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Stabilization of the Balance of Payments in a Small, Planned Economy, with an Application to Ethiopia 1/

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I. Introduction

In recent years the problem of choosing exchange rate regimes has confronted a number of developing countries, many of whom have traditionally pegged to a single currency either for historical reasons or simply because the bulk of their foreign transactions is denominated in that currency. Such a single-currency peg, however, severely limits the ability of the authorities to cushion the economy from the impact of fluctuations in exchange rates among the currencies of the major trading partners. Faced by recurring disequilibria in its balance of payments, the country may decide that a new way of managing the exchange rate is called for. Among alternative exchange rate regimes, allowing the rate to float is an extreme solution that is typically unacceptable to the governments of many small countries because of fears of the impact of speculation in their exchange markets, and also because of a general tendency to favor controlled rather than market-determined prices, interest rates, and exchange rates. 2/ This tendency is especially pronounced in the case of planned economies, where the choice of an exchange rate is one of the important policy parameters at the disposal of the planners.

1/ A number of significant features of this paper have been suggested by Mohsin Khan, while other useful comments have been made by Anupam Basu, Willem Buiter, Michael Dooley, and Morris Goldstein. Since writing this paper, I have moved to the Fiscal Affairs Department.

2/ In addition, there is usually a controlled capital account, since the loss of reserves that could occur with a fixed exchange rate regime, if the economy were open, could, as we shall discuss shortly, cause the national plan to become impossible to implement.

Rather than remaining with a single-currency peg or moving to a floating rate, the authorities in many countries have chosen to peg their currencies to baskets of other currencies. The choice of both the currencies and weights in an exchange rate basket may be directed at several different objectives. In general, a basket of currencies has two principal advantages compared to a single currency peg: it permits governments to diffuse the impact of exchange rate variability on domestic prices, activity, and the balance of payments, and it affords the possibility of changing the weights in the basket to effect changes in the level of the real exchange rate without undertaking an outright revaluation or devaluation.

Belanger (1976) constructs an exchange rate model for Zaire and Zambia that can be used to derive a basket of currency weights designed to neutralize the impact of world exchange rate changes on these countries' trade balances, while a similar model, derived by Feltenstein, Goldstein, and Schadler (1979), for four copper exporting LDCs has been used to derive trade balance-stabilizing weights for Zambia. Both papers have in common the feature that the economies in question can influence the world price of primary goods they export. 1/ A recent paper by Branson and Katseli-Papaefstratiou (1978) examines the case of a small economy that is a price taker for both its exports and its imports, and derives weights for currency baskets designed to correspond to a variety of objectives, such as the neutralization of the trade balance and the stabilization of the price of traded goods.

All of the papers that have been mentioned, along with most other ones in the literature, deal with an essentially competitive, nonplanned economy with no direct restrictions upon trade. A large number of developing countries, however, now have economies that, at least to some degree, are centrally planned, and this has certain consequences for the realistic modelling of the external sector. In such economies a simple elasticities approach to trade cannot be valid, since the planners may attempt to control directly the level of imports as part of the plan. In addition, the government itself will purchase imports in a manner determined by the real targets of the national plan and not immediately related to the prices of those imports. More generally, the government will typically attempt to determine the level of the plan in terms of real quantities, without consideration for its financing requirements, so that stabilization models that depend upon the control of the central government budget

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1/ Unlike the multilateral exchange rate model for industrial countries, developed by Artus and Rhomberg (1973), these papers do not make the Armington (1969) assumption that traded goods are distinguished both by type and by place of origin. Rather, they view exports as being of a single, homogenous commodity, not distinguished by place of origin, an approach that we also follow in this paper.

will not be relevant in this case. 1/ Finally, and perhaps most importantly, the small centrally planned economy usually has strict capital controls, so that any thought of treating it in the format of a monetary approach to the balance of payments, as applied to a small, open economy, must be abandoned. 2/

The aim of this paper will be to construct a simple model of a small, planned economy. Weights will first be derived for an exchange rate basket that is designed to neutralize external shocks to the trade balance. The exchange rate changes determined by the currency basket will then become part of an implicit economy-wide macroeconomic model that will determine the equilibrium price level and rate of monetary expansion that correspond to the particular exchange rate. The underlying assumption is thus that the planners wish to be able to stabilize changes in the trade balance in terms of foreign currency: capital movements are centrally controlled, and foreign reserves, or the lack of them, are often the binding constraint on obtaining the objectives of the plan, as most capital goods must be imported. Having stabilized changes in reserves (except for exogenous foreign borrowing), the planners may now carry out the real objectives of the plan, but in doing so must give up control over the price level. In short, the planners must allow some economic variable to be endogenous, and in this case have implicitly chosen to allow the money supply, and hence the price level to be so. It could, of course, be argued that the planners may still control prices and allow there to be disequilibria in consumer markets, as exemplified by the use of queueing or rationing for allocating consumer goods. Such disequilibria have, however, positive shadow prices in terms of lost output, so that the prices will not actually have been controlled. 3/

Both parts of the the model will then be estimated for Ethiopia, whose planning system resembles that of the model, and a simulation will then be carried out in which exchange rate, price, and money supply changes for 1980 will be calculated, given the information of 1979. The next two sections will describe the theoretical structure of our model, while Section IV will give the results of the estimations and simulations. Section V will make some concluding remarks.

II. The Exchange Rate Model

In this section we shall derive a currency basket designed to stabilize the foreign exchange-denominated trade balance of the country in question. The basket will depend upon world exchange rate changes and

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1/ There is a vast literature concerning planning in terms of material inputs. An interesting description of some of the problems that may arise is given in Montias' (1962) book on the post-war Polish planning experience.

2/ A discussion of repressed economies is given in McKinnon (1973), while Wolfe (1978) has analyzed the role of the exchange rate in such systems.

3/ This repressed inflation is discussed in Portes (1977, 1980).

and expected rates of inflation, along with the home country's expected rate of inflation. In addition, expectations of changes in certain world commodity prices will also play a role, and, as we shall see shortly, the actual rate of inflation will be an endogenous variable in the overall macroeconomic model that we shall construct. The weights of the exchange rate basket may, however, be derived independently from the macro model, treating the expected domestic rate of inflation as an exogenous variable.

In the next section we shall incorporate in the macro model the exchange rate changes derived from the exchange rate basket. The system of determining exchange rate weights is intended to reflect the position of the central planner who, at the beginning of the period in question, wishes to determine the exchange rate and monetary targets for that period. Both he and the importers and exporters in the country will respond to both actual and anticipated price variables, and the planner, by observing historical behavior, will construct estimates of the anticipated behavior of the public. These estimates can then be used to form the plan's targets. The methodology that we use is similar to that in Branson and Katseli-Papaesfratiou (1978), but has certain differences, primarily because we are looking at real rather than nominal prices, in order to reflect the importance of the difference between domestic and world rates of inflation.

Let us suppose that the country in question cannot affect the world price of the single, homogenous product that it exports. 1/ The percentage change expected by the planners in the domestic price of the good, p_x, is given by:

$$(2.1) \quad \dot{p}_x = \dot{e} + \dot{q}_x^E$$

where e represents the exchange rate in terms of units of domestic currency per unit of foreign currency, while q_x^E represents the world price expected by the planners, in terms of foreign currency, of the exported good.

Our underlying assumption is that changes in the domestic exchange rate are announced by the government for the forthcoming period. Changes in world prices are, however, only imperfectly anticipated by the planners, who must attempt to predict the public's response to future spot prices. Thus $\dot{q}_x^E$ represents the rate of increase in export prices anticipated by the planners for the forthcoming planning period. Suppose now that instead of dealing with a single foreign exchange rate, we have N such exchange rates T_i, each given in terms of units of the home country's domestic

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1/ The analysis could easily be extended to more than one exported commodity, but to do so would only serve to complicate the notation. In addition, in the empirical application to follow, there is only a single important export good.

currency per unit of the ith country's currency. Similarly, a single expected price rise will be replaced by N such rises. Thus (1) becomes:

$$(2.2) \quad \dot{p}_x = \sum_{i=1}^{N} \alpha_i \dot{T}_i + \sum_{i=1}^{N} \alpha_i \dot{q}^E_{ix}$$

where α_i are the shares in total exports of the N countries. As in Branson and Katseli-Papaefstratiou (1978), we will break up T_i in the following way:

T_i = units of domestic currency/unit of the ith foreign currency

J_i = U.S. dollars/unit of the ith foreign currency

r = units of domestic currency/U.S. dollars

Thus $T_i = r \cdot J_i$ so $\dot{T}_i = \dot{r} + \dot{J}_i$ and we have:

$$(2.3) \quad \dot{p}_x = \sum_{i=1}^{N} \alpha_i (\dot{r}+\dot{J}_i) + \sum_{i=1}^{N} \alpha_i \dot{q}^E_{ix} = \sum_{i=1}^{N} \alpha_i (\dot{J}_i+\dot{q}^E_{ix}) + \dot{r}$$

since $\sum_{i=1}^{N} \alpha_i = 1$

We will suppose that exporters respond to the relative export and domestic prices of the good they export. Thus, if $\dot{X}$ represents changes in exports, s_x is the export elasticity of supply and $\dot{q}^E_d$ is the anticipated change in the domestic price of the export good, then: 1/

$$(2.4) \quad \dot{X} = s_x[\sum_{i=1}^{N} \alpha_i (\dot{J}+\dot{q}^E_{ix}) + \dot{r} - \dot{q}^E_d]$$

where X represents the rate of change in the volume of exports expected by the planners.

Similarly, turning to imports, we have

$$(2.5) \quad \dot{p}^c_m = \sum_{i=N+1}^{M} \beta_i (\dot{J}_i + \dot{q}^E_{im}) + \dot{r}$$

1/ In a centrally planned economy the export good would typically be subject to a controlled price, so that $\dot{q}^E_d$ might very well not be equal to the expected rate of inflation.

where $\dot{p}^c_m$ is the percentage change in the price of consumer imports, $\dot{q}^E_{im}$ the expected change in the price of the ith country's consumer good exports to the home country, in terms of the ith country's currency, and β_i is the ith country's share in exports of consumer goods to the home country. 1/ We will suppose that changes in consumer imports are given by the following functional form:

$$(2.6) \quad \dot{M}^c_t = d_1 (\dot{p}^c_{m,t} - \pi^E) + d_2 (\dot{p}^c_{m,t-1} - \pi_{t-1}) + d_3 \dot{y}_t$$

where $\dot{M}^c_t$ represents the change in the volume of consumer imports in period t, π^E the expected rate of inflation, π_{t-1} the previous period's rate of inflation, $\dot{y}_t$ the current rate of growth of real income, d_1 the elasticity of demand with respect to current anticipated real price changes, d_2 the elasticity of demand with respect to lagged real price changes, and d_3 the elasticity with respect to changes in real income. 2/ From the point of view of the planners, equation (2.6) reflects the fact that consumers must make their decision to purchase imports on the basis of their inflationary expectations, since information on actual inflation is issued with a lag. They are, however, committed to certain purchases contracted for in the previous period, as reflected by the second term in the right-hand side of equation (2.6). Finally, $\dot{y}_t$ represents the rate of growth of real output that the government has projected for the national plan, so that equation (2.6) reflects the planner's projection of the rate of change of consumer imports, given the public's inflationary expectations and the planned target for real output.

In addition to imports by the private sector of consumer goods, the central government will be carrying out its own program of imports, primarily of inputs to production, as part of the national plan. The level of these imports are not price related, as in the case of consumer goods, but is determined exogenously by the physical requirements of the plan. Let G_M denote government imports and let p_G denote the price, in terms of U.S. dollars, of government imports.

The trade balance, BT, in terms of U.S. dollars, is now given by:

1/ We will be implicitly assuming that consumers and the private sector are identical in the home country.

2/ Unlike the exporter, the consumer purchasing an import is concerned with the relative prices of imports and all domestic goods, and thus deflates the expected change in the import price by the expected rate of inflation. In the next section we will discuss how the anticipated rate of inflation may be determined.

$$(2.7)\quad BT \equiv \frac{p_x X}{r} - \frac{(p_m^c M^c + p_G G_M)}{r}$$

The expected change in the U.S. dollar value of the trade balance, DBT, is then given by:

$$(2.8)\quad \dot{DBT} = (\dot{p}_x + \dot{x} - \dot{r})X_{t-1} - (\dot{p}_m^c + \dot{M}^c - \dot{r})M^c_{t-1} - (\dot{p}_G + \dot{G}_M)G_{M,t-1}$$

where variables subscripted by t-1 are from the previous period and all other variables are current. We may then derive:

$$(2.9a)\quad \dot{DBT} = (1+s_x)\sum_{i=1}^{M}\alpha_i(\dot{J}_i + \dot{q}^E_{ix})X_{t-1} + s_x\dot{r}X_{t-1} - s_x\dot{q}^E_d X_{t-1}$$
$$- (1+d_1)\sum_{i=M+1}^{M}\beta_i(\dot{J}_i+\dot{q}^E_{im})M^c_{t-1} - d_1\dot{r}M^c_{t-1} + d_1\,\pi^E M^c_{t-1}$$
$$- d_2\,(\dot{p}_{m,t-1} + \dot{r}_{t-1} - \pi_{t-1})M^c_{t-1} - d_3\dot{y}M^c_{t-1} - (\dot{p}_G + \dot{G}_M)G_{M,t-1}$$

The planners now wish to derive an exchange rate that stabilizes the U.S. dollar value of the balance of payments. 1/ Setting $\dot{DBT} = 0$ and solving equation (2.8) for $\dot{r}$, we obtain

$$(2.9b)\quad \dot{r} = \frac{-(1+s_x)\sum_{i=1}^{M}\alpha_i(\dot{J}_i+\dot{q}^E_{ix})X_{t-1} + (1+d_1)\sum_{i=M+1}^{N}\beta_i(\dot{J}_i+\dot{q}^E_{im})M^c_{t-1}}{(s_x X_{t-1} - d_1 M^c_{t-1})}$$
$$+ \frac{\dot{d}_2(p_{m,t-1} - \pi_{t-1})M^c_{t-1} + d_3\dot{y}M^c_{t-1} - (d_1\,\pi^E M^c_{t-1} - s_x\dot{q}^E_D X_{-1}) + (\dot{p}_G+\dot{G}_M)G_{M,t-1}}{s_x X_{t-1} - d_1 M^c_{t-1}}$$

Suppose now that we set:

$$(2.10)\quad w_i \equiv [-(1+s_x)\,\alpha_i\,X_{t-1} + (1+d_1)\,\beta_i\,M^c_{t-1}]/[s_x X_{t-1} - d_1 M^c_{t-1}]$$

where $i = 1, \ldots, M+N$

We can then express $\dot{r}$ as:

$$(2.11)\quad \dot{r} \equiv -\sum_{i=1}^{M} w_i(\dot{J}_i + \dot{q}^E_{ix}) + \sum_{i=M+1}^{N} w_i\,(\dot{J}_i + \dot{q}^E_{im}) + K$$

1/ The planners wish to stabilize the foreign exchange rather than the domestic currency value of the balance of payments, since shortages of foreign reserves will be a constraint in carrying out the import program deemed necessary to implement the plan.

where we define K by: 1/

$$(2.12)\quad K = \frac{d_2(\dot{p}_{m,t-1} - \pi_{t-1})M^c_{t-1} + d_3\,\dot{y}M^c_{t-1} - (d_1\,\pi^E M^c_{t-1} - s_x\dot{q}^E_D X_{t-1}) + (\dot{p}_G + \dot{G}_M)G_{M,t-1}}{s_x X_{t-1} - d_1 M^c_{t-1}}$$

Thus K will represent that portion of the required exchange rate change that is determined by changes in the domestic price level, real income, and government spending. Hence, if all predictions were made correctly, the exchange rate calculated would give DBT = 0.

In the next section we shall discuss the formation of the anticipated rate of inflation, while the anticipated rates of change in export and import prices could be generated in a number of ways. As a proxy for $\dot{q}^E_{im}$, the expected rate of change in the price of goods imported from the ith country, as measured in terms of the currency of that country, one might take the expected rate of inflation for that country. A similar proxy for $\dot{q}^E_{ix}$, the rate of change in the price of exports of the ith country, would probably not be satisfactory in the case of an exported primary good, so that one might use some other best available information. Given these anticipated price variables, the planned targets for rates of growth in real income and government imports, and the necessary past data, the planners may calculate the exchange rate change required to stabilize the trade balance as in equation (2.9b). The new rate for the period might then be announced at the beginning of the period and would be maintained for the duration of the period. At the end of the period, when the value of all anticipated or planned variables has become known, the planners may determine whether or not the exchange rate is correctly valued. If it is not, the planners may make a once-and-for-all change at the beginning of the next period to compensate for the disequilibrium, and would then use equation (2.10) to calculate any further changes. 2/

1/ If there were no inflation, either domestic or foreign, no government expenditure, and consumer imports depended only upon current prices, then the term K would vanish, and the solution for r would be equivalent to that of Branson and Katseli-Papaesfratiou (1978), in the case of foreign exchange stabilization.

2/ If it was desired to have the exchange rate move on a daily basis to reflect world exchange rate changes, then these rates would presumably be available on a daily basis, so that the first term on the right-hand side of equation (2.11) could also be calculated on a daily basis. The term K would be calculated for a much longer period, a month or a quarter, for example, so that if there were T days in this period, then the daily exchange rate change would be adjusted by K/T.

Before proceeding to the macroeconomic structure of our model, it may be useful to make a few observations concerning the differences between the formulation of our exchange rate basket and of the other formulations we have mentioned. First, we have an exogenous government expenditure element that enters the basket, and second, as we shall see shortly, the exchange rate basket interacts with the planning framework. The inclusion of the government expenditure component increases the burden of adjustment on the endogenous trade variables and thereby increases the size of an exchange rate adjustment needed to maintain equilibrium in the trade balance than would be the case in the absence of government spending. Finally, the formulation of the exchange rate basket need not be used solely as a policy instrument. The planners might, for various reasons, have decided to fix the exchange rate for a period of time and, having done so, may wish to make an ex post judgment concerning the effective exchange rate for the period of the fixed rate. The basket could be used, using actual rather than predicted price information for the period in question, to make a decision as to whether or not the exchange rate was still correctly valued.

III. The Macroeconomic Model

In this section we will derive the macroeconomic model which will reflect the central planning structure of our economy. The model will contain the domestic price level and money supply as endogenous variables, and will use the exchange rate system we derived in the previous section. The only anticipated changes in foreign reserves will then come as a result of foreign borrowing, which is assumed to be controlled by the government. The economy we are describing may best be thought of as one that is highly repressed in many aspects, but which still has a certain degree of openness in the external sector, and which has a significant private sector. 1/ The degree of openness, however, is controlled by the government and may be rapidly diminished if the country's external position, as measured by its level of foreign reserves, deteriorates below a certain point. 2/ The government has an overall plan which it sets in terms of real quantities, and in which it has its own program of expenditures, again set in real terms, and has targets for the real level of income and consumption in the country. The central bank will finance whatever deficit is thereby incurred, but by so doing will lose control of the price level. We shall consider first the behavior of the government, and then turn to the external sector.

1/ In a number of small, centrally planned economies, the government has allowed agriculture, for example, to remain in private hands because of the difficulties involved in collectivization.

2/ Even though the exchange rate basket is intended to stabilize the trade balance, errors in prediction may have nonetheless caused there to be an endogenous loss in reserves.

a. Government

The government has an overall economic plan that has a target, $\bar{y}$, for real national income. This income corresponds to the output of the public sector, which is directly controlled by the government, and the private sector, which still exists to a significant extent. The government's own output uses inputs of domestic and imported goods, and we will assume that these inputs are used in fixed proportions in real terms. If there were any possibility of substitution between domestic and foreign inputs to production, such an assumption would not be supportable. In most primary-producing LDC's, however, capital inputs to production are almost entirely imported, so that the relative price of imported and domestic goods has little impact upon their relative levels of use. Suppose then that the government decides upon a level G for its own expenditures in real terms, and allocates this as:

$$(3.1) \quad \bar{G} = \bar{G}_M + \bar{G}_D$$

where $\bar{G}_M$ and $\bar{G}_D$ are government expenditures on foreign and domestic goods, in real terms, and, in particular, $\bar{G}_D$ includes the real government wage bill. The other outlet for government expenditure is its payments on its foreign debt, which are fixed in U.S. dollar terms, and which we will denote by $\overline{DB}$. 1/ If r is the U.S. dollar exchange rate, then the government's external debt service, in terms of domestic currency, is r.DB and its total expenditure G, in nominal terms, is given by:

$$(3.2) \quad G = p_G \bar{G}_M + p\bar{G}_D + r\,\overline{DB}$$

where p denotes the domestic price level.

The government will collect taxes from three sources. It levies a tax upon exporters, which we will assume is applied at a single, uniform rate t^x; a tariff t^m on goods imported by the private sector; and a tax upon consumption, which may be thought of as a sales tax applied at a uniform rate t^s. The government's total tax revenues, T, will then be given by:

$$(3.3) \quad T = t^x p_x X + t^m p_m M^c + t^s p \bar{C}$$

Here $\bar{C}$ denotes the planned level of real domestic consumption and M^c denotes the goods imported by the private sector. The government's expected deficit, D, is then given by:

$$(3.4) \quad D \equiv G - T$$

1/ This would include both interest and principal repayments due in the forthcoming period.

The money supply, MO, is given by:

(3.5) $MO \equiv MO_{t-1} + \Delta MO$

where MO_{t-1} is the money supply in the previous period, and ΔMO is the change in the money supply.

The only endogenous factor expected to affect ΔMO is the government deficit, D, for the following reasons.

We have that: 1/

(3.6) $\Delta MO = k \Delta H$

where k denotes the money multiplier and H denotes high powered money.

(3.7) $H \equiv DC + rR$

where DC denotes domestic credit issued by the central bank and R denotes its foreign exchange reserves.

Thus

$$\Delta H = \Delta DC + r \Delta R$$

We also have:

(3.8) $\Delta DC = G - T - \Delta B_G^H - r\Delta B_G^F + \Delta CSF$

where B_G^H and B_G^F denote government debt held at home and abroad, 2/ respectively, and CSF denotes claims on specialized banks. 3/

(3.9) $\Delta R = CA + KA$

where CA and KA denote the current and capital account surpluses, respectively, in terms of foreign currency. The capital account is given by:

(3.10) $KA = \Delta B_G^F + OKI$

where OKI denotes nongovernment capital flows. Thus,

1/ A more elaborate version of this argument is given in Khan and Knight (1981).

2/ Here we are assuming that the government's domestic financing is mobilized only from the central bank.

3/ CSF will represent borrowing by the private sector and state enterprises. Since the banking system is fully nationalized, the planners will have direct control over the level of borrowing from specialized banks.

$$\Delta H = G - T - \Delta B_G^H - r\Delta B_G^F + \Delta CSF + rCA + r\Delta B_G^F + rOKI$$

$$= G - T - \Delta B_G^H + \Delta CSF + rCA + rOKI$$

Now the expected value of the current account is CA = 0, because of the choice of an exchange rate in the previous section. As we mentioned in the introduction, it is assumed that there is no domestic bond market, so that $\Delta B_G^H = 0$.

Thus,

(3.11) $\Delta H = G - T + \Delta CSF + rOKI$

We assume that ΔCSF is exogenous, since there is no market determination of interest rates and since the government directly rations credit. In addition, OKI is also exogenous, because of capital controls, and, specifically, because of the fact that state enterprises must apply to the government for permission to borrow money abroad.

In addition, the expected level of foreign reserves, R, is given by:

$$R = R_{t-1} + \Delta B_G^F + rOKI$$

If the exchange rate is changed improperly because of mistakes in forecasting export prices or rates of inflation, this will result in a change in R.

Our key behavioral equation specifies a functional form for the demand for money. Let $m \equiv \frac{MO}{P}$, $\bar{y}$ is planned real income, and π^E denotes the anticipated rate of inflation. Then,

(3.12) $\ln m^d = a_0 + a_1 \ln \bar{y} + a_2 \pi^E$

where m^d denotes the desired level of real cash balances.

We will assume that expectations are generated by an adaptive expectations scheme:

(3.13) $\pi^E - \pi^E_{t-1} = \beta(\pi - \pi^E_{t-1}) \quad : 0 < \beta < 1$

and that the actual stock of money adjusts proportionally to the difference between the demand for real money in the current period and the actual stock in the previous period. Hence: 1/

(3.14) $\Delta \ln m = \lambda (\ln m^d - \ln m_{t-1})$

1/ This formulation is derived from Khan (1980).

Combining equations (3.12-14), we obtain:

$$(3.15)\quad \ln m - (1-\beta)\ln m_{t-1} = \lambda a_0 + a_1 \lambda(\ln y - (1-\beta)\ln y_{t-1}) + \lambda a_2 \beta\pi + (1-\lambda)(\ln m_{t-1} - (1-\beta)\ln m_{t-2})$$

The interpretation of equation (3.12) from the point of view of the planner is that $\bar{y}$ represents the planned level of real output for the forthcoming period, π^E the rate of inflation that the public expects to take place during that period, and m the real quantity of money that will be demanded by the public.

The exchange rate r is given by:

$$(3.16)\quad r = (1+\dot{r})\, r_{t-1}$$

where $\dot{r}$ was defined in equation (2.11). In addition, π^E as derived in equation (3.13) will be that used in the definition of $\dot{r}$. We also have as further identities

$$(3.17)\quad X = (1+\dot{X})X_{t-1}$$

where X was defined in equation (2.4).

The case of imports is somewhat more complicated. Our assumption is that the government will not intervene in the import markets, as long as it deems the level of reserves to be sufficiently high. If, however, the level of reserves falls below some predetermined level, as might happen if its forecasts had been badly mistaken, then the government will intervene so as to restrict the level of imports. We will not actually model these restrictions, but in practice they are typically implemented by such tactics as sales of import licenses and withdrawal of access to foreign exchange. The practical impact of these schemes will be to increase the elasticity of demand for imports. Recall that imports, M, are divided between goods imported by the government, G_M, which are used as inputs to the plan, and goods imported by the private sector, M^C, which are used for consumption. Suppose that $\bar{R}$ represents some minimum level of foreign reserves, such that when reserves fall below R the government will restrict imports. 1/ Now $M = G_M + M^C$ and G_M is fixed by the plan, so changes in M will come via M^C. 2/

1/ In actual practice R might be set to be equal to, for example, two months of imports.

2/ This is not strictly true since if reserves fell far enough, the planners might cut back on G_M and hence on the plan itself.

Suppose that $\bar{d}_m$ is the elasticity of demand for imports that would exist if imports were not restricted, and let d_m denote the elasticity of demand for imports considered as a variable under government control. If $R_{t-1} \geq \bar{R}$ then $d_m = \bar{d}_m$. If $R_{t-1} < R$ we will define a new d_m by:

$$(3.18) \quad d_m \equiv [a(R-\bar{R}) + 1]\, \bar{d}_m : a<0, \text{ if } R<\bar{R}$$

Thus, since $\bar{d}_m<0$, if $R<\bar{R}$ then $d_m<d_m$. This particular linear form is by no means necessary, but it gives an illustrative example.

Summarizing the model:

$$(3.19a) \quad \dot{r} = -\sum_{l=1}^{M+N} w_i \dot{J}_i + K$$

$$(3.19b) \quad \dot{p}_X \equiv p_X(\dot{r})$$

$$(3.19c) \quad \dot{p}_m = p_m(\dot{r})$$

$$(3.19d) \quad \dot{X} = x(\dot{r}, \dot{q}_x^E, \dot{q}_d^E)$$

$$(3.19e) \quad \dot{M} = M(\dot{r}, \pi^E, \dot{q}_m^E, R_{t-1})$$

$$(3.19f) \quad \pi^E = \sum_{i=0}^{\infty} \beta\, (1-\beta)^i\, \pi_{-i}$$

$$(3.19g) \quad \ln \overset{M\Omega}{p} = a_0 + a_1 \ln \bar{y} + a_2\, \pi^E$$

$$(3.19h) \quad G = p_G \bar{G}_M + p.\bar{G} + \bar{DB}.r$$

$$(3.19i) \quad T = t^x\, p_x\, X + t^m\, p_m\, M^c + t^s\, p\, \bar{C}$$

$$(3.19j) \quad D = G - T$$

$$(3.19k) \quad \Delta MO = k\,(D + \Delta CSF + rOKI)$$

$$(3.19l) \quad \dot{X} = (1+\dot{p}_x+\dot{X})\, X_{t-1}$$

$$(3.19m) \quad \dot{M} = (1+\dot{p}_m+\dot{M})\, M_{t-1}$$

b. A solution to the model

The planner in our model derives a solution to the model in the following way. Given the past series of inflation rates $\{\pi\}_{t-i}: i=0,\ldots,$ and his estimate of the adjustment parameter β, he derives π^E, the rate of inflation anticipated by the public for the forthcoming period, as in

equation (3.19f). The planner may now derive the change in the exchange rate, r, deemed necessary to stabilize the trade balance, as in Section II. If the currencies in the exchange basket maintain purchasing power parity with the U.S. dollar over the period, then $\dot{J}_i$ should be equal to the ratio of the U.S. inflation rate to the ith country's rate of inflation over the period. The planner would either have forecasts of these rates of inflation or could simply take them to be equal to the past rate. If π^E_{USA}, π^E_i represent these anticipated rates of inflation, and $\dot{J}^E_i$ the anticipated exchange rate change in the ith currency, then $\dot{J}^E_i = \pi^E_{USA}/\pi^E_i$, and r may be calculated for the period as in equation (2.11). Given r, the planner may calculate $\dot{p}_x$ and $\dot{p}_m$, the changes in export and import prices for the period as in equations (2.2) and (2.5). The planner then calculates $\dot{X}$, the change in exports, as in equation (2.4). If $R_{t-1} \geq \bar{R}$, then $\dot{M}$ is calculated as in equation (2.6), using the demand elasticity $\bar{d}_m$. If $R_{t-1} < \bar{R}$, then d_m is calculated using equation (3.18). The planner may now derive $\dot{p}_x$, $\dot{p}_m$, $\dot{X}$ and $\dot{M}$ and may then derive the government deficit D = G - T as a function of a single variable, p, the overall price level. According to equation (3.19g):

$$(3.20)\quad \ln\left\{k\left[\frac{p_g M^G + \overline{DB}.r - t^x p_x X - t^m p_m M^c + \Delta CSF + rOKI}{p} + G - t^s C\right]\right\}$$

$$= \lambda a_0 + a_1 \lambda (\ln y - (1-\beta)\ln y_{t-1}) + \lambda a_2 \beta\pi$$

$$(1-\lambda)(\ln m_{t-1} - (1-\beta)\ln m_{t-2}) + (1-\beta)\ln m_{t-1}$$

from which p may be calculated. Having derived p, the nominal money supply, MO, may also be obtained from equation (3.19k), so that price and monetary projections consistent with the exchange rate policy will be achieved. 1/

1/ The price level derived from equation (3.20) is that which will yield an equilibrium in the money market, given consumers' anticipations and the government's own spending program, which is normally not known to consumers. Since the price level will typically be different than that anticipated by the consumers, they will revise their expectations next period.

IV. An Application

a. Estimations

In order to implement our model, we have estimated the relevant parameters and behavioral equations for Ethiopia, a country whose current economic system is roughly similar to that of the model. Since 1974, Ethiopia has had a system of planning which, although centralized, only partially controls economic activity: in particular, the export sector is largely in the hands of private enterprises, while consumer goods are also imported by private concerns. At the beginning of each year an annual plan is developed on the basis of a longer-term plan. The annual plan attempts to set, among other things, the level of real growth and consumption. The planners are not able to directly control outcomes in the external sector to the same extent because of its partially private nature, although capital goods used in implementing the plan are imported by the Government. 1/

The Ethiopian currency, the birr, has been pegged to the U.S. dollar for many years, but the possibility of shifting away from this peg is currently being considered. The reasons for such a move are to give the authorities greater leeway in controlling the domestic macroeconomic aggregates; 2/ money and prices, and also to give a price incentive to domestic exporters. The country's primary export is coffee, accounting for approximately 60 per cent of its export earnings, and it is felt that having an exchange rate fixed while world prices are declining removes most of the price incentives the coffee exporters might have. Indeed, if the domestic price of coffee is not fully controlled, then, in the face of domestic inflation and a stagnant or falling world price of coffee, the exporters would tend to increase their domestic sales at the expense of exports. Since the country has currently been experiencing balance of payments difficulties, the price disincentive to exports caused by an exchange rate that does not respond to changes in either domestic inflation or foreign prices should be avoided.

The possibility of moving to a freely floating exchange rate is not viewed as being feasible, because of the centrally planned nature of the economy. There is, on the other hand, no intention of removing the strict capital controls that currently exist so as to make a fixed rate more supportable. The main direction of concern is, therefore, in developing a currency basket to which the domestic exchange rate should be pegged. The objective of this basket should be to neutralize the trade

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1/ As in many developing countries, imports of oil are made by the Government.

2/ By changing the weights in the exchange rate basket the planners may influence the rate of change in the exchange rate, and hence the rate of growth in the money supply and price level.

balance against predicted external and domestic price changes and domestic output changes, so that the only expected changes in the country's reserves will be from the exogenously determined capital account. The achievement of this objective is of particular importance to the central planners, since unexpected losses in reserves may force them to curtail the national plan itself, as a high proportion of its inputs are imported. Thus, if the current account is stabilized, there will be no financial impediments to the success of the plan, since it is assumed that the planners will passively allow whatever domestic monetary expansion is necessary to finance the plan.

In order to implement our model we chose as import partners those six countries with the largest shares of non-oil imports to Ethiopia. These countries, with their respective, normalized, trade shares for the years 1975-1980 are:

Table 1. Import Partner Countries

Country	1974	1975	1976	1977	1978	1979	1980
1. United States	9.8	14.3	21.2	17.8	9.3	23.1	20.9
2. Japan	22.3	22.9	25.4	31.2	26.9	20.9	18.5
3. France	7.0	8.3	4.5	4.0	4.7	3.3	6.5
4. Germany	20.8	19.1	18.0	15.9	21.6	19.9	16.2
5. Italy	26.6	20.8	17.9	19.7	23.3	19.7	23.8
6. United Kingdom	13.5	14.6	13.0	11.4	14.2	13.1	14.1

Source: Directions of Trade, various issues.

We have considered only a single export, coffee, since this accounts for 60 per cent of Ethiopia's export earnings. We have not divided the world coffee market among Ethiopia's export partners, since coffee prices are determined not by a competitive market but rather by an international producers' agreement, so that the weighted price changes given in equation (2.2) would be replaced by a single expected price change in terms of U.S. dollars.

An import elasticity of demand was estimated from an equation of the form of equation (2.6). 1/ Our initial problem was to distinguish between goods imported by the government and those imported by the nongovernment sector, since government imports are not subject to a behavioral elasticity. Clearly there are a number of goods that are imported by the Government, but it is extremely difficult to obtain consistent series of price and quantity series for any such goods other than oil. 2/ We have therefore chosen to use oil as being representative of government imports, so that consumer imports, M^c, is determined as total imports minus oil, and have constructed a corresponding import unit price index that excludes oil. The equation estimate, using annual data from 1965 to 1980, was:

$$\ln \frac{M^c}{p_m} = \underset{(-1.74)}{-1.340} - \underset{(-4.02)}{0.616} \ln \left(\frac{p_m^c}{p}\right) - \underset{(-2.62)}{0.448} \ln \left(\frac{p_m^c}{p}\right)_{t-1} + \underset{(1.80)}{0.162} \ln y$$

D.W. = 1.98 $\qquad R^2 = 0.98$

Here M^c represents the value of imports, not including oil, p_m^c is the price index of non-oil imports, p is the consumer price index, (t-1) denotes the value of the corresponding variable lagged by one year, and the figures in parentheses are t-statistics. Thus both the current and the lagged values of the relative price of non-oil imported goods are significant, and their coefficients sum to approximately -1, which should be the long-run price elasticity of demand for imports. Real income is not significant, as might be expected in the short run, but its coefficient has the correct sign.

We were unable to estimate an export supply elasticity for either coffee or for aggregate export supply, perhaps because there has been considerable government intervention in the export market. Yet another reason may be that the series for the domestic price of coffee does not reflect the true price obtainable by coffee exporters if they choose to sell their product on the home market. We have therefore chosen to use an estimated short-run world supply elasticity of 0.6 for both coffee and for aggregate exports. 3/ Clearly this value could be modified if it leads to implausible results.

1/ We have no way of knowing if the initial levels of reserves, R_{t-1}, was below some critical level at the end of any given year as specified in equation (3.18), so in the estimations we have assumed that import demand has not been constrained by the Government.

2/ It is possible to derive estimates of the value of government imports from the consolidated balance of payments. There is, however, no corresponding price series that could act as independent variable.

3/ The figure comes from unpublished World Bank estimates which give a range from 0.12 to 0.72 for the world coffee supply elasticity. There are a number of other crops which enter into the Ethiopian export supply which are probably more price elastic than coffee, so we have chosen to take a high figure for the aggregate supply elasticity.

In order to generate exchange rate changes that are intended to stabilize the trade balance, as in equation (2.11) and (2.12), we must estimate the money demand equation specified in equation (3.12). This equation was estimated on an annual basis over the period 1965-1980, using the consumer price index to generate rates of inflation. 1/ A search was carried out for values of β in the range $0 \leq \beta \leq 1$ with the objective of maximizing the value of the log-likelihood function of the estimated equation. The value of β was allowed to vary by increments of 0.1, and it was found that $\beta = 0.8$ maximized the log-likelihood function. The estimated equation, corresponding to this value of β was:

$$\tilde{m} = \underset{(-1.08)}{-1.704} + \underset{(1.08)}{0.308}\,\tilde{y} - \underset{(-3.54)}{1.276}\,\tilde{\pi} + \underset{(4.95)}{0.946}\,\tilde{m}_{t-1}$$

$$D.W. = 1.84 \qquad R^2 = 0.85$$

Here we have made the following definitions:

$$\tilde{m} \equiv \ln m - (1-\beta)\ln m_{t-1}$$

$$\tilde{y} = \ln y - (1-\beta)\ln y_{t-1}$$

$$\tilde{\pi} = \beta\pi$$

$$m = \frac{MO}{p}$$

Thus the coefficients of inflation and the lagged dependent variable are significant, while that of real income, although not significant has the correct sign. 2/ The magnitudes of the estimated coefficients are broadly consistent with those reported for a group of developing countries in Khan (1980). As in equation (3.19f), we may now generate the expected rate of inflation for a particular year, and may thus also derive the estimated exchange rate change, $\dot{r}$, required to stabilize the exchange rate basket in that year.

b. A simulation example

As a simple experiment, let us derive currency weights and corresponding exchange rate changes for 1980, given the information of 1979.

1/ The CPI is the only available price series with sufficient coverage. Ideally we would prefer to use the wholesale price index.

2/ The long-run elasticity, however, is equal to 5.7 and therefore quite high.

We will then derive the rates of growth in the money supply and the price level consistent with the new exchange rate. This should be viewed as only an illustrative example, since we will make the myopic assumption that anticipated world price changes for 1980 are equal to their values for 1979. 1/ The weights, w_i, given in equation (2.10) are given by:

Table 2. Currency Weights of Import Partners

	Country	Weight		Country	Weight
1.	United States	0.0772	4.	Germany	0.0665
2.	Japan	0.0698	5.	Italy	0.0795
3.	France	0.0110	6.	U.K.	0.0471

The weight given to changes in the world price of coffee, w_7, is given by:

$$w_7 = \frac{-(1 + s_x)X_{t-1}}{s_x X_{t-1} - d_1 M^c_{t-1}} = -1.238 \quad 2/$$

Let us suppose that world rates of inflation for 1980 remain at their 1979 levels, and that purchasing power parity is maintained among the import partner countries. Thus expected exchange rate changes would be equal to the inflation differentials, leading to the following anticipated outcomes.

1/ In practice, planners might use available predictions, such as those published by economic forecasts, for world price changes.

2/ The weights do not sum to -1 because of the presence of government imports, G_M, and the fact that $M^c_{t-1} \neq X_{t-1}$. If $G_M = 0$ and $M^c_{t-1} = X_{t-1}$, i.e., the trade balance was in equilibrium at the beginning of the period, then it may easily be shown that $\sum_{i=1}^{N+M} \omega_i = -1$. This condition of initial equilibrium is normally required for the Marshall-Lerner conditions to hold.

Table 3. Expected Inflation and Exchange Rate Changes, Import Partner Countries for 1980

(In per cent)

		$\dot{J}_i$	π_i			$\dot{J}_i$	π_i
1.	United States	0	12.5	4.	Germany	7.7	4.8
2.	Japan	5.2	17.3	5.	Italy	-3.0	15.5
3.	France	-0.8	13.3	6.	U.K.	0.3	12.2

Let us also suppose the expected change in the U.S. dollar world price of exports is equal to the expected change in the world price of coffee, which in turn is taken to be equal to its average rate of change of the past three years, so that $\dot{q}_x = 6.10$ per cent. The value of the weighted exchange plus inflation rate change, $\sum_{i=1}^{6} w_i (\dot{J}_i + \dot{q}_{im}) + w_7 \dot{q}_x$ = -3.16 per cent.

In addition, we must calculate the term K, as in equation (2.12). To this end we have that for 1979, $\dot{p}_m - \pi = -8.13$ per cent, while we shall suppose that that planned rate of growth, $\dot{y}$, for 1980 was equal to the growth rate that occurred in 1979, so that $\dot{y} = 5.4$ per cent. 1/ The anticipated rate of inflation, π^E, is generated as in equation (3.19p), using the estimated adjustment parameter $\beta = 0.8$, resulting in: $\pi^E = 16.25$ per cent. Finally, in order to calculate $(\dot{p}_G + \dot{G}_M) G_{Mt-1}$, let us suppose that $\dot{p}_G$ is taken to be the expected price change in the U.S. dollar world price of oil, which we will assume was taken to be the 1978-79 price change of: $\dot{p}_G = 0.3362$. We will also assume that G_M, the rate of growth of real government imports, is taken to be equal to the projected real growth rate of the economy, 5.4 per cent. We may now calculate K as:

$$K = 0.2720$$

1/ Ethiopian national accounts are done on a July-to-July basis, so in order to have figures that correspond to the time periods of the rest of the data, we have taken simple averages.

Thus, summing, we have

$$\dot{r} = 0.2404$$

or, a 24.04 per cent devaluation of the birr is estimated to be required to compensate for the anticipated slight increase in world coffee prices, combined with larger increases in import prices, in particular of oil, with the increase in government imports, and with the rate of domestic inflation anticipated by the public. 1/ Actually, the rate of inflation that occurred in 1980 was considerably lower than that anticipated by the public, so that this devaluation would have been too severe and would have led to an undervalued currency.

How would this rate of devaluation affect the domestic monetary and price targets? The only element missing for the calculation of equation (3.20) is the domestic money multiplier, k. This parameter was estimated over the period 1965-80, using annual data, with the following result.

$$M_2 = \underset{(.994)}{92.258} + \underset{(12.408)}{1.4323}\ H$$

$$D.W. = 1.302 \qquad R^2 = 0.901$$

where H denotes high powered money and M_2 is broad money.

We may now derive the price level, p, as in equation (3.20), in the following way. The new exchange rate, r, is given by:

$$r = (1.2404)\ r_{t-1}$$

where r_{t-1} represents the initial exchange rate which we may normalize so that $r_{t-1} = 1$. The new level of government import prices, p_G, in terms of 1979 currency, is:

$$p_G = 1.3362$$

as the assumed change in world oil prices is 33.62 per cent. The initial level of government imports of oil was $G_{M_{t-1}} = 202$ 2/ so that

$G_M = (1.054)\ G_{M_{t-1}} = 212.9$. Thus:

$$p_G\ r\ G_M = 352.9$$

1/ In some sense this would be an insufficient rate of devaluation since it would only maintain the existing disequilibrium in the current account, assuming no liberalization of the existing restrictive system. Ideally the experiment should start from a position of equilibrium, perhaps by carrying out an initial once and for all exchange rate change.

2/ All value terms are in millions of birr.

For $\overline{DB}$, the payments on foreign debt of the Central Government for 1980, we have taken the actual U.S. dollar payments, so that:

$$\overline{DB} \cdot r = 35.3$$

The export tax rate, t^x, has remained fairly constant at $t^x = 30$ per per (as a percentage of export receipts). We have that $\dot{p}_x = 0.3014$, in terms of domestic currency, so that:

$$\dot{X} = s_x (\dot{p}_x - \pi^E) = -0.0833$$

and hence:

$$t^x p_x X = 365.4$$

The average tariff rate, t^m, has been approximately: $t^m = 16.7$ per cent, as a percentage of total non-oil imports, so that:

$$t^m p_m^c M^c = 204.3$$

In addition, $M_{2,t-1}$, the stock of broad money at the end of 1979, is: $M_{2,t-1} = 1863$, while G_{t-1}, the 1979 level of governmental expenditure on domestic goods and services was: $G_{t-1} = 1385$. 1/ The average rate of nonforeign sector taxes, as a percentage of private consumption, is $t^s = 14.7$ per cent, while C_{t-1}, the level of private consumption in the previous period was: $C_{-1} = 6674$, and we will assume that private consumption is planned to grow at the same 5.4 per cent rate as the overall economy. So, in terms of constant 1975 birr:

$$\overline{G} - t^s \overline{C} = 215.9$$

Let us also assume that CFS = OKI = 0, as in equations (3.8) and 3.10), an obviously unrealistic assumption, but one which we will make for simplicity of exposition.

Equation (3.20) is thus given by:

$$\ln \left(\frac{1603.0}{p} + 215.9\right) = 6.817$$

so that:

$$p = 2.290$$

in terms of the 1975 based price index. Since the 1979 price index was $p = 1.989$, the predicted rate of inflation for 1980, π, is 15.6 per

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1/ As in the case of national accounts, we have averaged the Ethiopian figures in order to arrive at the government expenditure.

cent, a rate of inflation considerably lower than the sum of the rate of devaluation and the import price change, namely, 36.5 per cent.

The predicted money supply, MO, may now be calculated from the left hand side of equation (3.20) and is:

$$MO = 2097.4$$

indicating an overall rate of expansion of 12.6 per cent in the money supply. There should thus be a decline of about 3 per cent in real money balances, as might be expected, since the anticipated rate of inflation rose considerably in 1979.

V. Conclusion

We have constructed a simple macroeconomic model of a small planned economy, and have formulated a method for deriving a currency basket that will stabilize the current account. The rate of change in the exchange rate will depend upon the weights given to each import and export partner country, the exchange rate and price level changes in those countries, along with the rate of inflation expected by the public in the home country, the planned rate of growth in real output, and the rate of growth in the value of goods imported by the Government. The anticipated rate of inflation is generated from an adaptive expectations scheme, whose parameters are estimated from a lagged adjustment formulation of the demand for money function.

Having derived an exchange rate change for the forthcoming period, the planners may incorporate this change in the macroeconomic model to obtain price and money supply targets consistent with the new exchange rate. Since the planners set real quantities and the exchange rate, they lose control over domestic financial variables and it is important for them to be able to correctly predict the equilibrium values of these variables in order to avoid domestic shortages.

The model has been estimated for Ethiopia, a country whose current economic system loosely resembles that of the model. Having derived weights for the currency basket for 1980, we carried out a simple hypothetical exercise in which the exchange rate change was derived, based on certain assumptions about expectations for 1980, given the required information for 1979. The rate of inflation yielding equilibrium in the macroeconomic model was then calculated and was found to be considerably less than the rate of increase in the price of imports. A similar methodology can also be used to calculate an effective exchange rate so that the model can also be used to make ex post judgments concerning the appropriateness of the exchange rate.

Since it allows the simultaneous calculation of exchange rate and domestic price changes, the model can be useful for the planner who sets targets in real terms, but must avoid losses in foreign reserves, since a major proportion of the inputs to the plan are imported. The price and money supply changes required by the combination of the plan and the exchange rate policy may be unacceptable to the planners, and they might therefore wish to change, for example, the rate of change in the exchange rate while increasing their foreign borrowing. Since this model allows a direct connection to be made between exchange rate, price, and plan variables, it is an advance over most current models that treat the first two of these variables as being independent of the third.

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