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An Empirical Model of Intertemporal Allocation and Financial Constraints

L. Alan Winters

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L. Alan Winters is an economist with the International Economic Research Division of the World Bank's Development Research Department.

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Abstract

This paper specifies and estimates for three developing countries two intertemporal models of total imports. Imports are related alternatively to foreign exchange receipts and to GNP, with explicit account taken of expectations about the future values of these variables, future import prices and interest rates. Using non-nested hypothesis tests, the models are compared between themselves and with two other models of imports in the literature. While the results are not entirely satisfactory, they suggest that the intertemporal approach is quite promising. As this attempt is the first to estimate an intertemporal model of international trade, considerable space is devoted to the operational specification of the theoretical models.

In preparing this paper I benefitted considerably from comments on an earlier draft by participants at the International Economics Seminar at the Johns Hopkins School for Advanced International Studies, and by Professors Jonathan Eaton, James Riedel and Robert Stern. Kathi Yu also helped in its preparation, both through discussions and first-rate research assistance. Karen Adams, Jean Epps and Vicky Sugui shared the unreasonable burden of typing several drafts, and Whitney Watriss edited the final text. I am most grateful to all these people. Naturally, none of them is to be implicated in the paper's remaining shortcomings.

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I. INTRODUCTION

The recession of the early 1980s hit developing countries in two ways. First, the markets for their exports were depressed and were frequently restricted by protectionism. Second, real rates of interest rose to unprecedentedly high levels. The latter perhaps constitutes the unique aspect of the recent experience and should in particular be contrasted with the experience of the mid-seventies, when interest rates were low and borrowing plentiful. Then, despite depressed export revenues, developing countries were able to maintain fairly high rates of domestic growth by extensive foreign borrowing. This borrowing allowed them to maintain their demand for imported goods from the OECD and contributed to the recovery of world economic activity in 1977-78.

It also, however, sowed the seeds of the present difficulties, for many developing countries became heavily indebted. Hence, when the real interest rate rose in 1980, they found their capacity to service their loans severely stretched. This situation was reflected in a reduced demand for imports, which lowered the growth of industrial countries' export growth and prolonged their depression. The mutual reinforcement of depressed markets and declining lending turned the early 1980s into one of the most extended depressions of recent history. These same conditions continue to raise questions about the extent and durability of the current recovery.

While it is certain that the amount of debt, rising interest rates and falling export revenues have curtailed developing countries'

imports, there has been little formal econometric work devoted to quantifying the effects or even to specifying the precise mechanism. This paper explores certain aspects of how the situation can be modelled and presents a very simple and highly specialized estimation model. The starting point is that developing countries' decisions to borrow and to import are made jointly: one decision does not completely dominate the other. Thus our model assumes neither that imports are determined as the sum of exogenously given exports and net borrowing, nor that borrowing is determined by the difference between exogenously given exports and imports.

The basic framework comprises a balance of payments identity and a behavioral sector that explains borrowing and importing. The former is:

$$X + M + N + F = 0 \tag{1.1}$$

where X = The value of exports of goods and non-factor services

M = The value of imports of goods and services

N = Net factor payments and

F = Net borrowing, including changes in foreign exchange reserves.

The behavioral component is:

$$M = M\ (X,N,Z) \tag{1.2a}$$

$$F = F\ (X,N,Z) \tag{1.2b}$$

where Z = A vector of exogenous variables.

Given exports and factor payments, the balance of payments constraint ensures that only one of (1.2a) and (1.2b) is independent. Thus, it is necessary to estimate only one. However, the variables relating to "borrowing," such as the interest rate, will still enter the import equation, and vice-versa. The reason is that since X + N, then $\frac{\partial M}{\partial Z} = -\frac{\partial F}{\partial Z}$. As our interest here is in imports, we focus on (1.2a). (This approach assumes that the errors and omissions in the balance of payments account are not important. If they were, it might be desirable to estimate both [1.2a] and [1.2b], essentially dropping [1.1] from the system.)

Because our purpose is mainly exploratory, we concentrate below on the relationship between imports and the borrowing variables. Our aim is to produce a simple equation that links import behavior to the borrowing variables in a theoretically clear manner. Simplicity is important, because ultimately our intention is to estimate the model for many developing countries, with a view to making global projections.

The paper starts with a survey of existing models of import behavior and borrowing (Section II). This review is followed in Section III by a discussion of the various lessons that may be drawn from previous efforts. Next we specify our own models in some detail. We explore two basic versions -- one that is based solely on foreign exchange considerations (Section IV), the other taking into account domestic factors as well (Section V) -- and we distinguish between pure equilibrium models and models embodying some degree of disequilibrium. To our knowledge, this effort is the first empirical implementation of models of the kind we are using. Thus we devote considerable space to the concept and to the measurement of the variables.

In the subsequent four sections, the models are estimated for three developing countries chosen at random. Section VI is devoted to a general test of the specification of the wealth model based on foreign exchange earnings. It treats the three countries merely as three examples of the same process and considers, first, whether certain necessary implications of the model are empirically valid and, second, which of several approaches to measuring wealth seems best. In general, the implications are satisfied, so that in the next section, VII, the basic model is estimated and simplified for each country separately. The results suggest a fairly high degree of intertemporal substitution for imports. Section VIII is devoted to estimating three other models -- the wealth model based on domestic flows, and two simple models from the literature against which to test the new models. The results of this effort are mixed -- the new model shows some capacity to explain imports, but is matched or surpassed by one of the strawmen.

In the final section, X, conclusions are drawn about directions for future research.

The heart of the paper is Section IV, in which we describe our models, and Sections VI to IX, where we test them. Readers familiar with (or uninterested in) previous attempts to model imports and financial conditions could start with these sections, referring back only where they require the justification for certain procedures.

II. MODELS IN THE LITERATURE

Two broad approaches to the question of developing countries' imports and financial variables may be identified. The first looks at the allocation of a given amount of foreign exchange between imports and increments to reserves: reserves are assumed to be desirable for some intertemporal reason, although this assumption does not figure prominently in the specification. The second approach is more explicitly intertemporal: it treats the current account of the balance of payments as an investment flow, arguing that it is primarily determined by the desire to reschedule absorption relative to income. This section briefly considers the research on these two approaches.

Imports and Reserves

The clearest exposition of the relationship between imports and foreign exchange reserves in developing countries is Hemphill (1974). Hemphill supposes that a country has an exogenously given flow of foreign exchange earnings in each year, F_t, and that this flow must be allocated between expenditures on imports, M_t, and additions to reserves ΔR_t. He assumes that long-run imports, M*, must equal long-run receipts, F*, and that there is a long-run desired stock of reserves, R*, that is also related to receipts. The allocation of foreign exchange is then made to minimize the costs (assumed to be quadratic) of the deviations of actual reserves and imports from their desired (or long-run) levels. The basic estimating equation is:

$$M_t = \alpha_0 + \alpha_1 R_{t-1} + \alpha_2 F_t + \alpha_3 \Delta F_t \qquad (2.1)$$

where ΔF_t occurs as part of the assumed function for F*. In fact, since data on Hemphill's definition of reserves are not available, R_{t-1} has to be replaced by a cumulative term in ΔR, but this changes nothing fundamental.

Hemphill's research is meticulous, and he makes many important detailed methodological observations. While we do not repeat all of them here, certain basic points should be made. First, Hemphill experiments with several different definitions of reserves, shifting items in the balance of payment accounts from the exogenous component, F, to the endogenous one, ΔR. Thus this approach can be adopted to deal with borrowing and debt. Furthermore, Hemphill shows that, provided the costs of disequilibrium are quadratic in the differences between actual and desired magnitudes, countries can have targets for different components of R without changing the form of the equation (2.1). This claim amounts to an assumption of separability between imports and the structure of their (net) finance (F - R). In other words, the propensity to spend cash on imports does not depend on whether that cash is owned (reserves) or borrowed.

Second, Hemphill's model assumes constant parameters for the cost function. That is, the costs of excessive reserves or excessive borrowing are assumed to be constant over the sample period. This assumption may have been a good approximation for his pre-1970 sample, but it certainly requires reconsideration in later years.

A third important feature of Hemphill's approach is that only financial variables explain imports. The traditional variables such as income and relative prices are excluded, as are any policy variables. The logic behind this approach is simple and compelling. Ultimately,

with inflows of F*, outflows, M*, must be at the same level. Some rescheduling is possible via ΔR, but the long-run budget constraint must eventually be binding: regardless of income and prices, and regardless of whether imports are limited to F* by market means or by rationing, ultimately M* = F*. Thus Hemphill conceives the developing country economy as a single decision unit, with no restraints on its ability to minimize the costs of disequilibrium. To this concept he adds his assumption of the constant costs of disequilibrium. The result is that imports depend only on financial variables.

Later research on imports and reserves has relaxed this aspect of Hemphill's work. Sundararajan (1983) supposes that desired imports are determined by a traditional import function, including relative prices, (P_M/P), income, Y, real balances, EM, and policy variables, and that permitted imports balance these against the need to maintain reserves. He does not, however, impose the long-run budget constraint. His basic equation is

$$M_t = \alpha_0 + \alpha_1 \left(\frac{P_M}{P}\right)_t + \alpha_2 Y_t + \alpha_3 EM_t + \alpha_4 F_t + \alpha_5 R_{t-1}, \qquad (2.2)$$

which is broadly Hemphill's plus some extra terms.

While Sundararajan does not rationalize it in this way, this approach is similar to allowing the costs of imports deviating from desired imports to vary in Hemphill's model. In the latter, if the costs of constraining imports go up with income and rising domestic prices, an equation similar to Sundararajan's would emerge. Chu, Hwa and Krishnamurty (1983) adopt a similiar approach to Sundarajan's.

Intertemporal Allocation

As noted already, the intertemporal nature of Hemphill's model is implicit but not prominent. This condition is rectified — but not without cost -- in the second approach to the determination of imports -- namely, the intertemporal allocation models. These models sprang to prominence with Sachs (1981), who argued that the current account deficits of the seventies owed more to changes in the incentives for investment and savings than to the direct effects of paying more for oil. Sachs used a simple two-period model to show how the responses to economic shocks would vary according to perceptions of the future. In particular, he showed that whereas an oil-importing country might meet a temporary rise in the price of oil by borrowing (running a current account deficit), there was little presumption it would do so for price rises thought to be permanent. In the first instance, the country would feel that its wealth, and hence its sustainable level of consumption, was little changed by the temporary shock. Thus it would tend to maintain consumption levels over the temporary setback by borrowing, relying on a lower price in the future to allow repayment of the debt. In the case of a permanent oil price rise, however, wealth and permanent consumption would fall pari passu with net income. With no relaxation in sight, the incentive would be to cut spending back to equal income as soon as possible. Thus, in this case, the current account would be negative only during the adjustment period.

The essence of the intertemporal model of imports lies in this simple model. Consumption depends on wealth -- which includes the present value of all future income -- and on the rate of transformation of present into future consumption. The latter involves both the rate

of interest and expectations about future prices; the comparison of these with the (unknown) rate of time preference determines whether consumption is to be shifted forward or backward in time relative to income.

Sachs (1982) develops this model further. He defines the "perpetuity" value of any variable, X^P, as that perpetuity that has the same present value as the actual stream of the variable, X. Thus,

$$X^P \int_t^\infty e^{-r^*(\gamma - t)} d\gamma = \int_t^\infty e^{-r^*(\gamma - t)} X(\gamma) d\gamma \qquad (2.3)$$

where r^* = The rate of interest and

$X(\gamma)$ = The value of X in period γ.

Then, writing the trade balance, TB, as output, Q, less private and government consumption, C and G, Sachs has:

$$TB = Q - C - G$$

and

$$TB^P = Q^P - C^P - G^P. \qquad (2.4)$$

(Including investment would, in Sachs' words, "enormously complicate the algebra.")

The intertemporal budget constraint means that the present value of all future trade deficits must equal current net foreign assets, B. That is, future trade can only be permanently unbalanced to the extent that we now have the assets to finance it. Hence $TB^P = -r^*B$. Furthermore, since the present current account, CA, equals (TB + r*B), we have, from equation (2.4),

$$CA = TB - TB^P = (Q - Q^P) - (C - C^P) - (G - G^P). \tag{2.5}$$

Thus the current account is merely the sum of the differences between the actual and perpetual values of output and consumption.

Equation (2.5) may be made operational in a number of ways. Sachs does not discuss government spending, G^P, further, but perpetual (permanent) private consumption, C^P, is, as above, a function of wealth. It is the integral of future private income plus current assets. Thus in period 0,

$$W(0) = B(0) + \int_0^\infty e^{-r^*\gamma}[Q(\gamma) - G(\gamma)]d\gamma \tag{2.6}$$

$$= B(0) + [Q^P(0) - G^P(0)]/r^* \quad . \tag{2.7}$$

However, from the intertemporal budget constraint,

$$C^P(0) = r^*B(0) + Q^P(0) - G^P(0) = r^*W(0) \quad , \tag{2.8}$$

which merely states that perpetual consumption can just be financed from the returns to wealth. Note that wealth includes all financial and human wealth (and, if it were recognized, physical wealth).

Current consumption, C, differs from perpetual consumption according to the incentives to switch consumption between periods. Adopting a particularly simple intertemporal utility function, Sachs expresses

$$C - C^P = (\delta - r^*)W, \tag{2.9}$$

where δ is the rate of time preference.

Sach's model contains two goods, both traded. The imported good has a fixed price in terms of world currency (the numeraire), while the other, which is exported, faces a downward sloping demand curve. Its price is thus endogenous and must be substituted out of equation (2.5) by relating export demand to world trade, T, and overall supply to the labor force, L, and productivity, R. Thus, the final equation contains no explicit relative price terms.

Hence, in period 0, the current account may be written as

$$CA = (r^* - \delta)W + \alpha_1(G - G^P) + \alpha_2(T - T^P) + \alpha_3(R - R^P), \tag{2.10}$$

where all variables are measured for period 0. Imports are clearly derivable from this equation, once we have decided how to calculate the perpetual values. We shall return to this point below.

In a model similar to Sachs', Dornbusch (1983) considers the case of traded and non-traded goods. Strictly, he considers four different prices: current and future import prices and current and future domestic prices. Imports are stimulated if their current price falls relative to either current domestic prices or any future prices. Dornbusch deals with discrete time rather than continuous time, and derives conditions for the change in planned consumption between two periods. Given stationary output,

$$d \log C = \alpha_1 [r^* - \delta + \alpha_2 d\log P], \tag{2.11}$$

where α_1 depends on the degree of intertemporal substitution and α_2 on the degree of contemporaneous substitution between domestic and foreign goods, and where P is the price of imports in terms of home goods. Dornbusch does not explicitly recognize future import prices in money terms because he uses traded goods rather than money as his numeraire. Thus assets represent claims on future traded goods rather than claims on money. This approach is easily adapted to Sach's nominal framework, however, by treating r^* as the real rate of interest in terms of imports.

Both Sachs and Dornbusch assume that a country can borrow or lend unlimited amounts at an exogenously given rate of interest that is expected to remain constant forevermore. They further assume a constant rate of time preference. This condition potentially leads to some difficulty with the intertemporal budget constraint, for it appears to allow the possibility of indefinite accumulation or decumulation of assets if $r^* \neq \delta$. Two alternatives are available: first, that imperfect capital markets impose rising interest rates as borrowing increases, and, second, that the rate of time preference is an increasing function of instantaneous utility. This latter option serves to bring consumption forward in time as wealth accumulates, thus stabilizing the system. Both these approaches are adopted by Obstfeld (1982), but since neither utility nor the time preference is observable, the latter case does not look like a promising avenue for empirical research. The former, however, is potentially more promising and could

be either tacked onto our present model or used to close a model based on optimal growth paths and borrowing. (Both these alternatives are held to a later occasion.)

The models surveyed in this subsection are theoretically more appealing than the import/reserve models treated previously. However, making the intertemporal nature of the import decision explicit vastly complicates the model's empirical application. Sachs (1981) produced some simple statistics to support his basic hypothesis, but these did not constitute a proper test, and later research has, to our knowledge, yielded no empirical work at all. The reason is the difficulties involved in operationally capturing expectations and thus, in particular, in measuring wealth. These problems will be quite evident when we move to our own estimation.

III. SOME EMPIRICAL ASPECTS OF THE PROBLEM

The literature offers a choice between a theoretically ad hoc but easily applicable model and a theoretically complete but almost totally inapplicable model. The intention of this paper is to bridge that gap by producing an estimable yet theoretically sound alternative. We do so primarily by trying to operationalize the intertemporal models of Sachs and Dornbusch. However, in the course of developing our alternative, we found that many restrictive assumptions were necessary to render the system tractable. These are specified clearly below. Some consideration should be given to their acceptability, even independently of how well the equations happen to fit.

This section contains various observations about the models surveyed in the previous section, in terms of both their theoretical and empirical (data-based) specifications. It also discusses how the various features should influence the specification of our own models. The issues covered include the way in which shocks (mistaken plans) affect importing, the special assumptions adopted for the capital markets, the specification of the utility function, the significance of domestic factors in the import decision, and the incorporation of investment into the system.

Plans and Mistakes

The intertemporal models solve simultaneously for the whole time profile of consumption, given the information and expectations

available at a particular time (say, year 0). However, ignoring forward purchases, only year 0's expenditures are actually made at the time of calculation; the plans for later years remain only plans. Indeed, by year 1, it is likely that new information and expectations will have become available and that the plan will need revising. We could model the revisions explicitly, but it is easier just to view the plan devised in year 1 as an entirely new project that determines actual expenditures in year 1, and so on with new plans for years 2, 3.... Thus our empirical estimates concern the first year's expenditures in each of a series of plans, rather than a series of more than one year's expenditures from only one plan.

In this string of first years, if year 1 turns out exactly as anticipated in year 0, expenditures in year 1 will be the same under both plan 0 and plan 1. Furthermore, there will be no regrets in year 1 about what was done in year 0. If, on the other hand, year 1 contains some surprises, year 1's expenditures will be revised from those intended for it in plan 0, and there will most likely be regrets about what was actually done in year 0. That is to say, agents will feel that had they known in year 0 what they know now in year 1, they would have behaved differently in year 0. Thus, in retrospect, mistakes are possible, and they make themselves felt through their effect on the wealth carried forward from one year to the next.

If, for example, the actual interest rate on variable rate loans in year 1 were higher than had been expected for that year in year 0, developing country policy-makers may well regret that they imported and borrowed so much in year 0. They will revise consumption (import)

plans for year 1 downwards relative to those in plan 0, first because current consumption is rendered more costly relative to future consumption by the rise in the interest rate, and second because the debt overhang now has to be serviced at a higher rate than expected, a situation that reduces real wealth.

The Market for Loans

The models discussed earlier assume that developing countries can borrow or lend unlimited amounts at exogenously given rates of interest. Three dimensions of this assumption deserve comment.

First, if the rates of interest for borrowing and lending were still exogenous but were different, the budget-set of feasible consumption points would be kinked. Thus, whereas a unit reduction in present consumption would allow an increase of $(1 + r_L)$ units next year, a unit increase this year would cost $(1 + r_B)$ units next year, where $(r_B > r_L.)$ This situation would considerably complicate both the analytics and the empirics, giving rise to discontinuities in importing and borrowing behavior, without adding much insight to the model. Ignoring it may, of course, substantially bias the model, but we do not expect it to do so. A further and sounder reason for ignoring the problem is that in fact most developing countries do little lending. Thus, provided that developing countries would still not lend much, even if the borrowing and lending rates were equal, the borrowing rate is the relevant one for our purposes.

The second dimension of the borrowing/lending question is the exogeneity of the interest rate. We might expect that as a country's

indebtedness rose, so too would its risk premium and hence its borrowing rate of interest. The evidence for this pattern is, in fact, rather weak (see Riedel, 1983, and MacDonald, 1983). It could be incorporated into our model by introducing an additional (simultaneous) equation for the supply of credit. However, we will ignore this complication for now.

The third aspect of the borrowing/lending nexus also concerns the supply curve of credit. Bankers tend to argue that they ration credit quantitatively rather than through price (interest rates). Hence developing countries may face a constant rate of interest up to some level of borrowing, and thereafter a complete stop in borrowing. However, the evidence that these constraints are frequently or widely binding is also relatively weak (see Riedel, 1983). Nevertheless, we can hardly argue that credit limits were never applied in 1983, and so this problem must be addressed seriously.

Theoretically we could construct a regime-switching model, with separate equations for the periods of constrained and unconstrained borrowing. A priori, however, we do not expect to have sufficient observations on the former to identify it correctly, and there is, besides, little guidance on how lending constraints are determined. Further, if the constraint is only on current borrowing, and if we treat running down the reserves as net borrowing, then the import function under the constraint becomes particularly simple and uninteresting in its own right: 1/

1/ The intertemporal allocation becomes more complex if the constraint, or expected constraints, affect future years.

$$M = X + \bar{F} ,$$

where $\bar{F}$ = The constrained level of borrowing.

Hence, at least in this first attempt, we estimate only the "unconstrained" import function, although we are prepared to omit observations where strong evidence of borrowing constraints exists. This approach is of interest, first, to see if constraints are actually necessary in explaining recent import behavior and, second, even if they are, to define what imports would rise to if the constraints were relaxed. After examining our results, it is clear that there is plenty of scope for plenty of future research in this area.

Utility Functions

Both Sachs and Dornbusch assume utility maximization over an infinite time horizon. The general utility function is of the form

$$V = \sum_{i=0}^{\infty} (1 + \delta)^{-i} U(C_i) , \tag{3.1}$$

where V = Total utility

U = "Instantaneous" utility and

C_i = Consumption in year i.

Note that the function U() does not change over time and that V is additively separable in $U(C_i)$. The latter severely limits the pattern of intertemporal substitution and means that the composition of any year's consumption bundle is independent of any other's, once the overall levels of consumption have been determined. The degree of intertemporal substitution is determined by the curvature of U().

Basically, the more sensitive utility is to declines in consumption, the greater will be the substitution that will occur between years in order to smooth away the potential costs.

To be specific, Sachs assumes

$$V = \int_0^\infty e^{-\delta t} \log (C_t)\, dt \tag{3.2}$$

and Dornbusch

$$V = \sum_{t=0}^{\infty} (1 + \delta)^{-t} \frac{1}{1 - \Theta} C_t^{1 - \Theta}, \tag{3.3}$$

where, in both cases, C_t is a Cobb-Douglas function of the consumption of the various goods consumed in t, for example,

$$C_t = C_{Tt}^{\alpha} C_{Nt}^{(1 - \alpha)} \tag{3.4}$$

where C_T = The consumption of traded goods and

C_N = The consumption of non-traded goods.

The separability of V allows consumption to be determined in two steps -- first total consumption, C_t, as a function of wealth and annual price indices and, second, disaggregated consumption, C_{Tt}, and C_{Nt} as functions of C_t and contemporary prices.

The separability assumption is probably too strong for reality. For example, it does not permit the option of consuming, say, a world tour this year rather than next, because next year's composition of consumption is independent of this year's. Nevertheless, its practical attractions are such that we shall adopt it. The simple form

of C_t is useful in rendering the price index for total consumption a simple function of P_{Tt} and P_{Nt}, as well as in easing various algebraic manipulations. This paper is not concerned with disaggregated consumption, so the issue is postponed, although there are good reasons for believing that equation (3.4) is far too restrictive (Winters, 1984).

The Role of Internal Factors

An important difference between Hemphill's and every other study is that Hemphill derives imports solely from "foreign" variables, that is, variables relating directly to foreign transactions. This approach arises from his view that, ultimately, the only determinant of what can be spent on imports is the foreign exchange generated by exports. Thus, for example, whether imports are relatively cheap or are urgently needed for domestic growth, or are strongly desired because wealth has increased, are not, in his scheme, fundamentally important. It is as if the whole economy were a black box: the input of foreign exchange from exports and the output for imports must be balanced in the long run, and what goes on inside the box is really not very significant.

We could perhaps envision a utility function separable between domestic output and imports; given a budget constraint for imports, domestic variables do not affect the import stream. However, this view is clearly very extreme, for even within an entirely foreign-determined long-run budget, we might expect domestic factors to influence the timing of imports. Nonetheless, it is sufficiently attractive empirically to make it worth exploring. Its empirical attraction is the

smallness of its parameter set and data requirements. In particular, it might be easier to measure foreign wealth, namely, foreign assets plus the present value of future foreign exchange earnings, than total wealth, namely, total assets plus the present value of future income.

Investment

As Sachs states, investment greatly complicates the analysis of an intertemporal model, for it both represents a demand and feeds back into wealth. The simplest procedure practically is to assume that consumption and investment can be aggregated into a single composite good (absorption) by virtue of having a constant relative price. This procedure in turn assumes that the marginal productivity of investment (in terms of present value) and the rate of time preference bear a constant relationship to each other. Further, if the aggregate is to be the sum of consumption and investment (namely, absorption), the constant relationship must be equality. Thus, a unit of consumption in year 0 is worth $(1 + \delta)$ in year 1 because people are impatient; a unit of investment in year 0 is worth $(1 + \delta)$ of consumption in year 1 because it actually produces a stream of output that would buy $(1 + \delta)$ in year 1. This condition is the Keynes-Ramsey rule for optimal growth paths, and it implies that consumption and investment are in perfect equilibrium. We adopt this subterfuge in constructing our basic models, but relax it crudely when we examine the disequilibrium forms (pages 27-28).

IV. A FOREIGN MODEL OF IMPORTS

Having discussed various practical and empirical points in the previous section, we are now in a position to outline our own models. These are exploratory and are therefore fairly general, and particular emphasis is laid on exploring issues of specification. Unfortunately, many of the models we discuss are not nested, and since they are often rather similar and we have so very few observations, we do not conduct many formal non-nested tests. A certain "ad hocery" will therefore be evident.

The Foreign Wealth Model

We start with the simpler of the two models -- the foreign wealth one. It follows Hemphill's rationale and concentrates entirely on foreign variables. We assume a country in which the optimal time pattern of imports is independent of any domestic variable, which faces given import prices, and which has exogenous export receipts (strictly current account credits). In the long run, all imports must be paid for in foreign exchange derived from current credits. Thus, given initial assets, these credits define the budget constraint. The country is assumed to face a common exogenous rate of interest for borrowing and lending and to be able to borrow or lend unlimited funds at that rate. Borrowing and assets are seen merely as the means of transferring import consumption over time.

Assuming that the import sub-utility is quite separable from domestic factors and that the allocation of imports over types of goods permits two-stage budgetting, we can write:

$$V = [\sum_{i=0}^{\infty} \delta_i \hat{M}_i^{-\gamma}]^{-1/\gamma}, \tag{4.1}$$

where V = Total "import utility"

δ_i = The rate of time preference relating consumption in period i to that in period 0,

$\hat{M}_i$ = Aggregate imports in period i in quantity terms and

γ = A parameter determining the degree of intertemporal substitution.

The budget constraint that all imports must eventually be paid for is

$$\sum_{i=0}^{\infty} \rho_i \tilde{p}_i^M \hat{M}_i = A_0 + \sum_{i=0}^{\infty} \rho_i \tilde{p}_i^X X_i \ , \tag{4.2}$$

where

$\hat{P}_i^X$ = The export prices for year i,

$\hat{P}_i^M$ = The import prices for year i

X_i = Exports for year i and

ρ_i = The discount factor between years i and 0.

Thus

$$\rho_i = (1 + r_0)^{-1} (1 + r_1)^{-1} \ldots . (1 + r_{i-1})^{-1} \quad , \tag{4.3}$$

and

$$\rho_0 = 1 \ ,$$

where r_j = The interest rate for year j.

In year 0, all variables with $(i > 0)$ are unknown; they are necessarily the subject of expectations, to be discussed shortly.

If we define present value prices (for year 0) as

$$p_i = \rho_i \hat{p}_i \tag{4.4}$$

then equation (3.2) becomes,

$$\sum_{i=0}^{\infty} p_i^M \hat{M}_i = A_0 + \sum_{i=0}^{\infty} p_i^X X_i = W \tag{4.5}$$

which, combined with equation (4.1), yields a perfectly ordinary allocation model: given wealth, W, choose $\hat{M}_i$ to maximize V subject to budget set (4.5).

Equation (4.1) is a CES function, with an elasticity of substitution ($\sigma = \frac{1}{1+\gamma}$). We can apply standard results by analogy with other applications of the CES function (Armington, 1969; Hickman and Lau, 1973). Thence:

$$\hat{M}_i = \delta_i^{\sigma} V \left(\frac{p_i}{P^*}\right)^{-\sigma} = V\left[\left(\frac{p_i}{\delta_i}\right)/P^*\right]^{-\sigma}, \tag{4.6}$$

where $p_i = p_i^M$ with the superscript omitted and

P^* = A present value price index for all future consumption of imports, where

$$P^* = \left[\sum_{i=0}^{\infty} \delta_i^{\sigma} p_i^{(1-\sigma)}\right]^{\frac{1}{1-\sigma}}. \tag{4.7}$$

Obviously, for practical purposes the unobservable V must be eliminated by multiplying equation (4.6) by p_i and P^*/P^*, summing, and then substituting equation (4.7) for P^*:

$$\sum_{i=0}^{\infty} p_i \hat{M}_i = \sum_{i=0}^{\infty} \delta_i^{\sigma} (VP^*) \left(\frac{p_i}{P^*}\right)^{1-\sigma} . \tag{4.8}$$

Thus,

$$VP^* = \sum p_i \hat{M}_i = W . \tag{4.9}$$

The import plan derived from equation (4.1), given expectations about future variables, then becomes:

$$p_i \hat{M}_i = \delta_i^{\sigma} \left(\frac{p_i}{P^*}\right)^{1-\sigma} W . \tag{4.10}$$

This equation implies that if present value prices are equal in each year, imports will vary over time according to δ_i^{σ}. Since $\delta_i < \delta_{i-1}$ -- i.e., more distant imports are valued less -- they will fall over time. From equations (4.6) and (4.7) it may also be shown that if the time-discounted present value prices (p_i/δ_i) were equal, the level of imports would be constant.

Recalling that we are interested only in the first year's imports (i = 0) from a series of plans formulated in years t = 1, 2...T, equation (4.10) generates the estimating equation

$$p_t \hat{M}_t = \delta_0^{\sigma} \left(\frac{p_t}{P^*_t}\right)^{1-\sigma} W_t , \tag{4.11}$$

where the subscript t denotes variables measured in period t and where $\delta_0{}^{\sigma} = 1$.

The Rate of Time Preference

There are three problems (at least) in implementing equation (4.11). First is its non-linearity. All applications of the CES function face the problem that P*, the aggregate price index, depends on the unknown parameter σ. This problem is easily solved, however, by non-linear estimation methods or linear approximations (Hickman and Lau, 1973). Our problem is, however, much greater: it is that the δ_i are unknown.

Let the rate of time discount -- assumed to be constant both across plans and between plans — be d. The discount factor relating year i's consumption to year 0's, δ_i, is $(1 + d)^{-i}$, or, in obvious notation, δ^i. Thus, all our unknowns about time discounting can be collapsed into a single parameter δ, which appears in equation (4.7), the formula for P*. Jumping ahead, we find it convenient to characterize the present value price series as having a constant growth rate over each plan (but not between plans). Thus, for the plan formulated at t, we assume that prices in the years ahead are expected to be:

$$p_i(t) = \eta_t^i \, p_t, \tag{4.12}$$

where η_t is the rate of growth of present value prices assumed in plan t which, along with p_t, is assumed to be known exogenously. Thus, from equation (4.7),

$$P_t^{*\,1-\sigma} = \sum \delta^{i\sigma} \, \eta_t^{\,i(1-\sigma)} p_t^{\,(1-\sigma)}$$

$$= p_t^{\,1-\sigma} (1 - \delta^{\sigma} \eta_t^{\,1-\sigma})^{-1}, \tag{4.13}$$

whence equation (4.11) becomes

$$p_t \hat{M}_t = (1 - \delta^{\sigma} \eta_t^{1 - \sigma}) W_t . \tag{4.14}$$

Equation (4.14) can be estimated in a number of different forms. For example, it can be transformed into a linear equation as follows:

$$1 - \frac{p_t \hat{M}_t}{W_t} = (\frac{\delta}{\eta_t})^{\sigma} \eta_t ,$$

from which

$$\log (1 - \frac{p_t \hat{M}_t}{W_t}) = \sigma \log \delta - (1 - \sigma) \log \eta_t . \tag{4.15}$$

Whether this approach is desirable, however, depends on the nature of the error process underlying the data. The errors of the regression equation should be normally distributed, homoskedastic and mutually uncorrelated. If those of equation (4.14) were, then those of equation (4.15) certainly would not be, and vice-versa. In fact, such transformations appear to make very little difference at estimation time.

In a consumption framework, the constancy of the rate of time discount has some plausibility. However, in an investment context, the rate of discount will be related to the (expected) marginal productivity of investment, which may vary over time. As an alternative to the basic model, therefore, we consider a so-called "disequilibrium" model, in which the rate of time discount varies with investment opportunities. 1/

1/ "Disequilibrium" is perhaps not such a good nomenclature as "non-steady-state," but we prefer it on the grounds of stylistic elegance.

When the capital stock is below that required by the Keynes-Ramsey optimal growth path, the marginal return on investment and the growth rate of GDP will be relatively high, and there will be an incentive to reschedule national absorption from the future back to the present. (Consumption may be lower under these circumstances, but total absorption, of which imports form a part, will be higher.) This condition is reflected in our model by a fall in δ -- future output is given relatively lower weight. We explore this possibility by setting

$$\log \delta \simeq d_t = \mu + \Phi g_t \tag{4.16}$$

where g_t can be the growth rate of GDP, the ratio of investment to GDP or the ratio of investment to wealth. In each case we would expect $\Phi < 0$.

There is, however, a great danger of simultaneity bias in substituting equation (4.16) into (4.14) and (4.15). Investment by developing countries is often thought to depend on imports, in that if the foreign exchange does not exist to generate a flow of imported capital goods, then investment will not take place. By way of illustration, in Malaysia in 1980, imports of machinery and transport equipment were around M$9 billion (about 30 percent of imports) and total fixed capital formation was around M$15 billion. These figures counsel great caution in the use and interpretation of the disequilibrium results.

The derivation of equation (4.13) assumes that $\delta^{\sigma}\eta_t^{1-\sigma} < 1$. If this assumption were violated, it would benefit the country to import infinite amounts now and pay off the debt later with depreciated cash.

Thus, in these circumstances, the country will be constrained in its borrowing by the lenders and will fall outside the purview of our model. This situation suggests that any observation for which $\delta^{\sigma}\eta_t^{1-\sigma} \geq 1$ should be omitted from our sample. Unfortunately, however, this approach is not necessarily straightforward. Assuming $\delta < 1$ and, if, as seems reasonable, $0 \leq \sigma \leq 1$, a sufficient condition for the inequality is that $\eta_t < 1$, which in turn amounts to assuming that the real rate of interest (in import terms) is positive, that is, that import prices increase less rapidly than the rate of interest. If, however, $\eta_t > 1$, the inequality depends on the unknowns δ and σ, and so cannot be tested prior to estimation. However, to estimate δ and σ correctly, we need to know which observations to include! Short of a switching-regime model, there is no simple solution to this dilemma, and it has to be treated ad hoc.

Measuring Wealth

The second problem area concerns the measurement of wealth. Conceptually it is very simple to do: wealth constitutes owned assets plus the present value of the stream of foreign exchange receipts, less scheduled repayments on accumulated debts.

Owned assets should contain a wide range of instruments, but in practice data are available only for international reserves and the net assets of the banking system. For many developing countries, however, these data probably provide a reasonable approximation of foreign-denominated wealth. We shall assume that domestic assets are not convertible into foreign exchange, that is, that borrowing is possible

against future export earnings but not against domestic assets, a fairly strong assumption.

The present value of export earnings provides no conceptual problems, once expectations have been determined, but there is one practical difficulty. If we assume an infinite planning horizon, as above, the present value becomes infinite if the (expected) rate of growth of earnings exceeds the (expected) rate of interest. If the former is denoted by v^X and the latter by r (both assumed to be constant), the present value W_X is:

$$W_X = \sum_{i=0}^{\infty} (1 + r)^{-i} X_i = \sum_{i=0}^{\infty} \left\{\frac{1 + v^X}{1 + r}\right\}^i X_0 \quad , \tag{4.17}$$

which is clearly finite only if the bracketed term is less than one. It is not inconceivable that a country should believe itself infinitely rich, but it is inconceivable that other countries would lend it the infinite amounts it would immediately wish to borrow. Thus, whenever $v_t^X > r_t$, the borrower will be supply-constrained in the loans market, which would put it beyond our model, a situation that suggests we should drop those observations from our sample.

Two alternatives to dropping the observations exist. First, we could respecify the model in terms of an (arbitrary) finite time horizon. This procedure, while it would complicate certain formulae, would not change anything fundamental. In these circumstances, W_X would merely become very large. Second, we could argue that countries experiencing $v_t^X > r_t$ would recognize it as a temporary phenomenon and would re-adjust their expectations to reverse the inequality. (It is moot whether world income is actually bounded above.) In this case we

would merely impose some arbitrary lower limit on $(r_t - v_t^X)$, say, 0.01, and use this to calculate present value. A similar approach would be justified if we explicitly recognized uncertainty, for a risk-averse country would presumably discount future export growth, which would also reduce the long-run average v_t^X below r_t.

An additional factor that must be considered is capital grants, which are straight additions to wealth. We assume that recipients expect to receive the same nominal grants in the future as in the current year.

More complex is concessionary borrowing. While current market borrowing makes no addition to net wealth, borrowing on softer terms clearly does so. We assume that such borrowing is rationed by the donors. If a loan of C is made at concessionary interest rate $\hat{r}_i$, rather than at market rate r_i, the increment to wealth, or the grant element of the loan, GE, is:

$$GE = \sum_{i=0}^{n} \rho_i \, (R_i - \hat{R}_i), \tag{4.18}$$

where

ρ_i = The discount factor for year i at market rates,

R_i = The necessary repayment stream if r_i had ruled ($C = \sum \rho_i R_i$)

$\hat{R}_i$ = The repayment stream at rate $\hat{r}_i$ (using discount factors $\hat{\rho}_i$, $C = \sum \hat{\rho}_i \hat{R}_i$, and assuming constant repayments starting immediately are required).

If the loan is for perpetuity and the rates of interest are constant, the grant element is easily calculated as:

$$GE = \sum_{i=0}^{\infty} \rho_i \, (R_i - \hat{R}_i) = \sum_{i=0}^{\infty} \rho_i \, (r\hat{C} - rC)$$

$$= C \, (r - \hat{r}) \, (\frac{1 + r}{r}). \qquad (4.19)$$

Obviously, calculating the grant elements requires detailed information on the nature of the loan, in particular, on the repayment stream. This information is not easily available to us, but the External Debt Division of the World Bank has the data and has calculated the grant elements, assuming that r = 10 percent. The precise formula is:

$$GE = C \, (1 - \frac{\hat{r}/a}{r'}) \quad \{1 - \frac{(1 + r')^{-aG} - (1 + r')^{-aM}}{r'(aM - aG)}\} \qquad (4.20)$$

where a = The number of repayments a year,

r' = The market rate <u>per period</u>, such that $(1 + r')^a = (1 + r)$ = 1.1,

G = The grace period before repayments commence and

M = The maturity of the loan,

and where it is assumed that the disbursement is made at the end of year 0 and that the principal is repaid linearly over the time period G to M.

Current borrowing affects net wealth only to the extent that interest rates are below market rates. Past borrowing, however, affects wealth more directly, for it reduces current wealth because it must be repaid. Unfortunately, data on required future repayments at each point in time are not easily available, and an approximation is needed. The

total of outstanding debt disbursed at any time (i.e., the principal) is known. We assume that payments of interest are up to date; so that outstanding debt represents the amount that, if paid immediately, would just repay all liabilities. In other words, at market rates of interest, this total just represents the net present value of the future repayment stream. However, because concessionary borrowing does not pay market rates, we must reduce this total by the extent of the grant element. Since we do not know the dates at which current outstanding debts were taken out, we use the mean grant element over the sample period for this calculation.

Strictly speaking, the grant elements should grow with the current rate of interest: the higher current rates, the greater the benefit that a fixed concessionary rate involves, and hence the greater the excess of the value of the outstanding debt (the capital value) over the present value of the actual repayment stream. This situation again is a matter of approximation. Assuming that all loans are for perpetuity, we can calculate the implied rate of interest (taking into account grace periods) using equation (4.19), our assumed grant element and the fact that the grant elements are calculated assuming a market rate of 10 percent. The implied rate of interest suggests a repayment stream, which is then converted into a capital value at the ruling (expected) rate of interest. This capital value is then subtracted from wealth.

Non-concessionary borrowing is in principle like concessionary borrowing. We assume that it has a grant element of zero (although, in fact, borrowing is classed as non-concessionary if its grant element is below 25 percent). Thus, no adjustment to current wealth is required.

We calculate the negotiated interest on the outstanding non-concessionary debt as a weighted average of the market rate over the previous five years. For the fixed rate debt, we then use this result to calculate the capital value of future repayments. Non-concessionary debt also includes variable rate loans, however, that must be treated differently. The capital value of the principal outstanding is the principal itself if, as we assume, variable rate loans must be paid at market rates. This situation is handled simply. We also assume, however, that between the time of negotiation and the present, any excess of actual interest payments over those expected when the loan was taken out is added to the principal outstanding at the present. This condition is not reflected in the World Bank data and thus must be added in.

Our only data are one figure a year on the share of outstanding debt that is at variable rates (from the World Bank Debt Tables). From this we calculate the absolute amount at variable rates and assume that this total had been negotiated over the previous five years, with equal shares of variable interest debt in total debt in each year. Thus, given a stock of variable rate debt in year t, V_t, we calculate the amounts negotiated in year (t - i), ${}_iV_t$, where i = 1...m, as

$$ {}_iV_t = \frac{L_{t-i}}{\sum_{j=1}^{5} L_{t-j}} V_t , \qquad (4.21) $$

where L_{t-j} is total non-concessionary loans received in year (t - j). This procedure is dreadfully crude (and temporally inconsistent), but it probably meets our need to pick up major interest rate mistakes satisfactorily.

For loans negotiated in year $(t - i)$, the interest rate surprise in year $(t - i + j)$ is $(r_{t-i+j} - {}_{t-i+j}r^e_{t-i})$, where r_s is the market rate for year s and ${}_s r^e_u$ the rate in year s as expected in year u. Thus, the additional payment on these loans is ${}_iV_t\,(r_{t-i+j} - {}_{t-i+j}\,r^e_{t-i})$, which must be cumulated forward from $(t - i + j)$ to the present, t. Finally, we must sum over the five previous years in which the loans were assumed to be raised.

In calculating the burden of interest rate surprises, we make two approximations for simplicity's sake: we assume (1) that the burden arising because r_{t-i+j} exceeds the expected rate accumulates to year t at interest rate r_{t-i+j}, rather than at rates $(r_{t-i+j}, r_{t-i+j+1})\ldots$, etc.; and (2) that debtors expect to pay off their debt at their long-run expected rate (r^e_{t-i}), a constant, rather than at year-specific rates. Thus, the change in the principal outstanding in year t attributable to previous interest rate shocks is

$$\sum_{i=1}^{5} {}_iV_t \left(\sum_{j=0}^{i-1} [r_{t-i+j} - r^e_{t-i}]\,[1 + r_{t-i+j}]^{i-j} \right). \quad (4.22)$$

This treatment of variable rate loans refers only to loans that are explicitly at variable rates and ignores any fixed rate loans that were contracted with the intention of renewal. In the absence of data, we have no alternative.

These calculations use data from the World Bank's External Debt Division and thus cover only loans with maturities of one year or more. Thus, we implicitly assume that short-term borrowing has no wealth effects, i.e., it is always at a rate of interest sufficiently

close to current market rates that any revaluations may be ignored. This assumption applies not only to new loans, but also to roll-over credits with periodicities of less than one year. These are not entirely happy assumptions, but they seem unavoidable.

Observe that this treatment of grants and borrowing in the wealth calculations assumes that the loans are disbursed entirely in year 0. This assumption leads to some overstatement of the grant element if, in fact, disbursement is delayed. Beyond that small discrepancy, however, the pattern of disbursements is not important under our assumptions, since we presume that any amount of borrowing or lending may be undertaken at market rates. Thus, any given pattern of gross disbursements may be translated into the desired time pattern of expenditures just like any other foreign exchange receipt. (Indeed, in theory we could test whether developing countries are constrained in the capital markets by seeing whether, given wealth, imports respond to different disbursement patterns.)

There is, however, one set of circumstances in which our assumption of independence between the disbursement and expenditure patterns may be violated, even with perfect capital markets. Assume that a loan's disbursements are tied to expenditures on a particular project. We would expect to find a closer relationship between disbursements and imports than between commitments and imports if the project being financed (1) requires only "additional" imports, in the sense that none of them would be bought in the absence of the loan, (2) imposes a rigid time pattern for these imports, and (3) has no effect on other imports. This situation basically implies that tied loans finance projects that the borrower's government feels are not socially

profitable and hence that it would not finance out of its own borrowing. In these cases, wealth must be reduced by the extent of the disbursement, for while the repayments still represent claims on the "general fund," the loan itself does not contribute to the latter. Hence, we would need to adjust our existing measure of wealth as follows:

Restricted loan	Adjustment to measured wealth
Non-concessionary	Subtract current disbursements
Concessionary	Subtract current disbursements less the current grant elements and the present value of future grant elements
Grants	Subtract the present value of future grants.

Note that by removing the present value of anticipated grants and grant elements, we are implicitly assuming that restricted loans are not expected to be renewed.

Without a huge amount of detailed research, it is impossible to know how borrowing is distributed between these constrained and unconstrained forms. However, provided the distribution is constant over time, an adjustment to the estimating equation is feasible. Equation (4.14) becomes:

$$p_t \hat{M}_t = (1 - \delta^{\sigma} \eta_t^{1 - \sigma}) (W_t - aW_t') + aD_t \qquad (4.23)$$

where W_t' = The addition to wealth stemming from receipts of (but not repayments on) all loans and grants of the type subject to restriction,

a = The share of restricted-type loans actually subject to restriction and

D_t = Disbursements of restricted-type loans.

The constant, a, is theoretically estimable, but in practice it proved possible only to restrict it a priori. Specifically, we experimented with (a = 1) for various definitions of W_t', e.g., that all concessionary loans are subject to restriction.

If the conditions under which disbursements and imports are linked, are considered sufficiently unlikely in perfect capital markets, tests on equation (4.23) could be interpreted as tests of the hypothesis of perfect capital markets. If disbursements matter, capital markets are not perfect.

Expectations

The third problem area with equation (4.11) is the treatment of expectations. Expectations figure very prominently in the model as outlined, and clearly their measurement is a crucial consideration. However, we have little guidance as to how to proceed. Below we experiment with different approaches, so that a number of alternatives are listed.

We require very simple mechanisms for expectations, for they must be both practical and forecastable. These mechanisms usually amount to assuming a constant rate of growth for the variable concerned. We do, however, use certain exogenous information for particular years of the sample period or particular components of wealth where this seems necessary, as, for example, with expectations about oil prices.

Rational expectations are currently popular, but they do not entirely answer our needs. First, we do not have a complete model, so the expectational component cannot be substituted out. Second, while it would be convenient to assume that in each year agents had unbiased expectations of unknown variables, so that we could use actual future values as a proxy, this assumption alone does not help because we would rapidly run out of future data. That is, we could not estimate the model for say, 1980, because the prices for 1983 are not yet available. We do, however, experiment with forward-looking data, but only in conjunction with very crude extrapolative formulae.

For transaction flows, simple conservative expectations are used. The inflow of current and capital grants is expected to continue at current nominal rates, and similarly for the grant element in concessionary borrowing. The inflow of current credits is broken into a price and a quantity dimension. For the latter we experiment with both static expectations and a constant expected growth rate equal to the average of the last five years. After preliminary tests, we select the former. An exception is where exports are based on known mineral deposits, in which case expectations are roughly based on known reserves.

The price dimension is more tricky still. Initially we had intended to let the expected future growth rate of export and import prices equal <u>next</u> year's actual rate (an element of rational expectations), and the expected interest rate to equal this year's actual rate. This approach leads to fluctuations in measured wealth far greater than could be believed a priori, however. For example, on this

measure, Malaysia, one of our test countries, would have had an 80 percent decline in wealth in 1981!

Two much more conservative approaches are therefore considered. For export prices we again consider static or constant growth rate expectations, and again prefer the former. Meanwhile, the interest rate is fixed exogenously either at a nominal 10 percent -- the rate the World Bank uses in assessing grant elements -- or at a real 2.5 percent in the long run. In the former case, 10 percent is used for all years, including the current one; in the latter case, the nominal rate is assumed to take three equal annual steps in moving from its current level to $(2.5 + \dot{p}^M)$, where $\dot{p}^M$ is the expected long-run change in import prices. The resulting interest rate profile is then averaged to get a single expected rate, the latter being that constant interest rate yielding the same net present value for a constant nominal income stream to infinity as the (assumed) variable rate would (see equation [2.3]).

The expected import price series is calculated by assuming that, from three years hence, import prices will grow at their average rate over the last five years. Until then, the growth rate for import prices is assumed to take three equal annual steps from the current level to that long-run level.

These procedures are very mechanistic and are imposed a priori. As an alternative, we experiment with an empirical approach, postulating that, ceteris paribus, a higher rate of investment indicates a more optimistic view of the future and thus higher perceived wealth. As a crude measure of this alternative, we consider replacing wealth, W, in some of the equations above by

$$(\mu' + \Phi' g_t + W_t), \tag{4.24}$$

where g_t is the investment/GDP ratio or the investment/wealth ratio. Empirically, this equation is rather close to the disequilibrium models discussed on pages 27-28, and in the estimation we treat equations using (4.24) as further disequilibrium models. (It is to try to distinguish the two families of disequilibrium models better that we use equation [4.24] rather than the more natural $[\mu' + \Phi' g_t]W_t$.)

Interest Rates

The model as outlined contains a single interest rate at which countries are assumed both to borrow and lend. This rate should be the rate on marginal transactions, and assuming that concessionary loans are rationed by the donors regardless of the borrowing aspirations of recipients, the marginal transactions will normally be with private financial institutions. We experiment with two possible rates: first, the rate on a country's own long-term borrowing from foreign financial institutions, and, second, the 12-month LIBOR (or an approximation of it for earlier years). The former captures the country risk premium and so may be somewhat endogenous, whereas the latter, while exogenous, may lack relevance, given that most countries borrow rather than lend and do so at varying premia above LIBOR.

Dynamics

The equations as specified above are entirely static. In the real world, there is at least some chance that an adjustment in the directions postulated takes time. Thus, we should consider the

possibility of a lagged adjustment. Given our very small sample of observations (see below), doing so is possible only for the simple forms of the models and for very simple dynamics. In general, the approach is to include only a lagged dependent variable (a partial adjustment model), but in certain cases more general forms are feasible. For example, if $\delta \simeq 1$ in equation (4.14), the following equation is estimable (where M replaces $p^M\hat{M}$ for notational convenience):

$$M = \alpha W + \beta M_{-1} + \gamma W_{-1} . \tag{4.25}$$

Linear restrictions of this equation make the following models testable: a static form $(\beta = \gamma = 0)$, a first difference form $(\beta = 1, \gamma = -\alpha)$, a partial adjustment form $(\gamma = 0)$, and a "catch-up" or serial correlation model $(\gamma = -\alpha\beta)$.

In the course of early empirical experiments, there is some evidence of heteroskedasticity in the residuals of equations such as (4.14), with the error variance growing over time. We therefore experiment by deflating the whole of the estimation equation by current import prices. This alternative reduces the heteroskedasticity, but it also suggests that we should perhaps consider the dynamics of "real" imports. Thus, for example, if we deflate equation (4.25) by current prices, and let $\alpha = 0$, we would have:

$$\frac{M_t}{p_t^M} = \alpha' \frac{W_t}{p_t^M} + \beta' \frac{M_{t-1}}{p_t^M}.$$

However, a natural alternative would be to consider the adjustment of $({}^M/_p M)$ to itself lagged, viz.,

$$\frac{M_t}{P_t^M} = \alpha \frac{W_t}{P_t^M} + \beta \frac{M_{t-1}}{P_{t-1}^M} . \tag{4.26}$$

This approach has considerable intuitive appeal — it is, after all, the adjustment of the quantity of imports that is painful and costly -- and it also allows direct comparison with "traditional" equations, which are usually specified in real terms (see below).

Most of the following estimation makes use of the lagged dependent variable to add a dynamic element to our models.

V. THE DOMESTIC MODEL

The second of our models, the domestic one, is a development of the first. Whereas in the first, following Hemphill, we consider only the import sector, in the second we extend the analysis to the domestic economy, following Sachs and Dornbusch. The extension is straightforward, at least in a formal sense. However, two new sets of problems present themselves: first, how to incorporate the macroeconomic balances and, second, what units to work in.

Sachs' Model

Sachs' model, which is built around the national accounting identity, distinguishes two goods and uses world money as the numeraire. As noted, the import good has a fixed world price, while the export good faces a downward sloping demand curve. Its price does not appear explicitly, however, as it is substituted out by factors determining the supply and demand for exports. (Sachs has a very simple model of exports, with unit elastic demand and a single factor exponential supply function). The resulting basic equation (based on equation [2.10] is:

$$CA_t = f(W_t) + \alpha_1 (G - G^P) + \alpha_2 (T - T^P) + \alpha_3 (R - R^P), \quad (5.1)$$

which expresses the current account as a function of wealth, plus the deviations from "perpetuity values" of government expenditures, world demand and productivity. For our purposes, we assume that all adjustment on the current account occurs through imports, with exports

and factor payments taken as predetermined. Thus, equation (5.1) can be treated as an import function.

The estimation of the perpetuity values of G,T and R is problematical, in that they refer to perpetuity values as perceived at time t. Thus expectations are involved. As a first pass, however, we take them as trend lines through their respective samples of observations.

Sachs assumes that government expenditure is exogenous and that investment is determined by the wealth function as part of private absorption. (He ignores the feedback from investment to output, as do we). Both assumptions are somewhat suspect: governments may well restrict their expenditures with a view to the current account, while the dichotomy between savers and investors may cause investment to have an exogenous component. Thus the term $(G - G^P)$ may be displaced by $(I - I^P)$ or dropped entirely from equation (5.1), with corresponding adjustments to the definition of wealth.

Sachs also implicitly assumes that all wealth is owned privately rather than publicly. Thus, the permanent value of private consumption C^P equals $r*W$. This view arises from the assumptions that the government finances its exogenous expenditures that contribute nothing to utility from either current or future taxation, and that future taxation is perfectly foreseen by the private sector and is capitalized into its estimate of wealth. It seems equally plausible, however, to assume that the government has some claim on wealth, a view that reinforces the argument for combining public and private consumption into the same process by dropping $(G - G^P)$ and redefining wealth.

Similarly, the terms $(T - T^P)$ and $(R - R^P)$ are under threat. They appear in the equation by virtue of Sachs' simple model of exports and output. As we are not committed to this model, we work directly with deviations in output.

The final component of equation (5.1) is the wealth function. It is similar to the functions developed for the previous model but has some additional features. Consumption is related to total private wealth. Given that spot estimates of wealth are notoriously scarce and unreliable, the best definition appears to be reserves plus the grant and borrowing terms described earlier plus the present value of the expected stream of GNP net of government expenditures. This definition includes, inter alia, all human and physical wealth and current income from abroad. We assume constant expected growth rates for real GNP and the appropriate deflator, with the former rate generally set equal to zero.

The estimating equation based on Sachs' model is thus

$$p_t\tilde{M}_t = - CA_t + p_t^X X_t - IPD_t$$

or

$$(p_t^X X_t - IPD_t - p_t\tilde{M}_t) = (1 - \delta^\sigma \eta_t^{1 - \sigma})\, W_t - \alpha_1(G - G^P) - \alpha_2(T - T^P) - \alpha_3(R - R^P) \qquad (5.2)$$

where IPD_t = The flow of interest abroad.

The functional form of the wealth component has been taken from equations (4.1)-(4.15), but with consumption replacing imports and a broader definition of wealth.

Dornbusch's Model

An alternative approach to the domestic model is Dornbusch's (1983). He assumes a traded/non-traded dichotomy and uses traded goods as his numeraire. He also assumes only a single component of demand (called consumption), so that his macrobalances are particularly simple. He finds the relative price of traded and non-traded goods a significant factor in the overall demand for consumption.

We need to make slight adjustments to Dornbusch's model to permit us to work in a money metric -- essentially, we define the interest rate in real terms relative to (expected) import prices. Thereafter, combining the model with the macroeconomic balance equation generates an import function

$$M = \hat{C} - GNP + IPD + X. \tag{5.3}$$

That is, imports equal "total consumption" less GDP plus interest payments and exports, all measured in foreign prices. With $\hat{C}$ covering all expenditures, wealth has to include the present value of total future GNP. It is possible to adapt equation (5.3) to allow for other elements of macro-imbalance along the lines of (5.1); for example, we could remove government expenditures from the accumulated values of GNP in the calculation of wealth and include $(G - G^P)$ directly in the equation.

Again, the formalities of the wealth explanation of consumption may be taken from above, but with the price term altered to reflect relative import and domestic prices.

A more direct approach to Dornbusch's model is to exploit its intertemporal separability, using wealth to determine total absorption,

but then using current variables alone to explain the allocation of the latter between imports and domestic goods. In fact, Dornbusch has a Cobb-Douglas function for this division, so that imports claim a constant share of absorption. We have chosen to generalize the model slightly, using a CES function. Thus, given the value of absorption, A, from the wealth calculation,

$$p_t^M \tilde{M}_t = \alpha \left(\frac{p^M}{\hat{P}}\right)_t^{\beta} (\hat{P}_t A_t), \tag{5.4}$$

where $\hat{P}_t$ = The aggregate price index for year t,

$$\hat{P}_t = (p_t^M)^{\alpha} (p_t^D)^{1 - \alpha}, \tag{5.5}$$

and where α may be calculated as $(p^M \tilde{M}/\hat{P}A)$ in the base year of the index numbers, year 0. Using an equivalent of equation (4.15) to determine $\hat{P}_t A_t$ -- current absorption — and manipulating so as to reach the equivalent of (4.15), we get

$$p_t \tilde{M}_t = \alpha \left(\frac{p^M}{\hat{P}}\right)^{\beta} (1 - \delta^{\sigma} \hat{\eta}_t^{1 - \sigma}) W_t, \tag{5.6}$$

where $\hat{\eta}_t$ = The deflator for total absorption.

For both the Sachs and Dornbusch formulations, lagged dependent variables are included at estimation time to allow some element of dynamic adjustment.

VI. SPECIFICATION TESTS OF THE FOREIGN WEALTH MODEL

There are two components to the empirical application of a model. The first is to try to identify the correct model, while the second, having done so, is to get the best possible estimate of it. The former concerns hypothesis testing, the latter does not.

In the present paper, we distinguish these operations carefully. In this section, we explore the various specifications of the models discussed above -- comparing, for example, different formulations of expectations and different treatments of potentially restricted loans. From these experiments we derive preferred specifications of the two models -- foreign and domestic -- in their two forms -- equilibrium and disequilibrium. In the second set of tests, described in the next section, we compare these models between themselves and with two simple alternative models: Hemphill's equation (2.1) and a traditional equation relating imports to GDP and relative import and domestic prices. These comparisons yield a generally preferred model of imports.

It should be emphasized at this stage that all our tests are of composite hypotheses comprising, first, the truth of the model concerned and, second, our ability to measure the concepts accurately. This observation is, of course, true of all applied economics, but it is particularly relevant here, given the manifest problems of measurement. However, applied economics does require operational models. Hence, while it may be philosophically feasible to claim that rejections of a particular model arise from its measurement problems, rather than from

its theoretical shortcomings, it is not practically very useful, at least until equally plausible alternative measures have been discovered.

This section starts by considering the sample data and the estimation methods adopted. It then specifies more precisely the nature of our general tests of specification. These involve estimating alternative models under a series of different assumptions and attempting to draw from the results some broadly consistent conclusions about the types of models that were introduced before. Specifically, we seek strong evidence to reject the null hypothesis that the intertemporal approach to imports is useful. The restrictions of the null hypothesis we test are that all components of wealth affect imports equally and that neither the pattern of disbursements of loans nor the stock of outstanding debt affects imports. Additionally, we seek information about the best interest rate to use. The three countries used in these experiments show a strong degree of uniformity in their conclusions on these issues.

The Sample

The preliminary experiments are conducted on three developing countries chosen at random in a stratified sample. The wealth model, with its assumption of unrestricted borrowing, is likely to be more applicable to middle-income than to low-income developing countries. Within that sub-set we seek countries from three different continents, with at least one oil-exporting and one oil-importing country. Finally, the countries chosen have to meet certain minimal conditions of data availability. (We diplomatically ignore the question of data

quality.) The three countries chosen are, in the order in which they are tested, Malaysia, Colombia and Kenya.

Details of the raw data are given in the Appendix 1. Briefly, however, they cover 1965-82 annually, although for several variables earlier data are also required. The principal sources are International Financial Statistics Yearbook, (1983), Balance of Payments Statistics and the World Bank Debt System. In a few cases, interpolations or extrapolations are required, as noted below. It seems desirable to stretch the sample data as far as possible in both directions in time, given the heavy load they have to bear; even so, our 18 observations is embarrassingly small, especially for the asymptotic test we apply below. Ideally, the models should be tested by their predictions of imports for 1983, as the fierce reductions in imports in that year were almost universally attributed to financial stringency. Unfortunately, however, the data are not yet available for such an acid test.

All the calculations in this section have been conducted using TROLL on the World Bank's IBM 3083 computer. (Many tests, as well as all the data preparation, have been carried out by Kathi Yu, to whom I am most grateful.)

The Estimation

All the models in this section are estimated by single equation least squares methods. Given the small samples, more sophisticated approaches are probably not warranted. There is, however, one potentially serious problem that deserves mention and for the illumination of which we are indebted to Professor Jonathan Eaton. We assume the exogeneity of export earnings in foreign currency terms. If

this assumption is correct, the only role that import prices play in our models is the intertemporal one explored in detail above. If, on the other hand, export revenues are endogenous, this condition involves a simultaneity bias in our estimates, for we omit a second role of import prices -- that of influencing the overall levels (present values) of exports and imports. Under these circumstances, the direction of the bias depends on whether the country is on the elastic or the inelastic segment of its offer curve. If expenditures on imports (and hence the required export revenue) fall as import prices rise, then the coefficient on import prices in our equation will overstate the degree of intertemporal substitution ($\hat{\sigma}$ will exceed σ). Alternatively, if import expenditures rise with import prices, the degree of intertemporal substitution will be understated. 1/

It is difficult to know, a priori, the direction of these biases, but their possible existence should be borne in mind in interpreting the results below. We choose not to allow for them formally in the estimation because of the complexity of modelling exports and imports simultaneously (especially intertemporally), and the fact that, with small samples, ordinary or non-linear least squares are often felt to be at least as efficient as simultaneous estimation methods, in a mean squared error sense.

1/ These biases are derived from a simple log-linear version of equation (4.11). The non-linear forms are more complex, but the result probably can be generalized.

The Tests

Each country is subjected to the same battery of specification tests. We first explore whether all components of wealth have the same impact on imports. Wealth is defined precisely in the earlier discussion as assets plus the net present value of exports, grants and the grant element of concessionary borrowing, plus the (negative) effects of repayments on past loans. In theory, each component has the same impact on imports. Thus a preliminary test that can provide a rejection of the maintained model is to look for evidence that the components have markedly different effects.

These wealth definition tests are conducted by starting with a restricted definition of wealth and progressively testing whether the addition of further components satisfies the null hypothesis. Four components of wealth are considered:

(1) Net present value of exports

(2) Foreign assets

(3) Net present value of grants and grant elements and

(4) Repayments.

They are tested in this order and also with the last two items reversed.

The test equation, derived from (4.14), was:

$$M_t = (1 - \delta^{\sigma}\eta_t^{1 - \sigma})\,({}_iW_t + \beta_{(i + 1)}\hat{W}_t) \qquad (6.1)$$

where M_t = The value of imports (previously denoted $p_t^M\hat{M}_t$)

δ = The (unknown) rate of time discounting

η_t = The rate of growth of discounted future import prices

${}_i\hat{W}_t$ = The ith component of wealth (e.g., assets or grants) and

${}_iW_t$ = The ith wealth concept $= \sum_{j=1}^{i} {}_j\hat{W}_t$.

The test comprises seeing whether $\beta = 1$. Similar tests are conducted on the share version of equations (4.14) and (4.15) — and a linearization of (4.14), but in fact neither yields additional information.

The next tests concern the possibility that certain loans are restricted in their timing, such that imports and disbursements are coincidental. As noted above, this procedure is largely a test of the perfect capital markets hypothesis. The test equation is (4.23), but there appears to be insufficient sample information to estimate a, so that the constraint (a = 1) is imposed. The model is tested, as written, in share and in linear form, but, again, the last two are quite consistent with the first. These tests are referred to below as the restriction tests.

Both sets of tests are conducted in real and nominal terms and for five different interest rates: the actual rate for the country, LIBOR, an "expected rate" based on the actual rates (see page 39), the same based on LIBOR, and 10 percent. In addition, various tests are conducted using 10 percent as the rate in defining wealth, but an actual rate in defining future discounted prices. This process might reflect a conservatism in assessing wealth (risk aversion) that is not reflected in intertemporal allocations. The restriction tests are also conducted with a lagged dependent variable to allow for evident dynamic mis-specification.

The comparisons among wealth definitions, loan restrictions and interest rates are made in terms of residual sums of squares, error whiteness and plausibility. At least in the wealth definition and restriction tests, we are seeking strong evidence of a rejection of our null hypothesis that total wealth with no restrictions is the correct way to proceed. Thus, formal non-nested procedures do not seem warranted, given the small sample, the large range of tests and the similarity of the alternatives.

A typical set of results from the wealth definition tests is given in Table 6.1. While these are based on a constant 10 percent rate of interest -- our preferred measure (see below) -- the results for the other interest rates and functional forms are very similar. There is clearly some tendency for different elements of wealth to affect imports differently, but except for Malaysia and foreign assets in Colombia and Kenya, this tendency is not particularly marked. Owned assets appear to stimulate imports more strongly than other elements of wealth; this result may reflect their role as collateral for additional borrowing ("banks only lend to people who don't need money"), in which case our capital market assumptions are violated. Grants appear precisely as do other components of wealth, while repayments have different effects in different countries. In Malaysia, higher repayments (a negative component of wealth) curtail imports strongly, while in Colombia they are (insignificantly) associated with higher imports.

Table 6.1: WEALTH DEFINITION TESTS (r = 10 percent) a/

Wealth measure (W)	Additional wealth component ($\hat{W}$)	Malaysia $\hat{\beta}$	Malaysia (s.e.)b/	Colombia $\hat{\beta}$	Colombia (s.e.)b/	Kenya $\hat{\beta}$	Kenya (s.e.)b/
(1) NPV of exports	(2) Assets	56.28 c/	(3.12)	2.73 c/	(0.76)	11.64c/	(2.27)
(1) + (2)	(3) Grants	1.43	(3.47)	1.43	(1.86)	0.92	(0.38)
(1) + (2) + (3)	(4) Repayments	27.32 c/	(3.37)	-1.25	(2.93)	1.51	(1.70)
(1) + (2)	(4) Repayments	27.26 c/	(3.38)	-2.84	(3.04)	-0.34	(1.98)
(1) + (2) + (4)	(3) Grants	1.36	(3.55)	1.99	(3.13)	1.96	(0.37)

a/ For definitions of wealth, see page 53.

b/ s.e. denotes the standard error of $\hat{\beta}$.

c/ Denotes that β differs significantly from unity at 5 percent.

Note: The estimating equation is:

$$M_t = (1 - \delta^{\sigma}\eta_t^{1 - \sigma}) \; ({}_iW_t + \beta_{(i + 1)}\hat{W}_t).$$

The restriction tests also generate somewhat mixed results, with occasional improvements in fit from treating some loans directly. Table 6.2 presents a typical set of results. As before, the conclusions are quite robust with respect to changes in interest rates, functional form, and dynamic specification. The only consistent pattern in these tests is for Colombia, where it generally appears preferable to have

Table 6.2: RESTRICTION TESTS (r = 10 percent) a/

Loans restricted (D)	Standard error of the equation		
	Malaysia	Colombia	Kenya
None	383	203	110
Non-concessionary	486	194	117
Grants and concessionary	399	205	124
Grants, concessionary and non-concessionary	491	200	130

a/ The estimating equation is:

$$M_t = (1 - \delta^{\sigma} \eta_t^{1 - \sigma}) (W_t - W'_t) + D_t + \gamma M_{t-1}.$$

See pages 36-38 for an explanation.

non-concessionary loans entering directly. Since the resulting improvement in fit is very slight, however, and since non-concessionary borrowing seems, a priori, the flow least likely to be subject to timing restrictions, this outcome does not constitute a convincing rejection of our postulated model. Thus we would conclude that any loans that are actually restricted do not increase the overall level of imports and are compensated for by changes in unrestricted or commercial borrowing. This interpretation is consistent with our perfect capital markets hypothesis.

The next issue to be decided is the interest rate to be used. The two batches of tests above were conducted on all the interest rates and combinations mentioned above, and certain other equations that are introduced below were also estimated with different interest rates to check whether subsequent specification tests might affect the choice of

rates. Thus, we have a considerable number of observations (not, of course, all mutually independent) with which to make the choice. Table 6.3 presents some typical results: the standard errors of the regressions from equation (4.14) estimated with a lagged dependent variable.

Table 6.3: THE EFFECTS OF DIFFERENT INTEREST RATES a/

Interest rate	Standard error of the equation ($ million)		
	Malaysia	Colombia	Kenya
Actual national	664	304	158
"Expected" national	703	308	131
LIBOR	660	304	276
"Expected" LIBOR	674	339	166
10%	383	203	110
10% and national	361	200	115
10% and LIBOR	356	206	120

a/ The estimating equation is:

$$M_t = (1 - \delta^{\sigma} \eta_t^{1 - \sigma}) W_t + \gamma M_{t-1}.$$

See page 27 for an explanation.

It is very clear from this table that the simple 10 percent interest rate dominates the others, at least for the calculation of wealth. The reason is partly that the actual interest rates cause the wealth estimates to fluctuate unrealistically: for example, with no changes in actual flows, cutting the interest rate from 10 percent to 8

percent increases wealth by around 20 percent. Almost certainly, national authorities would discount such fluctuations in estimating their wealth, although, curiously, our dampened interest rate series (the "expected" rates in Table 6.3) do not improve matters for two out of three countries. (The hypothesis that dampening occurs is supported by the fact that the difference between using actual and constant interest rates to calculate wealth is emphasized in the absence of the lagged dependent variable.)

The preference for a constant rate of interest casts some doubt on our composite hypothesis that the wealth model is correct and that we can adequately measure wealth and expectations. This is partly because it is difficult to believe that countries actually reckoned their wealth over 1965-80 using a constant nominal interest rate, but also partly using a constant interest rate takes the model a long way toward being observationally equivalent to a model relating imports to foreign exchange receipts. For example, if we measure wealth, W, as exports, X, plus grants, G, and assets, A, less repayments, R, then

$$W = \frac{X}{\bar{r}} + \frac{G}{\bar{r}} + A - \frac{R}{\bar{r}},$$

and

$$M = (1 + \alpha\eta^{\beta})W = \mu(\eta)W = \frac{\mu(\eta)}{\bar{r}}(X + G + \bar{r}A) - \frac{\mu(\eta)}{\bar{r}}R.$$

If $\bar{r}A$ approximates interest receipts on reserves, only the dependence of $\mu(\ )$ on η and the treatment of repayments identifies the wealth model from one in which imports are proportionate to current receipts.

In a final set of ad hoc specification tests, we consider including in the basic equation the variables reflecting the stock of indebtedness. The latter are important because they offer another fairly direct test of the null hypothesis that net wealth determines imports. Under the null hypothesis, stocks of indebtness matter only for their influence on net wealth (which enters via $\overline{W}$), but under many reasonable alternatives, they are crucial in determining both a country's willingness and its ability to borrow. Significant stock effects are, therefore, bad news for the wealth model. Three variables are considered: total debt outstanding and disbursed, DOD, DOD relative to wealth, and DOD relative to GDP. For lack of data, only the medium- and long-term official borrowing reported to the Bank can be included in these measures. In no case and for no country are the stock of debt variables significant.

The general specification tests have not been described in great detail, but the overall tenor of the results is accurately represented in the discussion above. There is no doubt about the empirical advantages of assuming a constant 10 percent nominal rate of interest, and no question of significant stock of debt effects (other than those embodied in the wealth estimate). On the other hand, the wealth definition tests do suggest that owned assets may affect imports differently from other components of wealth, and the restriction tests do raise some questions about the perfect capital markets hypothesis.

Overall, therefore, the basic foreign wealth model emerges for these tests with at least some credibility: while there certainly are some remaining questions about its relevance that require further

investigation, it survives the initial tests well enough to warrant continuing the present exercise by pitching it against some of the alternative theories of developing countries' imports.

VII. PREFERRED EQUATIONS FOR THE FOREIGN WEALTH MODEL

We turn now to the refinement of the general foreign wealth model into a preferred form for each country. This exercise involves a few remaining hypothesis tests and then the estimation of our final equations. In later sections, these equations are compared with the preferred equations from other models.

In comparing models, a strong case can be made for comparing the equations before any data-directed simplification has occurred, that is, for comparing the estimate of the a priori specifications. For several reasons, however, we choose to carry out a little further refinement (hypothesis testing). First, in some cases our theory is far from definite about whether a variable should be included. With small samples, carrying extraneous variables has a high cost in terms of efficiency, and in these cases, if the data do not reject the hypothesis that a coefficient is zero, we impose it. Second, the ultimate objective of this exercise is to produce equations for simulation, an objective that requires plausible parameter values. Thus we must be prepared to override certain implausible estimates. To be sure, when doing so involves imposing statistically significant constraints, we should return to the theory to discover why, but until we have done so, it seems reasonable to impose plausibility on an existing model. This is particularly so when several models are being compared: it is useful to know if model A plus any necessary plausibility constraints dominates model B plus its constraints. (Simulation models are used to make many conditional forecasts, and it is in order that these bear sensible relationships to each other that plausibility is required. If we were

making a single unconditional forecast, the case for overriding statistical results with prior views would be much weaker.)

The criteria used to determine the preferred equations are fit, plausibility and error whiteness. In the discussion that follows, we quote for each country the initial dynamic estimate of equation (4.14) and describe the path of inference followed. In particular, we highlight and justify any circumstances in which our decisions may be thought contentious. While a degree of judgment is occasionally necessary, we do not believe that other researchers would reach fundamentally different conclusions.

The preferred equations for the foreign wealth models are reported as equations (1) to (4) in Tables 7.1, 7.2 and 7.3. The tables use the notation developed above for the variables and report several summary statistics: R^2, Durbin's h or the Durbin-Watson statistic, the standard error of the regression, SER, and the residual sum of squares, SSR, in the units of reported equations, and, finally, the SER and SSR in terms of the nominal value of imports.

Malaysia

Among the most consistent features of the preliminary results for Malaysia are the smallness and complete insignificance of the coefficient of intertemporal prices, η.

$$M_t = (1 - \underset{(.006)}{0.955}\,\eta_t^{\underset{(0.60)}{0.011}})\, W_t + \underset{(.073)}{0.625}\, M_{t-1} \qquad (7.1)$$

$R^2 = 0.998$ Standard error = 382.8

$h = 0.86$ $SSR/10^6 = 2.1979$

The insignificance of discounted prices, η, implies that σ, the intertemporal elasticity of substitution, is not signficantly different from one, which in turn means that a Cobb-Douglas intertemporal utility function is consistent with the data. This result suggests greater intertemporal substitution than we expected a priori, but the result is strong and consistent. Imposing ($\sigma = 1$) reduces the standard error of the equation and allows us to use the linear model including only W and M as the basis for the tests of dynamic specification (see equation [4.25]). No equation dominates that involving only wealth and lagged imports, and so the preferred foreign wealth equation is (7.1.1) in Table 7.1.

We next consider the disequilibrium models, but still in nominal terms. While relating either the rate of time discount or the estimate of wealth to the growth rate of GDP yields no significant improvements, relating them to investment proves most useful statistically. Of the two ratios we try, investment relative to wealth is preferable, with a standard error of the equation, SER, of about 20 percent below that from investment relative to GDP. Of the two models, relating the rate of time discount to investment (equation 4.16) dominates relating wealth to investment (equation 4.24) by a similar amount. In the preferred equation (7.1.3 of Table 7.1), a dollar's investment generates $0.93 of imports, and the hypothesis that the relationship is one-for-one cannot be rejected. Looked at alternatively, a rise in the investment/wealth ratio of 10 percent from its mean of 0.0415 to 0.0457 is associated with a rise in the rate of time discount from 6.5 percent to 7.0 percent. It is clear that this model is a substantial improvement in terms of fit over the equilibrium

Table 7.1: PREFERRED EQUATIONS FOR MALAYSIA a/

		R^2 h or [DW]	SER SSR/10^6	Nominal SER SSR/10^6
FOREIGN WEALTH				
(7.1.1) Nominal	$M = 0.041\ WF + 0.626\ M_{-1}$ (.005) (.071)	0.998 0.96		371.0 2.2001
(7.1.2) Real	$\frac{M}{P^M} = 0.029\ \frac{WF}{P^M} + 0.707\ \left(\frac{M}{P^M}\right)_{-1}$ (.008) (.104)	0.997 0.83	501.4 4.0226	400.5 2.5662
FOREIGN DISEQUILIBRIUM				
(7.1.3) Nominal	$M = (0.023 + .927 * \frac{I}{WF}) * WF + 0.260\ M_{-1}$ (.004) (.149) (.070)	0.999 -0.93		201.6 .6094
(7.1.4) Real	$\frac{M}{P^M} = (0.023 + .483\ \frac{I}{WF}) * \frac{WF}{P^M} + .513\ \left(\frac{M}{P^M}\right)_{-1}$ (.006) (.136) (.093)	1.000 0.64	362.3 1.9689	260.5 1.0176
DOMESTIC WEALTH				
(7.1.5) Nominal	$\log M = -4.327 + \log WD + 0.154 \log M_{-1}$ (.179) (.022)	0.993 1.07	0.079 0.100 b/	501.0 4.3000
Real	No plausible equation			
DOMESTIC DISEQUILIBRIUM				
(7.1.7) Nominal	$M = 0.569\ [1 - (.980 - 2.038\ \frac{I}{WD})] * WD + 0.181\ M_{-1}$ (.004) (.285) (.086)	0.999 0.00		251.8 .9511
Real	No plausible equation			
TRADITIONAL				
(7.1.9) Nominal	$M = 417.7 + 0.315\ GDP - 27.79\ \frac{P^M}{P^{GDP}} + 0.593\ M_{-1}$ (774.6) (.043) (22.01) (.084)	0.995 -0.05		392.4 2.1560
(7.1.10) Real	$\frac{M}{P^M} = 2148.2 + 0.312\ \frac{GDP}{P^{GDP}} - 99.31\ \frac{P^M}{P^{GDP}} + 0.674\ \left(\frac{M}{P^M}\right)_{-1}$ (827.1) (.070) (29.08) (.128)	0.984 -1.05	446.5 2.7915	275.1 1.0594
HEMPHILL				
(7.1.11) Nominal	$M = 76.31 + 0.424\ R' + 0.454\ F + 0.334\ M_{-1}$ (145.1) (.196) (.087) (.090)	0.997 0.85		295.8 1.2250
(7.1.12) Real	$\frac{M}{P^M} = -23.25\ \frac{1}{P^M} + 0.145\ \frac{R'}{P^M} + 0.405\ \frac{F}{P^M} + 0.536\ \left(\frac{M}{P^M}\right)_{-1}$ (71.76) (.133) (.079) (.106)	0.999 -0.42	375.9 1.9788	266.5 0.9946

a/ M = Nominal Imports; P^M = Price of Imports; WF = "Foreign Wealth" (i.e. net present value of foreign exchange receipts + assets); I = Investment; WD = "Domestic Wealth" (i.e. net present value of GNP and assets); GDP = Nominal GDP; P^{GDP} = GDP Deflator; R = Level of Reserves, F = Foreign Exchange Receipts; η = Growth rate of present value prices.

b/ Not divided by 10^6.

version of the foreign wealth model. As observed above, however, there are probably more grounds to fear simultaneity bias here than in any of the other models considered in this paper.

The final tests concern the explanation of real imports. As discussed above, imports and wealth are both deflated by current import prices, but lagged imports are considered deflated by either current or lagged prices. The latter proves superior. The specification tests are repeated starting from an estimate of the real equivalent of equation (7.1). Exactly the same conclusions emerge. The resulting equation is (7.1.2) in Table 7.1. It implies slightly larger errors in nominal import predictions than does the nominal equation, which minimizes those errors directly. (The nominal errors from equation [7.1.2] are merely those in real imports multiplied by p^M, which is assumed to be exogenous.) The estimation in real terms reduces the heteroskedasticity, but from inspection it appears that the errors are still substantially larger over the period 1975-82 than prior to 1972. The largest errors affect 1973-75, which is hardly suprising: eighteen observations are too few for conducting a formal test of heteroskedasticity, and as yet no allowance has been made for it in the estimation. It is an obvious area for future research.

The disequilibrium analysis of real imports also mirrors its nominal counterpart closely. Again, the investment/wealth ratio proves the most effective of the disequilibrium terms, and, again, it is best seen as modifying the rate of time discounting. Its numerical effect is substantially reduced, however, by the real transformation, with only half of any extra investment showing up as imports.

Colombia

In most respects the results for the Colombian foreign wealth model are very similar to those for Malaysia. Intertemporal substitution seems relatively strong ($\sigma \approx 1$) and lagged imports highly significant. Thus,

$$M_t = (1 - \underset{(.010)}{0.935}\,\eta_t^{\underset{(.124)}{-0.084}})\, W_t + \underset{(.093)}{0.610}\, M_{t-1} \qquad (7.2)$$

$R^2 = 0.996$ Standard error = 203.1

$h = -1.29$ $SSR/10^6 = 0.6189$

When the intertemporal price effect is eliminated, the result is the preferred equation, (7.2.1), of Table 7.2. In this case, however, there is nothing to choose between the dynamic linear equation embodying serial correlation (SER = 195.3) and that embodying just a lagged dependent variable (SER = 200.0). For simplicity, we choose the latter. In real terms, these results are repeated, resulting in the preferred real equation (7.2.2).

Again mirroring Malaysia, investment relative to wealth proves to be the best disequilibrium variable, but here it is preferable to use it as a factor in the estimate of wealth (equation [4.24]), rather than using it as part of the discount rate (equation [4.16]). The resulting equations, nominal and real, appear as (7.2.3) and (7.2.4), respectively. For nominal imports, the two additional disequilibrium variables are not statistically significant at 5 percent (with an F-statistic of 2.19 compared with a critical value of 3.64), but for real imports they are (F = 5.04). Observe, however, that in terms of

Table 7.2: PREFERRED EQUATIONS FOR COLOMBIA

		R^2 h or [DW]	SER SSR/10^6	Nominal SER SSR/10^6
FOREIGN WEALTH				
(7.2.1) Nominal	$M = \underset{(.010)}{0.065}\ WF + \underset{(.087)}{0.597}\ M_{-1}$	0.996 -1.38		200.0 0.6398
(7.2.2) Real	$\frac{M}{P^M} = \underset{(.019)}{0.065}\ \frac{WF}{P^M} + \underset{(.153)}{0.547}\ \left(\frac{M}{P^M}\right)_{-1}$	0.992 -1.55	358.3 2.0541	213.7 0.7310
FOREIGN WEALTH DISEQUILIBRIUM				
(7.2.3) Nominal	$M = \underset{(.010)}{0.071}\ [WF - \underset{(7139)}{15103} + \underset{(42572)}{85741}\ \frac{I}{WF}] + \underset{(.085)}{0.553}\ M_{-1}$	0.992 -1.86		186.6 0.4873
(7.2.4) Real	$\frac{M}{P^M} = \underset{(.018)}{0.079}\ [\frac{WF}{P^M} - \underset{(11707)}{32725} + \underset{(72427)}{196740}\ \frac{I}{WF}] + \underset{(.146)}{0.415}\ \left(\frac{M}{P^M}\right)_{-1}$	0.995 -2.03	292.0 1.1940	238.0 0.7932
DOMESTIC WEALTH				
(7.2.5) Nominal	$M = \underset{(.0003)}{0.016}\ \left(\frac{P^M}{\hat{P}}\right)^{\underset{(.259)}{-0.484}} * WD$	0.990 [1.60]		199.7 0.6379
(7.2.6) Real	$\frac{M}{P^M} = 0.167 * (1 - \underset{(.002)}{.907}) * \left(\frac{WD}{P^M}\right)$	0.993 [1.478]	330.2 1.7443	232. .8612
DOMESTIC WEALTH DISEQUILIBRIUM				
(7.2.7) Nominal	$M = 0.167\ \left(\frac{P^M}{\hat{P}}\right)^{\underset{(.035)}{-0.071}}\ [1 - (\underset{(.007)}{0.914} - \underset{(.424)}{0.663}\ \frac{I}{WD})^{\underset{(.012)}{0.953}}\ \eta_D^{\underset{(.012)}{0.047}}] * WD$	0.997 [1.98]		191.8 0.5152
Real	No plausible equation			
TRADITIONAL				
(7.2.9) Nominal	$\log M = \underset{(.341)}{-2.495} + \underset{(.036)}{1.063}\ \log GDP$	0.982 [1.93]	0.105 0.175 a/	193.2 0.6355
(7.2.10) Real	$\log \frac{M}{P^M} = \underset{(.860)}{-3.658} + \underset{(.086)}{1.174}\ \log \frac{GDP}{P^{GDP}} - \underset{(.272)}{0.900}\ \log \frac{P^M}{P^{GDP}}$	0.927 [2.056]	0.103 0.159 a/	232.7 0.7578
HEMPHILL				
(7.2.11) Nominal	$M = \underset{(124.6)}{161.7} + \underset{(.129)}{0.301}\ R' + \underset{(.077)}{0.386}\ F + \underset{(.102)}{0.526}\ M_{-1}$	0.991 -1.22		203.6 0.5802
(7.2.12) Real	$\frac{M}{P^M} = \underset{(87.4)}{\frac{145.6}{P^M}} + \underset{(.126)}{0.292}\ \frac{R'}{P^M} + \underset{(.117)}{0.378}\ \frac{F}{P^M} + \underset{(.139)}{0.510}\ \left(\frac{M}{P^M}\right)_{-1}$	0.994 -1.019	329.1 1.5165	200.1 0.5603

a/ Not divided by 10^6.

nominal fit, the real equilibrium equation still dominates its disequilibrium rival and that the latter displays significant negative serial correlation. This last equation, (7.2.4), implies that a rise of 10 percent in the investment/wealth ratio from its mean of 0.171 to 0.188 will raise the estimate of wealth by 7.4 percent in 1980 and long-run real imports by $534 million in 1980 dollars.

Kenya

Kenya presents a slightly different picture from the other two countries. The elasticity of intertemporal substitution is stronger (nearly signficantly above unity at 5 percent), while no dynamics are evident. Thus, for example,

$$M_t = (1 - \underset{(.016)}{0.846}\eta_t^{\underset{(.115)}{-0.200}})\, W_t + \underset{(.095)}{0.030}\, M_{t-1} \,. \qquad (7.3)$$

$R^2 = 0.995$ Standard error = 110.1

$h = -0.82$ $SSR/10^6 = 0.1818$

While the coefficient on intertemporal prices is not significant (critical value $t_{16}[5\%] = \pm 2.112$, 2-tail), it is sufficiently well-determined to be retained in the equation, given our theoretical interest in its effect. 1/ Thus the preferred equation is the basic equation (4.14), which is reported as (7.3.1) in Table 7.3. Almost identical results with real imports lead to a preferred equation (7.3.2) for the real wealth model.

1/ Estimating σ considerably reduces the standard error of the equation. In this sense, the actual estimate is better than imposing ($\sigma = 1$), even though the latter cannot quite be rejected at 5 percent.

Table 7.3: PREFERRED EQUATIONS FOR KENYA

		R^2 h or [DW]	SER $SSR/10^6$	Nominal SER $SSR/10^6$
FOREIGN WEALTH				
(7.3.1) Nominal	$M = (1 - \underset{(.004)}{.841}\ \eta^{\underset{(.108)}{-.189}}) * WF$	.995 [2.36]		106.9 .183
(7.3.2) Real	$\frac{M}{P^M} = (1 - \underset{(.004)}{.841}\ \eta^{\underset{(.067)}{-0.133}}) * \frac{WF}{P^M}$	.993 [2.116]	228 .834	108.4 .188
FOREIGN WEALTH DISEQUILIBRIUM				
(7.3.3) Nominal	$M = (1 - \underset{(.009)}{.844}\ \eta^{\underset{(.119)}{-.189}}) * (\underset{(1016)}{-1430} + \underset{(11930)}{16176} * \frac{I}{WF} + WF)$	.995 [2.348]		106.6 .159
(7.3.4) Real	$\frac{M}{P^M} = 1 - \underset{(.020)}{.844}\ \eta^{\underset{(.065)}{-.073}}) * (\underset{(2188)}{-4250} + \underset{(22344)}{46468.3} * \frac{I}{WF} + \frac{WF}{P^M})$	.995 [2.662]	207.8 .605	102.5 .147
DOMESTIC WEALTH				
(7.3.5) Nominal	$\log M = \underset{(.551)}{-4.393} + \underset{(.126)}{.331} \log \frac{P^M}{\hat{P}} + \underset{(.161)}{(1 - .304)} \log WD - \underset{(.161)}{.304} \log M_{-1}$	.987 -.26	.086 .111 a/	123.6 .229
(7.3.6) Real	$\frac{M}{P^M} = (-(1 - \underset{(.005)}{.997}\ \eta^{\underset{(.040)}{-.002}})) * \frac{WD}{P^M} + \underset{(12.455)}{8.204}\ G\hat{N}P + \underset{(.225)}{.243} (\frac{M}{P^M})_{-1} + \frac{X}{P^M} + \frac{CGR}{P^M} - \frac{INVID}{P^M}$	.992 -5.35	252 .892	146.8 .3012
DOMESTIC WEALTH DISEQUILIBRIUM				
(7.3.7) Nominal	$M = \underset{(.185)}{.414} (\frac{P^M}{\hat{P}})^{.416} * (1 - (\underset{(.003)}{.922} - \underset{(.048)}{.073} * GRGDP)^{(1+.076)}\ \eta_D^{\underset{(.019)}{-.076}}) * WD$	.995 [2.947]		104.6 .153
Real	No plausible equation			
TRADITIONAL				
(7.3.9) Nominal	$M = \underset{(62.5)}{-101.7} + \underset{(.052)}{.467}\ GDP - \underset{(.142)}{.301}\ M_{-1}$	.974 -.641		135.9 .274
(7.3.10) Real	$\frac{M}{P^M} = \underset{(212)}{2045} + \underset{(.102)}{.526} \frac{GDP}{P^{GDP}} - \underset{(646)}{3240} \frac{P^M}{P^{GDP}}$	.992 [2.541]	249.9 .937	140.9 .298
HEMPHILL				
(7.3.11) Nominal	$M = \underset{(54.24)}{-75.5} + \underset{(.233)}{.196}\ R' + \underset{(.043)}{1.132}\ F - \underset{(.153)}{.389} \cdot \Delta F$	.981 [2.35]		120.1 .202
(7.3.12) Real	$\frac{M}{P^M} = - \underset{(21.3)}{\frac{7.556}{P^M}} + \underset{(.168)}{.191} \frac{R'}{P^M} + \underset{(.031)}{1.005} \frac{F}{P^M} - \underset{(.120)}{.602} \frac{\Delta F}{P^M}$	.997 [2.908]	157.4 .347	103.2 .149

a/ Not divided by 10^6.

The disequilibrium wealth results for Kenya match those for Colombia almost precisely. The investment/wealth ratio as a component of wealth is the best of the disequilibrium terms, although in this case, the additional terms are significant in neither the nominal model (F-statistic = 1.05) nor the real model (F-statistic = 2.65). Nonetheless, we report some preferred disequilibrium models in Table 7.3.

Conclusions

Despite their obvious differences, these three countries tell a fairly consistent story about the foreign wealth model. For example, all suggest that a Cobb-Douglas intertemporal utility function is an acceptable approximation, all generate identical functional forms for real and nominal imports, and all find the investment/wealth ratio the best of the disequilibrium terms.

Even the differences among the countries have a degree of consistency. For example, Kenya -- the poorest country by a long way -- shows no signs of either smoothing imports from year to year or of responding to disequilibrium shocks such as investment booms. Colombia, on the other hand, clearly smooths imports but is ambiguous about disequilibrium, while Malaysia -- the richest country -- displays both smoothing and the ability to respond to disequilibrium. A possible explanation of this pattern is that poorer countries have neither the wealth nor income to permit either smoothing or responses to investment booms, although this explanation seems more likely in a constrained borrowing framework than in our assumed world of perfect capital markets. A further consistency among countries is that the long-run

share of imports in wealth falls with increasing affluence, from 16 percent for Kenya through 14.3 percent for Colombia to 9.9 percent for Malaysia (in the equilibrium real models). As is clear from equation (4.14), if the intertemporal price effects are ignored, this share is a measure of the rate of time discount, and the result suggests that poorer countries have shorter horizons, an entirely plausible view.

We have, therefore, a reasonable amount of corroboration for the wealth model. True, there are some rejections of the implied hypothesis that all forms of wealth affect imports similarly, and doubts arise from the data's preference for a constant rate of interest and the need, in some cases, to relate imports to investment. Nevertheless, the model appears to perform reasonably well overall. It fits well, it generates fairly clean residuals, it is plausible and it is consistent across countries.

There are, however, two further sets of tests to conduct: first, to see if this model can outperform others in explaining the same data, and second, tests of structural stability.

VIII. OTHER MODELS

In this section we introduce estimates of three other models: the domestic wealth model, discussed already, and two strawmen against which to test our wealth models. A necessary condition for the acceptability of a new model is that, broadly speaking, it outperform existing alternatives. The alternatives considered here are, first, a traditional model relating imports to GDP and relative domestic and import prices, and, second, the Hemphill model that relates imports to foreign exchange receipts and the stock of debt. The section concludes with tests of the structural stability of all the preferred equations in Tables 7.1, 7.2 and 7.3.

The Domestic Models

The domestic models are not subjected to such vigorous testing as the foreign model. Given their small size relative to the net present value of GNP, it seems unnecessary to test whether different components of wealth have the same effects as GNP or whether the timing of loans is important. Thus, we use only one wealth concept and test versions of two models. The Sachs model is represented by equation (5.2), but with the non-wealth terms summarized into $\alpha_1[\log(GNP/\hat{GNP}) + \log p^{GDP}]$, which is the deviation of real GDP from its exponential trend, $\hat{GNP}$, converted into current prices. The Dornbusch model is represented by equation (5.6). The interest rate and stock of debt experiments are repeated, and each model is subjected to the various dynamic specification tests. For the comparisons between

models, we select four equations covering real and nominal imports and equilibrium and disequilibrium forms.

Before discussing the country results, certain generalizations should be made. First, the preference for a constant rate of interest is repeated. Second, these models prove very much harder to estimate than the foreign wealth models, in part because they contain more parameters. Frequently, it is impossible to achieve satisfactory convergence in the non-linear forms, and, universally, the final convergences are very sensitive to small changes in specifications. This problem alone is a serious handicap in applying the models. There are also, however, substantially more problems with plausibility than previously. 1/ We never achieve a converged plausible disequilibrium equation for real imports. Third, the stock of debt variables never prove useful. Fourth, the investment/wealth ratio again usually proves to be the most successful of the disequilibrium measures. Finally, the Dornbusch formulation far outperforms the Sachs formulation.

For Malaysia, only nominal imports can be satisfactorily explained by the domestic models. The Sachs version of the equilibrium model has plausible short-run coefficients, but because of a very high coefficient on lagged imports, it is not acceptable in the long run. The Dornbusch model, which with lagged imports contains five coefficients, requires several constraints to be estimable at all; in its logarithmic transformation some progress is possible, however, and it results in the preferred equation (7.1.5). This equation constrains

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1/ For these reasons, the term "preferred equation" should be interpreted very loosely.

the coefficient on wealth to unity, which implies the short-run proportionality between imports and wealth. Over the long run, however, imports rise by 1.18 percent for every 1 percent rise in wealth, which is clearly inconsistent with the model theoretically. On the other hand, the constraint is demanded most strongly statistically: imposing long-run rather than short-run proportionality increases the SER by over 50 percent. No other equation approaches the preferred equation in terms of fit, and so we use the latter in the model comparisons, despite its theoretical shortcomings.

In the disequilibrium experiments, convergence is very erratic, given the large number of coefficients, and it is necessary to replace the constant of equation (5.6) by the base-year imports/GNP ratio. (This is a normal practice in CES allocation functions; see Hickman and Lau, 1973). Nonetheless, a statistically respectable equation emerges (7.1.7), in which higher investment is associated with greater rates of time discount. It is a constrained version of the Dornbusch model. The Sachs model never converges.

The Sachs model encounters severe problems with the Colombian data: it either fails to converge or suggests negative rates of time discount. The Dornbusch model fares better but, as before, requires several constraints. The final equation (7.2.5) shows no auto-regression, but strong contemporaneous substitution between imports and domestic goods. Even stronger restrictions are necessary for real imports. Again, it proves impossible to estimate the constant, and no remotely significant effects can be found for contemporaneous or intertemporal prices, or for lagged imports. Thus, ultimately, imports are expressed as a proportion of total wealth (see equation [7.2.6]).

The estimation problems are compounded in the domestic disequilibrium models; indeed, little consistency can be found in the results. The preferred equation, (7.2.6), appears highly desirable, with investment increasing the rate of time discount and with significant contemporaneous and intertemporal price effects. It is not robust, however, and neither the difference between equations (7.2.6) and (7.2.4), nor the single disequilibrium coefficient on (I/WD), is statistically significant.

Kenya's nominal domestic models behave similarly to those of the other two countries. The Sachs model proves numerically unstable, while the logarithmic transformation of the Dornbusch model provides the best fit and most robust estimates. In this case, contemporaneous price effects are detected (they imply an import price elasticity of between 0 and -1), and the long-run proportionality of imports and wealth is acceptable.

In the disequilibrium models, only the Dornbusch model is viable. Surprisingly, the growth rate of GDP proves a better disequilibrium indicator than does the investment/wealth ratio. It is acceptable either as part of the wealth calculation or in its preferred form, where it positively affects the rate of time discount. Again, while the equation looks good, the estimates are rather sensitive to small changes in specification.

The Kenyan real domestic wealth model reverses all previous trends. Here the Sachs model fits better than the Dornbusch equations, and the most general equation is accepted. It implies that higher GNP produces higher imports, which is contrary to Sachs' prediction, but

this outcome does not seem so implausible as to require rejection of the model.

The Traditional Model

The traditional model is the first of our strawmen. It is introduced solely as a foil to the wealth models and receives no research effort. The estimating equation is

$$M = \alpha_o + \alpha_1 \, GDP + \alpha_2 \left(\frac{p^M}{p^{GDP}} \right) + \alpha_3 \, M_{-1} \, , \qquad (8.1)$$

which is estimated in nominal and real terms, with and without a lagged dependent variable, and in linear and log-linear forms -- eight attempts altogether. The economic coefficients are constrained to zero only in the cause of plausibility, while the lagged dependent variable is retained only where it is significant. The choice between logarithmic and linear forms is made using the criteria of error whiteness and fit. The reported preferred equations, numbered 9 and 10 in the tables, require no comment, save that in this model, in keeping with tradition but not with our treatment of the domestic wealth models, we deflate GDP by its own deflator in the real equations rather than by import prices.

The Hemphill Model

The Hemphill model was discussed briefly in Section II, but it is useful to review its features here. 1/ We start with the balance of payments identity,

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1/ Greater detail is available in Winters and Yu (1984).

$$F = M + \Delta R,$$

where F = Exogenous (net) foreign exchange receipts

M = Total import expenditures and

ΔR = The change in the stock of foreign assets.

Hemphill models the allocation of given funds, F, between spending, M, and savings, ΔR, both of which are endogenous. His estimating equation is

$$M_t = \alpha_0 + \alpha_1 R'_t + \alpha_2 F_t + \alpha_3 \Delta F_t, \tag{8.2}$$

where R'_t is the stock of foreign assets at the beginning of year t and is cumulated as $R'_t = \sum_{j=0}^{t-1} \Delta R_j = \sum_{j=0}^{t-1} (F_j - M_j)$. We expect $\alpha_1 > 0$ -- that is, higher reserves (lower indebtness) means higher imports.

Hemphill experiments with several different allocations of balance of payments items between the exogenous F and endogenous ΔR elements of his model. We cannot replicate his measures, but experiment ourselves with three different definitions, as follows:

	Definition of F	Definition of ΔR
(1) Narrow	Current credits including transfers	All capital items
(2) Official	(1) plus net long- and medium-term official borrowing	Monetary items plus long-term private and total short-term capital
(3) Basic	(2) plus net long- and medium-term private borrowing	Monetary items and short-term capital

As before, the equations are estimated in real and nominal terms, with and without a lagged dependent variable -- a total of 12 estimates in all. Coefficients on net foreign exchange earnings, F, and the stock of debt, R', are retained whenever plausible, while the dynamic terms ΔF and M_{-1} are kept only when significant. The choice between the three definitions of F and R' is made by reference to fit and error behavior, and in every case the "basic" definition is favored. This concept of exogenous foreign exchange receipts is the broadest and takes us some way toward estimating the balance of payments identity that the current account balance (X - M) is equal and opposite to the sum of the capital account balances. The latter comprise net long-term capital (F - X), short-term capital and official finance, and there is sufficient variation in the last two components to give us some confidence that our equations reflect actual behavior rather than mere accounting. (The ratio of the sample standard deviations of short-term capital plus official financing flows to that of imports is 12.4 percent, 23.0 percent and 21.0 percent for Malaysia, Colombia and Kenya, respectively.)

Three general observations should be made about the preferred equations, numbered 11 and 12 in the tables. First, in the real equations, every variable, including the constant, is deflated by the import price. This approach seems correct theoretically (debt accumulates in nominal terms) and is vindicated empirically in the case of Malaysia, for which it is tested. Second, the real equations always fit better than the nominal ones. Third, each equation requires one, but only one, of the dynamic terms.

The estimated Hemphill equation is a reduced form, and while the structural form cannot be estimated because it involves unobservables, the structural parameters are identifiable. Fortunately, they seem fairly plausible for all three countries. The most contentious implied structural parameter is the marginal increment in the desired stock of reserves and short-term assets with respect to an increase in long-term foreign exchange receipts; these are 0.41, 0.38 and 0.11 for Malaysia, Colombia and Kenya, respectively. All are positive, suggesting that as wealth rises, countries prefer to have higher short-term assets rather than higher short-term debts; they are related to income -- richer countries like higher reserves; and they are not wildly different from previous estimates of the reserve/import relationship.

Structural Stability

Clearly, a good model must display stable estimates as the sample period varies. Therefore, we conclude this section by conducting some limited stability tests of the preferred equations of Tables 7.1, 7.2 and 7.3. We use all our data in estimating the various models, so that independent forecasting results are not possible. We do, however, conduct two sets of in-sample tests, which are at least indicative. First, we experiment with Brown, Durbin and Evans' CUSUM and CUSUMSQ tests. Unfortunately, our sample is too small to yield meaningful results: in line with the findings of other researchers using small samples, the CUSUM test never rejects the null hypothesis of stability, while the CUSUMSQ always does. We thus place little reliance on these tests.

The second batch of tests are merely Chow tests conducted on various in-sample years. We separately test 3 years to see if they conform to the model explaining the remaining 17. The three years are 1965, which as the end point of the sample is likely to be the most sensitive indicator of functional misspecification; 1974, the most turbulent year of the sample period; and 1982, an end year also subject to large shocks. The results are reported in Table 8.1. Each model receives at least one rejection, and these tend to be concentrated in the later of the years. On the whole, the tests of stability reflect the other properties of the equations -- the better performing equations tend to show less instability.

These results are not perfect -- ideally we want no instability -- but, on the other hand, neither are they indicative of serious and widespread problems, at least among the stronger models (see the next section).

Table 8.1: STRUCTURAL STABILITY TESTS [a]

Model	Malaysia			Colombia			Kenya		
	1965	1982	1974	1965	1982	1974	1965	1982	1974
Nominal									
Foreign wealth		X							
Foreign w. disequilibrium					X				
Domestic									X
Domestic disequilibrium					X				
Traditional			X	X					
Hemphill			X	___	___	___			
Real									
Foreign wealth		X							
Foreign w. disequilibrium					X				X
Domestic	___	___	___	X					
Domestic disequilibrium	___	___	___	___	___	___	___	___	___
Traditional			X	X					X
Hemphill		X							

Note: X = rejection of stability at the 5 percent level.
___ = no preferred equation.
blank = hypothesis of structural stability not rejected.

[a] Chow-test of the null hypothesis that imports in the year tested exhibit the same behavior as in the year of the sample.

IX. COMPARING THE MODELS

Having identified a preferred real and a preferred nominal equation from each model, we now test them against each other, using, for ease of computation, Davidson and MacKinnon's (1981) P-tests. For non-tested hypotheses, if we have two models of process y,

$$H_0 : y_t = f(X_{ti}:\beta) + \varepsilon_{ot} \tag{9.1}$$

and

$$H_1: y_t = g(Z_{ti};\gamma) + \varepsilon_{1t}, \tag{9.2}$$

then we can test the truth of H_0 by seeing whether H_1 can contribute to the explanation of y in addition to the factors in H_0. The test statistic is derived from the equation

$$(y_t - \hat{f}_t) = \alpha(\hat{g}_t - \hat{f}_t) + \sum_{i=1}^{k_o} \frac{\partial f_t}{\partial \beta_i} \beta_i^* + \varepsilon_1, \tag{9.3}$$

where $\hat{f}_t$ and $\hat{g}_t$ are fitted values under H_0 and H_1, respectively, the $(\frac{\partial f_t}{\partial \beta_i})$ are derived from equation (9.1), and the (β_i^*) are nuisance parameters of no intrinsic interest. This equation asks whether the estimated residuals of H_0, $(y - \hat{f})$, are related at all to the factors appearing in H_1 but not in H_0, $(\hat{g} - \hat{f})$. The second set of terms in equation (9.3) appears only to correct for any correlations between the latter and the elements already included in H_0. If H_0 is true, the elements in H_1 but not in H_0 add nothing to the explanation, and so

$\alpha \approx 0$. Any other value of α suggests that H_0 is incorrect and thus rejects it. Davidson and MacKinnon show that α is asymptotically distributed as N(0,1), under the null hypothesis that H_0 is true.

The test is not symmetric, for $\alpha = 1$ does not prove that H_1 is true. For that, it is necessary to repeat the test with H_0 and H_1 reversed. Davidson and MacKinnon show that several alternatives, $y = g_j()$, can be tested simultaneously by replacing the first term on the right of equation (9.3) by $\sum_{j=1}^{m} \alpha_j (\hat{g}_{jt} - \hat{f}_t)$.

A drawback of this test is that it assumes that y is always the dependent variable, whereas in our case we might actually have any or all of M, ${}^{M}/_{p}M$, log (M) or log (${}^{M}/_{p}M$) as dependent variables. We have evaded this issue by always converting $\hat{g}$ to the units in which $\hat{f}$ is measured. For the deflation by p^M, this approach is unlikely to be flawed, for p^M is exogenous, and we are basically just reversing a heteroskedasticity transformation. For the logarithmic transformation, however, it is potentially serious, and we merely plead that it is not obviously actually so.

(Since we completed this work, we have noted that MacKinnon, White and Davidson, 1983, have addressed this problem of the P-test. They suggest using equation [9.3] but with $\hat{f}$ converted into the units in which $\hat{g}$ is measured. While this P_E-test has few desirable properties in theory, the authors claim it is of considerable practical use. It is not clear how it compares with our procedure, although intuitively we might expect ours to lead to fewer rejections, since in our case, H_1 meets H_0 on H_0's own ground.)

The models are compared in Tables 9.1, 9.2 and 9.3. These tables report both the standard errors of the various equations in terms of their fit to nominal imports and the results of the non-nested tests. Taking Malaysia first, it is plain that the two nominal disequilibrium models are the best-fitting, followed by the real models in general. The equilibrium wealth models fare very badly.

This pattern of preference is largely borne out by the non-nested tests. Reading along each row of the matrix shows which alternative models reject a particular null; the columns show which nulls a particular alternative rejects. Thus, for Malaysia, we observe a general tendency for the real models to reject the nominal ones (in the top right quandrant) and not to be rejected by them (bottom left). Against this result, however, the nominal foreign disequilibrium wealth model (7.3.2) rejects all other models and is rejected by none of them. This finding is powerful, and it is reinforced by noting that in Table 8.1, the foreign disequilibrium wealth model is one of the only two models not to display any structural instability.

If we were to put this model aside, however, because of its suspected simultaneity problem or because of the difficulties of projecting investment, then among the remaining equations, the real Hemphill one has similarly persuasive results. Observe how, in this case, the Hemphill model rejects the nominal domestic disequilbrium formulation and is not rejected by it, despite the latter's superior fit.

The predominant reason for the differences in fit between the disequilibrium wealth models and most of the other models concerns the former's ability to predict the continuing strong growth of imports in

Table 9.1: NON-NESTED TESTS AND FITS -- MALAYSIA

Alternative hypothesis a/		FN	FDN	DN	DDN	TN	HN	FR	FDR	DR	DDR	TR	HR	SER b/
Null hypothesis a/														
F	N	—	X		X		X	X	X	—	—	X	X	371.0
FD	N		—							—	—	X	X	197.9
D	N	X	X	—			X	X	X	—	—	X	X	518.4
DD	N	X	X		—		X	X	X	—	—	X	X	215.6
T	N		X	X	X	—	X	X	X	—	—	X	X	392.4
H	N		X		X	X	—	X	X	—	—	X	X	295.8
F	R		X		X		X	—		—	—	X	X	400.5
FD	R	X	X				X		—	—	—			260.5
D	R	—	—	—	—	—	—	—	—	—	—	—	—	—
DD	R	—	—	—	—	—	—	—	—	—	—	—	—	—
T	R		X					X	X	—	—	—	X	275.1
H	R		X							—	—		—	266.5

a/ Definitions: F -- foreign wealth; FD -- foreign wealth disequilibrium; D — domestic wealth; DD -- domestic wealth disequilibrium; T — traditional; H -- Hemphill; N -- nominal imports; R -- real imports; and X -- rejection of H_0 by H_1 using Davidson and MacKinnon's P-test.

b/ Standard error of nominal imports.

Note: ____ Not applicable.

1982. This growth occurred despite decelerating foreign exchange inflows, but coincided with a strong expansion of domestic investment.

It is also interesting to note the relatively poor performance of the equilibrium wealth models. A priori, Malaysia looked a rather good candidate for this approach to imports, for the responses to the discovery and development of oil typically would appear to be "forward-looking." Wealth, and thus expenditures, rose well before the oil resources came on-stream to boost exports or GDP. Capturing this effect is precisely the novelty of this type of model. Two observations might be made: first, we may be modelling oil expectations wrongly; second, the processes may be as postulated, but because the investment in the oil industry is financed by borrowing from abroad, the associated rise in foreign exchange receipts, which drives the Hemphill model, may reflect the imports of oil equipment more faithfully than does our imperfect wealth measure. Note, again, how we return to the interaction between imports and investment.

The discrimination among models is weaker for Colombia. Nearly all models can generate an equation with a standard error of around $200 million, and there are fewer rejections in general. Nonetheless, the nominal foreign disequilibrium model again sweeps the board, rejecting all models and being rejected by none.

There are two caveats to this result, however. First, the model shows signs of structural instability in Table 8.1. Second, while by Davidson and MacKinnon's P-test it rejects its equilibrium counterpart, it does not do so in the nested F-test that can also be made between these two models. Since the former is only an asymptotic test, while the latter is correct in small samples, we should really

Table 9.2: NON-NESTED TESTS AND FITS -- COLOMBIA

Alternative hypothesis a/		FN	FDN	DN	DDN	TN	HN	FR	FDR	DR	DDR	TR	HR	SER b/
Null Hypothesis a/														
F	N	—	X		X	X					—			200.0
FD	N		—								—			186.6
D	N		X	—	X					X	—			199.7
DD	N c/				—						—			191.8
T	N		X			—			X		—			193.2
H	N		X			X	—			X	—	X	X	203.6
F	R		X	X	X	X	X	—	X	X	—	X	X	213.7
FD	R		X		X	X			—	X	—	X		238.0
D	R		X		X	X			X	—	—		X	232.0
DD	R	—	—	—	—	—	—	—	—	—	—	—	—	—
T	R		X						X		—	—		232.7
H	R		X						X		—	X	—	200.1

a/ Definitions: F -- foreign wealth; FD -- foreign wealth disequilibrium; D -- domestic wealth; DD -- domestic wealth disequilibrium; T -- traditional; H -- Hemphill; N -- nominal imports; R -- real imports; X -- rejection of H_0 by H_1 using Davidson and MacKinnon's P-test.

b/ Standard error of nominal imports.

c/ Using Davidson and MacKinnon's C-test.

Note: ____ Not applicable.

simplify the disequilibrium model to its equilibrium form. However, in this form, which is analyzed in row 2 and column 2 of the matrix in Table 9.2, the wealth model is rejected by two models and rejects none.

Part of the reason for the greater ambiguity with Colombia is presumably that, in the absence of a large and obviously forward-looking component of wealth such as oil, there is less statistical discrimination between the foreign wealth and the foreign exchange receipts series. Further, Colombia is known to have had considerable illicit exports of narcotics at times. These presumably boost imports without appearing anywhere in our explanatory variables. If this trade fluctuated significantly, it could entirely swamp the "legal" component of trade that we can model.

Kenya exhibits a wider range of fit than Colombia and more model rejections. There is no general preference between the real and nominal models. The strongest model appears to be Hemphill's real equation, which rejects all alternatives and is rejected by none. Following it are the two nominal disequilibrium models. The Kenyan models show greater structural stability than the other countries'. This outcome partly reflects the fact that the in-sample fits (R^2) for Kenya are worse. Thus, a given percentage prediction error is more likely to be within the range experienced over the sample period. The only instabilities detected for Kenya are for 1974, and they arise from the severe underprediction of import expenditures as the oil price rose: the share of fuels in Kenya's imports rose from 10.9 percent in 1973 to 22.4 percent in 1974. Although not always statistically significant, this problem afflicts all the Kenyan models.

Table 9.3: NON-NESTED TESTS AND FITS -- KENYA

Alternative hypothesis a/		FN	FDN	DN	DDN	TN	HN	FR	FDR	DR	DDR	TR	HR	SER b/
Null hypothesis a/														
F	N	—			X		X		X		—		X	106.9
FD	N		—						X		—		X	106.6
D	N			—	X		X		X	X	—		X	123.6
DD	N				—				X		—		X	104.5
T	N	X	X	X	X	—	X	X	X	X	—		X	135.0
H	N	X	X	X	X		—	X	X		—		X	120.0
F	R		X	X	X		X	—	X		—		X	108.4
FD	R								—		—	X	X	92.9
D	R	X	X	X	X		X	X	X	—	—		X	133.0
DD	R	—	—	—	—	—	—	—	—	—	—	—	—	—
T	R	X	X	X	X		X	X	X		—	—	X	141.9
H	R										—		—	103.1

a/ Definitions: F -- foreign wealth; FD -- foreign wealth disequilibrium; D -- domestic wealth; DD -- domestic wealth disequilibrium; T -- traditional; H -- Hemphill; N -- nominal imports; R -- real imports; X -- rejection of H_0 by H_1 using Davidson and MacKinnon's P-test.

b/ Standard error of nominal imports.

Note: ____ Not applicable.

It is interesting that Kenya -- the poorest country of our sample and the one least attractive to lenders -- favors the model which assumes capital market imperfections, while Malaysia -- the richest and, with oil, ostensibly the most attractive -- favors the perfect capital (or unrestricted borrowing) assumption.

The upshot of these tests is that, of all the models, the nominal foreign disequilibrium wealth model and the real Hemphill model appear to be the best. In both Malaysia and Kenya, they constitute the optimal pair, while in Colombia the results are ambiguous. There are, however, possible simultaneous biases in both these models that caution against too uncritical an acceptance of the rankings. The disequilibrium model faces a possible link between imports and investment, while both models would be confounded by the endogeneity of exports. We rate the latter as the smaller danger, both absolutely and in terms of the damage that ignored correlations would do to the estimates.

We tentatively conclude that foreign exchange-based models of imports dominate GDP-based ones. It is clear that the domestic models need more attention before they can be applied, although it should be recalled that we simplified Sach's version even before estimation. The traditional model, while among the leaders for Colombia, does not in general perform well.

In economic terms, the models chosen here suggest a strong and direct link between financial variables and developing countries' imports. The Hemphill model suggests that, subject to some damping through changes in short-term debt, any shock to net foreign exchange receipts will produce a corresponding change in import expenditures.

This pattern is equally true for changes in export earnings, long-term borrowing or interest payments. The intertemporal models suggest a similar story. They indicate a degree smoothing to the import path, and in the disequilibrium form admit a role for investment booms, but otherwise changes in revenue get translated directly into changes in imports. The absence of strong intertemporal price effects renders changes in wealth the principal determinant of imports, and these changes in turn are driven primarily by current account receipts and the interest rate. Thus, according to this model, imports have been curtailed over the eighties both by weak export markets and high interest rates.

It is not appropriate here to make forecasts (even of past years), but the results of this paper suggest most strongly that greater exports to developing countries will not be a significant engine of recovery for the OECD in the near future. Indeed, without significant progress in at least some of the following directions -- lower interest rates, stronger export markets, or freer borrowing and capital transfers -- most developing countries' imports will remain rather stagnant for several years.

X. CONCLUSIONS

This paper explores four models of import determination for each of three developing countries. The objectives are twofold. Primarily we wish to explore the issue of financial variables in import determination. To this end, we develop an operational model of intertemporal foreign exchange management, devoting considerable space to its specification and measurement. The model proves viable -- in that an estimable form has been derived -- and potentially quite useful. For all three countries, it gives fairly plausible results, and there is a strong consistency across countries. It does appear, however, to require some modification to reflect disequilibrium factors for at least one of the sample countries.

The model is compared with three others models of imports. One applies the intertemporal analysis to total wealth rather than merely to its foreign exchange component, while the other two relate imports to flows of income or to foreign exchange receipts. In the case of one country -- Malaysia -- the model developed here is dominant (although the dominant form gives rise to some doubts about simultaneity bias); in another case -- Kenya -- it is dominated; while in the third -- Colombia -- there is considerable ambiguity.

The second, intimately related, objective is to discover a single, simple, robust import function for developing countries for use in the World Bank's and OECD's global modelling activities. The choice is essentially between the foreign disequilibrium wealth form and the real Hemphill model. Neither is perfect, and each is subject to worries about simultaneity. Thus, while they might be preferable to other

approaches, we do not at present have sufficient information to distinguish between them. Future research should be devoted to this distinction, a task that basically amounts to exploring the perfect capital markets hypothesis of the model developed here. On the other hand, both approaches agree on the importance of financial variables in developing countries' imports, and both suggest that until the industrial countries can generate better marketing opportunities, as well as higher capital transfers and lower interest rates, developing countries' imports will remain rather stagnant.

APPENDIX: DATA AND DEFINITIONS

The principal data sources used in the study are:

- International Financial Statistics
- Balance of payments statistics and
- The World Bank debt data bank.

The series for LIBOR, which is not published, was supplied privately by the Bank for international settlements. Certain World Bank debt data are also not published.

This appendix describes the sources and definitions of data where these are not obvious from the text and the published material. It starts with general definitions and then considers special features of each country's data.

All data are measured in (converted into) US dollars.

General Definitions

Imports: merchandise (f.o.b.) plus shipment plus "other" debits, i.e., total debits, less investment income and unrequited transfers.

Import prices: unit value of merchandise imports.

Assets: reserves plus gold (valued at London gold price) less net foreign liabilities of banks.

Exports: total credits less official grants and net unrequited transfers.

Export prices: unit value of merchandise exports.

National interest rates: rate on borrowing from financial institutions. This rate had to be extrapolated on the basis of the US rates of interest for the years prior to 1965.

Price of domestic sales of domestic output: GDP deflator.

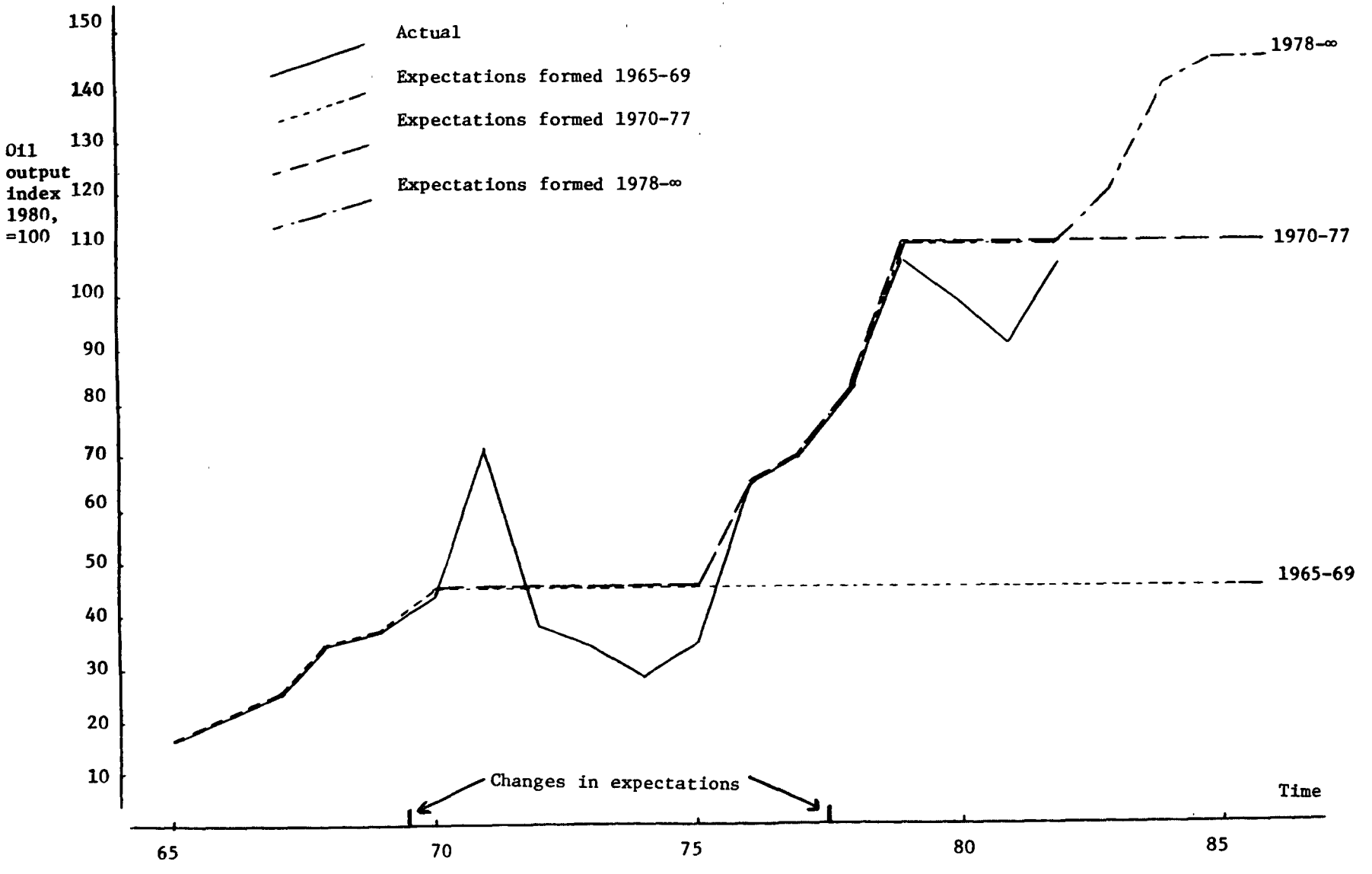
Debt and lending: all medium and long-term lending, as recorded by the World Bank's Debtor Recording System. All stocks refer to the beginning of the period.

Malaysia

Expected Export Receipts: Two problems were evident here. First, Malaysia became an oil exporter over our sample period. Merely extrapolating the rate of growth of export revenues seemed wholly inadequate. Therefore, we assumed (1) static expectations on oil prices, and (2) that oil quantities could broadly be foreseen up to five years in advance. Three series of expectations were constructed on this basis: one operating over 1965-69, one over 1970-77 (the switch to this series occurred when the leap in actual exports of 1975-79 was deemed anticipated), and one over 1978-82 (when the rise in exports in 1982-85 was deemed anticipated). The series are shown graphically in Figure A.1. For example, we assumed that the expectation in 1969 of oil exports in 1970 was 45, whereas the expectation in 1970 for that year was 110. The increases projected over 1983-85 are based on specialists' advice, and the export peak in 1971 is dismissed as an aberration, being balanced by abnormally high imports of oil.

The second problem concerned non-oil exports. These grew so fast throughout most of our sample period that extrapolating their growth rate led to infinite wealth in most years. When these years were

Figure A.1: MALAYSIAN OIL EXPORTS, ACTUAL AND EXPECTED



adjusted as suggested on pages 30-31 of the text, the wealth series proved highly volatile. We therefore chose to apply static expectations to export revenues, measuring the net present value of exports as (X/r).

Expected import prices: It was assumed that most import prices were expected to grow in the long run at their average growth rate over the last five years. The price of oil, however, was assumed fixed in nominal terms, as were all export prices.

Exports and imports: For technical reasons, imports for Malaysia include debits of unrequited transfers, while exports include only credits. Experiments suggest that this treatment made no practical difference to the results from the treatment specified above. In economic terms, our standard treatment implied that investment income payments and unrequited transfers were prior claims on foreign exchange revenues before imports could be obtained, whereas our "Malaysian" treatment implies that only investment income was.

Colombia

Coffee exports: Coffee exports are separated from non-coffee exports when calculating expectations. Non-coffee export price expectations are static, whereas the coffee export price expectation is the average price for the previous five years. Volume expectations are static for both.

Non-commercial lending: Our calculations required a series of non-concessional disbursements to Colombia back to 1960. However, there was no information for 1960, and we used half the value for 1961.

Kenya

Exports: Balance of payments data for Kenya begin in 1963, the year Kenya gained independence. It is possible to obtain data on imports and exports of merchandise from the colonial reports. These data are separated into external trade and trade within the East African territory. Data on trade within the territory are likely to be understated, since the boundaries of the three territories were administered by a total of six customs posts. All pre-independence data are customs data and are reported in East African pounds. These were converted to dollars and added to our sample. We needed data on total trade credits back to 1955, and these were estimated by extrapolating an ordinary least squares regression of the exports of other goods and services and net unrequited transfers (less grants) on merchandise exports and a time trend fitted over 1964-82.

Exceptional finance: Data for international capital flows and unrequited transfers contain elements of exceptional financing. In the latter class, these data are broken out because they are considered accommodating. They are not so treated for loans, however, since loans still entered the total stocks of debt. This treatment implies that Kenya could have expected to be able to borrow money without much difficulty to cover its imports; thus such funds are included in the import decision. On the other hand, grants, being costless, were probably more scarce and the country could not expect them. They would be given after the import decision was made.

For most of the models, exceptional financing was treated like any other capital flow. However, for Hemphill's model we experimented

by excluding exceptional financing from one version of the current foreign exchange earnings and by adjusting reserves to take these grants into account. There was little difference between the two versions.

Gold: Kenya has very small gold holdings. The data series begins in 1973, with zero values recorded until 1977. It was assumed that gold holdings were non-existent prior to 1973.

Interest rates: Data were needed back to 1955 for interest rate expectations. The value of 0.065 was used prior to independence. For years missing data on what the financial institutions were charging (1963, 1964, 1967, 1968, 1969 and 1974), the average rate on non-concessional loans was used.

Expectations: Export revenue expectations were adjusted to take into account price fluctuations for tea and coffee. Price expectations for these beverage exports were taken as the five-year averages of a composite price of the two goods. The composite price was calculated with 1970 weights.

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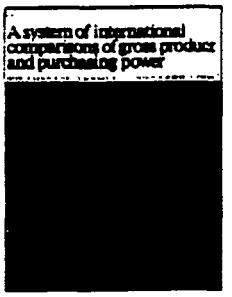

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