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A Dynamic Computable General Equilibrium Model with Working Capital for Honduras

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ABSTRACT

In this paper we develop a dynamic real-financial computable general equilibrium (CGE) model for Honduras that incorporates working capital. The model is designed to be useful as a development tool and to be used by policymakers who deal with short-run macro and trade issues. Our model extends previous modeling work on Honduras in several ways. First, it uses a new, updated social accounting matrix (SAM) for the country. Second, it is a recursive dynamic model that incorporates unemployment of labor in the short run. Most CGE models are not useful for short-run analysis because they are comparative static models that assume full employment. We specify a fixed minimum wage and an informal sector and use a recursive dynamic framework to solve for the short-run adjustment process that occurs as the economy responds to shocks. Finally, the model introduces working capital as an additional factor of production, complementary to physical capital, which allows us to examine the impact of monetary shocks that affect the supply of credit on the balance of payments, employment, and real income during periods of adjustment.

Keywords: economic growth, Honduras, CGE models, working capital

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1. INTRODUCTION

Honduras faces an extremely challenging macroeconomic environment. Through 2008, with large inflows of remittances and buoyant export markets, the country grew faster than at any time since the mid-1970s. This came to a sudden halt due to both the current political crisis and the economic downturn in the United States, which stunted the growth of both remittances and exports. In a recent paper (Morley 2010, the economy of Honduras was identified as one of six small economies that had not found an export niche or a viable growth strategy. Even though the country grew rapidly between 2004 and 2008, that growth was financed to a great extent by an explosion of remittances, official debt cancellations, and an expansion of the current account deficit, none of which are likely to continue in the future. In addition, the government complicated matters considerably by fixing the exchange rate and raising the minimum wage by 50 percent. In this environment it is useful to develop a short-run dynamic model capable of exploring the short- and long-run impact of these policy decisions as well as the implications for growth of remittances and of possible balance of payments shocks.

We use our model to analyze the impact of a reduction in remittances, a change in foreign saving, and changes in minimum wage policy. We first run the model forward for five years in a base dynamic scenario to establish a benchmark against which we can compare the results of the exogenous changes of interest. Note that the base scenario forecast for the economy for the first five years should not be seen as a forecast because it assumes smooth trends in the exogenous variables—there is no attempt to forecast short-run shocks or changes in expectations by economic agents. Rather, of interest is the impact on this basic scenario of the various changes that we will simulate.

Previous Work

This paper builds on previous real CGE models constructed at the International Food Policy Research Institute (IFPRI) but extends that work in a number of directions. The basic comparative statics framework follows the standard model presented in Lofgren, Harris, and Robinson (2001). We made the model dynamic by introducing updating equations for all the stock variables, (capital stock, working capital, and labor force) as well as various policy variables and then solving the model period by period with the updated variables. This follows the approach of El Said, Lofgren, and Robinson (2001); Thurlow (2003); and numerous others. This is a fairly standard method for turning a long-run comparative static CGE model into a tool that gives a time-series solution showing how an economy reacts to external shocks or internal changes in policy. It is analogous to making a movie by pasting together a sequence of snapshots.

The second feature is to introduce working capital and finance into the standard model. A number of previous models have included this feature: Robilliard, Bourguignon, and Robinson (2008); Taylor (1983); Naastepad (2001); Bourguignon, Branson, and de Melo (1989). In these models, credit or working capital is introduced into the production functions as an additional factor of production. This specification permits external financial crises or internal monetary policy to have real supply-side effects. For example, Robilliard, Bourguignon, and Robinson show how a financial crisis in the late 1990s in Indonesia caused a severe real-side contraction in the economy that stemmed purely from a severe working capital or credit contraction.

The third feature of the model is the introduction of nonmarket clearing behavior in the urban unskilled labor market. In the usual treatment all labor markets clear and the standard CGE solution can be interpreted as the necessary changes in wages and prices to permit that to happen. Since there is full employment, external shocks do not have significant real-side effects. The adjustment is in prices and wages, not in aggregate employment. But many countries and Honduras in particular, have minimum wage policies for formal-sector unskilled workers. That translates in our model into a flat supply curve for urban unskilled labor in the formal sector. This will be another factor, in addition to credit, which makes the short-run equilibrium level of output and employment a function of aggregate demand and prices. Monetary contractions as well as other exogenous disturbances will have short-run real effects,

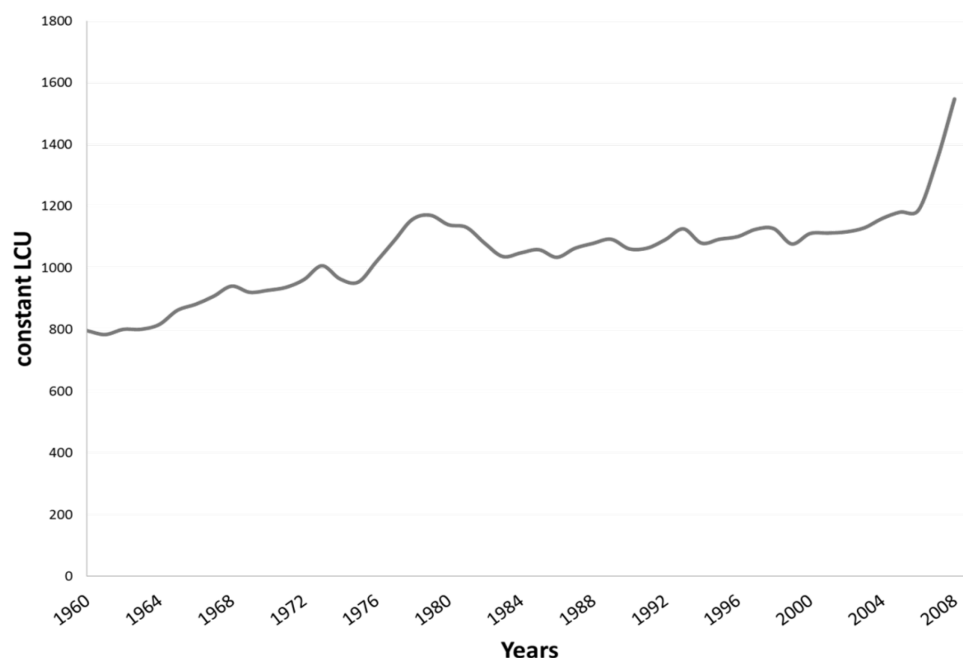
particularly on employment. In our model we also added an informal labor market for urban unskilled labor where wages are flexible; therefore, when a contraction in demand causes producer prices to decrease, the production of commodities shifts to the informal sector. This in turn causes a reduction in aggregate output because informal-sector labor is less productive than the formal and because some minimum wage labor becomes unemployed. Our model is similar to what Agenor, Izquierdo, and Jensen (2007, Chapter 1) call a model with sectoral wage rigidity and imperfect labor mobility. When wages for unskilled labor are fixed in the formal sector above the full equilibrium level that would be observed with full wage flexibility, production shifts to the informal component of each activity. Informal-sector employment increases slightly, but less than the reduction in minimum wage jobs in the formal sector.

2. AN OVERVIEW OF THE PERFORMANCE AND STRUCTURE OF THE HONDURAN ECONOMY¹

Honduras is the poorest country in Latin America. In 2007, 70% of its population was poor and 46% was indigent. Both of its recent and long run economic performance has been meager. Between 2000 and 2008, real wages fell and employment rose by only 1% per year, less than one half the growth rate of the working age population. (ECLAC 2009). Since 1960, Honduras has never enjoyed a period of rapid economic growth long enough to serve as the basis of a successful growth strategy. When the economies of other countries in the region were growing rapidly in the 1960–1980 period, Honduras's grew as well; but periodic recessions brought its average growth rate down to only 2.2 percent per year, one of the lowest in the region. Subsequently, along with most of the other countries, per capita income decreased in the 1980s, was essentially constant in the 1990s, and only began to grow again after the millennium. For the entire 48-year period after 1960, the average growth rate of per capita income was only 1.4 percent per year, one of the slowest in the Latin America.

Figure 2.1 shows the time path of GDP per capita from 1960 to 2008. The figure shows the good performance of the Honduran economy from 1960 to 1980, the deterioration from 1980 to 2006, and the sharp recovery in 2006–2008. The economy grew rapidly before 1980 but then stagnated in the 1980s and 1990s. Despite some recovery after 2000, it took 26 years for Honduras to reach the per capita income it had in the peak year of 1979. To show this more formally, we ran two regressions of GDP in constant local currency units on a time trend with a dummy for the change in base year in 2000. The first regression covered the period 1960–1979, and the second, 1979–2005. According to the regressions, the average rate of growth of GDP per capita during the period 1960–1979 was 2.0 percent but only 0.5 percent thereafter. Two questions need to be answered: First, what happened after 1980 to the relatively dynamic economy of the 1960s and 1970s? Second, is the resumption of growth at the very end of the period an indication that the economy has finally found a sustainable and adequate growth path?

Figure 2.1—GDP per capita in constant local currency units, 1960–2008



Source: World Development Indicators.

¹ The following section of this paper is taken from Morley and Piñeiro (2008).

To better understand the change in growth performance after 1980, consider the changes in the composition of GDP as well as the average growth rate of the different components shown in Table 2.1. There are two separate estimates of the composition and growth in the various components of GDP after 2000. That is because a new set of official national accounts for Honduras was published by the Central Bank in November 2008. It changes both the levels of GDP and their rate of growth throughout the period since 2000. What this will do to our interpretation of the period before 2000 remains to be seen. For the most part, our discussion here of differences between the periods will depend on the revised numbers in the final columns of the tables.²

Table 2.1—Changes in the composition of GDP in Honduras, 1960–2008

	1960-80	Average Growth Rates		2001-2005	Revised 2001-2008
		1981-90	1991-2000		
Government	2.78	-1.24	0.26	2.84	5.97
Investment	5.27	-0.65	4.96	-0.80	7.85
Exports	3.84	-2.15	-1.23	3.43	6.05
Imports	4.76	-3.30	1.37	4.97	7.74
Consumption	1.63	-0.73	0.42	2.85	6.09
GDP	1.86	-0.68	0.49	1.23	5.03
Government	10.77	12.09	9.00	11.16	15.14
Investment	20.76	16.69	27.87	25.88	28.59
Exports	36.08	33.41	28.21	27.49	54.00
Imports	35.90	30.13	30.79	34.33	73.15
Consumption	68.30	67.93	65.71	69.79	75.42
Total	100.00	100.00	100.00	100.00	100.00

Source: World Development Indicators.

There are some striking differences in the composition of output over time. The most obvious and important is the role of exports and investment. In the 1960–1980 boom period, exports and investment drove the economy. Government spending was relatively small, though it grew faster than income during that period. Although imports grew slightly faster than exports, the trade account was roughly in balance. All this changed dramatically in the post-1980s period. First, there was a sharp decline in capital formation as well as in both exports and imports during the 1980s, with the decline in imports so great that there was a surplus in the trade balance. In the 1990s Honduras embraced the Washington consensus; tariffs were dramatically reduced, tax policy reforms progressed, and the capital account was liberalized. The result was a very sharp increase in capital formation in the economy; but exports, instead of expanding as predicted by the reform literature, dramatically contracted. Indeed, the average growth rate of exports was negative during the entire 20-year period after 1980.

After the millennium the picture changed once again. Investment continued at a very high rate. But now both exports and imports increased rapidly. Obviously, part of that measured increase must be due to the change in the national accounts, but in any case the increase in openness and the dependence on foreign saving is striking. Also striking is the rise in consumption, both private and public, which reflects the increasing importance of remittances. The share of public plus private consumption rose by either 6 or 11 percent, depending on which data source one uses, with the increase accompanied by a large increase in imports.

The Washington Consensus stressed the importance of having an export-led growth strategy. One of the big drivers of export growth after 2000 was the maquila sector. But the problem is that not all export sectors have the same growth impact. From a growth perspective, the problem with the maquila sector is its weak linkages with the rest of the economy. Its exports create jobs and add value, but they do

² The main difference in the two tables is in imports and exports. In the original accounts, only the domestic value added of maquila was included in exports. Imported intermediate inputs destined for the maquila industry were not counted in total imports. Maquila exports were counted not as goods but as assembly services. The other differences stem from updating the base year from 1978 to 2000.

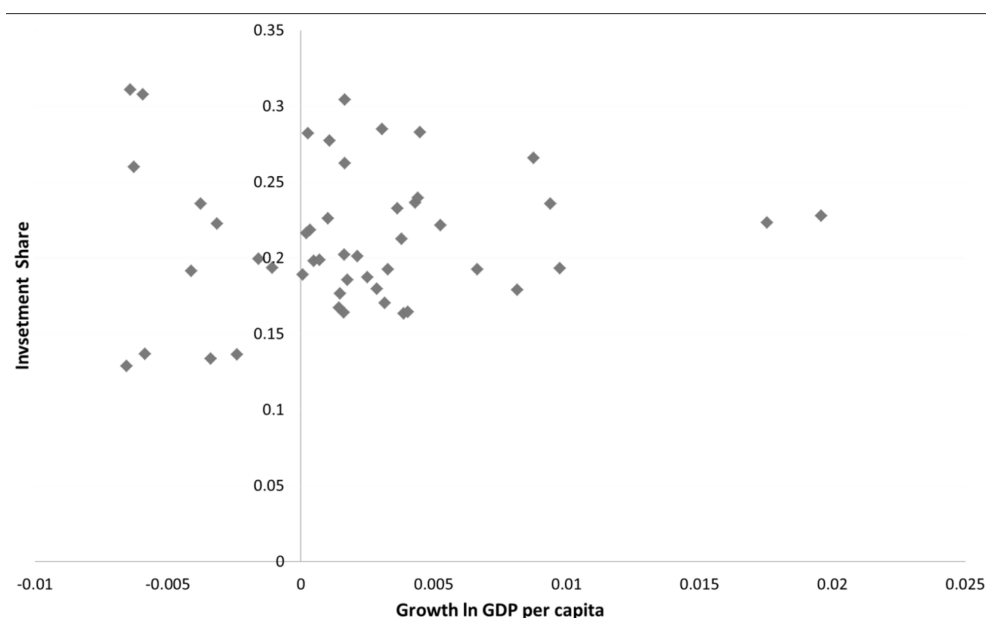
not have much of an impact on the demand for domestically produced intermediate inputs or the provision of imports for downstream industries. According to the SAM, domestic value added of the textile sector was about 19 percent of the value of production, with 81 percent being intermediate inputs. At least 60 percent of those intermediate inputs were imported. That means that for every additional dollar of exports, there was an increase of about 50 cents of imports, about 20 cents in domestic value added in textiles, and only 30 cents of demand for inputs from other sectors. This is one difficulty of an export strategy based mainly on the assembly of inputs, the bulk of which are imported.

The big increase in imports and in the trade deficit starting in the 1990s and accelerating after 2000 reflects trade liberalization after 1990, the rise of consumption, and the increasing role of remittances in the economy. The economy of Honduras is extremely open. When and if it grows rapidly, the demand for imports increases necessarily. Prior to 1980, that required a corresponding increase in exports, but not anymore. Now the imports are financed by remittances. Remittances increase aggregate demand, which generally causes an increase in imports and an appreciation of the exchange rate, which then shifts production away from traded goods such as agriculture and manufactured goods and toward non-traded service activities. We will examine the role of remittances in the growth process using a dynamic CGE model later in the paper.

Development economists and supply side theorists emphasize the importance of fixed capital formation as a driver of economic growth. It contributes in two ways: first, by increasing the capital available per worker thus increasing worker productivity; and second, since new machines are more productive than old ones, by increasing total productivity as well. One would therefore expect that increasing the investment share would lead to faster growth rates. Generally, economies that do not save and invest do not grow rapidly. But the relationship between investment and growth in Honduras is ambiguous. Table 2.1 confirms the positive relationship between investment and growth in the pre-1980 period, but not afterward. Investment decreased in the 1980s, along with GDP, but then it recovered quite strongly after 1990. The investment share in Honduras reached an average of more than 27 percent of GDP in the 1990s—a rate that should have dramatically increased the growth rate of the economy but did not, at least not until the last two years of the sample period, 2006–2008. Generally speaking, investment apparently does not lead to growth in Honduras.

The investment share is plotted against the growth rate of per capita income in Figure 2.2. The lower envelope of the points might indicate that some increasing minimum level of investment is required to achieve higher growth rates, but the variation is large—high investment rates do not seem to be productive.

Figure 2.2—Investment and growth



Source: World Development Indicators.

Relatively low investment shares in the pre-1980 period were associated with relatively high growth rates, whereas much higher rates of investment in later years were coupled with very low or even negative growth rates in the economy. That is undoubtedly because the debt crisis of the later years forced a retraction in demand, so that the increases in potential output or capacity made possible by higher levels of investment were not matched by higher levels of demand. If so, it is surprising to find so much investment in the 1990s, a time when, according to the capacity argument, there must have been a good deal of idle capacity. An explanation of why the high level of investment during the 1990s did not lead to much growth in that decade is also required. Between 1993 and 1999, the average investment rate was 29.3 percent. Yet the growth rate of per capita income during that same period was negative. Some part of that poor performance may be the result of Hurricane Mitch in 1998.³ It is also possible that high investment rates in the 1990s built the capacity that permitted faster growth after 2000. We will look more closely at the question of investment, capital, and idle capacity below.

Investment, Capacity Creation, and the Growth of Productivity

Honduras has had a very low growth rate of per capita income since 1980. Although the recent revision of the national accounts has raised the estimate of that growth rate a little, the record is still quite bad. One possible explanation for this performance that is not valid is a low rate of capital formation. In fact, since the mid-1980s, Honduras has had one of the higher investment rates in the region—more than 25 percent of GDP on average ever since 1990. (Some part of the high investment rate after 1998 is undoubtedly directed at repairing the destruction caused by Hurricane Mitch.)

Whatever slowed down the growth rate after 1980, it was not a lack of capital. Either the growth process is now far more capital intensive than it used to be, or Honduras is investing unwisely, or a demand-side problem has caused the economy to produce less than its potential capacity level. To look

³ Note that when the revision of the national accounts is extended backward to the 1980s and 1990s, this statement may need to be adjusted slightly. That is, the growth rate in the 1990s may have been higher than the one shown in Table 4.1, which is based on the unrevised national accounts.

more closely at this, we have used the reported investment series to develop an estimate of the capital stock. To do this we assumed an initial capital output ratio of 3.0 in 1960 and a depreciation rate of 5 percent per year. We then develop an estimate of the capital stock based on those starting values. Regardless of the initial values we chose, the estimated capital stocks will coincide after 1980, when all the initial capital has depreciated away. We then calculate a series of potential and actual GDP since 1960, using the estimated growth rates of capital, the observed population growth rates as a proxy of the growth rate of employable labor, and the shares of capital and labor from the 1997 SAM.

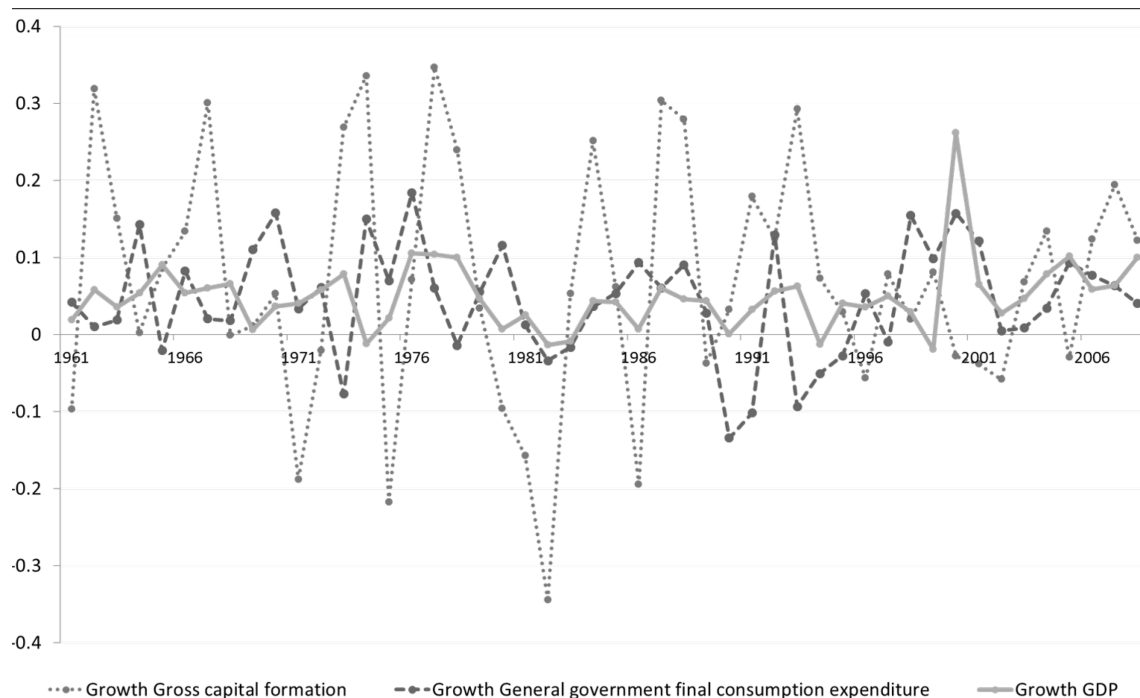
Total factor productivity growth can then be calculated as the difference between the observed rate of growth of the economy and the weighted average growth rates of capital and labor. We find that between 1960 and 1980, when the economy grew more than 5 percent, the implied growth rate of productivity was 1.5 percent per year. After 1980, productivity growth decreased to less than zero.⁴ Even with zero productivity growth after 1980, capacity output exceeds actual until 2005, although after 2000 the gap narrowed. This means that the weighted average growth rate of the factors of production was just about equal to the growth rate of the economy and average productivity did not increase at all, in spite of the large investment effort.

Until 1980, capacity and actual output grew more or less in tandem. More to the point, good growth rates were achieved with a relatively low rate of investment in the economy, thanks to significant increases in total factor productivity. The situation seems to be completely different after 1980. Honduras, like all the other countries in the region, had a recession in the early 1980s. Although it did subsequently recover, it did not reach its potential output level until 2008. Before 1980 Honduras had a significant growth boost from productivity. Afterward, potential output continued to grow, but only because of a tremendous increase in capital formation. In effect, Hondurans were investing a lot more but getting a lot less growth for their efforts.

The other feature of the macro picture after 1980 is the extreme volatility of investment, government spending, and output (see Figure 2.3). There are no periods of sustained growth in any of the three series. No takeoff into a period of sustained capital formation and growth appears. Unfortunately, the government does not appear to play a countercyclical role.

⁴ Loayza et al. (2002) made a comparable estimate of total factor productivity (TFP) growth in Honduras. They estimate TFP growth of 0.97 percent in the 1960s, 1.04 percent in the 1970s, -0.98 percent in the 1980, and -0.89 percent in the 1990s.

Figure 2.3—Growth of investment, government, and GDP



Source: World Development Indicators.

Note: These are annual growth rates of per capita spending on investment, government, and GDP.

The sharp deterioration in performance after 1980 was not caused by changes in the international terms of trade—defined as an index of the price of Honduran exports divided by the price of imports. When the terms of trade increase, a given quantity of exports buys a greater quantity of imports. According to ECLAC (Economic Commission for Latin America and the Caribbean), the terms of trade of Honduras decreased a bit in the 1980s, increased in the 1990s, particularly prior to 1996, and then decreased quite sharply after 2000, ending up below where they started in 1980. The period when the terms of trade increased in the 1990s was not one of accelerating growth, and the subsequent period, when growth accelerated, was one in which the terms of trade moved against Honduras.

Exports and the Real Exchange Rate

The performance of exports in the Honduran economy is striking, particularly when set against the real effective exchange rate, defined as the exchange rate deflated by the domestic price index. Exports were a leading sector in the economy in the period before 1980. Then for the next 20 years Honduras experienced virtually no growth in exports per capita. After 2000 exports started to grow again, in a sustained way, thanks to rapid growth in the exports of the maquila sector. Note that this all took place concurrent with a very large appreciation of the exchange rate. Between 1960 and 1980 the nominal exchange rate was fixed at 2 lempiras per US\$. But internal prices rose by 62 percent during that 20-year period, far faster than international prices, which means that the real, effective exchange rate appreciated dramatically. It continued to appreciate until the fixed exchange rate policy was abandoned in 1988. Then, after a 6-year recovery, it again continued to appreciate to a point where in 2005 it was 40 percent below the level it reached in 1990.

The real exchange rate is a critical variable that can be affected by policy. It plays a key role in determining the relative profitability of traded and nontraded goods in general and the export sector in particular. When the real exchange rate appreciates, as it did in Honduras, the cost of producing exports or

import substitutes rises relative to their price in dollars, penalizing the entire traded goods sector and encouraging a shift in production away from traded goods toward nontraded goods. In the period prior to 1980, exports increased rapidly in spite of real exchange rate appreciation. But as we have already seen in Table 2.1, the average growth rate of exports was negative for the next 20 years.

After 2000, exports started to grow rapidly again, mainly due to the maquila sector, most likely reflecting the more generous treatment of the industry in the Caribbean Trade Preference Act, which passed in 2000. This export growth certainly does not reflect changes in the real exchange rate—in fact, it occurred in spite of continued appreciation of the real exchange rate, which reflects the tremendous increase in remittances that have occurred since 2000. Remittances have become a dominant feature of the Honduran economy. In 2000 remittances totaled \$320 million, or 6 percent of GDP. By 2008 remittances had grown almost sixfold to \$2.8 billion, amounting to 27 percent of imports and 19.7 percent of GDP. In effect, the Honduran economy has switched from one in which exports lead growth and the imports were paid for by those exports to one in which the nontraded goods sectors lead the growth and more and more imports are paid for by transfers. Unfortunately, this enormous source of foreign exchange is beginning to shrink because of recession in the United States. In the next section of the paper we will examine some implications of this change.

3. THE DYNAMIC COMPUTABLE GENERAL EQUILIBRIUM MODEL

We have developed a dynamic CGE model to examine the impact of current shocks and policy alternatives in Honduras. The model is recursive dynamic and is solved in two stages. First, the model determines a within-period equilibrium, given parameters and exogenous variables. Second, some parameters and exogenous variables change over time. The model contains transition equations that determine how the exogenous variables and parameters relate to past solution values for particular endogenous variables or are assumed to grow according to trends. These transition equations provide values for all exogenous variables and parameters for the next period for the static CGE model, which is then updated and solved for a new within-period equilibrium.

The model is solved forward in a dynamically recursive fashion, with each static solution depending only on current and past values of variables and parameters. The model does not assume that agents have knowledge of the future. Instead, the behavior of agents is based on historical information and adaptive expectations. The variables and parameters used as linkages between periods are aggregate capital stock (which is updated endogenously, given previous investment and depreciation), population, domestic labor force, working capital supply, factor productivity, export and import prices, export demand, tariff rates, and transfers to and from the rest of the world (all of which are modified exogenously).

The Honduras model starts from 2004 (the base year for the data) and then is solved recursively year by year for five years for a base run and different simulations.

First Step: The Single-Period Solution

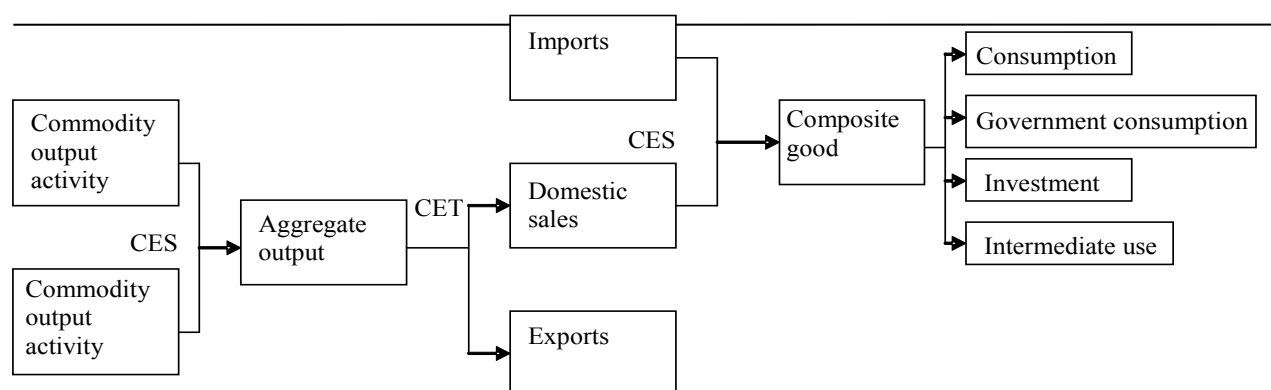
The database for the CGE model was obtained from the 2004 social accounting matrix (SAM) reported in Morley, Piñeiro, and Flores (2009). The model has three components. The first reflects all the payments to and from economic actors that are registered in the SAM, following the same disaggregation of factors, activities, commodities, and institutions shown in the matrix. The second component is the equations that represent the behavior of the different institutions and economic actors. The third component is the system constraints that have to be satisfied covering factor and goods markets and macro balances for savings and investment, the government, and the current account of the rest of the world.

Producers are assumed to maximize profits under constant returns to scale and perfect competition. There are two primary factors of production: labor disaggregated by skill (skilled and unskilled), location (rural and urban), and sector type (formal and informal); and capital. In addition, working capital is required and is assumed to be complementary with physical capital. Production is related to factor inputs through a constant elasticity of substitution (CES) production function, which allows producers to substitute among primary inputs so that the marginal revenue product of each factor equals its wage or rental rate (for capital). Producers demand intermediate inputs assuming fixed input–output coefficients (Leontief technology). In addition to input costs, producers also consider relevant taxes and subsidies.

Figure 3.1 shows the flow of a single commodity from producers to final demand. First, producers use factor inputs according to a CES production function to produce output. This output is sold domestically or internationally. Producers allocate supply between domestic sales and exports using a constant elasticity of transformation (CET) function, which assumes imperfect transformability between exports and domestic sales. The share of production going to domestic and export markets depends on relative prices. The domestic price of an export is the international price times the exchange rate plus any export taxes or subsidies. The good sold on the domestic market is, in turn, assumed to be an imperfect substitute for an imported good of the same commodity classification, assuming a CES trade aggregation function—the Armington specification.⁵

⁵ Armington (1969).

Figure 3.1—Flow of goods from producers to the national composite commodity



Source: Authors' worksheets.

Note: CES = constant elasticity of substitution; CET = constant elasticity of transformation.

There are four *institutions* in the model—households, enterprises, government, and the rest of the world—which do three things: (1) produce, (2) consume, and (3) accumulate capital. Households save a constant share of their disposable income and buy consumption goods. They own the enterprises and work in those enterprises. Household income is the sum of salaries, profits, net government transfers, and rest-of-the-world transfers. Household consumption of goods and services is determined by a linear expenditure system. Enterprises buy intermediate goods, hire factors of production, produce commodities and services, and sell them in the market. The government receives taxes, consumes goods and services, and makes transfers to households. The capital account acts as a loanable funds market, collecting savings from households, firms, government, and the rest of the world and buying capital goods (investment).

Financial Variables in the Model

This CGE model includes financial variables and working capital as a factor of production. At the moment, it appears that the Honduran banking sector is fairly well insulated from the financial disturbances that have caused so much instability in international capital markets. However, any balance of payment shock carries with it the risk of a monetary contraction, particularly when the exchange rate is fixed.

Working capital is included in the model because it is a key feature in the dynamic process by which the economy moves from one equilibrium to another when there is a shortage of credit. There is a large amount of literature on working capital as a factor of production. Production takes time, and during the production process, workers have to be paid and raw materials have to be purchased, all of which requires a stock of credit or working capital. Robilliard, Bourguignon, and Robinson (2008) built a CGE model for Indonesia to examine the effect of the East Asia financial crisis on output in that country through restrictions on the availability of credit to producers. Our model closely follows their approach. In each sector we used a nested CES function to create three composite factors consisting of working capital combined with skilled and unskilled labor and physical capital in the urban formal sector.

One complication is that at present we have no independent information on the actual stock of working capital in the Honduran economy. To get a first estimate of the sensitivity of the economy to variations in the supply of working capital, we assume that one-fourth of the aggregate return to capital reported in the national accounts and in the SAM is a return to working capital. We then distribute this total across the various sectors according to their share of intermediate inputs and labor. Working capital therefore appears in the model as a component of three composite factors that are defined by the nested CES functions for capital and skilled and unskilled labor.⁶ The effect of this treatment is to make

⁶ In the Robilliard, Bourguignon, and Robinson (2008) paper, these composites are called subfactors.

aggregate output sensitive to any reduction in the supply of working capital. Cuts in working capital raise the interest rate and make the three composite factors that include it more expensive or less productive.

The model links the real and financial sectors through borrowing needs for working and physical capital formation. An increase in the interest rate will reduce profits and therefore have a negative effect on investment. Since we assume substitution between working capital and the other formal sector factors, an increase in the interest rate or a contraction in the supply of working capital will also reduce employment and capacity utilization.

The Informal Sector

One of the innovations in our model is the inclusion of an informal sector.⁷ The treatment of labor in the typical CGE model assumes that all labor markets clear, which effectively means that macro disturbances do not produce unemployment but rather change the market-clearing real wage. That is not a very good assumption for an economy like that in Honduras, where most of the urban unskilled labor is covered by a nominal minimum wage floor. In our new SAM it was possible to identify and separate urban formal and informal labor categories. We include the informal-sector workers into the activity production function in each sector and assume a degree of substitution between this labor and the composite formal-sector labor defined above. For formal-sector unskilled labor, we assume a fixed wage, which makes total employment endogenous. In response to macro or credit disturbances or changes in the minimum wage, the labor market clears by changing relative wages, which strongly affects sectors with a significant informal component.

Factor Markets and Macro Closures

The macro closure of a model defines the mechanisms that determine how various macro constraints are satisfied by the economic system. Three macroeconomic balances need to be specified: (1) the external trade balance, which equates the supply and demand for foreign exchange (in flows, given that this model does not have assets or asset markets); (2) the fiscal balance, government savings (or deficit) being the difference between government income and expenditures; and (3) the savings-investment balance. This model specifies a *balanced* macro closure. Aggregate investment and government spending are assumed to be fixed proportions of total absorption, which implies that any macro shock affecting absorption will be shared proportionally among government spending, aggregate consumption, and investment.

Factor market closure defines the operation of factor markets. We assume a fixed (minimum) wage for urban unskilled labor. For the other labor types, aggregate supply is fixed and the wage is determined endogenously to clear the labor market. We assume that the supply of each type of labor increases by 2.5 percent per year, which is the growth rate of the working-age population. For physical capital, we assume a fixed rate of return and endogenous capacity utilization by sector. When the profit rate in a sector declines to a minimum, capacity utilization is assumed to decrease, reflecting the view that older vintages of capital will cease to be used when the rate of return falls below some minimum. For working capital, we also assume a minimum rate of return of 10 percent so that excess credit cannot be used productively. For the constrained working capital simulations, we fix the total supply of working capital and allow the rate of return above the minimum to be determined endogenously.

Second Step: Between Periods

In the second step of the recursive model, the linkages between periods are introduced. The static model is solved for a specific year; and then the capital stock, population, domestic labor force, factor productivity, export and import prices, credit supply, and export demand parameters are updated. The updated model is then solved again for the following year, and so on.

⁷ For an extensive discussion of labor markets in CGE models for developing countries, see Agenor, Izquierdo, and Jensen (2007), especially Chapters 1 and 4.

The steps followed for the factor of production updating is given by the following steps:

1. Update the sector shares of investment. Sectors with higher-than-average rental rates will receive larger shares of investment compared with their initial share of existing capital:

$$INVSHR1_{f,a,t}^a = capshr_{f,a,t} * \left(\beta^a * \left(\frac{WF_{f,t} * WFDIST_{f,a,t}}{WFKAV_{f,t}^a} - 1 \right) + 1 \right),$$

where:

Subscript f refers to the capital factor in these equations, a is activity or sector, and t is time.

$capshr_{f,a,t}$ is the sector's capital share.

$INVSHR1_{f,a,t}^a$ is the share of sector a in total capital formation.

$WFDIST_{f,a,t}$ is the wage distortion factor for the capital factor in sector a .

$WFKAV_{f,t}^a$ is the average capital rental rate.

β^a is the capital mobility parameter by activity.

2. Update the quantity of new real capital formation by sector of destination by calculating the investment share times the total quantity of new capital:

$$DKAPS_{f,a,t}^a = INVSHR1_{f,a,t}^a * \left(\frac{\sum_c PQ_{c,t} * QINV_{c,t}}{PK_{f,t}} \right),$$

where:

$\sum_c PQ_{c,t} QINV_{c,t}$ is the aggregate gross fixed investment expenditure.

$DKAPS_{f,a,t}^a$ is the gross fixed real capital formation for sector a in time t .

$PK_{f,t}$ is the price of capital good.

3. Update the quantity of aggregate capital (subscript f refers to capital):

$$QFS_{f,t+1} = QFS_{f,t} * \left(1 + \frac{DKAPS_{f,a,t}^a}{QFS_{f,t}} - deprate_f \right).$$

Total real capital accumulation is endogenous because it is equal to total saving, which is endogenous. By definition, the capital stock at the beginning of the current period is equal to the last period's capital stock plus net investment minus depreciation. New capital is allocated across sectors by adjusting the proportion of each sector's share in aggregate investment as a function of the relative profit rate of each sector compared with the average profit rate of the economy as a whole. Sectors with higher (lower) average profit rates will get higher (lower) shares of the available investment. Over time, the adjustment process should lead toward convergence of sector profit rates.

Labor supply for all categories except formal-sector unskilled labor is assumed to be exogenously increasing by 2.5 percent per year. For formal-sector unskilled labor, the wage rate is exogenous and total employment is endogenous, which means we assume that the total potential supply of unskilled workers in the urban sector is sufficient to satisfy the employment demand generated by the model simulations. Finally, productivity growth, real government consumption and transfers, world price of exports, and current account balances are set exogenously based on observed trends.

To summarize, the dynamic accumulation process is updated in three ways:

1. By exogenous trends (labor force growth, productivity changes, capital stock growth, and population growth)
2. By economic behavior (distribution of investment by sector and distribution of labor force by sector and category)
3. By implemented policies (credit crunch, changes in foreign savings, minimum wage changes)

The solutions derived from the model are going to be comparative growth rates over a five-year period. That is, they will show the baseline growth rate and how that growth rate is affected by changes in exogenous variables. It is important to understand that these results are not forecasts. They tell us the changes in the growth rates of wages, prices, sectoral outputs, and GDP that are caused by changes in exogenous variables, holding the growth rates of all other exogenous variables constant.

4. POLICY SIMULATIONS AND RESULTS

First, we initialized the model using the observed sectoral data from the updated SAM of 2004. Then we ran the model forward for five years using the observed rate of capital formation, foreign savings and remittances, and the sectoral composition of output and updating the capital stock and the labor force. In the following tables this run of the model is called the base. Changes between this run of the model and the different policy simulations will be our estimate of the impact of those policies or exogenous shocks on the economy. We ran four sets of simulations. First, we changed the amount of foreign savings by different percentages of GDP to show the sensitivity of the growth rate to changes in foreign financing of the current account deficit. Next, we lowered remittance inflows to households by 50 percent, which is like the foreign saving simulation except that the first round comes through a reduction in household disposable income. Next, we increased the urban minimum wage for unskilled labor by 50 percent, which reflects a policy change made by the Honduran government in 2009 under President Zelaya. Finally, we lowered the funds available for working capital by 10 percent and 20 percent to simulate the effect of a credit crunch.

We show selected data for the base run in Table 4.1. In the base solution, the Honduran economy invests 27 percent of GDP and grows at 4.5 percent per year. Because of both very large remittance flows and other capital inflows, the country runs a very large trade deficit of 30 millions of lempiras, which is equal to 18.6 percent of GDP. Two-thirds of that trade deficit is financed by remittances, which were equal to 20 millions of lempiras in 2004 in the base run, and one-third is financed by capital inflows or foreign savings. During the five years of the simulation, the trade deficit is reduced a bit, partially the result of a 0.3 percent per year real devaluation. Government consumption at 15 percent of GDP is relatively small in Honduras. Even so, the share of taxes is even smaller so that the initial government deficit is 4.4 percent of GDP, declining to 3.9 percent by the end of the five-year simulation.

Part B of Table 4.1 gives a quick overview of the structure of production and foreign trade. Agriculture grows a bit more slowly than manufacturing, but all center on the average overall growth rate of 4.5 percent. With respect to foreign trade, imports are dominated by manufactured commodities and the textile inputs to maquila. Exports are dominated by maquila, although processed food, coffee, light manufacturing, and tourism also are important. As shown in part A of Table 4.1, in the base run the economy reduces its trade deficit. Exports grow significantly faster than imports in all the big export sectors with the exception of maquila, the biggest exporter. Maquila is a special case because most of the textile inputs to the sector are imported. That makes the sector relatively insensitive to changes in the exchange rate. This feature of the economy makes it particularly difficult to correct a deficit in the balance of payments by expanding this largest export sector through devaluation.

Table 4.1a—The base solution

	Initial Value	Base Growth Rate
Absorption	191.56	3.86
Private Consumption	119.42	3.9
Investment	43.73	4.19
Change in Stock	4.18	
Government Consumption	24.24	3.69
Exports	93.39	5.74
Imports	-123.45	4.45
GDP market price	161.5	4.52
Net Taxes	17.08	4.33
GDP factor costs	144.42	4.54
Exchange Rate	1	1.02
Trade Deficit/GDP	0.19	0.15
Foreign Savings/GDP	0.07	0.07

Source: Author's worksheets.

Note: Except for the Initial Value column, all the ratios are for 2009. The exchange rate is the value in 2009.

Table 4.1b—The base solution

Sector	Imports				Exports	
	Initial Level	Growth Rate(%)	Initial Value	Growth Rate(%)	Initial Value	Growth Rate(%)
cagric	6.57	4.16	2.55	4.12	0.24	4.43
cagex	9.63	4.20	0.63	4.26	5.20	4.21
ccoff	9.02	4.40	1.69	3.79	5.15	5.14
clvstk	8.84	3.88	0.35	2.11	0.02	5.35
cpfood	38.62	4.11	6.09	3.09	7.09	5.45
chila	4.68	5.43	1.03	4.86	2.94	6.11
chilam	28.25	5.96	28.25	5.96	na	na
ctxtl	9.05	4.87	3.93	4.26	44.73	6.03
clmfg	25.78	4.37	17.66	4.12	5.17	5.65
cchem	17.83	4.43	17.09	4.41	na	na
chmfg	38.74	4.29	30.10	4.10	7.34	5.74
cutility	8.08	4.53	0.39	2.87	na	na
cconst	19.78	4.25	0.62	2.51	0.03	5.52
cscm	30.91	4.54	na	na	na	na
cstrncom	14.25	4.19	4.07	2.66	1.34	5.06
csexp	12.98	4.38	1.63	2.71	7.00	5.96
csothr	46.83	4.37	3.50	3.34	1.23	5.70
csgov	30.69	3.72	0.14	0.00	0.04	3.97

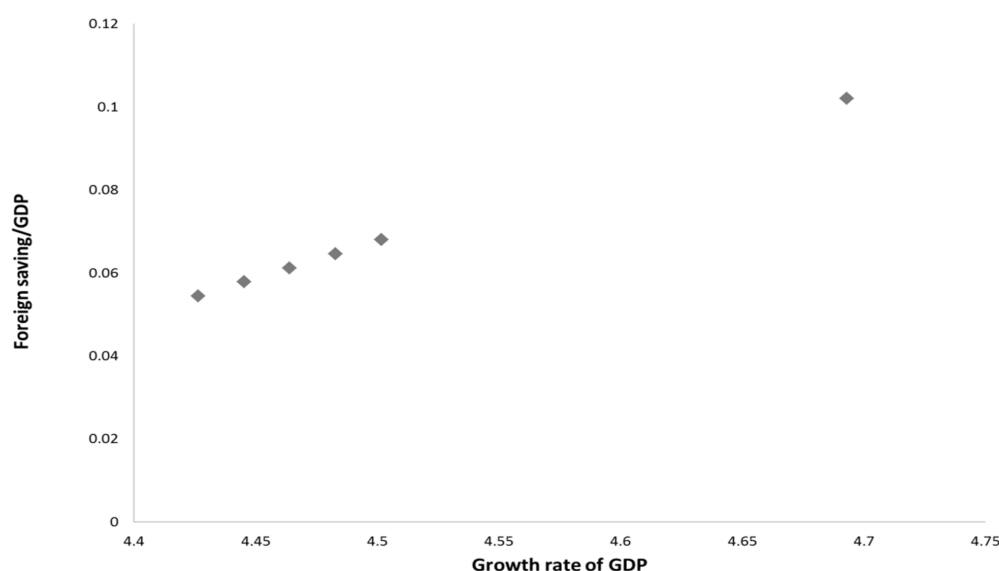
Source: Authors' worksheets.

The Impact of Variations in Capital Inflows

The economy of Honduras is very open, running a large trade deficit that is made possible by both large capital inflows and remittances. In this set of simulations we examine the impact of variations in capital inflows on the economy. In the next section we look at the impact of a reduction in remittances. To show the impact, we varied the amount of foreign saving from 50 percent to –20 percent of the level in 2004. Because the initial level of foreign saving was 6.8 percent of GDP in 2004, this exercise was equivalent to a variation in capital inflows to the economy from 3.4 percent of GDP to –1.3 percent.

Figure 4.1 shows the impact of these changes in capital inflows or foreign saving on the five-year growth rate of the economy. The base run has foreign saving equal to 6.8 percent of GDP in 2004, and a five-year growth rate of 4.5 percent. If those capital inflows are reduced to 5.4 percent of GDP, the growth rate decreases to 4.4 percent. Conversely, if capital inflows increase to 10.2 percent, the growth rate increases to 4.7 percent. In other words, changing the amount of foreign saving by 4.8 percent of GDP changes the growth rate by a bit less than 0.4 percent. Each 1 percent reduction in foreign capital costs about 0.1 percent of growth.

Figure 4.1—Foreign saving and growth



Source: Authors' worksheets.

Table 4.2 shows how exogenous changes in the availability of foreign saving or remittances affect the main macro variables in the economy. In all three foreign saving alternatives, exports grow faster than imports, causing a reduction in the trade deficit as a share of GDP by the end of the period. Reaching the necessary export growth rate requires a real devaluation, even in the base run. Part of the reason the export growth rate has to exceed the growth rate of the economy, even while imports grow less, is that in each simulation we are holding foreign saving and remittances constant at their initial or post shock level while GDP is rising. Given the openness of the economy and the large initial trade deficit, this requires that exports grow faster than imports. Obviously that differential growth rate in favor of exports is larger the smaller the inflow of foreign capital. The last line in the table shows the real devaluation that is necessary to keep the trade balance at the necessary level, given the amount of foreign savings and remittances available. It does not appear to require a very large real devaluation to offset quite large variations in capital inflows, which implies that both exports and imports are quite sensitive to changes in relative prices. This also suggests that the exchange rate is an important policy variable that helps to counteract changes in foreign capital or remittance inflows without requiring big fluctuations in the growth rate of real output.

Table 4.2—Growth rates of macro variables with variation in foreign saving remittances

	Initial	Base	+3.4% GDP	-1.4% GDP	- 50% remit
Absorption	191.57	3.86	4.47	3.61	2.68
Consumption	119.42	3.90	4.52	3.65	2.71
Investment	43.73	4.19	4.93	3.88	2.77
Government	24.24	3.69	4.14	3.51	2.80
Exports	93.39	5.74	5.04	6.01	7.00
Imports	-123.45	4.45	4.66	4.37	4.10
GDP at market prices	161.50	4.52	4.67	4.46	4.23
foreign saving (value)	10.982	10.982	16.474	8.786	10.982
trade deficit/gdp	0.19	0.15	0.18	0.14	0.10
for sav/gdp	0.07	0.07	0.10	0.05	0.07
real exchange rate in 2009	1.000	1.0160	1.0061	1.0200	1.035

Source: Authors' worksheets.

Note: Except for the initial column, all the ratios are for year five of the simulation.

The remittances simulation is different from a reduction in foreign saving because it directly affects consumption in the first round. This simulation is also a much bigger shock than the 20 percent reduction in foreign saving. Remittances were 20.2 in the initial 2004 SAM, so reducing them by 50 percent is equivalent to a 6.2 percent reduction in foreign saving. The shock is different in that it directly impacts consumption in the first round, which reduces the first-year growth rate from 4.5 percent to 2.2 percent. Subsequently, the growth rate stabilizes at 4.1 percent compared with 4.5 percent in the base run. For the five years combined, the remittance effect on total output is roughly the same as an equivalent reduction in foreign saving. There is a 3.5 percent real devaluation, a big increase in the growth rate of exports, and a smaller decline in imports, which partially offsets the big hit on consumption and investment. All of this underscores the importance of foreign exchange, from whatever the source, to the Honduran economy.

In Tables 4.3 and 4.4 we show what happens to sectoral growth rates of output, exports, and imports under the different foreign saving regimes and for a reduction in remittances. The tables indicate how the economy reacts to the changes in the real exchange rate forced by variations in foreign capital inflows or remittances. In agriculture, exports respond positively and imports negatively to a reduction in capital inflows, but the changes are relatively small. Maquila, which is the main component of the textile sector in the table, and light manufacturing are the two sectors that dominate the reaction. The main net export sector is textiles. Its export growth rate sharply declines (increases) when there is an increase (decrease) in foreign saving or remittances; however, imports into the textile sector follow what happens to exports, as they are intermediate inputs to this sector, for which we assume that there are few domestic substitutes. Because this is the biggest net export sector, it does not take a large change in the growth rate to offset fairly large variations in foreign saving or remittances. This is the main reason why the necessary adjustments in production and the exchange rate are relatively small, but it also implies that exchange rate flexibility does not imply dramatic adjustment costs and inflation when there are fluctuations in capital inflows.

Table 4.3—Sectoral average growth rates with changes in foreign saving

	Initial	Base	+3.4% GDP	-1.4% GDP	-50% Remit
cagric	6.57	4.16	4.42	4.06	3.40
cagex	9.63	4.20	4.53	4.06	3.50
ccoff	9.02	4.40	4.55	4.34	4.05
clvstk	8.84	3.88	4.14	3.78	3.32
cpfood	38.62	4.11	4.54	3.93	3.22
chila	4.68	5.43	5.26	5.50	5.71
chilam	28.25	5.96	4.98	6.35	7.73
ctxtl	9.05	4.87	4.76	4.91	5.16
clmfg	25.78	4.37	4.60	4.27	3.89
cchem	17.83	4.43	4.61	4.36	4.11
chmfg	38.74	4.29	4.87	4.06	3.24
cutility	8.08	4.53	4.81	4.41	4.08
cconst	19.78	4.25	4.89	3.99	3.02
cscm	30.91	4.54	4.71	4.47	4.20
cstrncom	14.25	4.19	4.61	4.02	3.51
csexp	12.98	4.38	4.76	4.23	3.63
csothr	46.83	4.37	4.68	4.24	3.84
csgov	30.69	3.72	4.16	3.53	2.87

Source: Authors' worksheets.

Table 4.4—Growth of exports and imports by sector

Growth rate of exports by sector						Growth rate of imports by Sector					
	Initial	Base	+3.4% GDP	-1.4% GDP	-50%remit		Initial	Base	+3.4% GDP	-1.4% GDP	-50%remit
cagric	0.24	4.43	3.93	4.63	5.33	cagric	2.55	4.12	4.71	3.88	2.62
cagex	5.20	4.21	3.86	4.35	4.90	cagex	0.63	4.26	5.29	3.84	2.16
ccoff	5.15	5.14	4.78	5.28	5.82	ccoff	1.69	3.79	4.37	3.56	2.57
clvstk	0.02	5.35	5.14	5.44	5.80	clvstk	0.35	2.11	2.92	1.78	0.38
cpfood	7.09	5.45	5.12	5.58	6.07	cpfood	6.09	3.09	4.09	2.68	1.04
chila	2.94	6.11	5.84	6.21	6.55	chila	1.03	4.86	4.77	4.89	4.99
ctxtl	44.73	6.03	4.99	6.45	7.90	chilam	28.25	5.96	4.98	6.35	7.73
clmfg	5.17	5.65	4.95	5.93	6.95	ctxtl	3.93	4.26	4.63	4.12	3.75
chmfg	7.34	5.74	5.63	5.78	5.92	clmfg	17.66	4.12	4.53	3.95	3.28
cconst	0.03	5.52	5.55	5.50	5.44	cchem	17.09	4.41	4.60	4.33	4.07
cstrncom	1.34	5.06	4.81	5.16	5.56	chmfg	30.10	4.10	4.77	3.83	2.88
csexp	7.00	5.96	5.56	6.12	6.73	cutility	0.39	2.87	3.63	2.56	1.65
csothr	1.23	5.70	5.34	5.85	6.38	cconst	0.62	2.51	3.98	1.92	-0.26
csgov	0.04	3.97	3.63	4.10	4.57	cstrncom	4.07	3.54	4.46	3.17	1.97
						csexp	1.63	2.66	3.89	2.16	0.25
						csothr	3.50	2.71	3.86	2.25	0.74
						csgov	0.14	3.34	4.94	2.70	0.41

Source: Authors' worksheets.

Increasing the Minimum Wage

Honduras, like many countries, has a minimum wage policy. One of the most controversial policy changes of the Zelaya government was an increase of 50 percent in the legal minimum wage for workers in the formal sector. In our model we have two different types of unskilled urban labor: one is covered by the minimum wage and the other is not. In this simulation we examine the effects of a 50 percent increase in the minimum wage. Note that this applies only to unskilled formal-sector labor in the urban economy. Note also that we changed the base run factor market assumption for skilled labor to make this comparison because the model could not accommodate a change this great in the minimum wage with fixed labor supply assumptions in that factor market. For this simulation, employment of both skilled and unskilled formal-sector labor is endogenous, whereas for all other labor markets, real wage rates are endogenous and labor supply is exogenous and growing at a uniform 2.5 percent per year.

What is relevant is the comparison of the base run and the increased minimum wage run, which we see in Table 4.5. This change has a big impact. It reduces the growth rate of the economy from 5.19 percent in the base run to 3.6 percent in the wage simulation, meaning that during the five years of our simulation, there is a steadily widening gap between the base run and the alternative with the higher minimum wage. By the end of five years, output is 7.4 percent lower than it would have been with the original minimum wage, and the total loss over the five-year simulation is 5.7 percent of total base period production.⁸

Table 4.5—Annual growth of macro variables with +50% minimum wage (MW)

	Initial	Base	+ 50% MW
Absorption	191.56	4.44	3.06
Consumption	119.42	4.38	3.16
Investment	43.73	4.66	3.07
Stocks	4.18		
Government	24.24	5.03	3.01
Exports	93.38	6.58	3.43
Imports	-123.45	5.12	2.64
GDP at market prices	161.50	5.19	3.59
Indirect taxes	17.08	4.87	3.48
GDP at factor cost	144.41	5.22	2.74
for sav/gdp	0.07	0.05	0.06
trade def/gdp	0.19	0.14	0.16
real ex rate	1.00	1.02	1.02

Source: Authors worksheets.

Note: Real exchange rate and ratios are for end of period.

This policy causes large losses because one of Honduras's main exports is textiles, which are produced primarily by the formal sector with a lot of unskilled labor. That makes a significant portion of total exports very sensitive to the level of the minimum wage, as can be seen in Table 4.5.⁹ Increasing the minimum wage by 50 percent reduces exports in 2009 by 13.9 percent. Assuming foreign saving is fixed, as we do in this simulation, the reduction in exports has to be matched by an equivalent absolute reduction in imports. In the 50 percent case, imports decline by 7.4 percent. GDP growth and absorption decline as the economy shifts production away from the formal sector and toward agriculture and the informal sector. Because the labor supply curve to the formal sector is flat, increasing the minimum wage

⁸ The total loss is higher than the loss in 2009 because of the large initial impact of the minimum wage shock.

⁹ Note that the maquila sector was in fact exempted from the legally mandated increase in the minimum wage.

causes some formal-sector unskilled workers to lose their jobs. Urban unemployment in the 50 percent case increases from zero in the base run to 13.6 percent of the urban labor force. The real exchange rate depreciates slightly but does not come close to compensating for the increase in the cost of unskilled labor to the export sector.

In Table 4.6 we show the effect of the change in the minimum wage on sectoral growth rates. Overall, income growth declines, which affects demand in all sectors including agriculture, even though its labor force is not subject to the increase in the minimum wage. The manufacturing sector in general and the main exporting sectors in particular are the most affected by increased minimum wage costs. Textiles and textile input growth rates decline, beginning at 5 percent to 7 percent to 1 percent to 2 percent. The growth of exports from these two sectors stalls, dropping from 7.2 percent in the base simulation to less than 2.8 percent with the higher minimum wage.

Table 4.6—Sector growth rates with 50% increase in minimum wage (MW)

	Initial	Base Growth Rate	+50% MW
cagric	6.57	4.55	3.43
cagex	9.63	4.51	3.58
ccoff	9.02	4.62	4.20
clvstk	8.84	4.16	3.21
cpfood	38.62	4.50	3.29
chila	4.68	5.88	3.53
chilam	28.25	7.15	1.63
ctxtl	9.05	5.69	2.23
clmfg	25.78	4.97	3.46
cchem	17.83	4.99	3.70
chmfg	38.74	4.77	3.27
cutility	8.08	5.10	3.67
cconst	19.78	4.75	3.17
cscm	30.91	5.02	3.64
cstrncom	14.25	4.75	3.45
csexp	12.98	4.98	3.20
csothr	46.83	4.97	3.64
csgov	30.69	5.04	3.07

Source: Authors' worksheets.

Consider now what happens to factor incomes and factor employment (see Table 4.7): Employment of unskilled labor declines sharply. For those formal-sector unskilled workers who keep their jobs, income goes up. A big increase in unemployment results in an overall reduction in unskilled labor income. But these are not the only effects—everyone loses. As can be seen in the table, labor income for all categories of labor decreases, and because capacity utilization also decreases, so does the return to capital. The minimum wage policy is a lose–lose policy choice.

Table 4.7—Factor incomes with a +50% increase in minimum wage (MW)

		Factor Supply		Real Wage		Factor Income	
		2004	2009	2004	2009	2004	2009
PHYCAP	base	408.51	503.09	0.13	0.13	54.47	67.08
PHYCAP	+50% MW	408.51	492.77	0.13	0.13	54.47	65.70
FINCAP	base	116.03	145.46	0.10	0.10	11.60	14.55
FINCAP	+50% MW	116.03	136.55	0.10	0.10	11.60	13.66
Flbr-ursk	base	34.08	43.45	1.00	1.00	34.08	43.45
Flbr-ursk	+50% MW	34.08	41.60	1.00	1.00	34.08	41.60
Flbr-urns	base	13.83	17.92	1.00	1.00	13.83	17.92
Flbr-urns	+50% MW	13.83	10.37	1.00	1.50	13.83	15.55
flabf-rusk	base	7.23	8.18	1.00	1.11	7.23	9.07
flabf-rusk	+50% MW	7.23	8.18	1.00	1.06	7.23	8.67
flabf-runs	base	10.75	12.16	1.00	1.16	10.75	14.08
flabf-runs	+50% MW	10.75	12.16	1.00	1.06	10.75	12.95
flabc-ursk	base	4.26	4.82	1.00	1.08	4.26	5.23
flabc-ursk	+50% MW	4.26	4.82	1.00	1.03	4.26	4.98
flabc-urns	base	2.45	2.77	1.00	1.10	2.45	3.03
flabc-urns	+50% MW	2.45	2.77	1.00	1.07	2.45	2.96
flabc-rusk	base	1.72	1.95	1.00	1.14	1.72	2.21
flabc-rusk	+50% MW	1.72	1.95	1.00	1.09	1.72	2.12
flabc-runs	base	4.02	4.55	1.00	1.14	4.02	5.19
flabc-runs	+50% MW	4.02	4.55	1.00	1.09	4.02	4.94

Source: Authors' worksheets.

Reducing the Supply of Working Capital

One of the innovations in this CGE model is the inclusion of working capital as a factor of production. This is a partial step toward a more fully specified financial sector, and it was included to examine the likely sensitivity of the Honduran economy to a financial crisis imported from the rest of the world. At the moment, it appears that the Honduran banking sector is fairly well insulated from the financial disturbances that have caused so much instability in international capital markets. However, any balance of payments shock carries with it the risk of a monetary contraction, particularly when the exchange rate is fixed.

A large amount of literature exists on working capital as a factor of production. Production takes time, and during the production process workers have to be paid and raw materials have to be purchased, which requires a stock of credit or working capital. In the credit crunch simulations, we reduce the stock of working capital by 10 percent and 20 percent in year one and then permit it to grow at 2.5 percent per year from the lower base. The following tables show the impact on macro variables, factor incomes, and sectoral production. Note that we retain here the assumption that the minimum wage is fixed at the base period level.

Since working capital is a factor of production, cutting its supply should be contractionary, and it is (see Table 4.8). If the supply of working capital contracts by 10 percent in year one, the growth rate of GDP over the five years of the simulation declines by 0.8 percent. If the supply contracts by 20 percent, the growth rate declines by an additional 0.6 percent. Because our information about the actual supply of working capital and its role in production is sketchy, these estimates should be regarded as first guesses.

But they do indicate clearly that monetary factors may have important supply-side effects that require further study.

Table 4.8—Effects of a reduction in working capital on macro variables (annual growth rates)

	Initial	Base	-20%	-10%
Absorption	191.57	3.86	2.65	3.18
Consumption	119.42	3.90	2.55	3.14
Investment	43.73	4.19	2.61	3.31
Stocks	4.18			
Government	24.24	3.69	3.63	3.66
Exports	93.39	5.74	4.23	4.90
Imports	-123.45	4.45	3.26	3.79
GDP at market prices	161.50	4.52	3.11	3.73
Indirect taxes	17.08	4.41	2.83	3.53
GDP at factor cost	144.42	4.54	2.16	2.75
for saving/gdp	0.07	0.05	0.06	0.06
trade def/gdp	0.19	0.15	0.16	0.15
real exch rate	1.00	1.02	1.01	1.01

Source: Authors' worksheets

In Table 4.9 we show what happens to sector growth rates when working capital is reduced. The contractionary effect is felt about equally in every sector except government.

Table 4.9—Sectoral growth rates with reduction in working capital

	Base	-20%	-10%
cagric	4.16	2.82	3.41
cagex	4.20	2.80	3.41
ccoff	4.40	3.08	3.67
clvstk	3.88	2.42	3.06
cpfood	4.11	2.56	3.24
chila	5.43	2.14	3.73
chilam	5.96	5.18	5.54
ctxtl	4.87	3.79	4.27
clmfg	4.37	2.96	3.59
cchem	4.43	2.92	3.59
chmfg	4.29	2.63	3.38
cutility	4.53	2.85	3.59
cconst	4.25	2.66	3.36
cscm	4.54	2.98	3.67
cstrncom	4.19	2.75	3.39
csexp	4.38	2.51	3.33
csothr	4.37	2.79	3.47
csgov	3.72	3.62	3.67

Source: Authors' worksheets.

We can get a better sense of how this contraction works by looking at factor returns. Making working capital more scarce increases its rate of return sharply, from 10 percent in the base run to 21 percent with the 10 percent contraction in working capital and to 31 percent with a 20 percent reduction. At the same time, the wages of all workers not covered by the minimum wage legislation decrease. For formal-sector unskilled workers and for physical capital, we assumed a fixed wage or rate of return. Thus, for these two factors, the impact of the contraction comes in the form of a rise in unemployment in the case of labor and underutilization in the case of capital. For the unskilled in the formal sector, the unemployment rate for minimum wage labor rises from zero in the base run to 3.2 percent if working capital declines by 10 percent and to 5.3 percent in the 20 percent contraction simulation.¹⁰ For capital, underutilization rises from zero in the base run to 4.5 percent in the 10 percent simulation and to 8.2 percent in the 20 percent contraction.

¹⁰ Note that we are counting the reduction in employment of formal-sector labor relative to the entire urban labor force in 2009.

5. CONCLUSIONS

We built our CGE model to apply specifically to small open economies highly dependent on external markets and inflows of capital both from official sources and remittances. We designed the model to capture the short-run impact of exogenous changes, which we accomplished by introducing a rigid nominal minimum wage for formal-sector unskilled labor and by introducing working capital as an additional factor of production. The model results demonstrate clearly the sensitivity of the economy to the availability of foreign exchange. In our base run, foreign saving is equal to 6.8 percent of GDP in 2004, and the five-year growth rate is 4.5 percent. If capital inflows are reduced to 5.4 percent of GDP, the growth rate slows to 4.4 percent. Conversely, if capital inflows increase to 10.2 percent, the growth rate rises to 4.7 percent. In other words, each 1 percent reduction in foreign capital costs about 0.1 percent of growth. Changes in remittances are potentially a bigger source of instability than other sources of foreign exchange because of their absolute size and because they directly affect consumption in the first round. In our simulation we reduced remittances by 50 percent, which is equivalent to a 6.2 percent reduction in the share of foreign saving in GDP. In year one, that decline reduced the growth rate by more than 3 percent, but then the growth rate stabilized 0.4 percent below the base run. In both cases, the decline in foreign exchange forced the economy to devalue; increased the rate of growth of exports; and reduced the growth rate of consumption, investment, and imports.

One of the more controversial policies enacted by the Zelaya government in 2009 was a 50 percent increase in the minimum wage. We designed our CGE model to show the impact of this change on growth, exports, and employment. The results indicate that raising the minimum wage by this amount has a significant negative impact. It reduces the growth rate of the economy from 5.2 percent in the base run to 3.6 percent in the increased wage simulation. This means that during the five years of our simulation, there is a steadily widening gap between the base run and the alternative with the higher minimum wage. By the end of five years, output is 7.4 percent lower than it would have been with the original minimum wage, and the total loss over the five-year simulation is 5.7 percent of total base period production.¹¹

Since the labor supply curve to the formal sector is flat, raising the minimum wage causes some formal-sector unskilled workers to lose their jobs. Urban unemployment in the increased wage scenario increases from zero in the base run to 13.6 percent of the urban labor force. For those formal-sector unskilled workers who keep their jobs, income goes up; but because of the increase in unemployment, total income for unskilled labor declines. But these are not the only effects. Every labor class has an income loss, and because capacity utilization decreases, so does capital.

Constraining the availability of working capital also has a large impact on the growth rate. We found that a one-year reduction in the supply of working capital by 10 percent reduces the growth rate of GDP by 0.8 percent. If the supply contracts by 20 percent, the growth rate declines by an additional 0.6 percent. Making working capital more scarce increases its own rate of return sharply, from 10 percent in the base run to 21 percent with the 10 percent contraction in working capital and to 31 percent with a 20 percent reduction. At the same time, wages decrease for all workers not covered by the minimum wage legislation. For formal-sector unskilled workers and for physical capital, the impact of the contraction comes in the form of a rise in unemployment or underutilization. For the unskilled in the formal sector, the unemployment of minimum wage labor rises from zero in the base run to 3.2 percent if working capital declines by 10 percent and to 5.3 percent in the 20 percent contraction simulation.¹² For capital, underutilization rises from zero in the base run to 4.5 percent in the 10 percent simulation and to 8.2 percent in the 20 percent contraction.

¹¹ The total loss is higher than the loss in 2009 because of the large initial impact of the minimum wage shock.

¹² Note that we are counting the reduction in employment of formal-sector labor relative to the entire urban labor force in 2009.

One final point should be made about our results and the prospects for growth in the Honduran economy. In our base run, we used the investment shares and parameter values implied by the 2004 SAM, and the lack of technical change over the last 30 years in projecting the base run growth rate. That base run had an initial investment share of 26.6 percent of GDP and produced an average growth rate of 4.5 percent, which is too little growth for that much investment. Aside from all the policy simulations we have run, a fundamental question that policymakers should ask is how to make investment more productive, or how to get more growth for the relatively large sacrifices of current consumption being made. Devoting more investment to increasing the efficiency of the nonmaquila export industries is likely to be an important component of a successful growth strategy—one that not only increases productivity but also relies less on remittances and more on an expanding export sector as a source of foreign exchange.

APPENDIX A: A FORMAL STATEMENT OF THE DYNAMIC CGE MODEL

Table A.1—The dynamic CGE model

Symbol	Explanation	Symbol	Explanation
$a \in A$	activities	$c \in CMN(\subset C)$	commodities not in CM
$a \in ACES(\subset A)$	activities with a constant elasticity of substitution (CES) function at the top of the technology nest	$c \in CT(\subset C)$	transaction service commodities
$a \in ALEO(\subset A)$	activities with a Leontief function at the top of the technology nest	$f \in F$	factors
$c \in CX(\subset C)$	commodities with domestic production	$f_{sub} \in F$	factors used in composite factors
$c \in C$	commodities	$f_{2s} \in F$	composite factors
$c \in CD(\subset C)$	commodities with domestic sales of domestic output	$i \in INS$	institutions (domestic and rest of world)
$c \in CDN(\subset C)$	commodities not in CD	$i \in INSD(\subset INS)$	domestic institutions
$c \in CE(\subset C)$	exported commodities	$i \in INSDNG(\subset INSD)$	domestic nongovernment institutions
$c \in CEN(\subset C)$	commodities not in CE	$h \in H(\subset INSDNG)$	households
$c \in CM(\subset C)$	imported commodities	$fls \in F$	factors with supply curve
PARAMETERS			
Symbol	Explanation	Symbol	Explanation
$cwts_c$	weight of commodity c in the consumer price index (CPI)	$\overline{qg}_c$	base-year quantity of government demand
$dwts_c$	weight of commodity c in the producer price index	$\overline{qinv}_c$	base-year quantity of private investment demand
ica_{ca}	quantity of c as intermediate input per unit of activity a	$shif_{if}$	share for domestic institution I in income of factor f
$icd_{cc'}$	quantity of commodity c as trade input per unit of c' produced and sold domestically	$shii_{ii'}$	share of net income of i' to I ($i' \in INSDNG'$; $I \in INSDNG$)
$ice_{cc'}$	quantity of commodity c as trade input per exported unit of c'	ta_a	tax rate for activity a
$icm_{cc'}$	quantity of commodity c as trade input per imported unit of c'	te_c	export tax rate
$inta_a$	quantity of aggregate intermediate input per activity unit	tf_f	direct tax rate for factor f
iva_a	quantity of aggregate intermediate input per activity unit	$\overline{tins}_i$	exogenous direct tax rate for domestic institution i
$\overline{mps}_i$	base savings rate for domestic institution i	$tins0I_i$	0–1 parameter with 1 for institutions with potentially flexed direct tax rates
$mps0I_i$	0–1 parameter with 1 for institutions with potentially flexed direct tax rates	tm_c	import tariff rate
pwe_c	export price (foreign currency)	tq_c	rate of sales tax

Table A.1—Continued

PARAMETERS			
Symbol	Explanation	Symbol	Explanation
pwm_c	import price (foreign currency)	$trnsfr_{i,f}$	transfer from factor f to institution i
$qdst_c$	quantity of stock change	tva_a	rate of value-added tax for activity a
$etals_f$	parameter in labor supply equation		
$INVSHR1_a$	capital shares	PK_r	price of capital
$DKAPS_{fa}$	gross fixed capital formation	QF_{fa}	next period sectoral capital stock
$WFXAV$	average capital rental rate	$deprate^k$	capital stock depreciation rate
GREEK LETTERS			
Symbol	Explanation	Symbol	Explanation
α_a^a	efficiency parameter in the CES activity function	δ_c^t	constant elasticity of transformation (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
		$\rho_{f2s,a}^{fs}$	CES exponent for factor (that goes into composite factor) for f2s aggregate
$\alpha_{f2s,a}^{fs}$	shift parameter for factor (that goes into composite factor) for f2s CES aggregates	$\delta_{fsub,f2s,a}^{fs}$	share parameter for factor (that goes into composite factor) for f2s CES aggregates
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	γ_{ach}^h	subsistence consumption of home commodity c from activity a for household h
α_c^t	CET function shift parameter	θ_{ac}	yield of output c per unit of activity a
β_{ach}^h	marginal share of consumption spending on home commodity c from activity a for household h	ρ_a^a	CES production function exponent
β_{ch}^m	marginal share of consumption spending on marketed commodity c for household h	ρ_a^{va}	CES value-added function exponent
δ_a^a	CES activity function share parameter	ρ_c^{ac}	domestic commodity aggregation function exponent
δ_{ac}^{ac}	share parameter for domestic commodity aggregation function	ρ_c^q	Armington function exponent
δ_c^q	Armington function share parameter	ρ_c^t	CET function exponent

Table A.1—Continued

VARIABLES			
Symbol	Explanation	Symbol	Explanation
$\overline{CPI}$	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 factor	$\overline{WFDIST}_{fa}$	wage distortion factor for factor f in activity a
$\overline{IADJ}$	investment adjustment factor	$QFSUB_{fsub,f2s,a}$	quantity demanded of factor fsub from activity and factor f2s
$WFSUB_{fsub}$	average wage of factor fsub (used in composite factor)	$QFSUBS_{fsub}$	Supply of fsub (used in composite factor)
$DMPS$	change in domestic institution savings rates (= 0 for base; exogenous variable)	QF_{fa}	quantity demanded of factor f from activity a
DPI	producer price index for domestically marketed output	QG_c	government consumption demand for commodity
EG	government expenditures	QH_{ch}	quantity consumed of commodity c by household h
EH_h	consumption spending for household	QHA_{ach}	quantity of household home consumption of commodity c from activity a for household h
EXR	exchange rate (LCU per unit of FCU)	$QINTA_a$	quantity of aggregate intermediate input
$GOVSHR$	government consumption share in nominal absorption	$QINT_{ca}$	quantity of commodity c as intermediate input to activity a
$GSAV$	government savings	$QINV_c$	quantity of investment demand for commodity
$INVSHR$	investment share in nominal absorption	QM_c	quantity of imports of commodity
MPS_i	marginal propensity to save for domestic nongovernment 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_c	export price (domestic currency)	$QXAC_{ac}$	quantity of output of commodity c from activity a
$PINTA_a$	aggregate intermediate input price for activity a	$TABS$	total nominal absorption
PM_c	import price (domestic currency)	$TINS_i$	direct tax rate for institution i (i ∈ 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)	$WFREAL_f$	average real price of factor f
PX_c	aggregate producer price for commodity	WF_f	average price of factor f

Table A.1—Continued

VARIABLES			
Symbol	Explanation	Symbol	Explanation
$PXAC_{ac}$	producer price of commodity c for activity a	YF_f	income of factor f
QA_a	quantity (level) of activity	YG	government revenue
QD_c	quantity sold domestically of domestic output	YI_i	income of domestic nongovernment institution
QE_c	quantity of exports	YIF_{if}	income to domestic institution i from factor f

EQUATIONS			
#	Equation	Domain	Description
Price Block			
1	$PM_c = pwm_c \cdot (1 + tm_c) \cdot EXR + \sum_{c' \in CT} PQ_{c'} \cdot icm_{c',c}$ $\begin{bmatrix} \text{import price} \\ (LCU) \end{bmatrix} = \begin{bmatrix} \text{import price} \\ (FCU) \end{bmatrix} \cdot \begin{bmatrix} \text{tariff} \\ \text{adjust -} \\ \text{ment} \end{bmatrix} \cdot \begin{bmatrix} \text{exchange rate} \\ (LCU \text{ per} \\ FCU) \end{bmatrix} + \begin{bmatrix} \text{cost of trade} \\ \text{inputs per} \\ \text{import unit} \end{bmatrix}$	$c \in CM$	Import price
2	$PE_c = pwe_c \cdot (1 - te_c) \cdot EXR - \sum_{c' \in CT} PQ_{c'} \cdot ice_{c',c}$ $\begin{bmatrix} \text{export price} \\ (LCU) \end{bmatrix} = \begin{bmatrix} \text{export price} \\ (FCU) \end{bmatrix} \cdot \begin{bmatrix} \text{tariff} \\ \text{adjust -} \\ \text{ment} \end{bmatrix} \cdot \begin{bmatrix} \text{exchange rate} \\ (LCU \text{ per} \\ FCU) \end{bmatrix} - \begin{bmatrix} \text{cost of trade} \\ \text{inputs per} \\ \text{export unit} \end{bmatrix}$	$c \in CE$	Export price
3	$PDD_c = PDS_c + \sum_{c' \in CT} PQ_{c'} \cdot icd_{c',c}$ $\begin{bmatrix} \text{domestic demand price} \end{bmatrix} = \begin{bmatrix} \text{domestic supply price} \end{bmatrix} + \begin{bmatrix} \text{cost of trade} \\ \text{inputs per} \\ \text{unit of} \\ \text{domestic sales} \end{bmatrix}$	$c \in CD$	Demand price of domestic nontraded goods
4	$PQ_c \cdot (1 - tq_c) \cdot QQ_c = PDD_c \cdot QD_c + PM_c \cdot QM_c$ $\begin{bmatrix} \text{absorption} \\ \text{(at demand} \\ \text{prices net of} \\ \text{sales tax)} \end{bmatrix} = \begin{bmatrix} \text{domestic demand price} \\ \text{times} \\ \text{domestic sales quantity} \end{bmatrix} + \begin{bmatrix} \text{import price} \\ \text{times} \\ \text{import quantity} \end{bmatrix}$	$c \in (CD \cup CM)$	Absorption
5	$PX_c \cdot QX_c = PDS_c \cdot QD_c + PE_c \cdot QE_c$ $\begin{bmatrix} \text{producer price} \\ \text{times marketed} \\ \text{output quantity} \end{bmatrix} = \begin{bmatrix} \text{domestic supply price} \\ \text{times} \\ \text{domestic sales quantity} \end{bmatrix} + \begin{bmatrix} \text{export price} \\ \text{times} \\ \text{export quantity} \end{bmatrix}$	$c \in CX$	Marketed output value

Table A.1—Continued

#	Equation	Domain	Description
Price Block			
6	$PA_a = \sum_{c \in C} PXAC_{ac} \cdot \theta_{ac}$ $\left[\begin{array}{c} \text{activity} \\ \text{price} \end{array} \right] = \left[\begin{array}{c} \text{producer prices} \\ \text{times yields} \end{array} \right]$	$a \in A$	Activity price
7	$PINTA_a = \sum_{c \in C} PQ_c \cdot ica_{ca}$ $\left[\begin{array}{c} \text{aggregate} \\ \text{intermediate} \\ \text{input price} \end{array} \right] = \left[\begin{array}{c} \text{intermediate input cost} \\ \text{per unit of aggregate} \\ \text{intermediate input} \end{array} \right]$	$a \in A$	Aggregate intermediate input price
8	$PA_a \cdot (1 - ta_a) \cdot QA_a = PVA_a \cdot QVA_a + PINTA_a \cdot QINTA_a$ $\left[\begin{array}{c} \text{activity price} \\ \text{(net of taxes)} \\ \text{times activity level} \end{array} \right] = \left[\begin{array}{c} \text{value-added} \\ \text{price times} \\ \text{quantity} \end{array} \right] + \left[\begin{array}{c} \text{aggregate} \\ \text{intermediate} \\ \text{input price times} \\ \text{quantity} \end{array} \right]$	$a \in A$	Activity revenue and costs
9	$\overline{CPI} = \sum_{c \in C} PQ_c \cdot cwts_c$ $\left[CPI \right] = \left[\begin{array}{c} \text{prices times} \\ \text{weights} \end{array} \right]$		Consumer price index
10	$DPI = \sum_{c \in C} PDS_c \cdot dwts_c$ $\left[\begin{array}{c} \text{Producer price index} \\ \text{for non-traded outputs} \end{array} \right] = \left[\begin{array}{c} \text{prices times} \\ \text{weights} \end{array} \right]$		Producer price index for nontraded market output
Production and Commodity Block			
11	$QA_a = \alpha_a^a \cdot \left(\delta_a^a \cdot QVA_a^{-\rho_a^a} + (1 - \delta_a^a) \cdot QINTA_a^{-\rho_a^a} \right)^{\frac{1}{\rho_a^a}}$ $\left[\begin{array}{c} \text{activity} \\ \text{level} \end{array} \right] = CES \left[\begin{array}{c} \text{quantity of aggregate value-added,} \\ \text{quantity aggregate intermediate input} \end{array} \right]$	$a \in ACES$	CES technology: activity production function
12	$\frac{QVA_a}{QINTA_a} = \left(\frac{PINTA_a}{PVA_a} \cdot \frac{\delta_a^a}{1 - \delta_a^a} \right)^{\frac{1}{1 + \rho_a^a}}$ $\left[\begin{array}{c} \text{value-added -} \\ \text{intermediate-} \\ \text{input quantity} \\ \text{ratio} \end{array} \right] = f \left[\begin{array}{c} \text{intermediate-input} \\ \text{- value-added} \\ \text{price ratio} \end{array} \right]$	$a \in ACES$	CES technology: value-added intermediate input ratio
13	$QVA_a = iva_a \cdot QA_a$ $\left[\begin{array}{c} \text{demand for} \\ \text{value-added} \end{array} \right] = f \left[\begin{array}{c} \text{activity} \\ \text{level} \end{array} \right]$	$a \in ALEO$	Leontief technology: demand for aggregate value-added

Table A.1—Continued

#	Equation	Domain	Description
Production and Commodity Block			
14	$QINTA_a = inta_a \cdot QA_a$ $\left[\begin{array}{c} \text{demand for aggregate} \\ \text{intermediate input} \end{array} \right] = f \left[\begin{array}{c} \text{activity} \\ \text{level} \end{array} \right]$	$a \in ALEO$	Leontief technology: demand for aggregate intermediate input
15	$QVA_a = \alpha_a^{va} \cdot \left(\sum_{f \in F} \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}} \right)^{\frac{1}{\rho_a^{va}}}$ $\left[\begin{array}{c} \text{quantity of aggregate} \\ \text{value-added} \end{array} \right] = CES \left[\begin{array}{c} \text{factor} \\ \text{inputs} \end{array} \right]$	$a \in A$	Value-added and factor demands
16	$W_f \cdot \overline{WFDIST}_{fa} = PVA_a \cdot (1 - tva_a) \cdot QVA_a \cdot \left(\sum_{f \in F} \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}} \right)^{-1} \cdot \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va} - 1}$ $\left[\begin{array}{c} \text{marginal cost of} \\ \text{factor } f \text{ in activity } a \end{array} \right] = \left[\begin{array}{c} \text{marginal revenue product} \\ \text{of factor } f \text{ in activity } a \end{array} \right]$	$a \in A$ $f \in F$	Factor demand
17	$QF_{f2s,a} = \alpha_{f2s,a}^{fs} \cdot \left(\sum_{fsub} \delta_{fsub,f2s,a}^{fs} \cdot (QFSUB_{QFSUB})^{-\rho_{f2s,a}^{fs}} \right)^{\frac{-1}{\rho_{f2s,a}^{fs}}}$	$a \in A$ $f2s \in F$ $fsub \in F$	Composite factors
18	$WFSUB_{fsub} \cdot wfdistsub_{fsub,f2s,a} = WF_{f2s} \cdot WFDIST_{f2s,a} \cdot (1 + tfa_{f2s,a}) \cdot QF_{f2s,a} \cdot \left(\sum_{fsub} \delta_{fsub,f2s,a}^{fs} \cdot QFSUB_{fsub,f2s,a}^{-\rho_{f2s,a}^{fs}} \right)^{-1} \cdot QFSUB_{fsub,f2s,a}^{-\rho_{f2s,a}^{fs} - 1}$	$a \in A$ $f2s \in F$ $fsub \in F$	Factor demand for factors used in composite factors
19	$QFSUBS_{fsub} = UNEMPSUB_{fsub} + \sum_{f2s,a} QFSUB_{fsub,f2s,a}$	$a \in A$ $f2s \in F$ $fsub \in F$	Factor equilibrium for factors used in composite factors
20	$WFREAL_f = \frac{YF}{CPI \cdot \sum_a QF_{fa}} \cdot CPI0$ $\left[\begin{array}{c} \text{average real wage} \\ \text{per factor unit} \end{array} \right] = \left[\begin{array}{c} \text{average wage corrected} \\ \text{by consumer index price} \end{array} \right]$	$f \in F$	Real wages
21	$QFS_f = QFS0 \cdot \left[\frac{\frac{WF_f \cdot WFDIST_f \cdot QF_f}{QFS_f}}{\frac{CPI}{WF0_f}} \right]^{etals_f}$	$f \in F$	Labor supply
22	$QINT_{ca} = ica_{ca} \cdot QINTA_a$ $\left[\begin{array}{c} \text{intermediate demand} \\ \text{for commodity } c \\ \text{from activity } a \end{array} \right] = f \left[\begin{array}{c} \text{aggregate intermediate} \\ \text{input quantity} \\ \text{for activity } a \end{array} \right]$	$a \in A$ $c \in C$	Disaggregated intermediate input demand

Table A.1—Continued

#	Equation	Domain	Description
Production and Commodity Block			
23	$QXAC_{ac} + \sum_{h \in H} QHA_{ach} = \theta_{ac} \cdot QA_a$ $\begin{bmatrix} \text{marketed quantity} \\ \text{of commodity } c \\ \text{from activity } a \end{bmatrix} + \begin{bmatrix} \text{household home} \\ \text{consumption} \\ \text{of commodity } c \\ \text{from activity } a \end{bmatrix} = \begin{bmatrix} \text{production} \\ \text{of commodity } c \\ \text{from activity } a \end{bmatrix}$	$a \in A$ $c \in CX$	Commodity production and allocation
24	$QX_c = \alpha_c^{ac} \cdot \left(\sum_{a \in A} \delta_{ac}^{ac} \cdot QXAC_{ac}^{-\rho_c^{ac}} \right)^{-\frac{1}{\rho_c^{ac}-1}}$ $\begin{bmatrix} \text{aggregate} \\ \text{marketed} \\ \text{production of} \\ \text{commodity } c \end{bmatrix} = CES \begin{bmatrix} \text{activity-specific} \\ \text{marketed} \\ \text{production of} \\ \text{commodity } c \end{bmatrix}$	$c \in CX$	Output aggregation function
25	$PXAC_{ac} = PX_c \cdot QX_c \left(\sum_{a \in A'} \delta_{ac}^{ac} \cdot QXAC_{ac}^{-\rho_c^{ac}} \right)^{-1} \cdot \delta_{ac}^{ac} \cdot QXAC_{ac}^{-\rho_c^{ac}-1}$ $\begin{bmatrix} \text{marginal cost of com-} \\ \text{modity } c \text{ from activity } a \end{bmatrix} = \begin{bmatrix} \text{marginal revenue product of} \\ \text{commodity } c \text{ from activity } a \end{bmatrix}$	$a \in A$ $c \in CX$	First-order condition for output aggregation function
26	$QX_c = \alpha_c^t \cdot \left(\delta_c^t \cdot QE_c^{\rho_c^t} + (1 - \delta_c^t) \cdot QD_c^{\rho_c^t} \right)^{\frac{1}{\rho_c^t}}$ $\begin{bmatrix} \text{aggregate marketed} \\ \text{domestic output} \end{bmatrix} = CET \begin{bmatrix} \text{export quantity, domestic} \\ \text{sales of domestic output} \end{bmatrix}$	$c \in (CE \cap CD)$	Output transformation (CET) function
27	$\frac{QE_c}{QD_c} = \left(\frac{PE_c}{PDS_c} \cdot \frac{1 - \delta_c^t}{\delta_c^t} \right)^{\frac{1}{\rho_c^t-1}}$ $\begin{bmatrix} \text{export-domestic} \\ \text{supply ratio} \end{bmatrix} = f \begin{bmatrix} \text{export-domestic} \\ \text{price ratio} \end{bmatrix}$	$c \in (CE \cap CD)$	Export—domestic supply ratio
28	$QX_c = QD_c + QE_c$ $\begin{bmatrix} \text{aggregate} \\ \text{marketed} \\ \text{domestic output} \end{bmatrix} = \begin{bmatrix} \text{domestic market} \\ \text{sales of domestic} \\ \text{output [for} \\ \text{ } c \in (CD \cap CEN)] \end{bmatrix} + \begin{bmatrix} \text{exports [for} \\ \text{ } c \in (CE \cap CDN)] \end{bmatrix}$	$c \in$ $(CD \cap CEN)$ $\cup$ $(CE \cap CDN)$	Output transformation for nonexported commodities
29	$QQ_c = \alpha_c^q \cdot \left(\delta_c^q \cdot QM_c^{\rho_c^q} + (1 - \delta_c^q) \cdot QD_c^{\rho_c^q} \right)^{\frac{1}{\rho_c^q}}$ $\begin{bmatrix} \text{composite} \\ \text{supply} \end{bmatrix} = f \begin{bmatrix} \text{import quantity, domestic} \\ \text{use of domestic output} \end{bmatrix}$	$c \in (CM \cap CD)$	Composite supply (Armington) function

Table A.1—Continued

#	Equation	Domain	Description
Production and Commodity Block			
30	$\frac{QM_c}{QD_c} = \left(\frac{PDD_c}{PM_c} \cdot \frac{\delta_c^q}{1 - \delta_c^q} \right)^{\frac{1}{1 + \rho_c^q}}$ $\left[\begin{array}{c} \text{import-domestic} \\ \text{demand ratio} \end{array} \right] = f \left[\begin{array}{c} \text{domestic-import} \\ \text{price ratio} \end{array} \right]$	$c \in (CM \cap CD)$	Import—domestic demand ratio
31	$QQ_c = QD_c + QM_c$ $\left[\begin{array}{c} \text{composite} \\ \text{supply} \end{array} \right] = \left[\begin{array}{c} \text{domestic use of} \\ \text{marketed domestic} \\ \text{output [for} \\ c \in (CD \cap CMN)] \end{array} \right] + \left[\begin{array}{c} \text{imports [for} \\ c \in (CM \cap CDN)] \end{array} \right]$	$c \in$ $(CD \cap CMN)$ $\cup$ $(CM \cap CDN)$	Composite supply for nonimported outputs and nonproduced imports
32	$QT_c = \sum_{c' \in C'} (icm_{cc'} \cdot QM_{c'} + ice_{cc'} \cdot QE_{c'} + icd_{cc'} \cdot QD_{c'})$ $\left[\begin{array}{c} \text{demand for} \\ \text{transactions} \\ \text{services} \end{array} \right] = \left[\begin{array}{c} \text{sum of demands} \\ \text{for imports, exports,} \\ \text{and domestic sales} \end{array} \right]$	$c \in CT$	Demand for transactions services
Institutions Block			
33	$YF_f = \sum_{a \in A} WF_f \cdot \overline{WFDIST}_{fa} \cdot QF_{fa}$ $\left[\begin{array}{c} \text{income of} \\ \text{factor } f \end{array} \right] = \left[\begin{array}{c} \text{sum of activity payments} \\ \text{(activity-specific wages} \\ \text{times employment levels)} \end{array} \right]$	$f \in F$	Factor income
34	$YIF_{if} = shif_{if} \cdot \left[(1 - tf_f) \cdot YF_f - trnsfr_{rowf} \cdot EXR \right]$ $\left[\begin{array}{c} \text{income of} \\ \text{institution } i \\ \text{from factor } f \end{array} \right] = \left[\begin{array}{c} \text{share of income} \\ \text{of factor } f \text{ to} \\ \text{institution } i \end{array} \right] \cdot \left[\begin{array}{c} \text{income of factor } f \\ \text{(net of tax and} \\ \text{transfer to RoW)} \end{array} \right]$	$i \in INSD$ $f \in F$	Institutional factor incomes
35	$YI_i = \sum_{f \in F} YIF_{if} + \sum_{i' \in INSDNG'} TRII_{ii'} + trnsfr_{igov} \cdot \overline{CPI} + trnsfr_{irow} \cdot EXR$ $\left[\begin{array}{c} \text{income of} \\ \text{institution } i \end{array} \right] = \left[\begin{array}{c} \text{factor} \\ \text{income} \end{array} \right] + \left[\begin{array}{c} \text{transfers} \\ \text{from other domestic} \\ \text{non-government} \\ \text{institutions} \end{array} \right] + \left[\begin{array}{c} \text{transfers} \\ \text{from} \\ \text{government} \end{array} \right] + \left[\begin{array}{c} \text{transfers} \\ \text{from} \\ \text{RoW} \end{array} \right]$	$i \in INSDNG$	Income of domestic, nongovernment institutions
36	$TRII_{ii'} = shii_{ii'} \cdot (1 - MPS_{i'}) \cdot (1 - TINS_{i'}) \cdot YI_{i'}$ $\left[\begin{array}{c} \text{transfer from} \\ \text{institution } i' \text{ to } i \end{array} \right] = \left[\begin{array}{c} \text{share of net income} \\ \text{of institution } i' \\ \text{transferred to } i \end{array} \right] \cdot \left[\begin{array}{c} \text{income of institution} \\ i', \text{ net of savings and} \\ \text{direct taxes} \end{array} \right]$	$i \in INSDNG$ $i' \in INSDNG'$	Intra-institutional transfers

Table A.1—Continued

#	Equation	Domain	Description
Institution Block			
37	$EH_h = \left(1 - \sum_{i \in INSDNG} shii_{ih}\right) \cdot (1 - MPS_h) \cdot (1 - TINS_h) \cdot YI_h$ $\left[\begin{array}{l} \text{household income} \\ \text{disposable for} \\ \text{consumption} \end{array} \right] = \left[\begin{array}{l} \text{household income, net of direct} \\ \text{taxes, savings, and transfers to} \\ \text{other non-government institutions} \end{array} \right]$	$h \in H$	Household consumption expenditure
38	$QH_{ch} = \gamma_{ch} + \frac{\beta_{ch}^m \cdot \left(EH_h - \sum_{c' \in C} PQ_{c'} \cdot \gamma_{c'h}^m - \sum_{a \in A} \sum_{c' \in C} PXAC_{ac'} \cdot \gamma_{ac'h}^h \right)}{PQ_c}$ $\left[\begin{array}{l} \text{quantity of} \\ \text{household demand} \\ \text{for commodity } c \end{array} \right] = f \left[\begin{array}{l} \text{household} \\ \text{consumption} \\ \text{spending,} \\ \text{market price} \end{array} \right]$	$c \in C$ $h \in H$	Household consumption demand for marketed commodities
39	$QHA_{ach} = \gamma_{ach}^h + \frac{\beta_{ach}^h \cdot \left(EH_h - \sum_{c' \in C} PQ_{c'} \cdot \gamma_{c'h}^m - \sum_{a \in A} \sum_{c' \in C} PXAC_{ac'} \cdot \gamma_{ac'h}^h \right)}{PXAC_{ac}}$ $\left[\begin{array}{l} \text{quantity of} \\ \text{household demand} \\ \text{for home commodity } c \\ \text{from activity } a \end{array} \right] = f \left[\begin{array}{l} \text{household} \\ \text{disposable} \\ \text{income,} \\ \text{producer price} \end{array} \right]$	$a \in A$ $c \in C$ $h \in H$	Household consumption demand for home commodities
40	$QINV_c = \overline{IADJ} \cdot \overline{qinv}_c$ $\left[\begin{array}{l} \text{fixed investment} \\ \text{demand for} \\ \text{commodity } c \end{array} \right] = \left[\begin{array}{l} \text{adjustment factor} \\ \text{times} \\ \text{base-year fixed} \\ \text{investment} \end{array} \right]$	$c \in CINV$	Investment demand
41	$QG_c = \overline{GADJ} \cdot \overline{qg}_c$ $\left[\begin{array}{l} \text{government} \\ \text{consumption} \\ \text{demand for} \\ \text{commodity } c \end{array} \right] = \left[\begin{array}{l} \text{adjustment factor} \\ \text{times} \\ \text{base-year government} \\ \text{consumption} \end{array} \right]$	$c \in C$	Government consumption demand

Table A.1—Continued

#	Equation	Domain	Description
Institution Block			
42	$ \begin{aligned} YG = & \sum_{i \in \text{INSDNG}} TINS_i \cdot YI_i + \sum_{f \in F} tf_f \cdot YF_f + \sum_{a \in A} tva_a \cdot PVA_a \cdot QVA_a \\ & + \sum_{a \in A} ta_a \cdot PA_a \cdot QA_a + \sum_{c \in CM} tm_c \cdot pwm_c \cdot QM_c \cdot EXR + \sum_{c \in CE} te_c \cdot pwe_c \cdot QE_c \cdot EXR \\ & + \sum_{c \in C} tq_c \cdot PQ_c \cdot QQ_c + \sum_{f \in F} YF_{\text{gov } f} + \text{trnsfr}_{\text{gov row}} \cdot EXR \\ \left[\begin{array}{c} \text{government} \\ \text{revenue} \end{array} \right] = & \left[\begin{array}{c} \text{direct taxes} \\ \text{from} \\ \text{institutions} \end{array} \right] + \left[\begin{array}{c} \text{direct taxes} \\ \text{from} \\ \text{factors} \end{array} \right] + \left[\begin{array}{c} \text{value-} \\ \text{added} \\ \text{tax} \end{array} \right] \\ & + \left[\begin{array}{c} \text{activity} \\ \text{tax} \end{array} \right] + \left[\begin{array}{c} \text{import} \\ \text{tariffs} \end{array} \right] + \left[\begin{array}{c} \text{export} \\ \text{taxes} \end{array} \right] \\ & + \left[\begin{array}{c} \text{sales} \\ \text{tax} \end{array} \right] + \left[\begin{array}{c} \text{factor} \\ \text{income} \end{array} \right] + \left[\begin{array}{c} \text{transfers} \\ \text{from} \\ \text{RoW} \end{array} \right] \end{aligned} $		Government revenue
43	$ \begin{aligned} EG = & \sum_{c \in C} PQ_c \cdot QG_c + \sum_{i \in \text{INSDNG}} \text{trnsfr}_{i \text{ gov}} \cdot \overline{CPI} \\ \left[\begin{array}{c} \text{government} \\ \text{spending} \end{array} \right] = & \left[\begin{array}{c} \text{government} \\ \text{consumption} \end{array} \right] + \left[\begin{array}{c} \text{transfers to domestic} \\ \text{non-government} \\ \text{institutions} \end{array} \right] \end{aligned} $		Government expenditures
System Constraint Block			
44	$ \begin{aligned} \sum_{a \in A} QF_{f a} = & \overline{QFS}_f \\ \left[\begin{array}{c} \text{demand for} \\ \text{factor } f \end{array} \right] = & \left[\begin{array}{c} \text{supply of} \\ \text{factor } f \end{array} \right] \end{aligned} $	$f \in F$	Factor market
45	$ \begin{aligned} QQ_c = & \sum_{a \in A} QINT_{c a} + \sum_{h \in H} QH_{c h} + QG_c \\ & + QINV_c + qdst_c + QT_c \\ \left[\begin{array}{c} \text{composite} \\ \text{supply} \end{array} \right] = & \left[\begin{array}{c} \text{intermediate} \\ \text{use} \end{array} \right] + \left[\begin{array}{c} \text{household} \\ \text{consumption} \end{array} \right] + \left[\begin{array}{c} \text{government} \\ \text{consumption} \end{array} \right] \\ & + \left[\begin{array}{c} \text{fixed} \\ \text{investment} \end{array} \right] + \left[\begin{array}{c} \text{stock} \\ \text{change} \end{array} \right] + \left[\begin{array}{c} \text{trade} \\ \text{input use} \end{array} \right] \end{aligned} $	$c \in C$	Composite commodity markets
46	$ \begin{aligned} \sum_{c \in CM} pwm_c \cdot QM_c + \sum_{f \in F} \text{trnsfr}_{\text{row } f} = & \sum_{c \in CE} pwe_c \cdot QE_c + \sum_{i \in \text{INSD}} \text{trnsfr}_{i \text{ row}} + \overline{FSAV} \\ \left[\begin{array}{c} \text{import} \\ \text{spending} \end{array} \right] + \left[\begin{array}{c} \text{factor} \\ \text{transfers} \\ \text{to RoW} \end{array} \right] = & \left[\begin{array}{c} \text{export} \\ \text{revenue} \end{array} \right] + \left[\begin{array}{c} \text{institutional} \\ \text{transfers} \\ \text{from RoW} \end{array} \right] + \left[\begin{array}{c} \text{foreign} \\ \text{savings} \end{array} \right] \end{aligned} $		Current account balance for rest of world (RoW) (in foreign currency)
47	$ \begin{aligned} YG = & EG + GSAV \\ \left[\begin{array}{c} \text{government} \\ \text{revenue} \end{array} \right] = & \left[\begin{array}{c} \text{government} \\ \text{expenditures} \end{array} \right] + \left[\begin{array}{c} \text{government} \\ \text{savings} \end{array} \right] \end{aligned} $		Government balance

Table A.1—Continued

#	Equation	Domain	Description
System Constraint Block			
48	$TINS_i = \overline{tins}_i \cdot \left(1 + \overline{TINSADJ} \cdot \overline{tins01}_i\right) + \overline{DTINS} \cdot \overline{tins01}_i$ $\begin{bmatrix} \text{direct tax} \\ \text{rate for} \\ \text{institution } i \end{bmatrix} = \begin{bmatrix} \text{base rate adjusted} \\ \text{for scaling for} \\ \text{selected institutions} \end{bmatrix} + \begin{bmatrix} \text{point change} \\ \text{for selected} \\ \text{institutions} \end{bmatrix}$	$i \in INSDNG$	Direct institutional tax rates
49	$MPS_i = \overline{mps}_i \cdot \left(1 + \overline{MPSADJ} \cdot \overline{mps01}_i\right) + \overline{DMPS} \cdot \overline{mps01}_i$ $\begin{bmatrix} \text{savings} \\ \text{rate for} \\ \text{institution } i \end{bmatrix} = \begin{bmatrix} \text{base rate adjusted} \\ \text{for scaling for} \\ \text{selected institutions} \end{bmatrix} + \begin{bmatrix} \text{point change} \\ \text{for selected} \\ \text{institutions} \end{bmatrix}$	$i \in INSDNG$	Institutional savings rates
50	$\sum_{i \in INSDNG} MPS_i \cdot (1 - TINS_i) \cdot YI_i + GSAV + EXR \cdot \overline{FSAV} =$ $\sum_{c \in C} PQ_c \cdot QINV_c + \sum_{c \in C} PQ_c \cdot qdst_c$ $\begin{bmatrix} \text{non-govern-} \\ \text{ment savings} \end{bmatrix} + \begin{bmatrix} \text{government} \\ \text{savings} \end{bmatrix} + \begin{bmatrix} \text{foreign} \\ \text{savings} \end{bmatrix} =$ $\begin{bmatrix} \text{fixed} \\ \text{investment} \end{bmatrix} + \begin{bmatrix} \text{stock} \\ \text{change} \end{bmatrix}$		Savings-investment balance
51	$TABS = \sum_{h \in H} \sum_{c \in C} PQ_c \cdot QH_{ch} + \sum_{a \in A} \sum_{c \in C} \sum_{h \in H} PXAC_{ac} \cdot QHA_{ach}$ $+ \sum_{c \in C} PQ_c \cdot QG_c + \sum_{c \in C} PQ_c \cdot QINV_c + \sum_{c \in C} PQ_c \cdot qdst_c$ $\begin{bmatrix} \text{total} \\ \text{absorption} \end{bmatrix} = \begin{bmatrix} \text{household} \\ \text{market} \\ \text{consumption} \end{bmatrix} + \begin{bmatrix} \text{household} \\ \text{home} \\ \text{consumption} \end{bmatrix}$ $+ \begin{bmatrix} \text{government} \\ \text{consumption} \end{bmatrix} + \begin{bmatrix} \text{fixed} \\ \text{investment} \end{bmatrix} + \begin{bmatrix} \text{stock} \\ \text{change} \end{bmatrix}$		Total absorption
52	$INVSHR \cdot TABS = \sum_{c \in C} PQ_c \cdot QINV_c + \sum_{c \in C} PQ_c \cdot qdst_c$ $\begin{bmatrix} \text{investment-} \\ \text{absorption} \\ \text{ratio} \end{bmatrix} \cdot \begin{bmatrix} \text{total} \\ \text{absorption} \end{bmatrix} = \begin{bmatrix} \text{fixed} \\ \text{investment} \end{bmatrix} + \begin{bmatrix} \text{stock} \\ \text{change} \end{bmatrix}$		Ratio of investment to absorption
53	$GOVSHR \cdot TABS = \sum_{c \in C} PQ_c \cdot QG_c$ $\begin{bmatrix} \text{government} \\ \text{consumption-} \\ \text{absorption} \\ \text{ratio} \end{bmatrix} \cdot \begin{bmatrix} \text{total} \\ \text{absorption} \end{bmatrix} = \begin{bmatrix} \text{government} \\ \text{consumption} \end{bmatrix}$		Ratio of government consumption to absorption

Table A.1—Continued

#	Equation	Domain	Description
System Constraint Block			
54	$WFKAV_{f,t}^a = \sum_a \left[\left(\frac{QF_{f,a,t}}{\sum_{a'} QF_{f,a',t}} \right) \cdot WF_{f,t} \cdot WFDIST_{f,a,t} \right]$ $\left[\begin{array}{c} \text{average capital} \\ \text{rental rate} \end{array} \right] = \left[\begin{array}{c} \text{weighted sum of sectors'} \\ \text{capital rental rates} \end{array} \right]$		Average economywide rental rate of capital
55	$INVSHR1_{f,a,t}^a = \left(\frac{QF_{f,a,t}}{\sum_{a'} QF_{f,a',t}} \right) \cdot \left(\beta^a \cdot \left(\frac{WF_{f,t} \cdot WFDIST_{f,a,t}}{WFKAV_{f,t}^a} - 1 \right) + 1 \right)$ $\left[\begin{array}{c} \text{share of} \\ \text{new capital} \end{array} \right] = \left[\begin{array}{c} \text{share of} \\ \text{existing capital} \end{array} \right] \cdot \left[\begin{array}{c} \text{capital rental} \\ \text{rate ratio} \end{array} \right]$		Sector's share of the new capital investment
56	$DKAPS_{f,a,t}^a = INVSHR1_{f,a,t}^a \cdot \left(\frac{\sum_c PQ_{c,t} \cdot QINV_{c,t}}{PK_{f,t}} \right)$ $\left[\begin{array}{c} \text{quantity of new} \\ \text{capital by sector} \end{array} \right] = \left[\begin{array}{c} \text{share of} \\ \text{new capital} \end{array} \right] \cdot \left[\begin{array}{c} \text{total quantity of} \\ \text{new capital} \end{array} \right]$		Allocate gross fixed capital formation
57	$PK_{f,t} = \sum_c PQ_{c,t} \cdot \frac{QINV_{c,t}}{\sum_{c'} QINV_{c',t}}$ $\left[\begin{array}{c} \text{unit price} \\ \text{of capital} \end{array} \right] = \left[\begin{array}{c} \text{weighted market price} \\ \text{of investment commodities} \end{array} \right]$		Price of capital
58	$QF_{f,a,t+1} = QF_{f,a,t} \cdot \left(1 + \frac{DKAPS_{f,a,t}^a}{QF_{f,a,t}} - deprete_f \right)$ $\left[\begin{array}{c} \text{average capital} \\ \text{rental rate} \end{array} \right] = \left[\begin{array}{c} \text{weighted sum of sectors'} \\ \text{capital rental rates} \end{array} \right]$		Updating quantity of capital

Source: Authors adaptation of Lofgren et al (2001).

APPENDIX B: SUPPLEMENTARY TABLES

Table B.1—Micro SAM accounts

Category	Account		Description
Activities/commodities (continued)	aagric	cagric	Agricultural products
	aagex	cagex	Agricultural products exports
	acoff	ccoff	Coffee
	alvstk	clvstk	Livestock
	apfood	cpfood	Agro industry
	ahila	chila	Weave
		chilam	Weave imports
	atxtl	ctxtl	Textiles
	almfg	clmfg	Light manufacturing
	achem	cchem	Chemicals
	ahmfg	chmfg	Heavy manufacturing
	autility	cutility	Utility (water, energy)
	aconst	cconst	Construction
	ascom	cscom	Commerce
	astrncom	cstrncom	Transportation
	asexp	csexp	Hotels and restaurants
	asothr	csothr	Others
	asgov	csgov	Government
Transportation costs	trt		Transportation costs
Trade costs	trc		Trade costs
Factors	flabf-rusk		rural formal labor skilled
	flabf-runs		rural formal labor unskilled
	flabc-ursk		Urban informal labor skilled
	flabc-urns		urban informal labor unskilled
	flabc-rusk		rural informal labor skilled
	flabc-runs		rural informal labor unskilled
	Phycap		Physical capital
	Fincap		Financial capital / working capital
	Fibr-ursk		Urban skilled labor
	Fibr-urns		Urban unskilled labor
Enterprises	ent		Enterprises
Households	hur-sk		urban household skilled
	hur-ns		urban household unskilled
	hru-sk		rural household skilled
	hru-ns		rural household unskilled
Government	gov		Government
Taxes	dtax		Direct taxes
	atax		Activity tax
	mtax		Import tariffs
	itax		Production tax
	iva		Value-added tax
	subs		Subsidies
Change in stocks	dstk		Change in stocks
Savings and investment	s-i		Savings and investment
Rest of world	row		Rest of world

Source: Survey data.

Table B.2—Summary of closures

		Summary of selected macroeconomic closures									
		base*	sim1	sim2	sim3	sim4	sim5	sim6	sim7	sim8	sim9
Numeraire	NUMERAIRE	1	1	1	1	1	1	1	1	1	1
Savings-investment	SICLOS	4	4	4	4	4	4	4	4	4	4
Current account	GOVCLOS	4	4	4	4	4	4	4	4	4	4
Government account	ROWCLOS	1	1	1	1	1	1	1	1	1	1
	GOVYG	1	1	1	1	1	1	1	1	1	1
		Summary of selected factor closures									
		base*	sim1	sim2	sim3	sim4	sim5	sim6	sim7	sim8	sim9
	flabf-rusk	1	1	1	1	1	1	1	1	1	1
	flabf-runs	1	1	1	1	1	1	1	1	1	1
	flabf-ursk	1	1	1	1	1	1	1	1	1	1
	flabf-urns	1	1	1	1	1	1	1	1	1	1
	flabf-rusk	1	1	1	1	1	1	1	1	1	1
	flabf-runs	1	1	1	1	1	1	1	1	1	1
	Phycap	2	2	2	2	2	2	2	2	2	2
	Fincap	2	2	2	2	2	2	1	2	2	1
	Flbr-ursk	1	1	1	1	1	1	1	2	1	1
	Flbr-urns	2	2	2	2	2	2	2	2	2	2

Source: Survey data.

Note: For the increase in the minimum wage simulation (sim7) the base closure for the urban skilled factor will be 2. See Table B.3 for simulations.

Numeraire

- 1 CPI is numeraire (and fixed)—DPI is flexible
- 2 DPI is numeraire (and fixed)—CPI is flexible
- 3 EXR is numeraire

Savings-investment

- 1 Investment-driven savings—uniform mps rate point change for selected institutions
- 2 Investment-driven savings—scaled mps for selected institutions
- 3 Investment is savings-driven

Factor closure options (selected on simulation sheets)

- 1 government savings are flexible, direct tax rate is fixed
- 2 government savings are fixed, uniform direct tax rate point change for selected institutions
- 3 government savings are fixed EXR is numeraire

4 Investment is fixed absolute share – uniform mps rate point change – balanced closure

5 Investment is fixed abs y mps – balanced closure

Current account

- 1 exchange rate is flexible, foreign savings are fixed
- 2 exchange rate is fixed, foreign savings are flexible

Government account

- 1 government savings are flexible, direct tax rate is fixed
- 2 government savings are fixed, uniform direct tax rate point change for selected institutions
- 3 government savings are fixed EXR is numeraire

Full employment, flew age for factor f
fixed real wage, flew employment, factor f

fixed sectoral employment of factor f, WFDISR adjusts

Table B.3—Simulations

sim1	FSAV increase 50%
sim2	FSAV increase 50%
sim3	FSAV increase 50%
sim4	FSAV increase 50%
sim5	FSAV increase 50%
sim6	Financial capital (working capital) decrease 20%
sim7	Nominal wages of urban nonskilled increase 50%
sim8	Remittances (transfers from ROW) decrease 50%
sim9	Financial capital (working capital) decrease 10%

Source: Survey data.

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