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Natural Resource Implications of Agricultural Trade Liberalization

As the recent debates over the North American Free Trade Agreement (NAFTA) and the General Agreement on Tariffs and Trade (GATT) illustrate, international trade and the environment is a highly controversial issue that will probably play an important role in future trade negotiations. Environmentalists have levelled a number of charges against free trade. Many of them revolve around the simple fact that, by encouraging economic activity, trade may increase pressure on the environment and natural resources. Proponents of free trade respond that trade policy is not the appropriate tool to address these concerns: the problem is not trade but a failure to price the environment correctly; other, more direct, policies that required people to account for environmental externalities could achieve more protection of the environment and natural resources for any given level of social welfare. Proponents also note that many trade restrictions lead to environmentally undesirable patterns of production. For example, agricultural trade policies in the European Union encourage intensive production practices in densely populated areas of western Europe. In addition, proponents note that the social demand for environmental protection is generally income-elastic, so that the additional income from free trade will ultimately induce policy makers to implement stricter environmental safeguards.

Objections have also been raised regarding the potential for free trade to encourage the migration of so-called 'dirty' industries from high-income countries, where environmental standards are strict, to developing countries, where they are lax. Some even contend that environmental degradation in these 'pollution havens' could impair production of goods and services to the point where aggregate income in these havens is actually reduced. (For example, air pollution harms human health and thus labour supply and labour productivity.) Proponents observe that the cost advantage enjoyed by polluting industries in developing countries is minimal because environmental costs are generally only a small share of total costs. They also note that free trade may encourage the movement of clean technology from high-income countries to developing countries by multinational firms, because there are economies of scale for a multinational in using the same technology at all its plants.

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Still other objections are based on the assumption that free trade will prevent countries from restricting imports of certain products from developing countries, such as tropical hardwoods, ivory, or tuna caught without using dolphin-safe nets. Proponents note that the incentives to conserve natural resources such as tropical forests depend in part on anticipated future income from resource exploitation, and that trade restrictions would reduce this income by depressing natural resource prices in exporting countries.

The potential linkages between trade policy, the environment and natural resources are of particular interest in developing countries. Primary or secondary production from natural resources is typically a large part of the economies of developing countries. In addition, these countries typically do not have or only weakly enforce environmental protection laws. Indeed, trade policies are often one of the few effective sets of policy instruments available to policy makers in developing countries. Governments in these countries often cannot even deliver essential public services, to say nothing of controlling the activities of producers or consumers. The complicated policy instruments often proposed to limit environmental externalities or promote 'sustainable development' are beyond the administrative capabilities of many developing countries. In this sense, the argument that trade policy is not the appropriate tool with which to deal with environmental problems is correct but not entirely relevant.

The objective of this paper is to explore the linkages between domestic trade policy, natural resources and the environment. We do this using an original computable general equilibrium (CGE) model for Costa Rica. CGE models have become popular tools in recent years to analyse many natural resource and environmental issues. Our model represents an initial attempt on our part to analyse these linkages. We focus solely on the argument that trade encourages economic activity and thus natural resource and environmental degradation. We do not attempt to model the many other arguments in the trade versus environment debate. Perhaps surprisingly, our results indicate that effects of trade policy changes on natural resource use and on economic activity would be relatively modest.

ENVIRONMENTAL ISSUES IN COSTA RICA

Costa Rica is an excellent case for study, for a variety of reasons. As with most other developing countries, the Costa Rican economy has always been highly dependent on natural resources. The central valley, which at present contains the capital of San José and most of the country's population, has good soils that permitted development of the country's agricultural sector in the nineteenth century. An abundant supply of tropical forest land absorbed the country's growing population, and over time Costa Rica's agricultural frontier expanded beyond the central valley. In the twentieth century, large amounts of land were deforested to make way for production of cattle and oranges (largely in the northwest part of the country), bananas (mostly in the east and northeast) and coffee (the central and east).

The Costa Rican economy still relies heavily on natural resource-based activities. During the 1980s, the agriculture, forestry and fisheries sectors

generated about 20 per cent of GDP, 28 per cent of employment and 67 per cent of exports. Natural resources are also the base for the manufacturing sector. During the 1980s, more than half of the value-added in manufacturing originated in the food and forest products industries, which obtain most of their raw materials from the agricultural, forestry and fishery sectors. Natural resources are also important in the provision of energy. By 1990, hydroelectric generators accounted for more than 90 per cent of total energy production, while 37 per cent of all households (mostly in rural areas) used wood as their main source of energy (Alvarado, 1992). Dependence on fuelwood is common in many developing countries, and was common in others in the past before most of their forests were cut down.

There are a variety of natural resource and environmental concerns in Costa Rica, but the most serious is undoubtedly deforestation. There have been a variety of estimates of its extent using different methodologies (Rodríguez, 1994), which vary in regard to how densely spaced and tall trees must be in order to constitute a forest 'cover area' and whether second-growth forests, or just virgin forests, should be counted. However, they agree that over 70 per cent of the country was under forest cover in the first part of the twentieth century. They also indicate that forest cover (counting first- and second- growth forests) has fallen to about one-third of total area since then, and that the most rapid deforestation has occurred since the 1960s.

Tropical forests are the richest ecological zone on earth, so that deforestation entails the possibility of irreversible losses of biodiversity. In Costa Rica, such losses so far appear to be modest (Lutz *et al.*, 1993), because at least some forest habitat in most major ecological zones still remains. However, Costa Rica is probably close to its limit in terms of its ability to absorb additional deforestation without significant losses in biodiversity. Tropical forests also recycle nutrients to soils, protect soils from erosion, prevent floods by acting as a watershed, moderate surface temperatures and absorb atmospheric carbon dioxide. Indeed, about 15–20 per cent of Costa Rica's soils show moderate to extreme erosion (Hartshorn *et al.*, 1982). However, there are differences of opinion over the costs and causes of soil erosion. Solórzano *et al.* (1991) estimate that the costs have been high and that agricultural production on deforested land has been the main cause. On the other hand, Lutz *et al.* (1993) argue that the costs have been modest and that deforestation plays only a supporting role.

Possibilities for additional deforestation are limited. Over 75 per cent of the country's remaining forests are in national parks or other publicly owned, protected areas, while another 10 per cent are in 'buffer zones' around protected areas where development is restricted (Servicio de Parques Nacionales, 1992). In addition, most of the remaining forest land would be of only marginal value as agricultural land. The most serious concern at present may be expansion of banana cultivation in northeastern Costa Rica. This is occurring close to the Tortuguero national park and buffer zone and the Barra del Colorado wildlife refuge. It has generated conflict, with the government and banana producers on one side and environmental groups on the other. Lutz *et al.* (1993) estimate that about 5000 to 10 000 hectares of forest area, or about 0.1 per cent to 0.2 per cent of Costa Rica's total area, are currently being converted to agricultural uses each year.

Water pollution from agricultural production is another important environmental concern. This is particularly true in the central valley because this is where population, coffee processing and other industry are concentrated. About 70 per cent of organic wastes in rivers are from coffee processing, 20 per cent are from other industries and 10 per cent are from sewage (Radulovich, 1988). In the eastern part of the country, run-off from pesticides used in banana production has led to the decimation of fish stocks on a number of occasions. Pesticide use has also led to a variety of severe health problems among banana plantation workers (Thrupp, 1988).

While Costa Rica is a small country, the issues surrounding deforestation and other natural resource degradation problems in Costa Rica are very similar to those in most of the Third World. As in many cases of deforestation throughout history, population pressures during the nineteenth and early twentieth century were a key contributor in Costa Rica (Cruz *et al.*, 1992). Since 1950, however, population growth has not been strongly associated with deforestation in Costa Rica (Harrison, 1991). Most of the additional population has settled on already cleared land and has engaged in economic activities that do not impose direct pressures on forest resources. As in other Third World countries today, public policies in Costa Rica have also promoted deforestation (Lutz and Daly, 1991; Peuker, 1991). Stumpage fees have always been very low. A 1969 forestry law set them at 4.24 colones per cubic metre, where they remained until they were raised to 188 colones by a 1990 forestry law. At 4.24 colones, stumpage fees were only about 1.7 per cent of the price of wood in 1969, and even this small percentage declined to complete insignificance by 1989 as inflation raised nominal wood prices. The increase to 188 colones brought fees back to about 1.7 per cent of the price of wood. A 1986 forestry law attempted to limit the ability of land owners to clear forests, but it was declared unconstitutional by the Constitutional Court. The 1990 law included revised terminology to accomplish the same purpose, but it has been poorly enforced.

Producers of livestock and other agricultural products have received subsidized credit for many decades, which has encouraged the clearing of land for agricultural purposes. The subsidies have been reduced in the last ten years under structural adjustment programmes, but they are still an important policy tool. Many imported agricultural inputs, such as fertilizer and pesticides, are exempt from import tariffs. The manufacturing sector which, as noted above, is based largely on agricultural and forest products, was heavily protected from imports until Costa Rica entered the General Agreement on Tariffs and Trade (GATT) in 1990. Modest export taxes of about 10 per cent are levied on bananas, coffee and sugarcane, but manufacturing exports receive subsidies of up to 30 per cent.

Squatters are a major cause of deforestation in some countries, but this does not appear to have been the case in Costa Rica. Historically, it would be more appropriate to view them as a 'conduit' for deforestation. A 1942 squatters law gave use rights to anyone who cleared and retained land for one year, with legal title granted after ten years of continuous possession. However, cleared land could be sold after one year to another party, who could then obtain title immediately. The result was that, rather than using the land themselves, many

squatters sold their land to cattle ranchers and others (Cruz *et al.*, 1992). At present, squatting on public or private land plays only a small role in land clearing (Lutz *et al.*, 1993).

A CGE MODEL FOR COSTA RICA

Space limitations prevent a full presentation of our CGE model for Costa Rica. Briefly, however, it contains 15 sectors, of which nine are directly based on natural resources (bananas, coffee, sugarcane, grains, other crops, livestock and dairy, silviculture, fishing, and electricity and water). Coffee and sugarcane include not only the actual production activities themselves but also the related processing activities. The other six sectors are food manufacturing, non-food manufacturing, petroleum refining, infrastructure, private services and government services. There are four primary factors of production: capital, unskilled labour, skilled labour and land. All prices in the model are relative to an overall consumer price index. For simplicity, the model is static rather than dynamic.

Production in each sector of the model can be viewed as a two-level process. At the lower levels, the primary factors combine in CES production functions to produce value-added, while intermediate inputs combine in another CES production function to produce an intermediate input 'aggregate'. At the upper level, value-added and the intermediate input aggregate combine to yield gross output. Because of costs to factor mobility and potential biases introduced by lumping all inputs into just four categories, factor prices differ between sectors. The fraction of the total supply of each primary factor that is provided to a particular sector is a constant-elasticity function of the price of the factor in that sector and an economy-wide average price for the factor. This average price is a CES function of the price of that factor in each sector. In turn, the total supply of each factor to the economy as a whole is a constant-elasticity function of the factor's economy-wide average price. A fixed fraction of income to each factor is transferred abroad, while a fixed fraction is invested (these two activities are only important in the case of capital). The remaining factor income goes to domestic households.

The economy's total supply of each of the 15 producer goods is the sum of domestic production and imports. Imports are a constant-elasticity function of the world price. The total demand for each good is the sum of exports, domestic consumer demand, government demand (the only good demanded by the government is government services), demand for the good as an intermediate input into production and demand for the good in the production of physical capital. Exports are a constant-elasticity function of the world price. Investment demand in each sector is a fixed fraction of the sector's capital stock. Consumer demand and government demand are discussed below. Market equilibrium requires that total supply equals total demand.

All households are put into one group for simplicity. Households purchase five consumer goods (food, durable goods, energy, health and education, and other goods). These consumer goods are produced in CES production functions from the 15 producer goods. The household's utility function is of the

Stone–Geary form (also known as the linear expenditure system). Households receive income from their supplies of the four factors and, to a small extent, from net transfers from abroad. Government taxes on household income, net of government transfers to households, are a fixed fraction of household income. A fixed fraction of household income is saved. Income remaining after taxes and saving is spent on the five consumer goods.

The government has a variety of policies. It imposes *ad valorem* taxes on the four primary factors. As noted above, it taxes income from, and transfers income to, households. It receives a small amount of net transfers from abroad, which are assumed to be a fixed fraction of other government revenue. In addition, it levies *ad valorem* import tariffs, imposes *ad valorem* export taxes in some sectors, and offers *ad valorem* export subsidies in other sectors. The government spends a fixed fraction of its net revenue from these taxes, subsidies and transfers on purchases of government services. The remaining net revenue is saved.

The CGE model is calibrated to a social accounting matrix (SAM) developed by Rodríguez (1994) using previously unavailable data for Costa Rica for 1985–9, the model's base period. All of the policy variables, and several of the parameters, can be derived directly from the SAM. The remaining parameters are drawn from a variety of studies, some of which are for Costa Rica, but most of which are for other countries. The results below are derived using two sets of parameter values, for the short run and the long run. Factor supply elasticities, the ease of factor mobility between sectors, substitution elasticities in production, export demand elasticities and import supply elasticities are all significantly greater in the long run than in the short run. Space limitations preclude a list of the specific parameter values and their sources.

The model does not contain any direct links to the environment. However, it does permit us to determine the magnitude and direction of economic changes in key sectors that would drive environmental impacts of trade policy reforms.

Data for the fifteen sectors are shown in Tables 1 and 2. The bulk of gross output and value-added is in manufacturing, infrastructure, private services and government services. The vast majority of land is in livestock. Classifying the 15 sectors according to their tradeability is difficult in some cases because both exports and imports are significant. However, bananas, coffee, sugarcane, livestock, silviculture and fishing are clearly exportables. Other crops and food manufactures are difficult to classify, but Costa Rica is a small net exporter in both cases. Grains, non-food manufactures and petroleum are clearly net importables. Electricity and water, infrastructure, private services and government services could be classified as non-tradeables, since trade was small or non-existent in the base period. This division of sectors into exportables, importables, and non-tradeables will turn out to be important in interpreting the results below.

Given this classification of sectors according to tradeability, the data in Table 1 indicate that exportables make the most intensive use of land relative to any of the other three factors. They also make the most intensive use of unskilled labour relative to capital or skilled labour. Importables make intensive use of unskilled labour relative to land. Non-tradeables make intensive use of capital and skilled labour relative to unskilled labour and land. These

TABLE 1 *Relative importance of each sector in CGE model*

	Percentage of total for Costa Rican economy, 1985–9					
Sector	Gross output	Value-added	Capital	Unskilled labour	Skilled labour	Land
Bananas	2.8	3.7	1.3	3.2	0.9	0.9
Coffee	7.8	6.5	1.9	19.8	3.4	4.7
Sugarcane	1.6	1.5	1.1	2.2	1.0	1.9
Grains	1.0	1.5	0.4	7.9	0.7	7.7
Other crops	2.6	3.6	0.2	5.9	1.1	11.8
Livestock	7.2	5.6	2.8	6.4	3.3	71.9
Silviculture	1.7	1.7	1.0	2.2	1.3	1.1
Fishing	0.5	0.7	0.3	1.7	0.3	—
Food manufactures	7.1	3.5	2.9	2.0	3.1	—
Non-food manufactures	16.5	9.8	8.0	8.7	11.0	—
Petroleum	2.5	1.0	1.2	0.0	0.2	—
Electricity and water	2.1	3.4	12.8	0.8	2.3	—
Infrastructure	9.8	9.0	14.5	10.7	7.7	—
Private services	26.1	32.3	31.2	23.3	35.5	—
Government services	10.5	16.1	20.4	5.2	28.3	—

Note: Columns may not add to 100 because of rounding.

differences between sectors in relative factor intensities also turn out to be important in interpreting the results.

RESULTS FROM THE CGE MODEL

In this section we investigate the effects of changes in Costa Rican trade policy using the CGE model outlined above. Three trade policy scenarios involving changes in tax or subsidy rates on exports and imports are examined. The scenarios are defined on the basis of recent and prospective trade policy developments in Costa Rica. Base period (1985–9) trade policies are shown in Table 2. Trade policies, at least at this level of aggregation, were fairly moderate. However, a few specific commodities (such as new cars) did face very high import tariffs. Exports of bananas, coffee, sugarcane and livestock were taxed, while exports of other crops, silviculture, fishing, food manufactures and non-food manufactures were subsidized. All imports were taxed except for petroleum, electricity and water, and private services.

TABLE 2 *Trade and trade policy by sector*

Sector	Trade measures, 1985–9		Trade policy, 1985–9	
	Exports as percentage of gross output	Imports as percentage of total consumption	Export tax rate (per cent)	Import tariff rate (per cent)
Bananas	88	0	8.7	—
Coffee	53	0	11.0	—
Sugarcane	27	0	11.1	—
Grains	0	18	—	5.0
Other crops	39	34	–9.1	5.0
Livestock	18	5	5.6	5.0
Silviculture	13	8	–9.1	5.0
Fishing	40	3	–9.0	10.7
Food manufactures	11	9	–10.6	10.0
Non-food manufactures	34	57	–2.3	12.0
Petroleum	5	33	0	0
Electricity and water	0	2	—	0
Infrastructure	12	0	0	—
Private services	2	6	0	0
Government services	0	0	—	—

Note: Total consumption is the sum of household consumption, government consumption, investment demands and intermediate demands.

Prior to 1986, Costa Rican import tariffs were defined by the Common Central American Tariff (ACC) and the Central American Agreement on Fiscal Incentives (CCIF). The ACC consisted of three import taxes: an *ad valorem* tax, a specific tax with the rate dependent on the type of good, and a tax of 30 per cent on the sum of the first two taxes. The CCIF provided exemptions, which in some cases were complete, for imported raw materials, imported capital goods and other imported inputs. Since 1986, import tariff rates have been reduced as part of structural adjustment and trade liberalization programmes.

Costa Rica entered the General Agreement on Tariffs and Trade (GATT) in 1990, but without signing the GATT Subsidy Code. This means that Costa Rica's current export subsidies are not subject to compensatory tariffs in the immediate future, at least by GATT members. Since the early 1970s, export subsidies of up to 30 per cent over the FOB value have been used to promote exports of some manufactured goods. However, an agreement between the government and the private sector in 1990 set rules for a gradual reduction of export subsidies between 1990 and 1996. Membership in GATT was a major

step towards freer trade and a radical departure from the protectionist policies that had been followed since the 1950s.

In the first scenario (S1), *ad valorem* rates for tariffs are limited to 5 per cent. Tariffs at or below that rate are unchanged. As Table 2 indicates, tariffs in most sectors in the base case are five per cent or below, with the exceptions being fishing, food manufactures and non-food manufactures. Tariffs are cut by half or more for these sectors, which is significant because manufactured goods constitute the vast majority of total imports. Export taxes are maintained at baseline levels in S1. This scenario corresponds most closely to Costa Rica's GATT obligations since the country is not now a signatory of the GATT Subsidy Code. The second scenario (S2) corresponds more closely to the spirit of GATT, and to the direction in which the country has been heading since 1990. In this case, export subsidies are also limited to 5 per cent. This represents about a 50 per cent cut in the export subsidy rate for other crops, silviculture, fishing and food manufactures. The third scenario (S3) has the fewest trade distortions. In this case, import tariffs, export taxes and export subsidies are all limited to 5 per cent. The cut in export taxes works to the benefit of bananas, coffee, sugarcane and (to a minor extent) livestock.

Changes in economy-wide average factor prices and the real exchange rate under the three scenarios are shown in Table 3. In an economy with three sectors (importables, exportables and non-tradeables), it can be shown that a reduction in either import tariffs or export subsidies increases the real exchange rate, while a reduction in export taxes reduces the real exchange rate (Dornbusch, 1974). Along these lines, the real exchange rate increases in S1, rises slightly more in S2 than in S1, and rises somewhat less in S3 than in S2. Taking changes in the real exchange rate into account, it can also be shown in a three-sector model that a reduction in either import tariffs or export taxes raises the relative price of exportables but lowers the relative price of importables. A reduction in export subsidies has the opposite effects. The

TABLE 3 *Selected price changes (percentages)*

	S1		S2		S3	
Price	Short run	Long run	Short run	Long run	Short run	Long run
Average rental rate on capital	–0.4	–0.2	–0.3	–0.1	–0.6	–0.2
Average unskilled wage rate	2.5	2.2	2.2	2.0	4.5	4.2
Average skilled wage rate	–1.6	–0.9	–1.4	–0.7	–2.0	–1.1
Average rental rate on land	4.7	3.7	4.2	3.3	4.8	3.9
Real exchange rate	4.1	3.9	4.2	4.0	3.4	3.2

changes in output prices that we obtain here, which are not presented in order to conserve space, are largely consistent with such a model. In all three scenarios, in both the short run and the long run, the prices of all the exportable goods increase. Changes in the prices of importables are mixed. However, the price of non-food manufactures always declines. This sector accounted for about 75 per cent of total imports in the base period.

Changes in land use by sector are shown in Table 4, while changes in output are shown in Table 5. The major story here is the fact that these changes are fairly modest. Petroleum output increases significantly in all three scenarios. However, petroleum is such a small sector that these changes do not amount to much. Apart from petroleum, the only changes in output which are larger than 10 per cent in absolute value occur in S3, and even here in only four sectors in the long run (bananas, coffee, sugarcane and non-food manufactures).

Since trade policy reforms do not lead to major changes in aggregate economic activity, the effects on the environment should also be modest. Of course, since some sectors are more harmful to the environment than others, the composition of output should not be ignored. From this perspective, the increases in the prices of exportables are of some concern. Higher coffee prices induce more coffee production and acreage. Additional coffee production means additional water pollution, since the wastes from the peeling of coffee cherries are usually dumped into rivers. On the other hand, coffee in Costa Rica is typically grown underneath a tree cover in order to provide shade for the coffee plants. This tree cover is obviously not as good as virgin forest from an environmental point of view, but it does have many of the environmental benefits from forests that were discussed above.

There are similar concerns with respect to the increases in banana and sugarcane prices, which encourage more production and acreage for these crops. As noted above, banana production has been expanding in recent years at the expense of buffer zones near national parks. It would be environmentally harmful if additional banana and sugarcane acreage came from virgin forest land and not from land already being used for agriculture or forestry. More-

TABLE 4 *Land use changes by sector (percentages)*

	S1		S2		S3	
Sector	Short run	Long run	Short run	Long run	Short run	Long run
Bananas	1.6	3.5	1.9	4.2	4.7	9.8
Coffee	2.0	3.8	2.2	4.5	7.6	15.6
Sugarcane	0.7	2.2	0.9	2.6	4.5	10.6
Grains	0.2	1.1	0.2	1.0	–0.7	–0.8
Other crops	0.8	2.6	–0.4	0.1	–1.7	–2.7
Livestock	–0.3	–0.4	–0.2	–0.1	–0.3	–0.4
Silviculture	0.2	0.2	–0.3	–0.5	–0.3	–0.7

TABLE 5 *Changes in output by sector (percentages)*

	S1		S2		S3	
Sector	Short run	Long run	Short run	Long run	Short run	Long run
Bananas	3.0	6.6	3.2	7.2	6.6	14.6
Coffee	3.9	8.2	4.1	8.8	10.8	24.1
Sugarcane	3.0	6.3	3.0	6.4	8.0	17.6
Grains	2.0	4.1	1.8	3.6	0.3	0.3
Other crops	2.3	5.2	0.7	1.7	–1.2	–2.2
Livestock	1.0	2.2	1.1	2.3	0.9	1.8
Silviculture	1.8	3.4	1.1	2.0	1.1	1.7
Fishing	2.7	5.6	–0.6	–1.4	–2.1	–4.6
Food manufactures	0.2	0.4	–0.4	–0.8	–0.7	–1.6
Non-food manufactures	–3.0	–8.8	–2.8	–8.1	–5.1	–14.0
Petroleum	10.3	19.2	10.3	19.2	9.9	18.2
Electricity and water	0.3	0.1	0.2	0.1	0.3	–0.1
Infrastructure	0.8	1.5	0.8	1.4	1.0	1.8
Private services	0.3	0.5	0.3	0.4	0.4	0.3
Government services	–3.6	–4.1	–3.1	–3.5	–4.9	–5.6

over, pesticides used in banana production lead to water pollution and human health problems. It should be noted that bananas occupied less than 1 per cent of all land in agriculture and commercial forestry in the base period, sugarcane occupied less than 2 per cent and coffee occupied less than 5 per cent (see Table 1). Thus even large percentage changes in land use in these three sectors do not amount to much in absolute terms. By far the largest sector in terms of land use is livestock, which has also historically been the most environmentally harmful. The amount of land in livestock declines slightly in all three scenarios.

The declines in non-food manufacturing production represent an instance where economic and environmental goals are compatible. The economy benefits because factors that had been employed in a sector protected from import competition are released for other uses. The environment benefits in so far as a reduction in output is accompanied by a reduction in air and water pollution associated with manufacturing production.

Consider a three-sector model (importables, exportables, non-tradeables) with three factors (capital, labour, land) in which relative factor intensities across sectors are the same as in Costa Rica. In this model, it can be shown, along the lines of the Stolper–Samuelson theorem, that an increase in the price of exportables raises the rental rate on land and the wage rate but lowers the rental rate on capital (Rodríguez *et al.*, 1994). The reason is that exportables

make relatively intensive use of land and labour. On the other hand, a decrease in the price of importables lowers the rental rates on land and capital but increases the wage rate. Our results here indicate that the former effect dominates for the rental rate on land. In spite of the decline in the price of the most important importable, non-food manufactures, increases in the prices of exportables cause the rental rate on land to rise in all three scenarios. In the short run, this has no effect on the total amount of land in production, since the aggregate supply elasticity for land is assumed to be zero. In the long run, the total amount of land in production increases by about 0.4 per cent in S1 and 0.3 per cent in S2 and S3. This additional land would have to come from land remaining in non-commercial forests. This implies a reduction in non-commercial forests of about 0.4–0.6 per cent, which is clearly modest in magnitude.

CONCLUSIONS

Both positive and negative environmental consequences can be inferred from the economic effects of trade liberalization in specific sectors of the Costa Rican economy. However, the dominant consideration in evaluating the results of the CGE model is the generally modest magnitudes of the changes in economic activity. Taken together, our results for the scale and mix of production and land use suggest that the trade policy reforms considered here probably do not have major implications for Costa Rica's natural resources or the environment. If true, this suggests that the focus of environmental concern needs to shift back from the aggregate level of international trade towards public policy at the sectoral or micro level, however difficult it may be for developing countries to design and enforce policies at these levels.

There are many reasons why trade policy can have dramatic impacts on economic activity in the long run which are not considered here. Trade encourages the diffusion of technology from higher-income countries to lower-income countries, since it is typically embodied in imported inputs. Competitive pressures caused by trade encourage firms to develop and adopt innovations more rapidly. Trade also enlarges the size of the market available to domestic firms, which is important if there are economies of scale in production. In addition, trade policy reform redirects towards productive activities resources that had been spent on rent seeking to maintain trade restrictions. The bottom line is that productivity growth and output growth are typically more rapid in more open economies (World Bank, 1991; Alam, 1991).

The question here is whether these long-run forces are good or bad for the environment. To a large extent, the answer depends on whether or not technical changes induced by trade make intensive use of environmental services and natural resources. The evidence, although very tentative, suggests that trade openness in developing countries is associated with the use of 'clean' technologies rather than 'dirty' ones (Low, 1992).

REFERENCES

Alam, M.S. (1991), 'Trade Orientation and Macroeconomic Performance in LDCs: An Empirical Study', *Economic Development and Cultural Change*, 39 (4).

Alvarado, F. (1992), *Memoria Estadística del Sector Energía de Costa Rica*, San José, Costa Rica: Dirección Sectorial de Energía.

Cruz, M.C., Meyer, C.A., Repetto, R. and Woodward, R. (1992), *Population Growth, Poverty and Environmental Stress: Frontier Migration in the Philippines and Costa Rica*, Washington, DC: World Resources Institute.

Dornbusch, R. (1974), 'Tariffs and Nontraded Goods', *Journal of International Economics*, 4 (2).

Harrison, S. (1991), 'Population Growth, Land Use and Deforestation in Costa Rica, 1950–1984', *Interciencia*, 16 (2).

Hartshorn, G.L., Atmella, A., Gomez, L.D., Mata, A., Morales, R., Ocampo, R., Pool, D., Quesada, C., Solera, C., Stiles, G., Tossi, J., Umaña, A. , Villalobos, C. and Wells, R. (1982), *Costa Rica Country Environmental Profile*, San José, Costa Rica: Tropical Science Centre.

Low, P. (ed.) (1992), *International Trade and the Environment*, Washington, DC: World Bank.

Lutz, E. and Daly, H. (1991), 'Incentives, Regulations and Sustainable Land Use in Costa Rica', *Environmental and Resource Economics*, 1 (1).

Lutz, E., Vedova W.M., Martínez, H., San Román, L., Vazquez L.R., Alvarado, A., Merino, L., Celis, R. and Huising, J. (1993), *Interdisciplinary Fact-Finding on Current Deforestation in Costa Rica*, Washington, DC: World Bank.

Peuker, A. (1991), *Public Policies and Deforestation in Costa Rica*, Washington, DC: World Bank.

Radulovich, R. (1988), 'Degradación Ambiental en Costa Rica', *Revista de Agronomía Costarricense*, 12 (2).

Rodríguez, A. (1994), 'Policies to Promote Development with Sustainable Use of Natural Resources in Costa Rica: A Computable General Equilibrium Approach', PhD dissertation, Agricultural Economics, Pennsylvania State University.

Rodríguez, A., Abler, D.G. and Shortle, J.S. (1994), 'Trade Policy, Natural Resources, and the Environment: The Case of Costa Rica', paper presented at Resource Policy Consortium Meeting, Washington, DC.

Servicio de Parques Nacionales (1992), *Sistema de Parques Nacionales, un Nuevo Enfoque*, San José, Costa Rica: Servicio de Parques Nacionales.

Solórzano, R., de Camino, R., Woodward, R., Tossi, J., Watson, V., Vásquez, A., Villalobos, C., Jiménez, J., Repetto, R. and Cruz, W. (1991), *Accounts Overdue: Natural Resource Depreciation in Costa Rica*, Washington, DC: World Resources Institute.

Thrupp, L.A. (1988), 'Pesticides and Policies: Approaches to Pest-Control Dilemmas in Nicaragua and Costa Rica', *Latin American Perspectives*, 15 (4).

World Bank (1991), *World Development Report 1991: The Challenge of Development*, New York: Oxford University Press.