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IFPRI Discussion Paper 01252

March 2013

A Regional Computable General Equilibrium Model for Honduras

Modeling Exogenous Shocks and Policy Alternatives

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IFPRI gratefully acknowledges the generous unrestricted funding from Australia, Canada, China, Denmark, Finland, France, Germany, India, Ireland, Italy, Japan, the Netherlands, Norway, the Philippines, South Africa, Sweden, Switzerland, the United Kingdom, the United States, and the World Bank.

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ABSTRACT

In this paper we develop a dynamic regional computable general equilibrium (CGE) model for Honduras that incorporates regional disaggregated sectors for agriculture. We undertook this research to address two pressing policy concerns in Honduras. First, what growth strategy should the country follow, given its severe balance of payments constraint and dependence on remittances and the price of oil? Second, what would be the impact on growth of investments in projects to increase agricultural productivity, given the importance of agriculture to the rural poor and to the Honduran economy? Our model extends previous modeling work on Honduras in several ways. First, it develops an updated regional social accounting matrix for 2008, coupled with an updated CGE model. Second, the CGE is a recursive, dynamic model that incorporates unemployment in the short run. 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 external shocks. Third, the model is regional, permitting us to examine the impact of sectoral development policies, particularly those focused on the agricultural sector.

Keywords: general equilibrium models, Honduras, economic development, regional CGE models, macro shocks

1. INTRODUCTION

In this paper we develop a recursive, dynamic regional computable general equilibrium (CGE) model for Honduras that incorporates regional disaggregated sectors for agriculture. The model is designed to be useful as a development tool for determining the effects of regional investments intended to reduce regional poverty, particularly in the North and West of the country, and also to explore policy options to deal with a number of macro and balance-of-payments issues. Our model extends previous modeling work on Honduras in several ways. First, it develops an updated regional social accounting matrix (SAM) for 2008, coupled with an updated CGE model. Second, the CGE is a recursive, dynamic model that incorporates unemployment in the short run. We specify a fixed minimum wage and an informal sector, and we use a recursive, dynamic framework to solve for the short-run adjustment process that occurs as the economy responds to shocks. We also use the dynamic model to address a number of growth questions. Finally, the model is regional, permitting us to examine the impact of sectoral development policies, particularly those focused on agriculture.

In Section 2 of the paper, we give a brief overview of the macro performance of the country, including some evidence bearing on the factors that can help explain the growth slowdown. In Section 3 we present a short description of the regional CGE model and its key characteristics. In Section 4 we look at the effects of investment on gross domestic product (GDP) and then show the sensitivity of the economy to balance-of-payments shocks, including the impact of several macro shocks that have hit the economy in recent years: first, variations in the inflow of remittances and direct foreign investment; second, a rise in the price of oil and third a fall in the price of textiles, a key export sector for Honduras. In this section we also simulate several alternative investment strategies aimed either at expanding exports or at improving the productivity of agriculture, particularly in the poorer areas of the country. Section 5 concludes.

2. HONDURAS'S MACROECONOMIC ENVIRONMENT

The years since 1980 have not been easy for Honduras. Between 1960 and 1980 its growth averaged about 4.6 percent per year. Subsequently the country, like most of the rest of Central America, went through a long recession and a protracted period of political conflict. In the 1990s Honduras embraced the structural reforms of the Washington Consensus. Tariffs were dramatically reduced, and there were also reforms in tax policy and liberalization of the capital account. 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 both exports and GDP was negative over the entire 20-year period after 1980. Partly that may be explained by Hurricane Mitch, which hit Honduras with tremendous force in October 1998. But whatever the cause, the slowdown was sufficiently severe that it took 26 years for the country to reach the per capita income level it had in 1979.

After the millennium the economy began a recovery that culminated in a period of rapid growth between 2003 and 2008, actually higher than the average growth rate in the pre-1980 period. But then the political crisis of 2009 pushed the economy back into a recession from which it is only now beginning to recover. What we have then is a small economy buffeted by shocks economic, political, and meteorological, all of which have caused the country to fall further and further behind the rest of the countries in the region.

Honduras is a very open economy in which the availability of foreign exchange to finance the importation of fuel, capital, and consumer goods not produced locally is crucial. If the country cannot borrow, and if it does not have sufficient foreign exchange to fund the purchases that would be made at full employment, then either the economy has to contract by enough to live with whatever level of foreign exchange is available or it has to devalue by enough to force residents to substitute away from foreign imports and to induce an expansion of exports. An increasingly important factor in the supply of foreign exchange is remittances. Between 1997 and 2009 remittances grew from US\$160 million¹ to \$3.6 billion and now constitute more than 50 percent of current account receipts. They are by far the fastest growing source of foreign exchange, and appear to be the main reason for the five-year boom period after 2003. Unfortunately for Honduras, the growth rate of remittances has slowed down dramatically since 2008. Going forward the Central Bank does not expect remittance growth to be more than 3 percent per year. That means that if Honduras is going to get back to a 4 to 5 percent GDP growth rate, it will need an increase in the growth rate of either exports or foreign borrowing to take over the role remittances played in the 2003–2008 period. A key question is going to be how to expand the capacity to import in the future.

In thinking about the changes in the growth rate of the Honduran economy and its causes, one is struck by the differences in the composition of output over time (see Table 2-1). The most obvious and important feature 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 over 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 being so great a surplus in the trade balance resulted. In the 1990s Honduras embraced the Washington Consensus. Tariffs were dramatically reduced, and there were as well reforms in tax policy and liberalization of the capital account. The results were 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 over the entire 20-year period after 1980. Essentially consumption stagnated while increased investment led to rising imports financed by foreign borrowing and remittances.

¹ All dollars are U.S. dollars.

The postmillennium period was completely different from the prior period of rapid growth before 1980. Now, thanks to remittances and foreign borrowing, consumption and imports were the leading sectors. The economy did not seem to need a vibrant export sector. Although exports grew faster than GDP after 2000, even in 2005 the export share was still 7 percentage points less than the average of the pre-1980 period.² What is also striking is the rise in consumption both private and public. This reflects the increasing importance of remittances. The share of public plus private consumption rose by between 6 and 11 percentage points depending on whether one uses the original or the revised GDP data, with the increase paid for by a large increase in imports and a reduction in the growth rate of capital formation.

The changes we are describing here have taken place alongside significant demographic changes both in the overall rate of growth and the degree of urbanization. In 1960 only 30 percent of the population was urban, the lowest rate in Central America, and total population was growing at 3 percent per year. By 1980 38 percent of the population was urban and the growth rate had fallen to 2.7 percent per year. After the millennium the population growth rate fell to 2 percent and 45 percent of the population lived in cities and towns.³ Both of these trends will have profound implications. Remittances are likely to grow more slowly in the future because the supply of potential migrants will be smaller. At the same time the shift of the population toward the urban sectors will increase the need to create employment opportunities for rural–urban migrants.

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

	Average growth rates			Revised	
	1960-80	1981-90	1991-2000	2001-05	2001-08
Government	2.78	3.00	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	-0.70	0.42	2.85	6.09
GDP	1.86	-0.68	0.49	1.23	5.03

	Sectoral Shares			Revised	
	1960-80	1981-90	1991-2000	2001-05	2001-08
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: Morley and Piñeiro (2008).

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. Since new machines are more productive than old ones, investment should raise total productivity as well. That being the case, one would expect that increasing the investment share should lead to faster growth rates. Indeed economies that do not save and invest generally do not grow rapidly. But the relationship between investment and growth in Honduras is ambiguous. The positive relationship between investment and growth is confirmed by the pre-1980

² Here we look at the 2001–2005 columns because the final column is not comparable because of a change in the base year in the national accounts.

³ Source: World Bank, World Development Indicators.

period, but not afterward. Investment fell in the 1980s, along with GDP, but then it recovered quite strongly after 1990. In fact 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 it didn't. Generally speaking it does not look like investment leads to growth, which is consistent with the notion that at least in the short run Honduras is more constrained by the capacity to import than by shortages of physical capital.

As we have seen, Honduras has had a very low growth rate of per capita income since 1980. Although the recent revision of the national accounts may raise 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, above 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 it was that slowed the growth rate after 1980, it was not a lack of capital. That implies that either the growth process is now far more capital intensive than it used to be, or Honduras is investing unwisely, or there is a demand-side problem that has caused the economy to produce below its potential capacity level. To look more closely at this, we use the reported investment series to build up an estimate of the capital stock. To do this we assume an initial capital output ratio of 3.0 in 1960 and a depreciation rate of 5 percent per year. We then build up an estimate of the capital stock based on those starting values. Regardless of what initial values we choose, 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 from 1960 on 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 (TFP) 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. When we do that, we find that between 1960 and 1980 when the economy grew at over 5 percent, the implied growth rate of productivity was 1.5 percent per year. After 1980, if we apply the same methodology, we find that productivity growth falls to less than zero. Even with zero productivity growth after 1980, capacity output exceeds actual output all the way to 2005, although after 2000 the gap narrows. That means that the weighted average growth rate of the factors of production is just about equal to the growth rate of the economy, and there is no increase in average productivity at all, in spite of the large investment effort.

In Figure 2.1 we plot real and potential GDP since 1960. Potential and actual GDP are assumed to be equal in 1960. From there to 1980, we estimate the growth rate of potential GDP as the weighted average growth rate of capital and labor plus the TFP growth rate needed to make the potential and actual GDP series equal in 1980. That gives a growth rate of productivity of 1.5 percent as mentioned earlier. After 1980 we use the same procedure, solving for the productivity growth rate that makes actual and potential GDP equal in 2005. That productivity growth turns out to be negative. The same pattern is found by Loayza, Fajnzilber, and Calderon (2005).⁴ We set TFP growth at zero in calculating capacity output growth in Figure 2.1.

⁴ Loayza, Fajnzilber, and Calderon made a comparable estimate of 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 1980s, and -0.89 percent in the 1990s.

Figure 2.1—Potential and actual GDP, 1960–2005

Source: World Development Indicators.

As the reader can see, up to 1980 capacity and actual output grew more or less in tandem. More to the point here, good growth rates were achieved with a relatively low rate of investment in the economy, thanks to significant increases in TFP. 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 subsequently recovered, it never again reached its estimated potential output level even though that potential output level was calculated with zero productivity growth. Before 1980 Honduras got 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, and getting a lot less growth for their efforts.

As if those development challenges were not enough, Honduras is also the poorest country in all of Latin America. More than three-fourths of its population was poor in 2002 according to the poverty lines of the United Nations Economic Commission for Latin America and the Caribbean (ECLAC 2002), and although that proportion fell during the growth spurt of the next six years, growth was far less favorable to the poor in Honduras than it was in other countries of the region. Over the period 2002–2009 GDP per capita rose by about 2.8 percent per year. Over that same period poverty fell by about 2.2 percent per year. In other words the poverty elasticity of growth in Honduras was about -0.8. Other countries with more pro-poor growth strategies have managed to reduce poverty by almost twice the growth rate in per capita income. One of the reasons growth in Honduras has not been more favorable to the poor is that whereas three-fourths of poverty is rural, more than 90 percent of growth has taken place in the urban economy.⁵ The regional model we have built will be useful in examining various investment strategies designed to increase agricultural productivity and income.

⁵ Central Bank of Honduras.

3. THE MODEL

We built a regional SAM for 2008, which extended previous work in three directions. First, we regionalized the SAM, using information from a recent agricultural census. Second, we put land into the matrix, which permitted us to tie production in agriculture to each of the seven regions in the SAM. Third, we regionalized household income in order to show the regional impact of each of the external shocks or increases in productivity that we simulated. The SAM is disaggregated into the 49 sectors shown in Table A.1 in the appendix and into the seven regions—the South, Center-West, North, Atlantic, Northeast, Center-East, and West (see Figure 3.1). We report data separately for labor divided into skilled and unskilled, formal and informal; for land by region; and for capital. Table 3.1 displays the macro SAM that results from aggregating all the columns and rows of the full regionalized SAM.⁶

It is important to note that in the regional SAM for all the agricultural sectors, there are regional activities producing the same commodity. These agricultural activities are disaggregated by the seven regions and then combined into one “national” commodity.

⁶ The full SAM can be requested by email from v.pineiro@cgiar.org.

Figure 3.1—Agricultural regions of Honduras

Source: Author's.

Notes: Region 1—Sur (South); region 2—Centro Occidental (Center-West); region 3—Norte (North); region 4—Atlántico (Atlantic); region 5—Nor-Oriental (Northeast); region 6—Centro Oriental (Center-East); region 7—Occidental (West).

Table 3.1—2008 macro SAM for Honduras, in billions of lempiras

	Activities	Commodities	Transport costs	Labor	Capital	Land	Households	Government	Firm	Import tax	Indirect tax	Direct tax	Subsidies	Change stocks	Saving-investment	Rest of world
Activities		459.00														
Commodities	211.04		56.00				210.98	36.90						6.20	88.57	138.54
Transport costs		56.00														
Labor	151.57															
Capital	92.81															
Land	3.58															
Households				151.57		3.58		5.97	50.10							38.69
Firm					92.81											
Government										3.00	21.80	15.77	-3.06			
Import tax		3.00														
Indirect tax		21.80														
Direct tax							5.66		10.10							
Subsidies		-3.06														
Change stocks															6.20	
Saving-inves.							28.87	-7.20	32.61							13.20
Rest world		211.50					13.16	1.84								

Source: Authors' worksheets.

Components of the Model

The regional CGE model used in this part of the research is based on the standard model used by IFPRI (see Lofgren, Harris, and Robinson 2001), which follows the neoclassical–structuralist tradition originally presented by Dervis, Melo, and Robinson (1982), with some modifications needed to capture the multimarket aspect of the agricultural sector included in this work. The advantage of the regionalized model is that it links decisions made at the national level with outcomes on poverty, employment, and production across regions. That permits us to examine policies intended to improve the regional distribution of activities and income in a consistent general equilibrium fashion, which incorporates national macro fiscal and monetary constraints. This advance is made possible by the availability of regional information from the agricultural census.

The CGE model has three components. The first shows the payments that are registered in the SAM, following the same disaggregation of factors, activities, commodities, and institutions shown in the matrix. The second is the equations that represent the behavior of the different institutions present. The third is the constraints that have to be satisfied by the whole system covering the factor and goods markets, the balances for savings and investment, the government, and the current account of the rest of the world.

Each producer maximizes profits under constant returns on scale and perfect competition. There are three factors of production: labor (differentiated by skill and region), land (differentiated by region), and capital. Production is related to factor inputs in a constant elasticity of substitution (CES) production function, which allows producers to substitute these three inputs until they reach the point where the marginal revenue of each factor equals the factor price (wage or rent). The second choice producers make is the amount of intermediate inputs they will use. This specification is made assuming fixed shares that specify the appropriate amount of intermediate inputs per unit of output and of labor or capital (value-added). Finally, output prices depend on the value-added (cost of labor, land, and capital), the intermediate inputs, and any relevant taxes and subsidies.

Figure 3.2 shows the flow of a single commodity from producers to final demand. First, there is the combination of goods from all producers into an aggregate commodity output. This is achieved using a CES product demand system with the intention of leaving the option to the buyers as to how much to buy of each individual product (maximizing their consumption). The aggregate output is sold domestically or internationally. The producers' allocation between domestic sales and exports is specified via a constant elasticity of transformation (CET) function, assuming imperfect transformability between exports and domestic sales. The producers will sell their products to the market with the highest profitability. The domestic price is the international price times the exchange rate plus any possible export taxes or export subsidies. The domestic good is combined with imports to produce the composite commodity. For this the Armington (1969) specification is used, which means that the domestically produced and imported goods are imperfect substitutes.

Figure 3.2—Flow of goods from producers to the national composite commodity

Source: Authors.

In this model there are three institutions—households, government, and the rest of the world—that do three things—produce, consume, and accumulate capital. Households save a constant fraction of their disposable income and buy consumption goods with the remainder. Household income is the sum of salaries, profits, and government and rest-of-the-world transfers. Household consumption of goods and services is determined by a linear expenditure system (LES). Government receives taxes, consumes goods and services, and makes transfers to households. The capital account collects the savings from the households, government, and rest of the world, and it buys capital goods (investment).

As was mentioned in the previous section, our CGE model contains detailed information on the demand and supply of 49 economic sectors and commodities, with 112 correspondent activities (including 10 agricultural activities further disaggregated by seven regions).

Labor is disaggregated by qualification (skilled and unskilled), sector (formal and informal), and region (rural and urban). Workers within each region can migrate between sectors and across regions according to labor demand, but total labor supply grows at a constant rate of 2 percent per year. Land is disaggregated by region and is region-specific. This is one of the elements that drives the regional production results. The other feature of our treatment of labor is the supply curve for unskilled labor in the formal sector. For this factor we assume a fixed minimum wage and assume that there is an excess supply of unskilled labor, at least over the range of solutions that we analyze. Effectively that means that the supply curve of labor is flat, or in other words that the wage is fixed and employment is endogenous. But since the entire model is a real model, or is expressed in terms of the Consumer Price Index numeraire, that means that the wage of unskilled labor is fixed in real terms.

Household income and expenditure patterns vary across regions.⁷ This is important, since the incomes earned by workers in different sectors will benefit different households, depending on their location and factor endowments. These representative households receive factor incomes and per capita transfers from the national government. Households save some of their income and use their remaining income to consume goods under an LES of demand. All commodity markets are national, so prices in all commodity markets differ only in the transportation costs.

⁷ Households are disaggregated in four regions: Tegucigalpa, San Pedro de Sula, other urban, and rural. This disaggregation is not the same followed for the production side. In this case we have the two major cities in the country, other urban areas, and the rural households.

The Dynamic Version of the Model

We developed a recursive, dynamic CGE model for this study. The model is solved in two stages. The first stage aims to find a solution for a one-year equilibrium using a static CGE model. In the second stage, a model between periods is used to create the dynamic linkages that update the variables that drive growth. The intertemporal equations provide values for all exogenous variables needed for the next period by the static CGE model, which is then solved for a new equilibrium. The model is solved forward in a dynamically recursive fashion, with each static solution depending only on current and past variables. The model does not incorporate future expectations; instead, the behavior of its agents is based on adaptive expectations, since the model is solved one period at a time. The variables and parameters used as linkages between periods are the aggregate capital stock (which is updated endogenously, given previous investment and depreciation), the population, the domestic labor force, 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).⁸

The allocation of new capital across sectors is done 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 average profit rates will get higher shares of the available investment, and those with lower rates will get lower shares. Over time, sector profit rates should converge.

We assume that the labor force grows by 2 percent per year, and we add those additional workers to the supply of skilled labor or to the surplus of unskilled labor. The growth of capital is determined by the amount of investment, net of depreciation. We also update the rate of disembodied technical change by 1 percent per year, or by a different amount when we do simulated technical change experiments. We can then vary the exogenous rates of saving, taxes, and each of the other policy parameters in the model over time to determine the effects of such changes on the rate of growth of the economy.

As mentioned before, growth in the labor force by skill class is exogenous and related to population growth, which in turn is based on population growth projections taken from national data. For unskilled labor, the total size of the available labor force does not affect the solution in any period because in the simulations we assume that there is an excess or a backlog of unemployed labor, which is not absorbed before the end of our simulations.

The simulations with the model for Honduras give us the growth path for the economy for 10 years under a number of different policy alternatives. These paths are compared with the one obtained using the base simulation (in which no exogenous policy changes are included) to see the impacts of implementing various different TFP scenarios combined with new investment.

To summarize, the recursive, dynamic model is

1. updated by exogenous trends (labor force growth, productivity changes, capital stock growth, and population growth);
2. updated by economic behavior (distribution of investment by sector, distribution of labor force by sector and category); and
3. updated by implemented policies (changes in remittances, in international prices, and in TFP accompanied with investment).

⁸ The dynamic model used in this research follows the models developed by IFPRI (Lofgren, Harris, and Robinson 2001; Thurlow 2004).

4. THE MACRO SIMULATIONS

In the first simulation we show using the comparative static CGE model the extreme dependence of the Honduran economy on variations in foreign saving. In the base run foreign saving is more than 16 percent of GDP and 27 percent of exports. In the first comparative static simulation we reduced the inflow of foreign saving from 15 percent in 5 percent increments down to 5 percent of GDP (see Table 4.1). Cutting the supply of foreign exchange in this way forces the economy to produce more exports while importing less. When foreign saving inflows are reduced to 5 percent of GDP, total absorption falls by more than 9 percent while exports rise by 8.8 percent and imports fall by 6.8 percent, all induced by a real devaluation of more than 4 percent, part of which comes from a nominal devaluation and part from a decline in domestic prices. Overall, GDP falls by about 0.9 percent.

Table 4.1—Effect of reductions in foreign saving on macro variables

		15%	10%	5%
		Base*	% change from base	
Real	Absorption	349.11	-4.79	-9.17
	Consumption	215.57	-5.52	-10.54
	Investment	89.28	-5.43	-10.42
	Stocks	6.17		
	Government	38.09	0.00	0.00
	Exports	154.93	4.52	8.79
	Imports	-231.90	-3.64	-6.84
	GDP at market prices	272.14	-0.48	-0.93
	Indirect taxes	22.36	-3.03	-5.75
	GDP at factor cost	249.78	-0.23	-0.43
	Foreign saving	42.66	-36.00	-0.69
	Fsav/GDP	0.15	0.10	0.05

Source: Authors' worksheets.

Note: * Base values are in real billions of lempiras of 2008.

Changes in factor market wages and employment are mixed. Consider first the effect of foreign saving on unskilled labor (see Table 4.2). Since we are assuming a fixed minimum wage for unskilled labor in the urban formal sector and a fixed subsistence wage in the informal sector, the adjustment in the unskilled labor market is mainly in employment and unemployment. One would expect that a contraction of foreign saving would reduce labor demand, and it does for skilled labor and urban informal sector labor. But the employment of unskilled labor in the formal sector increases slightly. That is because of the rise in production and exports from the maquila⁹ sector, which is a big employer of minimum wage labor. In the maquila sector, which employs fully one-fourth of the minimum wage formal sector labor in the country, employment rises by 14 percent. Overall employment and output rise in most of the traded goods sectors and fall in the services sectors or more generally in the nontraded goods sectors, all of which contract to make room for an expansion in exports and to a lesser extent import substitutes.

⁹ Maquila operations involve the importation of foreign merchandise into the country on a temporary basis, where it is assembled, or manufactured and then exported back to the rest of the world.

Table 4.2—Changes in employment and wages

	Base	Down 5%	Foreign Saving Down 10%
Quantity demanded of			
Urban skilled labor	66.65	66.12	65.67
Urban unskilled labor (formal)	31.33	31.45	31.60
Urban informal labor	24.64	24.39	24.16
Rural skilled labor	12.21	12.21	12.21
Rural unskilled labor	16.67	16.83	17.00
% change in real wage			
Urban skilled		-0.397	-0.741
Urban unskilled (formal)		0.000	0.000
Urban informal		0.000	0.000
Rural skilled		-0.028	-0.025
Rural unskilled		0.000	0.000
Capital		-1.987	-3.641
Land region 1		1.668	3.357
Land region2		0.718	1.408
Land region 3		0.119	0.304
Land region 4		1.740	3.491
Land region 5		-0.267	-0.475
Land region 6		0.598	1.209
Land region 7		1.222	2.383

Source: Authors' worksheets.

Whereas the reduction of foreign saving inflows is contractionary for the economy and bad for capital and skilled labor, it is good for the producers of exports. Employment of rural-sector unskilled labor rises and in all but one of the regions of the country there is an increase in the return to land.

There are significant differences in how the comparative static and the dynamic simulations represent the reaction of the economy to a foreign saving shock. Partly that is because the comparative static analysis ignores the feedback of investment on the capital stock, and partly because of the time path of the components of the economy as they react to the shock. In the comparative static experiment, investment falls by 10 percent. But that is a pure demand-side effect that ignores any negative effect on the capital stock or productivity in the economy. But obviously, if we reduce the rate of capital formation, over time this will have an effect on the amount of capital in the economy. We built a dynamic version of the model to incorporate this sort of feedback effect. As explained in the previous section, in the dynamic model we assume that the labor force grows by 2 percent per year, and that there is a 1 percent per year growth in TFP. The investment rate is set at the observed initial level of 32 percent of GDP. With those parameters and with foreign saving equal to 15 percent of base-level GDP, the long-run growth rate of the economy is 4.7 percent with investment growing at a slightly lower rate because we fixed foreign saving as a constant dollar amount rather than a fraction of GDP or total exports.

In our first dynamic simulation, we cut the inflow of foreign saving from 15 percent of base-period GDP to 10 percent and 5 percent, as in the comparative static simulation described earlier. We then hold foreign saving at those lower levels for a full 10-year simulation. We then examine the changes in the growth rates of macro and micro variables in response to those changes. In the base run, investment

grows by 4 percent per year (see Table 4.3). That rate falls to 2.7 percent when foreign saving is reduced to 5 percent of base-period GDP. Over time, that lower growth rate of investment has an effect on the growth rate of the capital stock, and through it on the growth rate of all the remaining macro variables. By year 10 in the base run investment has grown by 42 percent over its value in year one. With foreign saving shrinking to 5 percent of GDP in the first year of the run, investment does not reach its initial level until year five, and by year 10 it is 11 percent below its base-run level. This has a somewhat muted effect on the capital stock. In the base run the capital stock grows by 3.8 percent per year. That growth rate falls to 3.2 percent when foreign saving falls to 5 percent of GDP.¹⁰ By year 10 the capital stock in the economy is 9 percent below what it would have been had foreign saving continued at the 15 percent level of the base run. This has an effect on the growth rate of GDP. With foreign saving falling from 15 to 5 percent of the initial GDP, the growth of the economy falls from 4.7 to 4.2 percent. That implies that by year 10 of the simulation GDP in the 5 percent run is 4.2 percent below its year-10 level in the base run and the gap between the output level at the 15 percent and the 5 percent foreign savings run gets steadily wider over time.

Table 4.3—Effect on growth rate of macro variables of variations in foreign saving (in %)

		Base	Foreign saving base level	-5%	-10%
Real	Absorption	349.12	3.77	3.20	2.61
	Consumption	215.57	3.80	3.23	2.64
	Investment	89.28	3.98	3.35	2.69
	Stocks	6.17			
	Government	38.09	3.69	3.17	2.62
	Exports	154.93	5.94	6.09	6.25
	Imports	-231.90	4.25	3.85	3.44
	GDP at market prices	272.14	4.67	4.42	4.17
	Indirect taxes	22.37	4.27	3.85	3.40
	GDP at factor cost	249.78	4.70	4.47	4.23

Source: Authors' worksheets.

The differences between a comparative static and a dynamic approach to analyzing the effects of this shock are more significant than they might appear. In the comparative static run, we found that reducing the inflow of foreign saving reduced GDP by a bit less than 1 percent. The dynamic simulation of the same shock shows a 0.5 percent reduction in the rate of growth of GDP, which seems broadly consistent. However, when one looks more deeply into the results, important differences exist between the comparative static and the dynamic simulations, particularly with respect to foreign trade. According to the comparative static result, when foreign saving falls, the economy reacts by producing more exports and curtailing imports, all resulting from a significant depreciation of the exchange rate. In the dynamic run, the growth rate of exports rises slightly (from 6 to 6.2 percent) over the 10-year simulation period. That is only because of the big short-run increase in exports in the first year of the simulation, when the foreign saving shock occurs. In that year exports jump by 16 percent. But from then on, exports grow more slowly in the 5 percent foreign saving run than they do in the base. Likewise, imports fall sharply in

¹⁰ Note that we have assumed a balanced closure in this simulation. In the balanced closure the shares of consumption, investment, and government consumption are reduced proportionately when there is a negative foreign saving shock. The alternative closure forces investment to offset the entire foreign saving shock. That would quite sharply reduce the amount of capital formation and thus the growth rate of the economy.

the comparative static run. That also occurs in the dynamic simulation, but only in the first year. In that year, imports fall by 2 percent where they would have risen by 4 percent in the base run. From then on in years two through 10, the rate of growth of imports in the two runs is practically identical (around 4.2 percent). The point here is that the comparative static result shows only the short-run adjustment of the economy to a negative foreign exchange shock. In the longer run, the cumulative effects of lower levels of capital formation and lower growth rates in the economy reverse the favorable effect of foreign exchange pressure on the export sector. After year one, exports grow more slowly when foreign saving is 5 percent rather than 15 percent of GDP. To put this another way, in the short run, the economy reacts to a onetime balance-of-payments shock as predicted by the comparative static model. But the dynamic model reminds us that the macro components of the economy return to their previous growth trajectory, but at lower levels. In the long run, the overall rate of growth of the economy is determined by the growth rate of factor inputs and productivity, not the availability of foreign exchange. A onetime balance-of-payments shock reduces the growth rate of the economy if and only if it reduces the rate of capital formation.

How sensitive is the growth rate of the economy to changes in capital formation? To answer that question we changed the saving–investment closure and determined the exogenous growth rate of investment. We set the base-run growth rate of investment at 4 percent, equal to what it was in our balanced closure base run. We then reduced the growth rate of investment by 1 and 2 percentage points—that is, made investment grow at 3 percent and 2 percent per year (see Table 4.4).

Table 4.4—Effect of reducing the growth rate of investment

Investment growth			4%	3%	2%
		Base	Annual rate of growth (in %)		
Real	Absorption	349.11	3.60	3.44	3.28
	Consumption	215.57	4.07	4.22	4.34
	Investment	89.28	3.98	2.98	1.98
	Stocks	6.17			
	Government	38.09			
	Exports	154.93	6.04	5.75	5.47
	Imports	-231.90	4.33	4.11	3.89
	GDP at market prices	272.14	4.45	4.26	4.07
	Indirect taxes	22.36	4.38	4.22	4.07
	GDP at factor cost	249.78	4.46	4.27	4.07

Source: Authors' worksheets.

We found that reducing the rate of growth of investment by 1 percentage point reduced the growth rate of GDP by roughly 0.2 percentage point (the elasticity of the growth rate with respect to the investment rate is about 0.2). That does not sound like too big of an effect, but recall that the effects of the reduction in capital formation are cumulative. By year 10 with investment growing at 2 percent rather than 4 percent, the capital stock is 5 percent smaller and GDP is about 3 percent smaller than it would have been in the base run. The reason GDP growth falls less than the capital stock or investment is that as long as we have full employment and a growing labor force and productivity, reducing the amount of capital formation does not have much effect on the rate of growth of production. If we had linked productivity growth to the investment rate, that conclusion would be reversed. For example, suppose that with investment growing at 2 percent per year instead of 4 percent, the rate of growth of productivity was 0.5 percent per year rather than 1 percent. In that case, the growth rate of GDP falls by a full percentage point and the rate of consumption shrinks from 4.1 to 3.5 percent per year. Maintaining the rate of growth of capital formation is critical to increasing the rate of growth of welfare in Honduras.

Terms-of-Trade Shocks

Not only is Honduras dependent on a significant input of foreign saving to finance necessary imports; it is also extremely sensitive to fluctuations in key import and export prices. We examine several of those here. The first is oil. Since Honduras produces no oil itself, and since oil is both a key final demand commodity and also an intermediate input, any rise in oil price is bound to have a large and widespread effect. And so it does. Here we use the comparative static version of the model to simulate the effect of a onetime increase in the world price of oil of 10 percent through 30 percent. Table 4.5 shows some of the results of the simulation. The simulation confirms the great sensitivity of the entire economy to the price of oil. Raising the price by 30 percent reduces GDP by 12 percent, with investment and consumption falling by even larger amounts. Because oil is a key intermediate input, raising its price drives up domestic prices across the board. That has a big impact on exports in addition to domestic production, and that complicates the adjustment to such negative terms-of-trade shocks. Just because oil makes up a big share of imports does not necessarily imply that the economy would be so sensitive to its price. The reason is because of the difficulty of substituting away from oil, either in the production process or in final demand.

Table 4.5—Effect of terms-of-trade shocks

		Base	Change in oil price of			Change in textile price of		
			10%	20%	30%	-10%	-20%	-30%
Real	Absorption	349.11	-5.19	-9.95	-14.30	-5.14	-8.72	-9.98
	Consumption	215.57	-6.14	-11.72	-16.80	-5.48	-9.15	-10.19
	Investment	89.28	-5.47	-10.59	-15.34	-6.87	-12.01	-14.44
	Stocks	6.17						
	Government	38.09	0.00	0.00	0.00	0.00	0.00	0.00
	Exports	154.93	-5.96	-11.68	-17.13	-14.47	-30.07	-41.93
	Imports	-231.90	-7.14	-13.54	-19.20	-11.37	-20.94	-26.13
	GDP at market prices	272.14	-3.96	-7.88	-11.73	-5.14	-10.46	-14.41
	Indirect taxes	22.36	-5.65	-10.85	-15.62	-7.57	-14.06	-17.74
	GDP at factor cost	249.78	-3.75	-7.39	-10.89	-4.76	-9.52	-12.84

Source: Authors' worksheets.

Honduras's exposure to the risks of oil price fluctuations is fairly obvious and widely recognized. However, because of the concentration of export revenues in a small number of sectors, particularly the textile maquila, the economy also faces risks from price reductions or external competition in its maquila sector. In the 2008 SAM, maquila accounted for 62 percent of total merchandise exports with primary metal making up an additional 11 percent. That makes the economy very dependent on the fortunes of a small number of sectors. To see how important this dependence might be in practice, we simulated a reduction in the export price for textiles of 10 percent through 30 percent, and show some of the results in Table 4.5.

What we found is that a textile price reduction of 30 percent has a bigger negative impact on production than an equal percentage increase in the price of oil. If textile prices fall by 30 percent, GDP falls by more than 14 percent and exports fall by a whopping 42 percent. As it turns out, the falling price of Honduras's chief export has a somewhat larger impact on production and unemployment but a slightly smaller impact on consumption and total absorption than the oil price shock. As we saw, the 30 percent oil price shock cuts total absorption by 14 percent and household consumption by 17 percent, whereas both fall by only 10 percent in the 30 percent price reduction in textiles.

The oil shock has a big negative effect in all factor markets (see Table 4.6). In our model we assume a fixed wage for urban and rural unskilled labor and for the urban informal sector. In those three markets the 30 percent increase in oil prices roughly doubles the unemployment rate. For urban skilled labor, where we assume that the wage is endogenous, we found that a 30 percent oil price shock drives down the real wage by 6 percent. As with the macro variables, the 30 percent textile price shock has a bigger impact on the labor market than does the oil price shock. Lowering textile export prices by 30 percent raises urban formal sector unskilled unemployment from 7 to 14 percent, whereas that increases only to 12.5 percent in response to an oil price shock of equal percentage magnitude.

Table 4.6—Effect of terms-of-trade shocks on real wages and profits

	Oil price increase of			Textile price reduction of			
	10%	20%	30%	-10%	-20%	-30%	
Urban skilled labor	-2.18	-4.26	-6.22	-2.07	-3.68	-4.43	
Urban unskilled (formal)	0.00	0.00		0.00	0.00		
Urban unskilled (informal)	0.00	0.00	0.00	0.00	0.00	0.00	
Rural skilled	-2.85	-5.63	-8.34	-3.76	-7.06	-8.88	
Rural unskilled	0.00	0.00	0.00	0.00	0.00	0.00	
Capital	-10.16	-19.23	-27.27	-9.09	-15.19	-17.32	
Land region 1	-12.00	-22.83	-32.60	11.09	23.94	35.03	
Land region 2	-16.60	-30.96	-43.33	-22.34	-42.77	-55.68	
Land region 3	-13.24	-24.98	-35.31	0.54	2.69	5.95	
Land region 4	-11.85	-22.58	-32.24	10.64	22.94	33.54	
Land region 5	-17.41	-32.21	-44.70	-8.36	-15.27	-18.41	
Land region 6	-16.05	-29.88	-41.78	-11.91	-21.60	-26.44	
Land region 7	-16.32	-30.50	-42.75	-22.33	-42.64	-55.38	
Unemployment rate							
		Oil price increase of			Textile price reduction of		
	Base	10%	20%	30%	-10%	-20%	-30%
Urban unskilled (formal)	6.27	8.57	10.66	12.56	9.94	12.82	14.23
Urban unskilled (informal)	4.93	6.77	8.48	10.06	6.94	8.65	9.62
Rural unskilled	3.33	4.79	6.14	7.39	4.93	6.16	6.71

Source: Authors' worksheets.

The impact of the shock is also pronounced for both capital and land. The profit rate falls by a quarter, and the rent, or return to land, in the seven regions falls by an average of around 40 percent. That reminds us that oil is an important input to fertilizer and other uses in agriculture. Profits contract in both simulations, by 10 to 27 percent in the oil price case and by 9 to 17 percent in the textile case. One might ask why profit rates could fall across the board in response to the reduction in selling prices in one sector. Partly that reflects the effect of devaluation on imported inputs in other sectors. But it also reflects the size of the textile sector and our assumption that the capital stock in each sector is fixed. We do not permit capital to be redeployed away from textiles, where profits fall by 97 percent in the -30 percent price simulation. Since textiles are a very large sector in Honduras, that pulls down the weighted average of profits, even though profits in some traded goods sectors actually gain from the devaluations in the textile simulation. The other place where the two simulations differ is in agriculture. An oil price shock hurts agriculture across the board even though it causes devaluation simply because oil is an important input into fertilizer and farm transportation. In the textile price simulations, the economy also has a significant devaluation, which helps some sectors in agriculture and causes profit rates on land to rise in three of the seven regions in the model. Overall value added in agriculture falls by about 10 percent in the largest of the textile price shocks and slightly more in the oil price case.

Targeted Investment Strategies

In Honduras average levels of income, poverty, and economic structure vary widely across regions. For development-planning purposes it is useful to have a regionalized version of the national model that will reflect that heterogeneity. With a regional model we can simulate the impact of investment programs aimed at poor regions with unexploited economic potential and or high levels of poverty. Unfortunately we do not have sufficient information on regional trade flows to build a fully regionalized model where regional markets clear at different prices with differences between demand and supply satisfied by interregional trade flows.

The regional model that we develop here is partial in two dimensions. First, our regionalization of production covers only the agricultural sectors where land is a geographically fixed factor of production. Second, all markets, both agricultural and nonagricultural, are national. Production in all agricultural sectors is regional, but the commodities produced all flow into a national market where one single commodity price clears the market. Households, household consumption, and household income are distinguished by region, but all purchases are made in national product markets. We have the same six factors of production that we had in the national model—skilled and unskilled labor in the formal and informal sectors, capital, and land—but for each agricultural sector we have all categories of labor and land also disaggregated by region. Capital grows or shrinks over time in each sector in response to differences in relative productivity and the overall amount of capital formation in the economy. Each labor factor increases at an exogenous rate in each region. In that sense there is no permanent migration of labor between regions in the model. But since production outside of agriculture is not regionally defined, labor that lives in one region may in fact work in another. Therefore even though there is a regional wage for each type of labor, each of these labor markets clear at a wage that will be very close to equal across regions, and we will treat the income it earns as if it came from the region of residence rather than the region where the production takes place. But what about formal sector unskilled labor for which we imposed a fixed minimum wage? Here we do not have a market-clearing wage mechanism, and therefore no way for unemployment rates to be equal across the country. As we will see, exogenous changes in conditions have different effects on unemployment and therefore on regional incomes across the country.

Regional Disaggregation and Distribution of Arable Land between Crops

In Honduras, the rural sector is divided into seven regions: the South, Center-West, North, Atlantic, Northeast, Center-East, and West (see Figure 3.1). We have allocated the total amount of arable land across the sectors included in our CGE model using data from the Ministry of Agriculture and several other sources. Table 4.7 shows our estimate of the distribution of land across the crops and regions included in our model. Table 4.8 shows the national yields and areas planted to the main food crops in 2008. The reader should note that our distribution of crops across regions in Table 4.7 relies mainly on a survey from 1999, which did not include information on either flowers or tobacco. The data should therefore be regarded as suggestive of the patterns of cultivation by region rather than an estimate of current cropping patterns.

Table 4.7—Cultivated area by crop and region, in hectares, 1999

Region/Crop	R1	R2	R3	R4	R5	R6	R7	Total
Cereals	14376	190562	49507	18894	103723	54267	47096	478425
Beans	3355	44470	11553	4409	24205	12664	10990	111646
Other vegetable	49	2054	1073	1033	1420	2750	858	9237
Fruits	8871	715	29040	25243	604	1163	2447	68083
Oil seeds	0	45	22548	25793	2141	0	0	50527
Flowers	100	200	100	200	100	200	100	1000
Coffee	2642	57600	71598	1692	26469	38308	55967	254276
Tobacco			660		660	660		2000
Sugar	15767	924	25510	420	1649	7544	1849	53663
Other crops	na	na	na	na	na	na	na	na
Total	45160	296570	211588	77684	160971	117556	119308	1028837

Source: Instituto Nacional de Estadística de Honduras Resumen Agrícola-encuesta 1999.

Notes: Region 1 is the South; region 2, the Center-West; region 3, the North; region 4, the Atlantic; region 5, the Northeast; region 6, the Center-East; and region 7, the West.

na = no available data.

Table 4.8—Yields and areas planted in Honduras, various crops, 2008

	Yield (tons /hectare)	Yield per hectare in 2008 US\$ dollars	Area planted
Bananas	29.73	7785.41	23228
Coffee	1.00	2368.08	242000
Sugar	80.45	1404.74	75583
Tomatoes	27.09	12548.41	5931
Watermelons	28.63	5555.72	3415
Maize	1.69	518.43	317602
Beans	0.76	709.05	88050

Source: FAOSTAT. 2011.

Two important points are evident from the two tables. First, very large differences exist in yields per hectare across different crops. The payoff to tomatoes, bananas, and watermelons is 10 to 20 times greater than that of maize and eight to 15 times that of beans. The comparison is similar for the other cereals. And second, in spite of those differences, almost half of the cultivated area in the country is planted with low-payoff cereals and another 10 percent with beans. In other words, almost two-thirds of the cropland in Honduras is used for crops with the lowest value of production per hectare. That divergence is particularly apparent in region 2, the Center-West, and region 5, the Northeast. That is serious because those two regions constitute almost half of the arable land in the country.

Honduras is fortunate to have a relatively large endowment of arable land coupled with quite good access in international markets, but it is not using that land very effectively. Too much of it is used to grow subsistence crops, too little for higher-yielding exportables. To get a sense of how large the potential gains would be from crop substitution, perform the following mental experiment. Suppose that Honduras could shift one-third of the area devoted to corn and beans, or around 134,000 hectares, to tomatoes and watermelons, or fruit and vegetables. Suppose that half of the land freed up from corn and beans went to tomatoes and half to watermelons. Using the data from Table 4.8, the opportunity cost of the land taken out of corn production would be \$54 million (105,000 hectares (ha) × \$518) with beans

adding an additional \$20.6 million ($29,000 \text{ ha} \times \709). If half of that land could have produced tomatoes, the gross receipts would have been \$840 million ($67,000 \times \$12,548$), while the remaining 67,000 hectares would have produced \$372 million in watermelons ($67,000 \times \$5,556$). Thus the gross gain from this hypothetical switch would have been around \$1.1 billion dollars ($\$840 + \$372 - \$54 - \20.6). If we apply the observed 2008 ratio of value-added to gross receipts in agriculture (56 percent), then the value-added of agriculture would have risen from \$1.74 billion to \$2.35 billion, an increase of 35 percent. This in turn would raise total GDP by 4.4 percent. ($0.56 \times \$1.1 \text{ billion} / \13.9 billion). In other words, crop switching on this scale would have a significant impact not just in agriculture, but also on the real income and income per capita of the country.

This is not to downplay the technical and administrative difficulties of making such a switch; rather, it is to show that there appears to be a significant payoff to finding a way to make the switch possible. Note that in the spirit of the general equilibrium modeling we have employed in this paper, we cannot simply impose crop switching to see what would happen. Farmers are assumed to react to price signals, given the production possibilities open to them. Crop choice is endogenous. What we model instead is the impact of investments in upgrading technology or roads. Over time investments affect either farm gate prices in the case of roads or the cost of production in the case of changes in TFP growth. Either alternative will affect the profitability of different crops and the supply of different agricultural commodities. All of this takes place over time, which is the main reason we need a dynamic model to capture the changes in land use, production, and prices that result from changes in investment.

We are going to explore a number of different agricultural investment strategies here. The first alternative is to assume that investment is dedicated to improving productivity, either by crop or by region. Since our information on the activities in agriculture is limited, we are forced to assume that the investments in technical change are adequately captured by changes in TFP rather than changes in the CES production function itself. Also, we really do not know how much it might cost to produce the changes in TFP that we put into our simulations. Instead we assume an increase of 6 percent in total investment dedicated to the agricultural sector in a variety of different ways. One way is to suppose that the investment is crop-specific and that it produces a 10 percent increase in TFP in fruits and vegetables in all regions (simulation 1). One could think of this as building experimental labs, improving seed quality, or developing an extension service. Since this sort of knowledge is essentially free, once created, we assume that the improvements are enjoyed by farmers in all regions. An alternative approach is to assume that the improvements in technology are limited to specific regions rather than crops. We represent this alternative in simulations 2 and 3. In simulation 2 all the crops grown in regions 2 and 5 get a 10 percent increase in productivity. Simulation 3 makes the same assumptions in regions 1, 3, 4, 6, and 7. Here one could think of building irrigation systems or technical assistance limited to certain regions. An entirely different investment strategy would be to focus on improving roads, which we represent by imposing a reduction in marketing margins. By construction those margins are shown by commodity rather than activity, which means that they are going to affect commodities wherever they are produced. The final simulation shows the effects of a 25 percent export subsidy for nontraditional agricultural exports.

We show the macro results of these simulations in Table 4.9. Clearly, raising productivity has a big payoff, particularly compared with investing a similar amount in roads. If Honduras can raise productivity by 10 percent per year for 10 years in just fruits and vegetables, that alone raises the growth rate of GDP from 4.7 to 5.3 percent. That increased growth rate over the 10-year simulation raises the level of GDP by 5.7 percent relative to what it is in the base run. To put this in another way, by the 10th year Honduras is investing 24 additional units of local currency to get an additional 23 units of GDP. Investing in improved seeds, better methods of cultivation, or other ways of increasing productivity is clearly a very powerful way of enhancing growth prospects. Unfortunately there are no observed data that will tell us whether we have under- or overforecast the cost of such productivity improvements. The point of the exercise is simply to show how big an impact such changes could have, *if* they can be achieved. It may seem overly optimistic to simulate an increase in productivity of 10 percent per year, which implies that productivity doubles after 10 years. But we note that according to the agricultural census of 1999, the

range of output per hectare across the regions of Honduras for the same crop is two for cereals, four for fruit, three for coffee, 10 for sugar, and five for bananas. Clearly there is substantial room for improvements in regional productivity from targeted investment.

Table 4.9—Annual growth rates of real macro variables (in %)

			Sim 1	Sim 2	Sim 3	Sim 4	Sim 5
	Initial	Base run	TFP growth national	TFP growth 2 and 5	TFP growth rest	Roads	Export sub
Absorption	349.03	3.77	4.31	4.20	4.72	3.92	3.86
Consumption	215.51	3.79	4.32	4.13	4.97	3.68	3.88
Investment	89.26	3.97	6.00	6.00	6.00	6.00	4.07
Stocks	6.17						
Government	38.09	3.68	0.00	0.00	0.00	0.00	3.77
Exports	154.27	5.92	7.18	7.28	8.3	6.65	6.25
Imports	-231.57	4.23	5.19	5.27	6.07	4.78	4.48
GDP at market prices	271.73	4.66	5.31	5.18	5.80	4.85	4.77
Indirect taxes	22.37	4.26	1.92	4.44	3.42	4.67	4.22
GDP at factor cost	249.36	4.70	5.58	5.24	5.99	4.86	4.82

Source: Authors' worksheets.

Notes: Sim 1: increase in productivity of 10 percent per year only for fruits and vegetables in response to 6 percent rise in investment. Sim 2: increase in productivity of 10 percent per year in regions 2 and 5, with an increase of investment of 6 percent per year, and a decrease in margin costs of 10 percent for all agricultural products. Sim 3: increase in R&D of 10 percent a year in regions 1,3,4,6, and 7, an increase in investment of 6 percent per year, and decrease in margin costs of 10 percent for all agricultural products. Sim 4: an improvement in roads and other infrastructure projects with a decrease in margin costs of 10 percent (commerce and transportation) for all agricultural and agroindustry products and an increase in investment of 6 percent per year. Sim 5: an export subsidy of 25 percent for fruits, vegetables, and tobacco (primary and processed).

The next two simulations represent a pure regional investment strategy. In both we devote the same 6 percent increase in investment to increase the productivity of all crops grown in particular regions. For the purposes of these two simulations we divide the country into two groups: regions 2 and 5 representing the areas devoted to corn and beans, and the remaining regions (1, 3, 4, 6, and 7) representing higher-value activities (coffee, fruit and vegetables, palm oil, sugar, and bananas). Since regions 2 and 5 make up 44 percent of all the arable land in the country, the simulations are implicitly asking the question of how much of a kick to expect from raising productivity in basic necessities as opposed to higher-value activities. There will be some crop switching as well, as we will see below, but since all agricultural activities get the same increase in productivity, that should be less than occurs when the intervention is directed at just fruit and vegetables as it was in simulation 1.

As one might expect, regional targeting has a very big effect, particularly if the targets are the regions growing predominantly high-value crops (see simulation 3). GDP growth rises by 1.1 percentage points to 5.8 percent per year. Since the strategy favors crops most of which are exported, it has a particularly pronounced effect on exports, whose growth rate jumps by 40 percent relative to the base. As well, the additional foreign exchange made possible by rising exports permits a rapid increase in imports and consumption. Simulation 2 has less of an effect since it primarily benefits low-value agricultural activities, but even so, the effect on GDP growth is still considerable.

The alternative investment strategy of improving the transportation network rather than agricultural productivity (simulation 4) has a much smaller impact on the growth rate of GDP than any of the first three simulations. The GDP growth rate rises slightly, but the rate of growth of household

consumption actually falls. In effect, what happens is that the additional growth in production does not offset the increase in investment necessary to produce it. In this simulation we take the same additional investment that we used in the first three simulations and assume it reduces the transportation margin by 10 percent for all agricultural and ag-industrial commodities wherever they are produced. There is no increase in productivity. Reducing transport costs does not appear to have a very big payoff, particularly when compared with increasing the productivity of agriculture.

The final strategy is one in which the government gives all producers of nontraditional exports (fruits, vegetables, flowers, and tobacco [including processed tobacco]) a 25 percent export subsidy. There is no increase in either productivity or investment. As with roads, the effect of this alternative strategy is relatively small. Once again, the lesson is that price changes, either through reducing transport costs or subsidizing exports, do not have much of an effect unless they are accompanied by a concerted effort to raise productivity in the agricultural sector itself.

We now drill down into the sectoral data to see what effect these various simulations have within agriculture. Table 4.10 shows changes in total value-added by activity and simulation. The data are shown in the real currency units in which the CGE is calibrated in order to give one an idea of the relative importance of the changes being observed. If we direct investment to productivity enhancement in fruits and vegetables (simulation 1), we expect that there will be some shifting out of other crops. That is what happens. Fruits and vegetables rise by about 30 units relative to the base run, while cereals and bananas both decline. Two-thirds of that increase comes from the expansion of the production of fruits in regions 3 and 4, much of which is at the expense of bananas. These are big and significant changes. For the entire economy GDP rises by 157 units, which means that the growth in these two relatively small sectors makes up about 20 percent of the entire growth of the economy as a whole. But note also that for the most part, this growth in the production of high-value fruits and vegetables does not come from crop switching out of low value-added cereals production in regions 2 and 5.

Table 4.10—National value-added by agricultural sector and simulation

	Initial period	Base run	Inv + TFP: national	TFP growth: regions 2 and 5	TFP growth: rest	Roads	Export subsidy
Cereal	3.12	4.14	3.11	5.80	5.71	4.05	3.88
Vegetables	2.62	3.43	7.46	6.61	4.44	3.28	3.87
Fruit	3.09	4.34	29.92	22.61	4.75	4.32	6.46
Palm oil	2.48	4.00	4.11	5.32	4.33	4.31	3.93
Coffee	5.26	8.91	8.91	10.41	10.93	9.53	8.57
Sugar	1.13	1.68	1.74	2.00	1.77	1.72	1.67
Bananas	1.70	1.93	1.06	5.52	2.35	1.91	1.57

Source: Authors' worksheets.

Table 4.11 displays the changes in crop production in our various simulations. To make this easier to understand, we show the initial value-added for each crop, the value-added in year 10 in the base run, and finally the value-added in year 10 in each simulation. So, for example, for vegetables we see that in the base run total value-added rises from 2.6 local currency units to 3.4, or a yearly growth rate of about 2.7 percent. When we invest in productivity improvements in the sector in all regions of the country, production in the 10th year jumps to 7.5 local currency units, implying a rise in the growth rate from 2.7 to 8 percent. The table also shows how much crop switching there is. Obviously the first simulation, in which we assume a 10 percent increase in productivity for fruits and vegetables in all regions, favors those two sectors and they respond with big increases in production. Partly that is because of increased productivity within the two sectors, and partly it is because of crop switching particularly out

of cereals and bananas, both of which have lower output in year 10 in simulation 1 than they started with in the initial year.

Table 4.11—Total production in year 10

	Initial prod	Base run	Inv + TFP: national	TFP growth: 2 and 5	TFP growth: rest	Roads	Export subsidy
Cereal	3.12	4.15	3.11	5.80	5.71	4.05	3.88
Vegetables	2.62	3.43	7.46	6.62	4.44	3.28	3.87
Fruit	3.09	4.34	29.92	22.61	4.75	4.32	6.46
Palm oil	2.48	4.00	4.11	5.32	4.33	4.31	3.93
Coffee	5.26	8.91	8.91	10.41	10.93	9.53	8.57
Sugar	1.13	1.68	1.74	1.99	1.77	1.72	1.67
Bananas	1.70	1.93	1.06	5.52	2.35	1.91	1.57

Source: Authors' worksheets.

In the regional investment strategies (simulation 2 and simulation 3) we get increases in output in all sectors, but it is clear that the gains in output are much larger in simulation 3, where we invest in regions 1, 3, 4, 6, and 7, than it is in simulation 2, where we invest in regions 2 and 5. Regions 3 and 4 are the primary producers of fruits and vegetables, and they respond strongly to the improvements in productivity we are assuming. What is also interesting is that reducing transport margins by investing in roads has very little effect. In fact output falls relative to the base run in four of the sectors shown in the table. The same pattern is seen in the export subsidies simulation. Fruits and vegetables go up slightly relative to the base run, but growth in all the other sectors declines.

Not surprisingly, factor incomes in the rural sector are positively affected by all of these alternative methods for improving agriculture. In the base run the profit to land rises by 62 percent (over 10 years) and by 139 percent in simulation 1, where we make productivity-enhancing investments in fruits and vegetables in all regions of the country (see Table 4.12). Profit rises less in the other investment simulations, but is higher in all of them than in the base run. The same pattern can be seen for rural skilled and unskilled labor. The return to capital rises by less, but that is at least partly because we are reporting here returns to capital for the entire economy, not just the rural sector.

Table 4.12—Factor incomes and growth rates over 10 years

Simula- tion	Factor incomes in year 10 (in local currency units)				Growth over 10 years (in %)			
	Land	Rural unskilled	Rural skilled	Capital	Land	Rural unskilled	Rural skilled	Capital
Income initial year	3.68	16.39	12.19	94.54				
Base run	5.97	24.76	18.95	138.74	61.95	51.06	55.42	46.75
Inv + TFP: natl	8.83	29.39	20.44	146.45	139.64	79.33	67.60	54.91
TFP growth 2, 5	6.90	25.46	19.39	141.75	87.29	55.37	58.97	49.93
TFP growth: rest	5.95	26.20	19.05	151.28	61.49	59.90	56.21	60.01
Roads	6.19	25.67	19.00	144.57	68.06	56.62	55.78	52.92
Export subsidy	9.47	28.41	20.03	159.31	156.95	73.35	64.21	68.51

Source: Authors' worksheets.

5. CONCLUSIONS

In this paper we develop a dynamic regional computable general equilibrium model with regional disaggregated sectors for agriculture. We use the model to examine the impact of several recent or potential macro shocks and to explore a number of regional investment strategies for agriculture. All the macro simulations show the Honduran economy's extreme sensitivity to external shocks, particularly variations in the inflow of foreign resources, and variations in terms of trade. In the base run, foreign saving is equal to 15 percent of GDP. If that inflow is cut to 5 percent, the economy is forced to produce more exports while importing less. Private consumption shrinks by 10.5 percent, while exports rise by 8.8 percent and imports fall by 6.8 percent, all induced by a real devaluation of more than 4 percent. Overall, GDP falls by about 0.9 percent.

These are comparative static results, and they underestimate the full impact of the reduced inflows of foreign exchange on the growth rate if the rate of investment falls in response to the shock. In the longer run, the cumulative effects of lower levels of capital formation and lower growth rates in the economy reverse the favorable effect of foreign exchange pressure on the export sector. After year one, exports grow more slowly when foreign saving is 5 percent rather than 15 percent of GDP. To put this another way, in the short run, the economy reacts to a onetime balance-of-payments shock as predicted by the comparative static model. But the dynamic model reminds us that the macro components of the economy return to their previous growth trajectory, but at lower levels. In the long run, the overall rate of growth of the economy is determined by the growth rate of factor inputs and productivity, not the availability of foreign exchange. A onetime balance-of-payments shock reduces the growth rate of the economy if and only if it reduces the rate of capital formation.

Not only is Honduras dependent on a significant input of foreign saving to finance necessary imports; it is also extremely sensitive to fluctuations in key import and export prices. We examine oil price shocks using the comparative static version of the model. Raising the price of oil by 30 percent reduces GDP by 12 percent, with investment and consumption falling by even larger amounts. Because oil is a key intermediate input, raising its price drives up domestic prices across the board. That has a big impact on exports in addition to domestic production, which complicates the adjustment to such negative terms-of-trade shocks.

Honduras's exposure to the risks of oil price fluctuations is fairly obvious and widely recognized. However, because of the concentration of export revenues in a small number of sectors, particularly maquila, the economy also faces risks from price reductions or external competition in its maquila sector. To see how important this dependence might be in practice, we simulate a reduction in the export price for textiles of 10 percent through 30 percent.

We find that a price reduction of 30 percent in textiles has a bigger negative impact on production than does an equal percentage increase in the price of oil. If textile prices fall by 30 percent, GDP falls by more than 14 percent and exports fall by a whopping 42 percent. As it turns out, the falling price of Honduras's chief export has a somewhat larger impact on production and unemployment but a slightly smaller impact on consumption and total absorption than does the oil price shock.

The oil shock has a big negative effect in all factor markets. In our model we assume a fixed wage for urban and rural unskilled labor and for the urban informal sector. In those three markets the 30 percent increase in oil prices roughly doubles the unemployment rate. For urban skilled labor, where we assume that the wage is endogenous, we found that a 30 percent oil price shock drives down the real wage by 6 percent. As with the macro variables, the 30 percent textile price shock has a bigger impact on the labor market than does the oil price shock. Lowering textile export prices by 30 percent raises urban formal sector unskilled unemployment from 7 to 14 percent, whereas that increases to only 12.5 percent in response to an oil price shock of equal percentage magnitude. The impact of the oil shock is also pronounced for both capital and land. The profit rate falls by a quarter, and the rent, or return to land, in the seven regions falls by an average of around 40 percent.

We next explore a number of different agricultural investment strategies. The first assumes an increase of 6 percent in investment dedicated to improving productivity, either by crop or by region. One way is to suppose that the investment is crop-specific and produces a 10 percent increase in TFP in fruits and vegetables in all regions. An alternative approach is to assume that the improvements in technology are limited to specific regions rather than crops. In either strategy, raising productivity has a big payoff, particularly versus investing a similar amount in roads. If Honduras can raise productivity by 10 percent per year for 10 years in just fruits and vegetables in all regions, that alone raises the growth rate of GDP from 4.7 to 5.3 percent.

As one might expect, regional targeting has a very big effect, particularly if the targets are regions growing predominantly high-value crops. GDP growth rises by 1.1 percentage points to 5.8 percent per year. Since the strategy favors crops most of which are exported, it has a particularly pronounced effect on exports, whose growth rate jumps by 40 percent relative to the base. As well the additional foreign exchange made possible by rising exports permits a rapid increase in imports and consumption. Simulation 2 has less of an effect since it primarily benefits low-value agricultural activities, but even so, the effect on GDP growth is still considerable.

The alternative investment strategy of improving the transportation network rather than agricultural productivity has a much smaller impact on GDP's growth rate than any of the productivity simulations. The GDP growth rate rises slightly, but the rate of growth of household consumption actually falls. In effect, what happens is that the additional growth in production does not offset the increase in investment necessary to produce it. In this simulation we take the same additional investment that we used in the first three simulations and assume it reduces the transportation margin by 10 percent for all agricultural and ag-industrial commodities wherever they are produced. There is no increase in productivity. Reducing transport costs does not appear to have a very big payoff, particularly when compared with increasing the productivity of agriculture.

APPENDIX: SUPPLEMENTARY TABLE

Table A.1—Sectors of the disaggregated Micro SAM

Category	Account		Description
Activities/commodities	acere	ccere	Cereals
	averd	cverd	Vegetables
	afrut	cfrut	Fruits
	aolea	colea	Seeds and oleaginous fruits
	aflor	cflor	Live plants, flowers and flower seeds
	acafe	ccafe	Coffee
	ataba	ctaba	Tobacco
	acazu	ccazu	Sugar cane
	aotcu	cotcu	Bananas and other crops
	aanim	canim	Livestock
	aotan	cotan	Other livestock
	asilv	csilv	Products of forestry and logging
	apesc	cpesc	Fish and other fishing products
	ammet	cmmet	Metal ores
	amnom	cmnom	Nonmetallic mineral
	acarn	ccarn	Processed meat
	appes	cppes	Processed fish
	apvef	cpvef	Processed vegetable and fruits
	aacei	cacei	Vegetable and animal oils
	alact	clact	Dairy products
	amoli	cmoli	Milling
	apana	cpana	Bakery products
	aazuz	cazuz	Sugar
	acaca	ccaca	Cocoa, chocolate, and sugar confectionary
	abebi	cbebi	Beverages
	aptab	cptab	Tobacco products
	atext	ctext	Textiles, clothing, and leather
	amade	cmade	Wood products, cork, and others
	apape	cpape	Pulp, paper, paper products, and printing
	aquim	cquim	Chemicals and chemical and petroleum products
	acauc	ccauc	Rubber and plastic products
	avidr	cvidr	Glass and other nonmetallic products
	apmet	cpmet	Metal products, machinery, and equipment
	amueb	cmueb	Furniture
	aotma	cotma	Other manufactures
	aelea	celea	Electricity and water
	aconst	cconst	Construction

Table A.1—Continued

Category	Account		Description
	acome	ccome	Commercial services
	ahore	chore	Hotels and restaurants
	atran	ctran	Transportation
	asfin	csfin	Financial services
	asinm	csinm	Real estate services
	asalq	csalq	Rental services
	asgov	csgov	Public administration
	asens	csens	Education services
	assal	cssal	Health services
	ascult	cscult	Recreational and cultural services
	asdiv	csdiv	Other services
	asdom	csdom	Domestic services
Transaction costs	trc		Transaction costs
Transportation costs	trt		Transportation costs
Factors	flabf-ursk		Labor urban skilled
	flabf-urns		Labor urban unskilled
	flabc-ur		Labor informal
	flabf-rusk		Labor rural skilled
	flabf-runs		Labor rural unskilled
	fcap		Capital
	FIndR1		Land region 1
	FIndR2		Land region 2
	FIndR3		Land region 3
	FIndR4		Land region 4
	FIndR5		Land region 5
	FIndR6		Land region 6
	FIndR7		Land region 7
Enterprises	ent		Enterprises
Households	htegu		Tegucigalpa
	hsped		San Pedro Sula
	hourb		Other urban
	hrura		Rural
Government	gov		Government
Taxes	dtax		Direct taxes
	mtax		Import tariffs
	itax		Sales tax
	sub		Subsidies
Savings and investment	s-i		Savings and investment

Source: Authors' worksheets.

Note: The agricultural activities in grey are also disaggregated by region. For instance, there is one activity cereal region 1, one activity cereal region 2, one activity cereal region 3, and so forth (for all seven regions); they are all combined into one commodity cereal.

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