



NORTH-HOLLAND

# Short-Run Consequences of Trade Liberalization: A Computable General Equilibrium Model of Zimbabwe

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The elimination of import controls represents a challenging adjustment process for any economy. The mechanisms are investigated by the use of an economy-wide model of Zimbabwe. A benchmark version assumes import rationing and protection of domestic markets in an economy with unemployment of unskilled labor. Rather than modeling trade liberalization as a decrease in tariffs, we view it as a regime shift, requiring a new model closure. Compared with previous computable general equilibrium studies of trade liberalization, the analyses includes two expansionary channels, intermediate imports and savings response. It is shown that a combined consumption boom, short-run contraction, and growing trade deficit are likely, due to drop of savings and demand switching to foreign goods. © 1998 Society for Policy Modeling. Published by Elsevier Science Inc.

## 1. INTRODUCTION

Regulation of foreign trade has been a key feature of the Zimbabwean economy for 3 decades. During the unilateral declaration of independence (UDI) period between 1965 and 1980, international sanctions, and domestic policies to cope with them, induced

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Funding for this study was provided by the Ministry of Foreign Affairs, Norway. We are grateful for comments and discussions from seminars at Copenhagen University, Development Bank of South Africa, Harvard University, New School of Social Research, Oxford University, and Yale University; in particular, we thank Paul Collter, Jan Gunning, and Lance Taylor.

Received July 1994; final draft accepted November 1996.

*Journal of Policy Modeling* 20(3):305–333 (1998)

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Published by Elsevier Science Inc.

0161-8938/98/\$19.00

PII S0161-8938(97)00013-6

involuntary import substituting industrialization and strong growth up to about 1973, when the liberation war intensified. A sophisticated import control system was built, which the new government continued to use after independence in 1980. The import rationing apparatus was part of a general regulatory machinery used by the government to set the priorities of the economy. In particular, it was seen as a necessary instrument to control the foreign exchange situation. Observers agree that import compression was a major factor in explaining macroeconomic stability and stagnation during the 1980s (see Dailami and Walton, 1989; Davies and Rattsø, 1993, 1996; Green and Khadhani, 1986). During the 1990s the government has moved toward trade liberalization within the framework of a structural adjustment program. (Government of Zimbabwe, 1991).

Governments embark on trade liberalization programs to change the workings of the economy to gain long-term benefits from competition and comparative advantage. However, whatever long-run benefits might be anticipated, reforms are often postponed and opposed due to short-run adjustment costs. The present study attempts to understand some of the processes involved in such a trade liberalization in an economy like Zimbabwe. The analysis is undertaken using a computable general equilibrium (CGE) model, emphasizing real-side sectoral balances and macroeconomic interactions, based on our perception of the stylized facts of the Zimbabwean economy.

The starting point is a model representing the import compression regime at work through the 1980s, as analyzed by Davies, Rattsø, and Torvik (1994). The 1985 base-year version models the import controls in place during the decade, using a policy rule for allocating foreign exchange in which investment projects and intermediates to the export sector have priority. This links import capacity to both capacity utilization in import-dependent industries and to domestic savings via rationing of intermediates and noncompetitive consumer goods. Rationed imports include importables and food, protecting their domestic markets from international competition. Import capacity is determined by endogenous exports, and foreign financing (and thereby the trade balance) is exogenous.

Trade liberalization is conventionally modeled simply as a decrease in tariffs, assuming the rest of the model unchanged. However, this does not capture the essence of trade liberalization,

which is intended to change the fundamental workings and mechanisms ruling the economy. To overcome this shortcoming, we propose to model trade liberalization as a change in model closure, thus viewing it as a regime shift, replacing old mechanisms with new ones.

Based on the benchmark import rationing model, trade liberalization is analyzed as elimination of quantitative import controls. Two alternatives are investigated, representing different degrees of liberalization. Both alternatives assume an endogenous trade balance, thereby breaking the link between export performance and import capacity. The first, imported intermediates liberalization, is limited to lifting rationing of imported intermediates for the construction and importables sectors. Their demand functions for intermediates are satisfied, and consequently their supply curves shift out compared with the rationed benchmark. The elimination of the import compression bottleneck in import-dependent sectors is clearly expansionary.

The second alternative, full liberalization, adds competitive and noncompetitive finished goods to the list of liberalized commodities. The protected importables sector is forced to compete with imports, although imperfect substitution between them is assumed (the Armington framework). The improved access to noncompetitive consumer goods is assumed to affect savings rates, in accordance with the conventional wisdom in Zimbabwe. When domestic markets are opened up, both contractionary and expansionary demand side forces operate, since foreigners take a share of the domestic market and savings rates go down. The output consequences of trade liberalization depend on the policy context. Two additional elements are analyzed: devaluation and aid inflow.

The benchmark model is sketched out in section 2, and the mechanisms included in the study of the transition to trade liberalization are discussed in section 3. The analysis follows in two parts. The first shows the short-run consequences of the two liberalization attempts described above, sections 4 and 5. Trade liberalizing devaluation, assumed to keep the foreign balance constant, is analyzed in section 6. The second part investigates additional elements of a liberalization package. Foreign aid and devaluation to prevent total output from falling are discussed in section 7.

## **2. MODEL GUIDELINES**

The benchmark model formulation is the same as Davies et al. (1994), and describes the Zimbabwean economy of the 1980s. The

model brings together two types of dual models familiar from development economics. The dependent economy model distinguishing between traded and nontraded goods can be seen as the point of departure. With a view to including terms of trade effects and differences in import rationing, traded goods production is disaggregated to importables, exportables, and food agriculture. De Melo and Robinson (1989) and Bevan et al. (1990) argue for a disaggregation of the traded sector in developing countries. The exportables are often raw materials, agricultural crops, etc., whereas the importables have the characteristics of manufacturing goods and, in sub-Saharan Africa, foodstuffs. Since production structure and demand linkages differ, nontraded production is disaggregation to services and construction. The dual flexprice-flexprice approach of Taylor (1983), differentiating agriculture from the rest of the economy, is adopted, although our formulation differs from Taylor in that both food agriculture and most nonagricultural outputs are supply driven.

Taking all the above considerations into account, the model disaggregation is based on five production sectors as follows:

- Sector 1: food agriculture, comprising part of the agricultural sector (communal and commercial); flex-price adjustment; referred to in the text as “agriculture”
- Sector 2: nontradable consumer goods, comprising services, electricity, transport; demand determined output adjustment; “services”
- Sector 3: nontradable capital goods, comprising construction; supply-demand adjustment; “construction”
- Sector 4: exportables, comprising mining, large-scale agriculture and part of manufacturing; adjustment through export of residual output; “exportables”
- Sector 5: importables, comprising the rest of manufacturing; supply-demand adjustment; “importables”

A separation is made between skilled and unskilled labor in formulating both production and distribution technologies. In the labor market, skilled labor is in short supply, and the wage rate adjusts to clear the market. Unskilled labor is in permanent excess supply, and the use of unskilled labor is demand determined given an institutionally determined nominal wage rate.

The investment level is fixed exogenously, and the import share responds to relative prices. The formulation reflects the problem of identifying a well-defined investment function (see Mehlum

and Rattsø, 1993, Chhibber et al., 1989), and the understanding that investment demand was restricted by political and business uncertainty (see Dailami and Walton, 1989). The investment response to trade liberalization is left for future research.

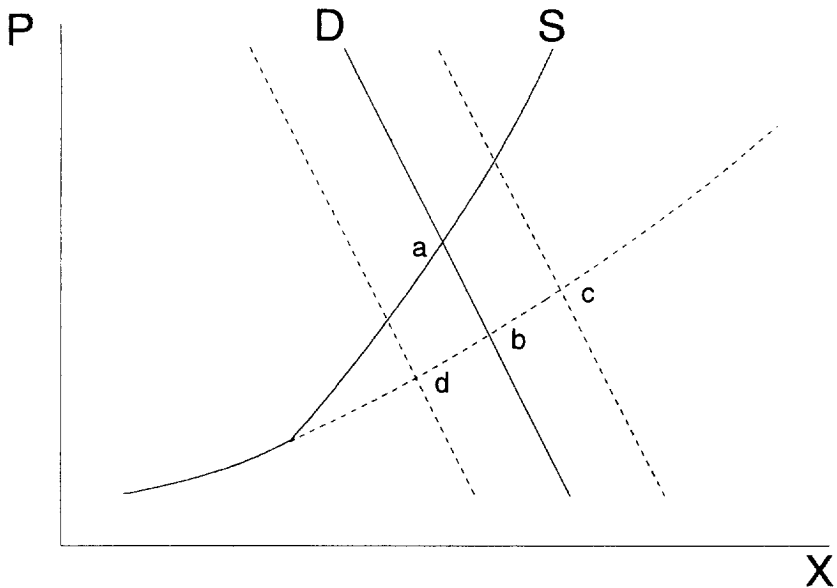
The benchmark model is built around a social accounting matrix (SAM) for 1985. The parameters and the exogenous variables of the model are set to have the endogenous variables consistent with the SAM. Full documentation is offered in Davies et al. (1994), and the equation set under alternative closures is presented in the appendix.

### **3. MODELING IMPORT RATIONING AND TRADE LIBERALIZATION**

In the benchmark model version, the import rationing system is based on the descriptions by Davies (1991) and Pakkiri and Moyo (1986). Available foreign exchange is allocated to satisfy priority needs (investment goods, intermediates for the exportables sector, and food). The importables sector is protected, and only a limited volume of importables is allowed to be imported. Any remaining foreign exchange is allocated as policy-determined shares, to meet requirements for imported intermediates by construction and importables, and to noncompetitive consumer imports. This formulation of the foreign exchange constraint is central to the working of the model. It makes the import compression of manufacturing and construction supply endogenously determined, dependent on the existing capacity to import. A theoretical framework for analyzing import compression is suggested by Rattsø (1994a), with additional aspects developed by Rattsø (1994b) and Torvik (1994). Gibson (1985) was the first to link export performance and import dependent industries in a model of Nicaragua.

The intermediate rationing motivates a detailed specification of the supply side of the import-dependent sectors. The formulation allows for substitution possibilities in a hierarchical system including imported and domestic intermediates, skilled and unskilled labor, and real capital. The production structure is similar to Grais et al. (1986), but the working of the model is different since they assume rent-seeking and no unemployment.

The supply function of the import-dependent sectors is shown in Figure 1. It is upward sloping because of fixed capital stock



**Figure 1.** Effects of liberalization.

implying increasing marginal costs. The supply curve under intermediate rationing is drawn as a solid line and is steeper when rationing bites. Reduced availability of imported intermediates can be compensated only imperfectly by domestic intermediates, and marginal costs are increasing for the intermediates aggregate. The rationing system offers the producers commodity-specific licenses for intermediates, and they are not allowed to resell. Clearly this system motivates rent-seeking, and costs associated with rent-seeking are another possible source of steeper marginal costs, as suggested by Grais et al. (1986). However, in Zimbabwe the license holders were old clients of the government, and observers agree that costs associated with rent seeking were not important. In our model, license holders do get an implicit rent as a result of the rationing. Rationing means a higher price of the finished goods in the protected domestic market than otherwise would be the case.

This leads us to the other important aspect of import rationing, protection of domestic final goods markets. The import compression almost eliminated imports of both importables and noncompetitive consumer goods, whereas there was a very thin domestic

market for those imports allowed. This motivates our assumption of fixed price rationing of final goods imports. The rents are handed to the government in the model.

Two effects of this protection are captured on the demand side. First, demand switches to domestic goods when foreign goods are not available. Neary and Roberts (1980) have suggested a modification of the linear expenditure formulation under rationing applied here. Since consumer imports are rationed, the ratio of imported to domestically produced consumption is lower than desired at the prevailing prices. The notional price of consumer imports is higher than the actual. Second, when demand for imports is not satisfied, part of the income can be set aside as savings—in the expectation of less severe rationing in the future. A theoretical justification is offered by Torvik (1993). Empirical evidence is identified by Chhibber et al. (1989) and Morande and Schmidt-Hebbel (1991). In the model, this stylized fact is taken care of by linking private savings rates to the rationing of noncompetitive consumer imports. The mechanisms may be as important to explain savings of private firms.

Imports of food are part of government policy to regulate domestic food markets, in particular in response to drought. We have made food imports endogenously dependent on food shortages, the gap between a target for food consumption and the actual consumption.

Trade liberalization is simulated by eliminating the rationing in two steps. The first, intermediates liberalization, does away with rationing of intermediate imports. The intermediate import demand functions for construction and importables (sectors 3 and 5) become unconstrained. The trade balance is endogenous, responding to changes in exports and imports, and foreign financing of the deficit is assumed to be available.

Figure 1 captures the expansionary supply effect, and the supply curve shifts outward to the dotted line. Given the demand curve  $D$ , output will expand from  $a$  to  $b$ . With fixed nominal wage of unskilled and overall unemployment, total employment can increase. The notional price of imported inputs falls. This is the opposite effect of the contractionary liberalization analyzed by Buffie (1984). In his model, a higher relative price of imported inputs explains possible output contraction.

The second package, full liberalization, adds free trade in importables, noncompetitive consumer goods, and food. Imperfect

substitution is assumed between domestically produced and imported importables, and the market shares are determined by relative prices. The demand function for noncompetitive consumer goods is unconstrained. The domestic price of food is determined at the international market (given the exchange rate) and net imports equilibrate the market.

The elimination of protection adds demand effects to Figure 1. Two counteracting forces can be identified. On the one hand, private savings rates are reduced when foreign goods are made available, and the consumption demand goes up given the income level. Since the stock of wealth accumulated under rationing can be higher than desired under liberalization, the immediate flow effect on consumption can be quite large (see Rattsø, 1994c, on the dynamics of this aspect). If demand expansion dominates, we may end up in an equilibrium like *c* in Figure 1. Both supply and demand factors are expansionary under liberalization. On the other hand, demand switches to imports since consumers have been forced to hold an inefficient mix of domestic and foreign goods. This effect tends to shift the demand curve to the left, possibly ending up in an equilibrium like *d* in Figure 1, with output contraction as a result of liberalization.

The standard welfare analysis of trade liberalization is based on a model assuming full utilization of resources. Trade liberalization is shown to improve resource allocation, since imperfections disturbing marginal efficiency conditions are eliminated. Static misallocation costs of trade restrictions have generally been shown to be small. The introduction of rent seeking has added to the estimates of possible gains. CGE studies addressing trade liberalization include Benjamin (1992), Condon et al. (1985), and Grais et al. (1986).

The more recent literature addresses the macroeconomic context of trade liberalization, as Collier and Gunning (1992). Even in models of full employment, credibility problems may lead to unfavorable outcomes regarding the trade balance and investment. Here we realistically assume unemployment of unskilled labor, opening up for possible effect on total employment. Theoretical studies by Buffie (1984) and Ocampo (1987) have shown that trade liberalization can be contractionary in this situation. Ocampo emphasizes demand switching, whereas Buffie assumes higher intermediate import costs. As shown above, demand switching may reduce output from import competing domestic industries. In models with full employment, more labor resources are available for

**Table 1:** Effects of Liberalization

	<b>Intermediates Liberalization</b>	<b>Full Liberalization</b>	<b>Trade Balance Preserving Devaluation</b>
GDP	+1.66	-1.81	+6.01
Services	+0.61	-3.74	+9.40
Constr.	+3.51	+2.58	+8.56
Exportables	+1.00	+2.70	+11.73
Importables	+6.73	-3.35	+0.54
Priv. Cons.	+4.49	+6.07	+11.94
CPI	-4.47	-6.96	+31.83
Exports	+1.38	+7.71	+17.93
Imports	+4.02	+27.53	+22.90

other sectors. In the unemployment situation, shifts in relative prices give an incentive for expanding output in other sectors. The total employment effect depends on the strength of the supply responses in these other sectors, particularly exportables. Adding real wage rigidity, as in Dixon et al. (1986), strengthens this effect. Lower import prices mean lower nominal wages and further increased competitiveness of the exportables sector.

#### 4. INTERMEDIATE IMPORTS LIBERALIZATION

The import rationing captured in the benchmark version imposes a supply constraint on the economy. When the firms cannot import the intermediates they desire, they are forced to apply an inefficient mix of domestic and imported intermediates, raising unit costs and reducing outputs compared to the nonrationed situation. In the intermediate imports liberalization experiment, the demand functions of imported intermediates are unrationed. This allows imported intermediates to replace less suitable domestic ones, reducing marginal costs, and increasing output supply. An overall expansion of the economy is expected. However, the demand for domestic intermediates per unit of output is also reduced, introducing a contractionary element into the process.

Table 1 shows the results of the experiment, presented as percentage deviations from the rationed 1985 benchmark. The intermediate import-constrained importables and construction sectors are the main sources of expansion. In the importables sector, the value added increases by 6.7%. Both supply and demand factors stimulate the formerly compressed sectors. The reduced costs

associated with a more efficient mix of intermediates lead to a relative price fall, switching expenditures away from other goods.

The construction sector experiences a more moderate expansion induced by the cost effect. Since most of the sector's deliveries go to the exogenous investment component, stimulation from increased aggregate demand is limited. However, the fall in the price of the rationed sectors reduces the price of domestic relative to imported investment goods. This effect explains much of the 3.5% increase in the sector's value added.

As pointed out by Collier and Gunning (1993), import restrictions often create an implicit subsidy for imported investment goods, since they imply an overvalued exchange rate compared to what would give the same trade balance under free trade. Since investment goods have priority over other imports, they can be imported at a low cost. Our model identifies an additional reason for liberalization to reduce the price of domestic relative to imported investment goods. Since intermediate imports for domestic sectors producing investment goods were previously rationed, liberalization will reduce their price relative to imported investment goods from the cost side, even if there is no devaluation.

The positive supply response of the import rationed sectors spreads out to the rest of the economy. GDP is increased by about 1.7%. As a consequence of given capital stocks and supply of skilled workers, the increase in unskilled employment is relatively higher—2.6%. Lower domestic costs of importables and construction reduce the price of composite intermediates for the exportables sector, and its value added rises by about 1%. The demand-determined service sector 2 follows along, stimulated by the economic expansion, but dampened by the expenditure switching toward other less expensive goods.

It is interesting to note an important difference between the experiment here and those in models with full employment. With unemployment, increased labor use in the formerly rationed sectors does not automatically mean less labor for the other sectors. In the full employment models, this is in effect what is assumed; they have a contractionary element hidden in the assumptions, since employment outside the formerly rationed sectors must, by assumption, decrease. Furthermore, rationing in some sectors is assumed to increase employment in others. In our model, restricting intermediates to some sectors is likely to have adverse effects on overall employment.

The favorable general expansion in the experiment brings with it a lower consumer price index (about 4.5%). The reduced domestic price of importables outweighs price-increasing demand effects. Private consumption expands by about 4.5%, well above the gross domestic product (GDP) effect. Increased foreign savings replace domestic savings, as income distribution shifts toward labor. The implicit rents of the previous license holders go down, explaining the shift away from profits.

The cost of intermediate goods liberalization can be read in the trade balance statistics. Total imports rise by about 4%. Some of this is self-financed, since new export revenues come in. The net trade deficit worsens by about 0.7% of GDP, a modest cost for the policy reorientation. The deterioration in the trade balance is moderate, partly because of the shift from imported to domestic investment goods, implying a reduced import bill for investment goods of about 0.5% of GDP.

All in all, the model results show that the short-run implications of liberalizing intermediate imports are limited. By extension this also suggests that the previous rationing cannot explain the growth stagnation during the 1980s, contrary to the understanding of most observers. The quantitative effects are dependent on our assumptions about the degree of rationing taking place before liberalization, but the conclusion holds for a wide range of realistic parameter values. Our explanation of this limited short-run response is that by the time liberalization was introduced, firms had adjusted to the rationed conditions. Those that were unable to do so did not survive. The economy had thus already rearranged itself to minimize the consequences of rationing. Whereas one would expect such a selection process to operate in any rationed economy, in Zimbabwe it was probably reinforced by various export incentive schemes, which had been introduced as early as 1983. These provided a channel for firms to reduce the constraint on their access to intermediate imports for domestic production. It follows that even if the short-run response to intermediates import liberalization is small, the rationing over time can be an important factor explaining stagnation.

## **5. FULL LIBERALIZATION**

In the second liberalization experiment, protection of domestic markets is eliminated, and trade in all imports is opened up. The nominal exchange rate is held constant to concentrate on the

responses to new trade arrangements. When finished goods are added to the list of liberalized goods, four implications of previous rationing are modified. First, the protected importables sector faces competition from abroad. In the benchmark rationed situation, the sector is treated as nontraded with exogenous imports and domestically determined prices. Now, imperfect substitution is assumed between domestically produced and imported importables in a composite CES aggregate. It follows that output supply can respond to cost and price conditions with a combination of domestic production and imports. Second, noncompetitive consumer imports come in. The demand function for noncompetitive consumption goods allocates consumer spending between domestic and foreign goods, and liberalization allows more of a given demand to be directed toward imported goods. Third, the new access to imported goods is assumed to reduce private savings rates, inducing higher consumer demand given the income level (as explained in section 3). Fourth, trade in food is now determined by market forces. The flexible food price implied by import controls is replaced by one fixed by the world market. Imports and exports of food vary to clear the domestic market, rather than its price.

This more ambitious liberalization experiment has the same expansionary effects as the more limited intermediates liberalization: lower costs of the composite intermediate and higher domestic content of investment goods. In addition, reduced savings rates mean more consumer demand out of a given income. However, countervailing contractionary effects are now in action. The opening up of the market for importables crowds domestic producers out of the market. The old protection was effective. The access to noncompetitive consumer imports switches demand from domestically produced goods. The net effect on domestic demand is dependent on our calibration of key parameters, in particular the desired switching to foreign consumer goods, the degree of substitution between domestic and imported importables, and the drop in private savings rates when imports are available. The assumptions explained in the appendix section A.4 represent our best judgment. Accordingly, the net effect is a drop in demand toward domestic goods. The appendix shows the range of parameters for which this holds true.

When the two types of expenditure switching dominate, and demand is reduced, the domestic activity level goes down. GDP is reduced by close to 2% in the experiment reported in Table 1.

Again, the unskilled employment effect is relatively stronger than the GDP effect. Employment of unskilled workers falls by 3.3%.

The contraction can be traced back to the importables sector 5. The previously protected importables sector is a key player in the liberalization process. In the old regime, both intermediate inputs and finished importable goods were rationed. When the protection is removed, the loss of market share is dominant. The reduced costs associated with free access to imported intermediates are not sufficient to defend the position at the domestic market. The changes in the composition of demand because of liberalized noncompetitive consumer imports, add to the contractionary forces. If Figure 1 is interpreted as the importables market, we end up in the new equilibrium d.

Liberalization generates structural adjustment away from non-tradable and importable goods toward exportables and domestic construction. The fall in intermediate input prices (importables and construction) stimulates exportable supply, and its value added rises by almost 3%. The nontraded service sector contracts (less than 4%) due to income contraction and demand switching because of higher relative price. The structural adjustment is according to the standard Washington recipe, but the expansion of exports is too slow to compensate for the loss of domestic market shares in the short-run. This is true even though the drop in domestic prices is quite large: the consumer price index (CPI) is reduced by about 7%. The relative price of importables falls with liberalization. Income distribution shifts away from profits, and falling private savings rates, explain an expansion of private consumption by more than 6%, even when the economy contracts.

The short-run structural adjustment where contraction goes hand in hand with a consumption boom is paid for by a huge trade deficit. Noncompetitive consumer imports and competitive importables goods are in high demand, and total imports rise by more than 27%. Some of the added import flow is financed by close to 8% exports revenue expansion, resulting from lower costs and lower demand for domestic goods. The demand effect not only means less domestic consumption of export sector goods. Since the trade in food is also opened up, lower demand for domestic goods implies food exports. Still, the trade deficit deteriorates seriously, to close to 8% of GDP. The deficit is comparable to the first years of independence and is hardly sustainable. The deficit and the deindustrialization associated with it are a high short-run price of liberalization, even if the long-run effects may

be favorable. As pointed out by Collier and Gunning (1992), trade liberalization may be incompatible. When private agents observe the large effect on the trade balance, they will expect future devaluations. Hence, imports are temporarily cheap. An import boom stronger than the model predicts may be the result, worsening the trade balance and making the liberalization even less sustainable.

The results above explain why trade liberalization is usually accompanied by devaluation. A devaluation may counteract the sustainability problem and the politically unacceptable contractionary consequences of liberalization. A trade-liberalizing devaluation assumed to maintain the initial trade balance with full liberalization is investigated in section 6. It is shown that the devaluation necessary is quite large, and that the price level is driven up to politically dangerous levels. Given the resistance to such a strong devaluation, other ways of avoiding the contraction are of interest. Two experiments, discussed in section 7, are constructed to show how the level of GDP can be held unaffected by liberalization—foreign aid and output preserving devaluation.

## 6. TRADE BALANCE-PRESERVING DEVALUATION

Devaluation is potentially an effective instrument for avoiding the unfavorable effects of liberalization described above. The devaluation necessary to keep the trade balance constant (in foreign currency) is investigated. In Collier's (1991) terminology, this is a trade-liberalizing devaluation as opposed to a payments-improving devaluation. Given the deterioration of the trade balance shown in the full liberalization experiment, quite a large devaluation is needed: to leave the foreign balance unaffected, the model asks for a nominal devaluation of 82%. Such dramatic changes could induce behavioral changes that would strain the *ceteris paribus* assumptions underlying our counterfactual experiments. Nevertheless, the main reactions discussed below are of interest. Table 1 sums up the impact on the main economic variables.

The trade-liberalizing devaluation expands the economy, with increased GDP of 6% compared to preliberalization. The export sector receives the most direct price signal and experiences the highest growth. The combined devaluation and removal of rationing imply a significant fall in the relative price of domestic to imported investment goods. When liberalization includes a

devaluation, the incentives to turn investment demand into domestic goods are stronger. The construction sector responds by increasing its value added by almost 9%, somewhat dampened because of the increased costs of imported intermediates. Compared with the other sectors, the importables sector is almost unaffected. Increased availability of intermediates and increased demand are offset completely by loss of market shares. The price effects of increased costs of imported intermediates and the general demand expansion favor the demand determined service output.

The relative price shifts induced by the devaluation stimulate exports and discourage imports. Even with the increased activity in the economy, this effect is sufficiently strong to reduce imports (compared to liberalization with no devaluation). Even if imports of intermediates increase because of increased production, the reduction in consumer imports because of the strong relative price shift is enough to outweigh this. In the savings-investment balance, the drop of private savings rates when imports are available is compensated by higher private incomes, as foreign savings are still basically zero.

On the price side it is worth noting that the 82% devaluation turns a fall in the CPI into a rise of above 30%. The consequence is a sharp decline in real wages for unskilled workers. Since virtual prices are higher than actual under rationing, their utility level is not necessarily reduced equivalently. But if compensation is demanded, the required nominal devaluation is even higher, and the economy may easily be thrown into accelerating inflation. Our interpretation of the trade-liberalizing devaluation effects is that it solves some problems of the liberalization package by creating other new ones. Balancing the two is a delicate political challenge.

## **7. OUTPUT PRESERVING FOREIGN AID AND DEVALUATION**

In the structural adjustment debate, the necessity of foreign aid inflow with reform is often emphasized. Pessimistic assessments suggest that foreign aid leads to deindustrialization. Starting out with the output contraction under full liberalization (with no devaluation), we ask how much aid is needed to preserve output (GDP). The experiment throws light on the role of foreign aid in the economy. Furthermore, it is of interest to contrast the effects with an output preserving devaluation, since changes in the sectoral composition of the economy depend on how output is prevented from falling during liberalization.

**Table 2:** Output Preserving Aid and Devaluation

	Output Preserving Aid	Output Preserving Devaluation
GDP	+1.85	+1.85
Services	+3.24	+2.82
Construction	+0.15	+1.46
Exportables	-0.78	+2.79
Importables	+3.20	+1.20
Priv. Cons.	+7.46	+1.17
CPI	+1.33	+7.05
Exports	-3.43	+2.89
Imports	+4.74	-0.49

Foreign aid inflow with liberalization is part of the Washington programs and is intended to overcome the threats to sustainability and credibility. This inflow is another possible source of expansion. The revenue involved adds to domestic demand during a period when demand is switched to foreign goods. This demand effect is highlighted here. (The aid is modeled as part of net factor payments from abroad (NFPA), which feeds directly into private incomes). An inflow of about 300 mill. Zimbabwe 1985-dollars will do the job, amounting to a little more than 4% of GDP. The consequences of such an additional injection are shown in Table 2.

Compared with the effects of full liberalization, nontraded services and importables production are the main winners, as expected when consumption demand goes up. The rise in consumption demand is significant, about 7 percentage points. The effect on the price level is small, however, since much of the demand is directed toward the service sector where the supply curve is quite flat.

The demand-expanding effect of foreign aid implies a worsening of the trade balance, although the current account is improved. If aid should be given so as to prevent the current account balance from worsening vis à vis the benchmark, considerably more aid than implied by this experiment is necessary. The conclusion is in accordance with the analysis of aided trade liberalization in Collier and Gunning (1992, p. 936): "The enormous foreign exchange requirement is liable to raise a question mark at the onset of the reform as to sustainability."

If aid inflow does not increase, devaluation of a little above 13% is necessary to prevent output from falling. Of course, the effects

on the economy go the same direction as with the trade balance preserving devaluation, although the changes are smaller because the devaluation is substantially smaller. It is of interest to compare the structure of the economy with the aid experiment. The key thing to note is that whereas imports are higher and exports lower with aid, the opposite is the case here. Compared with increased economic activity by devaluation, increased economic activity through demand injection has Dutch disease symptoms.

## **8. CONCLUDING REMARKS**

The model analysis has shown possible reactions to trade liberalization in the Zimbabwean economy. Liberalization of imported intermediates will help ease the previous supply constraint and is therefore likely to be expansionary. The recipe is not costless, however, as the trade balance will worsen. Full liberalization eliminates the protection of domestic markets for finished goods. Allowing the demand functions for finished goods to operate can have contractionary effects. Demand is switched away from domestically produced goods toward imports. Deindustrialization in the domestic economy may result. Sustainability problems related to trade deficit can be hard to handle.

In efforts to overcome threats to sustainability and credibility, trade liberalization is typically accompanied by devaluation. Devaluation is expansionary and improves the trade balance according to our results, but must be large to reduce the trade deficit significantly. New sustainability problems arise, related to inflation and possible claims for compensation.

Foreign aid inflow is a way of coping with the trade deficit and adding demand expansion to reform. Foreign aid can help avoid contraction, but the trade deficit will be even higher. Because of the demand effects of aid, the aid necessary to balance the current account is beyond realistic numbers. Compared with output-reserving devaluation, demand injection by aid is counterproductive if a shift to exports has high priority. Aid has Dutch disease effects.

Our analysis has shown that trade liberalization creates short-run adjustment problems, and can explain why liberalization has been controversial. Income distribution shifts identified when imports flow into the domestic market help us understand opposition to reform. The issue is discussed in the overview by Rodrik (1994): "if reform is such a great idea, why are governments typically so

reluctant to undertake it?" The usual answer is that even if trade liberalization improves resource allocation, there are winners and losers at the micro level. The losers can clearly be identified as the license holders, since they get cheap imports and high prices in the domestic market. If losers outweigh winners in political influence, they can prevent trade liberalization from taking place. In Zimbabwe, this argument goes a long way in explaining the skepticism to trade liberalization in the protected industrial establishment. Trade restrictions have been a way of hiding transfers that are otherwise difficult to undertake.

## **APPENDIX: MODEL DOCUMENTATION**

We present here only the essentials of the model; full documentation of the benchmark model is available in Rattsø and Torvik (1992). The equation set and the full list of symbols are shown below. The supply side of the model is described by equations 2 to 25 and is brought together with the demand side by the market clearing equation 1. The output of agriculture, sector 1, is exogenously given by capacity (equation 2) and a flexible price level arranges the market-clearing. Services, sector 2, are assumed to be demand determined with markup pricing (equation 3).

In the other three sectors, production functions include skilled and unskilled labor, domestic and imported intermediates, and real capital. They are specified as multilevel CES and Leontief functions. For each sector, output  $X$  is produced by a value added aggregate and an intermediate goods aggregate,  $N$ , in fixed proportions. The value added is a CES function of capital stock,  $K$ , and a labor aggregate,  $L$ , (shown by the term in parentheses in equation 4). The capital stock is historically given. Labor is a CES aggregate of unskilled  $L_u$  and skilled labor  $L_s$ . Intermediate goods,  $N$ , are a CES-aggregate of imported intermediates,  $II$ , and domestic intermediates,  $DI$ . Domestically produced intermediate goods are linked to aggregate  $DI$  by fixed coefficients.

The allocation of intermediate imports is a key aspect of the supply side adjustment. Exportables (sector 4) are assumed to have priority, so that their demand for imported intermediate is satisfied (equation 6). However, construction (sector 3) and importables (sector 5) are both import dependent and rationed. They are assumed to consume whatever quantity of imported intermediates they are given through the allocation system. The

rationed imported intermediates feed into the CES aggregate for intermediate goods (equation 8).

Prices in the three sectors are set equal to marginal costs (equation 9), and the marginal costs are the weighted sum of the marginal costs of intermediates and value added (equation 10).

The exportables sector is a price taker in the world market (equation 11). Since the sector is not rationed, the marginal cost of its intermediate goods aggregate is the price of the aggregate (equation 12). The marginal cost of the value added aggregate is derived from the value-added production function in the normal way (equation (13)). Export volume is determined as a residual given the supply function and the domestic demand for exportables.

The use of domestic intermediates in the rationed sectors is determined by standard cost-minimizing conditions. The part of the marginal cost associated with intermediates is influenced by the rationing of imported intermediates (equation 14). Equations 15 to 20 define costs and input-output coefficients, while the labor market is described by equations 21 to 25. This combines a fixed-wage demand determined unskilled labor market and a full employment wage-clearing skilled labor market. Unit labor costs are determined as a CES aggregate, and substitution between the two skill types follows from varying demand for skilled workers.

The income generation and consumption demand aspects of the model capture distributional effects and rationing of imported consumer goods (equations 26 to 34). The four income groups defined above have different propensities to save, an important aspect of overall savings formation. Savings rates are influenced by access to noncompetitive imported consumer goods (equation 31). The level of imports consumers desire is determined as a constant fraction of net consumer expenditures (equation 32). However, rationing of consumer imports means that these desires cannot be fulfilled, leading to postponed consumption and increased demand for domestic consumer goods.

Equations 35 to 37 model the public sector accounting. Equations 38 to 41 handle the foreign exchange rationing. The outlays for competitive imports, investment goods, and priority intermediate imports to exportables are subtracted from the sources of foreign exchange to determine the rationed amount (assumed to be positive) (equation 38). This is then allocated between imports of agricultural goods (equation 39), imported intermediates for

construction and importables, (equation 40) and imported non-competitive consumer goods (equation 41). The specification implies priority of imported food over intermediates and consumption goods; food imports are related to a target  $C_1^*$  for food consumption.

Investment is assumed to be a CES aggregate of sector 3, sector 5, and imported investment goods. The composition of the investment aggregate is made dependent on relative prices as in equations 42 and 43. The price of the investment aggregate follows by equation 44. Finally, equation 45 is a consistency check of the investment-savings balance.

### A1. Benchmark Rationing Model

$$X_i = \sum_{j=1}^5 a_{ij} \cdot X_j + C_i + G_i + J_i + E_i - M_i + DS_i \quad (i = 1-5) \quad (1)$$

$$X_1 = XB_1 \quad (2)$$

$$P_2 = \frac{(1 + t_2)(1 + \tau_2)}{1 - (1 + t_2)(1 + \tau_2)a_{22}} [a_{12} \cdot P_1 + a_{32} \cdot P_3 + a_{42} \cdot P_4 + a_{52} \cdot P_5 + q_2 \cdot b_2] \quad (3)$$

$$X_i = \frac{1}{1 - n_i} ([\mu_{1i} \cdot L_i^{-(1-\eta)/\eta} + \mu_{2i} \cdot K^{-(1-\eta)/\eta}]^{-\eta/(1-\eta)}) \quad (i = 3-5) \quad (4)$$

$$N_i = n_i \cdot X_i \quad (i = 3-5) \quad (5)$$

$$II_3 = \epsilon_{14}^{\delta_4} \left( \frac{e \cdot P_{04}^*}{MC_{N4}} \right)^{-\delta_4} N_4 \quad (6)$$

$$DI_4 = \epsilon_{24}^{\delta_4} \left( \frac{P_{D14}}{MC_{N4}} \right)^{-\delta_4} N_4 \quad (7)$$

$$N_i = [\epsilon_{1i} \cdot II_i^{-(1-\delta_i)/\delta_i} + \epsilon_{2i} \cdot DI_i^{-(1-\delta_i)/\delta_i}]^{-\delta_i/(1-\delta_i)} \quad (i = 3,5) \quad (8)$$

$$P_i = MC_i \quad (i = 3-5) \quad (9)$$

$$MC_i = n_i \cdot MC_{Ni} + (1 - n_i)MC_{VAi} \quad (i = 3-5) \quad (10)$$

$$P_4 = e \cdot P_4^* \quad (11)$$

$$MC_{N4} = [\epsilon_{14}^{\delta_4} (e \cdot P_{04}^*)^{1-\delta_4} + \epsilon_{24}^{\delta_4} \cdot P_{D14}^{1-\delta_4}]^{1/(1-\delta_4)} \quad (12)$$

$$MC_{VAi} = \frac{q_i}{\mu_{1i}} [\mu_{1i} \cdot L_i^{-(1-\eta)/\eta} + \mu_{2i} \cdot K_i^{-(1-\eta)/\eta}]^{1/(1-\eta)} \cdot L_i^{1/\eta} \quad (i = 3-5) \quad (13)$$

$$MC_{Ni} = \frac{P_{Di}}{\epsilon_{2i}} [\epsilon_{1i} \cdot II_i^{-(1-\delta_i)/\delta_i} + \epsilon_{2i} \cdot DI_i^{-(1-\delta_i)/\delta_i}]^{1/(1-\delta_i)} \cdot DI_i^{1/\delta_i} \quad (i = 3,5) \quad (14)$$

$$P_{Dij} = \sum_{i=1}^5 f_{ij} \cdot P_i \quad (j = 3-5) \tag{15}$$

$$B_j = \sum_{i=1}^5 a_{ij} \cdot P_i + a_{0j} \cdot e \cdot P_{0j}^* + q_j \cdot b_j \quad (j = 2-5) \tag{16}$$

$$A_{ij} = f_{ij} \cdot DI_j \quad (i = 1-5, j = 3-5) \tag{17}$$

$$a_{0j} = \frac{H_j}{X_j} \quad (j = 3-5) \tag{18}$$

$$a_{ij} = \frac{A_{ij}}{X_j} \quad (i = 1-5, j = 3-5) \tag{19}$$

$$L_i = b_i \cdot X_i \quad (i = 2-5) \tag{20}$$

$$q_i = [\alpha_i^{\sigma_i} \cdot w_{ui}^{1-\sigma_i} + \beta_i^{\sigma_i} \cdot w_s^{1-\sigma_i}]^{1/(1-\sigma_i)} \quad (i = 2-5) \tag{21}$$

$$L_{ui} = a_i^{\sigma_i} \left(\frac{w_{ui}}{q_i}\right)^{-\sigma_i} L_i \quad (i = 2-5) \tag{22}$$

$$L_{si} = \beta_i^{\sigma_i} \left(\frac{w_s}{q_i}\right)^{-\sigma_i} L_i \quad (i = 2-5) \tag{23}$$

$$L_u = \sum_{i=2}^5 L_{ui} + L_{ug} \tag{24}$$

$$L_s = \sum_{i=2}^5 L_{si} + L_{sg} \tag{25}$$

$$Y_a = P_1 \cdot X_1 \tag{26}$$

$$Y_u = \sum_{i=2}^5 w_{ui} \cdot L_{ui} + w_{ug} \cdot L_{ug} \tag{27}$$

$$Y_s = \sum_{i=2}^5 w_s \cdot L_{si} + w_s \cdot L_{sg} + NFPA \tag{28}$$

$$Y_z = \sum_{i=2}^5 P_i \cdot X_i - B_i \cdot X_i - \frac{t_i}{1+t_i} P_i \cdot X_i \tag{29}$$

$$D = (1 - s_a)Y_a + (1 - s_u)Y_u + (1 - s_s)Y_s + (1 - s_z)(1 - t_z)Y_z \tag{30}$$

$$s_j = s_j^* + \gamma_j \left( \frac{CIMP_D - CIMP_A}{CIMP_D} \right)^2 \quad (j = a, u, s, z) \tag{31}$$

$$CIMP_D = \frac{m_c}{e \cdot P_{0c}^*} (D - DB) \tag{32}$$

$$DB = \sum_{i=1}^5 P_i \cdot \theta_i \tag{33}$$

$$C_i = \theta_i + \frac{m_i}{(I - m_i)P_i} (D - DB - e \cdot P_{0i}^* \cdot CIMP_A) \quad (i=1-5) \quad (34)$$

$$GREV = t_z \cdot Y_z + T^{IND} \quad (35)$$

$$T^{IND} = \sum_{i=1}^5 \frac{t_i}{I + t_i} P_i \cdot X_i \quad (36)$$

$$GEXP = \sum_{i=1}^5 P_i \cdot G_i + w_{ug} \cdot L_{ug} + w_s \cdot L_{sg} - (P_1 - e \cdot P_1^*) M_1 - (P_5 - e \cdot P_5^*) M_5 \quad (37)$$

$$RAT = -e \cdot P_3^* \cdot M_5 - e \cdot P_{0j}^* \cdot J_0 - e \cdot P_{04}^* \cdot II_4 + DEF + P_2 \cdot E_2 + P_4 \cdot E_4 + NFPA \quad (38)$$

$$M_1 = M_1^* + h_{01} \cdot (C_1^* - C_1) \quad (39)$$

$$II_i = II_i^* + h_{0i} \cdot \frac{(RAT - e \cdot P_{03}^* \cdot II_3^* - e \cdot P_{05}^* \cdot II_5^* - e \cdot P_1^* \cdot M_1)}{e \cdot P_{0i}^*} \quad (i = 3, 5) \quad (40)$$

$$CIMP_A = h_{0c} \cdot \frac{(RAT - e \cdot P_{03}^* \cdot II_3^* - e \cdot P_{05}^* \cdot II_5^* - e \cdot P_1^* \cdot M_1)}{e \cdot P_{0c}^*} \quad (41)$$

$$J_i = \pi_i^\tau \left( \frac{P_i}{P_J^{COMP}} \right)^{-\tau} J \quad (i = 3, 5) \quad (42)$$

$$J_0 = \pi_0^\tau \left( \frac{e \cdot P_{0j}^*}{P_J^{COMP}} \right)^{-\tau} J \quad (43)$$

$$P_J^{COMP} = [\pi_0^\tau \cdot (e \cdot P_{0j}^*)^{1-\tau} + \pi_3^\tau \cdot P_3^{1-\tau} + \pi_5^\tau \cdot P_5^{1-\tau}]^{1/(1-\tau)} \quad (44)$$

$$P_3 \cdot J_3 + P_5 \cdot J_5 + e \cdot P_{0j}^* \cdot J_0 + \sum_{i=1}^5 P_i \cdot DS_i = s_u \cdot Y_u + s_a \cdot Y_a + s_s \cdot Y_s + s_z(1 - t_z)Y_z + GREV - GEXP + DEF \quad (45)$$

**ENDOGENOUS VARIABLES** The model consists of 117 equations: 116 of these are independent since the investment-savings balance can be calculated from the rest of the equations. We therefore have the following 116 endogenous variables:

- $A_{ij}$  : intermediate deliveries  $i = 1-5, j = 3-5$
- $a_{0j}$  : intermediate imports-output coefficients sectors  $j = 3-5$
- $a_{ij}$  : intermediate input-output coefficients sectors  $j = 3-5, i = 1-5$
- $B_i$  : variable costs pr. unit of output sectors  $i = 2-5$
- $b_i$  : labor-output coefficients sectors  $i = 3-5$

- $C_i$  : total consumption levels,  $i = 1-5$   
 $CIMP_D$ : desired noncompetitive consumer imports  
 $CIMP_A$ : actual noncompetitive consumer imports  
 $D$  : consumer spending  
 $DB$  : spending for floor consumption  
 $DI_i$  : domestic intermediate goods aggregate sectors  
 $i = 3-5$   
 $E_4$  : exports  
 $GEXP$  : gov. spending  
 $GREV$ : gov. revenue  
 $J_i$  : investment deliveries from sectors  $i = 0,3,5$   
 $II_i$  : intermediate imports sectors  $i = 3-5$   
 $L_{ui}$  : unskilled workers sectors  $i = 2-5$   
 $L_{si}$  : skilled workers sectors  $i = 2-5$   
 $L_u$  : total unskilled workers  
 $L_i$  : labor aggregates sectors  $i = 2-5$   
 $M_1$  : imports of agricultural goods  
 $MC_i$  : marginal cost sectors  $i = 3-5$   
 $MC_{Ni}$  : marginal cost of intermediate goods aggregate sectors  
 $i = 3-5$   
 $MC_{VAi}$  : marginal cost of value added aggregate sectors  
 $i = 3-5$   
 $N_i$  : intermediate goods aggregate to sectors  $i = 3-5$   
 $P_i$  : sectoral price levels  $i = 1-5$   
 $P_{Dii}$  : price of domestic intermediate goods aggregate sectors  
 $i = 3-5$   
 $P_J^{COMP}$  : price of investment aggregate  
 $q_i$  : labor cost sectors  $i = 2-5$   
 $RAT$  : foreign exchange available for rationed goods  
 $s_i$  : savings rates  $i = a, u, s, z$   
 $T^{IND}$  : indirect taxes  
 $w_s$  : wage rate skilled workers  
 $X_i$  : sectoral output levels,  $i = 1-5$   
 $Y_a$  : agr. income  
 $Y_s$  : wage income skilled workers  
 $Y_u$  : wage income unskilled workers  
 $Y_z$  : profit income

## PARAMETERS

- $a_{ij}$  : input-output coefficients  $i = 1-5, j = 1-2$   
 $b_2$  : labor-output coefficient sector 2

- $C_1^*$  : target on food consumption  
 $f_{ij}$  : shares in domestic input aggregate sectors  $j = 3-5$ ,  
 $i = 1-5$   
 $h_{oi}$  : rationing parameters  $i = 1,3,5,C$   
 $\Pi_i$  : minimum level of imported intermediates sectors  $i = 3,5$   
 $M_1^*$  : constant in agricultural imports function  
 $m_c$  : propensity to consume noncompetitive imports  
 $m_i$  : marginal propensity to consume:  $i = 1-5$   
 $n_i$  : intermediate goods-output ratio sectors  $i = 3-5$   
 $s^*_i$  : constant in savings functions  $i = a,u,s,z$   
 $t_i$  : indirect tax rates sectors  $i = 1-5$   
 $t_z$  : tax rate of profit income  
 $\alpha_i$  : distribution parameter of unskilled labor in CES aggregate  
 $\beta_i$  : distribution parameter of skilled labor in CES aggregate  
 $\gamma_i$  : savings respond parameter  $i = a,u,s,z$   
 $\Gamma$  : elasticity of substitution in investment aggregate  
 $\delta_i$  : elasticity of substitution in intermediate aggregate sectors  
 $i = 3-5$   
 $\epsilon_{i1}$  : distribution parameter of intermediate imports in intermedi-  
 ate aggregate sectors  $i = 3-5$   
 $\epsilon_{2i}$  : distribution parameter of domestic intermediates in interme-  
 diate aggregate sectors  $i = 3-5$   
 $\eta_i$  : elasticity of substitution in value added aggregate sectors  
 $i = 3-5$   
 $\theta_i$  : floor consumption levels  $i = 1-5$   
 $\mu_{1i}$  : distribution parameter of labor in value added aggregate  
 sectors  $i = 3-5$   
 $\mu_{2i}$  : distribution parameter of capital in value added aggregate  
 sectors  $i = 3-5$   
 $\pi_i$  : distribution parameter in investment aggregate from sectors  
 $i = 0,3,5$   
 $\sigma_i$  : elasticity of substitution in labor aggregate  $i = 2-5$   
 $\tau_2$  : markup rate sector 2

#### EXOGENOUS VARIABLES

- $DS_i$  : changes in stocks  $i = 1-5$   
 $DEF$  : trade deficit  
 $E_2$  : exports sector 2  
 $e$  : exchange rate  
 $G_i$  : gov. demand for commodities  $i = 1-5$   
 $J$  : investment aggregate

- $K_i$  : capital in sectors  $i = 3-5$
- $LB_s$  : supply of skilled labor
- $L_{ug}, L_{sg}$  : government employment
- $M_5$  : competitive imports, sector 5 goods
- NFPA : net factor payments from abroad
- $P_i^*$  : foreign price of sectoral goods  $i = 1,4,5$
- $P_{0i}$  : foreign price of intermediate imports to sectors  $i = 1,4,5$
- $P_{0j}$  : foreign price of investment goods
- $w_{ui}, w_{ug}$  : wage rates unskilled workers  $i = 2-5$
- $XB_1$  : output level sector 1

**A2. Intermediates Liberalization Model**

In the first liberalization model alternative, the rationing of imported intermediates is removed, and intermediate demand functions for sectors 3 and 5 operate as for the initially unrationed exports sector 4. The rationing rule (equation 40) is eliminated, and the demand is determined as in (equation 6). The demand for domestically produced intermediates is determined as in equation 7, and equation 8 can be eliminated. The rationed marginal cost functions (equation 14) are replaced by (equation 12). Food and noncompetitive consumer imports are still rationed, and  $M_1$  and  $CIMPA_A$  are exogenous, whereas the rationing rules (equations 39 and 41) are eliminated. The trade deficit is endogenous, and follows from the revised equation (38):

$$DEF = e \cdot P_1^* \cdot M_1 + e \cdot P_3^* \cdot M_5 + e \cdot P_{03}^* \cdot I_3 + e \cdot P_{04}^* \cdot I_4 + e \cdot P_{05}^* \cdot I_5 + e \cdot P_{0c}^* \cdot CIMPA_A + e \cdot P_{0j}^* J_0 - P_2 \cdot E_2 - P_4 \cdot E_4 - NFPA$$

**A3. Full Liberalization Model**

In this version, we remove protection from imported importables and noncompetitive consumer goods. We introduce a composite importables good  $X_5^*$ . It is a CES aggregate of domestically produced and imported importables determined by

$$X_5 = \xi_1^\psi \left( \frac{P_5}{P_5^{COMP}} \right)^{-\psi} X_5^*$$

$$M_5 = \xi_2^\psi \left( \frac{e \cdot P_3^*}{P_5^{COMP}} \right)^{-\psi} X_5^*$$

$$P_5^{COMP} = [\xi_1^\psi \cdot P_5^{1-\psi} + \xi_2^\psi (e \cdot P_3^*)^{1-\psi}]^{1/(1-\psi)}$$

where  $\xi_1$  and  $\xi_2$  are distribution parameters for domestically produced and imported goods in the CES aggregate,  $\psi$  the elasticity of substitution, and  $P_5^{\text{COMP}}$  the price of the aggregate (replaces  $P_5$  in all demand functions). Equation 1 for sector 5 is now a market balance for only the domestic components of demand, and  $M_5$  is left out of the equation.

The liberalization of noncompetitive consumer goods implies that imports are determined by demand in equation 32 where  $\text{CIMP}_D$  is replaced by  $\text{CIMP}_A$ ). The consumer demand functions (equation 34) are reformulated to:

$$C_i = \theta_i + \frac{m_i}{P_i}(D - DB) \quad (i = 1-5)$$

Since the domestic market for food is liberalized, imports  $M_1$  are made endogenous, with  $P_1$  determined by the world price and the exchange rate. The market equilibration is changed from a flex-price regime to an import adjusting regime in the standard open economy fashion.

#### A4. Calibration

The benchmark model is built around a social accounting matrix (SAM) for 1985 documented by Rattsø and Torvik (1992). All variables are calculated in millions of Zimbabwe dollars at 1985 prices. The parameters and the exogenous variables of the model are set so as to have the endogenous variables consistent with the SAM. Savings rates differ between economic groups ( $s_a = s_u = 0.22$ ,  $s_s = 0.27$ ,  $s_z = 0.5187$ ). The consumption demand parameters follow from assumptions about the income elasticities (0.8 for agriculture and 1.05 for services) and the supernumerary income ratio (0.48).

Other key parameter values used in the simulations are as follows:

##### Elasticities of substitution

in labor aggregate,  $\sigma = 0.5$ ,  $i = 2-5$

in intermediate goods aggregate,  $\delta_i = 0.333$ ,  $i = 3-5$

in value added aggregate,  $\eta_i = 0.5$ ,  $i = 3, 5$  and  $0.2$ ,  $i = 4$

in investment aggregate,  $\Gamma = 0.5$

in sector 5 Armington aggregate,  $\psi = 0.8$

Constants in savings functions,  $s_a^* = 0.22$ ,  $s_u^* = 0.18$ ,  $s_s^* = 0.23$ ,  $s_z^* = 0.4$

Savings response parameters,  $\gamma_a = 0$ ,  $\gamma_u = \gamma_s = 0.09$ ,  $\gamma_z = 0.2671$

Rationing parameters,  $h_{01} = 1$ ,  $h_{03} = 0.0535$ ,  $h_{05} = 0.3512$ ,  
 $h_{0C} = 0.5953$

Constant in food import function,  $M_1^* = 36$

Minimum levels of imported intermediates,  $I_3 = 90$ ,  $I_5 = 600$

The effect of liberalization depends in part on the pattern and extent of previously existing rationing of consumers and producers. Although there is little evidence of this, we judge the following assumptions to represent the Zimbabwe story. The production functions determine the desired demand for imported intermediates. Small elasticities of substitution capture the rigid production structure of the economy. The pure substitution effect of rationing intermediate imports assumes that 91% of the demand for intermediate imports by construction and importables is satisfied. Sensitivity analysis shows that if instead 95% of this demand had been satisfied before liberalization, the economic expansion is about 1 percentage point lower than in the experiment reported in Table 1.

Noncompetitive consumer imports and imports of sector 5 goods are assumed to be strictly rationed, with the actual imports satisfying only one-third of actual demand. The assumption is important for the demand switching and the savings response. Given the savings response parameters stated above, private savings rates fall by about 5% points for labor and by about 15% points for profit income with liberalization. Even with this strong drop in private savings, the demand switching dominates in the full liberalization experiment in Table 1. If the rationing of non-competitive consumer imports and imports of sector 5 goods is about one-half of actual demand in the base year, the demand switching is reduced, and the model predicts output expansion with full liberalization.

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