A General-Equilibrium Approach to the Analysis of Monetary and Fiscal Policies

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A MAJOR TASK CONFRONTING policymakers in recent years has been to predict the effects of changes in the various parameters under their control. Typically, the changes being examined are small—a slight shift in a tax rate, or a minor devaluation, for example. In such cases, partial-equilibrium models have normally been used for prediction, on the underlying assumption that the effects of the proposed changes are relatively minor and do not have reverberations throughout the economy. Such an assumption cannot be considered valid, however, when there are parameter changes that are specifically intended to bring about structural shifts in the economy. A country that decides to carry out a complete liberalization of its trade regime by relaxing tariffs would be such a case, since opening the economy to foreign competition is intended to bring about a restructuring of the domestic production technology. A long-term adjustment program, such as the extended Fund facility, is also intended to bring about major structural changes in a country's economy, and thus does not lend itself to analysis by partial-equilibrium methods.

The aims of this paper are to construct a general-equilibrium model of an open economy and to develop a computational technique for deriving a market-clearing solution to the model. The model will allow for disaggregated commodities, taxes, and

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tariffs, so that the individual parameter changes that are often considered by a government may be examined. The model includes a government that is an active participant in the economy as a producer of public goods and that may influence the rate of savings by its actions. The model allows for different rates of substitution between capital and labor in each sector, so that a precise analysis of the impact of government policies on the relative shares of scarce factors can be made. Because of its general-equilibrium nature, the model can cope adequately with the type of large changes that would be considered in a program designed to bring about major adjustments.

As will be discussed, the main innovation of this paper, compared with other disaggregated general-equilibrium models, is to incorporate financial assets. The large-scale computational models currently in existence either ignore money altogether or include it in such a way that it is neutral, that is, has no effect on any real variables. Thus, it is not possible to investigate, for example, the impact of changes in monetary policy on real output. Conversely, those models that do allow the inclusion of nonneutral financial assets are unable to cope with large numbers of commodities and differentiated taxes.

Although this paper is purely theoretical, the eventual aim is to carry out an empirical version of it to be applied to the United States. This model could be of use to countries other than the United States, since some governments attempt to manage their currency's exchange rates so as to maintain some type of parity between domestic and U. S. prices; for those countries where the rates are preannounced or are expected to be maintained for some time, it is important to be able to predict the effect of anticipated shocks or policies on future U. S. price movements. Because the relevant U. S. price level may not necessarily be the official consumer price index, it is important to be able to predict individual equilibrium nominal prices, so as to construct a suitable price index for the country in question to follow. Such prices will be the output of the model.

Section I discusses the strengths and weaknesses of various existing models of the open economy and gives a brief verbal description of the model to be developed here. Section II develops the technical structure of the model, while Section III summarizes the analysis and suggests directions for future research.

I. The Model: An Intuitive Description

The extensive literature on models of open economies falls into two categories. The first type, in the Walrasian tradition, focuses on the real side of the economy, while the second type deals with both the financial and real sectors of the economy.

In the first type of model, there is generally no monetary asset, or a neutral one that will have no impact on any real variables. In addition, there is no price level, as such models typically deal only with relative prices of commodities. The main advantage of recent versions of this type of model is that, because their mathematical framework allows the inclusion of a large number of commodities, and disaggregated groups of consumers, such models can be used to analyze the welfare implications of changes in complex tax and tariff systems. [1] The attempt to introduce a monetary asset into the Walrasian system leads to a number of difficulties, which have been dealt with rather successfully within the context of a pure exchange economy but which are still essentially unsolved in the context of an economy with production. [2]

In the second type of model, the emphasis is on the interaction between the financial and real sectors of the economy. In such models—unlike Walrasian models—financial assets are not necessarily assumed to be neutral with respect to their influence. In such models there are normally three items—typically, commodities, money, and bonds—from which the consumer chooses. Unlike the Walrasian system, these models include determination of a price level, of capital flows, and of government monetary policy and, in particular, allow the consideration of intertemporal choice between current and future consumption. Since they generally assume one or at most two composite goods, they cannot be used for calculating the effects of differential tariff or tax changes. [3]

[1] The theoretical foundations of the modern versions of this model are given in Debreu (1959), while recent computational examples, some with empirical content, are given in Dervis and Robinson (1978). Feltenstein (1979; 1980), da Fonseca (1978), Miller and Spencer (1977), Richter (1978), Shoven (1976), and Whalley (1977).

[2] A survey of the attempts to introduce money into the Walrasian system is given in Grandmont (1977).

[3] This is, of course, a great oversimplification of the characteristics of and differences between these types of model.

Recent papers by Clements (1980) and Dornbusch and Mussa (1975) have moved in the direction of combining the Walrasian and monetary/Keynesian approaches. Clements, in particular, allows the theoretical possibility of disaggregated commodity prices, although for empirical work he considers only a single good. In this model, however, there are neither mobile factors of production nor taxes of any type, and thus he is unable to analyze fiscal policies. In addition, there is not an explicit government agency, so that domestic credit expansion is purely exogenous with respect to public sector expenditure and revenues,[4] and government behavior cannot affect the overall savings rate. Finally, the Clements model takes the country in question to be a price taker for all traded goods, an assumption that is of doubtful validity when applied to the United States—the focus of his empirical analysis.

From the point of view of a government policymaker who wants to be able to estimate the impact of both fiscal and monetary policies, where the fiscal policies may include, for example, differential taxes, the shortcomings of the Clements (1980) and Dornbusch and Mussa (1975) models are apparent. The purpose of this paper is therefore to set forth a model of a disaggregated open economy that is similar in its general structure to the modern version of the Walrasian model, as formulated by Debreu (1959), but includes monetary variables. The model, which extends Feltenstein (1980), goes considerably beyond Clements in allowing mobile factors of production, many commodities, and an explicit tax structure. The interaction between fiscal behavior and the expansion of domestic credit is also considered, so that simulations reflecting different government policies may be carried out.

Private firms are assumed to have linear technologies in intermediate and final goods (an assumption that could easily be changed to one of smooth technologies), but have the possibility for substitution among the scarce factors that enter their value added, and are assumed to maximize profits at given market prices subject to taxes on profits, defined as returns to capital. These taxes are collected by the government, which also levies income and sales taxes and which uses them to finance its

[4] Aghevli and Khan (1978) and Tanzi (1978) have constructed monetary models that incorporate endogenous public sector deficits. They do not, however, consider differentiated commodity types.

production of public goods. The composition of these public goods is not specified, but they are simply treated as a single commodity produced by a smooth production function. [5] The government decides in advance on a particular level of the output, in real terms, of public goods. It receives no revenue from the sale of these public goods but must finance their production from tax revenues and the issuance of financial instruments. At an arbitrary set of prices, the government revenues may differ from the cost of producing the specified level of public goods. If the revenues are more than the cost, then the government surplus is distributed to consumers as subsidies, but if there is a deficit, the government will issue a combination of money and bonds. These bonds will pay a fixed return, that is, a coupon in terms of money, one period hence and will have a current price determined by the market. It is assumed that the government finances a fixed fraction of the deficit by selling bonds or by borrowing abroad, that is, selling bonds to foreigners, while the remainder of the deficit will be covered by the issuance of money, the numeraire in the model. [6] Thus, domestic credit expansion will be endogenous to the model, as will the rate of growth of the national debt. There will be no private creation of debt, that is, private enterprises issuing equity, since the problem of modeling private debt creation in an economy with production has not yet been dealt with in the general-equilibrium literature and is not essential for the purposes of this paper. Thus, by issuing a fixed quantity of bonds, the government authorities will know the nominal value of its debt creation, but because they do not know the eventual structure of relative prices or the price level, they do not know what the real value of this indebtedness will be. Similarly, they cannot anticipate the inflationary impact of their creation of money.

There are two types of consumer in the model—domestic and foreign—and there may be a large number of different domestic consumer categories distinguished by demand characteristics. Consumers are assumed to have constant elasticity of substitu-

[5] Richter (1978) has constructed a computational general-equilibrium model that emphasizes the production of public goods.

[6] This particular financing rule is not essential to the model; the government might instead, for example, choose to set the quantity of bonds that it will issue, while letting the market price fluctuate.

tion (CES) utility functions, and domestic consumers require their money holdings to be a constant fraction of the value of their consumption in order to cover transactions costs. Transactions costs have not, however, been modeled explicitly; it has only been assumed that their existence is reflected by consumer demand for money—a good that yields them no direct utility. [7] Consumers demand bonds that may be viewed as being essentially a proxy for future consumption and in the consumer's utility will be discounted by whatever his rate of time preference may be. The consumer knows what the coupon payment will be on the bond that he purchases, but, of course, he does not know its real purchasing power. There are two types of bond—domestic and foreign—each with its own coupon payment; both domestic and foreign consumers choose between these types to store a portion of their wealth for future consumption. If both types of bond were truly perfect substitutes in the eyes of the consumers, then they would purchase only the bond yielding the higher rate of return. In actual practice, however, domestic and foreign bonds are not perfect substitutes for a variety of reasons. Therefore, a choice mechanism has been specified for consumers, by which they always select a positive amount of each bond, according to their relative prices, while the relative weights given to each bond reflect the consumer's underlying uncertainties with regard to risk.

Finally, there is only a single type of money—a world currency—so that this model is formally equivalent to one with fixed exchange rates. The home country is viewed as influencing world prices for its exports, and hence as facing downward-sloping demand curves for these exports, while it is a price taker for its imports. A modified version of the Armington (1969) assumption is used, in which goods are distinguished both by type and by place of origin, so that imports are imperfect substitutes for corresponding domestic goods as inputs for production. [8] Trade will not change the total world money

[7] Hahn (1971; 1973) and Kurz (1974) are the basic papers introducing transactions costs into the general-equilibrium framework. Grandmont (1977) offers a survey of the current state of the subject. The treatment of transactions costs in this paper is admittedly ad hoc, as it is not derived from axiomatic reasoning.

[8] Ideally, one would like to be able to consider imported goods for which the country is a price setter, but doing so would require the specification of a world supply function for that good, a task that one might wish to avoid.

supply; thus, the only changes in this money supply will be caused by the deficit of the home country's government. It will be demonstrated that there exists an equilibrium in this economy at which there may be deficits in both the balance of payments and the government budget.

II. The Model: A Technical Description

It is the normal procedure in work on general-equilibrium models to deal separately with the supply and demand sides of the economy in question, and to then construct excess demand functions. The goal in this paper is also to construct excess demand functions, but because of the interaction that takes place between production and consumption, it is not possible to treat these two sectors as being independent of each other. Therefore, in the next two subsections, the structure of the production technology and the characteristics of public and private consumption, respectively, are described, while an excess demand function is constructed in the third subsection by simultaneously deriving supply and demand functions. [9]

PRODUCTION

It would be possible to use virtually any standard representation of the production technology of the economy in question: smooth production functions, activity analysis, or input/output are possible choices. Since the model should be applicable empirically, a particular version of the supply technology is constructed that is closely related to the availability of data. It is therefore assumed that the model has three types of physical commodity: scarce factors, which include all nonproduced goods and, in addition, capacity constraints; intermediate and final goods, which are the outputs of, and inputs for, production activities; and imported goods, which may include both inputs for production and consumption goods. Intermediate and final production are represented by an input/output matrix, so that there are fixed coefficients and no joint production for each activity that produces an intermediate or final good. [10] It is

[9] This is also the procedure developed in Feltenstein (1980).

[10] The production coefficients are not, actually, completely fixed, since a certain degree of substitution is allowed between domestically produced inputs for production and their imported counterparts.

supposed that there are $M > 0$ such goods, so that the input/output matrix is of dimension $M \times M$.

Each input/output activity requires inputs of scarce factors, of which only three types are considered: capital, labor, and capacity constraints. There may be several categories of each of the first two, so that, for example, one may have sector-specific partially immobile capital and different categories of skilled labor. These scarce factors are combined into a single output—value added—via neoclassical production functions, $\{f_i\}$, $i = 1, \ldots, M$, the parameters of which will differ from sector to sector. Although it would once again be possible to use any number of such functions, for the sake of being specific it is assumed that they are Cobb-Douglas, hence of the form:

$$VA_j = \prod_{i=1}^{k} K_i^{\alpha_i^j} \prod_{i=1}^{q} L_i^{\alpha_{k+i}^j} \tag{1}$$

such that

$$\alpha_i \geqq 0, \sum_{i=1}^{k+q} \alpha_i = 1$$

where VA_j is the total output of value added of the jth sector, K_i and L_i are the different categories of capital and labor, α_i^j are the relative shares in production of capital and labor in the jth sector (and hence are sector specific), and there are $k > 0$ types of labor and $q > 0$ types of capital. Each sector requires a certain fixed number of units of value added to operate at unit level, but the mix of capital and labor required to produce this value added will vary according to changes in relative prices. [11]

In addition to physical inputs of value added, certain sectors—let us say the first $c \geqq 1$—may have capacity constraints, that is, maximum levels at which they are capable of operating because of some unspecified limitation. When the sector operates at unit level, it is viewed as using one unit of capacity constraint, a scarce resource. The production technology may thus be thought of as a set of smooth production functions *plus* capacity

[11] A similar methodology is described in Whalley (1977). It is not true that scarce factors will have a constant share in the value of final output, since relative prices will change.

constraints "sitting on top of" an input/output technology, and may be represented in the following form: [12]

$$
\begin{bmatrix}
f_1(K_i,L_i), & ,\ldots, & f_c(K_i,L_i), & f_{c+1}(K_i,L_i), & f_M(K_i,L_i) \\
-1 & & 0 & 0 & 0 \\
0 & & . & . & . \\
. & & . & . & . \\
. & & -1 & . & . \\
. & & 0 & & \\
0 & & 0 & 0 & 0 \\
a_{11} & ,\ldots, & . & . & a_{1M} \\
. & & & & \\
. & & & & \\
. & & & & \\
a_{M1} & & & , & a_{MM}
\end{bmatrix}
$$

One modification remains to be made in this discussion of the domestic production technology. Let us consider a particular good that is an input for production and that may be both imported and produced domestically, oil being an obvious example. Using a modified version of the Armington (1969) model, in which it is assumed that traded goods are distinguished by both their physical characteristics and place of origin, domestic and foreign versions of an input for production are treated as being imperfect substitutes, so that the domestic manufacturers will purchase a combination of the domestically produced good and its imported counterpart. The reason for doing so could be a degree of product differentiation; Saudi Arabian oil may have a lower sulfur content than domestic oil, for example, causing it to be purchased even if its price is higher than that of domestically produced oil. [13] Conversely, domestic producers may hesitate to buy foreign oil, even if its price is lower than that of domestically produced oil, because of uncertainties about the foreign supply. Because it has generally been true, at least in the United States, that relative shares of imports and domestically produced goods have not been constant in production, it is assumed that their inputs are combined in production via CES functions in the

[12] The input/output matrix referred to is I-A, so that negative entries represent inputs for a particular sector, while positive entries represent net outputs.

[13] At the degree of aggregation that would be used in any empirical study, the price indices for domestic goods and their foreign counterparts are different, indicating that they are not perfectly comparable.

following way. Suppose that the ith commodity in the input/output matrix has a foreign counterpart, denoted by i_f, that can be imported. If a_{ij} is negative for some j, then the ith good is an input for production in the jth sector. [14] Suppose then that y_{ij} represents inputs of the ith domestically produced good and $y_{i_f j}$ inputs of its foreign counterpart. Total inputs of good i to the jth sector, a_{ij}, are given by

$$a_{ij} = [b_i^{1/s_i} \, y_{ij}^{(s_i-1)/s_i} + b_{i_f}^{1/s_i} \, y_{i_f j}^{(s_i-1)s_i}]^{s_i/(s_i-1)} \qquad (2)$$

The demand for domestic inputs as a function of p_i and pf_i, the domestic and world price of the ith good and its foreign counterpart, and of a_{ij}, the total input requirements, will soon be derived, but suppose for the present that this is given by $y_{ij}(p)$. [15] The lower matrix of domestic production is then modified so that the jth column has coefficients $(a_{1j}, \ldots, a_{i-1,j}, y_{ij}(p), a_{i+1,j}, \ldots, a_{Mj})$. The firm's demand for the foreign input for production is treated separately from the input/output technology in a manner to be described in the subsection, EXCESS DEMAND FUNCTIONS, but note here that the firm requires a constant amount, a_{ij}, of the composite commodity.

One other production agent has not yet been mentioned, namely, the government, which produces a single public good, again via a smooth production function that will, for simplicity, be taken to be Cobb-Douglas. This function requires inputs of capital and labor, and so is of the same form as specified in equation (1), while its output does not enter into production. [16]

Finally, several types of good in this model do not enter the productive process, these being the three financial assets: money, domestic bonds, and foreign bonds. Both money and domestic bonds are produced costlessly by the government in a manner that is described later, but suffice it to say at present that the supply function that produces money and bonds will depend on

[14] Here, a_{ij} represents the total input requirements of the ith type of good to the jth sector, a requirement that may be made up from foreign and domestic sources.

[15] These are considered functions of p—domestic prices—only, since world prices of imports are taken to be exogenous. In equation (2), it is assumed that for a particular commodity the coefficients and elasticity of substitution are constant across sectors, since in any empirical work it would generally be possible to estimate these parameters only on an economy-wide basis.

[16] Thus, the government's role in, for example, training human capital or building highways is ignored. Such roles, although obviously of great importance in the modern economy, are not germane to this model.

the size of the government deficit. This model thus goes beyond Clements (1980), where the rate of growth of the domestic money supply is exogenous. There are also foreign traded goods that are not used as inputs for domestic production; since the country is assumed to be a price taker for all imported goods, the supply function for all imports, including those used for domestic production, is chosen so that the supply of these goods is always equal to the domestic demand for them.

CONSUMPTION

There are $I > 0$ domestic consumers and one foreign consumer. Domestic consumers are assumed to have positive initial holdings of all scarce resources and financial assets and no initial holdings of any intermediate or final good, while the foreign consumer has holdings of financial assets only. All domestic consumers are assumed to have CES utility functions of the form:

$$U^i(x^i) = \left[\sum_j d_{ij}^{1/s_i}\, x_{ij}^{(s_i-1)/s_i}\right]^{s_i/(s_i-1)} \tag{3}$$

where U^i is the ith consumer's level of utility, x_{ij} his consumption of the jth good, s_i his elasticity of substitution, and d_{ij} are constants. In addition, j ranges over those goods that are consumed (primary, intermediate, final, and imported) but does not include financial assets, which the consumer does, however, demand. Although transactions costs are not explicitly introduced into the model, the claim is made that the consumer must hold an amount of money equal to a fixed fraction of the value of his consumption to cover the costs of transactions. [17] Thus, if $\bar{p}$ is the vector of market prices, for all goods (primary, intermediate, final, and imported), and x^i the vector of the ith consumer's consumption of the corresponding goods, then if there were no taxes the consumer would demand $k(\bar{p} \cdot \bar{x}^i) : 0 \leq t \leq 1$, units of domestic money, where k represents the fraction of the value of

[17] This admittedly ad hoc introduction of money has appeared in somewhat different form in various macroeconomic models of trade. See, for example, Weiss (1980). In Weiss's model, however, the nominal stock of money is given exogenously, so that there is no possibility of analyzing changes in the money supply.

consumption needed to be held in the form of money and is assumed to be constant across consumers.

The consumer is assumed to demand bonds to finance part of his consumption during the next period, and his demand for bonds would presumably depend on his anticipation of future salaries, rate of inflation, etc. Suppose then that a coupon price, c_d, and a corresponding principal value, p_d, are announced for a domestic bond. This principal value will typically be different from the market price, pm_d, of the bond, and the value of the income that the consumer receives from this bond for the next period is then $p_d + c_d$. If the consumer's rate of time preference is δ, assumed to be constant across domestic consumers, then, ignoring for the moment foreign bonds and dropping the superscript i, he will choose a quantity, x_d, of domestic bonds such that

$$(p_d + c_d) \cdot x_d + r_L w^E = \frac{1}{1+\delta} \bar{p} \cdot \bar{x} (1 + \pi^E) \tag{4}$$

where w^E is the consumer's expected wage for the next period, r_L is the amount of labor that he can offer, and π^E is the anticipated rate of inflation.[18] If, in addition, foreign bonds with nominal price p_f, coupon payment c_f, and quantity demanded x_f are also included, then equation (4) becomes

$$(p_f + c_f) \cdot x_f + (p_d + c_d) \cdot x_d + r_L w^E = \frac{1}{1+\delta} \bar{p} \cdot \bar{x} (1 + \pi^E) \tag{5}$$

The consumer is also subject to sales taxes on the goods that he purchases. The tax is paid by the consumer upon his consumption of all intermediate or final and imported goods; he does not directly pay income taxes, since these are withheld at the source.[19] If t^c denotes the vector of sales tax rates, then the total

[18] Both w^E and π^E might, in practice, be generated in a variety of ways. For the purpose of this paper, as is explained in greater detail in the next section, the consumer will be perfectly myopic, so that $w^E = (1 + \pi^E)\, w$, where w is his current wage and π^E is equal to the current rate of inflation.

[19] Here, income taxes are paid by the firm when it purchases labor and capital from the consumer.

cost to the consumer in purchasing the bundle x is then given by [20]

$$\bar{p} \cdot \bar{x} + (t^c \bar{p}) \cdot \bar{x} = \bar{p}\,(1 + t^c) \cdot \bar{x} \tag{6}$$

where the dot denotes vector multiplication. Consumer demand for money will thus be given by

$$k[\bar{p}(1 + t^c) \cdot \bar{x}] \tag{7}$$

Thus, the consumer requires money to cover transactions costs but does not require money to pay his income taxes, as the tax is withheld at the source. [21] Letting pm_d and pm_f represent the prices of domestic and foreign bonds, respectively, TR represent whatever transfer payments the government may make to consumers, and s represent this consumer's share in those payments, then his overall budget constraint can be expressed as

$$\begin{aligned} &\bar{p}(1 + t^c) \cdot \bar{x} + k[\bar{p}(1 + t^c) \cdot \bar{x}] + pm_d \cdot x_d + pm_f \cdot x_f \\ &\qquad \leqq p \cdot r + s \cdot TR \end{aligned} \tag{8}$$

so that the consumer's maximization problem is

$$\max\ U(x) \tag{9}$$

such that

$$\begin{aligned} &\bar{p}(1 + t^c) \cdot \bar{x} + k[\bar{p}(1 + t^c) \cdot \bar{x}] + pm_d \cdot x_d + pm_f \cdot x_f \\ &\qquad \leqq p \cdot r + s \cdot TR \\ &(p_d + c_d) \cdot x_d + (p_f + c_f) \cdot x_f + r_L\, w^E \\ &\qquad = \frac{1}{1 + \delta}\, \bar{p} \cdot \bar{x}(1 + \pi^E)\,(1 + t^c) \text{ [22]} \\ &w^E = w(1 + \pi^E), \qquad \pi^E = \Delta VAI \end{aligned}$$

where ΔVAI, the change in the consumer price index, is derived shortly.

Since domestic and foreign bonds do not enter the consumer's utility function directly, how is one to determine his relative demand for them? It is supposed, quite simply, that

[20] Thus, $t^c = (0, \ldots, 0, t_1^c, \ldots, t_M^c, \ldots, t_{M+F}^c)$, if there are F imported goods, while the zeros correspond to primary goods and financial assets.

[21] An empirical study of the impact on money demand of withholding at the source has been made by Tanzi (1974).

[22] It has been assumed that the consumer includes sales taxes, at their current rates, in evaluating the cost of his future bundle of consumption.

$$pm_d x_d = a \cdot pm_f x_f : a \geqq 0 \tag{10}$$

so that the consumer chooses that his domestic bonds and foreign bonds be maintained as constant fractions of the value of his total holdings of bonds. One could, of course, claim that the consumer would buy only the bond with the lower relative price, but it is asserted that, because of various uncertainties, he always wishes to hold at least some of each type of bond. If $a > 1$, then the consumer prefers domestic bonds to foreign bonds, all other things being equal, while if $a < 1$, the opposite is true. [23]

Let us now consider the foreign consumer, who has an initial holding only of money and domestic and foreign bonds. It would be possible for the foreign consumer to be a replica of his domestic counterpart, but that would imply the construction of a world model, which is beyond the scope of this exercise. Therefore, there is a highly simplified representation of the foreign consumer, who has a utility maximization problem that consists in the choice of goods exported by the home country *plus* his own demands for financial assets. The home country is taken to be a price setter (actually an influencer of prices) for all goods that it exports, so that the foreign consumer will play a role in determining the level of output of exports. To represent the foreign demand for exports from the home country, a simple elasticities approach is used, rather than a complete demand function, so that the foreign demand for exports of good i, E_i, is then given by

$$E_i = [1 + n_i(p_i/p_{i0} - 1)]\, E_{i0} \tag{11}$$

where n_i is the world elasticity of demand for exports of good i from the home country, p_i is the current domestic price of good i, p_{i0} is the price of good i in some previous base period, and E_{i0} is the demand for exports of good i in that base period. The value of consumption will thus represent a changing fraction of the foreign consumer's holdings of money, and the theoretical possibility that he may demand a value of exports greater than the value of his initial holdings of money is eliminated in the following way:

[23] If there were a possibility of a change in the exchange rate, then parameter a would presumably reflect the consumer's perception of exchange rate risk.

$$E_i = [1 + n_i\,(p_i/p_{i0} - 1)]\,E_{i0} \text{ if } \sum_i p_i\,E_i \leqq p \cdot r_f + M \qquad (12)$$

$$E_i = \frac{[1 + n_i(p_i/p_{i0} - 1)]E_{i0}}{\sum_i [1 + n_i(p_i/p_{i0} - 1)]E_{i0}} \cdot (p \cdot r_f + M):$$

$$\text{if } \sum_i [1 + n_i(p_i/p_{i0} - 1)]E_{i0} > p \cdot r_f + M$$

where r_f is the vector of the foreign consumer's initial holding of financial assets and M is the income that he receives from exports sold to the home country. [24] Thus, foreign demand for each export will be scaled uniformly in case the value of the total demand is greater than the initial holdings of money. For any empirical application, where the foreign consumer would represent the rest of the world, this would not, of course, take place. [25]

Since there is no attempt to describe foreign consumption of foreign goods, the foreign consumer's demand for money cannot be treated in the same way as that of the domestic consumer, namely, as a requirement for transactions. Rather, a two-part choice mechanism is specified in which the foreign consumer first chooses a consumption bundle of domestically produced exports in a manner defined in equation (12) and then divides the remainder of his income among money and domestic and foreign bonds. Suppose that g_i, $i = 1,2,3$ are the demand parameters (as a percentage of income) of the foreign consumer, for these three assets, respectively. The foreign consumer's demand for these assets, F_i, $i = 1,2,3$, is then given by

$$F_i = g_i\,(p \cdot r_f + M - \sum_j p_j\,E_j)/p_i : i = 1,2,3$$

$$0 \leqq g_i \leqq 1, \sum_{i=1}^{3} g_i = 1 \qquad (13)$$

Thus, the foreign consumer spends a constant fraction of the remainder of his income on each of the three financial assets. [26] Obviously, there would be many other ways to represent the

[24] Here, p refers only to the prices of the financial assets.

[25] Because the foreign consumer receives income from his sale of exports to the home country, his own levels of demand are subject to a wealth effect. This specification of foreign demand for exports is given in Boadway and Treddenick (1978).

[26] When $i = 1$ (i.e., when the asset in question is money), $p_i = 1$, since money is the numeraire.

foreign consumer's demand for financial assets, but this simple formulation is used for the sake of being specific.

TAXES AND THE GOVERNMENT

The government in this model has several functions. It collects taxes from businesses and consumers and uses these taxes to finance its production of public goods. Since it cannot determine in advance what the precise level of its tax revenues will be, it cannot be sure that they will cover the cost of its expenditure on public goods. The government therefore also functions as a central bank and a treasury in that it finances whatever deficit it may incur via the sale of bonds and the emission of money. If the government runs a surplus, this surplus is distributed to consumers in the form of transfer payments. Let us first consider the structure of taxes.

There are three types of tax in the model, the first of which is a profits tax that is levied on returns to capital and on inputs of labor.[27] If this tax rate is denoted by t_j^k for the jth sector when applied to capital (so that different sectors may be subject to different profits tax rates), and by t_i^L when applied to the ith type of labor,[28] then suppose that $(y_1^j, \ldots, y_{k+q}^j, y_{k+q+j}^j)$ represents the inputs of capital and labor, as in equation (1), to the value added of the jth sector, while y_{k+q+j}^j represents usage of the jth sector's capacity constraint. The total cost to the firm of producing this level of value added is then given by

$$(1 + t_j^k)\sum_{i=1}^{k} p_i y_{ij} + \sum_{i=k+1}^{k+q} (1 + t_i^L)p_i y_{ij} + p_{k+q+j} y_{k+q+j}^j \quad (14)$$

and the corresponding tax paid is given by T^j where

$$T^j \equiv t_j^k \sum_{i=1}^{k} p_i y_{ij} + \sum_{i=k+1}^{k+q} t_i^L p_i y_{ij} \quad (15)$$

The second general type of tax in this model is a consumption tax that is paid by the individual consumer and was mentioned

[27] When the tax is levied on inputs of labor, it represents the income tax withheld at the source that was mentioned earlier; when it is levied on capital, it can be interpreted as a profits tax.

[28] There is thus the same tax rate applied to different types of capital, while different rates may be applied to different types of labor, although the rates will be uniform across sectors. Progressive income taxes are not introduced here for reasons of simplicity.

briefly in the previous section. In this case, a tax rate t_i^c is levied on consumption of the ith good, so that if the jth consumer's consumption of that good is x_i^j, then the tax that he pays on his consumption of the ith good, c_i^j, is given by

$$c_i^j \equiv t_i^c p_i x_i^j \tag{16}$$

The ith commodity referred to here may be either an intermediate or final, or imported, good.

The third type of tax is one that is levied on imports, that is, a tariff. A tariff is treated as a consumption tax, hence paid by the consumer, and is levied on the sales price of the imported good, which is fixed in terms of domestic currency. Thus, tariffs may be formally represented as in equation (16). It is assumed that no taxes are levied on exports, [29] so that total taxes collected by the government, T, are now given by

$$T \equiv \sum_{j=1}^{M} T^j + \sum_{j=1}^{I} \sum_{j} c_i^j \tag{17}$$

where j in the second summation ranges over all intermediate and final and imported goods.

Let us now turn to the government's role as a provider of public goods, and suppose that it produces an output of public goods via a Cobb-Douglas production function using capital and labor as inputs. Clearly, other types of production function could be used, but this was chosen for simplicity. Thus,

$$Q = \prod_{i=1}^{k} K_i^{\alpha_i} \prod_{i=1}^{q} L_i^{\alpha_{k+i}}$$

where Q is the physical output of public goods and

$$0 \leqq \alpha_i \leqq 1, \sum_{i=1}^{k+q} \alpha_i = 1$$

Suppose then that the planners decide on a fixed level $\overline{Q}$ (fixed in physical terms) of the output of the public good. [30] If $p_i : i = 1, \ldots, k + q$ are the prices of capital and labor, then by the usual conditions of marginality

[29] The introduction of export taxes (or subsidies) would pose no technical problem, but they are not currently in use in most industrial countries.

[30] One notion of public goods is defense.

$$L_j = \frac{(1 - \alpha_{k+j})p_i}{\alpha_i\, p_{k+j}} K_i \tag{18}$$

Substituting, one obtains

$$K_i = \left(\frac{p_i^{\alpha_{i-1}}}{\alpha^i}\right) \prod_{j=1}^{i-1} \left(\frac{p_j^{\alpha_j}}{\alpha_j}\right) \prod_{j=i+1}^{k+q} \left(\frac{p_j^{\alpha_j}}{\alpha_j}\right) \overline{Q}$$

$$L_j = \left(\frac{p_j^{\alpha_{j-1}}}{\alpha_j}\right) \prod_{i=1}^{j-1} \left(\frac{p_i^{\alpha_i}}{\alpha_i}\right) \prod_{i=j+1}^{k+q} \left(\frac{p_i^{\alpha_i}}{\alpha_i}\right) \overline{Q} \tag{19}$$

so that the cost of producing $\overline{Q}$ is given by G where

$$G \equiv \sum_{i=1}^{k} p_i K_i + \sum_{i=k+1}^{k+q} p_i\, L_i$$
$$= \prod_{i=1}^{k+q} p_i^{\alpha_i} \sum_{i=1}^{k+q} \left\{ 1/\alpha_i^{\alpha_{i-1}} \prod_{j=1}^{i-1} \alpha_j^{\alpha_j} \prod_{j=i+1}^{k+q} \alpha_j^{\alpha_j} \right\} \tag{20}$$

The government deficit is then given by D where

$$D = G - T \tag{21}$$

so that if D is negative, the government runs a surplus. The government finances a deficit through a combination of bond sales and the creation of money. No distinction is made between a central bank and a treasury, but rather it is assumed that they are both in the same government body. In actual practice (in the United States, for example), the treasury would sell a certain number of bonds at the market price. If the revenues from this sale were insufficient to cover the deficit, the treasury would have another round of bond sales, driving the price of bonds lower and the interest rate higher. If, at the same time, the central bank felt that the interest rate was becoming too high—higher than its target for the rate of inflation—then it would purchase bonds by issuing money until the interest rate fell to the desired level. Since this paper deals with a static model, however, it is not possible to capture this dynamic mechanism. Instead, it is assumed that the planners decide to finance some fixed fraction of the deficit, if there is one, by selling bonds, while the remainder of the deficit will be covered by issuing money. Suppose that the fraction of the deficit to be covered by the creation of bonds is given by f, and the market price of domestic bonds is pm_d. Then, the quantity of domestic bonds that the government will put up for sale, y_d, is given by

$$y_d = f\frac{D}{pm_d} \tag{22}$$

while the quantity of money that it issues, y_M, is given by

$$y_M = (1 - f)D \tag{23}$$

if we recall that money is the numeraire. If, at a particular set of prices, there is a surplus, then the money and bond-creating activities do not operate, and the surplus is distributed among consumers. [31]

Formally, the government in this model operates as both a consumer and a producer. It purchases capital and labor from the market and is treated as a producer in doing so, and its income, as a consumer, is made up of the taxes that it collects. If one views the creation of bonds and money as the outputs of costless production, then the profits, that is, the total value of the money and bonds created, will go to the government. Thus, the cost of government expenditure will be covered, and Walras's law will hold.

EXCESS DEMAND FUNCTIONS

This section develops excess demand functions for the model just described. The section is of more than technical interest, since a considerable portion of the model is developed here.

As stated in the previous section, this model consists of three types of good: primary, which includes financial assets, intermediate and final, and imported.

The set of primary goods is numbered in the following way:

Goods $1, \ldots, k$	=	types of capital
Goods $k + 1, \ldots, k + q$	=	types of labor
Good $k + q + 1, \ldots, k + q + 3$	=	money, domestic bonds, and foreign bonds, respectively
Goods $k + q + 4, \ldots, k + q + 3 + c$	=	capacity constraints on the first $c \geqq 0$ activities (24)

[31] Thus, the introduction of a government allows the existence of a central bank that creates money. Unlike Grandmont and Laroque (1975), the author does not allow consumers to borrow directly from this central bank, thereby creating their own indebtedness.

In addition, two more commodities will be defined that will be proxies for transfer payments and the value of imports used as inputs for production. Let H, the total number of primary goods, be defined by

$$H \equiv k + q + 3 + c \tag{25}$$

and let $p \equiv p_i, \ldots, p_H$ be an arbitrary vector of market prices for these primary goods.

Suppose now that the jth sector (i.e., column) in the input/output matrix requires $\overline{VA}_j$ physical units of value added to operate at unit level, and as recalled from the previous section, the jth sector is subject to a tax rate t_j^k on its capital inputs, corresponding to taxes on profits. The cost-minimizing inputs of capital and labor can be derived as in equation (19). Hence, the total cost, that is, nominal value added $va^j(p)$, to the jth sector is

$$va^j(p) = \sum_{i=1}^{k} p_i K_i + \sum_{i=k+1}^{k+q} p_i L_i + p_{k+q+3+j} \text{ [32]} \tag{26}$$

There is now nominal value added for each column in the input/output matrix A, and if this matrix were composed entirely of constant coefficients, it would now be possible to calculate corresponding Leontief prices. Recall, however, that allowance is made for substitution between certain domestically produced and imported inputs for production, so that the coefficients corresponding to these goods must be formed first. It is supposed that domestic producers "follow" the world price of imported inputs for production in the following sense. Let ΔX denote the percentage change in the variable X, and let w_j: $\Sigma w_j = 1$, $w_j \geqq 0$ be the exogenously given weight of the jth good, and hence jth sector, in the domestic price index. Then one can form a proxy for the domestic price index by weighting $\{va^j(p)\}$ by these $\{w_j\}$ to obtain $VAI(p)$, defined by [33]

$$VAI(p) \equiv \sum_{j=1}^{M} w^j \, va^j(p) \tag{27}$$

[32] Recall that goods $k + q + 3 + 1, \ldots, k + q + 3 + c$ are capacity constraints on the first c sectors. Thus, $p_{k+q+3+j} \equiv 0$ if $j > c$.

[33] Because of the possibility of substitution between domestic and imported goods in production, $VAI(p)$ is not a totally satisfactory substitute for the domestic price index, as would be true if there were completely fixed coefficients in intermediate and final production. The justification for using this proxy is that producers look at, for example, changes in domestic labor costs in making initial decisions concerning the purchases of inputs.

Suppose that the consumer price index at time 0 is given by VAI_0, so that the proxy for the rate of inflation at prices p, $\Delta VAI(p)$, is defined by

$$\Delta VAI(p) = \frac{VAI(p) - VAI_0}{VAI_0} \tag{28}$$

Suppose also that ε_i is the price elasticity of demand for imports of the ith good as an input for production, assumed to be uniform across sectors.[34] It is assumed that changes in demand for imported inputs for production are functions of changes in the real price of the good; so let pf_j be the exogenously given world price of the jth commodity, and let Δpf_j denote the corresponding rate of increase from period 0 in this price. Recall that it was assumed that the aggregate requirements, a_{ij}, for the combined domestic and foreign inputs of the ith commodity to the jth sector are given by equation (2), and it is assumed that $b_{ij} = b_{ij'}$, $s_{ij} = s_{ij'}$, that is, that coefficients and elasticities are uniform across sectors.[35] If y^0_{ij}, $y^0_{i_fj}$ represent the domestic and imported inputs for production of the ith good in sector j in period 0, then

$$\Delta y_{i_f} = \varepsilon_i \left(\Delta pf_i - \Delta VAI(p)\right) \tag{29}$$

so that the percentage change in use of imports of the ith good as an input for production is given by the real change in that good's world price. Since a_{ij} is a constant, it can easily be shown that

$$\Delta y_{ij} = -(b_{i_f}/b_i)^{1/s}(y^0_{i_fj}/y^0_{ij})^{(s_i-1)s_i}\, \Delta y_{i_fj} \tag{30}$$

Thus, an increase in the real world price of the imported counterpart of good i will lead to a decrease in that good's use as an input for production and an increase in the use of the corresponding domestically produced good. The new coefficient in the input/output matrix, $a_{ij}(p)$, is then given by

$$a_{ij}(p) = (1 + \Delta y_{ij})\, y^0_{ij} \tag{31}$$

Let $A(p)$ represent the input/output matrix formed by these variable coefficients. Since the enterprise must purchase the

[34] Such elasticities are typically estimated in econometric studies. See, for example, Goldstein and Khan (1978).

[35] This assumption is not a technical necessity but rather is motivated by empirical considerations.

imported input for production, the total cost of the jth sector's value added *plus* nondomestically produced inputs for production, $\overline{va}^j(p)$ is given by

$$\overline{va}^j(p) \equiv va^j(p) + \Sigma\, pf_i \cdot (1 + \Delta y_{i_f j}) \cdot y^0_{i_f j} \tag{32}$$

where the summation is taken over all goods for which there is a corresponding import used as an input for production, and $\overline{va}^j(p)$ was defined in equation (26).

Define $\overline{va}(p)$ as

$$\overline{va}(p) = (\overline{va}^1(p), \ldots, \overline{va}^M(p)) \tag{33}$$

The Leontief prices, $pL(p)$, corresponding to this set of value addeds and foreign prices can now be calculated by

$$pL(p) = \overline{va}(p) \cdot (I - A(p))^{-1} \tag{34}$$

These prices will then be such that each sector in $A(p)$ earns exactly zero after profits taxes. Let $\overline{p}$ denote the set of factor prices augmented by Leontief and pF, imported goods prices, so that [36]

$$\overline{p} \equiv (p, pL, pF) \tag{35}$$

There is now a complete set of prices for all goods, including financial assets, and imports, and each domestic consumer's demand for real and financial assets can now be derived. The consumer's utility maximization problem as given in equation (9) can be reduced to

$$\max U^i(x)$$

such that

$$(1 + k)(1 + t^c) + \frac{(a + 1)p_{k+q+3}\,(1 + \pi^E)}{(1 + \delta)\lambda}\overline{p} \cdot \overline{x}\ (1 + t^c)$$
$$\leqq p \cdot r + s \cdot TR + \frac{(a + 1)\, p_{k+q+3}\, r_L w^E}{\lambda} \tag{36}$$

where

$$\lambda = (p_d + c_d)\, a\, \frac{p_{k+q+3}}{p_{k+q+2}} + p_f + c_f$$

[36] Recall that prices of imported goods are exogenously given in terms of money, the numeraire.

Let $I_i(p)$ denote the *RHS* of the constraint in equation (36). It is then straightforward to show that the consumer's demand for good j, $x_{i,j}$ is given by [37]

$$x_{i,j} = \frac{I^i(p)}{\sum_j a_{i,j} \cdot (\bar{p}_j)^{(1-s_i)}} \cdot \frac{d_{i,j}}{\gamma_j \bar{p}_j^{s_i}} \tag{37}$$

where

$$\gamma = (1 + k)(1 + t^c) + \frac{(a + 1)p_{k+q+3}(1 + \pi^E)(1 + t^c)}{(1 + \delta)\lambda}$$

and where the summation is taken over all goods.

In particular, the consumer's demand for imported goods is now well defined; hence, the total value of imports, $M(p)$, demanded by domestic consumers is given by

$$M(p) = \sum_{i=1}^{I} \sum_{j \varepsilon F} pf_j \cdot x_{ij} :$$

F is the set of all imported goods (38)

The foreign consumer will receive income from the home country from two sources. He will receive $M(p)$, the value of those imported goods used for final consumption, and the value of those goods imported for use as inputs for production. Let S stand for this value, which is taken to be the H + 2nd price in the set of factor prices. [38] The total wealth, that is, income of the foreign consumer at prices $p, I_{I+1}(p)$, is then given by

$$I_{I+1}(p) = \sum_{j=1}^{3} r_{k+q+j}^{I+1} + M(p) + S \tag{39}$$

where r_{k+q+j}^{I+1} is his initial holding of the jth financial asset. The demand of the foreign consumer for the ith immediate or final good is then defined by equation (12), while equation (13) defines the foreign consumer's demand for domestic and foreign financial assets. The aggregate demand for intermediate and final goods, xL, can now be derived by

[37] Recall that TR, total transfer payments, is being treated as the H + 1st price.

[38] These are not really factor prices, since domestic financial assets may be produced. Rather, they are the set of prices on which an equilibrium will be calculated.

$$xL_j = \sum_{i=1}^{I+1} xL_{i,j} \tag{40}$$

Given these levels of demand, the activity levels, z, needed to satisfy them can be derived by

$$z = (I-A(p))^{-1} \cdot xL \tag{41}$$

so that z is a $(1 \times M)$ vector of activity levels corresponding to the matrix $A(p)$. Recall that in equation (3) the capital and labor requirements for a particular activity to produce at unit level were derived, corresponding to the prices p. Let $y_{ij} : i = 1, \ldots, k + q$ be these requirements for the jth column. Then the aggregate supplies of capital and labor can be derived as

$$y_i = \sum_{j=1}^{M} z_j \cdot y_{ij} + r_i : i = 1, \ldots, k + q \tag{42}$$

where z_j is the activity level defined in equation (41), and r_i is the aggregate initial holding of good i. The supplies of each of the capacity constraints are given by

$$y_i = -z_i + r_i : i = k + q + 4, \ldots, H \tag{43}$$

since these activities are defined to use one unit of scarce capacity when operating at unit level. Total tax revenues paid out can now be calculated, defined by T in equation (13); hence, the value of the deficit (or transfer payments), D, defined in equation (21), can also be derived.[39] The "production" of money and domestic bonds, goods $k + q + 1$, $k + q + 2$, has been described in equations (22) and (23), and in the terminology of this section is given by[40]

$$y_{k+q+1} = (1 - f)D + r_{k+q+1} : 0 \leqq f \leqq 1, \text{ if } D > 0$$

$$y_{k+q+2} = f \cdot \frac{D}{p_{k+q+2}} + r_{k+q+2}$$

$$y_{k+q+1} = y_{k+q+2} = r_{k+q+2} : \text{if } D < 0 \tag{44}$$

[39] Where $D < 0$, the transfer payments going to consumers, $-D$, are not, in general, equal to TR, the H + 1st price that enters the consumer's budget constraint, as in equation (30). At the equilibrium that may be shown to exist, they are, in fact, equal.

[40] Here, $r_{k+q+1} > r_{k+q+2}$ refer to the total initial holdings of money and of domestic bonds, respectively.

where D is the government deficit. The aggregate supply function, y, can now be augmented by the negative of the value of the government transfer payments, D, and the negative of the value of total imports used as inputs for production, F.[41] This augmented supply vector, $y(\bar{p})$, is thus given by

$$\begin{aligned} y(p) &\equiv (y, D, -F) : \text{if } D \leqq 0 \\ &\equiv (y, 0, -F) : \text{if } D > 0 \end{aligned} \tag{45}$$

The augmented demand function, $\bar{x}(p)$, is similarly defined as

$$\bar{x}(p) = (x, -TR, -S) \tag{46}$$

where TR and S are the price proxies for transfer payments and the value of imported inputs for production, and x is the vector of aggregate demands for primary and financial assets. The aggregate excess demand function $u(p)$ is then defined as

$$u(p) = \bar{x}(p) - \bar{y}(p) \tag{47}$$

It can then be shown that there is some value of $p(p^*)$ for which $u(p^*) \leqq 0$, that is, for which supply is equal to or greater than demand, and the amount paid out in transfer payments and revenues going to foreign consumers is equal to or greater than the amounts actually collected.[42]

III. Summary and Conclusion

This paper has discussed the general features of the Walrasian and the macroeconomic approaches to modeling an open economy, and has briefly considered their relative strengths and weaknesses in coping with certain questions that might be of interest to a government policymaker. A model has been constructed of a disaggregated open economy that is a price taker for some goods and a price setter for others—an advance over the most recent macroeconomic general-equilibrium models,

[41] As in equation (32), this amount can be calculated as

$$F = \Sigma\, y_j\, \Sigma\, pf_i \cdot (1 + \Delta\, y_{i_f j})\, y^0_{i_f j}$$

where the inner summation is taken over the set of all domestically produced goods for which there is an imported substitute.

[42] A proof of this result is available upon request from the author, whose address is Research Department, International Monetary Fund, Washington, D.C. 20431.

which assume the country to be a price taker for all goods. There is an active government that produces public goods and pays for its purchases of factor inputs from the tariffs and taxes (income, profits, and sales) that it collects. Since these taxes will not necessarily be sufficient to finance the cost of the public goods, the government issues a combination of money and bonds to finance whatever deficit it incurs, so that the rates of change of both the nominal money supply and the level of public indebtedness are endogenous. This endogenicity is an advance over the current Walrasian general-equilibrium literature, which, with rare exceptions, has not considered economies with production and financial assets. Current macroeconomic models, on the other hand, which have provisions for disaggregated commodities, also require the money supply to be exogenous, thus precluding any investigation of the impact of government behavior on the financial sector. The model also contains foreign consumers and foreign bonds and can therefore generate endogenous capital flows.

The model can address a number of policy questions. What will be the impact on the savings and consumption behavior of the economy if the government changes its output of public goods? How will a differential change in tax rates affect the output and welfare levels of the economy through its direct impact on relative prices? How will a change in the government's method of financing its deficit, that is, changing the proportions financed by money and bonds, change the overall balance of payments? Since the model allows for substitution between domestic and imported inputs for production, depending on relative prices, it can also investigate the impact on the economy of an exogenous change in the world price of an imported good. A number of other questions that might be of interest to a government could be examined within the context of the model.

An algorithm has been constructed that calculates a numerical solution to the equilibrium of the model, so that explicit policy simulations may be carried out. [43] Unlike existing large-scale

[43] The algorithm used here is based on Merrill (1971) and Scarf and Hansen (1973). Manne and others (1980) and Eaves (1976), among others, have constructed somewhat different algorithms to solve similar problems. A different approach, based on Newton's method, has been employed by a number of other economists.

numerical models, such as Wharton and DRI, this model has market-clearing mechanisms that permit almost unlimited substitution and relative price changes, so that the impact of large exogenous shocks may be better estimated. There is thus an obvious appeal in attempting to construct an empirical version of the model; such a version, applied to the United States, is currently being undertaken, with the aim of addressing questions that are of interest not only to the United States but also, because of its central position in the world economy, to other countries. Foremost among these questions, from the point of view of this study, is how U. S. relative prices will change in response to changes in exogenous parameters, such as tax rates or prices of traded goods for which the country is a price taker. Since many countries attempt to manage their exchange rates in order to maintain parity with some relevant measure of the U. S. price index, the prediction of changes in U. S. relative prices is an essential ingredient in their exchange rate policies.

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