

Frank, Charles

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ECONOMIC GROWTH CENTER

YALE UNIVERSITY

Box 1987, Yale Station  
New Haven, Connecticut

CENTER DISCUSSION PAPER NO. 22

ECONOMIC GROWTH, FOREIGN TRADE AND CAPITAL FLOWS\*

Charles R. Frank, Jr.

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ECONOMIC GROWTH, FOREIGN TRADE  
AND CAPITAL FLOWS\*

The process of economic growth rarely involves a smooth, neoclassical balanced growth path with increments to the capital stock and technological change steadily increasing output per capita. On the contrary, growth usually occurs in fits and starts with sometimes serious and often prolonged periods of disequilibrium. The symptoms are inflation, balance of payments deficits (or surpluses), unemployment, underutilization of the labor force and the capital stock, and misallocation of investment. Attempts to correct disequilibrium situations can slow down the process of growth.

The causes of disequilibrium in a less developed, open economy are twofold. First, it may arise as the result of unforeseen variations in external conditions such as changes in the terms of trade. These are often beyond the control of domestic policy makers or planners. Secondly, disequilibrium may occur as the result of a conscious decision on the part of domestic policy makers to develop more rapidly by attempting, for example, to raise the rate of investment or by changing the pattern of investment and resource allocation. In any case, the resulting disequilibrium may require certain amounts of foreign aid to correct.

This paper will discuss some models of trade and growth which attempt to deal with problems of foreign aid and disequilibrium in the balance of payments. A model of trade and growth will be proposed which incorporates

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various aspects of the models discussed. The proposed model will be used to analyze various questions with regard to the magnitude, duration, and time path of foreign aid required to achieve eventual self-help and balance of payments equilibrium.<sup>1</sup> A variation of the model will be applied to Uganda as an illustrative example of its use.

#### A. Models of Trade and Growth

Neoclassical models of trade and growth usually are general equilibrium models which trace out the growth path and movements in the variables of the system by assuming competitive equilibrium at all points of time.<sup>2</sup> Another body of neoclassical theory deals specifically with problems of disequilibrium in the balance of payments but tends to abstract from considerations of capital accumulation and growth.<sup>3</sup>

Several attempts have been made to integrate the problems of growth, trade, and disequilibrium. Most of them are not neoclassical in that they tend to assume fixed proportions with regard to inputs and outputs. The most prominent are variations of the well known "two gap" model of growth.

The more simple versions of the "two gap" model assume that exports grow at some predetermined rate and that imports are a constant fraction of income.<sup>4</sup> Savings and investment are a constant fractions of income. Balance of payments equilibrium require that exports equal imports. Since imports (i.e., exports) must be a constant fraction of income, income can grow no faster than the rate of growth of exports call it  $\alpha_x$ . On the other hand, the rate of growth of output is also restricted by the fact that increments to the

capital stock are determined by the savings (i.e., investment) rate, and by the incremental capital output ratio, call it  $k$ . It is easy to show that the maximum rate of growth under these assumptions is  $g_k = s/k$ .<sup>5</sup> If  $g_k < g_x$ , the savings-investment constraint is said to be binding. Exports grow more rapidly than imports and a balance of payments deficit will emerge unless one somehow disposes of excess exports. If  $g_k > g_x$ , the balance of payments constraint is binding and excess capital stock is generated because the increment in output per unit increase in capital stock as determined by the capital output ratio cannot be realized. The induced increment in imports that the full increase output would entail is greater than that which can be financed by increased exports.

Another version of the "two gap" model assumes that the import intensity of consumption (direct and indirect import requirements) is less than the import intensity of investment. Exports are a constant proportion of income.<sup>6</sup> There is one and only one rate of saving which is consistent with balance of payments equilibrium (exports equals imports). An increased rate of saving raises investment relative to consumption and raises the ratio of imports to income. With a given ratio of exports to income a balance of payments deficit will result. A decreased rate of saving will lower the ratio of imports to income and result in a balance of payments surplus. Given the incremental capital/output ratio, this unique rate of savings determines the rate of growth of output.

The policy implications of the "two gap" models are extreme. Countries which are required to keep exports in line with imports are strictly limited in their efforts to grow faster. Attempts to raise savings and the rate of

investment are futile beyond a certain point because of the increased imports which are generated. There are some possible answers to this dilemma.

If exports are insufficient resources ought to be shifted to the export industries to produce more exports. While this advice may work for one country, it need not work for all underdeveloped exporters of primary products. If price elasticity of demand for exports is less than unity, reduced foreign exchange earnings rather than more will be the result.

Another possibility is to export commodities which are currently consumed domestically. The incentive to export can be given through a change in the system of taxes and subsidies or by a change in the price of foreign exchange (devaluation). This alternative is particularly attractive where a country produces food products with a relatively high income and price elasticities (such as meat and some types of dairy products) which are both exported and consumed at home. Thus a country like Argentina potentially has a good deal of flexibility in adjusting to balance of payments difficulties. The range of domestically produced products which can be exported at reasonable terms of trade, however, is very limited in many countries. It will not be profitable or possible to export the output of many service industries, electric power, manufactured goods of inferior quality and design, and products whose transport cost is high such as cement. Furthermore, price rigidities and political pressures make it difficult for the government to effect drastic changes in the domestic price structure which would result in significant and undesired reallocation of income in the process of changing patterns of trade.

Another possible solution to overcoming the balance of payments constraint is to channel resources into the production of import substitutes or into non-primary exports with higher price and income elasticities of demand. The main drawback to this suggestion is that resources in the form of already existing capital goods and trained manpower may be highly specific to the industry in which they are currently employed, coffee, cocoa, and rubber trees cannot be used to produce light bulbs, construction materials, or machinery. Tin and copper mines cannot produce dairy products or textiles. These kinds of rigidities and gaps in the product transformation curves of neoclassical theory, making the attainment of an equilibrium terms of trade impossible.

The "two gap" models, highlight the problems of rigidities. The only way to escape the export constraint in a two gap model is to change the structure of the system. By lowering the propensity to import, faster growth can be achieved. The faster growth can only be maintained by a continual lowering of import intensities until complete self-sufficiency is achieved and the link between exports and the rate of growth is broken.

The members of what is often referred to as the structuralist School of thought often go one step further than the two-gap theorists. Attempts to change the structure of the economy to eliminate balance of payments deficits and increase the rate of growth by import substitution will themselves, temporarily at least, aggravate the situation and cause further movement away from balance of payments equilibrium or full capacity utilization. Growing countries with poor export prospects are therefore caught in a dilemma where

short-run stability is impossible to achieve.<sup>7</sup>

The cause of the difficulties of adjusting to an equilibrium situation in the balance of payments are the following: (1) Attempts to increase investment in import substitutes or in manufactured exports (for which the growth prospects are often more promising) also increase imports because investments of this type often use more imported investment goods than investments in traditional exports. (2) The production of import substitutes and manufactured exports use more imported intermediate goods. (3) Incomes generated in industries of this type are spent more on imported consumption goods since they are often located in urban areas where the demonstration effect is most pervasive. (4) The minimum economic size of establishments in import substitutes and manufactured exports is greater than the market size. Until markets grow these industries will be characterized by inefficiency and excess capacity. (5) The short-run costs are high and profits low in these enterprises. With the passage of time increasing labor efficiency, economies of scale, and external economies will lower costs and raise profits. Initially, however, imported materials are wasted and high wage costs imply a large ratio of imports of consumption goods to value added in these industries.<sup>8</sup>

The more simple of the two gap and structuralist models possess several defects. One of the most important is that they both stress the structural rigidities in an under-developed country and tend to neglect the possibility of eventually, over time, reallocating resources and escaping from these pernicious constraints. The process of adjustment is much less difficult over a sufficient period of time because although capital goods already in existence



are often quite specific to the industry, in an ex-ante sense the allocation of investment or increments to the capital stock allows a great deal more flexibility.

Two interesting attempts to incorporate the allocation of investment over time into a model of trade and growth are contained in Chenery and McEwan [ ] and C.F. Diaz Alejandro [ ]. Chenery and McEwan use a linear programming model to determine the allocation of investment over time given that foreign aid must terminate after a specified amount of time (or that the total amount of aid is fixed). The optimal time path of capital inflows involves increasingly large inflows in the earlier periods to augment the capital stock and achieve a higher eventual growth path. As the termination date for aid approaches, the capital inflows slacken and eventually become zero as more is invested in trade improving industries (import substitutes and exports of non-traditional goods).

The Diaz-Alejandro model borrows heavily from the approach of the structuralist school. It emphasizes the increased imports of capital, intermediate, and consumption goods generated by any attempt to increase investment in the import-substituting industries.<sup>9</sup> Investment in the import substitution industries may actually worsen the balance of payments deficit in the short run. Thus there is a limit on the rate of investment in these industries as given by the balance of payments constraint.

#### B. An Attempted Synthesis

The next few sections of this paper are devoted to a model which synthesizes the important elements of both the Chenery-McEwan and Diaz-Alejandro

models and uses a different type of analysis. The basic elements of our model are the following:

(1) Capital is the only factor of production and is specific to the industry once the investment has taken place.<sup>10</sup>

(2) There are three industries, the home goods industry whose output is denoted by H, the export industry with output denoted by X, and the import substitution industry, output denoted by P. The output of home goods industry for one reason or another cannot be exported or imported profitably. The import substitution industry produces importable goods, i.e., goods which could be imported if profitable or necessary.

(3) The output of each industry is augmented in each period by the amount of investment divided by the marginal capital/output ratios,  $k_H$ ,  $k_P$ , and  $k_X$ , for the three industries H, P, and X.

(4) There are no intermediate goods. Thus H, P, and X represent value added as well as gross output. The model may be modified to include intermediate goods but its essential features will remain the same.

(5) Domestic savings is a constant proportion of total domestic income but varies by industry source. Thus if the profit share in the import substitution industry is higher than in the export industry, the fraction of savings out of income generated in the import substitution industry may be greater than in the export industry. Furthermore if the average tax rate on incomes generated in import substitutes is higher, savings may also be a greater fraction of income if the government's marginal rate of saving out of tax revenues is larger than the marginal savings out of profits and wages.

(6) There is a limit to the amount of import substitution which is possible. In particular, we will confine our discussion to the so-called easy stage of import substitution in which the production of import substitutes is limited at any period of time to the current consumption of importable goods. Various other assumptions concerning the feasibility of import substitution could be made but these will be avoided to keep the model fairly simple. For example, we could assume that as an increasing amount of import substitution takes place, the capital/output ratio rises in discrete steps.

(7) An optimal growth path with balance of payments equilibrium is described and its properties characterized.

The initial values of the variables may not permit attainment of the optimal growth path without disequilibrium for some finite period of time. For example, if the initial import bill exceeds the current output of the export industry, either the balance of payments will be in disequilibrium or total expenditure and output will have to be reduced to lower the import bill. Such a reduction in output implies excess capacity in some or all the sectors of the economy. The initial disequilibrium may be corrected over time by allocating enough investment to exports or import substitutes. In the process of eliminating deficit may actually increase for some time because of the changed structure of investment and consumption.

Even if the economy is operating on an optimal growth path with balance of payments equilibrium, autonomous variations of the parameters of the system

may result in temporary disequilibrium. For example, if an attempt is made to grow faster by reducing the propensities to consume out of incomes generated in the various sectors of the economy, investment relative to consumption will increase. If investment is more import intensive than consumption, balance of payments disequilibrium will result. Another example of a change in the structure of the model is a reduction in the terms of trade and the profitability of export promotion relative to import substitution. The optimal growth path may change towards one involving relatively more import substitution. If an attempt is made to increase the proportion of investment toward import substitution, to arrive at an optimal growth path, the current import bill will increase if investment in import substitution is more import intensive than in export promotion. Again a balance of payments deficit results.

The analysis in this paper will run along the following lines:

(1) Certain shifts in the structural parameters of the system will be discussed and their impact on the balance of payments specified

(2) An initial balance of payments deficit or one which arises from a change in the basic parameters of the economy can be eliminated in one of two ways, by a reduction in output (which will generate excess capacity) or by financing a temporary balance of payments deficit and allocating relatively more investment to trade improvement activities (export promotion or import substitution). For sake of brevity we will discuss only the latter alternative.

(3) The magnitude, duration, and time path of foreign aid will be specified for various patterns of reallocation of investment toward trade improvement.

C. The Basic Model

The demand for importable consumption goods are a certain proportion  $m_c$  of consumption  $C$ ; while the demand for importable investment goods is a proportion  $m_I$  of investment  $I$ . The total import bill is the demand for importables of both types less the production of import substitutes.

$$(1) \quad M = m_c C + m_I I - P$$

The proportion of income consumed varies by sector.

$$(2) \quad C = c_H \cdot H + c_P \cdot P + c_X \cdot X$$

where  $c_H$ ,  $c_P$ , and  $c_X$  are parameters. Total investment  $I$  is the sum of domestic savings and foreign capital inflow, i.e., the balance of payments deficit  $D$ .

$$(3) \quad I = (1-c_H) H + (1-c_P) P + (1-c_X) X + D$$

where

$$(4) \quad D = M - X$$

Total output is  $Y$ .

$$(5) \quad Y = H + P + X \equiv C + I - D$$

Let  $K_H$ ,  $K_X$ , and  $K_P$  represent the capital stock in each sector. The time rate of change of any variable is denoted by a dot over the variable. Thus if  $k_H$ ,  $k_P$ , and  $k_X$  are incremental capital/output ratios

$$(6) \quad \dot{H} = \frac{1}{k_H} \dot{K}_H = \frac{(1 - \epsilon_X - \epsilon_P)}{k_H} I$$

$$\dot{P} = \frac{1}{k_P} \dot{K}_P = \frac{\epsilon_P}{k_P} I$$

$$\dot{X} = \frac{1}{k_X} \dot{K}_X = \frac{\epsilon_X}{k_X} I$$

where  $c_X$  is the proportion of total investment (I), which is allocated to exports and  $c_P$  is the proportion of I which is allocated to import substitutes.

We assume that the import substitution industry produces only consumption goods and the output of that industry is limited by the consumption of importables.

$$(7) \quad P \leq m_c \cdot C$$

Finally, we require that for balance of payments equilibrium

$$(8) \quad D = 0$$

#### C.1 The Unrestricted Growth Path

In this section we will solve the simultaneous system of differential equations (1) through (6) in terms of time. (All the variables in the system are functions of time although no time subscript is used for sake of clarity.)

For the moment we can disregard the boundary conditions (7) and (8).

Equations (1) through (5) contain eight variables. We may solve for five of these variables in terms of the three variables H, P, and X. Thus

$$(9) \quad (a) \quad M = \frac{[m_c c_H + m_I(1-c_H)]}{(1-m_I)} H \\ + \frac{[m_c c_P + m_I(1-c_P) - 1]}{(1-m_I)} P \\ + \frac{(m_c - m_I) c_X}{(1-m_I)} X$$

$$(b) \quad C = c_H H + c_P P + c_X X$$

(9) cont.

$$(c) \quad I = \frac{(1 - c_H + m_c c_H)}{(1 - m_I)} H + \frac{(m_c - 1) c_P}{(1 - m_I)} P + \frac{(m_c - 1)}{(1 - m_I)} X$$

$$(d) \quad D = \frac{[m_c c_H + m_I(1 - c_H)]}{(1 - m_I)} H + \frac{[m_c c_P + m_I(1 - c_P) - 1]}{(1 - m_I)} P + \frac{[m_c c_X + m_I(1 - c_X) - 1]}{(1 - m_I)} X$$

$$(e) \quad Y = H + P + X$$

If we substitute the expression (9) (e) for I into the differential equations (6) we obtain a simultaneous system of differential equations in the three variables H, P, and X. In terms of time t, the solution of this system is <sup>11</sup>

$$(10) \quad H = \frac{(1 - \epsilon_X - \epsilon_P)}{k_H} \frac{I_0}{g} (e^{gt} - 1) + H_0$$

$$P = \frac{\epsilon_P}{k_P} \frac{I_0}{g} (e^{gt} - 1) + P_0$$

$$X = \frac{\epsilon_X}{k_X} \frac{I_0}{g} (e^{gt} - 1) + X_0$$

where  $H_0$ ,  $P_0$ ,  $X_0$  and  $I_0$  represent initial values of H, P, X, and I and where

$$(11) \quad g = \frac{(1 - c_H + m_c c_H)}{k_H} (1 - \epsilon_X - \epsilon_P) + \frac{(m_c - 1)c_P}{k_P} \epsilon_P + \frac{(m_c - 1)c_X}{k_X} \epsilon_X$$

The time path of all other variables in the solution is easily determined by substituting the solution (10) into the equations (9).

C.2. Optimal Restricted Growth Paths

Now let us consider the effect of the boundary conditions (7) and (8) on the time path of the variables. If (8) is satisfied for the initial values of the variables, it will continue to be satisfied only so long as

$$(12) \quad \dot{D} = 0$$

or from (9) and (10)

$$(13) \quad [m_c c_H + m_I (1 - c_H)] \frac{(1 - \epsilon_X - \epsilon_P)}{k_H} \\ + [m_c c_P + m_I (1 - c_P) - 1] \frac{\epsilon_P}{k_P} \\ + [m_c c_X + m_I (1 - c_X) - 1] \frac{\epsilon_X}{k_X} = 0$$

Equation (13) may be graphed in the  $(\epsilon_X, \epsilon_P)$  space along with the restriction that

$$(14) \quad \epsilon_X \geq 0 \quad \epsilon_P \geq 0 \quad \epsilon_X + \epsilon_P \leq 1$$

This is shown in Figure 1. The restriction (14) requires that  $(\epsilon_X, \epsilon_P)$  lie in the triangle OAB and (13) requires that  $(\epsilon_X, \epsilon_P)$  lie on the line PQR. Any  $(\epsilon_X, \epsilon_P)$  above the line PQR implies that  $\dot{D} < 0$  and below  $\dot{D} > 0$ . If the initial deficit  $D_0 > 0$ , then this deficit can only be eliminated if  $(\epsilon_X, \epsilon_P)$  lies in the area ABRP, i.e., if  $\dot{D} < 0$ .



Suppose there is a social utility function with regard to consumption, say  $U(C)$ . Then given that  $D = 0$  (no capital inflows or outflows) and given a non-satiation assumption concerning  $U(C)$ , the integral of utility from  $t = 0$  to any possible time in the future is maximized by maximizing  $g$ . (The coefficient  $g$  is in fact the long run rate of growth of both consumption  $C$  and income  $Y$ , i.e.,  $\lim_{t \rightarrow \infty} C/C = \lim_{t \rightarrow \infty} Y/Y = g$ ). Thus we want to maximize  $g$  as given by (11) subject to the restrictions (13) and (14). It is easy to show that the optimal values for  $(\epsilon_X, \epsilon_P)$  are

$$(15) \quad (\epsilon_X^*, \epsilon_P^*) = \left( 0, \frac{m'_H (k_P/k_H)}{1 + [m'_H (k_P/k_H) - m'_P]} \right)$$

if

$$(16) \quad \frac{(1 - c_P)}{k_P} > \frac{(1 - c_X)}{k_X}$$

and

$$(17) \quad (\epsilon_X^*, \epsilon_P^*) = \left( \frac{m'_H (k_P/k_H)}{1 + [m'_H (k_P/k_H) - m'_X]}, 0 \right)$$

if

$$(18) \quad \frac{(1 - c_P)}{k_P} < \frac{(1 - c_X)}{k_X}$$

where

$$(19) \quad m'_H = m_c c_H + m_I (1 - c_H)$$

$$m'_P = m_c c_P + m_I (1 - c_P)$$

$$m'_X = m_c c_X + m_I (1 - c_X)$$

If  $(1 - c_P)/k_P = (1 - c_X)/k_X$  then any convex combination of (15) and (17) is optimal. Thus in Figure 1 if (16) holds then the point P is an optimal point and if (18) holds, R is optimal.

If the condition (7) holds for the initial values of the variables, then the optimal allocation of investment is determined as before by (15) through (18). If (18) holds, however, the allocation of investment to import substitutes ( $\epsilon_P^*$ ) as given by (17) is so large that eventually production of import substitutes exceeds consumption of importables and (7) will no longer continue to hold. When (7) just becomes a binding constraint, it will continue to hold only so long as

$$(20) \quad \dot{P} = m_c \dot{C}$$

or from (9) and (10)

$$(21) \quad m_c c_H \frac{(1 - \epsilon_X - \epsilon_P)}{k_H} + (m_c c_P - 1) \frac{\epsilon_P}{k_P} + m_c c_X \frac{\epsilon_X}{k_X} = 0$$

In figure 1, the restriction (21) is shown as the line SQT. For any point above this line  $\dot{P} > m_c \dot{C}$ , and for any point below,  $\dot{P} < m_c \dot{C}$ . Thus if (18) holds, the optimal policy is one of maximum import substitution (the point P in Figure 1). After some finite period of time, this leads to a violation of (7) and the degree of import substitution must be reduced (to the point Q in Figure 1). This will also reduce the rate of growth. The new optimal policy ( $\epsilon_X^*, \epsilon_P^*$ ) is given by solving the two equations (13) and (21) for  $\epsilon_X$  and  $\epsilon_P$ .

### C.3 Eliminating an Initial Balance of Payments Deficit

Suppose that the initial balance of payments deficit  $D_0$  is positive. The only possible way to reduce this deficit is to invest heavily enough in

import substitutes or exports to either reduce the relative demand for imports or increase the capacity to pay for them, respectively. In terms of Figure 1, the allocation  $(\epsilon_X, \epsilon_P)$  must be in the area ABEP if  $P < m_c C$  or TBRQ if  $P \geq m_c C$ . Substituting (10) into (9) (d) we obtain

$$(22) \quad D = f(\epsilon_X, \epsilon_P) \frac{I_0}{g} (e^{gt} - 1) + D_0$$

where

$$(23) \quad f(\epsilon_X, \epsilon_P) = \frac{[m_c c_H + m_I (1 - c_H)]}{(1 - m_I)} \frac{(1 - \epsilon_X - \epsilon_P)}{k_H} \\ + \frac{[m_c c_P + m_I (1 - c_P) - 1]}{(1 - m_I)} \frac{\epsilon_P}{k_P} \\ + \frac{[m_c c_X + m_I (1 - c_X) - 1]}{(1 - m_I)} \frac{\epsilon_X}{k_X}$$

Setting  $D = 0$  in (22) and solving for  $t = T$ , we obtain the time  $T$  required to eliminate the balance of payments deficit.

$$(24) \quad T = \frac{1}{g} \log_e \left[ 1 + \frac{D_0 g}{I_0 f(\epsilon_X, \epsilon_P)} \right]$$

The total foreign aid bill or total net capital inflow  $F$  which is required to finance the balance of payments deficit over the period  $T$  is

$$(25) \quad F = \int_0^T D dt = f(\epsilon_X, \epsilon_P) \frac{I_0}{g} (e^{gT} - 1) \\ + (D_0 - f(\epsilon_X, \epsilon_P) \frac{I_0}{g}) T$$

In the process of eliminating an initial balance of payments deficit the growth rate will not necessarily remain the same. This depends on the particular  $(\epsilon_X, \epsilon_P)$  which is chosen to eliminate a deficit and on the derivatives of  $g$  (equation (11)) with respect to  $\epsilon_X$  and  $\epsilon_P$ . In some instances there may be a conflict between eliminating a balance of payments deficit most rapidly (which will also minimize the total capital inflow) and the rate of growth during the process of adjustment. Some optimal policy can be specified if a valuation of the two alternatives (rapid growth vs. rapid self sufficiency is given.)

C.4. Structural Change and Foreign Aid

Suppose some policy makers decide to raise the rate of growth by lowering the propensities to consume by a combination of fiscal policy and direct controls. If the propensity to import out of consumption is less than the import intensity of investment, the immediate result will be a worsening of the balance of payments because of an increased import bill. What is the magnitude of any such increase in the deficit? Using (9) (d) and assuming the changes in the propensities to consume,  $c_H, c_P, c_X$ , are  $\Delta c_H, \Delta c_P, \Delta c_X$ , respectively the initial change in the balance of payments deficit is

$$(26) \quad D_o = \frac{(m_c - m_I)}{(1 - m_I)} (\Delta c_H H_o + \Delta c_P P_o + \Delta c_X X_o)$$

This increase in the deficit which results from an attempt to reduce the propensities to consume can be eliminated by increasing investment in exports and/or import substitutes. The time  $T$  required to eliminate this increase in the deficit is given by (24) with  $D_o$  and substituted for  $D_o$ . The total capital inflow is given by (25).

D. An Important Variation in the Model

In this section we will change the import demand function (1) which is given in the basic model. The demand for imported investment goods varies depending on which industry's capacity is being augmented. For example, investment in cocoa or coffee exports may not require a very high proportion of imported investment goods relative to investment in manufactured import substitutes.

Thus

$$(1^*) \quad M = m_c c + m_{I_H} (1 - \epsilon_X - \epsilon_P) I + m_{I_P} \epsilon_P I + m_{I_X} \epsilon_X I$$

The resulting modification in equations (9) and (13) can be seen by substituting  $m_I^*$  for  $m_I$  in all equations where

$$(27) \quad m_I^* = m_{I_H} (1 - \epsilon_X - \epsilon_P) + m_{I_P} \epsilon_P + m_{I_X} \epsilon_X$$

Equation (13) is no longer linear but is a quadratic function of  $\epsilon_X$  and  $\epsilon_P$ . In figures 2a and 2b the constraint (13) is drawn concave and convex to the origin, respectively. Either curvature is possible. If (8) holds and (7) is not a binding constraint, the maximum growth rate is determined by maximizing (11) subject to (13) with  $m_I^*$  as given by (27) substituted for  $m_I$ . This quadratic programming problem is very simple to solve. (The algebra may be a bit messy). Any combination of import substitution or export promotion (any point along PQR in Figure 4) may be optimal and we are not limited to corner point solutions as in the basic model.

The outstanding differences between this model and the basic model are the following: First, in the basic model, the choice between import substitution or export promotion was solely dependent on the propensities to consume ( $c_P, c_X$ ) and the capital output ratios ( $k_P, k_X$ ) as in (16) and (13). In the modified model, the choice is not an either or choice and the proper "mix" between import substitution and export promotions crucially depends on the relative import intensity of investment in the two activities ( $m_{I_X}$  and  $m_{I_P}$ ). Secondly, if for any reason, balance of payments equilibrium is disturbed, the attempt to eliminate an initial deficit may actually make the deficit worse for some period of time. The reason for this is that a balance of payments deficit may be reduced only by finding an allocation ( $\epsilon_X, \epsilon_P$ ) which lies in the area ABRP. If this requires a change from the current allocation, say ( $\Delta\epsilon_X, \Delta\epsilon_P$ ), then the initial effect may be an increase in the balance of payments deficit. The reason for the change in the deficit is that a new allocation of investment will generally lead to a different import bill for investment goods. The magnitude of this initial increase is approximately

$$(28) \quad \Delta D \approx \frac{[(m_{I_X} - m_{I_H}) \Delta\epsilon_X + (m_{I_P} - m_{I_H}) \Delta\epsilon_P] [Y_0 - (1 + m_c) C_0]}{(1 - m_I^*)^2}$$

This increase in the deficit, of course, is eliminated if the allocation of investment is changed back to its original value. Thus the time path of a deficit follows the pattern in Figure 3. An initial deficit  $D_0$  is eliminated by increasing the deficit by an amount  $\Delta D$  and then reducing the deficit

exponentially until the deficit is  $D_T^*$ , at which point, the deficit may be immediately reduced to zero by going back to the old allocation  $(\epsilon_X, \epsilon_P)$ . The magnitude of  $D_T^*$  is approximately

$$(29) \quad D_T^* \approx \frac{[(m_{IX} - m_{IH}) \Delta\epsilon_X + (m_{IP} - m_{IH}) \Delta\epsilon_P] [Y_T - (1 + m_c) C_T]}{(1 - m_I^*)^2}$$

E. An Illustrative Example: The Case of Uganda

Uganda is a country of approximately 7 million people with a gross domestic product (not including subsistence production) of about £ 160 million in 1966. Its two main exports are cotton and coffee which together accounted for about 80 per cent of total exports outside East Africa<sup>12</sup> in the last decade.

Although export volume from Uganda grew at a rate of 2 to 3 per cent per annum between 1954 and 1964, export value has grown at only about 1 to 2 per cent because of declining export prices. As exports are the main stimulant to growth, GDP in current prices grew only at about 1 to 2 per cent per annum. Correcting for price inflation of goods purchased by Uganda, the rise in real income has been slight, if any, and per capita incomes have certainly been declining over the period.

The current Uganda Development Plan (1966-71) calls for an increase in the rate of growth of GDP in current prices to 7.4 per cent with a rise in the rate of investment (investment as a proportion of GDP) from 15 to 20 per cent over the plan period.

The main question to be asked in this section is: given that investment is to increase from 15 to 20 per cent of GDP

- (a) what is the balance of payments deficit that will be caused by this increase in the investment rate;
- (b) what is the minimum rate of investment in manufacturing necessary to eliminate this deficit over time;
- (c) how long will the balance of payments deficit persist; and
- (d) what will be the total foreign aid bill over the period of adjustment?

In order to answer these questions, the model presented above will be somewhat modified to fit the data available and the particular circumstances in Uganda.

We will assume the same type of import function as that given in (1) with consumption and investment having differing import intensities. Various studies of the structure of imports<sup>13</sup> have indicated that investment is from 50 to 100 per cent more import intensive than consumption. Let us assume that  $m_I = 1.75 m_C$ . The ratio of imports to total GDP has varied between 1954 and 1964 from 29 to 39 per cent with an average of 32 per cent. Since investment over this period has averaged about 18 per cent of total GDP, we have  $m_C = .28$  and  $m_I = .49$ .

Thus

$$(1^{**}) \quad M = .28 C + .49 I - V_P$$

where  $V_P$  denotes the gross output in the import substitution industry less direct and indirect imported inputs.



We assume that investment during the plan period will always be 20 per cent of GDP which leaves consumption as a residual.

$$(2^{**}) C = Y - I$$

$$(3^{**}) I = (.2) Y$$

Exports of Uganda have varied from 43 to 52 per cent of total GDP between 1954 and 1964. There was a consistent and sizeable export surplus for those years varying between 13 and 22 per cent of GDP. Part of this surplus can be attributed solely to the method of evaluating exports (f.o.b.) and imports (c.i.f.) to and from outside of East Africa at Mombasa which is some 600 miles from the border of Uganda. The rest may be accounted for by net capital exports and/or net imports of invisibles.

There are no reliable data on the magnitude of either of these, particularly with regard to transactions within the Common Market. There is reason to believe that Uganda has been a net importer of invisibles, particularly from Kenya which performs a great deal of the commercial and financial transactions for the whole of East Africa. Furthermore the transportation costs and middlemen markups on imports passing through Kenya tend to be quite high.

Uganda had no central bank over the 1954-64 period. Foreign exchange reserves, the money supply, and Ugandan incomes have tended to ebb and flow together with the fluctuations in export values. No recognizable balance of payments "problem" can arise in such a situation. Because of methods of evaluation, persistent imports of invisibles, and/or net capital exports, however, the value of exports (f.o.b.Mombasa) has always tended to exceed the value of imports

(c.i.f. Mombasa) by about 50 per cent on the average. Assuming that this will continue to be true in the future, and assuming that full capacity output will be maintained through a combination of government monetary and fiscal policy which can be implemented through the newly formed central bank, deficits in the balance of payments will emerge whenever exports do not exceed imports by at least 50 per cent. Thus

$$(4^{**}) D = 1.5M - X$$

The production of import substitutes mostly involves the production of manufactured goods of one sort or another or the processing of locally produced food products (e.g., coffee, jams, canned and frozen goods, bakery goods, etc.) which is also considered a manufacturing activity. According to the Kenya Census of Manufactures<sup>14</sup>, value added accounts for only 33 per cent of gross output in the manufacturing industry, while imports account for 31 per cent and domestic purchases for 29 per cent. Assuming that domestic purchases also include 31 per cent of imports, then the net saving on imports is  $100 - 31/(1 - .31) = 55$  per cent of each dollar of import substitutes produced of which possibly 70 per cent is manufacturing value added in other domestic sectors. Thus

$$(30) V_P = 1.43V_M$$

where  $V_P$  is total import replacing value added and  $V_M$  is manufacturing value added.

The production of exports in Uganda involves almost entirely production in the agricultural sector (copper, about 5% of total exports, is the only non-negligible, non-agriculture export). There are no data on proportion of domestic value added and value added in agriculture to gross value of exports but for the

sake of illustration, let us assume the ratios are 90 per cent and 50 per cent, respectively. Thus

$$(31) V_X = .90X$$

$$(32) V_{AX} = .50X$$

where  $V_X$  is value added in exports and  $V_{AX}$  is agricultural value added in exports.

Let us assume that total value added  $Y$  is

$$(5^{**}) Y = V_M + V_{AX} + V_R$$

where  $V_R$  is the residual value added, i.e., non-agricultural exports and non-manufacturing.

Whether or not the target rate of growth of 7.4 per cent is achieved or not depends very much on the behavior of export values. Since export values, however, are dependent on so many uncertain random and/or uncontrollable factors (such as coffee and cotton prices, the weather, quotas under the International Coffee agreement, the successful introduction of new export crops, etc.), it is impossible to predict with any degree of accuracy the growth performance over the plan period. For this reason, we will assume that exports grow at some given rate and then vary that rate to see what difference export performance will make if the plan is carried through in terms of the target rate of investment.

$$(6a^{**}) X = X_0 e^{rt}$$

where  $r$  is the rate of growth of exports.

Let  $\epsilon_M$  and  $\epsilon_{AX}$  be the proportion of investment in manufacturing and in agricultural exports, respectively. The current development plan calls for

5 per cent of total investment to be allocated to agriculture of which maybe two-thirds might be considered as investment in export crops. Thus  $\epsilon_R$ , the proportion of investment in the residual sector, is  $1 - \epsilon_M - .10 = .90 - \epsilon_M$  Furthermore

$$(6b^{**}) \quad \dot{V}_M = \frac{\epsilon_M}{k_M} I$$

$$(6c^{**}) \quad \dot{V}_R = \frac{(.90 - \epsilon_M)}{k_R} I$$

where  $k_M$  and  $k_R$  are the capital/output ratios in manufacturing and the residual sector, respectively. Let us assume that  $k_M = 4.0$  and  $k_R = 2.5$ .

The model now consists of equations (1<sup>\*\*</sup>) through (6<sup>\*\*</sup>) and (30), (31) and (32). If we solve all these equations except (6<sup>\*\*</sup>) in terms of  $V_{AX}$ ,  $V_M$  and  $V_R$ , we obtain the following solutions for I and D:

$$(33) \quad I = (V_M + V_{AX} + V_R) (.2)$$

$$(34) \quad D = -1.52V_{AX} - 1.66V_M + .48V_R$$

Differentiate (34) with respect to time and use (6<sup>\*\*</sup>) to substitute for  $\dot{V}_M$  and  $\dot{V}_R$ .

$$(35) \quad \dot{D} = -.76r \cdot X - .42\epsilon_M I + (.174 - .193 \epsilon_M) I$$

If we set  $\dot{D} = 0$  and solve for  $\epsilon_M^*$ , we obtain the proportion of investment  $\epsilon_M^*$  in manufacturing needed to keep the balance of payments constant over time:

$$(36) \quad \epsilon_M^* = .282 - 1.240r \cdot (X/I)$$

If we set  $X = X_0$  and  $I = I_0$ , we can obtain the necessary proportion of investment in manufacturing at initial levels of exports and investment.  $\epsilon_M^*$  will increase through time if investment (and income) grows faster than exports, otherwise  $\epsilon_M^*$  decreases through time or remains constant. Given the initial planned ratio between exports and investment, we obtain the following initial proportion of investment devoted to manufacturing as a function of the rate of growth of exports

Table 1

r	.01	.02	.03	.04	.05
$\epsilon_M^*$	.25	.22	.19	.16	.13

This corresponds with a planned investment in manufacturing of 16 per cent in the current development plan.

As mentioned above, the current development plan calls for an increase in investment from 15 to 20 per cent of GDP. This implies an increase in the import bill (with  $m_c = .28$  and  $m_I = .49$ ) of about one per cent of GDP or  $\approx 1.6$  million. In order to begin to eliminate this deficit, the rate of investment in manufacturing must be greater than  $\epsilon_M^*$  in Table 1, depending on the rate of growth of exports. Of course, if, momentarily all investment were devoted to exports or to manufacturing and the industries supplying the manufacturing ar

agricultural exports, the deficit could be eliminated quite quickly. There are many impediments to doing this, for example, identifying and properly planning the projects which takes time and entrepreneurial and planning skills, provision of financing for the particular projects, the lack of managerial and engineering skills to implement projects of this kind, etc. Thus we will calculate both time and the total capital inflow or foreign aid bill necessary to eliminate or pay for this increased requirement for foreign exchange under various assumptions concerning the rate of investment in manufacturing which can be maintained.

These calculations require us to solve the differential equations (6<sup>\*\*</sup>) where I is given by (33). Solving this system of equations in three variables  $V_{AX}$ ,  $V_M$ , and  $V_R$  we have the following:

$$(37) \quad V_M = .05 \epsilon_M \left[ .762 \frac{(r-g)}{g} - .238 \right] \frac{Y_o}{(r-g)} (e^{gt} - 1) + .05 \epsilon_M \frac{(.238) Y_o}{(r-g)} (e^{rt} - 1) + V_M^o$$

$$V_R = (.072 - .08\epsilon_M) \left[ .762 \frac{(r-g)}{g} - .238 \right] \frac{Y_o}{(r-g)} (e^{gt} - 1) + (.072 - .08\epsilon_M) (.238) \frac{Y_o}{(r-g)} (e^{rt} - 1) + V_R^o$$

$$V_{AX} = (.238) Y_o (e^{rt} - 1) + V_{AX}^o$$

where

$$(38) \quad g = .072 - .03\epsilon_M$$

Substituting (37) into D as given by (34), we have

$$\begin{aligned}
 (39) \quad D = & \left[ -.362 + \frac{(.238)}{(r - g)} (.034 - .121 \epsilon_M^*) \right] Y_0 (e^{rt} - 1) \\
 & + \left[ \frac{.762}{g} (.035 - .121 \epsilon_M^*) - \frac{(.238)}{(r - g)} (.035 - .121 \epsilon_M^*) \right] Y_0 (e^{gt} - 1) \\
 & + D_0
 \end{aligned}$$

To calculate the time T required to eliminate an initial deficit  $D_0 = \text{£ } 1.6$  million, set  $D = 0$  in (39) and solve for  $t = T$ . Integrating D between time  $t = 0$  and  $t = T$  gives the total foreign aid bill. The results for  $r = .01$ ,  $r = .03$  and  $r = .05$  are contained in Table 2.

Table 2

$\epsilon_M - \epsilon_M^*$	$r = .01$		$r = .03$		$r = .05$	
	T (years)	F (£ million)	T (years)	F (£ million)	T (years)	F (£ million)
.01	$\infty$	$\infty$	$\infty$	$\infty$	$\infty$	$\infty$
.02	$\infty$	$\infty$	$\infty$	$\infty$	$\infty$	$\infty$
.03	4.2	3.3	6.2	4.1	$\infty$	$\infty$
.04	2.7	2.1	2.9	2.3	3.0	2.2
.05	1.9	1.6	2.1	1.7	2.1	1.7
.06	1.6	1.3	1.6	1.3	1.6	1.3

The first column of this table gives the increase in the proportion of investment in manufacturing over and above what is necessary to keep the balance of

payments deficit from growing initially ( $\epsilon_M^*$  from Table 1). Note that for small increases in the proportion of investment in manufacturing although the balance of payments deficit falls initially, it begins to rise again before equilibrium is established and continues to rise. This occurs because exports are growing less rapidly than output in every case, and the proportion of investment in manufactures necessary to continue to reduce the balance of payments deficit is always increasing.

The most notable conclusion that one can draw from the above exercise is the marked increase in investment in manufacturing which is required to overcome slow export growth. Unless export value grow at from 3 to 5 per cent, the current development plan which calls for 16 per cent of investment in manufacturing cannot hope to succeed without a large balance of payments deficit emerging. For example, if exports grow at one per cent, a deficit of will emerge after 5 years which would require a capital inflow of £ during the 5 year period.

#### F. Concluding Remarks

The models presented in this paper were meant to be illustrative of an approach to analyzing balance of payments problems and their relation to economic growth. We place no great faith in any particular formulation as a model which is generally applicable for all places and all times. The approach used here is to define a balanced growth path and permit random shocks or policy changes to give rise to deviations from this growth path. Convergence back to the original growth path can be achieved by the appropriate manipulation of the control



parameters,  $\epsilon_X$  and  $\epsilon_P$ , the proportion of investment in exports and import substitutes, respectively. The cost of achieving this convergence back to balanced growth is expressed in terms of the foreign exchange necessary to pay for temporary balance of payments deficits.

The models presented here may also be used to analyze problems pertaining to the optimal level of foreign borrowing. Purposeful deviations from balance of payments equilibrium may be optimal. Although we have not considered the possibility of purposeful deficits, the model could easily be applied to such problems. One would have to specify the costs and benefits of foreign borrowing. By using the calculus of variations an optimal time path of borrowing and its characteristics could be specified.

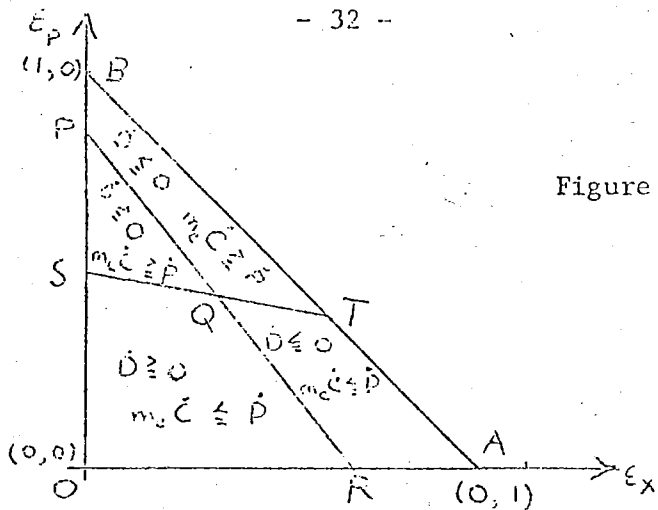


Figure 1

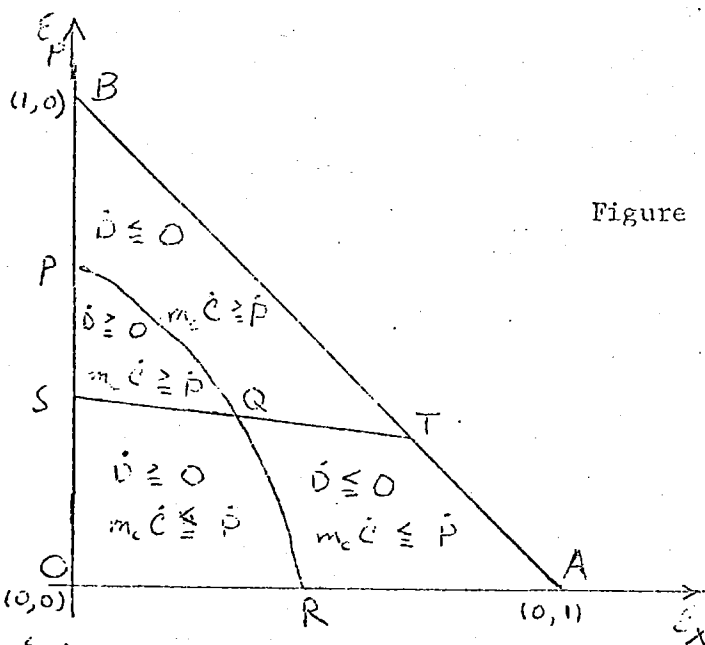


Figure 2a

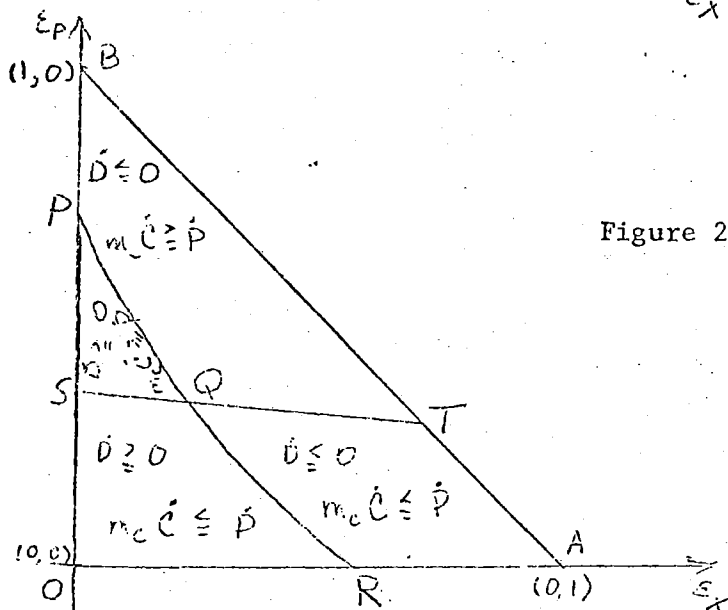
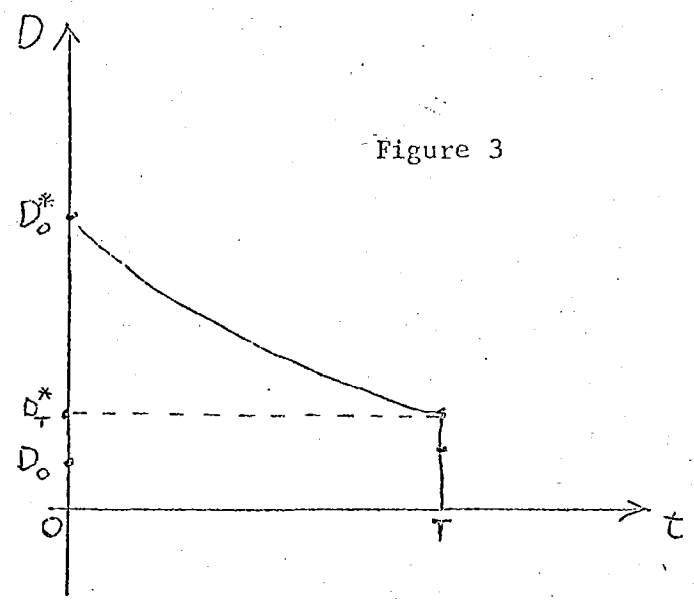


Figure 2b

Figure 3



Footnotes

<sup>1</sup>The notion of the time and capital needs to achieve self-sustaining growth has been analyzed in the case of a closed (non-trading) economy by Fei and Paauw [5].

<sup>2</sup>For example, see Uzawa [18].

<sup>3</sup>See Kindleberger [8].

<sup>4</sup>The seminal article here is Chenery and Bruno [3].

<sup>5</sup>This is the simple Harrod-Domar formula for the warranted rate of growth. If there is a net capital outflow ( $X - M$  is positive) investment is actually less than domestic savings and the rate of growth is less than  $s/k$ . With a net foreign capital inflow, faster rates of growth can be achieved. If there are no foreign capital inflows or outflows, the Harrod-Domar formula for a closed economy gives the rate of growth.

<sup>6</sup>See Mac Kinnon [9].

<sup>7</sup>See Seers [13] and [14], Baer [1] and Diaz Alejandro [4]

<sup>8</sup>An attempt to solve balance of payments difficulties through import substitution may even result in no net savings of foreign exchange if inefficiencies in the production process are very large. See Soligo and Stern [15].

<sup>9</sup>Diaz-Alejandro [4] greatly overstates the increase in imports generated by an increase in investment in import substitutes. He does not specify that other kinds of investment and/or consumption expenditure may be reduced as a result of increased investment in import substitutes. His model only makes sense in a Keynesian world with large amounts of excess capacity and not when total consumption and investment and hence total income is limited in the short run by available capital stock and trained manpower.

<sup>10</sup>The assumption of no ex-post substitutability is extreme but is made here only to emphasize the short run difficulty of reallocating resources. The inclusion in the model of ex-ante substitutability represents a compromise or synthesis between models based on fixed-proportions and those based on neo-classical instantaneous substitutability. See L. Johansen [6] and E. Phelps [12]. Seong Yawg Park [11] uses a "bounded substitution" approach in which ex-post substitutability is permissible for certain ranges of the variables. Park's approach could be applicable to our model.

<sup>11</sup>The system of equations (6) may be expressed in vector and matrix notation as  $\dot{y} = A \cdot y$ . The solutions are of the form  $y = c_1 e^{r_1 t} + c_2 e^{r_2 t} + c_3 e^{r_3 t}$  where  $r_1$ ,  $r_2$  and  $r_3$  are the characteristic roots of the matrix A. In this particular case the rank of A is unity and two of the characteristic roots are zero. The third root is the trace of the matrix A. I am indebted to Michael Lovell of Carnegie Institute of Technology for pointing this out.

<sup>12</sup>See Government of Uganda [16].

<sup>13</sup>See Van Arkadie and Ndeawa [19] and Newman [10].

<sup>14</sup>See Government of Kenya [7].

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