

SOCIO-ECONOMIC CONSTRAINTS ON JAMAICA'S STABILIZATION EFFORTS: THE IMPORTANCE OF SUPPLY-SIDE PROGRAMS

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Abstract—Recently, there has been considerable interest in alternative stabilization programs in developing countries. This paper examines the possibility of implementing this type of program in a country that traditionally has had considerable difficulty in complying with International Monetary Fund programs. The macro-economic simulations of Jamaica's economy clearly show that successful supply-side policies could have mitigated the adverse income effects of stabilization associated with the standard IMF approach to stabilization.

INTRODUCTION

There has been only limited formal quantitative analysis of the effects that alternative stabilization programs may have on the Jamaican economy. This, of course, has considerable implications for the International Monetary Fund's lending operations in Jamaica since relationships such as that between the money supply and growth are implicit in the stabilization programs that have been agreed to by the Jamaican government.

Evaluation of the IMF programs in Jamaica, together with the criticisms of these efforts, requires a macro-economic model with a framework where there is a fairly well-defined relationship between money, the balance of payments and domestic prices, in which the supply of and demand for money play a central linking role. The effects of policies on the real sector should also be treated explicitly.

Once a model of the economy has been specified, a computer simulation can be used to determine and compare the results of the different IMF or government policies. Presumably, with this information one could choose a policy which, though not necessarily optimal, is better than alternative policy packages. The approach developed below is that of optimal control. The formulation of short-term stabilization policy in Jamaica seems particularly amenable to optimal control. A goal of this paper will be to show that if one can work with a linear or linearized econometric model of the Jamaican economy, together with a quadratic cost function, then optimal control theory can provide a viable tool for: (1) analyzing and understanding the dynamic properties of the Jamaican economy; (2) formulating stabilization policies based on the model; (3) better understanding in a quantitative way the tradeoffs that the Jamaican economic policy-maker and IMF were faced with during the late 1970s.

SPECIFICATION OF THE MODEL

The estimated model contains 13 behavioral equations. Such simplicity was dictated mainly by a desire

to focus on the general aspects of the issues considered here and to develop an analysis that is applicable specifically to the Jamaican economy [1]. Any attempt to construct a more disaggregated model for the country would immediately run into the constraints of the limited availability of data [2].

Essentially, this model describes an economy that is:

- (1) small relative to the rest of the world;
- (2) open to international trade and financial flows;
- (3) maintaining a pegged exchange rate—this does not mean that the exchange rate cannot be altered, but only that it is policy determined, and
- (4) characterized by a relatively underdeveloped financial sector. This specifically implies that the number of financial assets that could substitute for money holdings is very limited, and/or that the authorities control the interest rates of those assets that are available.

The stochastic equations of the model explain inflation, the overall balance of payments, the fiscal budget (i.e. government expenditure and revenues), real output, money supply, domestic credit, the current account, government and private sector consumption and investment.

INFLATION

The specification for price changes is an extension of the monetary disequilibrium model of Goldman [3] to an open economy. The Jamaican rate of inflation relative to the world rate of price increase is assumed to be positively related to the excess supply of real money balances, and a function of the deviation of domestic prices from their equilibrium (purchasing power parity) level. Formally, the specification is written:

$$\begin{aligned} \text{INFC} = & a^1 [\text{MIPL} - \text{MIP}^d] \\ & - a^2 [\text{CPIL} - \text{EXAE} \cdot \text{USCPI} - b_0] \\ & + a^3 [\text{GEXAE} \cdot \text{USCPI}] + C_1 \end{aligned} \quad (1)$$

where:

INFC = the Jamaican rate of inflation (consumer price index).

EXAE = Jamaican exchange rate in units of Jamaican dollars per U.S. dollar.

USCPE = United States consumer price index.

MIP = stock of real money balances (MI) deflated by the Jamaican consumer price index.

L = lagged one year.

GEXAE = the rate of growth of EXAE.

The superscript denotes demand.

On the simplifying assumption that the country's equilibrium exchange rate did not change secularly, b_0 may be used as a parameter rather than varying over time. If there is no excess demand for real money balances and domestic prices are equal to their equilibrium level b_0 , then with the exchange rate fixed, the rate of Jamaican inflation will be equal to the rate of inflation prevailing in the United States (the country's major trading partner). This result of course assumes that Jamaican policy-makers always attempt to keep their country's prices in line with those charged in the United States.

Divergences from this equilibrium relationship can arise from two sources:

(1) any expansion of the money stock that results in an excess supply of real money balances will (in the next period) create inflationary pressures that tend to eliminate the disequilibrium in the money market;

(2) if domestic prices are pushed away from the equilibrium level, for whatever reason, they will move in the direction that restores the relationship.

In a sense, the second term in eqn (1) represents a type of "catch up" effect to any erosion that may occur in the country's international competitiveness.

Feeding into eqn (1) is the stock demand for real money balances. Here we follow the standard literature [4] in relating money demand to received income (GDPNP) and to the expected rate of inflation (INFCE).

$$M_t P^d = b_1 + a_4 \text{GDPNP} - a_5 \text{INFCE} \quad (2)$$

This formulation which is typically used for developing countries [5], differs from theoretical models in excluding the rates of interest from other financial assets from affecting money demand. This follows directly from the aforementioned assumption regarding the paucity of financial alternatives to money in Jamaica. The relevant substitution in the country is, therefore, between money and goods or real assets, with the opportunity cost being the expected rate of inflation.

Substituting eqn (2) into eqn (1) leads to the equation in its estimating form:

$$\begin{aligned} \text{INFC} = & (a_2 b_0 - a_1 b_1) \\ & + a_1 [\text{MiPL} - a_4 \text{GDPNP} + a_5 \text{INFCE}] \\ & - a_2 [\text{CPIL} - \text{EXAE} - \text{USCPIL}] \\ & + a_3 [\text{GEXAE} + \text{GUSCPI}] + C_1 \quad (3) \end{aligned}$$

BALANCE OF PAYMENTS

The overall balance of payments, as represented by the change in the stock of international reserves (in terms of domestic currency) is specified as a positive function of the excess demand for nominal money balances and a negative function of the deviation of the domestic price level from its purchasing power parity equilibrium.

$$\begin{aligned} \text{DR} - \text{DEXAE} = & a_6 [\text{MI}^d - \text{MIL}] \\ & - a_7 [\text{CPIL} - \text{EXAEL} \cdot \text{USCPIL}] - b_0 \quad (4) \end{aligned}$$

where:

DR = the change in the net stock of international reserves.

MI = nominal stock of narrow money.

In eqn (4) variations in the domestic currency value of foreign exchange reserves that are due solely to exchange rate movements are eliminated by subtracting the percentage change in the exchange rate from the left hand side of the equation. (This has to be done because such variation changes do not affect the domestic money stock or the excess demand for money.)

Equation (4) is a dynamic version of models in the tradition of the monetary approach to the balance of payments and, following that literature, it does not distinguish between the current capital accounts of the balance of payments. It makes no prediction as to whether domestic residents rid themselves of excess money balances by increasing expenditure (i.e. absorption) relative to output, or by purchasing financial assets abroad.

The second term, which says that the balance of payments will deteriorate when domestic prices increase relative to foreign prices, does not reflect current account factors alone since such a decline in the country's competitive position may induce domestic asset holders to export capital on the expectation that the probability of a future devaluation of the (fixed) exchange rate has increased [6]. Thus, the present treatment of the overall balance of payments in a single equation is consistent with our treatment of domestic financial markets.

Most empirical applications of the monetary approach to the balance of payments assume that the change in a country's international reserves is exactly equal to the difference between the flow demand for money and the flow supply of domestically created money. This standard assumption does not seem very realistic in the context of Jamaica, where the degree of international mobility of goods and assets may not be sufficient to allow an excess supply of money to be offset fully and instantaneously by balance of payments leakages.

The equation that is specified here for international reserves is consistent with the broad framework of the monetary approach, but it includes a degree of dynamic adjustment as measured by the parameter a_6 . Thus, it allows for inertia in the response of reserve flows to monetary disequilibrium in the short run, while still retaining the feature that the effect of an expansion in domestic credit on the money stock is completely offset in the long run.

Substituting for the nominal demand for money gives:

$$\begin{aligned} DR = a_6 [b_1 + a_4 \text{GDPNP} - a_5 \text{INFCE} + \text{CPI} - \text{M1}] \\ - a_7 [\text{CPIL} - \text{EXAE} - \text{USCPIL} - b_0] \\ \text{GEXAE} \end{aligned} \quad (5)$$

GOVERNMENT SECTOR

Fiscal policy and the government's budgetary position are modeled explicitly because of the crucial role that they play in the money supply process in Jamaica and in overall economic activity in the country. It is hypothesized that in most cases excess demand in the economy can be traced back to deficits of the public sector. Clearly, this assumption underlies the IMF's requirement in the late 1970s to reduce the fiscal deficit and limit credit from the Bank of Jamaica to the public sector. The causes of these effects and their impact on the economy are therefore important questions that need to be handled in any analysis where one must make recommendations about desirable changes in domestic credit policy.

The model of the government sector that we utilize assumes that nominal government expenditure adjusts proportionally to the difference between the authorities' target spending and the actual level of expenditure in the previous period [7].

$$\text{GE} = a_8 [\text{GE}^* - \text{GEL}] \quad (6)$$

where:

GE and GE* are the actual and derived levels of nominal government expenditures, respectively and a_8 is the coefficient of adjustment.

The derived level of government expenditure is simply related to the level of nominal income.

$$\text{GE}^* = b_2 + a_9 [\text{GDPNP} + \text{CPI}] \quad (7)$$

Until 1972 it was probably reasonable to assume that in the long run the government wished to increase its expenditure in line with the growth of nominal income, and therefore one would expect *a priori* that the income elasticity (a_9) would be equal or close to unity. Such a restriction would normally also be required to ensure that the overall model has a steady state solution when capacity income and foreign prices, or the exchange rate are allowed to change over time. This constraint is not imposed on the model during estimation, since there is no reason to suppose that it has held during the sample period, especially in light of the change in government priorities during the Manley administration (1972-1980).

Substituting eqn (7) in eqn (6) and solving for the level of government expenditure one obtains:

$$\begin{aligned} \text{GE} = a_8 b_2 + a_8 a_9 [\text{GDPNP} + \text{CPI}] \\ + (1 - a_8) \text{GEL} \end{aligned} \quad (8)$$

As with expenditure nominal government revenues (GR) are assumed to adjust to the difference between planned revenues (GR*) and actual revenues obtained in the previous period.

$$\text{DGR} = a_{10} [\text{GR}^* - \text{GRL}] \quad (9)$$

Desired nominal revenues are assumed to be a function of nominal income.

$$\text{GR}^* = b_3 + a_{11} [\text{GDPNP} + \text{CPI}] \quad (10)$$

Substituting from this equation for GR* in eqn (9) gives:

$$\begin{aligned} \text{GR} = a_{10} b_3 + a_{10} a_{11} [\text{GDPNP} + \text{CPI}] \\ + (1 - a_{10}) \text{GRL} \end{aligned} \quad (11)$$

REAL INCOME

Reflecting the short term perspective of the applied IMF stabilization programs, the model focuses on determining the deviations of actual output from its full capacity level, rather than on capacity output itself. Since capacity output is treated as exogenous to the model, such factors as capital accumulation, population growth and technical progress are not considered here. However, because this model distinguished clearly between capacity output and current output, it would not be difficult to extend it to allow for endogenous capacity growth if a more detailed analysis of the supply side of the economy were desired; for example, in the context of the programs after 1980 designed for purposes of structural adjustment.

It is assumed that the rate of growth of output in Jamaica is positively related to: (1) the excess stock of real money balances, (2) the so-called output gap, represented here by the difference between normal capacity output and actual output of the period, and (3) the impact of the trend in real government expenditure on output.

$$\begin{aligned} \text{GDPNP} = a_{12} [\text{M}_2 \text{PL} - \text{M}_1 \text{P}^*] \\ + a_{13} [\text{GDPNP}^* - \text{GDPNPL}] \\ + a_{14} [\text{GEHEX}] + \text{C}_2 \end{aligned} \quad (12)$$

where:

GDPNP = real gross domestic product $\text{M}_2 \text{P}$ = real stock of broad money (M_2) GEHEX = the rate of growth in real government expenditure 1960-1980. GDPNP is the normal level of output. This latter variable is simply proxied by the trend level of real income:

$$\text{GDPNP}^* = \text{YHT} \quad (13)$$

where:

YHT = the linear trend in GDPNP. It follows that:

$$\text{YHTE} = \text{GDPNP}^* - \text{GDPNPL} \quad (14)$$

It is assumed that the sign on the trend in government expenditures is positive (along Keynesian lines). However, it should be noted that the expansion in government expenditures which accompanied the deflationary monetary policies in the late 1970s did not generate adequate investment while the structure of revenue of expenditure and of the government debt which evolved created additional difficulties. The burden of maintaining economic activity was largely on government expenditure at a time when revenues were constrained.

Brown feels that the overall rate of expansion of government expenditures was "not in itself the main

source of difficulty, particularly since an expansionary fiscal program was necessary to insulate the domestic economy from the deflationary policies addressed to the balance of payments. Specific difficulties arose from the fact that the financing of this expenditure increasingly relied on central bank financing, on extending the scope of indirect taxes, and on external short term loans" [8].

This formulation assumes that any disequilibrium in the money market will result in a temporary expansion of real income and/or, conversely, any tightening of monetary policy that results in a fall in real money balances will have output consequences through hoarding effects on the level of real expenditure. The degree to which this occurs is measured by the parameter a_{12} . While there are no strong theoretical priors on the size of this parameter, conventional wisdom would probably tend to argue that it would be small. However, this is clearly an empirical question.

Substituting for M_2^d and $GDPNP^*$ in eqn (12) yields:

$$\begin{aligned} GDPNP = & a_{12}[-b_1 + M_2PL - a_4GDPNP \\ & + a_5INFCE] + a_{13}[YHTE] \\ & + [GEHEX] + C_2 \end{aligned} \quad (15)$$

Or, in terms of the level of real income:

$$\begin{aligned} (1 + a_{12}a_4)GNPNP \\ = a_{12}[-b + M_2PL + a_5INFCE] \\ + a_{13}[YHTE] + a_{13}[GEHEX] + C_2 \end{aligned} \quad (16)$$

EXPECTED INFLATION

The expected rate of inflation follows the formulation of Harberger [9] and is equal to the current rate of inflation minus that of the prior year, or:

$$INFCE = INFC - INFCL \quad (17)$$

While this formulation is arbitrary and does not fit easily into the currently popular rational expectations framework [10], it has the advantage of simplicity, given no other data series for Jamaica [11].

DOMESTIC CREDIT AND MONEY SUPPLY

Generally speaking, in an open economy such as Jamaica's, the domestic component of the money stock—the level of domestic credit extended by the banking system—is taken to be the basic monetary tool. However, any model for a developing country must recognize the linkage that exists between government fiscal operations and the supply of money. For this reason, domestic credit is assumed to be determined endogenously. More specifically, changes in domestic credit (DDC) can take place through changes in the banking system's claims on the government (DGG) and on the private sector (DCP), that is:

$$DDC = DCG + DCP, \text{ or} \quad (18)$$

$$DDC = DCG + DCP + DCL \quad (19)$$

If all changes in claims on the government are a reflection of the fiscal deficit of the government, then

eqn (19) can be written as:

$$DC + GE - GR + DCP + DCL \quad (20)$$

In this formulation, any expansion of the fiscal deficit results in an equivalent increase in the stock of domestic credit. This simply assumes that the government finances its deficit by borrowing from the banking system, using its cash balances held with banks or by borrowing abroad and converting the proceeds into domestic currency. Only if the government were able to borrow domestically from the non-bank sector—say by selling bonds or bills—would this identity break down. It is obvious that here the assumption of the lack of a sufficiently developed domestic market for securities, government or otherwise, becomes crucial. Despite Jamaica's recent progress in the development of these markets, the scope for such borrowing is fairly limited thereby confirming the appropriateness of the definition contained in eqn (20).

The supply of money (M_2)—broadly defined to include current demand deposits and time and savings deposits—is identically equal to the net stock of international reserves (in domestic currency terms) and the level of net domestic credit extended by the banking system:

$$M_2 = R + DC \quad (21)$$

For estimation purposes, the identities of domestic credit and the money supply were estimated using the following formulation:

$$DC = a_{15}GE - a_{16}GR + a_{17}DCP + a_{18}DCL \quad (22)$$

and for the money supply:

$$\begin{aligned} a_{19}M_1 = & M_1L + a_{20}[EXAE + GRL] \\ & - a_{21}[EXAEL + RL] + a_{22}DC \\ & - a_{23}DCL + b_5 \end{aligned} \quad (23)$$

$$\begin{aligned} a_{24}M_2 = & M_2L + a_{25}[EXAE + R] \\ & - a_{26}[EXAEL + RL] \\ & - a_{27}DC - a_{28}DCL + b_6 \end{aligned} \quad (24)$$

THE CURRENT ACCOUNT

Throughout most of the 1970s, a combination of events caused the international economic environment to become less conducive to stable growth for the country, and in particular made its balance of payments adjustment much more difficult. The substantial fluctuations in the world market prices of primary commodities, the sharp increases in the price of energy products, the slowdown of economic activity in the industrial countries, and the rise in real interest rates toward the end of the period were all major contributors to the serious deterioration in the country's current account position. At the same time, domestic developments in the country played a significant role in exacerbating payments disequilibrium. In particular, the government's inflationary demand-management policies—undoubtedly combined with a relatively rigid exchange rate and restrictions on trade and payments—resulted in domestic demand pressures and a cumulative loss in

Table 1. Jamaica: trends in investment, 1969-1976

(Millions of Jamaican dollars)	1969	1970	1971	1972	1973	1974	1975	1976
Gross fixed capital formation	315.3	367.1	356.0	366.8	448.2	478.2	609.6	450.8
Gross accumulation	348.9	369.2	411.5	393.4	541.8	525.0	670.1	494.4
Increase in stocks	33.6	2.1	55.5	26.6	93.6	47.0	60.5	43.6
Government investment	12.4	15.8	18.2	23.4	26.1	36.5	58.1	69.1
Private investment	302.9	351.3	337.8	343.4	422.1	441.7	551.5	381.7
(% of gross domestic product)								
Gross fixed capital formation	31.8	31.4	27.8	25.5	25.8	22.0	23.4	16.6
Gross accumulation	35.2	31.6	32.2	27.3	31.2	24.2	25.7	18.2
Increase in stocks	3.4	0.2	4.3	1.9	5.4	2.2	2.3	1.6
Government investment	1.3	1.4	1.4	1.6	1.5	1.7	2.2	2.5
Private investment	30.5	30.2	26.4	23.9	24.3	20.4	21.1	14.1

Source: Department of Statistics. *National Income and Product*, various issues.

international competitiveness that also gave rise to current account difficulties.

With respect to the terms of trade, what Jamaica apparently lost from the inflation of oil and non-oil prices appears to have been gained back from higher bauxite, alumina and sugar so that the terms of trade generally did not turn against her over this period [12].

Based on the above considerations of the likely internal and external factors that have effected Jamaica's balance of payments, the following equation was specified [13] for estimating the current account:

$$DCA = a_{29}TOT + a_3GYIC - a_{31}RRI - a_{32}RER - a_{33}GEHTE \quad (25)$$

where

DCA = Changes in the current account balance (other measures of the balances of payments included; DTA = changes in the trade account; DCAA = changes in the trade plus service accounts; DCAB = CAA + changes in private transfers—excluding official transfers). TOT = terms of trade. GYIC = Growth of real GNP in the industrial countries. RRI = Real foreign interest rate. RER = Real effective exchange rate. GEHTE = Deviations from the linear trend of real government expenditures.

Equation (24) can be viewed as an unrestricted reduced form relationship that is derived from a structural model of the components of the current account—imports and net service payments. The chief advantage of this formulation is that it allows separate identification of the relative importance of

external factors TOT, GYIC and RRI from domestic factors RER and GEHTE.

PRIVATE INVESTMENT

Private investment (Tables 1 and 2) is assumed to be positively affected by: (1) an accelerator mechanism (depicted by the change in real GDP (DGDPNP)); (2) the activity of the public sector (both directly through "crowding out" and indirectly through effecting the investment climate); and (3) inflationary expectations.

Clearly private investment is affected by inflows of capital. Foreign private capital inflows have always played a key role in the balance of payments and capital formation in Jamaica [14]. In the late 1960s and early 1970s, during a major expansion of the bauxite sector, net foreign capital inflows made up 20-25% of all foreign exchange receipts and contributed up to 30% of domestic capital formation.

After the completion of these major investments in 1971, foreign direct investment declined and by 1975 there was a net capital outflow. One of the major reasons for the worsening balance of payments in 1975 and 1976 was the precipitous drop in long term private net capital inflows from J\$139 million in 1974 to J\$30.5 million in 1976. This reduction in private capital inflows was only partly offset by the growth of official foreign borrowing on the Eurodollar markets between 1973 and 1976.

It has been argued [15] that the decline in foreign financing in Jamaica after 1975 was mainly the result of domestic rather than external factors, in so far as the internal incentives offered to foreign investors were not sufficiently attractive from 1974 onwards

Table 2. Jamaica: trends in investment, 1977-1982

(Millions of Jamaican dollars)	1977	1978	1979	1980	1981	1982
Gross fixed capital formation	349.5	498.9	748.2	690.1	954.3	1153.6
Gross accumulation	365.1	568.7	813.6	737.2	1114.1	1155.8
Increase in stocks	15.6	69.8	65.4	47.1	159.8	2.2
Government investment	114.9	187.3	249.7	349.2	430.8	601.5
Private investment	234.6	311.6	228.4	340.9	523.5	552.1
(% of gross domestic product)						
Gross fixed capital formation	11.8	13.4	17.5	14.6	18.2	20.3
Gross accumulation	12.4	15.2	19.1	15.6	21.3	20.4
Increase in stocks	0.5	1.9	1.5	1.0	3.1	0.1
Government investment	3.9	5.0	5.9	7.4	8.2	10.6
Private investment	8.0	8.4	5.4	7.2	10.0	9.7

Source: Department of Statistics. *National Income and Product*.

and the social and political climate was a major disincentive to foreign capital.

In addition to affecting foreign capital flows, the public sector in Jamaica has had a strong impact on savings investment decisions, both directly through the choice of public investment projects and indirectly through the impact of its taxing, spending and domestic credit policies on decisions taken by the private sector. It has been shown [16] that unless the supply of foreign savings to the domestic economy is perfectly elastic, private sector capital formation and the growth of private sector potential output will be retarded by ceilings that hold real interest rates below their equilibrium levels, by taxes on savings, or increased public sector deficits. However, the effect of such policies on the growth of total potential output (including both the private and public sectors) depends critically on what the authorities do with the funds that these policies put at their disposal. Many types of government policies may be easily justifiable in global terms, even if they tend to compress private sector fixed capital formation. For example, it may be argued that taxing or running deficits to finance public sector infrastructural investments, education and manpower training, etc. will yield external economies that increase the return on private investment and thus the rate of growth of total potential output. Even here, of course, taxing or deficit spending policies impose the usual dead-weight loss on the static efficiency of the saving-investment process.

Here the net impact of the government budget seems to have been negative in that the government's deficit also contributed to crowding out of private investment. The deficit (in real terms) increased from J\$41 million (4% of GNP) in 1976. Nominal central bank credit to the central government increased from J\$4 million in 1971 to J\$402 million in 1977. Commercial banks lending to the government increased rapidly as well, from J\$44 million (11% of bank assets) in 1970 to J\$248 million (33% of bank assets) in 1977.

Apart from causing inflation, this massive expansion of government debt displaced private sector debt, including that of productive enterprises. Government debt as a percentage of total debt rose from 11% in 1970 to 50% in 1977. Furthermore, the average ratio of taxes to GNP increased from 0.17 in 1970 to 0.28 in 1977. Through its credit and fiscal operations the Jamaican government succeeded in bidding away real resources on an increasing scale [17].

The share of government in total consumption expenditures rose from 17% in 1970 to 24% in 1977. No data is available on its share in total imports. However, the exemption of government transactions from the stringent import restrictions implies that government's share became larger. "In effect the government facilitated its own requirements by crowding out the import demands of the private sector" [18].

Unfortunately, during this period public sector expenditures appear to have on the balance negatively affected private investment. There were two main difficulties. One was the lack of appropriate functional distinction between public ownership as an

objective of democratic socialist purpose and public ownership as a means of redistribution.

While the political directorate clearly understood the need to complement the new perception of the political framework by altering the economic power structure, the means to change were missing. As the decision-making process did not cohere, and as this was reinforced by political fragmentation, the practice of democratic socialism was more and more conducted within short run constraints oriented to short run objectives. Unfortunately, the need to emphasize appropriate investment policies was paramount, not only because of the attempt to change the political and economic direction. A focus on investment was particularly necessary at that time because this was the only means through which short run deflationary policies, such as were then in existence to protect the balance of payments can be made to complement or at least not retard long run growth prospects [19].

The second negative factor associated with government expenditures was that these expenditures did not extend productive capacity nor did they induce private sector activity. Further, given the economic conditions of the period, the government budget in spite of continuous increases was simply not adequate for the traditional task of filling the gap left by private economic activity. The point is of some relevance for an appraisal of the period after 1976, when business economic activity declined even further. "Given the basic structural characteristics of the economy, the traditional budget structure, whatever the increases, could not generate growth dynamic" [20].

The impacts of government action on private investment are difficult to quantify. There was no significant relationship found between government investment and private investment. Consequently, the level of government consumption (GCNP) was assumed to serve as a proxy for the total impact of government activity on private sector investment. Inflationary expectations for inventory and other anticipatory speculative gains were assumed to be proxied by the change in world market prices from the previous year to that of the prior period [21] (CPIWL).

In summary, private investment was specified as:

$$IPP = a_{34}DGDPNP - a_{35}GCNP + a_{36}CPIWL. \quad (26)$$

PRIVATE CONSUMPTION

Income redistribution and short term employment objectives rather than production objectives appear to have dominated government expenditure and saving (Tables 3 and 4) programs. Thus, basically non-productive programs, such as the Special Employment Program introduced in 1972 as a temporary form of unemployment relief, grew throughout the 1970s. "The trends in government consumption and the social welfare nature of many of the public programs indicate that the main effect of governmental growth was the substitution of public con-

Table 3. Jamaica: patterns of saving, 1969-1976

(Millions of Jamaican dollars)	1969	1970	1971	1972	1973	1974	1975	1976
Government saving	55.8	50.6	64.2	42.8	17.4	123.0	69.5	-24.2
Private saving	190.2	241.0	79.1	233.7	362.9	262.6	370.3	212.7
Depreciation	(93.0)	(117.0)	(122.2)	(144.0)	(172.7)	(204.9)	(230.6)	(248.3)
Other	(97.2)	(124.0)	(-43.1)	(89.8)	(190.7)	(57.7)	(139.7)	(-35.6)
Gross domestic savings	246.0	291.6	143.3	276.5	380.3	385.6	439.8	188.5
Net saving	153.0	174.6	145.6	132.5	207.6	180.7	209.2	-59.8
Net borrowing from rest of world	106.1	85.1	148.2	122.3	168.2	174.8	225.6	302.2
Net capital transfers from rest of world	-3.2	-4.7	-4.5	-5.4	-6.7	-8.2	4.7	3.7
(% of gross domestic product)								
Government saving	5.6	4.3	5.0	3.0	1.0	5.7	2.7	-0.9
Private saving (total)	19.2	20.6	6.2	16.2	21.1	12.2	14.3	7.9
Private saving (other)	9.8	10.6	-3.4	6.2	11.1	2.7	5.4	-1.3
Gross domestic savings	24.8	24.9	11.2	19.2	22.1	17.9	17.0	7.0
Net saving	15.4	14.9	11.4	9.2	12.1	8.4	8.1	2.2
Net borrowing from rest of world	10.7	7.3	11.6	8.5	9.8	8.1	8.7	11.2

Source: Department of Statistics. *National Income and Product*, various issues.

sumption and less productive public expenditures for more productive private expenditures. Bureaucratic growth through its resource allocative effect, further determined the productive capacity and performance of the economy" [22].

In addition to the usual levels of real incomes (GDPNP) and negatively related to declines in wealth caused by domestic inflation (DCPI); or

$$PCNP = a_{37}GDPNP + a_{38}GCNP - a_{39}DCPI. \quad (27)$$

GOVERNMENT CONSUMPTION AND INVESTMENT

For purposes of model simulation real government expenditures (GEHEX) are taken as exogenous. Since the composition of public expenditures appears to be important in affecting both private consumption and simply related to the trend in real government expenditures:

$$GCNP = a_{40}GEHEX \quad (28)$$

where

GCNP = Government consumption

$$IGP = a_{41}GEHEX \quad (29)$$

where

IGP = Government investment.

ESTIMATION RESULTS

The model described in the previous sections was estimated using two stage least squares estimation technique [23]. Several dummy variables were included to take into account structural shifts caused by the oil price increases in the early 1970s, and for changes in political regimes during this period. For the oil price changes, DUMO = 0, 1953-1963 (years of pre-independence); 1, 1962-1972 (JLP administration); 2, 1973-1980 (Manley PNP administration); and 3, 1981-1982 (Seaga JLP administration).

As theoretically expected the results [24] (Table 5) indicate that an excess supply of real money balances results in an increase in the rate of inflation. The monetary theory to the balance of payments appears to explain quite well changes in reserves (DR).

Not surprising is the strong negative impact of the trend in real government expenditures (GEHEX) on real income (GPNP). On the other hand, major determinants of real income are: (1) the difference between capacity; real income and the actual level; and (2) monetary disequilibrium.

The current account balance appears to be affected by both internal (GEHTE) factors and external development (GYICL) and DUMOA). Interestingly, there was a shift over time in the relative importance of internal and external factors with the lagged rate of growth in GNP in the industrial countries

Table 4. Jamaica: patterns of saving, 1977-1982

(Millions of Jamaican dollars)	1977	1978	1979	1980	1981	1982
Government saving	-91.9	-163.6	-63.2	-127.3	-195.1	-449.8
Private saving	332.9	654.0	675.4	593.0	589.6	859.2
Depreciation	(284.2)	(342.7)	(393.7)	(422.8)	(427.6)	(537.3)
Other	(48.7)	(311.3)	(287.1)	(170.2)	(162.0)	(321.9)
Gross domestic savings	241.0	490.4	612.2	465.7	394.5	409.4
Net saving	-43.2	147.7	218.5	42.5	-33.1	-127.9
Net borrowing from rest of world	118.2	62.3	183.7	255.8	701.8	724.1
Net capital transfers from rest of world	5.9	16.0	17.7	16.0	17.8	22.3
(% of gross domestic product)						
Government saving	-3.1	-4.4	-1.5	-2.7	-3.7	-7.9
Private saving (total)	11.3	17.5	15.8	12.5	11.3	15.2
Private saving (other)	1.7	8.3	6.7	3.6	3.1	5.7
Gross domestic savings	8.2	13.4	14.3	9.8	7.5	7.2
Net savings	-1.5	4.0	5.1	0.9	-0.6	2.3
Net borrowing from rest of world	4.0	1.7	4.3	5.4	13.4	12.8
Net capital transfers from rest of world	0.2	0.4	0.4	0.3	0.3	0.4

Source: Department of Statistics. *National Income and Product*, various issues.

Table 5. Jamaica: macro-economic model

(Two stage least squares estimation)						
Inflation (INFC)						
INFC = 0.031 MIPL - 0.0023 GDPNP + 1.69 GUSCIP + 0.14 GEXAE - 3.41 DUMP - 2.55						
	(3.06)	(-2.25)	(4.97)	(2.93)	(-2.96)	(-2.08)
						SE = 2.02 DW = 1.46
Balance of payments (DR)						
DR = 0.007 GDPNP - 0.7 MIL + 85087 CPI - 352.53 CPIL + 0.91 GEXAE - 49.93						
	(2.06)	(-2.39)	(2.79)	(-1.78)	(2.10)	(-1.32)
						SE = 28.77 DW = 2.41
Government expenditures (GE)						
GE = 0.030 GDPNP + 1394.1 CPI + 0.48 GEL + 110.49 DUMDA - 272.9						
	(4.23)	(4.84)	(2.98)	(2.24)		
						SE = 30.68 DW = 2.23
Government revenues (GR)						
GR = 0.025 GDPNP + 1228.24 CPI + 0.28 GRL - 212.18						
	(3.04)	(6.83)	(2.03)	(-4.24)		
						SE = 30.68 DW = 2.23
Real gross domestic product (GDPNP)						
GDPNP = 0.60 M2PL + 2.31 GDPNPL - 2.78 GEHEX + 1.71 YHTE - 3997.75						
	(2.54)	(4.02)	(-4.43)	(3.20)	(-2.27)	
						SE = 172.74 DW = 2.00
Narrow money (M1)						
M1 = 1.37 M1L - 75.92 EXAE - 81.79 EXAEL - 0.34 R - 0.39 RL + 104.43						
	(20.21)	(-2.06)	(-2.69)	(2.47)	(-2.77)	(3.86)
						SE = 18.21 DW = 2.9
Broad money (M2)						
M2 = 0.80 M2L - 59.53 EXAE - 131.68 EXAEL + 0.69 R + 0.24 DC + 117.35						
	(14.40)	(-1.91)	(-3.07)	(5.19)	(8.16)	(4.00)
						SE = 17.61 DW = 2
Domestic credit (DC)						
DC = 0.60 DCL + 0.51 DDCP + 0.72 GEL + 125.84 DUMD - 45.22						
	(4.33)	(9.94)	(4.06)	(-2.50)	(-5.50)	
Current account balance of payments (DCA)						
DCA = -0.79 GEHTE + 25.80 GYICL - 230.2 DUMOA + 86.23						
	(-3.17)	(2.76)	(-2.11)	(0.78)		
						SE = 76.44 DW = 2
Private investment (IPP)						
IPP = 0.37 DGDNP - 1.85 GCNPL + 1731.4 DCPIWL + 2217.21						
	(2.73)	(-7.92)	(3.44)	(12.82)		
						SE = 127.70 DW = 1.79
Private consumption (PCNP)						
PCNP = 0.42 GDPNP + 0.80 GCNP - 2860.84 DCPI + 852.88						
	(10.10)	(4.36)	(-4.53)	(7.80)		
						SE = 124.56 DW = 1.68
Government consumption (GCNP)						
GCNP = 0.56 GEHEX - 219.02						
	(3.31)	(0.67)				
						SE = 191.59 DW = 0.46
Government investment (IGP)						
IGP = 0.24 GEHEX - 219.02						
	(10.00)	(-5.61)				
						SE = 27.35 DW = 0.84

(GYICL) being the only significant variable for the 1960-1981 period (Table 6). For the sub-period 1969-1981 (Table 7) government expenditures and the oil price increases also contributed to the deterioration in the current account (but probably not the rise in real foreign interest rates—RRI). As anticipated, government consumption had a negative impact on private investment, but contributed to increases in real personal consumption expenditure during this period.

OPTIMUM PATHS OF THE ECONOMY

The literature [25] on optimal control is highly technical, yet the concept itself is straightforward. The essential idea of optimal control is to precisely derive the optimal policy, in order to steer the economy to specified targets deemed desirable to policy-makers.

In examining the model (Table 5), it is clear that a package of stabilization measures can obviously reduce excess demand in the economy either by a policy of squeezing domestic demand or augmenting

domestic supply. Prudence and common sense suggest that the best stabilization strategy for Jamaica during this time would have been one that made use of an integrated package that sought to maximize the benefits or minimize the costs of adjustment. This section uses simple simulation experiments to quantify these relationships.

Specifically, we consider the effects of restraint on real government expenditures, exchange rate devaluation and supply side policies that raise the level of productive capacity.

For the purposes of the optimal control analysis of the IMF stabilization period in Jamaica, the model's exogenous variables were set at their actual historical values. In the first set of runs, real government expenditures were used as the design variable intended to control aggregate demand during the period 1977-1980.

In run I (Table 8) real government expenditures were held at their 1976 level, with historical movements in the exchange rate incorporated into the calculations. The level of credit to the private sector was also assigned its actual values for the 1977-1980 period. In contrast to the actual developments during

Table 6. Jamaica: determinants of the current account balance, 1960-1981

Measure of external balance	Independent variables				Statistics		
	GEHTE	GYICL	RRI	DUMOA	r ²	DW	F
1. DTA	-0.18 (-1.76)	26.27 (2.73)			0.243	1.45	4.38
2. DCA	-0.21 (-2.08)	30.13 (3.13)			0.380	2.00	5.84
3. DCAA	-0.20 (-1.82)	31.23 (3.04)			0.357	1.87	5.27
4. DCAB	-2.00 (-1.97)	31.35 (3.25)			0.389	2.08	6.05
5. DTA		22.10 (2.19)	-59.86 (-0.18)		0.205	1.47	2.45
6. DCA		25.4 (2.43)	-58.55 (-0.17)		0.241	3.00	1.90
7. DCAA		26.64 (2.46)	-56.04 (-0.16)		0.245	1.82	3.09
8. DCAB		26.77 (3.61)	-16.79 (-0.05)		0.264	1.95	3.42
9. DTA	-0.21 (-1.61)	2.90 (1.77)		-23.24 (-0.40)	0.322	1.44	2.84
10. DCA	-0.22 (-1.65)	29.55 (2.27)		-4.02 (-0.07)	0.381	1.99	3.69
11. DCAB	-0.22 (-1.63)	27.95 (2.02)		-22.62 (-0.36)	0.362	3.40	1.84
12. DCAB	-0.19 (-1.48)	32.08 (2.46)		5.08 (0.08)	0.389	3.82	2.09

this period, the simulation results are striking:

1. real income declines by only 2.2% per annum, compared with the actual decline of 8.2% per annum;
2. private consumption declines by 5.6% per annum, as contrasted with an actual decline of 9.7% per annum;
3. perhaps most importantly, private investment stabilizes and actually increases by 2.1% per annum, compared with the historical 1976-1980 decline of 22.4% per annum;
4. total foreign reserves increase nearly as well as under the IMF programs, reaching 160.4 compared with the actual level of 187.0 for 1980;

5. there is also a decline in inflation to a 19.8% average increase in the consumer price index, compared with the historical increase of 25.3; and

6. finally, the current account averages a positive gain over this period of 3.8 million U.S. dollars, compared with the average historical decline of 27.1 million U.S. dollars.

To determine the level of reduction in government expenditures necessary to stabilize real income at its 1976 level, runs II and III were performed. In run II, real government expenditures declined by 1.0% per annum during this period while in run III the decline was set at 1.5%. The results indicate that a decline in

Table 7. Jamaica: determinants of the current account balance, 1969-1981, II

Measure of external balance	Independent variables				Statistics		
	GEHTE	GYICL	RRI	DUMOA	r ²	DW	F
1. DTA	-0.26 (-1.71)	35.27 (2.37)			0.389	1.41	3.19
2. DCA	-0.32 (-2.30)	45.47 (3.29)			0.547	2.11	6.04
3. DCAA	-0.31 (-1.91)	44.07 (2.80)			0.464	1.91	4.33
4. DCAB	-0.31 (-0.21)	46.00 (3.29)			0.543	2.21	5.94
5. DTA		42.42 (2.37)	-1305.34 (-1.54)		0.361	1.44	2.82
6. DCA		54.83 (3.36)	-1692.30 (-2.19)		0.532	2.00	5.68
7. DCAA		51.49 (2.73)	-1488.04 (-1.66)		0.426	1.87	3.72
8. DCAB		54.60 (3.28)	-1605.31 (-2.03)		0.519	2.09	5.40
9. DTA	-0.82 (-3.64)	15.97 (1.20)		-270.71 (-2.89)	0.683	1.87	6.46
10. DCA	-0.79 (-3.57)	28.88 (2.21)		-227.40 (-2.46)	0.730	2.60	8.09
11. DCAA	-0.90 (-3.95)	22.87 (1.69)		-290.63 (-3.05)	0.736	2.47	8.38
12. DCAB	-0.78 (-3.50)	29.31 (-2.45)		-228.83 (-2.44)	0.729	2.66	7.93

Table 8. Jamaica: optimal control demand oriented stabilization programs, 1977-1982

Macro-economic indicator	Actual values		Optimal control run values for 1981				
	1976	1980	I	II	III	IA	IB
Gross domestic (GDPNP)	6693.1	4760.4	6134.2	6471.9	6761.2	6344.8	5872.5
Private consumption (PCNP)	4676.6	3109.2	3706.5	3819.9	3948.8	3648.4	3737.1
Private investment (IPP)	940.8	340.9	1020.7	1113.0	1182.0	1078.2	914.1
Total reserves (R)	29.5	187.0	160.4	137.9	128.7	-119.4	345.7
Real government expenditures (GEHEX)	1786.2	2351.9	1786.2	1715.9	1681.2	1786.2	1786.2
Consumer in price index (CPI)	0.406	1.000	0.837	0.829	0.815	0.837	0.731
Change in current account (DCA)	-19.8	-27.1	3.8	18.3	16.1	14.9	23.5
(Average annual change 1976-1980)							
Gross domestic product		-8.2	-2.2	-0.8	-0.3	-1.3	-3.2
Private consumption		-9.7	-5.6	-4.9	-4.1	-6.0	-5.5
Private investment		-22.4	2.1	4.3	5.9	3.5	-0.7
Total reserves		58.8	52.7	47.0	44.5	-49.9	85.0
Real government expenditures		7.1	0.0	-1.0	-1.5	0.0	0.0
Consumer price index		25.3	19.8	19.5	19.0	19.8	15.8

Notes: See text for assumptions made in each optimal control run.

The 1980 values for the change in current accounts are the average changes over the 1976-1980 period.

real government expenditures somewhere between 1.0 and 1.5% would have been consistent with a stable level of real gross domestic product.

While it might be argued that a more equitable goal would have been to stabilize or increase real consumption expenditures, the model indicates that growth (measured by real gross domestic product) and equity (as measured by real personal consumption expenditures) were not in conflict. In fact, maximizing real personal consumption expenditures in 1980 instead of real gross national product yielded the same growth in government expenditures. Interestingly enough, while the personal consumption equation has a positive sign for real government expenditures, it turns out that its value is more strongly influenced by increases in real gross domestic product and the negative impact of inflation. If, in fact, government consumption expenditures were undertaken for equity purposes during this period, the evidence in runs I through II indicates that these programs actually had perverse results.

In the context of demand management through controlling government expenditures, exchange rate policy was also examined. Run IA simulates the economy under conditions in run I, but without devaluation (the 1976 exchange rate held throughout the 1976-1980 period). Run IB assumes a once-and-for-all dramatic devaluation of 100% in 1977. The main results of exchange rate oriented policies indicate that:

1. no devaluation appears beneficial to real income growth and private investment, but results in a serious loss in foreign exchange reserves;
2. the 100% devaluation, while contributing significantly to the country's reserve position, appears to significantly impair the growth in real income.

In general, the simulations indicate purely demand related stabilization programs (incorporating exchange rate adjustments) place a high cost on the domestic economy. While there is evidence that the level of income could have at least been stabilized during this period through government expenditure restraint, it is unlikely that any set of realistically structured stabilization programs concentrating exclusively on demand management would have per-

mitted a positive rate of increase in income or living standards.

On the other hand, the model developed above indicates that there was ample scope for supply-side measures in Jamaica during the 1970s. These supply-side policies must be specifically directed towards the removal of distortions and other structural impediments to rapid economic growth. To the extent that such supply oriented adjustment measures could succeed in their objective of increasing the capacity level of output in Jamaica, the macro-economic model developed above indicates that they will also have an effect on other major variables in the economy, including monetary variables and the balance of payments.

The simulation of the supply side policy traces these effects. Given the micro-economic character of most supply side policies outlined above, no attempt is made here to specify the precise nature of the measures that could produce this result. Instead, the purpose of this simulation is to determine the effects of a given increase in the level of capacity output, assuming it can be achieved, on other variables that are important targets in the stabilization program.

The supply side optimal control programs (Table 9) were structured to be comparable with the demand oriented simulations summarized earlier. In runs IA through IID, it is assumed that initiation of the price distortion measures during the 1977-1980 period were capable of increasing the level of productive capacity by 5% per annum—(YHTE) in the gross domestic product equation.

In run IIA with capacity output increasing at 5% over its level in the 1977-1980 period and government real expenditures held at their 1976 levels the following occurred:

1. real gross domestic product is able to expand by 2-3% per annum and private investment by 2-7% per annum;
2. there is a dramatic improvement in the current account, however, the overall reserve position of the country deteriorates somewhat compared with the purely demand management program (run I in Table 8).

Table 9. Jamaica: optimal control supply oriented stabilization programs, 1977-1980

Macro-economic indicator	Actual values		Optimal Control Run Values for 1980				
	1976	1980	IIA	IIB	IIC	IID	IIE
Gross domestic product	6693.1	4760.4	7335.2	6993.1	6641.6	5539.5	8536.5
Private consumption	4676.1	3109.2	4264.5	4131.1	3994.1	3588.5	4818.5
Private investment	940.8	304.9	1047.5	959.6	861.7	564.3	1076.2
Total reserves	29.5	187.0	108.0	117.6	128.1	149.6	77.9
Real government expenditures	1786.2	2351.9	1786.2	1858.7	1933.4	2171.1	1786.2
Consumer price index	0.405	1.00	0.788	0.807	0.816	0.850	0.743
Change in current account	-19.8	-27.1	39.1	33.9	27.0	10.8	74.8
(Average annual change 1976-1980)							
Gross domestic product		-8.2	2.3	1.1	-0.2	-4.6	6.3
Private consumption		-9.7	-2.3	-3.1	-3.9	-6.4	0.8
Private investment		-22.4	2.7	0.5	-2.2	-12.0	3.4
Total reserves		58.8	38.5	41.3	44.4	50.1	27.5
Real government expenditure		7.1	0.0	1.0	2.0	5.0	0.0
Consumer price index		25.3	18.1	18.8	19.1	20.4	16.4

Notes: See text for assumptions made in each optimal control run.

The 1980 values for the change in current account are the average changes over the 1976-1980 period.

Increases in the average annual rate of real government expenditures above 2% per annum would result in a decline in real income albeit some gain in total foreign reserves. As might be expected, dramatic increases in capacity output (10% per annum) between 1977 and 1980 produce corresponding gains in real output and enable personal consumption to stabilize at slightly above its 1976 level (run IIE, Table 9).

CONCLUSIONS

To summarize, the optimal control simulations suggest that all three types of policy measures—demand management, devaluation, and supply management—are “effective” in the sense that they have non-negligible effects on the macro-economic quantities that are the major target variables of the Jamaican stabilization programs. While this conclusion may seem self-evident, it deserves to be reiterated because some well-known historical studies of stabilization programs [26] have concluded that orthodox demand management policies were ineffective in achieving these objectives, while others have denied that supply-oriented policies can play any significant role in economic stabilization programs.

More importantly, this analysis shows that although the three policies have somewhat similar impact on the overall balance of payments and international reserves, both the direction and the time pattern of their effects on other important variables—particularly prices, output and consumption—are quite different. This suggests that it would have been possible to find a combination of policy measures that would have allowed the Jamaican authorities to achieve their major objectives at a smaller cost, in terms of undesired changes in other important economic indices, than the program actually undertaken.

Finally, the simulation results clearly show that successful supply-side policies could have mitigated the adverse income effects of stabilization via demand restraint. However, given the current state of the art, the difficult practical question of exactly how supply management policies could have been implemented and how long they might have taken to achieve their effect remains unresolved.

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