AN ABSORPTION-LINDER MODEL OF THE MONETARY SECTION OF THE JAMAICAN ECONOMY 1962-71.

by

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I. INTRODUCTION

This paper reports the specification, estimation and testing of an absorption-type model of a representative developing economy. The point of departure is Linder's (1967) theory of trade for a developing country. According to that, during the first stage of development, the economy must run a persistent trade deficit needing continuous accommodation in the capital account. Jamaica in the 1960's appears to be exactly the kind of economy he had in mind. So this study may be regarded as an attempt to flush out the monetary implications of his prescriptions. It is also an attempt to modify current balance of payments theory by taking explicit note of the characteristics of a fairly large group of countries. These are open developing economies.

The study has an additional pertinence for Caribbean economies. An acquaintance with the more developed countries in the region, leads one to expect the existence of a cost-sensitive demand for money function. Yet all the previous studies of the Jamaican economy have failed to discover such a relationship. This study follows a hint in Ladenson (1974), that in a highly monetized economy where there are nonetheless a limited range of non-money financial assets, the appropriate cost of money variable in the demand for money function is the real rate of interest. This follows from the fact that the critical substitute for money in this case is physical capital. It is argued below, that this particular specification and careful attention to techniques of estimation are responsible for the improved finding on the demand for money.

Since Linder's (1967) thesis implies a very crucial role for capital transfers to developing countries, the capital outflow function in the model is carefully developed. Most of the findings here, and in the other relationships are what were expected *a priori*.

The paper proceeds as follows. Section II is a brief account of previous efforts to estimate monetary relationships for the Jamaican economy. Section III introduces and discusses the model. Section IV and V respectively, report on the estimation and test of the model. And Section VI consists of a brief and concluding summary.

II: Monetary Studies of the Jamaican Economy

An early paper in the monetary analysis of Caribbean economies, which include Jamaica, was produced by Thomas (1963). An important feature of this paper is that it contains an embryonic treatment of some of the matters discussed by McKinnon (1969) and Currie (1976). The point of common interest is the case where the automatic mechanism of the balance of payments correction under a regime of fixed exchange rates is thwarted. In the case that Thomas (1963) discusses there is no central bank. He explains how in this situation the dependence of the balance of payments on domestic credit expansion is a function of the managment of commercial banks' portfolios and not of government policy. He concludes that in an open "dependent" economy like Jamaica, the money supply is initially a function of the balance of payments, but after a lag, and depending on the credit policies of the banks, the balance of payments may become dependent on monetary expansion.

It seems to me ironic, in view of the openness of the Jamaican economy, that the early econometric studies of that economy did not attempt to investigate some of the monetary relationships implied in Thomas (1963). In general, these studies were concerned mainly with the real sector. However, Harris (1970) attempted to estimate Jamaica's foreign-exchange gap in line with the dual-gap hypothesis.

Harris' (1970) model contains 57 endogenous variables and 6 exogenous variables. But it is not as complex as it appears since many of the equations are simply decompositions of more aggregative relationships. Mainly, his model estimates (1) merchandise imports; (2) merchandise exports; (3) external service transactions, (a) payments, (b) receipts; (4) foreign transfers; (5) government finances; (6) domestic saving and (7) investment and production. His analysis covers the period 1950-65.

Although the basic dual-gap hypothesis is formally derived from the Keynesian system, the estimating equations in his model are ad hoc; so that care must be exercised in construing the test of any economic theory from the estimates of the parameters he specifies. Nonetheless, these estimates help to convey a picture of the Jamaican economy. Not surprisingly, this picture is of a very open economy.

According to the study the disposable personal income elasticity of imports "is slightly above unity (1.067) and the highest value is that for the durables component (consisting mainly of household furnishings and automobiles). Food comes next with an elasticity of about 1.1 which is rather high in comparison to the observed elasticity of general food consumption." Later on, after demonstrating that the "import requirements of intermediate goods are approximately proportional to GDP",he goes on to show that the coefficient on import for capital goods "indicates a fairly rapid expansion of capital imports as investment increases." These results clearly indicate the conditions that cause an import minimum.

Harris (1970) experiments with a variety of specifications of his basic export function. For the bulk of Jamaica's exports including bauxite, alumina and sugar, he obtains the best results from fitting a semi-log equation between exports and income in the developed world. Although he does not discuss this, the success with the semi-log form suggests a decreasing world income elasticity of demand for Jamaica's exports.

Finally, Harris (1970) makes projections of the Jamaican economy under four different sets of assumptions about growth rates in Jamaica and the advanced capitalist economies. He concludes that "The trend of the two resource gaps under the (four) assumptions (shows that the) trade turns out to be dominant in all four cases."

Much less confidence attaches to the estimates of the parameters of two other real-sector models of the Jamaican economy. These are by Carter (1970) and Manhertz (1971). The former attempts to estimate from 8 observations 22 behavioural relationships in a system containing 14 predetermined variables. Similarly, Manherz (1971) uses 8 observations to estimate 24 behavioural relationships in a system that has 27 predetermined variables.

These authors used respectively, instrumental variables and two-stage least squares to estimate their systems. However, they both found the results "inferior" to those they obtained using ordinary least squares (OLS). They have therefore published their OLS estimates. Carter (1970) writes: "In general the differences (between OLS and instrumental variables) are minor and hardly worth the considerable additional effort required." However, it is not very surprising that he obtained unsatisfactory results with the instrumental variables estimator. This technique gives biased but consistent estimates of parameters. But with a sample of 8 observations, it is unlikely that he obtained the benefit of the asymptotic properties of the instrumental variables estimator.

Manhertz (1971) seems to have ignored the degrees of freedom problem associated with the use of two-stage least squares. With more predetermined variables than data observations, the first stage in two-stage least squares is undefined and the second stage collapses into OLS. This could explain why he found his two-stage least squares estimates inferior to his OLS estimates. However, as is well-known, OLS estimates of the parameters of a non-recursive simultaneous equation system are biased. We must therefore exercise care in interpreting the results of these two studies. But in those areas where their work has any bearing on this study their results do not differ qualitatively from those of Harris (1970).

The next two studies of the Jamaican economy are, more explicitly, monetary studies. These are by Taylor (1972) and Bourne (1974). The former is a straight application of Polak's (1957) model to Jamaican data. The stated purpose of this exercise is to show that "A monetary model also (can) provide a sufficient explanation for income behaviour" in Jamaica.

The attractiveness of Polak's (1957) model lies in its simplicity. However, this virtue is gained at the expense of much realism. The model assumes: (1) a constant income velocity; (2) that imports, the only leakage out of the system, are proportional to income and (3) that injections take the form of changes in the money supply. Once we know the income velocity and the average propensity to import for any country, the model can be used to determine income and imports.

In order to justify the application of this model to Jamaica, Taylor (1972) attempts to show that that country is characterised by a constant income velocity. However, in doing so, he constructs a peculiar argument. His method is to estimate by least squares a time trend for velocity over the period 1950-70. He does this although his data show velocity fluctuating between 5.53 and 8.54. Having obtained from his regression the result

$$v = 6.664 + 0.052t \; ; \; R^2 = 0.159$$

he comments:

> It seems apparent that despite the fairly steady climb in v over the period 1950 to 1961, the irregular decline over the rest of the period eliminated that increase resulting in virtually no change in average velocity over the period as a whole. R^2 in the fitted equation is low and probably over-estimated in view of the low value of the Durbin-Watson statistic (.80). The t value on the regression coefficient is not significant at the 5 percent level and the best single value for v over the entire period is probably 6.664. There is thus some empirical support for the assumption of constant velocity in Jamaica.

It is difficult to see how Taylor's (1972) results can be construed to prove that Jamaica is characterised by a constant income velocity. It is hoped that the demand for money function in my model may shed some light on the appropriateness of the constant velocity assumption for Jamaica.

Bournes's (1974) paper represents the most sophisticated monetary analysis of the Jamaican economy extant. It is an attempt to apply what the author regards as the most relevant economic theory to the particular circumstances of the Jamaican economy. This is how he describes the problem he perceives and the solution he attempts:

> Even in the relatively underdeveloped financial structures of the Caribbean,

> the demand for money has important consequences for monetary and real growth and change. A priori the relative and absolute magnitudes of interest-rate, price and income elasticities are critical determinants of the impact of monetary measures such as changes in the money stock, bank rate, and exchange rate on the size and composition of the public's portfolio of real and financial assets. Nonetheless, the analysis of the demand for money is grossly a neglected area among Caribbean monetary theorists and practitioners. ... (This) paper formulates at a high level of theoretical abstraction a micro model of the demand for money, and then proceeds to apply a modified form to quarterly data for Jamaica.

In this modified form the demand for money is made a function of (1) a weighted average of interest rates (RTSD); (2) expected inflation (P^e) and expected income (GNP^e). Bourne's (1974) own specification is

$$M^D = B_o + B_1 RTSD + B_2 P^e + B_3 GNP^e$$

where the dependent variable is desired money balances.

A problem emerges here. This demand for money function contains three unobservable magnitudes. These are: (1) desired money balances; (2) expected inflation and (3) expected income. Bourne (1974) transforms these unobservables "by utilising the Nerlovian partial adjustment mechanisms and Muth's rational expectations hypothesis." After the transformation he has six structural parameters, three from equation I and three adjustment coefficients. However, his estimating equation contains ten independent variables, so that his model is over-identified. Unfortunately he estimates it by the method of OLS. However, this method will not permit us to infer unique values for the structural parameters in an over-identified equation.

Nonetheless, Bourne's (1974) account of his findings are of great interest. First we note that his results suggest that the demand for money is interest-insensitive. According to him, "regardless of the definitions of money employed and irrespective of whether the interest rate is expressed in real or nominal terms, they generally fail to pass the "t" test at the 25 percent level." Should this finding be replicated in a study using a more appropriate estimating technique it would be reasonable to conclude that the Keynesian monetary transmission mechanism analysis does not offer a plausible description of the Jamaican monetary sector. This alone justifies what I am trying to do in my thesis.

After stating that the results for expected inflation are ambiguous, Bourne (1974) goes on to discuss what appears to be the main determinant of the demand for money in Jamaica. He says "the income coefficients are statistically significant at the 1 percent level or better. A great deal of confidence therefore reposes in our estimate of those coefficients."

Later on he discusses the income elasticity of the demand for money and tells us: "There is no discernible tendency for long-run elasticities to differ in any particular direction from short-run elasticities when the broad money definition is adopted. On the other hand with the narrow money definition, income elasticity tends to decline as adjustment is completed. The range is 0.1057 to 1.8312, depicting at the lower end a relatively income-insensitive demand for money function, and depicting at the upper end an income-sinsitivity reminiscent of Friedman's well-known luxury good finding". However, we are unable to judge the plausibility of this claim since, as we saw above, the estimator the author used does not permit us to infer a unique value for the income-adjustment coefficient in this case.

The main relevance of Bourne's (1974) study for us is that it directs our attention to many important monetary issues in the Jamaican economy that still need resolving. For example, will a demand for money function which is part of a larger structural model still exhibit interest insensitivity? Is the income elasticity of the demand for money unity or otherwise? These and some other questions I attempt to answer later on.

III. The Model

The model developed in this section attempts to trace through the consequences of persistent increases in the money supply of a developing economy that is characterised by the features outlined in Linder (1967). It will be recalled that such an economy tends to be in 'external disequilibrium' on account of having to import more than it can export. It is assumed: (1) that the monetary expansion is to supplement economic development policies; (2) that the monetary authorities maintain a desired level of high-powered money so that they are prepared to sterilise the balance of payments whenever they deem this necessary; (3) that there are (a) a stable money multiplier and (b) a stable demand for money; (4) that the money market clears in a single period; and (5) that we are concerned with a regime of fixed exchange rates.

With these assumptions, the picture that emerges is of a country sometimes spending in excess of its domestic income. The resultant deficit on the balance of trade is not always offset by capital flows. In order to maintain a money supply commensurate with the level of economic growth the monetary authorities must sometimes sterilise deficits on the balance of payments. How much they sterilise is an empirical matter, but complete sterilisation involves the risk that the system may run out of foreign exchange reserves prematurely. It therefore seems likely that they sterilise only partially. The model subjects this picture to an empirical test.

The basic structure of the model consists of twelve endogenous variables and twelve predetermined variables. However, five of the endogenous variables are stated as definitions and one, the nominal interest rate, is determined by the assumption of equilibrium in the domestic money market. This means that there are six behavioural relationships, each of which will now be formally specified and discussed, starting with the change in the money supply function.

The "Change in the Money Supply" Function

This function attempts to capture the insight of Thomas (1963), which was cited above. Discussing the Caribbean economies including Jamaica, he claims "that both money supply and balance of payments are inter-dependent." The first set of equations below attempts to show this interdependence.

The monetary base, here called high-powered money consists on the sources side, of the central bank's stock of foreign exchange reserves in terms of domestic currency, and its stock of domestic assets. Recalling the assumption that the authorities have a desired stock of high-powered money, it is assumed that adjustment to this desired stock always takes place within one period. We have

$$H_t = H_t^*$$

A simple linear adjustment function which contains as arguments: (1) the balance of payments; and (2) the change in the level of income is postulated. That is.

higher powered money is treated as endogenous

Central bank reaction (f).

$$H_t^* = H_{t-1} + a_0 + a_1 B_t + a_2 \Delta Y_t \qquad 4$$

where H_t^* is desired high-powered money in the current period, H_t is the actual stock of high-powered money, H_{t-1} is high-powered money in the previous period, B_t is the balance of payments, ΔY_t is the current change in the level of domestic income and the a_i's are constant coefficients.

To complete the derivation of a change in the money supply function, recall that money consists of bank deposits and cash in the hands of the non-bank public. That is

$$M_t^S = \frac{1}{d} R_t + CA_t$$

where $M^S{}_t$ is current money stock, R_t is the commercial banks' current holding of reserves, CA_t is the current stock of cash in the hands of the non-bank public and d is the reserves-deposits ratio. Equation 3.3 may be written as

$$M_t^S = \frac{1}{d} R_t + (H_t - R_t)$$

or

$$M_t^S = (\frac{1}{d} - 1) R_t + H_t$$

When this is transformed into first differences we have

$$\Delta M_t^S = (\frac{1}{d} - 1) \Delta R_t + \Delta H_t$$

Substitution of 3.1 and 3.2 into equation 3.5 yields the following behavioural equation

$$\Delta M_t^s = \left(\frac{1}{d} - 1 \right) \Delta R_t + a_0 + a_1 B_t + a_2 \Delta Y_t \qquad 8$$

which may be simplified to

$$\Delta M_t^s = \alpha_0 + \alpha_1 \Delta R_t + \alpha_2 B_t + \alpha_3 \Delta Y_t \qquad 9$$

$$\alpha_1 \gtrless 0; \quad \alpha_2 \gtrless 0; \quad \alpha_3 > 0$$

The gist of 3.7 is that the balance of payments and the change in the level of income help to determine the supply of money by determining the rate of adjustment of actual to desired level of high-powered money.

The Money Demand Function

It is now well known that most recent work on the balance of payments assumes a stable demand for money function. According to Friedman (1956) the criteria for stability are a small error variance and a limited number of arguments. The arguments he suggests should be in the demand function establish it as a topic in capital theory. This is how a large number of monetary economists have regarded the demand for money, some more explicitly than others. The major landmarks in this tradition are Keynes (1930, 1936), Hicks (1935), Robinson (1951) and Friedman (1956, 1970). The basic view is that money is just one —

albeit the most liquid — of many assets in an efficient portfolio, all of which are held for their expected yields. In my opinion the clearest, though somewhat neglected, statement of this thesis is given in Robinson's (1951) classic paper where she declares:

> Each type of asset is a potential alternative to every other; each has, so to speak, a common frontier with every other and with money. Equilibrium in the market is attained when the interest rates are such that no wealth is moving across any frontier.

What this seems to mean is that given his wealth or permanent income, the investor, either individual or firm, will seek a composition of assets such that all yields are equalised at the margin.

The question arises as to whether this kind of theory is applicable to developing countries. Some economists, Bolnick (1976) for example, seem to hold that it is not. According to these, the cash balance hypothesis offers the best account of the demand for money in developing countries. However the problem with this view is that, as Hicks (1935) demonstrated long ago, the cash balance theory can be expected to hold only in cases where there are no assets, real or monetary, that can substitute for money. This is hardly the case in Jamaica.

These considerations have led me to specify an asset demand for money function, that bears some resemblance to the one suggested by Friedman (1970). The major modification I have made is to combine the expected yield on bonds — the nominal interest rate — and the expected yield on durables which is the expected rate of inflation, into a single variable. This specification is valid in cases where the main substitute for money is physical capital, and appears to be particularly appropriate for Jamaica which I find to be truly a nation of small shop-keepers. The demand for money function in the model is

$$m^d_t = b_0 + b_1 y^p_t + b_2 r^e + u_t \qquad 10$$

where m^d_t is current real balances, y^p_t is the current value of permanent income, r^e is the expected real rate of interest and u_t is a stochastic term. As is customary, I assume a constant elasticity.

The variable y^p appears in the demand for money function. However, permanent income is an unobservable magnitude. To deal with this problem, I assume that permanent income can be represented by a geometrically weighted distributed lag on actual income. That is

$$y^p_t = y_t + \lambda y_{t-1} + \lambda^2 y_{t-2} + \lambda^3 y_{t-3} + \ldots. \qquad 11$$

Substitution of this equation into equation 3.8 yields

$$m^d_t = b_0 + b_1(y_t + \lambda y_{t-1} + \lambda^2 y_{t-2} + \lambda^3 y_{t-3} \ldots) + b_2 r^e + u^t \qquad 12$$

Equation 3.10 may be transformed by using the method given by Koyck (1954). This involves lagging a period and multiplying through by λ to get

$$\lambda m^d_{t-1} = \lambda b_0 + b_1(\lambda y_{t-1} + \lambda^2 y_{t-2} + \lambda^3 y_{t-3} + \ldots) + \lambda b_2 r^e_{t-1} + \lambda u_{t-1} \qquad 13$$

Next, equation 3.11 is subtracted from 3.10 leaving

$$m_t^d = b_0 - \lambda b_0 + b_1 y_t + b_2 r_t^e - \lambda b_2 r_{t-1}^e + \lambda m_{t-1}^d + u_t - \lambda u_{t-1} \qquad 14$$

which may be simplified to get

$$m_t^d = \beta_0 + \beta_1 y_t + \beta_2 r_t^e + \beta_3 r_{t-1}^e + \beta_4 m_{t-1}^d + v_t \qquad 15$$

$$\beta_1 > 0;\ \beta_2 < 0; \beta_3 > 0;\ \beta_4 > 0; v_t = u_t - \lambda u_{t-1}$$

I believe that equation 3.13 will be of especial interest to Caribbean economists. A successful money demand function for any of the countries in the region has so far eluded them, although casual empiricism suggests that a function containing a wealth variable and an interest rate variable should perform well. My judgment is that what is needed is to embed this kind of demand for money function in a structural model, such as I am attempting here.

The Absorption Function

A check will show that original absorption theorists believed that domestic income was the main argument in the absorption function. That view is maintained in this model, but the following gloss is added. The government of a developing country usually is committed to a high level of expenditure on infrastructural projects. Commenting on the practice of the Jamaican government during the period covered by this study, Palmer (1968) has the following to say:

> It is obvious that the Jamaican economy is a predominantly private interprise economy. In this setting, the government's economic role is that of providing the economic and financial infrastructure appropriate for rapid economic development. The share of government capital formation in total capital formation reflects substantial effort on the part of the government to lay down and improve social overhead capital to facilitate growth and development. (pp.62-64)

It appears reasonable to me to assume that the level of income would be a major determinant of the level of government expenditure. In the first place as an index of demand for infrastructural projects, and in the second place as a source of revenue. In the latter case, we know from the balanced budget multiplier theorem, that government spending financed by taxation raises the ratio of absorption to income. During the period of the study the share of government expenditure in gross domestic product rose from 7% to 12.5%. The latter proportion is within the range suggested for a developing country by Lewis and Martin (1956). I expect that altogether there will be a very strong positive relationship between the level of income and absorption.

Another major influence on absorption in Jamaica should be the stock of real balances. Modern monetary theory shows that in the absence of sufficient capital inflow to offset a deficit on the balance of trade, the government has to run a deficit on its budget if it wants to counteract the monetary consequence of a deficit on the balance of payments. This consequence is an automatic correction of the balance of payments disequilibrium accompanied by a general fall in absorption. The Jamaican authorities have always wished to avoid a general fall in absorption. As well as retarding economic development, this probably increases unemployment which as is well known is ordinarily as high as 20 percent. The commitment of the authorities to a high level of absorption has been stated by politicians as well as by officers of the Bank of Jamaica, one of whom wrote to me: ''Bear in mind though, that these policies (ie. certain central bank policies) are operating in a framework of an economy which is in an almost permanent state of depression. This partly explains the Governments's heavy reliance in deficit financing.''[2]

Since in developing economies deficit financing is done mainly by monetary expansion, we may expect to find a link between the level of the money stock and the level of absorption.

The way this link works is through the real balance effect. This is of course the oldest monetary transmission mechanism in economics. It was clearly understood by Cantillon and was implicit in Hume. However, the current interest in it stems mainly from Pigou (1943) and Patinkin (1948). The theory is well known. Given that there is a stable demand for money, an increase in the supply of money over the trend growth rate causes the actual stock of real balances to exceed the desired stock and induces a rise in expenditure.

In addition to this, McKinnon (1973) has argued that in a developing country there is likely to be a significant real balance effect on investment. According to him an increase in real balances, especially if it is brought about through a decline in the price level, complements the other forms of saving available to small entrepreneurs.

The foregoing suggests that the two main arguments in the absorption function should be the level of domestic income and the stock of real balances. To these I have added a third explanatory variable, the domestic rate of interest. This is expected to influence absorption mainly through its influence on investment. It is a purely empirical matter whether such an influence — called the cost of capital effect — exists independently of the real balance effect. The estimation of this model might shed some light on this empirical problem, which is so far still unresolved. The absorption function therefore takes the form

$$A = \gamma_0 + \gamma_1 Y + \gamma_2 (M^s/P_D) + \gamma_3 i \qquad 16$$

$$\gamma_1 > 0; \ \gamma_2 > 0; \ \gamma_3 < 0$$

The Balance of Trade Function

The balance of trade function in my model is based primarily on the absorption approach. Pierce and Shaw (1974) present a succinct account of the views of early absorption theorists. According to them:

> The absorption approach emphasises the fact that payments imbalances are 'characterised' by (but not necessarily 'caused' by) ex ante divergences between aggregate income receipts and aggregate domestic expenditure (absorption). In some situations a strong causal connection between (income) and (absorption) on the one hand, and (exports) and (imports) on the other can exist. For example an (increase) in (absorption) holding (income) constant, creates an excess of aggregate receipts causing the increase in (absorption) to spill over on to imports and deteriorate the balance of trade. (p.339)

These authors go on to caution that ''the whole structural form of the absorption equation does not lend itself easily to a conclusive specification of the directions of causation between trade variables, absorption variables and the level of domestic income.''

The model developed in this study offers a possible explanation of why absorption can increase, relative to income, and deteriorate the balance of trade. The crucial link is the relationship between money and absorption that was outlined above. A rise in the size of the money stock, ceteris paribus, causes the level of real balances to exceed the desired level. This causes a rise in absorption, and in an open economy such as we are discussing, a rise in imports. With exports unchanged the balance of trade deteriorates. In the model, the rise in absorption causes income to rise first after which the rise in income induces a rise in imports. Some of these imports are necessary imports à la Linder (1967) in the sense that they are required to maintain the new level of desired income in the succeeding period. A special case is where all additional absorption spills over on to imports. Assuming these are necessary inputs to the development process, income will not rise until later on. In all this it is assumed that the initial change in the money supply is intended either to counteract the contractionary consequences of balance of payments deficits correction under fixed exchange rates or to increase the rate of economic growth. It is the necessity for this kind of policy that led Linder (1967) to claim that in a developing economy '' The simultaneous establishment of internal and external equilibrium is ... not possible.'' (p. 9)

The foregoing suggests that income should be an argument in the balance of trade function of an absorption model. In the case of Jamaica, I expect to find a highly significant negative relationship between income and balance of trade.

Although the absorption approach is a rival explanation of the balance of trade to the relative price theory, absorption theorists do not claim that relative prices are unimportant. Therefore the second explanatory variable in the balance of trade function is the ratio of the domestic price level to an index of foreign prices. The current state of economic knowledge does not permit us to infer the a priori sign of the relationship between relative prices and the balance of trade. The approach that stems from Robinson (1937) postulates a negative relationship. However, following Harrod's (1952) rejection of post-war U.K. devaluation policies, a school has emerged which stresses the negative impact on the balance of trade, of a worsening of the barter terms of trade. This issue is the subject of much current debate in Jamaica due to the IMF - imposed devaluation of this country's currency. Although the data used to estimate the balance of trade function in my model come from an earlier period, the results from the estimation may shed some light on the current debate.

The final argument I have put in my balance of trade function is the change in the level of income. It is hoped that this will pick up any effects of economic development not included in the level of income. If it does this efficiently i should have a negative effect on the balance of trade in light of Linder's (1967) theory. The foregoing leads to the following estimating equation.

$$T = \varepsilon_0 + \varepsilon_1 Y + \varepsilon_2 (P_d/P_f) + \varepsilon_3 \Delta Y \qquad (17)$$

$$\varepsilon_1 < 0; \ \varepsilon_2 \lessgtr 0; \ \varepsilon_3 < 0$$

The Capital Outflow Function

In recent years there has been much refinement of the capital flow-interest rate relation. Earlier, capital flows were seen as affecting changes in flow equilibria and responding to differences in the levels of domestic and foreign interest rates. This view was put strongly by Mundell (1968) a decade ago. Talking about the foreign exchange market he said:

> This market can be divided into two components, the balance of trade ... and the net flow of capital, influenced chiefly by the rate of interest. To every level of the terms of trade there will correspond a given balance of trade and for every rate of interest there will be a specific rate of lending ... at high rates of interest the net inflow of capital will be larger, or the net outflow will be smaller than at the low rates of interest. (pp. 154-155)

The stimulus for rethinking this view seems to have come from a number of sources. Notably the recent contributions to the monetary approach to the balance of payments opened the way for seeing capital flows as stock adjustments in international assets rather than as continuous flows. Later an important remark by Tinbergen (1967) highlighted the fact that changes in the levels of interest rates caused once for all changes in international portfolios, and not continuous flows in capital at the new level as Mundell (1968) claimed.[3] Later Branson (1968) and Floyd (1969) developed Tinbergen's (1967) insight; and it is now generally agreed that to the extent that capital flows are interest sensitive, they are a function of differences in changes in interest rates rather than differences in levels of interest rates.

It is possible to identify two versions of the stock adjustment model of international capital flows. The earlier portfolios balance version represented in the work of Branson (1968) and Branson and Hill (1971), and a later version which is part of recent empirical work on the monetary approach to the balance of payments. The latter version is exemplified in the work of Kouri and Porter (1974). The portfolio version assumes that in the domestic economy the demand for and the supply of money determine the domestic interest rate, changes in which, relative to changes in other countries' interest rates, induce international portfolio adjustments. According to this view the critical choice is between foreign bonds and domestic bonds. The monetary approach is slightly different.

According to this, the domestic interest rate is determined in the world money market, and foreign and domestic bonds are perfect substitutes. In this view an increase in the domestic money supply, ceteris paribus, because it increases the world money stock, leads to an excess demand for world bonds. When the domestic share of world bonds is exhausted, investors turn to the world market causing an outflow of capital.

Mostly, the same arguments enter the capital flow functions of both models, but they are given different rationalisations. For instance, the change in foreign interest rates enters both specifications. However, in portfolio studies it enters in conjunction with the change in the domestic interest rate, whereas in monetarists' studies it is the only relevant interest rate change. Put another way, the monetarists' assumption that foreign and domestic bonds are perfect substitutes implies, as Kouri and Porter (1974) correctly show, that foreign and domestic interest rates are equal. On the other hand, Branson's (1968) assumption that there is substitution between the two kinds of bonds implies only that, in regression studies, the absolute values of the coefficients on the two kinds of interest rate changes should be equal.

Another variable that enters the capital flow functions of both versions of the stock adjustment model is the balance of trade. Branson and Hill (1971) rationalise the inclusion of the balance of trade on the grounds that it is a proxy for trade credit. Kouri and Porter (1974), on the other hand, put it in because ''the current account—in the same way as a change in the Central Bank's net domestic assets—affects capital flows because it is an autonomous source of a change in the monetary base.'' To test the validity of this monetarist postulate, it is necessary only to compare the coefficients on the trade balance and the change in domestic assets of the central bank, when they appear together in the same regression. In the monetarists' view, these should not be significantly different.

However, in Kouri's and Porter's (1974) own work, such an equation appears for the following countries: Germany, Australia, Italy and The Netherlands. The monetarist hypothesis is confirmed in the first two cases but falsified in the others. Kouri and Porter (1974) admit that they ''have no good explanation available for these differences.'' We may consider their failure as a justification for attempting a modification of the strict monetarist hypothesis. This modification is already implied in my model.

Kouri and Porter (1974) regard the change in the domestic assets of the central bank as an exogenous variable. In their reduced - form model, capital flows always respond passively to changes in the bank's domestic assets. However, they concede that ''it is possible that the authorities try to adjust (the change in the domestic assets of the central bank) at times so as to offset the liquidity effect of payments deficits or surpluses.'' What appears as an obiter dictum in their model is closer to a ratio decidendi in mine. Equation 4 in this study along with the specification of the balance of payments as an endogenous variable imply that the domestic assets of the central bank must sometimes change passively to maintain the authorities' desired stock of high-powered money. This is one reason why I think it is not appropriate to estimate the capital outflow function, which contains the change in the domestic assets of the central bank, by the method of ordinary least squares. A similar argument is made against the use of this estimator when an interest rate variable appears in the capital flows function. Both these variables appear in the capital outflow function in this model.

The foregoing suggests that the balance of trade and the change in the domestic assets of the central bank should have similar signs. However, there is no necessity for their magnitudes to be equal. In other words, the hypothesis that is being tested here is neither the strict monetarist nor the one associated with the earlier Branson and Hill (1971) model, but one that attempts to synthesize both approaches. The above-mentioned signs are expected to be positive.

The last two variables that the modern theory of international capital movements indicates should enter the capital outflow function are the change in domestic income and the change in world income. These two change in income variables may be regarded either as proxies for changes in investment or proxies for changes in wealth in the domestic and world economies respectively. Floyd (1969) argues that a rise in domestic investment relative to investment in the rest of the world should induce an inflow of capital. If a change in domestic income mirrors a change in investment, there should be a negative relationship between capital outflows and the change in domestic income. Kouri's and Porter's (1974) monetarist model also postulates a negative relationship between the change in domestic income and capital outflows. However, this is based on the monetarist view that a rise in income causes a rise in the demand for money which corresponds to a fall in the demand for both domestic and foreign bonds. This implies a reduction in capital outflows. Hence whether the change in income enters as a proxy for a change in investment or as a proxy for a change in wealth, we ought to observe a negative sign on the change in domestic income coefficient and the opposite sign on that for the change in world income.

Before leaving this section, it is necessary to mention the omission of two important sets of variables. The modern theory of capital movements contends that the growth and size of the stock of wealth and also the degree of risk attached to holding domestic and foreign assets should be arguments in the capital outflow function. However, all of the published studies encounter difficulty in modelling these effects. These omissions are more critical in some cases than in others, depending on whether or not the included variables capture the effect of the omitted variables. It has proven impossible to find accurate data on the stock of wealth and the degree of risk in Jamaica for the sample period. It is left to the estimation of the model to indicate how serious this specification err. is in the present case.

In the model capital outflow is defined to mean the net outflow of both short-term and long-term capital. This aggregation of 'compensatory' and 'autonomous' items — to use Meade's (1951) terms — into one variable may be criticised on the grounds that movements in the two kinds of assets are motivated by different factors. To illustrate, asset changes of the bauxite firms in Jamaica are probably much more insensitive to short run interest rates movements than changes in short run capital. This is a valid criticism and should be noted when reading the results of the estimation of this model. However, I have been unable to find a comparable data series on disaggregated capital flows. Perhaps Caribbean economists should try hard to collect such a series. But this problem seems to have plagued analysts before. For instance, Pierce and Shaw (1974) cite the following claim made in a U.K. Treasury report to illustrate how difficult in principle it is to distinguish between the two kinds of capital flows. It says:

> For instance if (a U.K. resident) buys shares on Wall Street and sells them a short time later, these count as long-term capital transactions, because the shares bought and sold cannot be distinguished from other deals in shares held for a long time. (p.332)

Bearing the above caveats in mind, the estimating equation that comes out of the foregoing analysis is

$$K = \kappa_0 + \kappa_1(\Delta i_D - \Delta i_F) + \kappa_2 T + \kappa_3 \Delta DC + \kappa_4 \Delta Y + \kappa_5 \Delta W \qquad 18$$

$$\kappa_1 < 0;\ \kappa_2 > 0;\ \kappa_3 > 0;\ \kappa_4 < 0;\ \kappa_5 > 0$$

The Domestic Price Level Function

The price equation in this model is different from those generally encountered in monetary models. In the original version of the quantity theory the domestic price level is determined in the domestic money market. However, this is for a closed economy. Consequently, in the monetary approach to the balance of payments, a distinction is made between traded goods and non-traded goods. Only the price level of the aggregate of the latter is determined by the interaction of supply and demand for domestic money. The price level of traded goods is assumed to be determined in the world market. However the two price levels are shown to be functionally related.

Although I agree with the international monetarists that in an open economy the domestic price level is related to the world price level, I believe that in the case of an open economy like Jamaica this relationship is brought about through the cost of production rather than through substitution in trade. Some monetarists, on the other hand, contend that a rise in import prices cannot cause a permanent rise in the domestic price level. Whether or not this is true for advanced economies, it makes little sense in the case of Jamaica where the production of nearly all goods involves the use of 'necessary imported inputs'. This includes the production of wage goods, and links the cost of domestic labour to import prices. Therefore, a rise in the price of 'necessary imported inputs', ceteris paribus, implies a rise in the domestic price level.

Furthermore, some economists are coming around to the view that the prices of imported inputs are a critical factor for determining the price level in industrial economies. This is clearly the view of the Cambridge Economic Policy Group as exemplified in the work of Cripps and Godley (1976). As far as the Caribbean is concerned, Brewster (1968) has shown convincingly that the predominant factor determining the price level in these economies is the price of imported inputs. I have therefore chosen to treat the domestic price level as a simple linear function of an index of the export prices of Jamaica's major trading partners. The particular index I have chosen is a principal component of those prices, which explains 97 percent of their variance. Although this is an extremely simple specification, I do not think it will be regarded as a naive one by those familiar with the Caribbean economy and Caribbean economics. We therefore have

$$P_D = \mu_0 + \mu_1 P_F \qquad (19)$$

$$\mu_1 > 0$$

Closing the Model

The model has an income accounting framework and is closed with the following set of definitions.

$$Y = A + T \qquad (20)$$

$$B = T + K \qquad (21)$$

$$\Delta DQ = \Delta H_t - B \qquad (22)$$

$$r_t = i_t - \dot{P}^e \qquad (23)$$

$$M^S = M^d \qquad (24)$$

Finally, given any endogenous variable Z_t — $\Delta Z_t = Z_{t-1}$.

The Workings of the Model

To see how the model works, assume that from a position of full equilibrium, but at a level of activity below that desired by the authorities, there is a rise in the money supply. The money market is thrown out of equilibrium as there is an excess of cash balances over the level desired by the private sector. Because there is a stable demand for money an attempt to unload some of the excess cash balances is made. This is reflected in the absorption function where we see that absorption is positively related to the stock of real balances.

Assuming that the economy is not at full employment, and there are no other reasons why all of the rise in absorption should spill over on to imports, income will rise. This will cause a rise in imports and with exports unchanged, a fall in the balance of trade.

However, we see from the capital outflow function that a fall in the balance of trade is associated with an inflow of capital. Since in the model the balance of payments is defined to be the sum of the balance of trade and capital outflows, it follows that in general, the change in the balance of trade will have a direct and/or an indirect impact on the balance of payments. It will fail to do so only in the case where the net effect of capital flows on the balance of payments just offsets the net effect of the balance of trade. There is no reason why this particular <u>ex ante</u> case should be typical. Any net change in the balance of payments is transmitted to the money supply since, as we have seen, the balance of payments is an argument in the reaction function of the monetary authorities. Should this change lead to a rise in the money supply, the process outlined above will begin again.

Actually, the analysis carried out in earlier of this study suggests that a kind of money supply — balance of payments spiral similar to the one outlined in the preceding paragraph — might be characteristic of developing countries. Recall that according to Linder (1967) these countries continually run deficits on the balance of trade. Whenever these are not offset by capital flows the balance of payments also goes into deficit. This reduction in the stock of high-powered money would lead normally to a drop in liquidity which we may expect the authorities in a developing country to be anxious to avoid. So it is reasonable to expect that these authorities sterilise deficits on the balance of payments enough to permit the money supply to continue to rise. This would result in the kind of spiral outlined above.

In the meantime the domestic money market continues to clear. The rise in income and change in interest-rate that accompanies a rise in the money supply together cause the demand for money to rise. Furthermore, the rise in income causes a fall in the balance of trade which also helps to absorb the excess supply of money. In other words, equilibrium in the domestic money market is maintained at the cost of disequilibrium in the foreign sector. This appears to be the problem with which Linder (1967) was concerned. The present model may be viewed as an attempt to develop some of the monetary implications of his work.

The complete working of the model is illustrated by the flow chart in Figure 1. The variables above the double line are predetermined and the arrows indicate the direction of causation hypothesised in this study.

The model was designed primarily to offer a structural explanation of balance of payments problems in developing countries and to forecast some of the important parameters in that explanation. However, it is possible to infer some rudimentary policy conclusions from its structure. In the model, lagged high-powered money is a predetermined variable which has associated with it impact multipliers. These can be used to predict the impact in the next time period of a unit change in the current period's monetary base over which the authorities are assumed to have some control. Furthermore, the way that the policy reaction function of the authorities has been specified allows for an exogenous component in the rate of change of high-powered money. It may be presumed that, mutatis mutandus, the higher is the rate of change of the exogenous part of the monetary base, the higher will be the rate of change of the money supply.

Finally, although the model is cast in terms of comparative statics, two dynamic considerations are implicit. The first relates to the degree of sterilization and the second to the rate of economic growth. It is clear that the greater is the degree of sterilization, the sooner will the economy run out of foreign exchange reserves. On the other hand, the faster is the rate of economic growth, the earlier will the economy reach the phase envisaged in Linder (1967) where the value of necessary imports no longer exceeds the value of maximum exports.

In the next section the theory developed in this study is submitted to empirical falsification and validation.

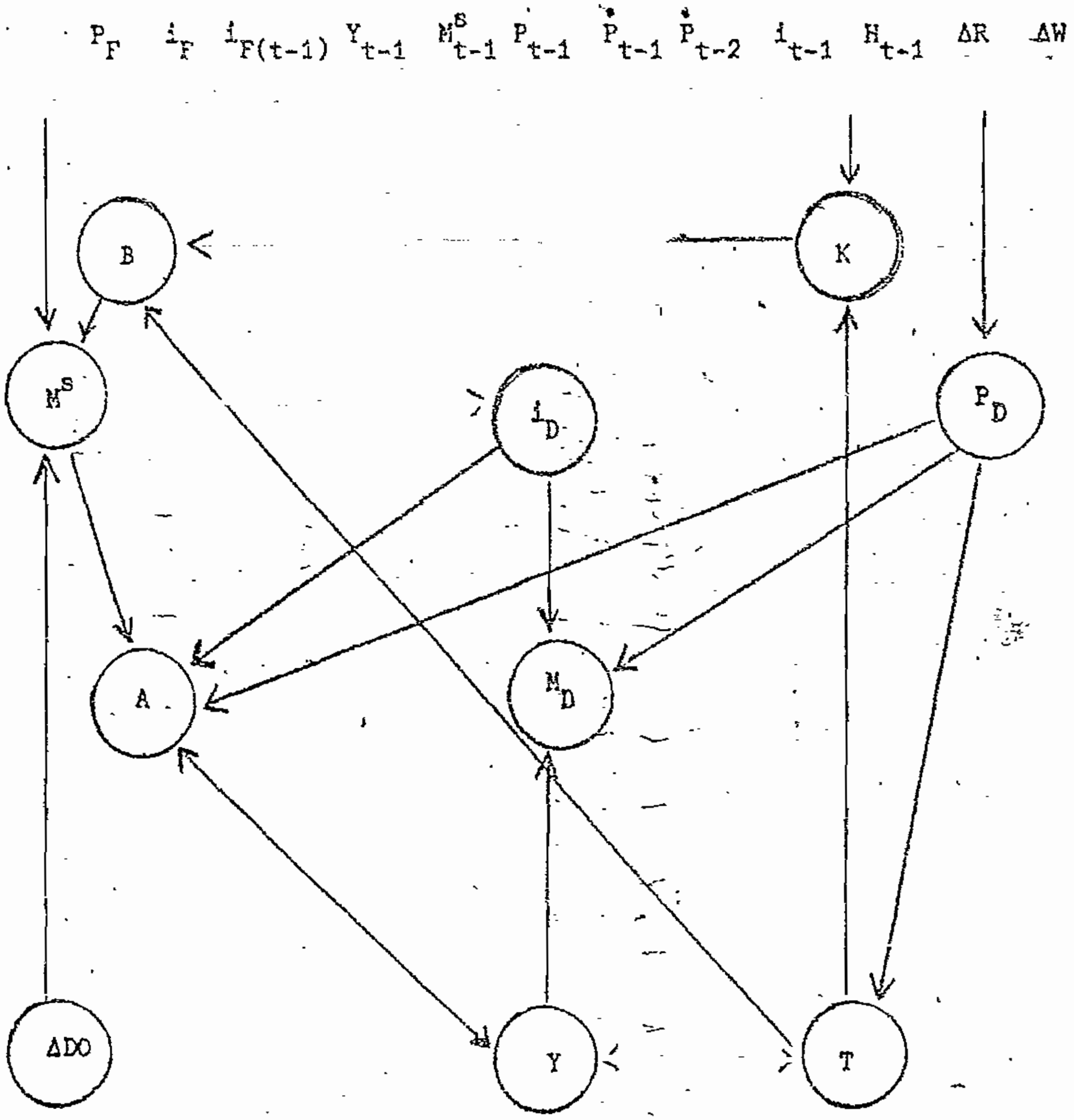
P_F i_F $i_{F(t-1)}$ Y_{t-1} M^S_{t-1} P_{t-1} $\dot{P}_{t-1}$ $\dot{P}_{t-2}$ i_{t-1} H_{t-1} ΔR ΔW
B
K
M^S
i_D
P_D
A
M_D
ΔDO
Y
T

Figure 2

IV. Estimation of the Model

The model was estimated by the method of two-stage least squares (2SLS). As pointed out in the previous chapter, some of the variables in the model are non-linear though all the coefficients are linear. In an important paper, Edgerton (1972) has shown that the unmodified 2SLS method will yield consistent estimates of the parameters in a system like mine, if the total number of predetermined variables in the system is greater than or equal to the sum of the linear endogenous variables, the non-linear variables and the included predetermined variables in each estimated equation.[8] An examination of my model will show that this condition is easily met. This is important since in Section II, I claim that the best previous study of the monetary sector of the Jamaican economy, that by Bourne (1974), did not employ a consistent estimator.

Most of the model was estimated on the Simon Fraser University computer, using the Econometric Software Package (ESP) programme. However, some additional estimations were carried out on the University of the West Indies computer. A discussion of the regression results now follows.

The Change in the Money Supply Function

In terms of the features generally regarded as desirable in regression analysis, the money supply regression is the most disappointing one. There is little doubt that this defect reflects the fact that the regressors in equation 9 turn out to be collinear in the present sample. However, much of the rest of the model pivots around equation 3.7 and any alteration of this equation might have induced a specification error. Shourie (1972) discusses this dilemma which he claims is frequently encountered in econometric models of developing countries. Arguing the case for keeping all of the regressors even if they are collinear, he says they ''should be included even if the t-ratios of one or (all) are not significant so that mechanical regression procedures do not attribute to one of them the variance of the dependent variable that (all) together help explain. From this negative point of view a variable may be very important even if it is 'statistically insignificant'.''

The results from estimating equation 3.7 are:

$$\Delta M^S = 8.30 + 0.26\Delta R - 1.15B + 0.11\Delta Y \qquad 25$$

$$(t=8.48) \quad (1.19) \quad (-8.55) \quad (2.31)$$

$$\bar{R}^2=0.34; \quad S.E.E.=5.2; \quad d=2.4$$

All the coefficients have signs that were expected. The t value of the intercept coefficient implies that during the period under investigation there was a significantly positive rate at which the monetary authorities permitted the stock of high-powered money to change that was independent of any of the variables specified in my model. This is not surprising since the model does not pretend to incorporate information about all the institutional factors that influenced the decisions of the governor of the Bank of Jamaica. This fact is acknowledged by the inclusion of an intercept in equation 4 from which the intercept in the money supply function is derived. It might be of some interest to note that if the estimate of the intercept coefficient in equation 25 can be trusted, it forms the basis for some rudimentary policy analysis, since it permits us to infer the rate at which high-powered money and consequently the money stock, would change for different magnitudes of what we may call the institutionally determined rate of change of high-powered money. I suggest below that this is an area that deserves further study. However, this policy implication is noted in principle only here. Since it appears possible that equation 25 may be affected by multicollinearity, it would be wrong to use individual coefficients from that regression for policy prescriptions.

The coefficient linking the change in the level of the reserves of the commercial banks to the change in the money supply is positive, as expected, but the level of significance is disappointing. Also, the size of the reserve-deposit ratio implied by this coefficient is biased upward.

Perhaps the most striking coefficient in the change in the money supply function is that for the balance of payments variable. This is significantly negative and appears to imply that during the period covered in the sample, the monetary authorities pursued a policy of sterilising the balance of payments. This result is of some interest in light of what has happened subsequently to the Jamaican economy.

The final argument in the change in the money supply function is the change in the level of domestic income. This variable yields a significant coefficient with the sign that was postulated in section III. Since, in that chapter, the relationship between the change in income and the change in the money supply was fully discussed, no further analysis will be made here. However, in view of the multicollinearity between regressors in equation 25,, the results of this regression are offered cautiously.

The Demand for Money Function

Because it is generally assumed that the demand for real balances function is a constant elasticity function, equation must be interpreted as a log linear transformation of that function. It follows that the coefficients in the estimating equation are the elasticities of their respective variables. The results are:

$$m_t^d = -0.05 + 0.37y_t - 0.47r_t + 0.31r_{t-1} + 0.7m_{t-1}^d \qquad 26$$

(t=-.27) (1.9) (-4.4) (3.1) (4.4)

$\bar{R}^2$=0.89; S.E.E.=0.08; d=1.7

All the coefficients have their expected signs and pass the customary level of significance test. According to the results, the short run income elasticity of the demand for real balances in Jamaica during the 19?0's was 0.37. This is within the very wide range reported by Bourne (1974) who for the same period writes:

> The findings on income-elasticity are much less unambiguous. (ie. than other findings in his study) There is no discernible tendency for long-run elasticities where the broad money definition is adopted. On the other hand with the narrow money definition, income elasticity tends to decline as adjustment is completed. In both cases, the short-run elasticities are positive, though substantially varying in magnitudes. In the case of narrow money the range is 0.1057 to 1.8312: depicting at the lower end a relatively income-insensitive demand for money function and depicting at the upper end an income-sensitivity reminiscent of Friedman's well-know 'luxury good' finding.

As indicated above, the coefficient on the income variable may be interpreted as the short-run income elasticity of the demand for real balances. This is as expected positive and significant. It is well-known that an estimating equation like 26 can be generated either from the adaptive expectations process for the permanent income hypothesis or from the partial adjustment of actual to desired stocks of real balances. Following Feige (1967), the former hypothesis was preferred in this thesis. But it is interesting to notice that had I employed the partial adjustment mechanism, the long-run income elasticity of the demand for real balances which can be computed by dividing the coefficient on income by the adjustment coefficient in the equation, would have been estimated to be 1.23. This estimate which is different from Bourne's (1974) is similar to those found in other demand for money studies, where the partial adjustment hypothesis has been maintained.

The fact that the income elasticity of the demand for real balances appears to be significantly different from unity should warn us against the naive application of Polak's (1957) model to the economy of Jamaica in the manner of Taylor (1972).[9]

According to the results, the real interest rate elasticity of the demand for real balances is 0.47. This is within the range usually found in demand for money studies, and suggests that the Jamaican economy was in the 1960's behaving like a typical monetary economy. It is interesting to notice that equation 14 constrains the coefficient on the lagged interest rate variable to be equal to λ times the coefficient on the current real rate of interest, and opposite in sign to the latter coefficients. According to the estimated results this value should be 0.33. As can be seen, the actual estimated value is 0.31 with the correct sign.

It is important to note that this study is the first to discover a significant interest rate elasticity of the demand for money in Jamaica, although others appear to have anticipated such a result.

As expected, the coefficient on the lagged dependent variable is positive and highly significant. The way that the demand for money is specified in the model implies that the weights attached to previous income streams in the calculation of permanent income is relatively high. This may reflect a feature of a fast growing economy such as Jamaica was during the period of this study.

The Absorption Function

The theory developed in Section III suggests that the absorption function is of the form

$$A = \gamma_0 + \gamma_1 Y + \gamma_2(M^S/P_D) + \gamma_3 i$$

A single modification was made to the above specification. In 1969, Jamaica encountered its first major balance of payments crisis. The authorities responded by imposing reluctantly a number of controls on the commercial banks and other lending agencies in the country. The aim was to decrease drastically the value of luxury imports that were financed mainly by loans from commercial banks. The controls remained in operation for five quarters. I incorporated a 'crisis' dummy variable (C) to the model to pick up the influence of government policy on absorption and the balance of trade.

The results from estimating the absorption function are:

$$A = -14.5 + 0.99Y + 49(M^S/P_D) - 1.6i - 1.8C \qquad 27$$
$$(t=-2.2) \quad (23.9) \quad (2.9) \quad (-1.7) \quad (-1.3)$$
$$\bar{R}^2 = 0.99; \quad S.E.E.=2.5; \quad d=1.7$$

In general, this equation appears to explain domestic absorption very well. A good indication of this is given by the standard error of the estimate. The mean value of absorption over the sample period was \$321.4m. The typical size of the difference between the estimated and observed value of absorption is only \$2.5. The equation therefore fits very well.

As expected, the estimated partial derivative of absorption with respect to income is close to unity. This partial relationship is the strongest in the function. The next most important link appears to be that between the stock of real balances and absorption. According to the coefficient, when real balances change by a unit with the other variables held constant, absorption changes by nearly $50m. This is plausible in view of the fact that one of the variables that is being held constant is income, which we have seen has a very strong impact on absorption.

It is interesting to note that the interest rate coefficient has the right sign and is significant at the 95 percent level for a one-tailed test. On reflection this is not surprising since so much of domestic expenditure by the private sector for both consumption and investment during the 1960's was financed by credit. This result appears to suggest that there was much more scope for interest rate policy than is accepted by conventional wisdom.

The coefficient on the 'crisis' dummy variable has the expected sign, but it is significant only at the 90 percent level. This means that we should be cautious in claiming that this study shows that the crisis measures had their desired impact. Nonetheless the dummy variable marginally improved the fit of the regression.

The Balance of Trade Function

The results from estimating the balance of trade function are

$$T = 12.2 - 0.1Y - 0.008(P_D/P_F) - 0.002\Delta Y + 3.8C \qquad 28$$

$$(t=3.6) \quad (-6.2) \quad (-2.4) \qquad (-0.07) \quad (1.5)$$

$$\bar{R}^2 = 0.62; \ S.E.E.=4.6; \ d=2.3$$

Once more, all the coefficients in the regression have the signs that were predicted in Section III. However, that for the change in the level of domestic income is not significantly different from zero. That on the 'crisis' dummy is significant at the 90 percent level and the others at the 95 percent level or more.

Just as outlined in the model, a rise in income causes a deterioration in the balance of trade. The coefficient shows that when income rises by \$1m it causes the deficit in the trade balance to increase by \$100,000. Jamaica therefore corresponds very closely to the type of economy Linder (1967) was discussing. An understanding of that work, along with the finding in this study makes it difficult to accept Johnson's (1977) attack on structural models of the balance of payments for underdeveloped economies.

The coefficient on relative prices makes it clear that a rise in the local price level relative to world prices causes a fall in the balance of trade. This is in agreement with received theory. It may also suggest that Harrod's (1952) doctrine, according to which devaluation worsens rather than improves the balance of trade, is not relevant for Jamaica. However, this is only a tentative conclusion. The thrust of that argument is that devaluation can actually cause the domestic price level to rise if the demand for imported inputs is inelastic and this is clearly the case in Jamaica. More research is needed to discover if the adverse effect on imported inputs of a change in the terms of trade brought about by devaluation outweighs the beneficial effects on trade in final goods, of an adjustment in relative prices. Nonetheless, the finding on this coefficient should be of some value to policy makers in Jamaica.

The coefficient on the 'crisis' dummy suggests that the measures introduced in the last quarter of 1969 had the desired impact on the decline in the trade balance.

The Capital Outflow Function

The capital outflow function developed in Chapter III is meant to represent a synthesis of both the Branson and monetarist versions of the stock adjustment model. The results from estimating that function are

$$K = -0.67 - 0.05(\Delta i_D - \Delta i_F) + 1.18T + 1.16\Delta DO + 0.0004\Delta W + 0.06\Delta Y \qquad 29$$

$$(t=-0.58) \quad (-0.03) \quad (8.81) \quad (1.80) \quad (0.84) \quad (1.49)$$

$$\bar{R}^2=0.69; \quad S.E.E.=4.6; \quad d=1.75$$

In this regression, the coefficients on relative changes in interest rates, the balance of trade, change in the domestic assets of the central bank and the change in world income all have the right signs. That on the change in the level of domestic income differs from what was predicted in Section III.

However although the sign of the coefficient on the interest rate variable is what was expected, this coefficient does not differ significantly from zero. This appears to confirm the view expressed to me by Jamaican economists that most of the capital movements between the rest of the world and Jamaica during the 1960's was undertaken by the multi-national bauxite corporations and was not very sensitive to short-term interest rates movements. The problem here was anticipated in Chapter III when I admitted that the capital outflow variable in the model might be too aggregative to enable us to test the modern theory of international capital movements adequately. Nonetheless the coefficients on the other two major variables are significant at the 95 percent level and over.

It will be recalled that the monetarist version of the stock adjustment model of capital flows predicts that the coefficients on the balance of trade and the change in domestic assets of the central bank should be similar. This turns out to be the case in Jamaica. The coefficients are close to unity. In the monetarist model this is evidence of perfect capital mobility. But it was made clear in Section III that the capital outflow function in this thesis is meant to reflect a synthesis of the Branson model and the monetarist model; so the value of those coefficients should not be interpreted necessarily as proof of any exclusive monetarist hypothesis. Branson's and Hill's (1971) purpose for including a balance of trade variable is to capture the effect of trade credit on capital flows. Th... effect also might be expected to produce a coefficient close to unity in an economy like Jamaica.

The coefficient on the change in the proxy for world income has the sign predicted by monetarists for a given rate of change in the world money supply. However the value of this coefficient does not differ significantly from zero.

Finally in the capital outflow function, the coefficient on the change in domestic income has a positive sign and is significant at the 90 percent level for the one-tailed test. This means that as Jamaicans became richer they demanded relatively more foreign assets. This finding is contrary to what is predicted by monetarists and what was expected in this thesis. However, it is consistent with the accusation made by certain Jamaicans against some of their wealthy compatriots. These are sometimes accused of exporting wealth that is needed for the development of the country.

Slightly more than 30 percent of the variance in capital movements between Jamaica and the rest of the world is left unexplained by the present model. This probably reflects the fact that the explanatory equation does not include a variable to capture the stock or scale effect of capital movements. The modern theory of capital flows shows unambiguously that such an effect is important. However, as it was pointed out in Chapter III, it is usually difficult to find data that are useful for incorporating that effect. Such was the case in this study.

The Domestic Price Level Function

When equation 19 was estimated by the straightforward 2SLS method, the sole independent variable and the intercept explained 97 percent of the variance of the domestic price level. However the Durbin Watson statistic was 0.43 signifying a very high degree of negative autocorrelation. It seemed desirable to tackle this problem.

Fair (1970) has developed a consistent estimator that combines the properties of 2SLS and the Cochrane and Orcutt iterative least squares method. A problem with this method, is that it requires in addition to the use of all the predetermined variables in the model as regressors at the first stage, those also of the lag of the predetermined variables, the lag of the included endogenous variables and the lag of the regressand. The use of all these variables as first stage regressors greatly increases the danger of multicollinearity and reduces the degrees of freedom available for estimating the first stage.

To over come this problem, I replaced the predetermined variables and the lag of the predetermined variables which are excluded from equation 19 with a vector of their principal components. A simple treatment of this approach, which incidentally takes special note of the problems incurred in estimating simultaneous equations models for less developed economies, is given by Klein (1973). The results from estimating the transformed equation are

$$P_D = 133.3 + 16.3P_F \qquad (30)$$

$$(t=96.4) \quad (13.7)$$

$$\bar{R}^2=0.97; \; S.E.E.=1.6; \; d=1.9$$

As expected, nearly all the variance in the domestic price level can be explained by an index of the price of imports. This is ample confirmation of the hypothesis, first stated by Brewster (1968) and accepted in this thesis, that the determinant of the price level in Jamaica and other Caribbean economies is the cost of imported inputs, including food, for domestic production.

The Impact Multipliers of the Model

In view of the fact that the model is a short-run one, I have derived in absolute terms the impact multipliers with respect to the predetermined variables for those six endogenous variables that are functions in the model. These multipliers are given in Table I. Each element in the coefficient matrix shows the direct impact on the now endogenous variable of a unit change in the column predetermined variable when the other predetermined variables are held constant. A blank element indicates that the t statistic of the coefficient is less than unity. Although impact multipliers are of limited value for the construction of economic policy, they may help decision makers to understand the short-term impact of a change in monetary policy on some crucial endogenous variable, for instance the impact of a unit rise in balance of trade performance. To this extent, the entries in the last column may be of considerable interest.

TABLE I

Endogenous Variables	Predetermined Variables											
	ΔR	ΔW	P_F	i_F	$i_{F(t-1)}$	Y_{t-1}	M^s_{t-1}	P_{t-1}	$\hat{P}_{t-1}$	$\hat{P}_{t-2}$	i_{t-1}	H_{t-1}
ΔM^s			22.3			-0.09	0.6				1.6	
m^d			0.07			-0.0006	0.001		0.04			0.003
A	-1.0		66.6			-0.2			-20.7	-14.7		
T	-0.3		3.2			0.08	-0.2				1.3	-0.4
K	-0.8		-5.0			0.2					2.5	
P_D	-0.1		17.2	-1.7		0.03	0.1				-0.2	-0.3

V. Testing The Model

The first test applied to the model is to determine whether the identifying restrictions were correctly employed. The problem addressed here stems from the use of 2SLS to estimate a system which contains several over-identified equations. In order to produce unique estimates of the structural parameters in these equations 2SLS makes use of predetermined variables in the system excluded from individual equations. This first test given by Basmann (1960) is to discover if predetermined variables that have been excluded from individual equations were correctly excluded.

This test compares the unexplained variation (e'e) in the dependent variables in the structural model, with the unexplained variation that would result from making the endogenous variables in each equation a function of all the predetermined variables in the system (w'w). If predetermined variables are correctly excluded, there should be no significant difference between e'e and w'w. That is, the ratio e'e/w'w should be close to unity.

The Basmann test has an F distribution with (n-g+1) and (T-K) degrees of freedom where n is the number of excluded predetermined variables, g is the number of endogenous variables, T is the number of observations and K is the total number of predetermined variables. It is written

$$F = \left\{ (e'e/w'w) - 1 \right\} \left\{ (T-K)/(n-g+1) \right\}$$

A computed F less than the critical value of F (F_c), indicates that the related equation is well-specified in terms of the predetermined variables in the model. The results of the Basmann test are given in Table II.

TABLE II

Equation	e'e	w'w	F	F_c
4.1	1138.16	573.0	3.80	3.39
4.2	0.059	0.041	2.96	4.11
4.3	539.0	518.01	0.14	3.39
4.4	676.1	561.8	0.92	3.56
4.5	1704.3	1003.3	3.49	3.86
4.6	98.7	78.6	0.66	3.06

Only the change in the money supply equation fails (marginally) to pass the specification test. Therefore we can look forward with some interest to the predictive power of the model.

The model was tested for its forecasting accuracy using as a measure of performance Theil's (1966) Inequality Coefficient. This coefficient is yielded by the formula

$$U = \left[\Sigma(P_t - A_t)^2 / \Sigma A_t^2\right]^{\frac{1}{2}}.$$

where P_t is the predicted value and A_t the actual value of the variable being predicted. It is bounded by zero and infinity. A value close to zero indicates a good forecast whereas a value greater than unity indicates a fairly inefficient forecast. The coefficient is implicitly compared to the naive forecast of no change in the variable. However I have compared the forecasts from the model with the forecasts yielded by a more rigorous naive predictor according to which, for any variable z,

$$z_{t+1} = a_1 z_t + a_2(z_t - z_{t-1})$$

The Theil Inequality Coefficient for the naive forecast is given in the last column of Table III under the heading U'. In fact, this turns out to be a very powerful forecast test, for as Nelson (1973) has remarked: "Because of the strong tendency economic time series have to maintain their level of rate of change, these naive predictors are often hard to beat." It will be seen that the model beats this naive predictor in all but one case, the change in the money supply function. The OLS estimates of the reduced form of the model were used to generate the forecasts.

TABLE III

Quarter	Forecast	Observed	Error	U	U'
A. Change in the Money Supply					
3/1971	4.87	12.60			
4/1971	1.83	19.80			
1/1972	-4.86	-8.10			
2/1972	0.62	12.00			
Average absolute error			10.08		
Theil Inequality Coefficient				0.83	0.36
B. Real Balance Demand					
3/1971	0.82	0.85			
4/1971	0.86	0.97			
1/1972	0.92	0.92			
2/1972	0.90	0.98			
Average absolute error			0.056		
Theil Inequality Coefficient				0.076	0.03
C. Absorption					
3/1971	305.3	317.4			
4/1971	326.1	316.0			
1/1972	341.2	307.7			
2/1972	332.8	344.3			
Average absolute error			16.80		
Theil Inequality Coefficient				0.060	0.91

Quarter	Forecast	Observed	Error	U	U'
	D. Balance of Trade				
3/1971	-15.39	-19.60			
4/1971	-16.23	-19.50			
1/1972	-21.44	-20.70			
2/1972	-21.88	-23.20			
	Average absolute error		2.38		
	Theil Inequality Coefficient			0.133	0.99
	E. Capital Outflow				
3/1971	-15.53	-15.18			
4/1971	-18.13	-29.06			
1/1972	-22.99	-46.70			
2/1972	-32.66	-2.62			
	Average absolute error		16.26		
	Theil Inequality Coefficient			0.695	0.82
	F. Domestic Price Level				
3/1971	162.6	165.0			
4/1971	167.5	165.0			
1/1972	171.8	165.0			
2/1972	170.9	167.0			
	Average absolute error		3.88		
	Theil Inequality Coefficient			0.025	0.47

Table III must be interpreted as showing that in every case the model forecasts better than the naive forecast implicit in the Theil Coefficient. However, it is well-known that accurate forecasts by themselves do not establish the validity of a model. It is doubtful whether any econometric criterion that establishes the validity of an econometric model will ever exist. But in an economy where many of the strategic variables are beyond the control of the authorities, some method of forecasting the values of these variables is desirable. Although the model in this study is small, it has embedded some of the key monetary variables of a developing economy in a structure based on sound economic theory. And as Klein (1968) asserted, "best predictions will be made from best structural models". The forecasting ability of the model is recommended with the above caveat and testimonial equally in mind.

VI. Summary And Conclusions

This paper reported a small econometric model of open developing economies and estimated it for Jamaica in the 1960's. Two major theoretical insights emerged. (1) Linder's (1967) theory of trade for developing countries, appropriately complements modern balance of payments theory in particular the absorption model. (2) Open developing economies may be characterised by a stable demand for money function in which the choice at the margin is between narrow money and some form or other of physical capital.

The study reviewed some previous attempt to construct econometric models for the Jamaican economy and indicated a number of errors that were committed. This study is not perfect, but it has avoided all of the errors it has discussed. Its major weakness appears to have been an incorrect specification of the central bank's reaction function. It should be possible to improve this without changing the basic structure of the model.

Finally, the parameter estimates discussed above confirm that the Jamaican economy in the 1960's behaved exactly in the manner Linder (1967) outlines. It is difficult to evade the conclusion that the policy makers of Jamaica in the early 1970's were mistaken about the structure of the Jamaican economy.

Appendix 1: Variables in the Structural Model

Endogenous Variables		Pre-determined Variables	
H	= high-powered money	ΔR_t	= change in banks' reserves
M^S	= money supply	ΔW	= change in world income
m^d	= real money demand	P_F	= foreign prices
A	= absorption	i_F	= foreign interest rate
T	= balance of trade	$i_{F(t-1)}$	
K	= capital outflows	Y_{t-1}	
P_D	= domestic price level*	M^S_{t-1}	
Y	= nominal income	P_{t-1}	
B	= balance of payments	$\dot{P}_{t-1}$	
i_D	= nominal interest rate	$\dot{P}_{t-2}$	
r	= real interest rate	i_{t-1}	
ΔDO	= change in domestic assets of the central bank.	H_{t-1}	

* Note that $\dot{P}_{t-1}$ is defined to be the expected rate of inflation by invoking the extrapolative hypothesis and imposing extreme values.

Appendix 2: Data

All the data used in the study are taken from the International Financial Statistics of the International Monetary Fund.

This source does not publish quarterly data on income and absorption and these are not available for Jamaica in any other source. Following Bourne (1974) the quarterly series for these variables were derived from the annual series by a linear interpolation subjected to the constraint that the interpolated quarterly values of merchandise imports were used as weights in the interpolation.

Throughout the study the domestic interest rate refers to the yield on Jamaican treasury bills and the foreign interest rate to the U.K. treasury bill rate.

The domestic price level is the Kingston consumer price index. The derivation of the foreign price index is described in the text.

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