Medium-run adjustment under import compression: Macroeconomic analysis relevant for sub-Saharan Africa

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Received February 1991; final version received March 1993

Abstract

The dynamic small open economy model of Kouri (1979) is modified to analyze the role of the foreign exchange constraint in import dependent economies typical for sub-Saharan Africa. Structural adjustment and investment allocation are related to the sectoral balance between traded and protected goods. The import compression policy of the region establishes a linkage between the export performance of the traded sector and the capacity utilization of the protected sector. It is shown that the relationship implies possible contractionary effects of demand expansion, since exports are crowded out and the import capacity is reduced. A destabilizing downward growth spiral may follow. Policies modifying the excessive demand and the import dependency seem necessary to turn contraction into growth.

Keywords: Adjustment; Import compression; Macroeconomic analysis; sub-Saharan Africa

JEL classification: O11, O55

* I am grateful for comments at the European Meeting of the Econometric Society, Munich, Institute of Social Studies, the Hague, University of Oslo and Norwegian School of Economics and Business Administration, Bergen, in particular to Bill Gibson, Jan Gunning, Lance Taylor, Ragnar Torvik and a referee.

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SSDI 0304-3878(94)00025-8
1. Introduction

Import compression is a policy response to balance of payments crisis. Most of the governments in sub-Saharan Africa have chosen this strategy to handle the foreign exchange situation of the 1980s. They have taken direct control of the allocation of imports. The compression of imports has economy-wide consequences because of the dependency of imported intermediate and investment goods. Given the import capacity and restricted imports of consumer goods, the authorities set the priorities between imports of intermediates and investment goods. This foreign exchange constraint produces a tradeoff between capacity utilization and capacity expansion.

The import dependency of the region reflects imperfect substitution between imported and home goods. Ndulu (1990) shows the stability of the ratio of investment goods imports to real investment, about 35% for sub-Saharan Africa as a whole during 1980–87. Investment projects often combine foreign machinery and transport equipment with domestic construction. Ndulu confirms a similar, although less rigid, relationship between capacity utilization and intermediate imports. A number of country studies emphasize the role of import dependency, e.g. Green and Kadhani (1986), Ndulu (1986), and Davies and Rattso (1993). It is a general characteristic of low income developing countries as shown by the analysis of Moran (1989). He estimates a short-run price elasticity of total imports of about −0.1 for 21 countries. Expenditure switching is hardly a realistic alternative under such circumstances. From the point of view of governments, import controls have been an attractive alternative to massive devaluations and dramatic demand contractions.

The background of the problem is the growth of the current account deficits during the early 1980s, the combined result of unfavorable external conditions and domestic policies. Increasing surpluses at the capital account of the balance of payments were required. The external financing was increasingly difficult to obtain and international reserves were lost. The following import controls necessarily influenced the supply side of the economies because of the import dependency. Wheeler (1984, p. 3) concludes that the growth performance reflects "...the impact of changes in export earnings on current production through fluctuations in intermediate production inputs...". The observation seems to be common among analysts of the region, a foreign exchange constraint links the export performance and the domestic capacity utilization, see Helleiner (1992).

The importance of the foreign exchange constraint has been recognized for many decades in the gap models. Bacha (1984) has recently linked the gap approach to standard open economy macroeconomics, and Taylor (1991, ch. 8) has extended the framework. The foreign exchange gap assumes a fixed import coefficient for investment. Here we add intermediate imports as a determinant of the capacity utilization. Rattso (1993) has applied both supply side relationships in a North–South model analyzing the relationship between sub-Saharan Africa and
the rest of the world. Rakshit (1992) has investigated the supply side aspects of import dependency in a model relevant for India.

The foreign exchange constraint and the import dependency represent a structural adjustment problem. Sectoral asymmetries with respect to foreign exchange production and foreign exchange consumption are of interest to understand the growth process. Gibson (1985) introduces a linkage between export agriculture and industrial production in a study of Nicaragua, based on the industrial dependency of intermediate imports. His approach has motivated the formulation of sectoral balances relevant for sub-Saharan Africa, separating between an export oriented traded sector and a protected sector dependent on imported intermediates. The dynamic interactions are investigated to understand the role of supply bottlenecks related to capacity and foreign exchange in the analysis of the structural adjustment. The small open economy model is the natural foundation of the analysis, and the model specification can be seen as an extension of Kouri (1979).

The favorite controversy over structural adjustment in sub-Saharan Africa concerns the sources of the economic stagnation of the last decade, external conditions or domestic policies. Influential studies, such as Wheeler (1984) and World Bank (1989), point in different directions. Wheeler blames the external environment, while the World Bank insists on the importance of overly expansive monetary and fiscal policies and overvalued exchange rates. Helleiner (1992) reports on a convergence among analysts of African development performance. No common policy advice has emerged, but the starting point is clarified: "Once the most grotesque distortions, particularly, in Africa, those related to the real exchange rate and the fiscal deficit, are repaired..." (Helleiner, p. 785). This study addresses the policy debate by analyzing the responses to shifts in key policies and parameters. The understanding of the economic adjustments to import compression may be of relevance to other regions as well, notably in Latin-America and Eastern Europe.

2. The model approach

The small open economy model is the standard framework for the analysis of structural adjustment. The formulation of Kouri (1979) adds investment dynamics and opens up for the investigation of medium-run adjustments of sectoral balances. In the model developed, the foreign exchange is produced by the traded sector 1 including export agriculture, raw materials exports such as mining, and non-traditional industrial exports. The sector competes with regulated imports delivered to the domestic market, such as food imports during drought years. The protected sector 2 consists of capital intensive and import intensive industries oriented towards the domestic market. Their capacity utilization is dependent on access to
imported intermediate inputs. The sector includes construction and capital goods industries delivering to investment projects, and therefore is of importance for the growth process. Informal sectors and services are abstracted from. Implicitly their production is assumed to vary with overall demand.

The model structure can be seen as five modifications of the model of Kouri (1979):

1. In his model, and typical to the small open economy models, the trade balance is determined as a residual clearing the market for traded goods. There are no feed back effects from variations in the trade balance. Here the net exports of traded goods determine the capacity to import intermediate and investment goods.

2. Small open economy models generally assume that the non-traded sector is demand constrained. In the sub-Saharan Africa context, the protected non-traded sector is better formulated as supply constrained due to limited access to imported intermediates. The rationing of imported intermediates establishes a relationship between the import capacity and the capacity utilization of the protected sector.

3. Kouri assumes investment only in the traded sector, since investment in the demand-determined non-traded sector has no output effect. The assumption is essential to the relationship between the real exchange rate and investment that he derives. Since the protected non-traded sector is supply constrained here, the allocation of investment is important. Possible substitution between real capital and intermediates in the protected sector is captured.

4. When investment goods are imported or produced in the traded sector, the domestic capacity of producing investment goods is not important. Investments in Africa are best understood as combinations of foreign technology and domestic construction. Domestic construction industries are protected and supply constrained and important for the supply of investment goods.

5. The labor market is the central area of economic interaction in small, open economy models, as shown in the survey by Corden and Neary (1982). In Kouri’s model, the equilibrium growth is defined by the full employment path. The emphasis on labor market relations is not productive in the study of labor surplus economies. The wage formation is important for profitability and investment, but the wage determination is better formulated as indexation influenced by institutional factors.

The model is related to the standard dual economy workhorse of development macroeconomics. The interactions between agriculture and industry have been the building blocks of many macroeconomic studies associated with Taylor (1983, ch. 3). Food price inflation results from expansion of oligopolistic manufacturing industries when the agricultural capacity is constrained. Medium-run stories where the food prices affect profitability and growth through the wage formation are told by Taylor (1983, ch. 9; 1991, ch. 9) and Rattsø (1989). Some modifications are
necessary to make the dynamics relevant for Africa. First, the sectoral disaggregation should take into account the structural differences in relation to foreign trade. Agricultural products and ‘non-traditional exports’ are traded goods competing with international markets, while most industrial goods are produced for the protected domestic market. Second, the dependency on intermediate imports and the import rationing shift the determination of the output of industrial goods from demand to supply. Third, the price formation must reflect the openness of the economies and the supply bottleneck. Fluctuations of the food prices are of less importance when agriculture is mainly a traded sector and domestic food markets are strongly regulated. The industrial sector is likely to be flex-price under a supply constraint. The interplay between agriculture and industry is different when agriculture is exporting, industry is import dependent and imports are compressed.

The analysis concentrates on three types of linkages between the traded and the protected sector in addition to the conventional spillovers via income generation and consumption demand. They are interconnected through the foreign exchange constraint, the wage formation, and the investment determination. The three linkages are fundamental to the results:

First, an import compression relationship is introduced, linking up the traded sector exports to the capacity utilization of the protected sector. The import capacity is determined by export revenues and foreign savings, and used for imports of intermediate and investment goods:

\[ B = S^e_t + E - (1 - \alpha)J. \]  

The imports of intermediates to the protected sector \( B \) are the residual of the foreign savings \( S^e_t \), the net exports of traded goods \( E \), and the share \( 1 - \alpha \) of total investment \( J \) that is imported. All variables are measured in foreign currency and the international prices are set to 1. Consumer imports, transfers and interest payments are abstracted from, assuming they are exogenously controlled. Imported intermediates to the traded sector can be seen as a shadow factor built into the net export concept. The access to foreign financing is assumed to be determined by international factors, and the current account deficit consequently is exogenous.

The import compression function represents a policy rule of the government. Imports of investment goods are given priority, and the intermediate imports to the protected sector are rationed according to the current account situation. The rule is consistent with the description of Tanzania given by Ndulu (1986), of Zimbabwe by Davies (1991), and the conclusions of Wheeler (1984) and Ndulu (1991) for the whole region.

A reorientation of the import allocations took place in the late 1980s when the priority of investment was strongly criticized. The low capacity utilization motivated the shift, and the investment levels fell, possibly because of rationing of imports of investment goods. We do not have much interesting to say about the dynamics of such a regime, since the investment allocation is decided by political considerations. The private investment demand is no longer satisfied, and the
development of the production structure is in the hands of the foreign exchange allocation committee.

Second, the flex-price of protected goods influences the costs of traded goods production. In practice, the cost effect from the protected to the traded sector is channeled both through deliveries of intermediate goods and the wage formation. In the model, this is represented by an assumption of real wage rigidity, whereby a higher price level of protected goods raises the nominal wage level. The real wage rigidity is probably an overstatement of the wage indexation process of the region. The assumption is a convenient simplification to handle the cost linkage. Empirical justification for any formulation of the wage formation is hard to find, but Chhibber et al. (1989) tell a realistic story for Zimbabwe implying indexation.

The adjustments are channeled through the real exchange rate, $p = P_2/e$, the relative price of protected $P_2$ to traded goods $e$ (the nominal exchange rate). The real exchange rate is equivalent to the domestic terms of trade. The real wage is defined in terms of a price index, $P$, that reflects the consumption basket. The cost of living index is a geometrically weighted average of the prices of traded and protected goods when fixed consumption shares are assumed ($c$ is the consumption share of protected goods):

$$P = e^{1-c}P_2^c = ep^c.$$ (2)

The price index can be written in terms of the real exchange rate in (2). Real wage rigidity is assumed, implying that nominal wages adjust to a real wage target $\omega$, $W/P = \omega$. It follows that the nominal wage $W$ can be stated as a function of the real exchange rate:

$$W = \omega ep^c.$$ (3)

The real exchange rate is basically determined by the market balance of the flex-price protected sector in the model, since the nominal exchange rate is assumed to be fixed. The intersectoral importance of the wage formation is linked to the relationship between the real product wage of the traded sector and the real exchange rate, $W/e = \omega p^c$.

Third, the investment demand affects the sectoral balance through the combined demand for domestic construction and imported technology. The market balance of the protected sector and the import compression function consequently have to adjust. The sectoral investment demands are assumed to be functions of the actual rates of return of capital, $r_1$ and $r_2$, and the required rate of return $r^*$:

$$J_i = J_i(r_1 - r^*)K_i.$$ (4)

A model of a profit maximizing sector with costs of adjusting the capital stock and stationary expectations produces investment functions such as (4). The standard reference is Stein (1971), and the formulation is used by Kouri (1979). We have found no convenient way of handling investors expectations about future export earnings and macro policy regime. The required rate of return is usually
interpreted as the going rate at international capital markets. In the protected environment of sub-Saharan Africa, it can be thought of as a normal profit rate motivating a target capital stock. The sectoral investments $J_1$ and $J_2$ add up to the total investments $J$.

The dynamics of the investment process follows from the assumption that investment is a composite good produced by combining domestic and imported components in fixed proportions. A positive shift in the investment level tends to imply real exchange rate appreciation, since excess demand for protected goods results. Demand for protected sector construction follows automatically, and the capacity utilization of the protected sector tends to go down because of the competition between imports of investment and intermediate goods. The dynamic relationship between the investment level and the real exchange rate is important to the growth process, since the real exchange rate affects the profitability of both sectors.

3. The short-run adjustments

The setup assumes that the short-run macro adjustments of the economy are driven by the net exports and the real exchange rate, the equilibrating variables of the two sectors. The sectoral output supplies are determined by the real exchange rate and the import compression. The supply function of the traded sector responds to the real product wage in standard fashion. The wage indexation rule introduced above links the real product wage to the real exchange rate. The capacity utilization of the protected sector is determined by availability of imported intermediates. The supply functions are formulated in terms of output–capital ratios:

$$X_1/K_1 = t(W/e) = t(Wp^e),$$

$$X_2/K_2 = n(b).$$

The output capital ratio of the traded sector $t$ is a negative function of the real exchange rate $p$ and the real wage target $\omega$ in (5), given a homogeneous of degree 1 production function in real capital and labor. The sectoral capital stocks, $K_1$ and $K_2$, are state variables in the dynamic model. In the protected sector, the output capital ratio $n$ varies with the volume of imported intermediate goods relative to the capital stock, $b = B/K_2$. The formulation in (6) is consistent with a homogeneous of degree 1 production function in real capital and intermediate inputs.

The intersectoral linkages presented above are built into a macrodynamic model. The economic structure is described by the two sectoral balances:

$$X_1 = C_1 + E,$$

$$X_2 = C_2 + \alpha J.$$
The traded sector delivers its gross output $X_1$ to consumption $C_1$ and net exports $E$. The small open economy assumption implies that the price level is determined at the world market, and that net exports adjust to market balance. The protected sector delivers its output $X_2$ to consumption $C_2$ and investments $\alpha J$. A fixed share $\alpha$ of the investments $J$ are produced domestically. The relative price of protected goods, the real exchange rate $p$, adjusts to drive the excess demand to zero.

The consumption demand system concentrates on the essentials. Fixed consumption shares are assumed, consistent with a Cobb–Douglas utility function. Wealth effects and intertemporal optimization are abstracted from:

$$C_1 = (1 - c)(1 - s)(t(\omega p^c)K_1 + pn(b)K_2 - B), \quad (9)$$

$$pC_2 = c(1 - s)(t(\omega p^c)K_1 + pn(b)K_2 - B). \quad (10)$$

Total consumer spending in terms of traded goods is determined by the income level and the savings rate, $s$. The development of the savings rate is hard to explain, and the lack of a convincing story leads to the simple formulation adopted. The consumer spending feeds into the consumption demand equations in (9) and (10), consistent with the price index (2).

The investment demand functions are introduced by Eqs. (4). The rates of return motivating investment need to be defined:

$$r_1 = f(p)/(\alpha p + (1 - \alpha)), \quad (11)$$

$$r_2 = ((p - \omega p^c)n(b) - b)/(\alpha p + (1 - \alpha)). \quad (12)$$

In the traded sector, the profits definitely go down with an increase in the real product wage when labor use is the only variable factor. The real profits in the traded sector, $f$, can be written as a negative function of the real exchange rate (given the real wage target and the homogeneous of degree 1 production function). Real exchange rate appreciation reduces the profit rate of the traded sector both through the real wage rigidity and the price of capital. The price of capital follows from the composition of investments, and in terms of traded goods it is $P_K/e = \alpha p + (1 - \alpha)$. In the protected sector, the labor use is simply assumed to be determined by a fixed labor–output ratio (set equal to 1). The profit rate can be written as (12), and real appreciation increases the profits, but also increases the price of capital.

The short-run adjustments of the import compressed economy are defined by Eqs. (1) to (12). The output supply of the protected sector fluctuates with the net exports of the traded sector due to import compression, and the real exchange rate equilibrates the protected goods market. The analytical solution is worked out in Appendix A and shown in Fig. 1. For simplicity of exposition, the excess demand curves, $ED_1$ and $ED_2$, are drawn linear, and they are both downward sloping. Real exchange rate appreciation reduces the supply of traded goods and stimulates its consumption demand, thereby crowding out exports, as shown by $ED_1$. Increased
exports allow for higher imports of intermediates and the output supply of protected goods go up, implying real exchange rate depreciation along $ED_2$. The stability condition, the excess demand function for traded goods $ED_1$ must be steeper than the excess demand function for protected goods $ED_2$, is shown in Appendix A. The real exchange rate must have stronger effect on the excess demand for protected than for traded goods.

Comparative statics of the short-run model show the main policy surprise built into the economic structure: Expansionary effect of demand contraction. A positive shift in the savings rate creates immediate excess supply at both markets. Such a shock will move the equilibrium solution to region I in Fig. 1, with increased net exports and real exchange rate depreciation. Output expansion will be experienced in both sectors. The traded sector responds to the reduced real product wage because of the real depreciation. The protected sector will have more intermediate imports available.

In the model, the real exchange rate is endogenous and nominal exchange rate changes have no real effects. Nominal exchange rate policy can be studied when we do away with the real wage rigidity and assume fixed nominal wages. The modified model is explained in Appendix A. Nominal devaluation reduces the product real wage of the traded sector and contributes to exports expansion given the supply function (5). Real depreciation is expected in the short run when the imports of intermediate inputs are increased and the output supply of the protected sector goes up. In Fig. 1 the movement is south-east along the $ED_2$-curve.

The expansionary result is opposite from the contractionary devaluation of Krugman and Taylor (1978). They establish a model where the contraction follows from reduced aggregate demand. In our model, devaluation improves the economic conditions of the key foreign exchange producing sector, generating a supply side effect. Intermediate imports as a supply side channel of devaluation effects are included in the more recent studies of exchange rate policies, as shown
in the overview of Lizondo and Montiel (1989). Typically, the higher costs of imported intermediate inputs induce a negative shift in the supply function. In our model, there is always excess demand of the rationed imported intermediates, and the expansionary effect results from the increased ration. If the contractionary demand effects emphasized by Krugman and Taylor had been added, the expansionary outcome may have been strengthened. As shown above, reduced domestic demand allows for more exports and thereby more import-dependent production under foreign exchange constraint.

4. Medium-run dynamics

The medium-run dynamics are formulated as investment response to short-run profitability. It allows for investigation of the structural adjustment problem and the dynamics of import compression. The real exchange rate is the key adjusting variable. Short-run real appreciation influences the profitability of the traded sector and domestic costs of investment goods. The net exports of traded goods determines the import capacity and affects the profitability of the protected sector via intermediate imports rationing. The compact reduced forms of the investment functions (Appendix B) describe the dynamics:

\[
\begin{align*}
\frac{dK_1}{dt} &= J_1 = g(p(K_1, K_2))K_1, \\
\frac{dK_2}{dt} &= J_2 = h(b(K_1, K_2))K_2.
\end{align*}
\]

The four sectoral interactions built into the model are complex, and several types of development paths are possible. The dynamic adjustments are determined by the role of the state variables in the short-run equilibrium. Given the analytics of Appendix B, additional assumptions are needed to derive definite stories. They are best clarified when the full dynamics of the model is worked out:

\[
\begin{align*}
\frac{dK_1}{dt} &= \phi(K_1, K_2), \\
\phi_1 &= g_1K_1 \frac{dP}{dK_1} + g, \\
\phi_2 &= g_1K_1 \frac{dP}{dK_2}, \\
\frac{dK_2}{dt} &= \psi(K_1, K_2), \\
\psi_1 &= h_1K_2 \frac{db}{dK_1}, \\
\psi_2 &= h_1K_2 \frac{db}{dK_2} + h.
\end{align*}
\]

The model is solved around a long-run stationary equilibrium with \( r_1 = r_2 = r^* \). The system can be linearized around the equilibrium \( \frac{dK_1}{dt} = \frac{dK_2}{dt} = 0 \):

\[
\begin{bmatrix}
\frac{dK_1}{dt} \\
\frac{dK_2}{dt}
\end{bmatrix} =
\begin{bmatrix}
\phi_1 & \phi_2 \\
\psi_1 & \psi_2
\end{bmatrix}
\begin{bmatrix}
\frac{dK_1}{dt} \\
\frac{dK_2}{dt}
\end{bmatrix},
\]

(17)
The import compression and the cost linkage threatens the stability of the adjustment process. It is easy to see how unstable growth spirals (or contraction) can be generated. If investment and increased capacity of traded goods are allowed to depreciate the real exchange rate, the investment will stimulate it's own growth with higher traded sector profitability. The import linkage from traded goods net exports to protected sector output supply contributes to real depreciation, and cannot be allowed to dominate. Technically this is part of the trace condition, and $\phi_1 < 0$ when $dP/dK_1 > -g/(g_1 K_1) > 0$, the real exchange rate appreciates with increased traded sector capital stock.

The cost linkage is another source of instability. Investment and capacity growth in the protected sector may increase protected sector profitability and investment if the import capacity is improved. The cost linkage channels higher output of protected goods via real depreciation to a positive supply shift of traded goods. The potential explosion is avoided if $\psi_2 < 0$, that is $db/dK_2 < -h/(h_1 K_2) < 0$. When the consumption and investment linkages dominate, the trace condition will hold.

The stable case with no cycles shown in Fig. 2 is based on additional assumptions. The phase lines are definitely increasing when the direct effects of the capital stocks dominate at each market, that is $db/dK_1 > 0$ and $dp/dK_2 < 0$. The capacity to import intermediates increases with the capital stock of the traded sector, and the real exchange rate depreciates when the capital stock of the protected sector is extended. (The assumption implies that both $\psi_1$ and $\phi_2$ are positive.)

With the stability assumptions made above, the system will have a saddle point equilibrium if the determinant $(\phi_1 \psi_2 - \psi_1 \phi_2)$ is negative. The determinant condition is related to the relative steepness of the phase curves of Fig. 2:

$$
\frac{dK_1}{dK_2} \left( \frac{dK_1}{dt} = 0 \right) - \frac{dK_1}{dK_2} \left( \frac{dK_2}{dt} = 0 \right) = \frac{1}{(\psi_1 \phi_1)} (\phi_1 \psi_2 - \psi_1 \phi_2).
$$

(18)
The model has a saddlepoint equilibrium if (18) is positive, the phase line of $dK_2/dt = 0$ is steeper than $dK_1/dt = 0$. To avoid saddlepoint instability, changes in the capital stock of the traded sector must have a stronger effect on the traded sector investments than on the protected sector investments, and vice versa. The combined result of the import compression and cost linkages can throw the economy into saddlepoint instability, that is a process where the sectors stimulate each others growth (or contraction).

The stable node drawn in Fig. 2 means that the adjustment mechanisms encourage balanced growth towards the stationary solution. The economic implications can be illustrated by starting out from a situation outside equilibrium, such as point I, where the target capital stocks are higher than the actual capital stocks in both sectors. Growth in the protected sector stimulates a shift in the investment pattern in favor of the traded sector. The real exchange rate depreciates, motivating higher investments in the traded sector and lower investments in the protected. The other way around, if the traded sector grows faster than the protected sector, the investments in the protected sector will be stimulated both by the real exchange rate appreciation and the increased availability of imported inputs. The investment and consumption linkages lead the economy on a balanced path towards the stationary equilibrium.

5. Domestic policy, stability and medium-run development

The two ‘grotesque distortions’ (Helleiner, 1992), the role of the domestic absorption and the real exchange rate, can be investigated by model experiments. Short-run expansionary effect of demand contraction and devaluation has been shown (Section 3) under the import compression assumptions made. A fall in consumer spending creates excess supply at the traded goods market and allows for higher net exports. The real exchange rate depreciates because of the excess supply of protected goods. The two sectors help each other to expand by increasing the availability of intermediates to the protected sector and by reducing the real product wage of the traded.

The dynamics of a demand contraction can be simulated by assuming a permanent positive shift in the savings rate. The medium-run effect depends on the investment response, and the analytics are worked out in Appendix B. The rate of return in the traded goods sector goes up with the real depreciation, and the $dK_1/dt$-curve shifts to the right as in the phase diagram 3. The investment demand of the protected goods sector is increased with the higher capacity utilization, and the $dK_2/dt$-curve shifts up.

Balanced growth results. The positive investment responses in both sectors carry the short-run expansion over to medium-run growth. The process is stabilizing around the stationary equilibrium when the demand linkages between the two
sectors are strong. Then the expansion of the protected sector creates excess demand of traded goods and crowds out exports, thereby strangling protected sector investment via import compression. And the growth of the traded sector creates excess demand for protected goods, reducing traded sector investment via real appreciation.

The two sectors can stimulate each other to a destabilizing growth process when the import compression and cost linkages are too strong. Higher capital stock of the traded goods sector gives room for more exports, thereby increasing the capacity utilization and the investment demand of the protected sector. The output effect of increased capital stock of the protected goods sector induces further real exchange rate depreciation. The rate of return of the traded goods sector goes up, and the investment demand is increased. The growth explosion in the saddlepoint situation implies a steady movement north-east in the phase diagram.

In reality, a negative growth spiral is more relevant. Demand expansion starts a contraction of both sectors. The import compression linkage imply that the protected sector investment is discouraged by reduced traded goods production. Reduced protected goods production motivates a fall in traded sector investment because of the following real exchange rate appreciation and the cost linkage. When the two intersectoral linkages are strong, it is hard to see economic mechanisms turning the contraction to growth. Policy reversal seems necessary.

Balancing problems can arise when the stability conditions are violated. When the import compression and cost linkages dominate the sectoral interactions, and the trace condition fails to hold, destabilizing processes can work in different directions. An important mechanism for unbalanced growth relates to the role of investment goods imports for the capacity to import intermediates. A positive shift in the investments of the traded sector increases the total investments and thereby the imports of investment goods. The import compression implies reduced imports of intermediate goods and both the capacity utilization and the investments of the protected sector go down.

The results above indicate that expansionary demand policies have reduced growth. Crowding out of exports and real exchange rate appreciation explain the channeling of effects. In the policy debate, the demand expansion is often linked to overvalued exchange rates. Overvaluation of the currency is not easily defined when the foreign exchange allocation is managed by the government. Contraction of domestic demand seems to be the best policy to achieve real depreciation. In the case of nominal wage rigidity, exchange rate devaluation may help the growth process shown in Section 3.

6. Import capacity and import dependence

The demand contraction analyzed above indicates a way of expanding both traded and protected goods production. The import-dependent protected sector
expands with the improved import capacity arranged by higher net exports. The balanced growth path means that the development not necessarily leads out of the import compression regime. It is of interest to study the conditions for an elimination of the excess demand for imported intermediates and an end to the import rationing. There are two ways of achieving this, the development must involve a structural change increasing the relative size of the traded sector and/or the import requirement of the protected sector must be reduced.

Foreign exchange injection stimulates growth, but does not guarantee the structural change desired. Higher foreign savings raise the rates of return for both sectors, as documented in Appendix B. In the short run, foreign financing reduces the import bottleneck, increases the supply of protected goods and implies real depreciation. The expansion path is like the balanced growth of Fig. 3. Van Wijnbergen (1985) has warned against possible Dutch disease effects of aid. They may be important in our model if the new foreign financing opens up for expansion of domestic demand. Aid channeled via public budgets often do. In this case, the medium-run contractionary forces analyzed in Section 5 come into play. The real exchange rate may appreciate and lead to a structural change in the wrong direction, away from traded goods.

A shift in the production structure to the advantage of the traded goods sector can be obtained by reducing the domestic component of investment. It is a paradox that the desired structural change can be achieved by increasing the import dependency of investment. If the domestic share $\alpha$ of investment goods is reduced, the demand effect of a given investment level is shifted from domestically produced protected goods to imports. The real exchange rate will depreciate, stimulating output supply and investment in the traded sector. The reduced availability of imported intermediates will reduce capacity utilization and investment in the protected sector. The structural change is shown in Fig. 4 and
Figure 4. Structural change.

documented in Appendix B. Starting out from equilibrium, the decumulation of capital in the protected sector should be interpreted as the result of capital depreciation. The dynamics of the process contain conflicting forces. If the expansion of the traded sector is sufficiently strong, both sectors may expand. On the other hand, if the capital stock reduction in the protected sector dominates, both sectors may contract. The structural change scenario also follows when consumption demand shifts from protected to traded goods.

The alternative approach to overcoming the foreign exchange constraint requires increased productivity of imported intermediates. A positive shift in the output–capital ratio of the protected sector implies excess supply of protected goods and real exchange rate depreciation under the assumptions made. Both demand and supply of traded goods go up, and the net exports are reduced when the demand effect of protected sector expansion is sufficiently strong. The traded sector investment is stimulated by real depreciation. The net effect for the protected sector investment is negligible when the productivity shift is balanced out by the reduced import capacity. Then biased growth as described in Fig. 5 results. There is a structural shift, and both sectors expand. The traded sector growth brings with it the protected sector because of the improved import efficiency.

7. Conclusions

A modified version of the small, open economy model has been taken into use to analyze the medium-run adjustment mechanisms under import compression. Structural characteristics of the sub-Saharan Africa countries are emphasized: the foreign exchange constraint, the import dependency, the import rationing, the
duality between traded and protected sectors, and the supply bottlenecks. The analysis investigates the dynamic interactions between the traded and the protected sector. In addition to the traditional consumption linkages, three intersectoral relationships are formulated: exports from the traded sector give room for intermediate imports to the protected sector, the relative price of protected goods affects the costs of traded goods production, and the deliveries of investment goods from the protected sector depend on the overall investment level.

Domestic demand expansion is shown to crowd out exports of traded goods and reduce the import capacity. The capacity utilization of the protected sector goes down when imported intermediates are endogenously rationed. The supply of traded goods is reduced because the real appreciation following excess demand at the protected goods market imply higher costs of traded goods production. The result is consistent with the observation that the protected manufacturing industries in sub-Saharan Africa have high profits, but are supply constrained. The situation does not motivate the structural adjustment needed in favor of traded goods.

There is no easy way of achieving real depreciation to stimulate the traded goods sector. The real exchange rate is determined by the market situation for protected goods when the price of traded goods is determined at the world market (with fixed nominal exchange rate). It follows that neglect of the import-dependent protected sector will lead to real appreciation and discourage the expansion of the traded sector. This is essentially the mechanism generating balanced growth in the model. Increased growth of traded goods production gives room for higher imports of industrial inputs, thereby stimulating the import dependent protected sector. On the other hand, higher production growth of protected sector goods increases the traded goods production through a real depreciation effect. The real exchange rate adjustment and the investment response contribute to equalization of profit rates.

A destabilizing growth process results if the above mentioned import compression and cost linkages are too strong. In reality, a negative growth spiral is more
relevant. Demand expansion starts a contraction of both sectors. The import compression linkage implies that the protected sector investment is discouraged by reduced traded goods production. Reduced protected goods production motivates a fall in traded sector investment because of the real exchange rate appreciation and the cost linkage. When the two intersectoral linkages are strong, it is hard to see economic mechanisms turning the contraction to growth. Policy reversal seems necessary to modify the negative effects of the expansive demand and the import dependency.

Appendix A: The short-run equilibrium

To facilitate simple algebraic expressions, the following compact forms are used. The investment function of the traded sector is written $J_1 = g(p)K_1$ with $g_1 < 0$. The derivative represents the combined effect of reduced profits and increased price of capital, as in Eq. (11). The investment function of the protected sector is written $J_2 = h(b)K_2$ with $h_1 > 0$. The specification assumes that the two conflicting effects of the real exchange rate cancel out - increased profits and increased price of capital, as appearing in Eq. (12). The supply function of the traded sector (7) is compressed to $t(p)$ with $t_1 < 0$, assuming $\omega$ and $c$ constant.

The excess supply function of the traded sector is

$$A_1 \frac{dE}{ds} + A_2 \frac{dp}{ds} = A_3 \frac{ds}{ds}.$$

The excess demand function of the protected sector is

$$B_1 \frac{dE}{ds} + B_2 \frac{dp}{ds} = B_3 \frac{ds}{ds}.$$

\begin{align*}
A_1 &= -\left(1 + (1 - c)(1 - s)(p n_1 - 1)a_1 K_2\right) \quad (< 0), \\
A_2 &= t_1 K_1 - (1 - c)(1 - s)(t_1 K_1 + n K_2 - (p n - 1)a_2 K_2) \quad (< 0), \\
A_3 &= -(1 - c)D \quad (< 0), \\
B_1 &= \left((c(1 - s) - 1)pn_1 - c(1 - s) + \alpha ph_1\right)a_1 K_2 \quad (< 0), \\
B_2 &= K_1(t_1 c(1 - s) + \alpha (g + pg_1)) + K_2(c(1 - s)((n - (p n_1 - 1)a_2) \\
&\quad - p(\alpha h_1 - n_1)a_2 - n + \alpha h) \quad (< 0), \\
B_3 &= cD \quad (> 0),
\end{align*}

with

\begin{align*}
D &= (1 - s)(t(p) K_1 + p n(b) K_2 - B) \quad (> 0), \\
a_1 &= 1/((1 + (1 - \alpha)h_1)K_2) \quad (> 0), \\
a_2 &= ((1 - \alpha)g_1 K_1)/((1 + (1 - \alpha)h_1)K_2) \quad (< 0).
\end{align*}

Stability of the system requires $(A_1 B_2 - B_1 A_3) > 0$. In this case it can readily be seen that $dE/ds > 0$ and $dp/ds < 0$. 
The assumption of nominal wage rigidity to study the consequences of devaluation simplifies the system above, since the real exchange rate will have no effect on the supply of traded goods, $t_1 = 0$. Essentially, the excess demand system is as above (with $t_1 = 0$) and devaluation shifts the supply of traded goods up according to the supply equation (5) with $W$ exogenous.

**Appendix B: The dynamic model**

The role of the state variables in the short-run model is shown first. To facilitate the dynamic formulation, the model is solved with respect to the ratio of intermediate imports $b$ and the real exchange rate $p$.

The excess supply function for the traded sector is:

$$C_1 \, db + C_2 \, dp = C_3 \, dK_1 + C_4 \, dK_2.$$ 

The excess demand function for the protected sector is:

$$D_1 \, db + D_2 \, dp = D_3 \, dK_1 + D_4 \, dK_2.$$ 

$$C_1 = -(1-c)(1-s)(pn - 1) + 1 + (1-\alpha)h_1)K_2 \quad (< 0),$$

$$C_2 = t_1 K_1 (1 - (1-c)(1-s)) - nK_2 (1-c)(1-s) - (1-\alpha)g_1K_1 \quad (< 0),$$

$$C_3 = (1-\alpha)g - (1 - (1-c)(1-s))t \quad (< 0),$$

$$C_4 = b + (1 - \alpha)h + (1-c)(1-s)(pn - b) \quad (> 0),$$

$$D_1 = (c(1-s) - 1)pn - c(1-s) + \alpha ph_1)K_2 \quad (< 0),$$

$$D_2 = K_1 (t_1 c(1-s) + \alpha (g + pg_1)) + K_2 ((c(1-s) - 1)n + \alpha h) \quad (< 0),$$

$$D_3 = - (c(1-s)t + \alpha pg) \quad (< 0),$$

$$D_4 = c(1-s)b - \alpha ph - (c(1-s) - 1)pn \quad (> 0).$$

Stability of the excess demand adjustments require ($C_1 D_2 - D_1 C_2 > 0$, equivalent to the condition stated in Appendix A. Based on the above, $b(K_1, K_2)$ and $p(K_1, K_2)$ are discussed in the text.

The analysis discusses shifts of the savings rate $s$, the foreign savings $S^*_f$, the import share of investment goods $\alpha$, and the productivity of intermediate imports $n$. The consequences are derived from the market balance equations above:

$$C_1 \, db + C_2 \, dp = C_5 \, ds + C_6 \, dS^*_f + C_7 \, d\alpha + C_8 \, dn,$$

$$D_1 \, db + D_2 \, dp = D_5 \, ds + D_6 \, dS^*_f + D_7 \, d\alpha + D_8 \, dn,$$
$C_1, C_2, D_1$ and $D_2$ are defined above,

$C_5 = -(1 - c) D < 0,$

$C_6 = -1,$

$C_7 = -J < 0,$

$C_8 = (1 - c)(1 - s) pK_2 > 0,$

$D_5 = c D > 0,$

$D_6 = 0,$

$D_7 = -pJ < 0,$

$D_8 = (1 - c(1 - s)) pK_2 > 0.$

The dynamic system taking into account the shifts is:

$$
\begin{bmatrix}
\frac{dK_1}{dt} \\
\frac{dK_2}{dt}
\end{bmatrix} = 
\begin{bmatrix}
\phi_1 & \phi_2 \\
\psi_1 & \psi_2
\end{bmatrix}
\begin{bmatrix}
\frac{dK_1}{dt} \\
\frac{dK_2}{dt}
\end{bmatrix} + 
\begin{bmatrix}
\phi_5 & \phi_6 & \phi_7 & \phi_8 \\
\psi_5 & \psi_6 & \psi_7 & \psi_8
\end{bmatrix}
\begin{bmatrix}
ds \\
d\alpha \\
dn
\end{bmatrix}
$$

$\phi_5 = g_1 K_1 (C_1 D_5 - D_1 C_5) / (C_1 D_2 - D_1 C_2) \quad (> 0),$

$\phi_6 = g_1 K_1 (C_1 D_6 - D_1 C_6) / (C_1 D_2 - D_1 C_2) \quad (> 0),$

$\phi_7 = g_1 K_1 (C_1 D_7 - D_1 C_7) / (C_1 D_2 - D_1 C_2) \quad (?),$

$\phi_8 = g_1 K_1 (C_1 D_8 - D_1 C_8) / (C_1 D_2 - D_1 C_2) \quad (?),$

$\psi_5 = h_1 K_2 (C_5 D_2 - D_5 C_2) / (C_1 D_2 - D_1 C_2) \quad (>,)$

$\psi_6 = h_1 K_2 (C_6 D_2 - D_6 C_2) / (C_1 D_2 - D_1 C_2) \quad (> 0),$

$\psi_7 = h_1 K_2 (C_7 D_2 - D_7 C_2) / (C_1 D_2 - D_1 C_2) \quad (?)$,  

$\psi_8 = h_1 K_2 (C_8 D_2 - D_8 C_2) / (C_1 D_2 - D_1 C_2) \quad (?)$. 

Increased savings rate $s$ and foreign savings $S^*_t$ definitely expand the capital stocks of the two sectors. The ambiguous effects of the import coefficients $\alpha$ and $n$ are discussed in the text.

References


