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ECONOMIC IMPLICATIONS OF FOREIGN EXCHANGE RATIONING IN ETHIOPIA[1]

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Abstract

Increases in foreign transfers and capital inflows helped spur Ethiopia's economic growth in recent years, but also contributed to a real exchange rate appreciation that reduced incentives for production of tradable goods. Then, beginning in March 2008, following major external shocks, foreign exchange for imports was restricted to avoid excessive drawdown of reserves.

This paper examines the implications of these shocks and policies using a Computable General Equilibrium (CGE) model of the Ethiopian economy. The results show that there are substantial costs to both foreign exchange rationing and real exchange rate appreciation in terms of economic efficiency and income distribution.

Key words: Ethiopia, CGE model, real exchange rate, rents, foreign exchange rationing.

JEL codes: D58 (Computable and Other Applied General Equilibrium Models), O2 (Development Planning and Policy); F31 (Foreign Exchange); O24 (Trade Policy; Factor Movement Policy; Foreign Exchange Policy).

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1. Introduction

Ethiopia enjoyed remarkable economic growth from 2004/05 to 2008/09, in large part due to increases in foreign transfers and capital inflows combined with expanded domestic credit to fund major increases in private and public investments in infrastructure and housing. The agricultural sector also played a major role in the rapid economic growth, as increased efforts in agricultural extension, good weather and improved transport and telecommunications infrastructure, all contributed to increases in agricultural productivity and overall production.

However, this growth was accompanied by a real exchange rate appreciation of 14 percent from July 2004 to January 2007, as nominal exchange rates were kept almost constant while domestic inflation increased. Then, when major external shocks (including increases in world prices of fuel and reduced private transfers) hit the economy, a foreign exchange shortage resulted. Beginning in March 2008, access to foreign exchange for imports was restricted (rationed) to avoid excessive drawdown of foreign exchange reserves, and by July 2008, the real exchange rate appreciation had increased by a further 20 percent (relative to July 2004).[5]

This paper examines the implications of these external shocks and policies, particularly the appreciation of the real exchange rate and the subsequent foreign exchange rationing on the overall economy and household welfare in Ethiopia. Section II presents the macro-economic setting in Ethiopia, focusing on developments from 2004/05 to 2008/09, along with a discussion of the basic analytical framework for assessing the effects of import rationing on the real exchange rate. Section III utilizes a computable general equilibrium (CGE) model of the Ethiopian economy to examine the economy-wide implications of the surge in foreign capital inflows from 2004/05 to 2007/08, the subsequent decline of these flows, and the foreign exchange rationing beginning in March 2008. The final section summarizes the results of the analysis and presents policy implications.

[5] Subsequent nominal depreciation of the Birr reduced the real exchange rate appreciation relative to July 2004 to 30 percent in March 2009.

2. The Macro-Economic Setting: The Investment Boom and Foreign Exchange Rationing

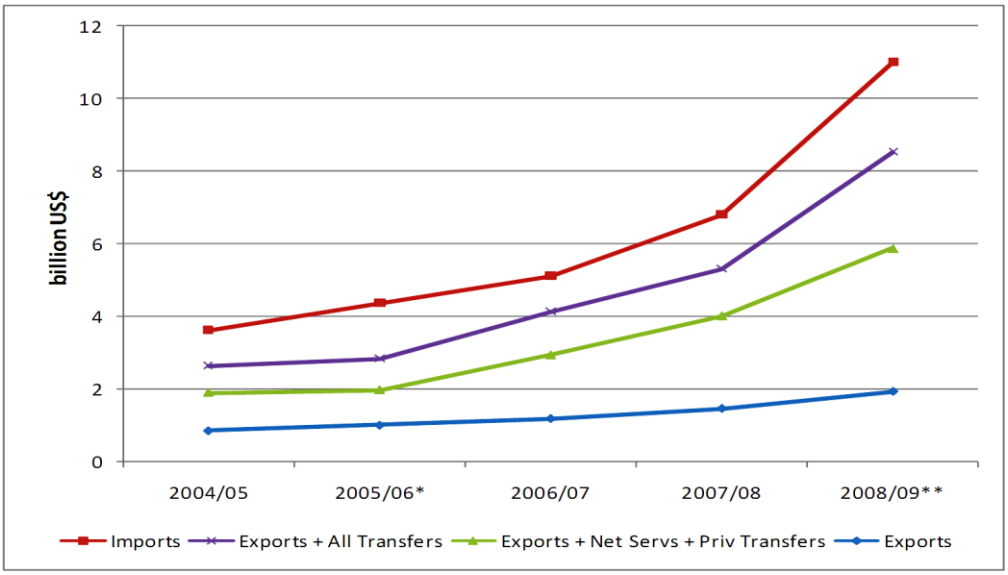
Between 2004/05 and 2007/08, Ethiopia successfully accelerated its economic growth through a deliberate policy of expanded domestic credit to finance private investment and increased foreign borrowing to finance public investment. Increased investment implied increased demand for imports (and for foreign exchange) since private (and public) sector investors had access to foreign exchange to finance imported intermediate and capital goods. At the same time, workers' remittances and private transfers were increasing, supplying resources for private investment in residential housing and other domestic consumption and investment. As a result, merchandise imports surged by 87 percent ($3.2 billion) between 2004/05 and 2007/08. Half of this increase in merchandise imports was financed by a 195 percent increase in private transfers (including workers' remittances); increases in merchandise exports and capital inflows each financed 16-19 percent of the increase in merchandise imports (Table 1).

Table 1: Ethiopia Imports and Import Financing, 2004/05 to 2007/08

	2004/05	2007/08	2004/05 to 2007/08	2004/05 to 2007/08	2004/05 to 2007/08
	mn $	mn $	mn $	% change	% of Imports
Imports (Merchandise)	3,633	6,811	3,178	87%	100%
Exports (Merchandise)	847	1,466	619	73%	19%
Net Services	242	160	- 82	-34%	-3%
Private Transfers	811	2,393	1,582	195%	50%
Public Transfers	750	1,312	563	75%	18%
Capital Inflows	983	1,480	496	50%	16%
Subtotal	3,633	6,811	3,178	87%	100%

Source: National Bank of Ethiopia data.

Figure 1: Ethiopia Imports and Import Financing, 2004/05 to 2007/08



Source: National Bank of Ethiopia data.

Higher world prices, increased domestic credit, foreign capital inflows, changes in inflationary expectations and other factors contributed to increases in overall domestic inflation, however, which rose from 11.5 percent in 2004/05 to 64.5 percent in 2007/08[6)]. Inflation has slowed substantially since then, though, and between July 2008 and March 2009, the price level actually fell by 6 percent. Yet, with nominal exchange rates changing little relative to the US dollar, the real exchange rate appreciated by 13.8 percent between July 2004 and January 2008 and by a total of 33.8 percent through July 2008. Nominal depreciation of the Birr (from 9.83 to 12.0 Birr/$) between July 2008 and June 2009 helped reduce real appreciation of the birr to 26.3 percent, but this still represents a major reduction in incentives for production of tradables (export goods and import substitutes) since July 2004.

[6] The Ethiopian fiscal years cited here run from July to June.

Table 2: Ethiopia Nominal and Real Exchange Rates, 2004-2009

Index	Nominal Exchange (Birr/$)	Nominal Exchange Rate (Birr/$) (Index)	World Price Index ($)	World Price Index (Birr)	CPI	Real Exchange Rate Index
July 2004	8.80	100.0	100.0	100.0	100.0	100.0
January 2005	8.83	100.3	102.7	103.0	102.9	100.1
July 2005	8.84	100.5	101.4	101.9	111.5	91.3
January 2006	8.86	100.6	104.1	104.7	112.8	92.8
July 2006	8.87	100.8	108.7	109.6	125.7	87.2
January 2007	8.99	102.1	110.4	112.7	131.6	85.7
July 2007	9.21	104.7	116.8	122.3	143.6	85.1
January 2008	9.40	106.9	127.0	135.7	157.5	86.1
July 2008	9.83	111.7	139.6	156.0	235.8	66.2
January 2009	11.06	125.7	120.0	150.8	217.0	69.5
June 2009	12.00	136.4	121.3	165.4	224.4	73.7
July 04 - June 09 (percent change)	36.4%	36.4%	21.3%	65.4%	124.4%	-26.3%

Source: EDRI and authors' calculations.

Moreover, Ethiopia had been increasingly financing its current account deficit through drawdown of official foreign exchange reserves. From end June 2007 to the end of March 2008, foreign exchange reserves fell by $381 million (equivalent to 13 percent of the value of merchandise imports in that period).[7] (For 2007/08 as a whole (i.e. through June 2008), foreign exchange reserves fell by $264 million in 2007/08 (i.e., an amount equal to 5 percent of merchandise imports in 2006/07), in spite of large inflows of private and public transfers.)

With foreign exchange reserves near zero and import demand in excess of supply of foreign exchange, there were two broad options:

- Devalue the currency so as to reverse the real exchange rate appreciation of the past few years, reducing demand for imports, increasing supply of exports and restoring equilibrium in the market for foreign exchange; or
- Control imports by imposing foreign exchange controls and allow the exchange rate to remain overvalued (and in fact become increasing over-valued)

[7] Average foreign exchange reserves for 2007 were 1.3 billion US dollars (World Bank, Ethiopia at a Glance)..

3. Foreign Capital Inflows, Rationing and the Real Exchange Rate: Analytical Framework

Similar to the goods market, in the foreign exchange markets, the supply of foreign exchange from exports (which includes merchandise and services exports, foreign aid, private transfers and other transfers) plus foreign exchange net capital inflows (equal to the current account deficit) equals demand for foreign exchange from imports. However, the difference between the unrestricted and rationed foreign exchange markets is in the way these market forces (supply and demand) adjust in response to exchange rate changes (devaluation). Hence, the effects of an exchange rate devaluation in a market with foreign exchange rationing are very different from the effects of a devaluation in an unrestricted foreign exchange market.

In an unrestricted market for foreign exchange (Figure 2), the (real) exchange rate adjusts so that supply of foreign exchange from exports (and current account transfers) (X0) plus net foreign exchange capital inflows (Trade Deficit 0) equals demand for foreign exchange from imports (M0). In such an unrestricted market, a (real) exchange rate depreciation (from ER0 to ER1) tends to increase supply of exports and reduce demand for imports, lowering the trade (current account) deficit (to Trade Deficit 1). In other words, the nominal exchange rate devaluation does its intended effect of reducing the deficit through reduced absorption and increased export supply.

In a restricted or rationed market for foreign exchange, however (Figure 3), changes in the (real) exchange rate need not result in a reduction in imports. This is because, in a ration regime, the demand for foreign exchange for imports (M0) at the official exchange rate (ER0) exceeds total supply of foreign exchange (equal to export (and current account transfer) earnings plus the available foreign exchange from capital inflows and reserve drawdown (M2-X0)). This results in an unmet demand for foreign exchange (M2-M0) at the official exchange rate (ER0). A parallel market for foreign exchange will tend to develop with an exchange rate (ERpar) such that total demand for foreign exchange at this exchange rate (M2) equals total supply.

Figure 2: Impacts of a Devaluation in an Unrestricted Market for Foreign Exchange

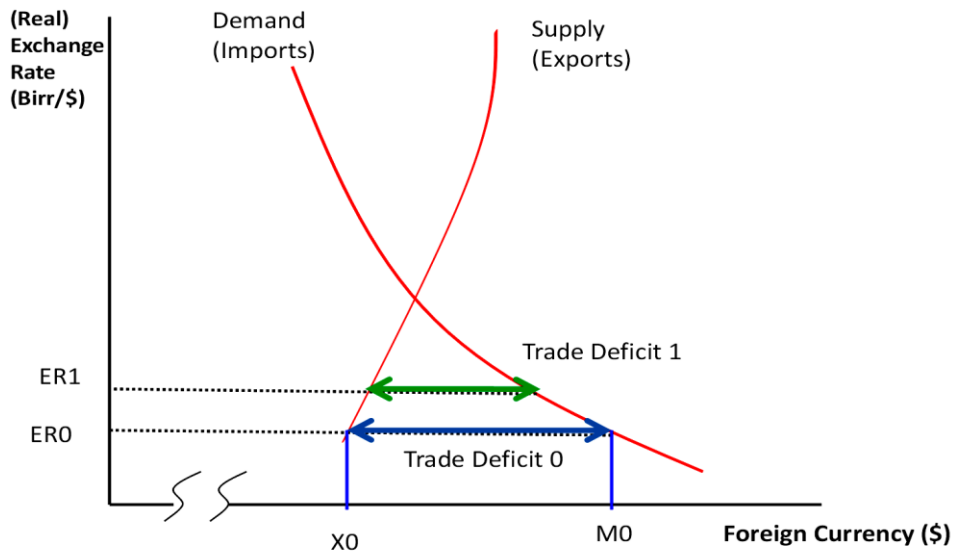
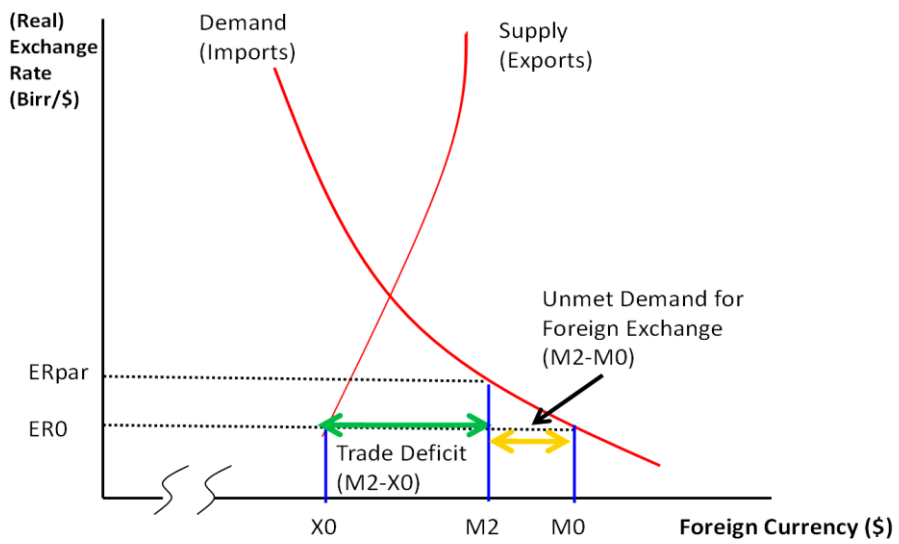


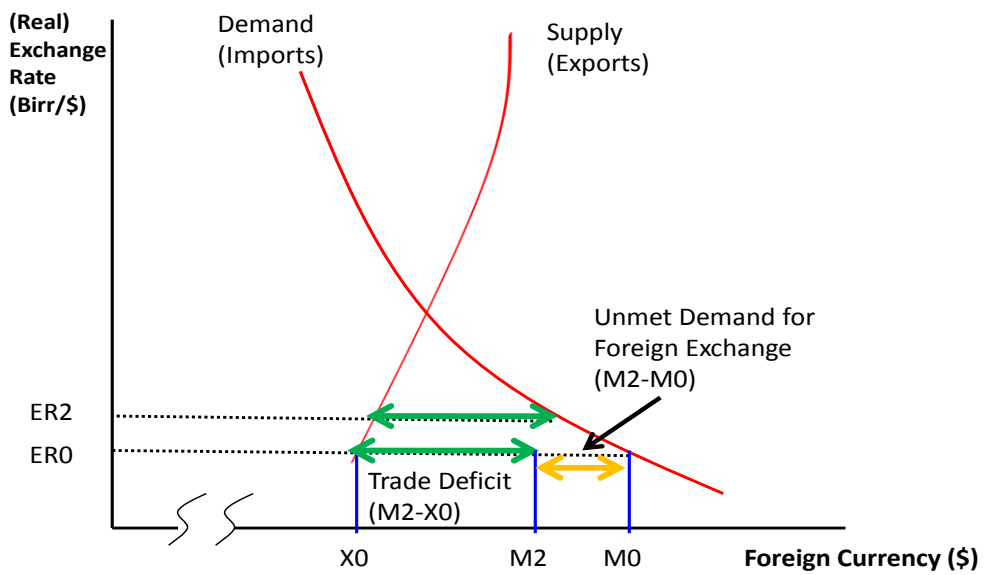
Figure 3: Demand and Supply of Foreign Exchange (Restricted Market)



In this case, (which is the current situation in Ethiopia), a small devaluation will provide additional incentives for exports. However, import demand at that new exchange rate may still be in excess of available foreign exchange, so that foreign exchange rations will still be binding. In this case, the parallel market exchange rate would remain unchanged, as would the market price of imports. Even those importers that obtain the foreign exchange at the low official rate through rations would still sell at the higher rate.[8]

Only if the devaluation is large (i.e. greater than ER2 in Figure 4) will it reduce import demand and increase export supply enough so that the gap between foreign exchange demand and supply is eliminated, the trade deficit is reduced, and imports fall to less than the quota amount.

Figure 4: Impacts of a Devaluation in a Restricted Foreign Exchange Market



[8] In fact, the only instance that the depreciation will have an impact on prices is on those items whose import and supply are government controlled, and for which the government then passes on the higher cost to purchasers.

4. Economy-wide Implications of Rationing of Foreign Exchange

To assess, the economy-wide implications of rationing of foreign exchange, including implications for income and consumption of poor households, we utilize a CGE model of the Ethiopian economy to examine two broad policies:1) the surge in investment, public transfers and foreign capital inflows between 2004/05 and March 2008, and 2) strategies in response to the subsequent decline in foreign capital inflows: import rationing (the policy actually adopted) and an alternative strategy (a significant depreciation of the real exchange rate).

The base data is the EDRI/IDS 2005/06 Ethiopia Social Accounting Matrix, a consistent macro- to micro- accounting framework that is based on Ethiopia's national accounts, the 2004/05 Household Income, Consumption and Expenditure Survey (HICES) and other data.

The CGE model used here is based on those of Dervis, deMelo and Robinson (1982) and Lofgren et al. (2001). Value added in production is modeled using constant elasticity of substitution (CES) production functions of factor inputs (land, livestock capital, various types of labor and non-agricultural capital). Intermediate inputs into production are determined as fixed shares of the quantity of output. Imported goods are assumed to be imperfect substitutes for domestically produced goods; likewise, exported goods are imperfect substitutes for domestically produced and consumed goods. Incomes of the various factors are allocated to households and other institutions on the basis of factor endowments reflected in the factor payment shares in the base SAM. Household consumption is modeled using a Linear Expenditure System (LES) specification.

In the simulations below, non-agricultural capital is fixed by sector, as is agricultural land. Labor is free to move across sectors, but total labor supply is exogenous and the wage rate adjusts to balance supply and demand for labor. We adopt a savings-driven investment closure with marginal propensities to save of all households fixed and the quantity of investment adjusting, so that total savings in the economy is equal to the value of total investment. In simulations 1, the nominal exchange rate is fixed at its base level; foreign savings is also exogenous, and the level of prices of non-tradable goods (and thus the real exchange rate, equal to the ratio of the

nominal exchange rate to the domestic price index), adjusts to bring about equilibrium in the market for foreign exchange. In simulation 2 (foreign exchange rationing), both the domestic price level and the nominal exchange rate are fixed (thereby fixing the real exchange rate). The premium on foreign exchange for imports is modeled using an implicit tariff for all imports that adds to the cost of the foreign exchange. Rents, equivalent to the implicit tariff times the domestic value of imports evaluated at the official exchange rate, are distributed to institutions in fixed shares.[9] In Simulation 3, in which there is no foreign exchange rationing, the domestic price level is again fixed, but the nominal (and real) exchange rates adjust to bring about equilibrium in the foreign exchange market.[10]

Simulation 1: Implications of Increased Capital Inflows and Investment

In simulation 1, we model the effects of the policies of increased investment from 2004/05 through March 2008 when for the most part, foreign capital inflows were not a major constraint for development plans. Historically, the surge in investment derived from two sources: increased private transfers (including workers' remittances) and expansion of domestic credit (and foreign borrowing to meet the resulting increase in demand for foreign exchange). Here, we model the domestic credit – driven increase in investment through an increase in foreign savings that increases the total pool of savings (enabling more investment) and accommodates the increase in demand for foreign exchange for investment (and other resulting demand). Specifically, simulation 1 shows the effects of the increase in investment consistent with an increase in foreign savings inflows equivalent to 20 percent of the value of total imports in the base.

The simulated foreign savings increase approximates the increase in foreign financing between 2005/06 and 2007/08. Note that just between 2006/07 and 2007/08, the current deficit plus public transfers rose by $602 million (equal to 12% of the previous year's merchandise imports), from $2.19 billion to $2.79 billion.

[9] See Annex 1 for details on the estimation of the distribution of rents. See also Condon, Robinson and Urata (1985) for an early discussion of rents from foreign exchange rationing, and Dorosh and Sahn (2000) for a similar treatment of rents in a CGE modeling framework in other sub-Saharan African countries.

[10] Annex Tables 2 and 3 present the model variables and equations. See Dorosh and Thurlow (2009) for details of a slightly different version of the Ethiopia CGE model.

In the simulation, the increased inflow of foreign savings augments total savings and permits an increase in investment spending. To the extent that these funds are spent in the domestic economy, demand for non-tradable goods and their prices tend to rise. Prices of tradable goods, which are tied to world prices by a fixed nominal exchange rate, remain unchanged. Overall, the average price of non-tradable goods rises and the real exchange rate (approximated by the nominal exchange rate divided by a price of non-tradable goods) falls (appreciates) by 21.5 percent (Table 3). This leads to higher incomes and higher investment in the short-run and (implicitly) higher overall growth in the medium-run, at a cost, however, of increased foreign debt.

Table 3: Simulation 1: Increased Foreign Capital Inflows and Total Investment

	Base (bn 2005/06 Birr)	Increase in Foreign Savings (% change)
Real GDP	128.6	0.0%
Absorption	158.8	5.9%
Consumption	114.8	6.1%
Investment	28.2	8.5%
Government	15.9	0.0%
Exports	16.8	-32.6%
Imports	47.0	8.4%
Real Exchange Rate	1.0	-21.5%
Nominal Exchange Rate	100.0	0.0%
CPI	100.0	21.8%
Real HH Incomes		
Rural Poor	21.1	4.8%
Rural Non-Poor	66.0	6.1%
Urban Poor	4.3	4.9%
Urban Non-Poor	23.4	7.5%
Total	**114.8**	**6.1%**

Source: Ethiopia CGE model simulations.

The appreciation of the real exchange rate lowers the domestic prices of exportable goods, inducing a decline in production of major export sectors and a fall in total exports by 32.6 percent. Non-tradable sectors, particular construction, which also benefits from the 8.5 percent in total investment demand, expand (Table 4). The decline in incentives for tradable goods production (the real exchange rate appreciation) is particularly serious since efficient production of tradables (substituting for imports or increasing exports) has been the path for sustained

economic growth in successful developing countries. (In fact, China's macro-economic policies have been designed to maintain an undervalued currency (i.e. to depreciate the real exchange rate relative to its equilibrium value) in order to promote export-led growth.)

The expansion in the economy increases returns to the relatively scare factors of production (capital and land) more than returns to labor. Thus, non-poor households, who own a greater share of capital and land, gain more than poor households in percentage terms. Nonetheless, all household incomes rise, by an overall average of 6.1 percent. This rise in simulated real household incomes reflects the historical rise in real incomes from 2004/05 to late 2007, a period marked by increased foreign exchange inflows and real exchange rate appreciation.

Table 4: Simulation 1: Increased Foreign Capital Inflows and Total Investment: Sectoral Results

	Base (bn 2005/06 Birr)	Increase in Foreign Savings (% change)
Agriculture	53.0	-0.3%
Cereals	16.9	1.8%
Export Crops	9.0	-7.4%
Other Crops	9.5	1.0%
Livestock	17.6	0.6%
Industry	14.5	0.8%
Services	54.8	-0.2%
Total Value Added	122.2	-0.1%

Source: Ethiopia CGE model simulations.

Note, however, that these simulations show the results of a foreign savings inflow in a comparative static framework, essentially showing the economy-wide effects of the shock relative to the base. They do not show the effects of alternative growth paths of the Ethiopian economy over the period. This would require simulating the effects of changes in investment on future levels of capital stock, as well as the effects of increases in total factor productivity in each sector, and the effects of changes in world prices, government spending, and other exogenous variables over time.[11]

[11] In this comparative static model, increases in investment do not add to the current period's capital stock. Moreover, since both labor supply and total capital are fixed, real GDP changes little in these simulations.

Simulations 2 and 3: Implications of Foreign Exchange Rationing

Simulations 2 and 3 illustrate the implications of foreign exchange rationing. In both simulations 2 and 3, foreign savings is reduced by 10 percent of base year's total imports. In simulation 2, foreign exchange for imports is rationed (the policy effectively adopted in March 2008) so that the nominal (and real) exchange rates do not change. In simulation 3, the nominal and real exchange rates are allowed to depreciate in response to the reduction in foreign savings.

In Simulation 2, the decline in foreign savings forces a 10.0 percent reduction in imports. With a smaller pool of total savings, investment falls as well, by 16.6 percent (Table 5). Large rents are created, however, equaling 25.6 billion Birr, (3.0 billion dollars at the 2005/06 average exchange rate of 8.68 Birr/US dollar), with an implicit tariff on imports of 61 percent. These rents accrue mainly to those who have access to foreign exchange for imports.

Table 5: Effects of a Decline in Foreign Savings with and without Import Rationing

	Base (bn 2005/06 Birr)	Simulation 2 Reduced Foreign Savings with Import Rationing (% change)	Simulation 3 Reduced Foreign Savings with no Import Rationing (% change)	Simulation 3 relative to Simulation 2 (% change)
Real GDP	128.6	-1.2%	-0.5%	0.7%
Absorption	158.8	-3.9%	-3.3%	0.6%
Consumption	114.8	-2.6%	-3.2%	-0.6%
Investment	28.2	-12.9%	-5.6%	8.4%
Government	15.9	2.6%	-0.5%	-3.0%
Exports	16.8	-0.2%	16.7%	16.9%
Imports	47.0	-10.1%	-4.1%	6.7%
Real Exchange Rate	1.0	0.0%	11.8%	11.8%
Nominal Exchange Rate	100.0	0.0%	11.8%	11.8%
CPI	100.0	0.0%	2.1%	2.1%
Real HH Incomes				
Rural Poor	21.1	-5.3%	-3.2%	2.2%
Rural Non-Poor	66.0	-8.4%	-3.2%	5.7%
Urban Poor	4.3	-5.9%	-2.1%	4.0%
Urban Non-Poor	23.4	16.9%	-3.4%	-17.4%
Total	**114.8**	-2.6%	-3.2%	-0.6%

Source: Ethiopia CGE model simulations.

In Simulation 3, foreign savings decline, but since there is no foreign exchange rationing; the real exchange rate depreciates by 11.8 percent. This depreciation spurs the export sector, leading to a 16.7 percent increase in exports and generating additional foreign exchange so that imports fall by only 4.1 percent. Imports are thus 6.7 percent higher than in the rationing scenario (simulation 2). Moreover, real GDP falls by only 0.5 percent (and so is 0.7 percent higher than in simulation 2). The export crop sector expands most in this scenario (by 3.2 percent; Table 6), as it benefits from the real exchange rate depreciation.

Except for the households receiving rents from foreign exchange rationing, household incomes are higher in the no rationing scenario, as compared to the import rationing scenario. In the rationing scenario (Simulation 2), the average income of the urban non-poor increases by 16.9 percent (Table 5). Incomes of other household groups fall, however, as overall economic activity falls (real GDP declines by 1.2 percent). Declines in other household group incomes range from 5.3 and 5.9 percent for the rural and urban poor, respectively, to 8.4 percent for the rural non-poor.

Table 6: Effects of a Decline in Foreign Savings with and without Import Rationing (Sectoral Results)

	Base (bn 2005/06 Birr)	Simulation 2 Reduced Foreign Savings with Import Rationing (% change)	Simulation 3 Reduced Foreign Savings with no Import Rationing (% change)	Simulation 3 relative to Simulation 2 (% change)
Agriculture	53.0	0.0%	0.1%	0.1%
Cereals	16.9	-0.9%	-1.1%	-0.2%
Export Crops	9.0	0.5%	3.2%	2.7%
Other Crops	9.5	-1.3%	-0.5%	0.8%
Livestock	17.6	1.2%	-0.1%	-1.4%
Industry	14.5	-1.4%	-0.4%	0.9%
Services	54.8	0.1%	0.0%	-0.1%
Total Value Added	122.2	-0.1%	0.0%	0.1%

Source: Ethiopia CGE model simulations.

The declines in the incomes of household groups other than the urban non-poor are smaller in the no import rationing scenario (Simulation 3). For these households, average real incomes decline by 2.1 to 3.2 percent. Compared with the rationing scenario, incomes of the rural non-poor rise by 5.7 percent, in large part because of

the improved performance of the export crop sector. The real incomes of the rural and urban poor also improve, by 2.2 and 4.0 percent, respectively, reflecting increased economic activity (the 0.7 percent increase in real GDP). Although real household incomes of the urban non-poor fall by only 3.4 percent relative to the base scenario, the fall relative to simulation is very large (-17.4 percent), because of the loss of rents from foreign exchange rationing.

Sensitivity analysis shows that the major results are robust with respect to changes in the parameters determining export supply and import demand response. Parameters determining the export supply elasticities are inelastic in the base run. Making these parameters even more price inelastic makes little difference to the results. For example, reducing the elasticity of substitution between (fixed) land and labor for export crops from 0.2 to 0.1, reducing the elasticity of substitution between aggregate of factor inputs and intermediate inputs from 0.6 to 0.3, and reducing the elasticity of substitution in the CET function for export crops from 0.4 to 0.2, cuts the gain in export crop output from 2.7 percent with the base parameters to 1.4 percent with the alternative parameters, but increases the real exchange rate difference between simulation 3 and simulation 2 only slightly, from 11.8 percent to 12.6 percent. One reason for the small effect of changes in export parameters on the real exchange rate is that exports earnings are only about one-third the value of imports in the base 2005/06 SAM.

Making import demand parameters more elastic, (by raising the Armington elasticity of substitution between domestically produced and consumed goods, and imported goods from a very low 0.2 in the main simulations to 0.7 for all imported manufactured goods and services), reduces the magnitude of the real exchange rate change needed to bring the external accounts in to equilibrium. Thus, with more elastic import demand, the real exchange rate depreciation in simulation 3 is only 11.7 percent, as compared to 12.6 percent with inelastic export supply and very inelastic import demand. These minor changes in magnitude of the effect do not change the main results, however: allowing the real exchange rate to depreciate produces better distributional and efficiency outcomes that does import rationing.

Table 7: Effects of Real Exchange Rate Depreciation vis a vis Foreign Exchange Rationing: Sensitivity Analysis

	Base Parameters (% change)	Inelastic Export Supply (% change)	Inelastic Export Supply and More Elastic Import Demand (% change)
Real GDP	0.7%	0.7%	0.5%
Absorption	0.6%	0.6%	0.5%
Consumption	-0.6%	-0.5%	-0.4%
Investment	8.4%	8.3%	5.8%
Government	-3.0%	-3.0%	-1.8%
Exports	16.9%	16.7%	16.7%
Imports	6.7%	6.7%	6.6%
Real Exchange Rate	11.8%	12.6%	11.7%
Nominal Exchange Rate	11.8%	12.6%	11.7%
CPI	2.1%	2.2%	1.9%
Real HH Incomes			
Rural Poor	2.2%	2.0%	1.9%
Rural Non-Poor	5.7%	5.9%	4.4%
Urban Poor	4.0%	4.4%	2.6%
Urban Non-Poor	-17.4%	-17.3%	-13.7%
Total	-0.6%	-0.5%	-0.4%
Agriculture	0.1%	0.1%	0.0%
Cereals	-0.2%	0.1%	0.0%
Export Crops	2.7%	1.4%	1.3%
Other Crops	0.8%	1.1%	0.8%
Livestock	-1.4%	-1.1%	-1.0%
Industry	0.9%	1.1%	0.5%
Services	-0.1%	-0.1%	-0.1%
Total Value Added	0.1%	0.1%	0.1%

Notes: This table shows the percentage difference between simulation 3 (reduced foreign savings with no import rationing) and simulation 2 (reduced foreign savings with import rationing) using alternative sets of parameters that determine overall export supply import demand responses. See text.

5. Conclusions

The quantitative estimates presented in this paper suggest that there are substantial efficiency and distributional effects of foreign exchange rationing. Foreign exchange controls result in the creation of large rents that likely accrue mainly to non-poor households.[12] At the same time, foreign exchange controls reduce economic

[12] See Sahn, Dorosh and Younger (1997) and Dorosh and Sahn (2000) also show major adverse consequences of foreign exchange rationing for sub-Saharan Africa countries in the 1980s and early 1990s.

efficiency so that real incomes from factors of production (land, capital and labor) decline, as do overall household incomes (except for those who gain large rents). Moreover, foreign exchange controls inhibit depreciation of the real exchange rate, and thus slow or prevent reversal of the real exchange rate appreciation between 2004/05 and 2007/08, which has resulted in major price disincentives for exports.

The modeling results presented here are not meant as definitive estimates, but rather as indicators of the broad magnitudes of the effect of the policies simulated. Further efforts are needed to refine the model simulations so as to include the effects of changes in world prices and to assess dynamic effects of shocks and policies on growth and income distribution. Dynamic simulations of alternative investment strategies, including greater investment in tradable goods sectors, would also be helpful in assessing medium-term growth options.

Nonetheless, the broad policy implications of this analysis are clear. There are substantial costs to both foreign exchange rationing and real exchange rate appreciation in terms of lower investment, reduced incentives for production of tradables, lower levels of foreign trade (and opportunities for the acquisition of technology that can enhance future growth), as well as more unequal income distribution (large rents accruing to the non-poor).

Policy reforms need not involve full liberalization of the foreign exchange market, however. Various versions of managed floats and controls in foreign capital markets exist that can gradually reduce economic rents, improve incentives for exports and increase overall economy efficiency. Indeed, policies since late 2008 have effectively reduced the earlier appreciation of the real exchange rate. To recover more fully from the effects of the adverse external price and capital inflow shocks of 2007 and 2008, and to sustain the rapid pro-poor growth of recent years, though, further measures to restore real price incentives to exports, and reduce rents and economic inefficiencies arising from import rationing should be considered.

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Annex 1: Estimation of Distribution of Rents

The distribution of rents is based on the structure of the use of imports by commodity group in the 2004-05 SAM and assumptions regarding the structure of rents by these commodity groups.

For wheat, it is assumed that urban poor households acquire imported wheat through the direct government sales and sales through cooperatives (41 percent of total wheat imports, Table 4) at a price based on the official exchange rate. The remaining 59 percent of the value of rents from imported wheat are assumed to accrue to the urban non-poor.

Petroleum rents are allocated on the basis of total uses (final consumption, intermediate demand and investment demand), where rents from use of petroleum in trade and transport accrue to households and government according to their shares in total consumption and investment demand for all goods and services (with the share of investment demand in total demand allocated to the government). Rents from petroleum used in construction and other activities are assumed to be split evenly between the urban non-poor and the government. Total rents from petroleum thus accrue mainly to the urban non-poor (39%), the government (35%) and rural non-poor (19%).

Rents arising from petroleum use in trade and transport activities are allocated on the basis of shares in total consumption and investment expenditures, with government assumed to receive rents from investment. Thus, total rents from petroleum us in trade and transport activities are allocated mainly to rural non-poor households (46%), urban non-poor (26%), government (10%), and rural poor (15%).

For all other commodities, rents are initially allocated as 50% to the urban non-poor and 50% to the government.

In the final step, all rents initially allocated to government are distributed to households according to their shares in total consumption expenditures. The outcome of these calculations is that 56% of total rents accrue to urban non-poor

households, 30% to rural non-poor households, 10% to rural poor households and 4 percent to urban poor households.

Annex Table A1: Assumed Distribution of Rents by Institution and Commodity

	Imports	Share	Hrural-P	Hrural-np	Hurba-p	Hurban-np	Govern	Total
Ctef	0.00	0.0%				50%	50%	100.0%
Cwheat	1.64	3.5%			41%	59%		100.0%
Cmaize	0.00	0.0%				50%	50%	100.0%
Cbarsor	0.00	0.0%				50%	50%	100.0%
Cagex	0.04	0.1%				50%	50%	100.0%
Censet	0.00	0.0%				50%	50%	100.0%
Cothrag	0.53	1.1%				50%	50%	100.0%
Clivstk	0.08	0.2%				50%	50%	100.0%
Chome1	0.00	0.0%				50%	50%	100.0%
Chome2	0.00	0.0%				50%	50%	100.0%
Cmilling	0.09	0.2%				50%	50%	100.0%
Cfood	1.57	3.3%				50%	50%	100.0%
Cchem	5.78	12.3%				50%	50%	100.0%
Celect	0.00	0.0%				50%	50%	100.0%
Cwater	0.00	0.0%				50%	50%	100.0%
Cptrl	5.73	12.2%	5%	19%	2%	42%	32%	100.0%
Ci-mfg	4.34	9.2%				50%	50%	100.0%
Cf-mfg	15.82	33.6%				50%	50%	100.0%
Cconst	0.00	0.0%				50%	50%	100.0%
Ctrd-trn	8.14	17.3%	15%	46%	3%	26%	10%	100.0%
Cgov	0.08	0.2%					100%	100.0%
Cosvc	3.18	6.8%				50%	50%	100.0%
SubTotal	47.01	100.0%	3.2%	10.3%	2.2%	45.1%	39.2%	100.0%
Public Rents			6.4%	20.1%	1.3%	11.4%		39.2%
Total			9.6%	30.4%	3.5%	56.5%		100.0%

Source: EDRI 2005/06 SAM and authors' estimates.

***Annex Table A2*: CGE Model Sets, Parameters and Variables**

Symbol	Explanation	Symbol	Explanation
Sets			
$a \in A$	Activities	$c \in CMN(\subset C)$	Commodities not in *CM*
$a \in ALEO(\subset A)$	Activities with a Leontief function at the top of the technology nest	$c \in CT(\subset C)$	Transaction service commodities
$c \in C$	Commodities	$c \in CX(\subset C)$	Commodities with domestic production
$c \in CD(\subset C)$	Commodities with domestic sales of domestic output	$f \in F$	Factors
$c \in CDN(\subset C)$	Commodities not in *CD*	$i \in INS$	Institutions (domestic and rest of world)
$c \in CE(\subset C)$	Exported commodities	$i \in INSD(\subset INS)$	Domestic institutions
$c \in CEN(\subset C)$	Commodities not in *CE*	$i \in INSDNG(\subset IN$	Domestic non-government institutions
$c \in CM(\subset C)$	Aggregate imported commodities	$h \in H(\subset INSDNG$	Households
Parameters			
$cwts_c$	Weight of commodity c in the CPI	$qdst_c$	Quantity of stock change
$dwts_c$	Weight of commodity c in the producer price index	$\overline{qg}_c$	Base-year quantity of government demand
ica_{ca}	Quantity of c as intermediate input per unit of activity a	$\overline{qinv}_c$	Base-year quantity of private investment demand
$icd_{cc'}$	Quantity of commodity c as trade input per unit of c' produced and sold domestically	$shif_{if}$	Share for domestic institution i in income of factor f

***Annex Table A2* (continued): CGE Model Sets, Parameters and Variables**

Symbol	Explanation	Symbol	Explanation
$ice_{cc'}$	Quantity of commodity c as trade input per exported unit of c'	$shii_{ii'}$	Share of net income of i' to i (i' ∈ INSDNG'; i ∈ INSDNG)
$icm_{cc'}$	Quantity of commodity c as trade input per imported unit of c'	ta_a	Tax rate for activity a
$inta_a$	Quantity of aggregate intermediate input per activity unit	$\overline{tins}_i$	Exogenous direct tax rate for domestic institution i
iva_a	Quantity of aggregate intermediate input per activity unit	$tins01_i$	0-1 parameter with 1 for institutions with potentially flexed direct tax rates
$\overline{mps}_i$	Base savings rate for domestic institution i	tm_c	Import tariff rate
$mps01_i$	0-1 parameter with 1 for institutions with potentially flexed direct tax rates	tq_c	Rate of sales tax
pwe_c	Export price (foreign currency)	$trnsfr_{i\,f}$	Transfer from factor f to institution i
pwm_c	Import price (foreign currency)		
Greek Symbols			
α_a^a	Efficiency parameter in the CES activity function	δ_{cr}^t	CET function share parameter
α_a^{va}	Efficiency parameter in the CES value-added function	δ_{fa}^{va}	CES value-added function share parameter for factor *f* in activity *a*
α_c^{ac}	Shift parameter for domestic commodity aggregation function	γ_{ch}^m	Subsistence consumption of marketed commodity c for household h
α_c^q	Armington function shift parameter	θ_{ac}	Yield of output c per unit of activity a

***Annex Table A2* (continued): CGE Model Sets, Parameters and Variables**

Symbol	Explanation	Symbol	Explanation
Greek Symbols			
α_c^t	CET function shift parameter	ρ_a^a	CES production function exponent
β^a	Capital sectoral mobility factor	ρ_a^{va}	CES value-added function exponent
β_{ch}^m	Marginal share of consumption spending on marketed commodity c for household h	ρ_c^{ac}	Domestic commodity aggregation function exponent
δ_a^a	CES activity function share parameter	ρ_c^q	Armington function exponent
δ_{ac}^{ac}	Share parameter for domestic commodity aggregation function	ρ_c^t	CET function exponent
δ_{cr}^q	Armington function share parameter	η_{fat}^a	Sector share of new capital
υ_f	Capital depreciation rate	QF_{fa}	Quantity demanded of factor f
Exogenous Variables			
$\overline{CPI}$	Consumer price index	$\overline{MPSADJ}$	Savings rate scaling factor (= 0 for base)
$\overline{DTINS}$	Change in domestic institution tax share (= 0 for base; exogenous variable)	$\overline{QFS}_f$	Quantity supplied of factor
$\overline{FSAV}$	Foreign savings (FCU)	$\overline{TINSADJ}$	Direct tax scaling factor (= 0 for base; exogenous variable)
$\overline{GADJ}$	Government consumption adjustment	$\overline{WFDIST}_{fa}$	Wage distortion factor for factor f in activity a
$\overline{IADJ}$	Investment adjustment factor		

Endogenous Variables			
AWF_{ft}^{a}	Average capital rental rate in time period t	QG_c	Government consumption demand for commodity
$DMPS$	Change in domestic institution savings rates (= 0 for base; exogenous variable)	QH_{ch}	Quantity consumed of commodity c by household h
DPI	Producer price index for domestically marketed output	QHA_{ach}	Quantity of household home consumption of commodity c from activity a for household h
EG	Government expenditures	$QINTA_a$	Quantity of aggregate intermediate input
EH_h	Consumption spending for household	$QINT_{ca}$	Quantity of commodity c as intermediate input to activity a
EXR	Exchange rate (LCU per unit of FCU)	$QINV_c$	Quantity of investment demand for commodity
$GSAV$	Government savings	QM_{cr}	Quantity of imports of commodity c
MPS_i	Marginal propensity to save for domestic non-government institution (exogenous variable)	QQ_c	Quantity of goods supplied to domestic market (composite supply)
PA_a	Activity price (unit gross revenue)	QT_c	Quantity of commodity demanded as trade input
PDD_c	Demand price for commodity produced and sold domestically	QVA_a	Quantity of (aggregate) value-added
PDS_c	Supply price for commodity produced and sold domestically	QX_c	Aggregated quantity of domestic output of commodity
PE_{cr}	Export price (domestic currency)	$QXAC_{ac}$	Quantity of output of commodity c from activity a

Endogenous Variables continued

$PINTA_a$	Aggregate intermediate input price for activity a	RWF_f	Real average factor price
PK_{ft}	Unit price of capital in time period t	$TABS$	Total nominal absorption
PM_{cr}	Import price (domestic currency)	$TINS_i$	Direct tax rate for institution i (i $\in$ INSDNG)
PQ_c	Composite commodity price	$TRII_{ii'}$	Transfers from institution i' to i (both in the set INSDNG)
PVA_a	Value-added price (factor income per unit of activity)	WF_f	Average price of factor
PX_c	Aggregate producer price for commodity	YF_f	Income of factor f
$PXAC_{ac}$	Producer price of commodity c for activity a	YG	Government revenue
QA_a	Quantity (level) of activity	YI_i	Income of domestic non-government institution
QD_c	Quantity sold domestically of domestic output	YIF_{if}	Income to domestic institution i from factor f
QE_{cr}	Quantity of exports	ΔK^a_{fat}	Quantity of new capital by activity a for time period t

Annex Table A3: **CGE Model Equations**

Production and Price Equations

$$QINT_{ca} = ica_{ca} \cdot QINTA_a \quad (1)$$

$$PINTA_a = \sum_{c \in C} PQ_c \cdot ica_{ca} \quad (2)$$

$$QVA_a = \alpha_a^{va} \cdot \left(\sum_{f \in F} \delta_{fa}^{va} \cdot \alpha_{fa}^{vaf} \cdot QF_{fa}^{-\rho_a^{va}} \right)^{-\frac{1}{\rho_a^{va}}} \quad (3)$$

$$W_f \cdot \overline{WFDIST}_{fa} = PVA_a \cdot QVA_a \cdot \left(\sum_{f \in F'} \delta_{fa}^{va} \cdot \alpha_{fa}^{vaf} \cdot QF_{fa}^{-\rho_a^{va}} \right)^{-1} \cdot \delta_{fa}^{va} \cdot \alpha_{fa}^{vaf} \cdot QF_{fa}^{-\rho_a^{va}-1} \quad (4)$$

$$QF_{fa} = \alpha_{fa}^{van} \cdot \left(\sum_{f' \in F} \delta_{ff'a}^{van} \cdot QF_{f'a}^{-\rho_{fa}^{van}} \right)^{-\frac{1}{\rho_{fa}^{van}}} \quad (5)$$

$$W_{f'} \cdot WFDIST_{f'a} = W_f \cdot WFDIST_{fa} \cdot QF_{fa} \cdot \left(\sum_{f'' \in F} \delta_{ff''a}^{van} \cdot QF_{f''a}^{-\rho_{fa}^{van}} \right)^{-1} \cdot \delta_{ff'a}^{van} \cdot QF_{f'a}^{-\rho_{fa}^{van}-1} \quad (6)$$

$$QVA_a = iva_a \cdot QA_a \quad (7)$$

$$QINTA_a = inta_a \cdot QA_a \quad (8)$$

$$PA_a \cdot (1 - ta_a) \cdot QA_a = PVA_a \cdot QVA_a + PINTA_a \cdot QINTA_a \quad (9)$$

$$QXAC_{ac} = \theta_{ac} \cdot QA_a \quad (10)$$

$$PA_a = \sum_{c \in C} PXAC_{ac} \cdot \theta_{ac} \quad (11)$$

$$QX_c = \alpha_c^{ac} \cdot \left(\sum_{a \in A} \delta_{ac}^{ac} \cdot QXAC_{ac}^{-\rho_c^{ac}} \right)^{-\frac{1}{\rho_c^{ac}-1}} \quad (12)$$

$$PXAC_{ac} = PX_c \cdot QX_c \left(\sum_{a \in A'} \delta_{ac}^{ac} \cdot QXAC_{ac}^{-\rho_c^{ac}} \right)^{-1} \cdot \delta_{ac}^{ac} \cdot QXAC_{ac}^{-\rho_c^{ac}-1} \quad (13)$$

$$PE_{cr} = pwe_{cr} \cdot EXR - \sum_{c' \in CT} PQ_c \cdot ice_{c'c} \quad (14)$$

Annex Table A3 (continued): **CGE Model Equations**

$$QX_c = \alpha_c^t \cdot \left(\sum_r \delta_{cr}^t \cdot QE_{cr}^{\rho_c^t} + (1 - \sum_r \delta_{cr}^t) \cdot QD_c^{\rho_c^t} \right)^{\frac{1}{\rho_c^t}} \quad (15)$$

$$\frac{QE_{cr}}{QD_c} = \left(\frac{PE_{cr}}{PDS_c} \cdot \frac{1 - \sum_r \delta_{cr}^t}{\delta_c^t} \right)^{\frac{1}{\rho_c^t - 1}} \quad (16)$$

$$QX_c = QD_c + \sum_r QE_{cr} \quad (17)$$

$$PX_c \cdot QX_c = PDS_c \cdot QD_c + \sum_r PE_{cr} \cdot QE_{cr} \quad (18)$$

$$PDD_c = PDS_c + \sum_{c' \in CT} PQ_{c'} \cdot icd_{c'c} \quad (19)$$

$$PM_{cr} = pwm_{cr} \cdot (1 + tm_{cr}) \cdot EXR + \sum_{c' \in CT} PQ_{c'} \cdot icm_{c'c} \quad (20)$$

$$QQ_c = \alpha_c^q \cdot \left(\sum_r \delta_{cr}^q \cdot QM_{cr}^{-\rho_c^q} + (1 - \sum_r \delta_{cr}^q) \cdot QD_c^{-\rho_c^q} \right)^{-\frac{1}{\rho_c^q}} \quad (21)$$

$$\frac{QM_{cr}}{QD_c} = \left(\frac{PDD_c}{PM_c} \cdot \frac{\delta_c^q}{1 - \sum_r \delta_{cr}^q} \right)^{\frac{1}{1+\rho_c^q}} \quad (22)$$

$$QQ_c = QD_c + \sum_r QM_{cr} \quad (23)$$

$$PQ_c \cdot (1 - tq_c) \cdot QQ_c = PDD_c \cdot QD_c + \sum_r PM_{cr} \cdot QM_{cr} \quad (24)$$

$$QT_c = \sum_{c' \in C'} icm_{cc'} \cdot QM_{c'} + ice_{cc'} \cdot QE_{c'} + icd_{cc'} \cdot QD_{c'} \quad (25)$$

$$\overline{CPI} = \sum_{c \in C} PQ_c \cdot cwts_c \quad (26)$$

$$DPI = \sum_{c \in C} PDS_c \cdot dwts_c \quad (27)$$

Annex Table A3 (continued): **CGE Model Equations**

Institutional Incomes and Domestic Demand Equations

$$YF_f = \sum_{a \in A} WF_f \cdot \overline{WFDIST}_{f\,a} \cdot QF_{f\,a} \quad (28)$$

$$YIF_{i\,f} = shif_{i\,f} \cdot \left[YF_f - trnsfr_{row\,f} \cdot EXR \right] \quad (29)$$

$$YI_i = \sum_{f \in F} YIF_{i\,f} + \sum_{i' \in INSDNG'} TRII_{i\,i'} + trnsfr_{i\,gov} \cdot \overline{CPI} + trnsfr_{i\,row} \cdot EXR \quad (30)$$

$$TRII_{i\,i'} = shii_{i\,i'} \cdot (1 - MPS_{i'}) \cdot (1 - \overline{tins}_{i'}) \cdot YI_{i'} \quad (31)$$

$$EH_h = \left(1 - \sum_{i \in INSDNG} shii_{i\,h} \right) \cdot \; 1 - MPS_h \; \cdot (1 - \overline{tins}_h) \cdot YI_h \quad (32)$$

$$PQ_c \cdot QH_{c\,h} = PQ_c \cdot \gamma^m_{ch} + \beta^m_{ch} \cdot \left(EH_h - \sum_{c' \in C} PQ_{c'} \cdot \gamma^m_{c'h} \right) \quad (33)$$

$$QINV_c = IADJ \cdot \overline{qinv}_c \quad (34)$$

$$QG_c = \overline{GADJ} \cdot \overline{qg}_c \quad (35)$$

$$EG = \sum_{c \in C} PQ_c \cdot QG_c + \sum_{i \in INSDNG} trnsfr_{i\,gov} \cdot \overline{CPI} \quad (36)$$

System Constraints and Macroeconomic Closures

$$YG = \sum_{i \in INSDNG} \overline{tins}_i \cdot YI_i + \sum_{c \in CMNR} tm_c \cdot pwm_c \cdot QM_c \cdot EXR + \sum_{c \in C} tq_c \cdot PQ_c \cdot QQ_c + \sum_{f \in F} YF_{gov\,f} + trnsfr_{gov\,row} \cdot EXR \quad (37)$$

$$QQ_c = \sum_{a \in A} QINT_{c\,a} + \sum_{h \in H} QH_{c\,h} + QG_c + QINV_c + qdst_c + QT_c \quad (38)$$

$$\sum_{a \in A} QF_{f\,a} = QFS_f \quad (39)$$

$$YG = EG + GSAV \quad (40)$$

$$\sum_{r\,c \in CMNR} pwm_{cr} \cdot QM_{cr} + \sum_{f \in F} trnsfr_{row\,f} = \sum_{r\,c \in CENR} pwe_{cr} \cdot QE_{cr} + \sum_{i \in INSD} trnsfr_{i\,row} + FSAV \quad (41)$$

$$\sum_{i \in INSDNG} MPS_i \cdot \; 1 - \overline{tins}_i \; \cdot YI_i + GSAV + EXR \cdot FSAV = \sum_{c \in C} PQ_c \cdot QINV_c + \sum_{c \in C} PQ_c \cdot qdst_c \quad (42)$$

$$MPS_i = \overline{mps}_i \cdot 1 + MPSADJ \tag{43}$$

Capital Accumulation and Allocation Equations

$$AWF_{f\,t}^{a} = \sum_{a}\left[\left(\frac{QF_{f\,a\,t}}{\sum_{a'} QF_{f\,a'\,t}}\right)\cdot WF_{f\,t}\cdot WFDIST_{f\,a\,t}\right] \tag{44}$$

$$\eta_{f\,a\,t}^{a} = \left(\frac{QF_{f\,a\,t}}{\sum_{a'} QF_{f\,a'\,t}}\right)\cdot\left(\beta^{a}\cdot\left(\frac{WF_{f,t}\cdot WFDIST_{f\,a\,t}}{AWF_{f\,t}^{a}} - 1\right) + 1\right) \tag{45}$$

$$\Delta K_{f\,a\,t}^{a} = \eta_{f\,a\,t}^{a}\cdot\left(\frac{\sum_{c} PQ_{c\,t}\cdot QINV_{c\,t}}{PK_{f\,t}}\right) \tag{46}$$

$$PK_{f\,t} = \sum_{c} PQ_{c\,t}\cdot\frac{QINV_{c\,t}}{\sum_{c'} QINV_{c'\,t}} \tag{47}$$

$$QF_{f\,a\,t+1} = QF_{f\,a\,t}\cdot\left(1 + \frac{\Delta K_{f\,a\,t}^{a}}{QF_{f\,a\,t}} - \upsilon_{f}\right) \tag{48}$$

$$QFS_{f\,t+1} = QFS_{f\,t}\cdot\left(1 + \frac{\sum_{a}\Delta K_{f\,a\,t}}{QFS_{f\,t}} - \upsilon_{f}\right) \tag{49}$$