negative impact of $\bar{r}$ on income and hence the wealth target. BB represents equations (19) and (20) in $\bar{r}/M_2$ space; it must slope down as both the substitution and the income effect reduce the demand for loans as $\bar{r}$ increases. The equilibrium real lending rate is $\bar{r}'$, while $\bar{r}' + \delta'$ is the equilibrium real deposit rate and m_2' is the equilibrium stock of real broad money. Despite financial openness and monetary stability, $\bar{r}' + \delta$ may well deviate from r^* because of the imperfect substitutability of foreign currency for sterling; the stronger is the currency preference for sterling over other currencies, the less interest elastic the demand for sterling assets and liabilities, the shallower the AA and BB loci, and the more the scope for divergence between $\bar{r}' + \delta'$ and r^*.

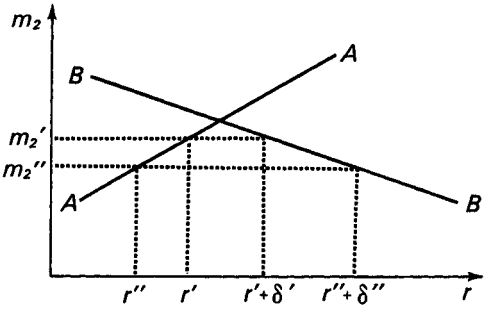

Figure 2

What is the effect of an exogenous improvement in competitiveness representing, for example, a reduction in wage demands or an improvement in domestic technology? Assuming that the income effects on stock targets of a reduction in $\bar{\alpha}$ are stronger than the disinflationary price effects, the loci AA and BB both shift upward in $m_2/\bar{r}$ space. The resulting equilibrium has a higher real money stock. The impact on real interest rates is uncertain,

[11]Price stability requires that the nominal interest rate be set equal to the equilibrium real interest rate.

depending on the relative slopes of AA and BB, that is, on the relative income and interest elasticities of the demand for sterling deposits and loans. Other comparative-static effects, such as the impact of a shift in portfolio preferences or in stock targets, may be deduced in a similar manner.

If the authorities are willing to sacrifice price stability or to manipulate the behavior of the banking system, that is, to alter the values of ρ, δ, or η, then they may regain some influence over real variables:

(i) The value of the rate of inflation would matter if and only if it would affect the total domestic demand for broad money even though real interest rates were kept constant. For instance, if the shift away from noninterest-bearing money that was caused by inflation were to reduce the total monetary share of wealth portfolios, then it would shift AA down to the right in $\bar{r}/m_2$ space. In equilibrium, an increased rate of expansion of M_2 or rate of depreciation of e, leading to a higher ρ, would result in an increase in the real interest rate (hence, a fall in real income) and a reduction in the real money stock. However, one would expect that persistent inflation would eventually lead to the evolution of interest-bearing means of payment, such as those mentioned in Section I, to make it possible to hold liquid funds without incurring a negative return. This institutional development would limit the extent of the inflationary impact on the demand for broad money.

(ii) By increasing the cost of bank intermediation to engineer a rise in the interest rate spread (δ), the authorities may achieve a reduction of real monetary balances. In Figure 2, raising the spread from δ' to δ'' reduces equilibrium real monetary balances to m_2''. The deposit interest rate falls while the lending rate rises. The real effect of such a policy is limited by the extent of any shift of intermediation from the domestic banking system elsewhere—to alternative domestic financial institutions or offshore.

(iii) Reducing the proportion of foreign reserve assets that are held against the sterling liabilities of the banking system (i.e., raising η) increases the availability of sterling loans, and hence shifts BB down to the left. In equilibrium, this action reduces domestic interest rates and increases real income. The extent of this effect is limited by the degree of interest elasticity of demand for sterling broad money balances: if interest elasticity is high, AA tends to be steep, and a shift in η will be reflected mainly in a reduction in real money balances rather than in a reduction in interest rates. Moreover, the scope for raising η is constrained by

the country's need for foreign reserves to guard against short-run balance of payments difficulties caused by exogenous shocks.

IV. Monetary Equilibrium with Wage/Price Adjustment

This section investigates the short run during which relative prices and wages adjust slowly toward their long-run values. Movements of the exchange rate, which have an immediate impact on import and export prices, disturb the relative price of the domestic good on the home market from its long-run level. So α is an increasing function of the exchange rate as in equation (13), while its rate of increase β (which rises with $(\alpha - \bar{\alpha})$, as in equation (14)) becomes a declining function of the exchange rate. The rate of domestic price inflation (ρ) depends on the rate of depreciation of the exchange rate (γ) and on β as in equation (15). Real capital and wealth stocks are increasing functions of short-run output and income, f and y, respectively, which depend on α as in equations (10) and (11).

Under these assumptions, the short-run monetary equilibrium conditions include

$$\begin{aligned} M_2 = {} & [k_{M_1}(\rho, R-\delta-\rho, .) \\ & + k_{MQ}(\rho, R-\delta-\rho, R-\delta-\gamma, .)]\cdot \\ & \cdot\alpha(e,.)\cdot\frac{PM^*}{e}\cdot w(y(\alpha(e,.),.),.) \\ & + k^*_{MQ}(R-\delta-\gamma,.)\cdot\alpha(e,.)\cdot\frac{PM^*}{e}\cdot w^* \end{aligned} \tag{21}$$

$$\begin{aligned} M_2 = {} & \eta\cdot[c(R-\rho,\ R-\gamma,.)\cdot\alpha(e,.)\cdot\frac{PM^*}{e}\cdot k(f(\alpha(e,.),.),.) \\ & + c^*(R-\gamma,.)\cdot\alpha(e,.)\cdot\frac{PM^*}{e}\cdot k^*] \end{aligned} \tag{22}$$

$$\rho = \beta(\alpha(e,.),.) + \gamma \tag{23}$$

Taking δ and η as behavioral parameters, these conditions are three equations in five endogenous variables: M_2, R, e, ρ, and γ. Clearly missing is an equation governing the formation of exchange rate expectations. But, in general, if expectations are to approach rationality, then it would be necessary to discover the complete adjustment path in order to model γ. To simplify, let the domestic portfolio share of broad money ($k_{M_1} + k_{MQ}$) be indepen-

dent of the inflation rate. Then the equation system (21)–(23) may be expressed in terms of only four endogenous variables: M_2; e; the real interest rate, $R - \rho$; and the relative interest rate factor, $R - \gamma$. In this formulation, real values in the present are determined irrespective of anticipated future nominal values; only the nominal interest, inflation, and depreciation rates cannot be discovered without a model of the complete adjustment path.

In either case, the authorities possess—in the short run—a degree of freedom to set a monetary target. Because prices are sticky, the value of this target has repercussions on the real economy as well as on purely nominal values. In particular, monetary policy can be seen as an important element of any macroeconomic stabilization strategy. Alternative fixed-target types of regime will provide the economic system with alternative insulation properties against exogenous shocks, while shifts in target could in theory be used to accelerate the process of wage/price adjustment.

To illustrate how the system would behave under different policy regimes, it is convenient to simplify the model further by assuming that the rate of wage/price adjustment is negligible; that is, $\beta = 0$. Provided that exogenous variables and policy targets are expected to remain at their present values, the equilibrium in the next period is the same, in both real and nominal terms, as equilibrium in the present. So ρ and γ can also be set to zero. Last, let δ equal zero. Then the short-run monetary equilibrium conditions can be reduced to

$$M_2 = [k_{M_1}(R,.) + k_{MQ}(R,.)]\cdot\alpha(e,.)\cdot\frac{PM^*}{e}\cdot w(y(\alpha(e,.),.),.) + k^*_{MQ}(R,.)\cdot\alpha(e,.)\cdot\frac{PM^*}{e}\cdot w^* \tag{24}$$

$$M_2 = \eta\cdot[c(R,.)\cdot\alpha(e,.)\cdot\frac{PM^*}{e}\cdot k(f(\alpha(e,.),.),.) + c^*(R,.)\cdot\alpha(e,.)\cdot\frac{PM^*}{e}\cdot k^*] \tag{25}$$

Rather than attempt a systematic survey of the comparative-static properties of this system,[12] this section concentrates on a few topics to bring out some of the possibilities that are inherent in this framework of analysis.

[12]See Collyns (1981, Chs. 7 and 8).

FIXED INTEREST RATE REGIME

If the authorities act so as to fix R to some target value, e and M_2 then adjust to ensure monetary equilibrium in the short run. Figure 3 illustrates equations (24) and (25) in e/M_2 space. The loci AA and BB—representing equations (24) and (25), respectively—both slope down as, with a fixed interest rate, an appreciation in the exchange rate leads to a fall in the demand for both sterling assets and liabilities. Equilibrium occurs at P, with an exchange rate of e' and a money stock of M_2'.

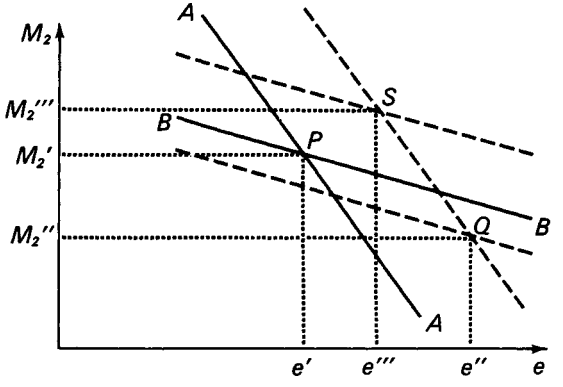

Figure 3

An increase in the interest rate target shifts AA out to the right and BB down to the left. Provided that the slope of AA is steeper than the slope of BB (i.e., provided the wealth target is more responsive than the capital target to shifts in the exchange rate), the new equilibrium at Q has a higher exchange rate and a lower money stock than originally. This result is compatible with the conventional wisdom that raising domestic interest rates leads to an exchange rate appreciation and a contraction of monetary aggregates.

In the United Kingdom, in the period 1980–81, the authorities had difficulty in controlling the growth of the money stock within the limits stated by their financial strategy. An explanation offered for this phenomenon was that raising interest rates in a recession might increase rather than reduce the demand for loans. Within the present analytical framework, this perverse response would indeed lead to the observed result: BB would shift not to

the left but rather to the right; the new equilibrium at S then has a higher rather than a lower money stock than before.

All floating exchange rate regimes, the fixed interest rate regime included, have the property of shielding the economy from external price shocks: the exchange rate moves to offset any movement in PM^* to keep domestic prices at their original levels. The fixed interest rate regime has the distinctive property that it also insulates the real economy from internal price shocks. Consider an exogenous increase in the domestic markup, hence in PD. If the exchange rate depreciates so as to increase import prices by the same proportion, α is unaffected by the shock, while M_2 grows to accommodate the proportionally higher demand for sterling assets and liabilities. By contrast, fixing M_2 or some other monetary aggregate rather than R would mean that, in equilibrium, e would have depreciated less than PD had risen, so that α would increase and real income and output levels would fall.

ALTERNATIVE MONETARY AGGREGATE REGIMES

Figure 4 illustrates equations (24) and (25) in e/R space for a given M_2 target. The locus AA, representing equation (24), slopes up as an increase in the interest rate is needed to counterbalance the deflationary effect of an exchange rate appreciation to keep the total demand for sterling assets fixed at the target. The locus BB, representing equation (25), slopes down as a reduction in the interest rate is required to offset the impact of an increase in the

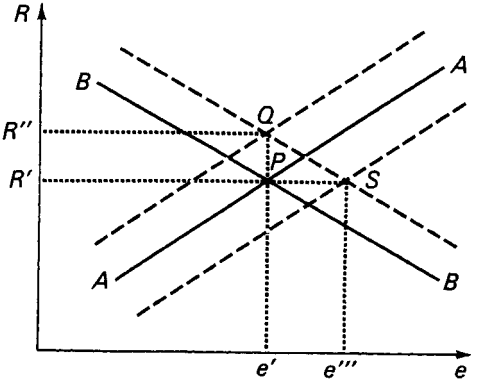

Figure 4

exchange rate to maintain the demand for sterling liabilities consistent with the target. Equilibrium is at P.

In this framework, it is clearly important to keep track of the direct effect of the exogenous shock on the demand for sterling liabilities as well as on the demand for sterling assets. For example, a rise in foreign interest rates will reduce the demand for sterling assets but will raise the demand for sterling liabilities, shifting AA up to the left and BB up to the right. There must be a corresponding rise in the sterling interest rate as equilibrium shifts to Q. By contrast, a general rise in foreign income levels, raising foreign wealth and capital stock targets, will raise foreign demand for both sterling assets and liabilities, shifting both AA and BB to the right. The result is an appreciation in the exchange rate with an indeterminate and small effect on the sterling interest rate as equilibrium shifts to S.

A variety of other monetary aggregates may also be used as the target for monetary policy, including the narrow money stock, M_1; the domestic component of broad money, $M_2(-)$, which excludes foreign holdings of domestic deposits; and domestic credit, DC, the domestic component of sterling lending. The choice between alternative targets has consequences for the response of the economic system to different types of exogenous shock. Each of these may be analyzed after appropriate rearrangement of equations (24) and (25).

Consider a favorable income shock, such as, for example, the exploitation of a newly discovered oil reserve, which shifts the functions $y(\alpha, .)$ and $f(\alpha, .)$ upward. Under all four regimes, the exchange rate appreciates to restore monetary equilibrium at the original monetary target; this appreciation reduces domestic competitiveness and, hence, partially neutralizes the original shift's positive effect on real income. However, the extent of this appreciation is less under the M_2 target regime than under any of the other three. Under the former regime, the aggregates M_1, $M_2(-)$, and DC may all increase as the exchange rate rises, as this appreciation reduces foreign demand for sterling assets and liabilities. Hence, the squeeze on the non-oil economy that is required to restore equilibrium is rather less.

The effects of various financial shocks may be qualitatively as well as quantitatively different under the alternative regimes:

(1) A shift in domestic portfolio preferences from narrow money to quasi-money has no effect on equilibrium under $M_2(-)$, M_2, or DC target regimes. However, with an M_1 target,

an exchange rate depreciation and a fall in the interest rate are required to restore balance.

(2) A shift in foreign portfolio preferences toward sterling assets under a fixed M_2 or DC regime leads to a fall in the domestic interest rate and an exchange rate depreciation; under a fixed M_1 or $M_2(-)$ regime, the same shift leads to a fall in the domestic interest rate with an exchange rate appreciation.

VI. Conclusion

Recent institutional developments, particularly in developed economies, have led to increasingly competitive money markets dominated by the adjustment of price rather than quantity. The theme of this paper is that in such a situation monetary aggregates, interest rates, and the exchange rate are jointly determined, and it is then essential to pay as much attention to modeling the supply of money as to the demand. Otherwise, the analysis of monetary policy is sometimes misleading and at best incomplete.

If an interest rate on money balances is simply introduced into a standard model of asset-market equilibrium, it appears that the authorities have two degrees of freedom, being able to set two from the set of monetary aggregates, interest rates, and the exchange rate; this conclusion is at odds with the conventional wisdom on the limits to sustainable monetary policy. But the money market-clearing condition—that the demand for monetary assets be compatible with the demand for bank borrowing—provides an additional restraint on the power of monetary policy. In the long run, in which nominal prices are perfectly flexible and stocks are at their target values, the authorities may control the price level but not real activity levels, relative prices, or real interest rates in monetary equilibrium, unless they are prepared to manipulate the behavior of the banking system. In the short run in which nominal prices are sticky, the authorities may exert some influence over the real economy through their choice of monetary policy, but this policy cannot hope to achieve more than one independent monetary target without altering bank behavior.

The analysis contained in the body of this paper is also intended to bring out some of the comparative-static implications of models that treat the liability as well as the asset side of the money market. These include: (1) the conventional view that raising

interest rates leads to an exchange rate appreciation and a contraction of the money stock rests on (i) the demand for money balances being more responsive to shifts in the exchange rate than the demand for bank borrowing, and (ii) the substitution effect of an increase in lending rates on bank borrowing outweighing the income effect; (2) the qualitative effect of a financial shock on monetary equilibrium depends on (i) the impact of the shock on the demand for bank borrowing as well as on the demand for money balances, and (ii) the precise choice of monetary target.

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SUMMARIES

The Macroeconomic Effects of Changes in Barriers to Trade and Capital Flows: A Simulation Analysis—MOHSIN S. KHAN and ROBERTO ZAHLER (pages 223–82)

The liberalization of foreign trade and capital movements, or what is commonly termed opening up the economy, is a subject of increasing interest to developing countries, including many in Latin America. While the longer-run costs and benefits of such a strategy may be well known, there has been little systematic study of the short-run effects on the economy as it changes from a relatively closed system to a more outward-oriented one. Analysis of some of the short-term to medium-term economic effects of reducing barriers to trade and capital flows is the basic focus of this paper.

The short-term issues related to opening up are handled within the framework of a dynamic general-equilibrium model constructed specifically for this purpose. This model, which concentrates on the determination of major macroeconomic variables, has its roots in both theoretical and empirical general-equilibrium models, as well as in the monetary-oriented models that have been developed to study the macroeconomics of open economies. At the same time, care is taken to explicitly incorporate certain phenomena that have emerged in country experiences with liberalization, such as persistent deviations from the law of one price and from interest rate parity. This approach makes the resulting model more representative of a "typical" Latin American country, although it should be stressed that the model is quite general and therefore is not entirely applicable to a particular country. Dynamics are introduced to enable one to trace the transition paths of variables—such as economic activity, employment, prices, the balance of payments, external indebtedness, and interest rates—from one equilibrium position to another.

Using a representative set of parameter values, the model simulates various types of opening-up strategy, including (1) gradual and sudden reduction in tariffs, (2) gradual and sudden removal of restrictions on capital flows, (3) simultaneous gradual removal of both of these barriers, and (4) gradual removal of both types of barrier in different sequences. It is believed that such experiments cover most types of policy actually adopted by those developing countries that have sought to open up their economies. Briefly, the results indicate that in all cases some transitory costs are incurred, including reductions in economic growth and employment, the emergence of current account deficits, and reductions in government revenues. The overall exercise yielded the following important insights. First, the effects of liberalizing foreign trade differ markedly from the effects of liberalizing capital flows, and the effects of a simultaneous liberalization of both are not the same as the effects of implementing the two liberalization policies separately. Second, the speed with which the reforms are instituted is important. As expected, a shock type of approach has a more pronounced impact at the beginning, but the adjustment to equilibrium is faster.

Finally, and perhaps most interesting, it is shown that the choice of the type of policy to be implemented first is not a matter of indifference. Clear trade-offs emerge, allowing policymakers to choose particular strategies that are consistent with their own overall perspectives.

The Underground Economy in the United States: Annual Estimates, 1930–80—VITO TANZI (pages 283–305)

This article presents yearly estimates for the underground economy in the United States for the period 1930–80. The method used for calculation is one developed a few years ago by the author, and it has been used in many other countries. The main conclusions can be summarized as follows: (1) in 1980 the underground economy, expressed as a percentage of gross national product (GNP), was somewhere between 4.5 percent and 6.1 percent; (2) the only other period in which it might have been higher than that was during World War II; (3) it has been increasing since the mid-1960s; and (4) over the period 1965–80, it has grown by more than 2 percentage points of GNP (by almost 50 percent). The recent trend is disturbing, as it seems to have accelerated in recent years, especially since the mid-1970s. This trend was probably influenced by the substantial increase in marginal tax rates over the period 1975–80, caused by inflation and the absence of significant tax cuts. It is not possible at this point to speculate on whether the tax cuts enacted in 1981 have reversed the trend.

The results obtained in this paper should not be taken as precise measures of the underground economy; they are, at best, broad indications of trends and of orders of magnitude because they are sensitive to the assumptions made as well as to data revisions. However, it is comforting to realize that for 1974 and 1976 they are of the same order of magnitude as direct estimates by Simon and Witte (1980) and by the Internal Revenue Service (1979).

A word on what has been measured is necessary. The estimates attempt to measure the incomes that were associated with the excessive use of cash and that presumably were not reported to the tax authorities. Whether these incomes were or were not measured by the national accounts authorities cannot be determined. Presumably, part of these incomes not only evaded the tax net but also may have escaped the attention of the national accounts authorities—but, how large this part was cannot be assessed with the information at hand. Should this part be large, it would have serious implications for the conduct of economic policy that is based largely on changes in economic activity as reflected by the national accounts.

Measurement of the Public Sector Deficit and Its Implications for Policy Evaluation and Design—WILLEM H. BUITER (pages 306–49)

This paper studies budgetary, financial, and monetary policy evaluation and design using a comprehensive wealth or permanent income accounting framework. A set of stylized balance sheets and permanent income accounts is constructed for the public, private, and overseas sectors. These are then contrasted with the conventionally measured balance sheet and flow of funds accounts. This

permits a new look at the issues of "crowding out" and the "eventual monetization of fiscal deficits."

The conventionally measured public sector financial surplus, even when evaluated at constant prices or as a proportion of gross national product, presents a potentially misleading picture of the change in the real net worth of the public sector. One reason is that capital gains and losses on outstanding stocks of marketable financial assets and liabilities are not included in the flow of funds. This omission includes changes in the real value of public sector debt that are due to inflation and to exchange rate changes. A second reason is the omission of revaluations in nonmarketable (and often merely implicit) assets and liabilities, such as the expected future streams of tax receipts and of benefit payments. The need to distinguish between transitory (e.g., cyclical) and permanent (or structural) changes in the deficit and between current account and capital account deficits is reiterated.

The paper than proposes some general rules for the design of stabilization policy—measures to facilitate expenditure smoothing by avoiding or minimizing the incidence of capital market imperfections. Both national governments and international agencies should design fiscal, financial, and budgetary policies so as to induce an evolution of the conventionally measured balance sheet and flow of funds accounts that permits private agents and national economies, respectively, to approximate the behavior that would be adopted if comprehensive wealth or permanent income were the only binding constraint on economic behavior. This goal can be achieved by keeping disposable income in line with permanent income and by ensuring an adequate share of disposable financial wealth in total wealth.

Estimating Models of Financial Market Behavior During Periods of Extensive Structural Reform: The Experience of Chile—DONALD J. MATHIESON (pages 350–93)

This paper examines the problems involved in estimating portfolio balance models of the behavior of financial markets during a period of extensive structural reforms. The model encompasses specifications of the portfolio behavior of banks and nonbanks (firms and households) regarding holdings of currency, demand deposits, time deposits, and bank loans. In addition, the analysis describes the determinants of bank loan and time deposit rates and the linkages between inflation, the balance of payments, interest rates, and financial aggregates. The model is estimated for a sample of monthly Chilean data from July 1965 to June 1980. The estimation results are also contrasted with those obtained in previous work on Argentina.

Applied General-Equilibrium Tax Modeling—JOHN B. SHOVEN (pages 394–420)

This paper summarizes the progress that has been made in computational general-equilibrium (CGE) models designed for tax policy evaluation. After reviewing the structure of CGE models, the paper discusses the inclusion of taxes, foreign trade, and financial behavior. The data requirements and use are examined, as is the measure of economic welfare used for efficiency comparisons.

The U.S. model (constructed with the assistance of the U.S. Treasury Department) is reviewed, and results are presented for both the integration of the corporation and personal income taxes and the adoption of a personal consumption tax instead of the current income tax. Primary results indicate that the present value of the efficiency gain from integrating the two tax systems is $350–450 billion (in 1973 dollars), between 0.7 and 0.9 percent of the present value of national income *plus* leisure; the gain from moving to a consumption tax is larger, amounting to roughly $630 billion (1973 dollars), 1.25 percent. The paper also asks how long the long run is for such a policy change as the adoption of the consumption tax. The model suggests that it takes 30–40 years to adjust fully to the new tax program, indicating that policies designed to increase real wages by taxing saving more lightly to increase capital/labor ratios may take a long time to produce the desired effect.

The paper reports estimates of the total efficiency losses caused by the entire tax system. The hypothetical experiment that was involved replaces the existing set of federal, state, and local taxes with an equal-yield set of nondistortionary lump-sum levies. The estimated total losses of the existing system are 10 percent of the present value of future national income and 6.7 percent of the present value of national income *plus* leisure. These estimates are significantly higher than those previously published for individual components of the overall tax system.

The final results for the U.S. general-equilibrium model give an estimate of how much efficiency losses increase per dollar of increased tax receipts. The paper asserts that if all taxes are raised proportionally, the deadweight loss increases between $0.52 and $0.76 per additional dollar raised, implying that the private sector loses between $1.52 and $1.76 for each dollar raised. These results indicate that considerations of tax efficiency have important implications for the economy's allocation of resources. The paper also briefly discusses the implications that tax efficiency considerations have for cost/benefit studies of governmental expenditure programs.

The paper concludes by asserting that applied general-equilibrium analysis is now sufficiently well developed to be a useful tool for policy analysis.

On the Monetary Analysis of an Open Economy—CHARLES COLLYNS (pages 421–44)

Recent institutional developments in developed economies have led to increasingly competitive money markets that are dominated by price rather than quantity adjustment. In this situation, monetary aggregates, monetary interest rates, and the exchange rate are jointly determined. But, if an interest rate on money balances is simply introduced into a standard asset-market model of monetary equilibrium, it then appears that the authorities have two degrees of freedom, being able to set two from the set of monetary aggregates, interest rates, and the exchange rate. This conclusion is at odds with conventional views on the limits to sustainable monetary policy. This paper reconciles this discrepancy by requiring that, in equilibrium, the demand for bank loans be compatible with the demand for monetary assets. This procedure requires an explicit treatment of the money supply process, including the behavior of the banking system and of the demand for credit. In the context of this extended model, the mon-

etary authorities can achieve only one independent monetary target. In the long run, monetary policy does not affect real variables, unless the authorities manipulate the behavioral characteristics of the banking system; in the short run, in which nominal prices are sticky, the choice of monetary policy does have real effects. The comparative-static implications of policy choices and exogenous shocks are seen to depend on the relative force and direction of their impact on the demand for bank borrowing as well as for monetary assets.

RESUMES

Effets macroéconomiques des modifications apportées aux obstacles aux échanges commerciaux et aux mouvements de capitaux : analyse de simulation — MOHSIN S. KHAN et ROBERTO ZAHLER (pages 223–82)

La libéralisation du commerce extérieur et des mouvements de capitaux, ou ce qu'il est encore communément convenu d'appeler l'"ouverture" de l'économie, est un sujet qui suscite un intérêt croissant dans les pays en développement, notamment dans un grand nombre de pays d'Amérique latine. S'il est vrai que les coûts et les avantages à long terme de cette stratégie sont sans doute bien connus, peu d'études systématiques de ses effets à court terme sur l'économie, à mesure que celle-ci passe d'un système relativement fermé à un système davantage axé sur l'extérieur, ont été entreprises. Le présent document est essentiellement consacré à l'analyse de certains effets économiques à court et moyen termes de la réduction des obstacles aux échanges commerciaux et aux mouvements de capitaux.

Les questions à court terme liées à l'ouverture de l'économie sont traitées dans le cadre d'un modèle dynamique d'équilibre général construit spécifiquement à cette fin. Ce modèle, qui se concentre sur la détermination des principales variables macroéconomiques, trouve ses racines dans des modèles d'équilibre général, tant théoriques qu'empiriques, ainsi que dans les modèles reposant davantage sur la théorie monétaire qui ont été conçus pour l'étude macroéconomique des économies ouvertes. Dans le même temps, les auteurs ont pris soin d'incorporer explicitement certains phénomènes qui se sont présentés dans plusieurs pays ayant fait l'expérience de la libéralisation, comme, par exemple, des écarts persistants par rapport à la loi du prix unique du marché et par rapport à la parité des taux d'intérêt. Cette méthode rend le modèle qui en résulte plus représentatif d'un pays "typique" d'Amérique latine, encore qu'il faille souligner que le modèle est plutôt général et, par conséquent, n'est pas entièrement applicable à un pays particulier. Sa dynamisation est introduite pour permettre de déterminer la trajectoire de transition suivie par les variables — telles que l'activité économique, l'emploi, les prix, la balance des paiements, la dette extérieure et les taux d'intérêt — lorsque l'économie passe d'une position d'équilibre à une autre.

Utilisant un ensemble représentatif des valeurs des paramètres, le modèle simule différents types de stratégies d'ouverture, parmi lesquelles : 1) une réduction progressive ou brusque du tarif douanier; 2) une suppression progressive ou brusque des restrictions aux mouvements de capitaux; 3) l'élimination progressive simultanée de ces deux types d'obstacles; et 4) l'élimination progressive en séquences de ces deux types d'obstacles. On estime que ces expériences recouvrent la plupart des types de mesures effectivement adoptées par les pays en développement qui ont cherché à ouvrir leur économie. En bref, les résultats montrent que, dans tous les cas, le processus entraîne des coûts temporaires, parmi lesquels une diminution de la croissance économique et de l'emploi,

l'apparition de déficits extérieurs courants et une baisse des recettes publiques. Dans son ensemble, l'étude fournit les indications importantes suivantes. Premièrement, les effets d'une libéralisation des échanges commerciaux avec l'extérieur sont très différents des effets d'une libéralisation des mouvements de capitaux et les effets d'une libéralisation simultanée des uns et des autres sont différents des effets de politiques de libéralisation mises en oeuvre séparément dans ces deux domaines. Deuxièmement, la rapidité avec laquelle les réformes sont mises en oeuvre est importante. Comme on peut s'y attendre, une méthode de "choc" a une incidence plus prononcée dans un premier temps, mais le retour à l'équilibre se fait plus vite. Enfin, et c'est peut-être la chose la plus intéressante, les auteurs montrent que le choix du type de politique à mettre en oeuvre en premier lieu n'est pas indifférent. Des arbitrages apparaissent nettement qui permettent aux responsables de la politique économique d'opter pour les stratégies qui sont compatibles avec leurs propres perspectives générales.

L'économie clandestine aux Etats-Unis : estimations annuelles, 1930–80 — VITO TANZI (pages 283–305)

Le présent article fournit des estimations annuelles relatives à l'économie clandestine aux Etats-Unis pour la période 1930-80. La méthode utilisée pour effectuer les calculs a été mise au point par l'auteur il y a quelques années et a été appliquée dans de nombreux autres pays. Les conclusions principales peuvent être résumées comme suit : 1) en 1980, l'économie clandestine, exprimée en pourcentage du produit national brut (PNB), s'est située entre 4,5 % et 6,1 %; 2) la seule période pendant laquelle elle a peut-être représenté un pourcentage plus élevé est celle de la deuxième guerre mondiale; 3) la part de l'économie clandestine a augmenté depuis le milieu des années 60; et 4) au cours de la période 1965–80, elle a augmenté, en proportion du PNB, de plus de deux points de pourcentage (soit de près de 50 %). La tendance enregistrée récemment est préoccupante, étant donné que l'économie clandestine semble se développer à un rythme croissant, surtout depuis le milieu des années 70. Cette tendance a probablement été influencée par l'augmentation considérable des taux marginaux d'imposition au cours de la période 1975–80, augmentation due à l'inflation et à l'absence de réduction sensible des impôts. Il n'est pas possible à ce stade de déterminer si les réductions d'impôts adoptées en 1981 ont renversé ou non la tendance.

Les résultats figurant dans la présente étude ne doivent pas être considérés comme des mesures précises de l'économie clandestine; ils ne donnent, au mieux, que des indications générales des tendances et des ordres de grandeur parce qu'ils sont sensibles aux hypothèses retenues ainsi qu aux révisions des données. Toutefois, il est rassurant de constater que, pour 1974 et 1976, les chiffres sont du même ordre de grandeur que les estimations directes effectuées par Simon et Witte en 1980, et par l'administration fiscale des Etats-Unis (Internal Revenue Service) en 1979.

Il convient de préciser brièvement les éléments qui ont été mesurés. Les estimations cherchent à évaluer les revenus liés à l'utilisation excessive des règlements en espèces et qui n'ont probablement pas été déclarés à l'administration des impôts. Il n'est pas possible de déterminer si ces revenus ont ou non été évalués par les services responsables de la comptabilité nationale.

Selon toute vraisemblance, une partie de ces revenus a non seulement échappé à l'impôt mais, en outre, a échappé à l'attention des services de la comptabilité nationale; toutefois, il n'est pas possible d'évaluer, sur la base des renseignements disponibles, l'ampleur de cette partie des revenus. Si elle est effectivement importante, elle pourrait avoir des effets graves sur la conduite de la politique économique qui se fonde essentiellement sur les variations de l'activité économique telles qu'elles apparaissent dans la comptabilité nationale.

Mesure du déficit du secteur public et ses implications pour l'évaluation et l'élaboration de la politique économique — WILLEM H. BUITER (pages 306–49)

La présente étude analyse l'évaluation et l'élaboration des politiques budgétaire, financière et monétaire à partir d'un cadre comptable reposant sur le patrimoine global ou sur le revenu permanent. Un ensemble de comptes types de patrimoine et du revenu permanent est mis au point pour les secteurs public, privé et le reste du monde. Ces comptes sont ensuite comparés aux comptes de patrimoine et aux comptes d'opérations financières établis selon les méthodes traditionnelles. Cette comparaison jette un jour nouveau sur les questions d'envahissement du marché financier par le secteur public et de monétisation finale des déficits budgétaires.

L'excédent financier du secteur public, lorsqu'il est mesuré selon les méthodes traditionnelles, même s'il est calculé à prix constants ou en proportion du produit national brut, donne une idée de la variation de la valeur réelle nette du patrimoine du secteur public qui risque d'induire en erreur. L'une des raisons en est que les gains et pertes en capital sur les stocks existants d'actifs et de passifs financiers négociables ne sont pas inclus dans les opérations financières. Cette omission porte aussi sur les variations de la valeur réelle de la dette du secteur public dues à l'inflation et aux fluctuations de taux de change. Une autre raison est que sont également omises les réévaluations des actifs et des passifs non négociables (et souvent purement implicites), tels que les flux futurs actualisés de recettes fiscales et de dépenses de transferts. L'auteur réitère la nécessité d'effectuer une distinction entre variations temporaires (par exemple cycliques) et variations permanentes (ou structurelles) du déficit et entre déficits des opérations courantes et déficits des opérations en capital.

L'auteur propose ensuite quelques règles générales pour l'élaboration de mesures de stabilisation destinées à atténuer les variations des dépenses en évitant ou en minimisant l'incidence des imperfections du marché des capitaux. Les gouvernements comme les institutions internationales devraient mettre au point des politiques fiscales, financières et budgétaires propres à susciter une évolution des comptes de patrimoine et des tableaux d'opérations financières établis selon les méthodes traditionnelles, de façon à permettre aux agents économiques privés et aux économies nationales, respectivement, d'approcher le comportement qui serait adopté si le patrimoine global ou le revenu permanent était la seule limite contraignante au comportement économique. Cet objectif peut être atteint si le revenu disponible suit le revenu permanent et en rendant disponible une part suffisante du patrimoine financier à l'intérieur du patrimoine total.

Estimation de modèles du comportement du marché financier en périodes de réformes structurelles généralisées : l'expérience du Chili — DONALD J. MATHIESON (pages 350–93)

L'auteur de la présente étude analyse les difficultés que présente l'estimation de modèles du comportement du marché financier — axés sur l'équilibre des portefeuilles — en périodes de réformes structurelles généralisées. Le modèle spécifie le comportement en matière de portefeuilles des banques et des agents non bancaires (entreprises et ménages) au niveau des avoirs en monnaie, des dépôts à vue, des dépôts à terme et des prêts bancaires. L'analyse comporte également une description des facteurs déterminants des taux servis sur les prêts bancaires et les dépôts à terme ainsi que des liens existant entre l'inflation, la balance des paiements, les taux d'intérêt et les agrégats financiers. Le modèle est estimé au moyen d'un échantillon de données mensuelles observées au Chili pendant la période allant de juillet 1965 à juin 1980. Enfin, l'auteur compare les résultats à ceux obtenus dans le cadre d'une étude effectuée antérieurement pour l'Argentine.

Modèles d'équilibre général appliqués incorporant la fiscalité — JOHN B. SHOVEN (pages 394–420)

L'auteur fait état des progrès réalisés dans le domaine des modèles informatiques d'équilibre général conçus pour évaluer les politiques fiscales. Après avoir examiné la structure de ces modèles, il traite de la prise en compte, dans ces modèles, des impôts, du commerce extérieur et des comportements financiers. Il passe en revue les données qu'il convient de rassembler, l'utilisation qui en est faite, ainsi que la façon dont on mesure le bien-être économique pour effectuer des comparaisons d'efficacité.

L'auteur analyse le modèle élaboré pour les Etats-Unis (en collaboration avec le Ministère des finances des Etats-Unis) et présente les résultats donnés par la prise en compte de l'impôt sur les sociétés et de l'impôt sur le revenu des personnes physiques ainsi que par le remplacement de l'impôt actuel sur le revenu par un impôt sur la consommation des personnes physiques. Les premiers résultats indiquent que la valeur actuelle du gain d'efficacité dû à l'intégration des deux régimes d'imposition est d'environ 350-450 milliards de dollars E.U. (en dollars de 1973), soit entre 0,7 et 0,9 % de la valeur actuelle du revenu national *plus* les loisirs; le gain résultant de l'adoption d'un impôt sur la consommation est plus élevé puisqu'il est de l'ordre de 630 milliards de dollars E.U. (en dollars de 1973), soit 1,25 %. L'auteur cherche également à quantifier l'horizon temporel d'un changement de politique économique tel que l'adoption d'un impôt sur la consommation. D'après le modèle, il faut de 30 à 40 ans pour que l'économie puisse s'adapter complètement au nouveau programme fiscal, ce qui signifie que les mesures prises pour accroître les salaires réels en allégeant l'imposition de l'épargne de manière à accroître les ratios capital/travail peuvent ne produire l'effet désiré qu'après une longue période.

L'auteur donne un certain nombre d'estimations concernant les pertes d'efficacité causées par l'ensemble du système fiscal. L'auteur fait fonctionner le modèle en choisissant, par hypothèse, de remplacer les impôts fédéraux, d'Etat et locaux actuellement en vigueur par une série de prélèvements forfaitaires qui ont le même rendement et ne produisent aucune distorsion. Les pertes totales

sont estimées, pour l'ensemble du système fiscal existant, à 10 % de la valeur actuelle du revenu national futur et à 6,7 % de la valeur actuelle du revenu national *plus* les loisirs. Ces estimations sont significativement supérieures à celles qui ont été publiées antérieurement pour les diverses composantes de l'ensemble du système fiscal.

Les résultats finals du modèle d'équilibre général pour les Etats-Unis fournissent une estimation de la proportion dans laquelle les pertes d'efficacité augmentent lorsque les recettes fiscales progressent d'un dollar. L'auteur affirme que, si tous les impôts sont relevés dans les mêmes proportions, la perte d'efficacité ("deadweight loss") augmente d'un montant compris entre 52 et 76 cents des Etats-Unis pour chaque dollar de recette supplémentaire, ce qui signifie que le secteur privé perd de 1,52 à 1,76 dollar E.U. pour chaque dollar perçu au titre de l'impôt. Ces résultats montrent que les considérations relatives à l'efficacité de l'impôt ont d'importantes répercussions sur l'allocation des ressources au sein de l'économie. L'auteur examine ensuite brièvement l'implication que ces considérations d'efficacité de l'impôt ont pour les analyses coûts/avantages des programmes de dépenses publiques.

L'auteur conclut en affirmant que les modèles appliqués d'équilibre général sont maintenant suffisamment au point et constituent un instrument utile aux fins de l'analyse des divers aspects de la politique économique.

Analyse monétaire d'une économie ouverte — CHARLES COLLYNS (pages 421–44)

Certaines mutations institutionnelles récentes au sein des économies développées se sont traduites par des marchés monétaires de plus en plus compétitifs, dominés par des ajustements de prix plutôt que par des ajustements de quantité. Dans une telle situation, les agrégats monétaires, les taux d'intérêt monétaires et les taux de change sont déterminés conjointement. Mais, si un taux d'intérêt sur les encaisses est simplement introduit dans un modèle typique, fondé sur le marché des avoirs d'équilibre monétaire, il apparaît que les autorités ont deux degrés de liberté puisqu'elles sont à même de définir deux éléments de l'ensemble constitué par les agrégats monétaires, les taux d'intérêt et le taux de change. Cette conclusion est en contradiction avec l'opinion traditionnelle concernant les limites d'une politique monétaire soutenable. Le présent document concilie ces points de vue divergents en posant comme condition que, en situation d'équilibre, la demande de prêts bancaires soit compatible avec la demande d'avoirs monétaires. Cette procédure requiert un traitement explicite du processus d'offre de monnaie, et notamment du comportement du système bancaire et de la demande de crédit. Dans le contexte de ce modèle élargi, les autorités monétaires ne peuvent atteindre qu'un objectif monétaire indépendant. A long terme, la politique monétaire n'affecte pas les variables réelles à moins que les autorités ne manipulent les caractéristiques du comportement du système bancaire; à court terme, étant donné la viscosité des prix nominaux, le choix de la politique monétaire a des effets réels. On constate que les implications, sur les positions statiques comparées, des choix de politique économique et des chocs exogènes dépendent de la force relative et du sens de leur impact sur la demande de prêts bancaires et d'avoirs monétaires.

RESUMENES

Efectos macroeconómicos de cambios en las barreras al comercio y al movimientos de capitales: Un modelo de simulación—MOHSIN S. KHAN y ROBERTO ZAHLER (páginas 223–82)

La liberalización de los intercambios comerciales y de los movimientos de capital, llamada comúnmente la apertura de la economía, es un tema de creciente interés para los países en desarrollo, incluidos muchos países de América Latina. Aunque los costos y beneficios a largo plazo de esta estrategia son bien conocidos, se han hecho pocos estudios sistemáticos sobre los efectos a corto plazo en la economía, al pasar ésta de un sistema relativamente cerrado a un sistema orientado hacia el exterior. Este trabajo se centra en el análisis de algunos efectos económicos a corto y a mediano plazo de la reducción de barreras al comercio y a los movimientos de capital.

Las cuestiones de corto plazo relacionadas con la apertura se estudian en el marco de un modelo de equilibrio general dinámico elaborado específicamente para este fin. Este modelo, centrado en la determinación de las principales variables macroeconómicas, se basa en modelos teóricos y empíricos de equilibrio general, así como en modelos de orientación más monetaria que se han elaborado para estudiar la macroeconomía de una economía abierta. Al mismo tiempo, el trabajo se ha ocupado de incorporar explícitamente determinados fenómenos ocurridos en los países en que se ha llevado a cabo un proceso de liberalización, como es el alejamiento continuo de la ley del precio único y de la paridad del tipo de interés. Este enfoque hace que el modelo resultante sea más representativo de un país "típico" de América Latina, aunque debe señalarse que es bastante general y, por lo tanto, no es aplicable exactamente a un país determinado. Se introduce en el modelo la dinámica para que se pueda trazar la senda de transición de las variables—actividad económica, empleo, precios, balanza de pagos, deuda externa y tipos de interés—desde una posición de equilibrio a otra.

Utilizando un conjunto representativo de valores de los parámetros, se simulan en el modelo diversos tipos de estrategia de apertura, incluyendo: 1) reducciones graduales y repentinas de los aranceles, 2) abolición gradual y repentina de las restricciones a los movimientos de capital, 3) abolición gradual simultánea de ambas clases de barreras y 4) abolición gradual de ambas clases de barreras en diferentes secuencias. Se considera que tales experimentos abarcan la mayoría de las políticas adoptadas por los países en desarrollo que han intentado abrir sus economías. En resumen, los resultados señalan que en todos los casos existen algunos costos transitorios, como una reducción del crecimiento económico y del empleo, la aparición de déficit en cuenta corriente y reducciones de los ingresos públicos. El trabajo global produjo las siguientes aclaraciones importantes. Primero, los efectos de una liberalización de los intercambios comerciales pueden ser muy diferentes de los efectos de una liberalización de los movimientos de capital, y los efectos de una liberalización simultánea de ambos

no son los mismos que los efectos producidos si se ejecutan ambas políticas de liberalización en forma separada. Segundo, es importante el ritmo de aplicación de las reformas. Como cabía prever, un método de choque tiene un efecto más pronunciado al inicio, pero el ajuste al equilibrio es más rápido. Por último, y quizás esto sea lo más interesante, se demuestra que no es indiferente la elección del tipo de medidas de política a aplicar en primer lugar. Surgen relaciones de correspondencia claras, lo que permite que quienes deciden las medidas de política puedan elegir estrategias determinadas compatibles con sus propias perspectivas globales.

La "economía subterránea" de Estados Unidos: Estimaciones anuales, 1930–80
—VITO TANZI (páginas 283–305)

En este estudio se presentan estimaciones anuales de la "economía subterránea" de Estados Unidos durante el período 1930–80. El método empleado para el cálculo es el ideado hace unos años por el autor y se ha aplicado ya en muchos otros países. Las conclusiones principales serían las siguientes: 1) en 1980 la "economía subterránea", medida en porcentaje del producto nacional bruto (PNB), se situó entre 4,5 por ciento y 6,1 por ciento; 2) el otro período en que podría haber sido superior fue el correspondiente a la segunda guerra mundial; 3) "la economía subterránea" ha venido creciendo desde mediados del decenio de los sesenta, y 4) durante el período 1965–80 ha aumentado más de 2 puntos porcentuales del PNB (casi 50 por ciento). Esta última tendencia es alarmante ya que parece haberse acelerado en los últimos años, especialmente a partir de mediados del decenio de los setenta. Probablemente esta propensión se haya visto influida por el gran aumento de las tasas impositivas marginales durante el período 1975–80 causado por la inflación y la falta de reducciones tributarias significativas. De momento no se puede saber si las reducciones tributarias de 1981 habrán invertido la tendencia.

Los resultados obtenidos en este artículo no deben entenderse como medidas precisas de la "economía subterránea"; en el mejor de los casos son una indicación general de tendencias y de órdenes de magnitud que a su vez están influenciados por los supuestos utilizados y posibles revisiones de datos. Sin embargo, resulta alentador comprobar que para 1974 y 1976 son del mismo orden de magnitud que las estimaciones directas de Simon y Witte (1980) y de la Dirección de Impuestos de Estados Unidos (1979).

Conviene puntualizar qué ha sido objeto de medición en este estudio. Las estimaciones tratan de cuantificar ingresos asociados al uso excesivo de dinero en efectivo y que puede suponerse no fueron declarados a las autoridades tributarias. No puede determinarse si estos ingresos han sido o no contabilizados por las autoridades encargadas de las cuentas nacionales. Cabe suponer que parte de estos ingresos no sólo evadieron ilegalmente la red tributaria sino que además escaparon de la atención de las autoridades a cargo de las cuentas nacionales. Sin embargo, con la información disponible, no es posible saber de qué porcentaje se trata. Si este porcentaje de ingresos es importante, tendría serias consecuencias sobre la aplicación de la política económica, ya que ésta se basa en gran medida en las variaciones de la actividad económica tal como se reflejan en las cuentas nacionales.

Medición del déficit del sector público e implicaciones para la evaluación y formulación de ciertas políticas—WILLEM H. BUITER (páginas 306–49)

En este trabajo se estudian la evaluación y la formulación de las políticas presupuestaria, financiera y monetaria en un marco conceptual de riqueza en sentido amplio y contabilidad de la renta permanente. Se elabora un conjunto de balances generales y cuentas de renta permanente para los sectores público, privado y exterior. Luego se cotejan con el balance general medido de forma convencional y con las cuentas de flujos de fondos. Esto da una nueva visión de los problemas de "desplazamiento o exclusión" y de la "monetización final de los déficit fiscales".

El superávit financiero del sector público medido de forma convencional, aun cuando se lo evalúe a precios constantes o como proporción del producto nacional bruto, da una idea potencialmente engañosa de la variación del patrimonio real neto del sector público. Uno de los motivos de esto es que las pérdidas y ganancias de capital de la masa existente de activos y pasivos financieros negociables no están incluidas en la corriente de fondos. Esta omisión se extiende también a las variaciones del valor real de la deuda del sector público debidas a la inflación y a las fluctuaciones del tipo de cambio. Un segundo motivo es la omisión de revaluaciones de los activos y pasivos no negociables (y a menudo solamente implícitos), tales como las corrientes futuras previstas de ingresos tributarios y pagos de beneficios. Se reitera la necesidad de establecer una diferencia entre las variaciones transitorias (es decir, cíclicas) y permanentes (o estructurales) del déficit, y entre los déficit en cuenta corriente y en cuenta de capital.

Se proponen luego algunas normas generales para la formulación de medidas de política de estabilización para facilitar la fluidez del gasto evitando o minimizando la incidencia de las imperfecciones del mercado de capitales. Tanto los gobiernos nacionales como los organismos internacionales deberían formular políticas fiscales, financieras y presupuestarias a fin de inducir una evolución del balance general medido de forma convencional y cuentas de flujos de fondos que permitan a los agentes privados y las economías nacionales, respectivamente, acercarse al comportamiento que se adoptaría si la riqueza en sentido amplio o el ingreso permanente fueran la única restricción forzosa al comportamiento económico. Esta meta puede alcanzarse manteniendo el ingreso disponible en armonía con el ingreso permanente y haciendo que la riqueza financiera disponible constituya una proporción adecuada de la riqueza total.

La estimación de modelos de comportamiento del mercado financiero durante períodos de reforma estructural amplia: La experiencia de Chile—DONALD J. MATHIESON (páginas 350-93)

En este estudio se abordan los problemas de la estimación de modelos de equilibrio de cartera del comportamiento de los mercados financieros durante un período de amplias reformas estructurales. El modelo incluye especificaciones del comportamiento de cartera de la banca y del sector no bancario (empresas y unidades familiares) en cuanto a las tenencias de moneda, depósitos a la vista, depósitos a plazo y préstamos bancarios. También se describen los factores determinantes de los tipos de interés de los préstamos bancarios y los depósitos a plazo, y los vínculos entre inflación, balanza de pagos, tipos de interés y

agregados financieros. Se estima el modelo para una muestra de datos mensuales chilenos que abarca desde julio de 1965 hasta junio de 1980. Se comparan también los resultados de la estimación con los obtenidos en un trabajo anterior sobre Argentina.

Modelos tributarios aplicados de equilibrio general—JOHN B. SHOVEN (páginas 394–420)

En el estudio se resumen los avances logrados en modelos de cálculo de equilibrio general concebidos para evaluar la política tributaria. Tras examinar la estructura de estos modelos, se estudia la inclusión de los impuestos, el comercio exterior y el comportamiento financiero. También se estudian las necesidades y empleo de datos, así como la cuantificación del bienestar económico utilizado para comparaciones de eficiencia.

Se estudia el modelo de Estados Unidos (elaborado con la ayuda del Departamento del Tesoro) y se presentan los resultados tanto para la integración de los impuestos sobre la renta de las personas físicas y de sociedades como para la adopción de un impuesto personal sobre el consumo que sustituya el actual impuesto sobre la renta. Los resultados primarios indican que el valor actual de la mayor eficacia conseguida al integrar los dos sistemas tributarios es de $350.000 millones a $450.000 millones (dólares de 1973), lo que supone entre 0,7 y 0,9 por ciento del valor actual de la renta nacional *más* el ocio. La ventaja de pasar a un impuesto sobre el consumo es mayor, ascendiendo aproximadamente a $630.000 millones (dólares de 1973), equivalentes a 1,25 por ciento. El autor también se pregunta sobre la duración posible del período de dicha modificación de política, como es la adopción del impuesto sobre el consumo. El modelo indica que llevará de 30 a 40 años el ajuste total al nuevo programa tributario, y que las medidas dirigidas a aumentar los salarios reales mediante una imposición más ligera sobre el ahorro a fin de incrementar los coeficientes capital/trabajo requerirán probablemente mucho tiempo para producir el efecto deseado.

Se ofrecen en el estudio estimaciones de las pérdidas de eficiencia total ocasionadas por el sistema tributario en su totalidad. El experimento hipotético en cuestión sustituye el conjunto actual de impuestos federales, de los estados y locales por una serie de igual rendimiento de gravámenes a tanto alzado no distorsionantes. Las pérdidas totales estimadas del sistema vigente son el 10 por ciento del valor actual del ingreso nacional futuro y 6,7 por ciento del valor actual del ingreso nacional *más* el ocio. Estas estimaciones son considerablemente más altas que las publicadas anteriormente correspondientes a componentes individuales del sistema tributario global.

Los resultados definitivos del modelo de equilibrio general de Estados Unidos dan una estimación de cuánto aumentan las pérdidas de eficiencia por dólar de incremento de los ingresos tributarios. En el estudio se afirma que si se elevan proporcionalmente todos los impuestos, la pérdida por falta de eficiencia aumentará entre $0,52 y $0,76 por cada dólar adicional recaudado, lo que significa que el sector privado pierde entre $1,52 y $1,76 por cada dólar recaudado. Estos resultados también indican que las consideraciones de eficiencia tributaria tienen importantes repercusiones en la asignación de recursos dentro de la economía.

En el estudio también se abordan brevemente las consecuencias que los aspectos de eficiencia tributaria tienen en relación con los estudios de costos-beneficios de los programas de gasto público.

Finalmente se afirma que el análisis de equilibrio general aplicado está ya suficientemente desarrollado para ser un instrumento útil de análisis de política.

Del análisis monetario de una economía abierta—CHARLES COLLYNS (páginas 421–44)

La reciente evolución institucional de las economías desarrolladas ha dado origen a mercados monetarios cada vez más competitivos dominados por el ajuste de los precios más que por el ajuste cuantitativo. En este contexto, los agregados monetarios, los tipos de interés y el tipo de cambio se determinan conjuntamente. Pero si se introduce simplemente un tipo de interés para los saldos monetarios en un modelo normal de equilibrio monetario del mercado de activos, entonces parecería que las autoridades tendrían dos grados de libertad y podrían fijar dos magnitudes dentro del conjunto formado por los agregados monetarios, los tipos de interés y el tipo de cambio. Esta conclusión difiere de las opiniones convencionales respecto a los límites de una política monetaria sostenible. En el trabajo se neutraliza esa discrepancia exigiendo que, en estado de equilibrio, la demanda de crédito bancario sea compatible con la demanda de activos monetarios. Esta lógica requiere un tratamiento explícito del mecanismo de oferta monetaria, incluyendo el comportamiento del sistema bancario y de la demanda de crédito. En el contexto de este modelo ampliado, las autoridades monetarias sólo pueden alcanzar un objetivo monetario independiente. A largo plazo, la política monetaria no afecta a las variables reales, a menos que las autoridades manipulen las características de comportamiento del sistema bancario; a corto plazo, con precios nominales rígidos, la selección de una política monetaria tiene efectos reales. Se considera que las implicaciones comparativas y estáticas de las diferentes opciones de política y de los choques exógenos dependen de la intensidad relativa y de la dirección de su impacto en la demanda de crédito bancario así como de activos monetarios.

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In statistical matter (except in the *résumés* and *resúmenes*) throughout this issue,

Dots (. . .) indicate that data are not available;

A dash (—) indicates that the figure is zero or less than half the final digit shown, or that the item does not exist;

A single dot (.) indicates decimals;

A comma (,) separates thousands and millions;

"Billion" means a thousand million;

A short dash (-) is used between years or months (e.g., 1977-79 or January-October) to indicate a total of the years or months inclusive of the beginning and ending years or months;

A stroke (/) is used between years (e.g., 1978/79) to indicate a fiscal year or a crop year;

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