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The Influence of Agricultural Policy on Economic Integration Among Central American Countries: A Game Theoretic Analysis.

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THE INFLUENCE OF AGRICULTURAL POLICY ON ECONOMIC INTEGRATION AMONG CENTRAL AMERICAN COUNTRIES: A GAME THEORETIC ANALYSIS

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Louisiana State University and
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in partial fulfillment of the
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in

The Department of Agricultural Economics and Agribusiness

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ABSTRACT

The influence of eight commodity groups on international economic integration in five Central American Countries are analyzed. The commodity groups are rice, beans, corn, sorghum, bananas, coffee, sugar, and beef. The countries are Costa Rica, El Salvador, Guatemala, Honduras, and Nicaragua. A game theory framework is used to find a Nash equilibrium solution to a set of trade negotiation scenarios. The payoffs of the Political Preference Function (PPF) are used for the trade liberalization scenarios under analysis. These PPF payoffs are estimated using the MISS model.

The nominal protection coefficient (NPC) is used as the main criterion for trade liberalization. Status quo (SQ) or no reduction in protection, 25%, 50%, 75%, and 100% reductions in protection or free trade (FT), are the scenarios under analysis. Four games are modeled. In game one all PPF weights equal one, which means that all commodities groups have the same importance in the government's view. In game two, all PPF weights are different from one, i.e., the government assigns different degrees of importance to some sectors relative to other sectors and to itself. Game three and four include the PPF weights of game one and two but with a reduction of five percent in the exchange rate.

The results show that any individual country will agree to free trade when the rest of countries, as a bloc, reduces protection by 50%. This indicates that Central American countries will be likely to agree on a partial trade liberalization rather than to a more involved form of economic integration. Commodity groups do not affect trade liberalization adversely. The study suggests that the use of game theory is an appropriate approach to analyze economic integration in Central America.

CHAPTER ONE- INTRODUCTION

Introduction

In June 1990, the Central American presidents signed an accord calling for the creation of a stronger regional common market in an effort to end the poverty that has contributed to regional instability. In 1992, the presidents of the Central American Countries met to restart the process of economic integration one more time. This was a second attempt to deepen economic integration of the area. In the new scheme of economic integration the objective is to promote the socioeconomic development of the region through an increase in exports and the participation of the countries in international markets as a bloc. With this objective in mind, the agreement of 1992 included a more open trade relationship with the rest of the world and the re-elimination of tariff and non-tariff barriers in intra-regional trade. This time the agreement did not look forward to achieve the creation of the Central American Republic. The main objective was to alleviate the external debt burden through the creation of a greater export supply of commodities produced in the region, the modernization of the productive infrastructure, and the increase of income and employment.

The agreement of 1992 indicates that each country will have to completely eliminate tariff and non-tariff measures applied to trading partners in Central America. This implies a reduction of 3% for Guatemala, 5% for El Salvador, 10% for Honduras, 8% for Nicaragua, and 2% for Costa Rica. It is reasonable to expect that the countries with the higher level of duty levied will suffer the most dramatic reductions in government revenue. Will this agreement really improve the welfare of all countries or only that of a few? A clear answer to this question is the determinant for the success of the implementation of the

agreement. Therefore, a formal analysis is needed to measure the change in welfare from such changes in trade policy. Little work has been done to analyze the effects of these changes. It seems important to assess trade liberalization in Central America from different perspectives and using various empirical approach. More research on this topic is recommended because, for example, commodity groups may be very influential in shaping domestic policies towards a trade liberalization agreement. Among few studies on this issue, De Franco (1996) found that a total elimination of the intra-regional trade barriers and the adoption of a common external tariff (CET) against the rest of the world, i.e., the formation of a customs union, is harmful for the welfare of Honduras and Nicaragua. However, the influence of commodity groups on the domestic policy-making process is not captured in the study of De Franco but it could be crucial for countries as how and when to enter the trade liberalization agreement.

Overview of Central America

Geographical Overview of Central America

Central America consists of seven small nations: Belize, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, and Panama. They are strung along the narrow isthmus that links North America (Mexico) with South America (Colombia), with the Caribbean Sea to the north and east and the Pacific Ocean to the west and south. This strategic location has helped shape the region's history, culture, and economy. Central America has an area of some 522,000 sq km (202,000 sq mi), and its population in 1992 was estimated at about 31 million. Its geography varies from towering volcanoes to some of the world's densest jungles. The volcanoes are the most spectacular feature, forming a nearly 1,300-km-long (800-mi) chain from the Mexican border into central Costa Rica and reaching heights of

over 3,650 m (about 12,000 ft). Many of these peaks are still active, contributing to both the richness of the soil and the dangers of life in the area. Central America is also prone to earthquakes. There is a major break in the chain of volcanoes and mountains in southern Nicaragua, and the chain ends in central Panama. This has made these two areas particularly attractive for trade routes between the Atlantic and Pacific oceans and as possible canal sites.

Economic Overview of Central American Countries

The economic development of Central American countries has been slower than in other American Countries. By present standards, Central American countries are poor and in developing stages. Table 1 presents data on key macroeconomic indicators. The total economy of the countries is very small when compared with, for example, Louisiana

Table 1.1. Key Economic Indicators of Five Central American Countries (1997)

Item	Guatemala	El Salvador	Honduras	Nicaragua	Costa Rica
Pop, mill	11.2	6.0	6.3	4.6	3.5
GDP, US$ billion	17.8	11.4	4.7	2.0	9.5
Inflation,%	9.2	4.6	20.2	9.2	13.3
GDP growth, %	5.0	5.0	5.3	5.8	3.6
Agriculture*	23.6	13.2	22.6	33.8	15.1
Industry*	20.2	26.7	30.2	21.7	23.2
Services*	56.4	60.1	47.1	44.6	61.7
Exports**	3187	2049	2007	936	4328
Imports**	4193	3256	2216	1482	4571
Debt**	3914	3182	3998	5887	3548
Debt/GDP	22.0	27.8	85.1	291.7	37.2

Source: World Bank, 1999. *=As a percentage of GDP, **=includes good and services, US$ millions

which had a GSP of about $120 billion and a population of 4.4 millions in 1996 (Mindscape US Atlas, 1996). All the countries in Table 1 present a negative balance of payments and a high level of debt. This is one of the main reasons why accelerated improvement of the productive sector is needed.

Table 1 shows the structure of the economies of the countries under the agreement. Although the largest sectors are industry and services, it is clear that agriculture plays an important role in the economies of these countries. Therefore, the impacts of the agreement on economic integration will affect the agricultural sector of each country.

Historical Overview of Economic Integration

In earlier decades, Guatemala, Honduras, El Salvador, Nicaragua, and Costa Rica tried to deepen the economic integration of the area. This task proved to be difficult. There were many obstacles in the way of integration and this caused many delays and nearly caused the disintegration of the Common Market created in the sixties. The objective of the economic integration of that time reflected the fact that the terms of trade of the agricultural commodities produced in the area were worsening. Therefore, a fast way to industrialization was envisaged in the agreement of the Central American Common Market (CACM). There were four main elements of this economic integration agreement. First, free intra-regional trade among the country members of the CACM. Secondly, a unified duty was levied on imports from countries not member. Third, the CACM included the creation of the Central American Peso, a common currency for the country-members. Finally, the creation of institutions, such as the General Secretary of the Treaty of Economic Integration, the Central American Monetary Council and the Central American Bank of Economic Integration, were included in the agreement (De Franco, 1996).

The Central American Common Market (CACM) formed in 1960 spurred some industrial growth. Economic development produced better communications and more education. The growing middle class began to demand more democratic and efficient governments. At the same time, the new export crops took the best land away from the rural poor, leading many to move to the cities. As pressures for change mounted, large landowners combined with conservative military leaders to use increasing force to defend their power. Elections were controlled, and the path to peaceful change seemed closed. This prompted many to support radical-left violence as means of social and political changes. In Nicaragua the long dictatorship of the Somoza family fell before the Sandinista guerrilla campaign in 1979. Violence also spread to El Salvador and increased in Guatemala. The CACM, already weakened by a 1969 war between El Salvador and Honduras, virtually disintegrated as the fighting spread. Tourism and investments declined sharply and debts rose. High interest rates and low crop prices contributed to near economic collapse, and U.S. efforts to restore stability via military and economic aid met with little success.

Conflict and economic decline continued despite efforts of the Contadora group (Colombia, Mexico, Panama, and Venezuela) to find a solution acceptable to both U.S.-supported forces and others aided by Cuba and the Soviet Union. In 1987, Costa Rica, Guatemala, Honduras, El Salvador, and Nicaragua signed a peace plan that helped bring about elections in Nicaragua in February 1990, which the Sandinistas lost, and the disbanding of the U.S.-supported rebel forces (the contras) there. Negotiations between the central government and rebel forces in El Salvador were concluded in a cease-fire in January 1992.

International Economic Integration

Robson (1984) defines economic integration "to denote a state of affairs or a process involving the combination of separate economies into larger economic regions." In addition, economic integration is concerned with efficiency in the use of resources. Robson (1984) distinguishes three levels of economic integration: 1) national; 2) international; 3) worldwide. In addition, at each level there may be sectoral integration. For example, there can be integration in the agriculture sector or in industry. In this study, the second level of integration is the relevant one.

International economic integration may take different forms and it depends on the intended degree of economic integration (Robson, 1984). Depending on the degree of integration, there are free trade areas, custom unions, common markets and economic unions. A free trade area involves the free movement of product in the area, i.e, it involves elimination of trade barriers between the members of the free trade. In addition, each member retains it own tariff with respect of the rest of the world. By contrast, a custom union agreement involves not only the free movement of products in the area, but also a common external tariff (CET) against the rest of the world. A common market is a deeper form of integration. A common market contains the elements of a custom union and additionally allows for free labor and capital flow in the area. Thus, in a common market, factor and product markets are integrated. Presently, the deepest form of international integration is represented by an economic union. An economic union contains all the elements of a common market and a high degree of unification of monetary, fiscal and other policies. In this case, depending on the degree of integration, a wide spectrum of forms of integration can be seen. The degree of integration will depend mostly on the degree of

harmonization policies among the members. In general, most agreements on international integration are focused on the suppression of discrimination among members, the maintenance of discrimination against the rest of the world and, the lasting character of the agreements which limits the use of certain instruments of economic policy.

According to Robson (1984), there are important motives for the existence of economic integration, such as gains in welfare for the group as a whole. The gains that may be derived from the integration can be expressed in terms of increased production according to comparative advantage, increased output arising from economies of scale, improvement in the terms of trade with the rest of the world, changes in efficiency due to increased competition among members, and integration-induced changes affecting the quantity and quality of factor inputs.

On the other hand, economic integration is not a panacea for economic problems. In real life, for example, a custom union (CU) agreement often has both trade-creating and trade-diverting effect. The success of the agreement is based on the net trade-creating effect, i.e., by how much the trade-creating effect is greater than the trade-diverting effect. If trade creation is greater than trade diversion, then countries can expect to gain from the agreement. The reverse is true if trade diversion is greater than trade creation. Thus, the CU agreement may well be beneficial or detrimental for the group involved.

International Economic Integration in Practice

Starting from the second half of the present century one can find many examples of economic integration across the world. Some of them have been successful and others have stagnated or completely disintegrated. Most of the agreements are made by countries that are located close to each other or that share similar cultural, educational and political views.

The most successful example of an agreement of economic integration is perhaps the European Union (EU). The EU started as a common market in the late fifties and initially included Italy, France, West Germany, Belgium, the Netherlands, and Luxemburg as members. In later years, the common market became what is now known as the European Union (EU). Presently, there are 15 country-members. As described earlier, since the EU is an economic union, it involves free trade among members, the determination of a common external tariff (CET), factor and capital mobility and the creation of a common currency for all the members of the union besides fiscal and monetary policies. Although many problems have been present which have caused delays along the way to the realization of the objectives of economic integration, this union can be said to be a success from both theoretical and empirical points of view.

Other less successful examples are found around the globe in all continents. For example, Robson (1984) found that six groups of economic integration have been set up in Africa in the present century. The Custom and Economic Union of Central Africa (UDEAC) was setup by the francophone People's Republic of Congo, Gabon, Cameroon and the Central African Republic. These countries were also linked by a monetary union. The Economic Community of East Africa (CEAO) was formed in 1974 by Ivory Coast, Mali, Mauritania, Niger, Senegal, and Upper Volta. The CEAO is a second francophone grouping and is also grouped in a monetary union with Benin and Togo. Liberia and Sierra Leone established the Mano River Union (MRU) in 1973, the latter involving a custom union and other forms of cooperation. In 1980, Guinea joined the union. The Economic Community of West African States (ECOWAS) was setup in 1975 by fifteen countries in Lagos. This union included both francophone and anglophone countries and countries already linked in

the CEAO and MRU. In 1969, Botswana, Lesotho, Swaziland, and the Republic of South Africa signed a custom union agreement on foundations dating back to 1910. In 1976, Zaire, Burundi and Ruanda formed the Economic Community of the Great Lakes (CEPGL). Finally, the East African Community formed by Kenya, Uganda and Tanzania broke up in 1978 although there was evident effectiveness during its existence.

In Latin America, there are also various examples of economic integration besides the 1960 common market of Central America. The Treaty of Montevideo (1980) set up the Latin America Integration Association (LAIA). This treaty included all Latin American Countries with the exception of Guyana, Surinam and French Guiana. The LAIA is the successor of the Latin American Free Trade Association (LAFTA). The Cartagena agreement of 1969 established the Andean Group which included Chile, Colombia, Venezuela, Ecuador, Peru, and Bolivia. The Caribbean Common Market was established in 1973 by Guyana, Jamaica, Trinidad and others.

In Asia, besides the Association of South-East Asian Nations (ASEAN), formed by Singapore, Malaysia, the Phillippines, Indonesia, and Thailand, there are no other schemes of international integration. There are, however, arrangements for sectoral integration between Iran, Turkey and Pakistan in the group known as Regional Cooperation for Development (RCD).

Problem Definition

At this moment, there is little information available to each Central American country's decision-makers to foresee the effects of an economic integration agreement at the national, regional and international levels, and specifically in the agricultural sector. This study will analyze the consequences of the customs union agreement on the welfare of several important agricultural commodities of the participating countries.

Problem Justification

Since little information is available, Central American decision-makers have no clear idea of the effects the economic integration system may bring to each country. In addition, little research has been done on the long term effects of the customs union agreement on the five central American countries, which can be a serious obstacle for the successful development of the 1992 accords. For example, De Franco(1996) argues that in the short and middle term Guatemala and Costa Rica will gain and Honduras and Nicaragua will lose form the agreement. This outcome may persuade policy-makers of the latter countries to be skeptical about the agreement. However, the long term effects (5-10 years) are not discussed anywhere. In addition, the Social Accounting Matrix (SAM) used by De Franco (1996) to estimate the effects of the custom union in the Computable General Equilibrium Model (CGE)only included capitalists (owner) and workers without a sectoral analysis of the impacts of the agreement. In general, international trade theory suggests that trade liberalization brings positive changes in welfare for all parties (Krugman, 1994). This is the reason why countries are willing to negotiate and liberalize trade. If there is not a feasible gain from the agreement, then it is reasonable to expect that the status quo situation will prevail. Likewise, for the agreement to be acceptable, it is important to show how long it will take for the benefits to show up for all countries. Finally, this study is important for the agricultural sector of all countries within and outside the agreement in terms of trade creation and diversion effects. So, this analysis is important for the US because it is the main trading partner of the Central American countries.

Objectives

Main Objective

The main goal of this research is to provide an analysis of the possible effects of the economic integration efforts on the agricultural sub-sector of the five Central American Countries and their repercussions on the successful implementation of the integration agreement of 1992.

Specific Objectives

1.- To identify and evaluate recent relevant national and international trends in economic integration and the outcomes of such trends.

2.- To hypothesize a plausible economic model useful in explaining the long term effects of economic integration at country and sectoral levels.

3.- To empirically estimate and test the hypothesized economic model, and

4.- To draw conclusions from the model and provide recommendations to policy- and decision-makers which can be used in further development of the economic integration of the Central American region at the sectoral level.

Procedures

Objective One

The first objective of this research will be accomplished by a review of the relevant literature in order to develop a thorough background on the relevant areas of the present research. Therefore, empirical evidence of international economic integration will be assessed. Moreover, the conceptual and empirical approach to evaluate economic integration agreements will be reviewed. This literature review should generate relevant information to understand recent trends in economic integration around the world and give some hints as to what direction this present research should take.

Objective Two

To achieve objective two of this research, based on the information obtained in accomplishing objective one, an economic model will be conceptualized. This model will relate the implementation of economic integration in Central American countries through various economic policies (trade, fiscal, monetary) and the effects of such integration on the agriculture sector. Since the objective of economic integration is the improvement of the welfare standard of the populations of the members of the integration scheme, the benefits or losses derived from the scheme of integration changes in welfare will be estimated. Thus, changes in consumer surplus, producer surplus, and total welfare changes will be estimated to assess the impact of the agreement on the welfare of each country. As in a cost-benefit analysis, it is believed that if benefits outweighs costs, then the chances of successful integration are increased and the agreement is more likely to last. On the other hand, if country members believe that the agreement is detrimental to welfare, the agreement is likely to fail.

It is worthwhile to recognize that the effects of the integration agreements are to be spread over the whole economy. Nonetheless, as will be shown in this study, agriculture is a very important economic sector in Central American countries. So, the focus of this research is to investigate the effects of economic integration on the agricultural sector. Thus, the conceptual model will be developed in a partial equilibrium framework because any change in welfare in this sector is a representative situation of the whole economy. Therefore, the use of a partial equilibrium framework to analyze the effects of economic integration on the agriculture sector will contribute toward this assessment of the impact of this economic agreement on the whole economy.

Objective Three

This objective will be achieved through the empirical modeling of the relationships established in objective two. Until recently, Central American countries continued defining the timetable and the extent of a new economic integration agreement. Therefore, several integration scenarios are likely to be present in the table of negotiations. Most of these scenarios have to deal with the coordination of national policies. This coordination is a crucial condition in order for each country to start benefitting from the reduction of trade barriers and increased size markets. At the same time, integration efforts convey costs in terms of sovereignty, welfare trade-offs and trade diversion as a whole and from the perspective of specific domestic sectors. Therefore, some scenarios may bring positive or negative benefits for all or some of the members. Thus, it is important to assess what scenarios are the most relevant to achieve the stated goal of standard of living improvement of the populations of Central American countries.

Since it was stated that the theoretical framework will involve the use of a partial equilibrium model, the use a Political Payoff or Preference Function (PPF) is proposed as one of the most appropriate techniques in this kind of analysis. The approach of the PPF used in this research is based on the one used by Kennedy (1995), previously developed by Gardner, Rauser and Freebairn and also similar to the approach developed by Stigler and Peltzman, Magee, and Hillman. Thus, the PPF used in this research is a weighted, additive function of money metric welfare measures for various societal groups. The PPF is the objective function that policy-makers seek to maximize through the selection of specific policy actions.

The discussion above indicates that societal groups enter as arguments in the PPF and economic integration affects their welfare. Therefore, producers, consumers, lobbyists,

and politicians will seek to influence the decisions of the government as to how to enter the economic integration agreement. Through this influence, each group seeks to minimize adverse effects or to maximize gains when entering the agreement. Thus, the appropriateness of the PPF to analyze economic integration in Central America derives from the extent that the political influence of various societal groups can be modeled. In addition, the numerical estimate of each group's influence will probably indicate what integration scheme is the most likely to be considered as the best scheme for each country, given the solution of the PPF maximization problem.

Objective Four

The final objective of this study will be achieved through a generalization of findings resulting from empirical estimation of the partial equilibrium model proposed in objective three. Results will be interpreted in the context of information needs of the policy makers, consumers, and producers of Central American and foreign countries affected by the agreement of economic integration in Central America.

Outline of the Dissertation

Chapter one will present the introduction, problem statement, justification, objectives, and procedures for the research. Chapter two will present an exhaustive literature review on the trends of economic integration in the Central American region, empirical studies using various techniques and methods to analyze international economic integration. Trade issues will also be reviewed. Chapter three will present a review of the relevant literature on partial equilibrium analysis and the derivation of the theoretical model to estimate the effects of the scheme of economic integration chosen by the Central American countries on welfare inside and outside the economic bloc. Chapter four deals

with the estimation of elasticities of supply and demand which are required for the empirical estimation of the conceptual model of Chapter three. Chapter five includes data collection, assessment of the quality of the data and the empirical results of the model conceptualized in chapter three. Chapter six will summarize the results and present the implications, conclusions, and recommendations for policy-makers inside and outside Central America.

CHAPTER TWO-LITERATURE REVIEW

An exhaustive exercise is developed in this chapter. Therefore, the chapter is divided into four sections. First, reviews of Central American agriculture and the main policies that affect performance of agriculture are included. Second, relevant literature to the Central American Common Market and its system of economic integration is examined. Third, relevant literature to the issues of economic integration is reviewed in the light of the developing countries context. Fourth, since the new philosophy of economic integration in Central America is based on the idea of export promoting policies, empirical evidence on Export Promotion (EP) Policies is reviewed. Finally, empirical applications analyzing economic integration based on a game theoretical approach using a Political Preference Function (PPF) are reviewed.

Central American Agriculture and Policies

Central American Agriculture

Climatic conditions are favorable to grow a wide variety of tropical crops in Central America (Table 2.1). However, rice, beans, corn, sorghum, cotton, coffee, sugar cane, bananas, African palm, cattle, and shrimp are the main agricultural activities in Central American countries. Central American Agriculture has historically had a dual nature. On one hand, the domestic consumption sector has been neglected. Therefore, little attention has been devoted to its technological development and productivity in this sector is very low. The domestic consumption group is composed of beans, sorghum, corn and rice. On the other hand, the group of crops devoted to the export sector has received most of the efforts devoted to the development of agriculture in Central America. The agricultural export sector consists of cotton, bananas, coffee, sugar cane, and beef.

Table 2.1. Production of Main Agricultural Products in Central American Countries, 1998.

Item	Costa Rica		El Salvador		Guatemala		Honduras		Nicaragua		Total	
	Area[a]	Output[b]	Area	Output	Area	Output	Area	Output	Area	Output	Area	Output
Rice	64.7	276.9	8.8	52.4	13.3	40.7	10.9	13.8	57.9	215.9	156	599.7
Beans	38	13.4	63.1	55.4	124.6	84.4	78.9	72.7	145.7	97.8	450	323.7
Corn	17	32	250	582	589	1021	447	471	229	451	1532	2557
Sorghum	0	0	101.9	170.8	42.3	51.6	82.3	90.2	21.8	40.6	248	353.2
Cotton	0	0	0	0	0.4	0.6	1.4	1.4	1.8	2.7	3.6	4.7
Coffee	106	148.9	163.9	119.6	273	223.1	199.7	155.1	89.1	64.7	832	711.4
Sugar C.	49	3682	81	5546	182	19845	45	4113	46	3261	403	36447
Banana	51.3	2443	0	0	17.0	710	22.4	862	1.8	88	92.5	4103
A. Palm	26.5	444	0	0	19	289	33.4	522	2	53	80.9	1308
Cattle	1527[c]	82[d]	1038	35	1769	54	5400	138	1688	48	11422	357
Shrimp	N/A	2.4	N/A	7.9	N/A	4.0	N/A	17.4	N/A	8.6	N/A	40.3

Source: ECLAC, 1999. For all countries: (a) area in 1000 Ha; (b) output in 1000 MT; (c) cattle in 1000 heads; (d) beef in 1000 MT.

Table 2.2. Self-sufficiency Ratios of Main Agricultural Products in Central American Countries, 1997

Item	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua	Average
Rice	82.2	56.3	50.89	33.84	62.38	57.12
Beans	38.63	93.5	100.52	106.50	116.46	91.12
Corn	3.23	55.61	82.88	75.54	99.72	63.39
Sorghum	0	97.38	101.91	56.54	111.23	73.41
Beef	116.78	76.86	95.46	103.96	178.11	114.23

Source: ECLAC, 1999.

Table 2.3. Exports of Main Agricultural Products of Central American Countries, 1998.

Item	Costa Rica		El Salvador		Guatemala		Honduras		Nicaragua		Total	
	volume[a]	Value[b]	volume	Value	volume	Value	volume	Value	volume	Value	volume	Value
Cotton	0	0	1.4	1526	0	0	0	0	0.9	1274	2.3	2800
Sugar	106.1	39.2	243.9	66.5	1364.5	315.8	21	10.2	186.5	44.6	1922	476.3
Banana	2013.5	616.1	0	0	650.2	177.0	513.3	175.7	74.3	19.5	3251.3	988.3
Coffee	129	405	100.7	322	212.7	585	139.8	430	55.1	171	637.3	1913
Beef	12100	22700	2	2	437	N/A	1792	4000	19036	34551	33367	61253
Shrimp	4889	61289	4510	32785	7516	27494	9513	128800	5167	86665	31595	337033

Source: ECLAC, 1999. For all countries: (a) Cotton, Sugar, Bananas, and Coffee in 1000 TM; Beef and Shrimp in TM; (b) Sugar, Bananas, and Coffee in million of US $; Cotton, Beef, and Shrimp in 1000 US $.

Table 2.4. Imports of Main Agricultural Products of Central American Countries, 1997.

Item	Costa Rica		El Salvador		Guatemala		Honduras		Nicaragua		Total	
	volume[a]	Value[b]	volume	Value	volume	Value	volume	Value	volume	Value	volume	Value
Rice	65.2	25565	34.3	11332	26.6	8692	58.0	28061	81.2	34382	265.3	108032
Beans	19.6	11499	6.2	5312	0.1	31	1.1	437	1.8	803	28.8	18082
Corn	568.5	93749	325.9	55670	251.2	38272	116.1	25364	16.3	2836	1278	215891
Sorghum	0	36	5.1	1038	0.1	144	70.5	10561	0.9	629	76.6	12408
Wheat	309.2	62624	173.2	33576	262.8	51972	154.8	44341	65.2	14621	965.2	207134

Source: ECLAC, 1999. For all countries: (a) volume in 1000TM; (b) value in 1000 US$.

To get a better idea about food self-sufficiency in Central America, self-sufficiency ratios are included in Table 2.2. It is clear that in all agricultural products for domestic consumption, such as rice, beans, sorghum, and corn, domestic consumption has to rely on imports. This situation implies that countries have to earn foreign exchange to satisfy needs of main food staples. Thus, other crops devoted to exports are helpful in coping with this situation.

Agricultural exports are very important for the Central American countries. As was shown in Table 1.1 in Chapter one, agricultural exports made up 52.52% of Central American total exports in 1997. This important contribution to exchange earnings came from exports of coffee, cotton, sugar, bananas, and beef. Historically, these crops have represented the main source of foreign exchange (Table 2.3). However, in recent years, exports of shrimp have been increasing steadily and lately shrimp exports have made up a good share of agricultural exports.

Central American Agricultural Policies

There are many obstacles to production and trade in Central American countries. Various measures, such as licenses, permits, import and exports taxes are widely applied in all countries. On the contrary, it seems that little policy efforts in food production are directed to promote production of agricultural commodities in Central America when compared to other countries outside the region. Table 2.5 shows export restrictions effective in Central America in 1999. Permits and licenses are required to export in all countries with the exception of Honduras. In addition, the degree of restrictiveness varies across countries. Nicaragua is the most restrictive country among those imposing restrictions. Export quotas are only imposed in El Salvador on exports of textiles to the

US. This is probably related to the activity of the export processing zones (EPZ) or "*maquilas*" present in the country.

As in the case of exports, there are restrictions to imports in Central America. According to Table 2.6, with the exception of Costa Rica and Honduras, permits and licenses are widely used in Central America. Nicaragua is the extreme case of import control since licenses are required for all imports. However, there were no quantitative restrictions such as quotas in Central American countries in 1999.

As in many other developing countries, export taxes are present in Central American countries. Coffee, bananas, sugar, and beef are affected by this type of tax (Table 2.7). Exports are more heavily taxed in Costa Rica when compared to the rest of Central American countries. On the contrary, there were no export taxes in effect in El Salvador or Nicaragua in 1999. In Guatemala, export taxes are applied to all commodities. In Honduras, only the export of bananas is taxed.

The application of an import tax or tariff is another kind of restriction to trade commonly used in Central America. In general, there has been a tendency to tax imports of final goods more heavily than imports of capital goods and raw materials. This is consistent with data reported in Table 2.8. Accordingly, all countries impose taxes with a maximum level between 15-18% and minimum level of 0%. This is in agreement with the new economic integration negotiations developed during the nineties.

On the other hand, some producer support policies are implemented in Central American countries. However, in developing countries it is more common to find taxes than measures of support. In the case of Central America, the most common measure of support to agriculture is the implementation of subsidy programs for exportable commodities, taxes and import duties exemptions for agricultural inputs (fertilizers,

Table 2.5. Trade Policies in Effect in Central America in 1999, Export Restrictions.

Item \ Country	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua
Licenses/Permits	Permits are required for products of vegetal, sea, and mineral origin, wildlife species, drugs, flowers, textiles, weapons and explosives.	Licenses for endangered species, coffee, sugar, and other products under international agreements. Permits for diesel, liquified gas, cement, animal feed, sea products, meat, medicines and biological agrochemicals	No permits required. Licenses to export to Central America, except Costa Rica when payment is made in US currency. Licenses are required to export to the rest of the world.	Not required	Permit for: metal for recycling, capital goods, shrimp, lumber, fur, taxidermic pieces, leather, various forestry products, coffee, live animals, vehicles, processed wood except cedar and mahogany, personal property, scientific and commercial exhibits. Precious metal can be exported only with authorization of the Central Bank
Quotas	None	Textiles for the US market	None	None	None

Source: SIECA, 1999.

Table 2.6. Trade Policies in Effect in Central America in 1999, Import Restrictions.

Item \ Country	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua
Licenses/Permits	Only for petroleum products	License to import endangered species. Permit for gasoline, kerosene, turbo fuel, diesel, petroleum, liquefied gas, textiles, fiber bags, sugar, molasses.	Licenses not required. Permits for natural and synthetic rubber, fertilizers, basic staples, oilseed, wheat fluor, herbicides, insecticides, animal feed and veterinarian products.	None	Licenses are required for all imports.
Quotas	None	None	None	None	None

Source: SIECA, 1999.

Table 2.7. Trade Policies in Effect in Central America in 1999: Export Taxes

Item \ Country	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua
Coffee	a)1.5% of the exported value in US $ at all prices b)An additional 1% of the price FOB if the price of a 46 Kg sac is above US $92.00.	None	1.0% of the price FOB	None	None
Bananas	1.0% of the FOB price, $0.18 and 1.5 colones for each exported box	None	None	$0.18 per 40 Lb. box.	None
Sugar	1.0% if FOB price is below US$18.00, 5% when price is between US$18.00 and US$23.00, 13% if price is between US$28.00 and US$33.00, and 18% if price is above US$35.00	None	None	None	None
Other	Beef: 1.0% of the FOB price Cattle: Pure breed: 1.0%, Mixed breeds: 6.0%	None	1.0% of FOB price except import regime and Export Processing Zones (Maquilas)	None	None

Source: SIECA, 1999.

Table 2.8. Trade Policies in Effect in Central America in 1999: Import Taxes

Item \ Country	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua
Various	18% of value of final goods 1.0% of the value of raw materials and capital goods	15.0% of the value of final goods. Between 5% and 10% for intermediate goods. 0% for raw material and capital goods.	17% for final goods 7.0% of value of intermediate goods. 0.0% for raw material and capital goods.	18.0% of the value of final goods. Between 5% and 10.0% of the value of intermediate goods. 1.0% of the value of capital goods and of all kinds of raw material (medicines, fertilizers, insecticides, and agricultural fungicides)	between 0.0% and 15.0%. In general higher rates are applied to sugar, sucrose, rice, beans, white corn, and chicken.

Source: SIECA, 1999.

Table 2.9. Support Policies in Effect in Central America in 1999: Subsidies

Item \ Country	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua
Various	Tax Credit Certificate (CAT) for non-traditional agricultural products exported to the rest of the world. 8% minimum and 20% maximum of the FOB value. A 15% tax is applied to the total amount of the CAT.	A subsidy is given to diesel for public transportation and gas for domestic use.	A marginal subsidy is given to public transportation	A subsidy is given to public transportation. Electricity is subsidized when private monthly consumption is less the 300 kWh.	1.5% of the FOB value of export is given to exporters in concept of compensation for payments on import taxes.

Source: SIECA, 1999.

pesticides, capital goods). Table 2.9 shows that some export subsidies are given to agricultural commodiy exporters in Costa Rica and Nicaragua. No measures of direct support were reported in the rest of the countries.

Central American Common Market (CACM)

The CACM was first established in 1960. A number of problems of various nature caused its virtual disintegration in the eighties. In 1992, an effort to revive the CACM was in vogue and a series of steps were taken to do so. In this section, a review of the nature of the agreement of 1960, the objectives, achievements and problems are discussed. Then, a review of the direction of economic integration in the nineties is presented and compared to that of the sixties and seventies.

CACM in the 1960-1980 Period

Economic integration in Central America apparently started a long time ago. According to Quiros-Guardia (1973), after World War II there was a favorable international market situation for many Central American export products, such as coffee, bananas and other agricultural products. This situation led to a network of bilateral agreements among Central American countries in the 1950s. The changing situation in the international economic environment and the European Common Market in that period became the inspiration for Central American countries to sign the *"Central American Treaty on Tariff Equalization"* of 1959 and the General *"Treaty of Central American Economic Integration"* of 1960 (SIECA, 1999). For a better understanding of these treaties, their main objectives are presented here.

Walter et al (1967) mentioned five main objectives of the Central American Economic Integration Treaty of 1960. First, the most important objective was to establish

a regional free trade area. Secondly, an equalization of external tariffs was envisaged. Third, the harmonization of measures to promote industrialization was another objective included in the agreement. Free mobility of capital and labor was the fourth objective. Finally, the last objective was the encouragement of industries to produce and supply for the regional market. So, the main objective of the CACM was to create a customs union for the goods being produced in Central America.

For the purpose of achieving the objectives mentioned above several organizational structures were created (McClelland, 1972). The economic council, made up of the five ministers of economy, was among the highest authority in the system. The executive council, made of the five vice-ministers of economy, was responsible for the direct execution of the agreements. The Permanent Secretariat (SIECA), made up of international officers highly trained and competent (Business International Corporation, 1969), was responsible for the technical matters of the integration process. The Central American Bank for Economic Integration (CABEI) was the financial institution through which important projects for the economic integration of the area were to be financed. The monetary council formed by the presidents of the central banks of the countries had the tasks of the stabilization of the exchange rate and, in the long run, the creation of the Central American currency unit.

It is important to mention that the scheme of integration of the sixties not only pursued economic but also political integration of the region. Therefore, several structures of political objectives were established. The Central American Court of Justice was created as a supreme court at the regional level. The Education Council, the Central American Legislative Council and the Central American Defense Council were established to promote political integration in the region (Business International Corporation, 1969).

Along with the objectives and organizational structures of economic and political integration, the "rules of the game" of integration were created and established. For this purpose several protocols were signed and brought into effect. In 1958, the *"Multilateral Treaty of Free Trade and Central American Economic Integration"* was signed in Honduras. This treaty was supplemented with a treaty on integration industries (Walter, 1967). The former was the first document defining the integration process. The latter defined what industries would be given a status of regional development importance and would enjoy free access to the markets of all countries. In 1959, the "*Central American Agreement on Equalization of Import Duties*" was signed. This agreement defined a five-year schedule to equalize external tariffs.

The "*General Treaty of Central American Integration*", signed in 1960 in Nicaragua, is probably the most important document related to the economic integration in the area. This treaty formally established the creation of a customs union over a five-year period. At the same time, the protocol of the agreement on the equalization of import duties and the agreement establishing the Central American Bank of Economic Integration (CABEI) were ratified (Walter, 1967). According to this general treaty the CABEI was envisaged as an institution with a high degree of independence although its capital was created with funds from each country member and with funds provided by the U.S. In addition to these agreements, many other protocols were signed in the same period to regulate the activities of the CACM (SIECA, 1999).

Organization Structure of the CACM in the 1960-1980 Period

Implementation of the CACM in the way it was planned required an adequate structure to be successful. The structure of the CACM in the sixties is shown in Figure 2.1.

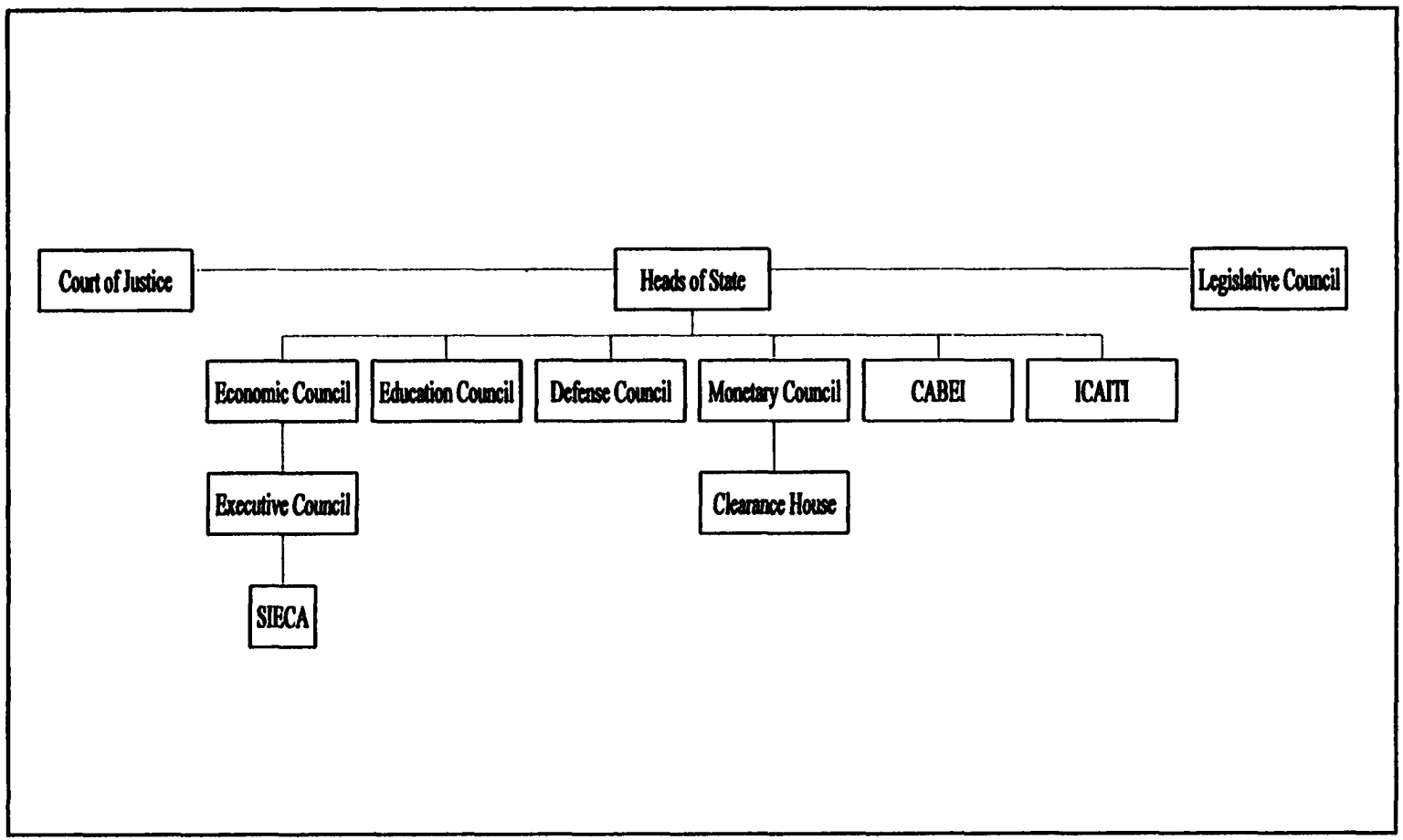

Figure 2.1. Organization of the Central American Common Market of the Sixties

Since one of the main objective of the economic union was to achieve political union, the formation of the CACM brought about the formation of the Court of Justice and the Legislative Council or Central American Parliament. The structure of the integration scheme in Central America was greatly dependent on the economic, education, monetary, and the defense council which were of great relevance in the implementation of the CACM agreements. All matters related to economic development were under the responsibility of the economic council and the direct execution under the responsibility of the executive council.

The CABEI and the Central American Research Institute of Industrial Technology (ICAITI from the name in Spanish), given status of institutions, were very important in the development of the CACM. Various projects directed to strengthen integration in the area were to be primarily financed by the CABEI. The CABEI was the main source for large projects such as the international Pan-American highway and other large projects in the area for public and private industries. Finally, the ICAITI was the main industrial research institution of the CACM. The ICAITI was instrumental in developing feasibility studies in several industrial sectors of the Central American economies. The SIECA, the Permanent Secretariat of Central American Integration, strongly relied upon the advice of the ICAITI in deciding on what was convenient or undesirable for the CACM economy.

Performance of Central American Countries under the CACM in the 1960-1980 Period

In general, there is a common consensus that the implementation of the CACM brought many positive changes to the economies of the Central American countries (Wardlaw, 1966;Walter, 1967; Business International Corporation, 1969; McClelland, 1972; Alonso, 1994). Moreover, in many cases the CACM experience has been presented

as an example of success of integration in less developed countries (Robson, 1984). However, for some analysts, the fast changes during the period 1960-80 are not only a result of the implementation of the CACM but also of the favorable international terms of trade for agricultural products (Alonso, 1994). Since it is somewhat difficult to measure the impact of the CACM on the development of the region, analysts have different opinions on this point.

However, under the CACM, countries began to grow at a fast rate. For example, between 1960 and 1970, the real GDP of Central American countries grew at 6% on average. This rate was above the 5.6 % average growth rate for all Latin American countries (Washington Institute for Values in Public Policy, 1983). This situation favored intra-regional and international trade in the area. For example, between 1960 and 1965 exports increased in the area by 316% to a total of $132 million and total exports in the area reached $772 million (Table 2.1) (Wardlaw, 1966; Institute of Latin American Studies, 1988). Thus, as a result of the elimination of internal tariffs, intra-regional trade grew in the first three years from 3.5% to 27% of total trade. In addition, by 1968, manufactured commodities were two-thirds of intra-regional exports (Washington Institute for Values in Public Policy, 1983).

The impressive picture of the sixties contrasted with that of the seventies. During the first half of the seventies, real economic growth in the region declined to 5.2% whereas the total growth rate in Latin America averaged 6.5%. However, the worst was yet to come. In the second half of the decade real GDP in Honduras grew at a rate of 6.6% but in Nicaragua it declined by 1.8% in 1978, causing the region's growth to decline to 1% on average (Washington Institute for Values in Public Policy, 1983).

In addition, the fast population growth rate observed in the area during the years 1960-80 caused per capita economic performance remain below the average for all Latin American Countries (Washington Institute for Values in Public Policy, 1983). For example, measured in 1980 US$, per capita income in 1960 averaged $692 in Central America against an average of $842 for Latin America as a whole. By 1970 per capita income of the CACM ($991) was still below the average for Latin America ($1106). Thus, during the period 1960-80 the average population growth rate for CACM was 2.8% while the average economic growth rate was 5.12%. Per capita income growth rate was 1.8% during the same period which was below the average for Latin America as a whole.

Although the implementation of the CACM expanded trade in the region, the balance of trade of the CACM countries worsened relative to the rest of the world during the same period (Table 2.10). From 1960 to 1980, the value of imports of the CACM increased 18% while exports increased 11.9% per year on average. This is one of the main reasons for the negative trade balance of the CACM relative to the rest of the world during

Table 2.10 Trade Balance of CACM Countries in Selected Years (US$ Million).

Years	Imports		Exports		Trade Balance	
	Total	Regional	Total	Regional	Total	Regional
1960	468	33	444	30	-24	-3
1965	806	121	772	132	-34	+11
1970	1133	310	1113	299	-20	-11
1975	2704	520	2352	519	-352	-1
1980	5657	1160	4775	1160	-882	0

Source: Institute of Latin American Studies, 1988.

the analyzed period. At the regional level, both imports and exports grew 18.24% per year on average during the same period. So, it seems that the trade balance worsening was

mainly caused by the slow growth in exports to rest of the world relative to the growth in imports.

Another perspective of CACM performance can be obtained from the industrial and agricultural sectors. It appears that industries related to consumer goods (foodstuff, shoes, textiles, etc) and others with historical tradition were the most dynamic industries during the first decade of the CACM (Institute of Latin American Studies, 1988). In addition, some intermediate goods industries expanded in those years (paper, tires, petrochemicals and metal-mechanic). This pattern of development, known as Import Substitution Industrialization (ISI), caused industrial production share in the GDP to increase from 12.3% in 1960 to 17% in 1970 (Institute of Latin American Studies, 1988) and then decline to 14% between 1970 and 1980 (Washington Institute for Values in Public Policy, 1983).

Agriculture has been the main source of foreign exchange earnings for Central American countries. Bananas, coffee, cotton, beef and sugar have been historically the primary export products accounting for about 80% of foreign exchange earnings. By contrast, intra-regional exports have consisted mainly of manufactured commodities (Alonso, 1994). As of 1980, agriculture continued to be the most important source of exchange rate revenue of the economy despite the integration process. However, agricultural share in the GDP decreased from 29% in 1960 to 25% in 1970 and to about 23% in 1980 (Washington Institute for Values in Public Policy, 1983). In addition, food self-sufficiency notably decreased in the seventies and enormous shortages in the food supplies became increasingly apparent. Also, there still exists backwardness in storage infra-structure and food preservation (Institute of Latin American Studies, 1988).

Factors Affecting Performance of the CACM in the 1960-1980 Period

As was mentioned before, the Central American experience with the CACM has been presented as an example of successful economic integration among LDC. However, despite the initial great success, the CACM had practically disintegrated by the beginning of the eighties. Analysts mention many factors that worked for the initial success and later failure of the CACM from 1960 to 1980.

A.- Input Substitution Industrialization (ISI) Scheme as the Philosophy of Growth

Ballance et al (1982) defined Input Substitution Industrialization as a long term process. Initially, a country following this scheme should discourage consumer goods imports through imposition of tariffs to protect and enhance conditions for domestic production. Secondly, expansion of production of supplies and intermediate goods is achieved. Finally, production of capital goods is expanded. The immediate objective of this process is to initially encourage consumer goods industries followed by an expansion of industries supplying inputs to reduce dependence on external sources of inputs. Thus, import substitution should create an industrial sector able to rely on domestic sources of inputs and capital goods. Once the industrial sector has developed enough to become competitive relative to international suppliers of manufactures, tariffs were to be reduced to create a competitive environment as an incentive to further industrial growth.

There is an accepted concept that ISI has not been implemented as initially suggested in most LDC including those of the CACM and therefore many problems have arisen (Ballance et al, 1982). For example, once tariffs were imposed, their levels were never reduced and this became a permanent feature of industrial policy. In addition, the structure of the economy has been affected by two types of bias. The "home market" bias

caused resources to be reallocated out of agriculture and mining into the import-competing industries due to discrimination against exporters. The "consumer good" bias caused a shift of resources out of less favored manufacturers to import-competing industries. Thus, as can be expected under the ISI scheme, agriculture was the main loser in most of countries that followed this model of industrial development. In addition, this protectionism often led to very high profits, inefficient use of resources and has been crucial in discouraging the establishment of industries providing inputs. The reason for the discouragement in establishing industries providing inputs is that final goods producers did not want to have any competition for the benefits of protection they enjoyed and they knew that producers of intermediate products could eventually also be protected and become competitors for those benefits.

In brief, it has been stated that the good industrial performance of the CACM in the sixties was a consequence of the first stage of the ISI scheme and the poor performance in the seventies was a consequence of the end of this stage (Institute of Latin American Studies, 1988) and the incorrect implementation of the ISI scheme. Because of the incorrect implementation of the ISI scheme, protection remained at high levels for consumer goods industries. In addition, only a small number of intermediate industries was established between 1960 and 1980. This situation led to a growing dependence on external sources of oil and raw materials. Since prices of oil and raw materials increased greatly in the first half of the seventies, the share of manufactures in the GDP during the seventies decreased considerably.

B.- Dual Economy

The economies of the Central American countries historically have consisted of a subsistence domestic sector and a strong exporting sector (Alonso, 1994; Institute of Latin

American Studies, 1988). The export sector is mainly characterized by large size properties, high concentration ratios and the control of export of agricultural products (coffee, bananas, sugar cane and cotton). The subsistence sector consists of small farms with low productivity, low income and high levels of unemployment. The subsistence sector produces mainly beans, rice, corn and sorghum. In addition to this division of the agriculture sector, there is a lack of productive infrastructure (irrigation sources, means of transportation and communications, shortage of financial credit, etc.). Few efforts have been directed to remedy this situation and the export sector has been the main beneficiary. The declining growth in agriculture during the seventies was caused by a decline in the world price of the export products. This situation led to large shortages of food and exchange earnings to purchase food abroad. In addition to the worsening terms of trade, trade balance got almost out of control by the end of the seventies.

C.- Industrial Integration Process

In the fifties, Central American countries lagged in industrial development relative to leading Latin American countries. Therefore, to accelerate industrial development in Central America, the "*System of Integration Industries*" agreement was signed in 1958. The program was intended to promote and coordinate development through the creation of free internal trade for designated products of chosen companies (Walter et al, 1967). The idea was that chosen companies would receive exclusive "common market rights" for a period up to ten years. Other companies selling the same product would be forced to trade in the CACM with the same tariffs applied to imports from outside of CACM. However, these barriers were to be gradually decreased in a period of ten years. As can be inferred, the purpose was to facilitate the establishment of important industries that otherwise could

have not survived under the ongoing market conditions. One of the major concerns of the program was to prevent concentration of industries and therefore a second integration industry could not be granted to any CACM country until every member nation has been awarded one.

In practice, problems with this system of industries became apparent soon after its creation and therefore it did not have the expected results. First, a provision of the general treaty signed in 1960 granting immediate internal free trade in all products supplied within the CACM practically nullified the system (Walter et al, 1967). Secondly, there was opposition form external sources of financing, particularly the AID, which saw in this program a monopolistic nature discouraging the free trade and enterprise that were the very nature of the economic integration treaty of 1960 (Cochrane, 1964). Thirdly, economic theory suggests that it is more economically feasible to create large industrial centers than a distribution of industries over a large geographical area (Krugman, 1994).

D.- Fiscal Policy for Industrial Development

Fiscal incentives as a means to attract foreign investment for rapid industrial development became a two-edge sword for countries using them. For example, CACM countries that have used a wide variety of incentives to attract investors have found that in the long run the effect of such policies has not been as positive as expected (McClelland, 1972). This happens because competing countries are likely to offer better incentives relative to these countries in order to secure investment. Once the offer is made, other countries competing for investment will offer a better deal to investors than the initial offer they received. This process may continue until a point at which a country could be made worse off with the establishment of industries than without them. This may happen because

of losses in government revenue due to offered tax breaks, subsidies, monopoly rights, and so forth. So, in the end, competing countries would be better off by agreeing on the level of fiscal incentives to be given to investors instead of competing against each other. This seemed to be a strong incentive to unify fiscal policies within the CACM.

It seemed that Central American countries seriously intended to implement uniform fiscal policies to attract investment. Article 19 of the general treaty stated the intention to reach an agreement which would substitute the existing programs of each country on fiscal incentives for industries. In July 1962, an agreement to unify fiscal incentives was signed by all CACM countries. The harmonization of laws of the respective member countries to provide the greatest possible incentives and the correction of the disparities that contributed to imbalances in regional development were two important objectives of this agreement. In addition, the agreement was very detailed in specifying various types of incentives to be granted to industries according to their importance in CACM countries' industrial development. Finally, the agreement was to be completely enforced by 1970.

However, practical implementation of this agreement proved to be an impossible task leading to negative repercussions for the economies of CACM countries. For example, in 1969, when Honduras withdrew from the CACM, this agreement had not been ratified by several member countries and it was never enforced. In the meantime, each country had resumed implementing a wide variety of fiscal incentives to attract investors. On the other hand, it has been argued that investors looked at other factors, such as location of natural resources , labor, weather, local financial institutions and so forth, in addition to fiscal incentives, to make a decision on what and where to invest in Central America (Business International Corporation, 1969). Therefore, as each country resumed offering its own fiscal

incentives to attract capital, results showed a wasteful use of these policy instruments, resulting in welfare losses for CACM members (McClelland, 1972).

E.- Political-military Problems

Political and military instability in the Central American region has been another negative factor for economic development. Political instability in the region began to be more notorious after it received independence from Spain in 1821. Local political forces were not educated enough to run the countries in a stable way and therefore political turmoil was often the way to solve economic and social problems. Turmoil scared away many potential national and foreign investors. In addition, foreign powers tried to "re-conquer" the region several times. This compelled countries to exert great efforts into building armies and defending themselves from foreign re-colonization attempts.

In the last few decades, the war between El Salvador and Honduras in 1969, civil unrest during the seventies in Guatemala and El Salvador, the Sandinista revolution of Nicaragua in 1979 which led to a change of government in Nicaragua, the re-militarization of the area; the continuous US intervention in the area (Institute of Latin American Studies, 1988), and beliefs of interventions from other Central American Countries (Schmitter, 1972) may be mentioned as some of the negative political and military conditions surrounding achieving the goals of the CACM agreements. Thus, these conditions created an endogenous problem that negatively impacted economic development in the area. For example, it is assumed that the failure of the CACM agreement is due partly to political instability, which led to disinvestment and dis-industrialization in the area (Institute of Latin American Studies, 1988). For example, in the sixties, gross domestic investment (GDI) grew faster than the average for Latin America 7.3%. However, in the seventies, GDI

growth rate slowed down and in some countries there was no growth at all. This can be explained by capital flight, reduced access to international capital markets, lower saving rates and chronic trade and budget deficits. All these conditions were effects of the political instability in the region (Alonso, 1994).

F.- Social-economic Problems

Social-economic conditions in Central American countries may be seen as a cause and at the same time as an effect of failed attempts to develop the region. On the one hand, poor economic conditions have led to inability to adequately satisfy social needs. Generally speaking, social conditions, such as nutrition, health, employment, education, and housing, have been historically less satisfactory in Central America than in other Latin American countries (Washington Institute for Values in Public Policy, 1983). On the other hand, the very existence of such conditions have made it impossible to develop the region rapidly. Thus, attempts to implement various programs in the region have failed because the region lacked the necessary physical infrastructures, skilled and educated labor, and other important pre-conditions for an fortunate end to such efforts.

G.- Terms of Trade

Worsening terms of trade for agricultural products over time have led to worsening trade balances and, in turn, deficits in balances of payments. This has had the consequence of causing lags in industrial development in the CACM (Alonso et al, 1994). The center-periphery development upon which Latin America has built its international economic relations is blamed for the many problems the region faces today and the CACM is not an exception (Institute of Latin American Studies, 1988). It is argued that this scheme of relationships led to unequal exchange due to worsening terms of trade. The CACM exports

consist mainly of agricultural products for which terms of trade have declined considerably and productivity growth has not kept the pace to offset the decline in terms of trade of agricultural commodities in the last few decades. This situation has led to an increase in the negative trade balance for this area (Table 2.10). In addition, the small sizes of national markets worked against the possibility of selling greater shares of agricultural product domestically at higher than international prices.

H.- Budget Deficit

Budget deficits have been a chronic problem long before Central American countries entered the common market. The situation did not improve under the CACM (Alonso, 1994). The competition among countries in using fiscal incentives to promote domestic investment domestically may well have reduced government revenues even more and, in turn, led to increases in budget deficits (McClelland, 1972; Institute of Latin American Studies, 1988). In addition, low or negative savings, defined as current revenues minus current expenditures, may cause a decline in capital expenditures and become an obstacle for the overall development of the region. This situation was one more problem faced by the CACM, which, without adequate infrastructure had little chance of succeeding.

I..- Natural Disasters

Central American countries probably have suffered the fury of nature more than any other part of the world. The geographical location of the region makes it a target for a wide variety of natural disasters that have negative impacts on social and economic development. Hurricanes, earthquakes, volcanic eruptions, floods, and tsunamis are among the most common disasters in the area. To name a few cases, in the sixties Guatemala City was completely destroyed by an earthquake. In 1968 one volcanic eruption almost completely

destroyed León, one of the most important cities of Nicaragua. In the seventies, an earthquake destroyed Managua, the capital of Nicaragua, killing 15,000 people. In 1976, Hurricane Fifi completely devastated Honduras. Floods are present in all countries almost every year during the rainy season. In 1998, Hurricane "Mitch" devastated Honduras and caused many human and material losses in Honduras, Nicaragua, El Salvador, and Guatemala. So, mother nature has also slowed down economic growth in Central American countries by sending to this region many unfortunate catastrophes (Institute of Latin American Studies, 1988). This catastrophes have provoked human and material losses by order of many billions of dollars for the region during the period of study.

CACM in the 1980-1990 Period

As Alonso et al (1994) put it, the economic performance of Central American countries during the eighties was disastrous. Moreover, the CACM had almost disintegrated by 1981. Armed conflict broke out in several countries of the region and economic problems inherited from the seventies increased. Alonso et al (1994) argued that the decade can be divided in three periods. The period form 1981 to 1983 was a period of recession and all Central American countries experienced negative growth rates. This was caused mainly by a world-wide recession and a further deterioration of export prices of agricultural commodities. The second period, extending from 1984 to 1986 witnessed a modest recovery was present in all countries with the exception of Nicaragua. The last period was from 1986 to 1989. During this period, economic growth slowed due to poor performance of exports. So, the eighties was one of the saddest period in the history of Central American countries (Lizano, 1989).

A General Evaluation of the CACM in the 1960-1990 Period

Since the CACM appeared to have vanished in the decade of the eighties in comparison to what was initially planned, it is desirable to evaluate the positive and negative consequences of regional integration and what future perspective the market had at the end of the eighties. In evaluating the general performance of the CACM in its first era of existence it is important to compare the achievements with the initial objectives of the CACM agreements. In addition, an assessment of what conditions made the CACM to enter such an acute crisis is in order to avoid these mistakes in the present second era of the CACM. The evaluation of the CACM is developed in three subsections. The first subsection gives a brief introduction of the historical nature of the CACM, what was gone and what remained at the end of the eighties. The second subsection consists of what could be thought as positive consequences of the CACM during that period. The third section evaluate the obstacles to the CACM. Finally, final thoughts on the integration scheme during these 30 years are given in the last subsection.

Historical Background for the CACM (1960-1990)

To understand the particular nature of the CACM as an economic integration scheme, a brief historical prelude can be of considerable help. During the fifties, it became increasingly apparent that there was an urgent need to raise living standards of the populations of Central American countries. Governments as well as national and international institutions undertook the task of assessing the best way to do so. This task was not easy. Economically and socially speaking, Central American countries were already long behind more developed countries. Without a developed productive sector, many necessary products were imported from abroad. Therefore, there was a need for foreign

exchange. To obtain foreign exchange, countries had to heavily rely on international trade and terms of trade were not always favorable. This situation brought about the need to decide whether to export more to gain more foreign exchange or to produce normally imported products domestically. However, the possibility of developing and establishing a strong agricultural and industrial domestic sector to fulfill domestic needs was impossible, given the small size of each country taken alone. On the other hand, given resources endowment of each country, no country sought to follow an export-led economic growth scheme. This situation was probably one of the strongest reasons why the CACM as an economic integration scheme was planned initially using the ISI model discussed earlier.

The CACM had general and specific objectives. Lizano (1989) stated that there were two main objectives of economic integration: increasing the size of the Central American market by removing barriers to regional trade, and enabling the region to participate more fully in the world economy. These two objectives appear to have been fulfilled in the first 10 years of existence of the CACM. However, its performance during the following two decades showed that the process of trade liberalization was reversible, as countries re-established protectionist barriers in the 70 and 80s. In spite of this situation, there is a consensus that the success of the CACM in promoting intra-regional trade was overwhelming. The value of intra-regional trade reached one billion dollars in 1980 and represented 20% of the CACM total external trade up from 6.5% in 1960 (Lizano, 1989). However, several adverse conditions made the CACM intra-regional trade fall to 9.0% of total trade in 1987. Increases in trade barriers were present among these conditions.

The second main objective is difficult to evaluate because the structure of trade of the CACM with the rest of the world did not change much from 1960 to 1990 (Alonso,

1994). Coffee, bananas, cotton, sugar, and meat continued to be the main export commodities of the CACM. Imports continued to be represented by manufacture, fuels and consumer goods. Lizano (1989) mentioned that the Central American area could be characterized by its openness to international trade during the fifties before the CACM agreements were reached. However, had the agreements not been signed, countries probably would have increased the level of protection anyway. So, in Lizano's opinion, the CACM served as an alternative to prohibitive levels of protection by Central American countries. From this point of view, the CACM may be said to have fostered a better participation of Central American countries in the world economy.

Several specific objectives were pursued under the CACM. In the economic sector, an economic union was envisaged. In the political arena, a Central American republic was foreseen. With a Central American republic in mind, the defense council was established. The equalization of education standards was pursued and the education council created. To save foreign exchange, which would be devoted to more urgent needs, the Central American Clearing House was created. Moreover, the monetary union was also one long run specific objective. However, none of these specific objectives was completely fulfilled. Since each country has other economic and political problems to solve, too little attention was given to the compromises within the CACM agreements. In addition, Central American countries have historically lacked a true commitment to unity and this was a big obstacle to achieve the specific objectives mentioned above.

Positive Effects of the CACM (1960-1990)

Lizano (1989) mentioned several positive consequences of the CACM besides the considerable increase in regional trade. First, although the CACM had almost disintegrated

by 1981, some institutions remained. The permanent secretariat of the treaties (SIECA), the Central American Bank for Economic Integration (CABEI), the Central American Institute of Public Administration (ICAP), the Central American Institute for Research and Industrial Technology (ICAITI), and the Central American Clearing House (CACH) have proven flexible and resilient in adapting to changing circumstances. These institutions were a signal that the CACM was not completely dead and they continued to operate under the uncertain environment of the eighties when the future of the CACM seemed to be ominous. Second, the CACM fostered growth in the manufacturing sector, which has had important effects, such as the acceleration of the urbanization process and the formation of an industrial proletariat. Third, countries have learned from the experience within the CACM to deal with conflicts and disputes related to trade in a more educated and efficient manner. Fourth, member countries learned to save foreign exchange by using the Clearing House.

Obstacles to Successful Regional Integration in the 1960-1990 Period

There are various factors that badly affected the implementation of the CACM during this period (Lizano, 1989). First, costs and benefits were not adequately distributed among countries. Thus, although technical analyses show that the whole area benefitted from integration, Honduras and Nicaragua complained that they could have been harmed by the agreement. The possible negative effects are related to the consumption of regionally produced goods at prices higher than international prices and geographical concentration of industrial output in countries that enjoyed a greater degree of industrial development. This was mainly caused by two factors. First, there was a lack of agreement on fiscal incentives to new industrial companies. The agreement signed in 1962 was never enforced.

Secondly, the System of Integration Industries agreement, signed in 1960, was never fully implemented and caused disparities in industrial development among countries. In

addition, there was a lack of coordination of national economic policies. In Lizano's opinion (1989), countries were not able to properly perceive that the participation in the CACM implied in part modifications in their own national economic policies. Moreover, countries never coordinated agricultural policies and this represented a major failure of the CACM. This generated some contradictions. For example, Honduras showed comparative advantage in the production of certain agricultural products. However, while this country had to import industrial goods from other Central American countries, it was not allowed to export its agricultural products to these countries.

Monetary policies also were not coordinated and this generated several problems. For example, too little attention was given to the effects of each country's monetary policies on regional trade flows and the regional payments agreement. Thus, if a country expanded the money supply, the volume of imports would increase and exports decrease generating a deficit in its regional trade.

So, regional integration faced many dilemmas that could not be solved effectively and, therefore, this integration attempt essentially failed after the first 10 years of its implementation. This failure could be related to mistrust among countries and lack of complete commitment to regional integration. This could mean that although all the economic instruments to secure success were drawn, countries were always politically reluctant to enter a situation that they probably thought could be too compromising to national sovereignty. For example, there was a lack of will to rationally distribute the benefits and costs of integration because this implied changes in national policies. This is probably why the location of key industrial companies, the agreement on fiscal incentives, and the coordination of national economic policies were never agreed upon.

The CACM from 1990-Present Period

To analyze the CACM during the present decade, this section is divided into three sub-sections. First, a review of the background for the agreement during the nineties is developed and the agreement for the reinstallment of the CACM is analyzed in the context of past decades of experiences. Secondly, the new organizational structure is analyzed. Finally, the performance of the CACM in the present decade is evaluated.

Background for the Integration of the Nineties

Although the eighties witnessed the near disintegration of the CACM, several steps taken in the region brought hope of a renewed effort to revive the CACM. In 1987 and 1988, several peace accords were signed by fighting groups in which fighting parties agreed that armed struggle was no longer a viable alternative to solve the region's problems (Institute of Latin American Studies, 1988). With a clear possibility of entering a peaceful period, governments agreed to discuss the acute economic crisis of the region. Thus, in 1987, the International Commission for Central American Recovery and Development concluded that the region should start to diversify and expand exports to generate foreign exchange and employment (Alonso et al, 1994).

The nineties brought many positive changes to the region. First, armed conflicts were officially ended in Nicaragua, El Salvador and Guatemala. This opened the possibility of a faster economic recovery. Second, Central American governments agreed to reestablish the CACM to foster economic development. Thus, in 1991, the Tegucigalpa protocol was signed. This protocol reformed the Organization of Central American States (ODECA, from the name in Spanish), created in 1962, into the Central American System of Integration (SICA, from the name in Spanish) as the new organization responsible for

overall development of the area (SIECA (a), 1999). Another important document, the Guatemala protocol, which substantially reformed the 1960 "*General Treaty of Central American Integration*", was signed in 1993. The Guatemala protocol became the new general treaty for economic integration in the region (SIECA(b), 1999).

It is worthwhile to discuss the Guatemala protocol because it defines the general new rules of the economic integration. This protocol consists of sixty three articles contained in six titles. Title I conceptualizes the process of economic integration as a means to maximize development options for the contracting countries and their insertion in the world economy. According to this protocol, economic integration is a gradual, complementary and flexible process to enhance the convergence of intention and policies.

Title II defines the objectives and principles of economic integration. The main objective of economic integration is the achievement of equitable, sustainable social, and economic development of the Central American countries. This objective is to be reached by means of a process to transform and modernize the social, technological and productive structure which should bring an increase in competitiveness. This process should help in reaching the efficient and dynamic reinsertion of Central American countries in the international economy.

Title III of the Guatemala protocol refers to the proposed achievements of the process of economic integration in this new period. Chapter I defines the steps to accelerate the transformation of the present free trade zone of Central America into the Central American customs union. In addition, this chapter identifies the need for a uniform external trade relation with the rest of the world. Finally, the free mobility of production factors and monetary policy is addressed. Chapter II addresses the improvement and harmonization

of policies across countries. Chapter III states that all sectors of the economy should be developed in a integrated fashion.Titles IV, V, and VI are the last but not least important titles of the protocol. Title IV describes the institutional organization of the economic integration subsystem which is discussed in more detail in the following subsection. Title V consists of the final disposition of the protocol and title VI describes transitory dispositions of the protocol.

There are not many differences between the treaty of 1960 and the Guatemala protocol. In general, both documents show the intention for a deep integration of the region. Both documents are very general and mostly they state the global objectives of integration. Both documents are very specific in describing the institutional structure of the integration scheme. By contrast, one major difference of the Guatemala protocol is that it eliminated the "*System of Integration Industries*" signed in 1958, the treaty of fiscal incentives of 1962, and the special protocol for grain products (protocol of El Limón). Another major difference is that the Guatemala protocol included Panama and the possibility of Belize to join the CACM.

Structure of the CACM in the Nineties

The organizational structure of Central American integration in the nineties is somewhat larger than that of the sixties. This new structure probably represents the new context of integration. Article 12 of the Tegucigalpa protocol describes the organs of Central American Integration within the Integration System of Central America (SICA) which is shown in Figure 2.2. The highest level of decision within the system consists of the presidential meetings, vice-presidential meetings, the Central American Parliament, the Central American Supreme Court of Justice, and the Consultive Committee. The latter, as

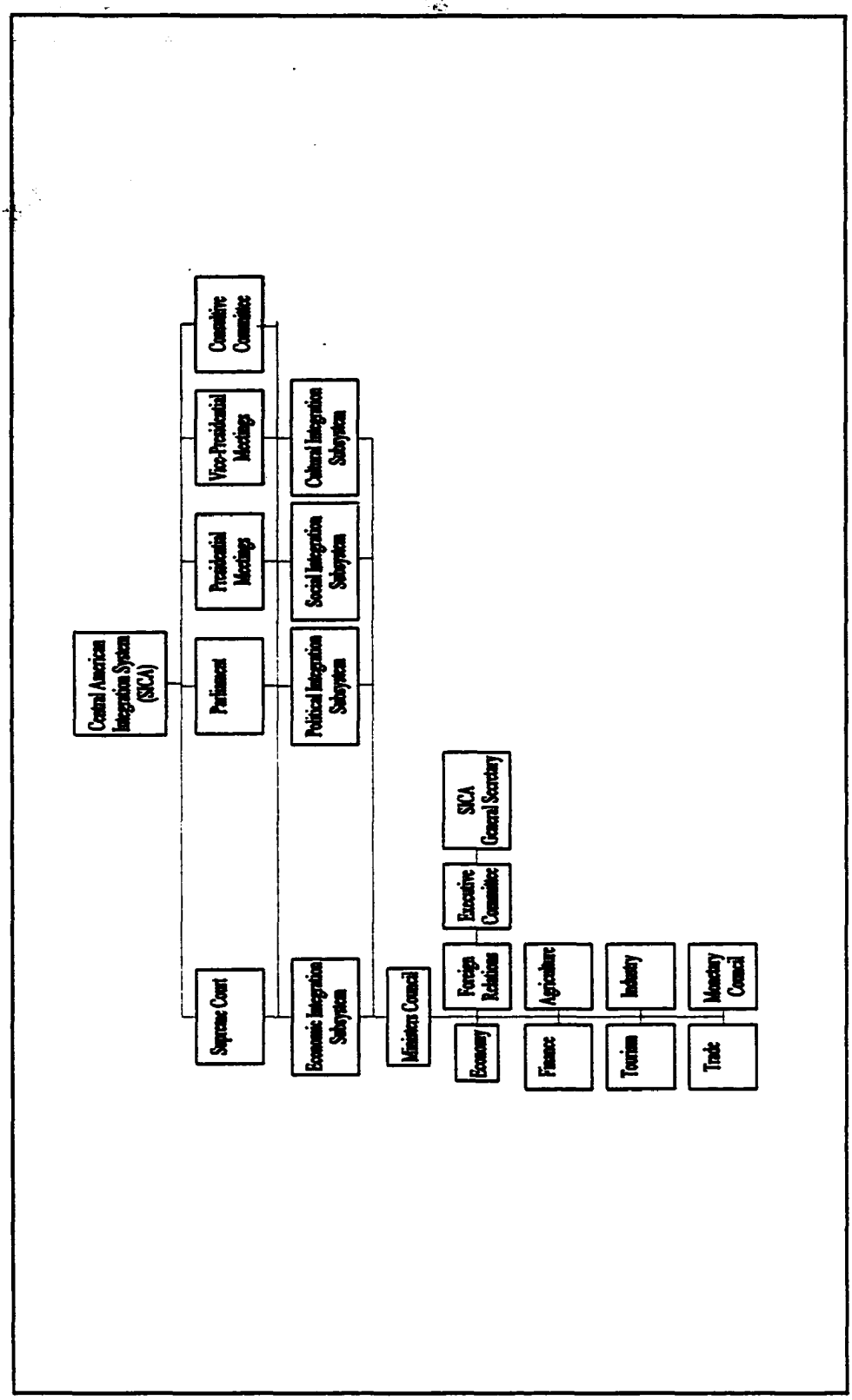

Figure 2.2. Central American Integration System (SICA) General Organization Structure According to the Tegucigalpa Protocol, 1991.

its name implies, is only a consultation organ whose members are representatives of the private sector of the region.

A deep degree of integration seems to be sought this time through the Tegucigalpa protocol. The Tegucigalpa protocol breaks down the integration system into the economic, political, social, and cultural integration subsystem (Figure 2.2). The ministers council is responsible for the implementation of the strategies developed in each subsystem. At the same time, the ministers council relies heavily on the council of foreign relations ministers to implement such policies. The foreign relations ministers council is responsible for the coordination of the sectoral ministers council. In addition, the foreign relations ministers council through the executive committee is responsible for the correct and timely implementation of all agreements, guidelines and policies that are designed by all the subsystems. Finally, the General Secretary of the SICA is the administrative agency of the system. One of the objectives of the SICA is to foster development in all sectors of society in an integrated way.

For purposes of the present research, a detailed description of the economic subsystem is in order. As was mentioned earlier, the Guatemala protocol, signed in 1993, is the juridical framework for economic integration in the region. According to this protocol, the subsystem of economic integration consists of organs, techno-administrative organs, and institutions. This organizational structure is included in Figure 2.3. The Economic Integration Ministers Council is responsible for the coordination, harmonization, convergence or unification of economic policies across countries. The sectoral ministers council of economic integration is composed of the ministers by sector. Mostly these meetings will be held by the ministers of Agriculture, Finance, Economy, Trade, Industry,

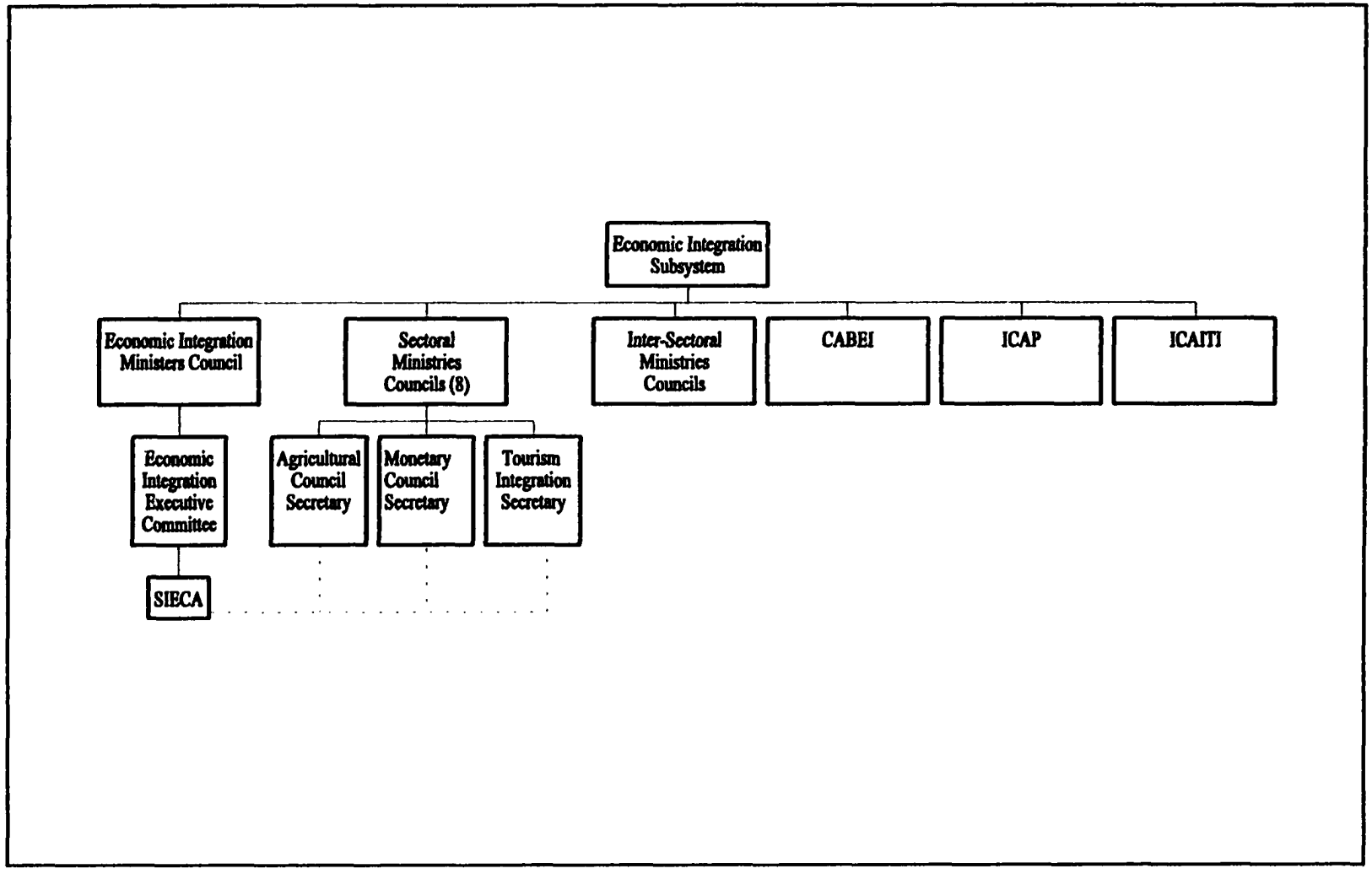

Figure 2.3 Organizational Structure of the Economic Subs-system of the SICA According to the Guatemala Protocol of 1993

Tourism, and the Monetary Council, the latter composed by the presidents of the Central Banks of each country. The inter-sectoral council meetings are to be held when there is a common issue to be addressed by two or more ministries. The CABEI, ICAP, and ICAITI are institutions of the economic subsystem. Given the importance of agriculture and monetary issues to the region, both the Central American Agriculture Council and the Monetary Council have their own specific secretaries. These are the Secretary of the Agriculture Council (SCA) and the Secretary of the Central American Monetary Council (SCMCA). Finally, the Permanent Secretariat of Central American Economic Integration (SIECA) is the techno-administrative organ of the economic subsystem. In addition, the SIECA coordinates the operations of both the SCA and the SCMCA.

Performance of Central American Countries in the Nineties

After 40 years, the process of integration in Central American remains between a free trade zone and a customs union (SIECA(c), 1999). There is free trade for almost all goods originated in the region but some tariffs and non-tariff barriers still remain. On the other hand, there are some elements of a customs union. Thus, the countries have already agreed on the Common External Tariff (CET) and the Common Custom Normative. However, these measures are not applied equally in all countries. As of the present, countries have a wide percent range in the application of duties. For example, countries agreed in 1993 to apply a duty rate to imports from outside the region between 5% and 15%. In addition, duties are still levied on imported goods produced in the region and other non-tariff barriers, such as licenses, permission, and others still exist in the region (De Franco, 1996; SIECA (e), 1999).

There are several achievements of the integration efforts in the recent past. First, all countries, with the exception of Panama, ratified the Tegucigalpa Protocol in 1996. In

addition, the Guatemala Protocol was also ratified by all countries. As an immediate consequence of the changes in the last few years, the GDP has been growing at an optimistic rate (Table 2.11). However, there are still big oscillations in the rate of growth of Central American countries. This fact reveals the sensibility and fragility of these economies when faced with adverse conditions.

Table 2.11. GDP Growth Rate of Central American Countries, (%)

Year	Guatemala	El Salvador	Honduras	Nicaragua	Costa Rica
1991	3.7	3.6	3.3	-4.8	2.3
1992	4.8	7.5	5.6	0.4	7.7
1993	3.9	7.4	6.2	-0.4	6.3
1994	4.0	6.0	-1.4	3.3	4.5
1995	4.9	6.3	4.3	4.3	2.4
1996	3.0	2.2	3.7	4.5	-0.6
1997	4.1	4.0	4.9	5.0	3.2

Source: SIECA (e), 1999.

On the other hand, the changes in the last few years have had a considerable positive impact on trade. For example, the volume of intra-regional trade increased from US$650 million in 1990 to US$2200 million in 1998 (SIECA (d), 1999). In addition, Table 2.12 shows trends in intra-regional and extra-regional trade for several years of the present decade. Intra-regional trade, measured as the share of Central American exports to the region, has steadily represented about 21% of total exports. However, Central America represents about 16% of the total trade volume.

The trade balance situation seems to a chronic problem in Central America. During the period from 1992 to 1997, in both intra-regional and total, Central America has shown a negative trade balance. This is explained by the fact that during this period both intra-

regional and total imports and exports have increased at a rate of about 12%. Imports from outside the region have increased at a rate close to 11%. Thus, in nominal terms both imports and exports have almost doubled from 1992 to 1997. However, the trade balance deficit has remained stable representing almost 30% of total trade volume (imports plus exports).

The stable composition of export products over time is another interesting feature of Central American trade. As in the sixties, today's exports are predominantly represented by bananas, coffee, meat products, and sugar (SIECA (e), 1999). Thus, in 1996, coffee represented 20.67% of the total value of exports, bananas represented 12.70%, and sugar represented 4.23%. In addition, in 1996, the main markets for Central American exports products were the United States (38%), European Union (25%), CACM (21%) and the G-3 group (3%), composed of Mexico, Colombia, and Venezuela.

Table 2.12. Central American Intra-regional, extra-regional, and Total Nominal Trade Balance (Million of US dollar)

Year	Exports			Imports			Trade Balance		
	Central America	Rest of the World	Total	Central America	Rest of the World	Total	Central America	Rest of the World	Total
1992	997.25	3654.36	4652	1067.20	7485.41	8552.61	-69.95	-3831.05	-3901
1993	1108.20	3842.93	4951.13	1133.14	8606.80	9739.94	-24.94	-4763.87	-4788.81
1994	1233.63	4320.25	5553.88	1275.88	8808.82	10084.7	-42.25	-4488.57	-4530.82
1995	1456.06	5360.59	6816.65	1490.82	10625.54	12116.36	-34.76	-5264.95	-5299.71
1996	1662.83	5890.37	7553.2	1665.33	10736.73	12402.06	-2.5	-4846.36	-4848.86
1997	1833.71	6716.48	8550.19	1959.70	12790.83	14750.53	-125.99	-6074.35	-6200

Source: SIECA (e), 1999.

As in the case of exports, there have not been many changes in the structure of Central American imports. Capital goods, intermediate goods, and primary raw materials remain the main bulk of imports. Thus, in 1996 oil and oil products (10.34%), work vehicles (3.60%), pharmaceutical products (2.37%), hard wheat (1.42%), and yellow corn

(1.25%) were among the 10 most important imported products in the region. The United States (45.5%), the G-3 group (13%), the CACM (12.7%), the European Union (9.9%), and Japan (4.2%) were the main sources of Central American imports in 1996 (SIECA (e), 1999). Thus, this pattern of trade shows that both the United States, the CACM countries, the G-3 countries, and the European Union are the most important trading partners for Central America.

General Evaluation of Central American Countries Integration in the Nineties

As the analysis in the preceding sections shows, conditions for integration during the nineties are more troubling than those of the sixties. This becomes clear when several facts are taken into account. First, countries have already experienced a scheme of integration that in terms of a rising living standards of the population is less than satisfactory. The final outcome of the scheme of the sixties was the poor economic performance of each country. This is probably a result of an inadequate design of the integration scheme (Lizano, 1989). This is shown by the fact that it was impossible to enforce several agreements because they did not satisfy all country members. Secondly, the increase in population, the budget deficit, trade deficit, unfavorable terms of trade, political changes, and social and infra-structural backwardness caused the poor economic performance of the 1960-1990 period. Therefore, the conditions for the implementation of a new integration scheme call for greater efforts than those of the sixties. Third, because of the unfavorable outcome of the integration attempt of the sixties, policy makers are looking for a more adequate scheme than that of the sixties to secure success this second time.

This time the objective of the integration scheme is more pragmatic. In short and medium terms, the goal is to alleviate the pressure on the external sector through the

increase of export supply, modernization of the productive sector, the creation of more jobs, and the increase in income. This situation seems to be somewhat paradoxical relative to the objectives of the Tegucigalpa and Guatemala Protocol. Thus, the organization structure of the integration scheme of the nineties covers far more sectors than that of the sixties but the essence of the integration scheme is the same. Countries are still looking for economic, social, cultural, and political union.

It seems that countries know what they should do to secure the success of the integration of the nineties but how to do it is still an open question. At the present countries seem to understand that integration means giving up a part of their sovereignty. This means harmonization of national policies under a regional scheme. However, it seems that national leaders do not completely trust the leaders of other countries. For example, there are several border delimitation problems between Honduras and Nicaragua, and Costa Rica and Nicaragua (La Prensa, 1999) and this has caused political frictions between them . This can mean that although the process may be successful, it will take longer than under an atmosphere of greater confidence. On the other hand, if leaders of the countries spend much time looking for trust, the process can be greatly eroded and under risk of failure.

The strategy of this new integration is based on export promotion policies (De Franco, 1996). Countries want to abandon the Import Substitution strategy (ISI) of the sixties and embrace an outward oriented strategy or Export Promotion strategy (EP) offered as a better choice for development than the former. Resource allocation efficiency, elimination of direct unproductive profit and rent seeking activities (DUP), efficient allocation of investment, and dynamic effects on saving and innovations have been mentioned as advantages of the latter over ISI strategy (Bagwhati, 1990).

As policy makers embraced the ISI strategy in the sixties, Central American policy makers moved in the nineties toward outward oriented strategies in the search for economic growth. This time the idea is to foster economic growth through a growth in exports. However, several studies reveal that although there is a high correlation between exports and economic growth, it has been difficult to establish the direction of causality (Bhagwati, 1990). In addition, there are still some open question about how to promote exports (Nam, 1990). Thus, export subsidies without reduction of tariffs and tariff reductions with adjustments in the real exchange rate, defined as the ratio of the price of non-traded goods to the price of importable goods, have been proposed as two viable routes to promote export expansion.

So, although some economic recovery is under way in Central America, several questions still remain open to further analysis in this new wave of integration. As was shown in the preceding subsections, Central American countries still need to find the best strategy to foster economic development in the area in a balanced manner. In addition, how to implement export promotion programs is a problem that countries are facing now. Finally, harmonization of objectives instead of harmonization of policies could be a smooth way to achieve the objectives of economic integration this time (De Franco, 1996).

Empirical Studies on Economic Integration

This section includes an exhaustive exercise. This section is divided into two subsections. The first subsection includes a review of empirical studies analyzing economic integration around the world. The second subsection includes studies analyzing economic integration in Central America. The objective here is to identify the main objectives of these empirical studies. This will help to identify what are the main points of

evaluation when economic integration is under scrutiny. It is important to look at previous studies to understand the variety of empirical models (general and partial equilibrium) used, the focus of the analysis (one crop, one sector, or the whole economy), and the time frame of analysis. Thus, some studies are descriptive and validate trade theory while other are pro-active and make an *ex-ante* analysis of the effects of economic integration.

Economic Integration Around the World

Brada et al (1988) analyzed the dynamic effects of economic integration of six economic integration schemes. The European Economic Community (ECC), the European Free Trade Agreement (EFTA), the Latin American Free Trade Agreement (LAFTA), the CACM, the East African Common Market (EACM), and the Council for Mutual Economic Assistance (CMEA) were the schemes analyzed. The analysis was based on the idea that economic integration should bring about faster factor productivity and higher investment levels than without integration. Thus, one equation was estimated relating the ratio of investment over real GDP to the growth of real GDP, real foreign capital inflow, a dummy to account for membership in an economic integration scheme. A second equation was estimated relating the growth rate of real GDP to the growth rate capital, labor, and the dummy to account for membership in an economic integration scheme. The estimation covered 1951 to 1977. The results showed that economic integration has had a positive impact on the growth rate of GDP due to higher investment and higher rate of growth in factor productivity. Based on the examination of the six integration schemes, the results showed that while there, in fact, exist dynamic effects due to economic integration, the impact of the effects on economic growth is small. Therefore, it was concluded that dynamic effects can not explain the rapid growth of west European countries in the sixties.

In addition, dynamic economic effects of integration are not enough evidence to encourage countries to join existing ones or create new economic schemes.

Testas (1997) analyzed the effects of economic integration in the case of African Arab Maghreb Union (AMU) from the perspective of Algeria. The study used the supply-demand approach proposed by Verdoon, Janssen, and Clague. Import price, export supply, and substitution are the three main elasticities to estimate the model. In addition, tariff rates applied in 1989 were obtained for 96 groups of commodities. The analysis was done under two scenarios. First, a complete elimination of tariffs (unilateral trade liberalization). Secondly, a customs union with Morocco, Tunisia, Mauritania, and Lybia, i.e., the actual agreement of AMU, was analyzed. The results showed that the impact of non-discriminatory trade liberalization will cause no trade diversion and only trade expansion both with respect to the world and the rest of AMU countries. The customs union situation generates trade diversion but also creates it. So, net trade is created. This should imply that there are trade gains from entering the agreement. The problem here is that the welfare impact of the two scenarios cannot be assessed.

Roland et al. (1997) reviewed the socioeconomic implications of NAFTA on Mexico, the US and Canada. The main objective of the study was to analyze the impact on trade and welfare of the complete elimination of tariff and non-tariff barriers (NTB) to trade. Initially, an analysis of the economy of each country is developed to assess the size and the level of technological development across countries. For this purpose, data for 1988 were used to build a Social Accounting Matrix (SAM) model in which the economies of the analyzed countries were divided into 26 productive sectors.

The analysis revealed that the US represents the greatest economy and Mexico the smallest. However, Canada is more dependent on international trade than the US or

Mexico. In addition, the analysis showed that bilateral US-Canada trade links are of considerable size. Thus, the US is the main trading partner of Canada in for both imports and exports. In addition, the analysis shows that tariff protection levels are low in North American countries by world standards.

Then, the authors made use of a general equilibrium model approach to assess the effects of the removal of the trade barriers on the economy of each country. Initially, six flows of exports and six of imports are analyzed: US-Canada, US-Mexico, Mexico-Canada,

Table 2.13. Simulations of the CGE model for North America.

Experiment	Prices	Protection	Markets	RTS
1	Homogeneous	Tariffs only	--	Constant
2	PPP	Tariffs only	--	Constant
3	Homogeneous	All protection	--	Constant
4	PPP	All protection	--	Constant
5	Homogeneous	--	Cournot	Increasing
6	PPP	--	Cournot	Increasing
7	Homogeneous	--	Contestable	Increasing
8	PPP	--	Contestable	Increasing

US-Rest of World (ROW), Canada-ROW and Mexico ROW. The model uses a non-nested CES specification for demand and non-nested CET for supply. The model is used to run eight experiments summarized in table 2.13. The results indicate that the US gains the least because it is the largest and the least trade dependent country. Canada gains as much as three times in terms of the GDP and Mexico is in between. However, economic integration will make Mexico experience up to 5 times the amount of structural adjustment as the US. Canadian adjustments are somewhere in between. This situation raises the question about

feasibility of the adjustment in Mexico. The article shows that a CGE model is a good tool to analyze the impacts of economic integration of a region. It is important to observe the assumption made in order to estimate the model. CES demand functions and CET supply functions are assumed. On the other hand, markets are assumed to price competitively or in a Cournot fashion with zero profits because free entry is assumed. In addition, the model is tested under the assumptions of both constant and increasing returns to scale. The model is estimated under increasing returns because trade liberalization may lead to the realization of potential increasing returns to scale. This is true in the case of Mexico and Canada. At the same time, the model tested the elimination of tariffs alone and then the elimination of all protection. The implication is that in an international trade framework, not only the elimination of tariffs should be addressed but also the elimination of all forms of trade barriers. The sectoral analysis showed that the structure of trade changes for each country because economic integration creates trade diversion and makes each sector expand with the exception of agriculture in Mexico. This issue was important because agriculture is a large sector in Mexico and economic integration can make agricultural producers worse off. Finally, the results showed that all countries gain from economic integration but specific forecasts are given cautiously because of data limitations and the need for more extensive research in the field.

Sorbazo (1997) addressed the impact of NAFTA on the economy of Mexico. For this purpose, an applied general equilibrium model (AGE) is estimated. The main objective was to measure the impact of the removal of all kinds of protection in the process of integration. The model included 27 production sectors. Domestically and internationally mobile capital and domestically mobile labor were assumed as the two factors of

production. Although trade flows between Mexico and North America (NA) and Mexico and the rest of the world (ROW) are assumed, only the Mexican economy is explicitly modeled. A Cobb-Douglas specification was assumed in production and consumption. To model the economy, competitive, regulated and imperfectly competitive industries are assumed to exist. Then, constant returns to scale (CRTS) are assumed in the competitive industries and increasing returns to scale are assumed in the case of the imperfectly competitive industry. To calibrate the model Armington elasticities of substitution, exports demand elasticities and scale of size are either estimated or assumed (taken from other sources).

The results showed that with the exception of agriculture, all other sectors expand their production, particularly in construction, non-electrical machinery, iron and steel, mining transport equipment, and electrical machinery. In addition, if GDP were to increase, then a large reallocation of labor would take place. This reallocation of labor would produce very high adjustment costs. The results also show that exports to NA increase in nearly every sector, and in particular, in wearing apparel, rubber, leather, tobacco, and textiles. On the other hand, services experience a contraction in exports to NA. Exports to ROW increase modestly and in some sectors exports decrease. Economic integration leads to a very large increase in imports from NA and, in particular, in the agriculture, food, and beverages sector. Imports from ROW also increase but the increase is smaller than imports from NA. Finally, the author warned about the reliability of the outcome since some elasticities were assumed or taken from other sources and there is no empirical evidence about the correctness in doing so.

The analysis of the impact of NAFTA on Mexico was made under very simplifying assumptions. For example, the use of Cobb-Douglas function in production and

consumption. Also, the exchange rate was assumed to be fixed. These assumptions restrict the analysis to an easy but unrealistic framework to analyze the economy of Mexico. However, even under this simplistic framework, a good assessment of the impact of NAFTA on Mexico can be made. The results showed that the outcome of the economic integration of Mexico within NAFTA poses some question of feasibility. First, agriculture, an important sector for the Mexican economy, contracts in size under NAFTA. Secondly, the adjustment process to new economic conditions may result in a net loss in the short run although it is not clear if the long run outcome is a net positive gain from integration. Third, the results show that under the realization of the economies of scale capital will become scarce and it is not certain how the Mexican economy might deal with that situation.

Cox (1997) analyzed the impact of a trade agreement on the Canadian economy under three scenarios. The first scenario includes a bilateral trade agreement between the US and Canada which is known as the CAFTA. The second scenario is the NAFTA. The third scenario includes the CAFTA and a US-Mexico trade agreement. The last scenario is called the hub and two spokes (HASP) agreement. First, CAFTA is analyzed and then used as a benchmark to analyze the other scenarios, the NAFTA and HASP scenarios. A general equilibrium model (CGE) is used to develop the analysis. The model assumes that the commodities produced in each region are perceived as close substitutes. Canada is viewed as an "almost" open small economy that faces perfectly elastic import supply functions from the foreign regions but in export markets faces a set of downward-sloping export demand functions. In addition, labor and capital are assumed to be the two primary factors of production. Capital is assumed to be mobile domestically and internationally but labor only domestically. Industries were divided into competitive constant returns to scale

and noncompetitive increasing returns to scale. The pricing decision was made taking the average of values generated from the two hypotheses. The first is based on the notion of the perceived demand curve and the second is based on the collusive model of pricing by Eastman-Stykolt. The production technology is characterized by a Cobb-Douglas specification and the demand side is characterized by a two-stage utility maximization process. First, the individual utility function is a CES specification and on the aggregate a Cobb-Douglas formulation is assumed. The model is calibrated based on the elasticities of substitution, inverse elasticities of scale and import demand elasticities.

The results show that CAFTA has a significant impact on the economy of Canada. Real GDP increases by 4.5 % and trade volume by 25%. On the other hand, using CAFTA as a benchmark, the implementation of NAFTA or HASP scenarios resulted in insignificant changes for the Canadian economy. Under NAFTA, there is a significant 57 % increase in trade volume between Mexico and Canada but the initial share of Mexico in Canadian trade is just one percent. This means that in absolute terms the increase in trade volume is small.

The results showed that once CAFTA is implemented, NAFTA will have a very small impact on the Canadian economy. However, the paper does not give any information of the stage of the implementation of CAFTA at the moment NAFTA went into effect. On the contrary the paper assumed a complete implementation of CAFTA and then the implementation of NAFTA. But this situation does not reflect reality. The truth is that CAFTA had not been completely implemented when NAFTA went into effect. So, the results of this paper are somewhat misleading. Also, it is not clear what happens to CAFTA once NAFTA is implemented. So, the results reflect an unrealistic situation and therefore the results are not reliable.

Levy et al. (1997) analyzed the effects of NAFTA on Mexican agriculture and, specifically, on the maize producer. The main objective is to analyze the distributional effects of liberalizing maize in Mexico, the policies that may be implemented to alleviate them and the incentive problems that can arise by the presence of such policies. International trade theory suggests that the NAFTA agreement should result in efficiency gains and net welfare gains for the US, Canada and Mexico. However, when such policies are implemented, there is not a clear answer on how the losers should be compensated. This is a major problem in Mexico where state institutions are not transparent in their job and therefore are not reliable in implementing programs. For this purpose, the authors implemented a general equilibrium model (CGE). The model divided the economy into rural and urban sectors. The urban sector produces only a tradeable industrial good and a non-tradable services good. Both goods are produced with a Cobb-Douglas technology with fixed intermediate inputs for urban labor and sector-specific capital. Maize, other basic grains, fruits and vegetables, other agricultural goods and livestock are produced by land and rural labor. In addition, the model distinguished six types of households, four in rural areas and 2 in urban areas according to ownership of assets. The results show that a gradual liberalization with a longer adjustment period is more adequate than a shorter one. The results also showed that a gradual liberalization accompanied by investment in an irrigation program would result in a better situation than using other type of programs.

The authors showed a very real side of NAFTA: the losers. Previous studies on NAFTA have shown that agriculture in Mexico contracts as a result of NAFTA. Therefore, rural labor should be reallocated in the industrial and service sectors. However, this reallocation is not costless in financial and cultural terms. First, maize producers lose

because their land loses value (if rain-fed) and they do not have any support from the government to survive. Secondly, migration of rural population to urban areas implies a need of change in skills and behavior because there are big differences between rural and urban life. This adjustment is painful and requires financial support from the government. Finally, in order to deal with this problem, the government should start a quick implementation of the program directed to make agricultural producers more competitive and productive. This requires infra-structural changes and educational programs. Also, a greater access to credit and extension programs must be made available.

Economic Integration In Central America

Wilford (1970) analyzed the CACM and its effects on trade creation and trade diversion. The model proposed by Balasa (1966) was used for this purpose. Thus, income elasticities of import demand were estimated for the pre-integration period and for the post-integration period. If income elasticities of intra-regional import demand under integration were greater than those prior to integration, then "gross trade creation" occurred. In addition, an increase in income elasticity of total import demand (extra- and intra-regional) would indicate the presence of "net trade creation". On the other hand, a fall in extra-regional income elasticity of import demand indicates "gross trade diversion". Moreover, a fall in total income elasticity import demand will indicate "net trade diversion". The results indicated that overall net trade creation occurred in the first seven years after integration. However, when analyzed by sectors some trade diversion was identified. Thus, there was trade diversion for fuel and lubricants and for fats and edible oils.

Flower et al (1994) estimated welfare effects of economic integration in Central America for the period from 1970 to 1984. A model proposed by Cline et al (1978) was

used. For this purpose, propensities to import, estimated as the ratio of the value of imports to total domestic consumption, were obtained. Estimates of net trade creation and trade diversion were obtained using the above estimated propensities. Finally, the output effect was estimated as the sum of net trade creation and net trade diversion. It is suggested that positive net trade creation is an indication of welfare gain. Moreover, it is suggested that a positive output effect would imply a substantial degree of non-traditional welfare benefits. The results show that during the period from 1970 to 1982 both trade diversion and trade creation were present but declining in value. Thus, there were positive net trade creation and net output effects. After 1982, this situation changed drastically and negative output effect indicated that countries were losing in terms of welfare. However, the authors pointed out because of methodological problems, the reliability of the results was limited.

De Franco (1996) analyzed the effects of economic integration of the nineties using a General Equilibrium Model (CGE) based on a Social Accounting Matrix (SAM) calibrated for 1992. In contrast with various studies using this approach, the SAM matrix for Central America was not disaggregated into economic sectors but included all countries separately. The SAM included activities, goods, capitalists, workers, government, capital account, and exports. Different scenarios were analyzed. Results were obtained for the effects of a free trade area (FTA) and a customs union (CU). The results showed that the formation of a customs union (CU) will benefit Guatemala and Costa Rica and could be harmful for Honduras and Nicaragua. An improvement in the level of real exchange rate to avoid overvaluation of the currencies of Central American countries is given among the recommendations. This is required to improve competitiveness of commodities produced in the area.

Caceres (1994) analyzed the costs and benefits of integration in Central America. Initially, a quantitative estimation of the possible benefits of integration was developed. Secondly, obstacles to reap the benefits of economic integration were measured. As a first task, possible sources of benefits were identified and quantified. Thus, domestic savings, trade creation, increased economic growth, stabilization of economic growth, increased intra-industry trade, and the increase of the market size were identified as possible benefits to be attained through integration. The quantitative assessment of saving revealed that since intra-regional trade is mainly made up of final goods which require the imports of intermediate goods, the possibilities of increasing savings were small. To measure trade creation, the approach proposed by Balasa (1967) was used. The results showed that in the period 1962-1969 integration did not lead to a significant change in resource allocation. This indicates that little trade was created. A further analysis to measure the possibilities of increased economic growth showed that distance between countries could be a determinant factor to propel economic growth in country members through a greater flow of trade. Based on previous studies and the estimation of the Grubel-Lloyd index for Central American countries, the results show that there is a good opportunity to benefit from intra-industry trade. In addition, according to Gray (1988), intra-industry trade is greatest among countries with similar income levels. So, intra-industry trade could be very beneficial for Central America given this fact. Finally, it is clear that broadening the market creates room to reap the benefits of increasing returns to scale in production and competition.

Transport costs and low levels of human capital have been mentioned as important obstacles to a successful economic integration. At this moment, the costs of transport and

insurance for commodities in the region are really high in Honduras and Nicaragua relative to the rest of the Central American countries. According to Caceres(1994), levels of human capital have a considerable impact on the export performance of a given country. Therefore, a model was estimated to determine the importance of the level of human capital in the export sector performance of the CACM. The results showed that the role of human resources in intra-regional trade has been gaining importance as time passed. Thus, countries should make an effort to promote more activities to improve the pool of human capital.

Empirical Evidence on Export Promoting (EP) Policies[1]

Very often export promoting policies are implemented under an export-promoting (EP) strategy. A country is said to follow an export-promoting strategy if the real exchange rate of exportable goods (EER_x) is approximately equal to or greater than that of importable goods (EER_m) (Baghwati, 1990). Performance of countries under an EP strategy is commonly contrasted with other countries following an import substitution industrialization (ISI) strategy. It has been argued that an export promoting strategy is superior to an ISI strategy in several aspects. First, EP strategy improves resource allocation efficiency relative to the ISI strategy. Secondly, directly unproductive profit-seeking and rent-seeking activities are commonly present under an IS strategy but less often in countries following an EP strategy. Thirdly, EP strategy tend to lead to a better use of foreign resources relative to an IS strategy. Finally, saving and innovation are more likely to be present under an EP strategy.

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[1]Note: This section relies on the work of Milner et al (1990), *"Export Promotion Strategies: Theory and Evidence From Developing Countries"*.

There have been several alternative instruments proposed to promote exports. For example, import liberalization, exchange rate regimes, compensatory financial and fiscal incentives, and export processing zones have been used as such instruments. Milner (1990) analyzed import liberalization as an instrument in export promotion. The analysis is developed under a general equilibrium framework. The analysis showed that high rate of protection in many developing countries make the general lowering of import barriers a desirable and feasible means of relative export promotion. On the other hand, policy-makers may choose to selectively import-protect and export-protect particular activities. However, past experience has shown that policy-makers often fail in adequately choosing the best commodity candidates for import protection or export promotion.

Falvey et al (1990) summarized the wide variety of export-promoting incentives used in developing countries. Accordingly, there are input related incentives, output related incentives, and externality-related incentives. Most of these incentives are given as tax exemptions, direct subsidies, lower interest rates than the ongoing rates, and monopoly rights in a given industry. In addition, theoretical frameworks to analyze compensatory exports incentives are developed. This included final demand-related policies, direct-production related policies, factor market related policies, and externality-related policies.

Warr (1990) analyzed the impact of export processing zones (EPZ) on economic welfare. EPZ are described as "especial enclaves, outside a nation's normal customs barriers, within which investing firms, mostly foreign, enjoy favored treatment with respect to imports of intermediate goods, company taxation, provision of infrastructure and freedom from industrial regulations applying elsewhere in the country" (Warr, 1990). In exchange, in general, these companies are required to hire local labor and to export most

of production outside the country. This situation corresponds to several objective of the host county with respect to the presence of the EPZ. It has been stated that foreign exchange savings, employment and technology transfer are the objective of establishing EPZ in various countries.

A study of EPZ in four Asian countries is then developed. To do so, the "enclave approach" proposed by Corden (1974 and 1985) is used. The results showed that indirect labor export seems to be the main benefits from the EPZ for Korea, Malaysia and the Philippines. The situation for Indonesia, the fourth country included in the analysis, was a little different. First, in contrast with the EPZ in other countries, an unusually high proportion of raw materials were purchased locally. Secondly, although taxes were low in the country, there has been a rent-seeking behavior by government officials which has diverted considerable sums of money into their hands. In addition, technology transfer has been a difficult task to carry out. This is so because EPZ are not interested in developing local industries which in turn could become difficult competitors in local and foreign input and output markets. Thus, there is an opinion that the overall costs of the EPZ seem to outweigh the benefits derived from it. In conclusion, EPZs are not "engines of progress' as they were initially thought to be but a temporary relief for labor surplus.

Nam (1990) investigated whether trade policy in Korea has been inward- or outward-oriented. For this purpose, relative incentive rates on exports and domestic sales for the Korean economy were estimated for 1978. Thus, the effective subsidy rate for export sales, the effective protection rate for domestic sales, and the effective incentive rate for total sales were estimated by the Balassa and Corden methods. The results showed that Korean trade incentives in 1978 were biased toward export activities. On the other hand,

in the late seventies, it became apparent that the structure for domestic sales became increasingly complex and inefficient. So, as it was pointed out the experience of Korea in removing "export bias" has been through the implementation of the so-called 'export-subsidy' route to outward orientation.

This way to encourage exports is somewhat similar to import liberalization with currency realignment (the 'free-trade' route to outward orientation). It is argued that there are several reasons why an 'export-subsidy' outward orientation has been implemented instead of the 'free-trade' route. First, political pressure made cutting import protection very difficult. Secondly, the currency devaluation that may have been required to reduce import barriers could cause some inflationary pressure. Third, import taxes have been a major source of government revenue. Fourth, there was an erroneous belief that both exports and import substitution can be better promoted by the scheme of export subsidies with import barriers. Finally, is should not be overlooked that an 'export-subsidy' outward orientation is costly relative to a 'free-trade' route and this makes 'export-subsidy' outward orientation a transitional instrument to a 'free-trade' outward orientation route.

Applications of Game Theory and the Political Preference Function (PPF) Framework in Economic Integration Analysis

Kennedy et al (1998) analyzed the accession of Turkey to the European Union (EU) using a PPF analytical framework. To get an idea about how this process of accession may be carried out, the importance of various Turkish social and productive groups in policy making was established and compared to their counterparts in the United States (US) and the EU. The PPF is a partial equilibrium analysis framework in which it is assumed that the government maximizes an additive social utility function of various sectors of society. Beef

and veal, dairy products, corn, wheat, rice, soybeans, cotton, sugar, tobacco, and pork and poultry were the ten commodity groups included in the analysis. The budget sector (government) and consumers were also included in the estimation of the PPF. The MISS model was used to estimate weights of each sector in the PPF. These weights represent the political influence of consumer and producer sectors relative to the government budget in the formulation of agricultural policies. The results showed that the dairy and rice sectors are the most politically relevant groups in the US. In the EU, the dairy sector along with wheat producers, beef and veal, and soybeans producers appear to be the most influential sectors. In Turkey, the rice sector along with corn producers and consumers were the most influential groups. These results show that policies are influenced by different groups when a comparison is made between Turkey and either the US or the EU. By contrast, there are small differences in the importance of groups among the US and the EU.

Kennedy et al (1996) analyzed multilateral trade negotiations between the European Union (EU) and the United States (US) in light of recent GATT agreements. The Political Preference Function (PPF) framework was used to quantify the welfare implications of different trade liberalization scenarios. The estimates of changes in welfare were then used in a game theoretical framework to identify the most likely trade agreement between the US and EU under cooperative and non-cooperative games. Sugar, milk, cereals, oilseeds, beef, pork, and poultry are the seven commodity groups included in the study. In addition, consumer surplus and the budget sector are included in the analysis. Weights for each commodity sector, consumers, and government budget were estimated and then normalized by dividing by the budget deficit weight. Thus, the budget sector is assumed to have a weight equal to unity and the rest of weights are analyzed relative to the budget sector.

These weights are then used to estimate changes in welfare for each commodity group and get one estimate of the PPF under each action for the US and the EU.

Four scenarios were employed in the analysis of trade negotiations between the US and the EU. Status quo (SQ), no export related subsidies (EX), partial free trade (PF), and free trade (FT) were chosen as the relevant scenarios of analysis based on the latest GATT negotiations and agreements. The non-cooperative and cooperative games are modeled. In addition, simulations are run with a 9.4% depreciation and a 40.2% appreciation of the US dollar. The results of the various scenarios used are shown in Table 2.14. These results indicate that in the non-cooperative game the Nash equilibrium outcome is EX for exchange rate is changed. Under the cooperative game, the outcome for the EU is again

Table 2.14. Nash Equilibrium Solutions to Games Based on Uruguay Round Options the EU regardless of the exchange rate whereas for the US the outcome changes when the Using Various Exchange Rates Levels

US Actions	EU Actions			
	SQ	EX	PF	FT
SQ		N^R	C^R	
EX		N^A		
PF				
FT		N^D	C^A, C^D	

Note: game solutions for non-cooperative and cooperative games are represented by N^E and C^E respectively, E=A, R, D, where A=actual exchange rate, R=40.2 appreciation of the dollar, and D=9.4 depreciation of the dollar.

Source: Kennedy et al (1996).

insensitive to exchange rate variations. In this case, the Nash equilibrium is PF for the EU. Likewise, the outcome for the US under the cooperative game is sensitive to changes in exchange rate regimes. However, with no changes in the exchange rate (A) and exchange rate depreciation (D), the US optimal outcome turns out to be FT. Oehmke et al (1990) used a Political Preference Function (PPF) to analyze government intervention in the US

wheat market. Changes in consumer welfare, changes in producers' welfare, and the budget sector were assumed to be the relevant variables in the PPF. The study analyzes two separate years, 1977 and 1985, to determine the dynamics of political environment in policy formulation. Since wheat is exported, excess demand was assumed to be represented by a constant elasticity equation. Likewise, domestic supply and demand are represented by a constant price elasticity equation. On the other hand, since government intervention is given through various policies the "policy-optimal" target price, research expenditures, and sales from government stocks were estimated. The results showed that in 1977 wheat producers were weighted more highly than taxpayers (government budget). Thus, the weight for producers in the PPF was 1.43 whereas consumers weight was 0.43. If the situation of 1985 is taken alone, the picture changes a little. In this case, producers are weighted at 1.25, which is lower than the weight of 1977. Consumers continue to be relatively less influential than both groups. However, the fact that producers were less influential in the PPF than in 1977 indicates that producers have lost some power in the policy making process. This outcome is consistent with the real behavior of policy-making in the US. In conclusion, it is noteworthy that the PPF framework consistently described real life situations and it is useful as an analytical tool.

Gordon et al (1975) used a Political Preference Function (PPF) framework to analyze policy changes in the US cattle industry in the years 1959 to 1969. This time, consumer's meat costs, margins to breeding cow-calf producers, margins to cattle feeders, and beef import quota level were assumed to be the arguments of the function. Estimation of the PPF was made under a quadratic mathematical representation. One of the objectives of the study was to obtain various estimations of the PPF and to do so the PPF is estimated

under various sets of weights for each group. The results show that the PPF framework adequately described relative sectoral influence when there was a policy change. Thus, it was concluded that a trade-off of two to one between aggregate cattle producers and consumers was the most plausible scenario under which policy changes were made. For example, with a trade-off of 2:1 producers weight relative to consumers was 1.62 during 1959-63 (free trade), 5.06 during 1964 (quota imposition), 2.51 during 1965-67 (stable quotas), and 0.91 during 1968-69 (imports increase). This outcome is consistent with the observed situations under which policy changes were decided.

CHAPTER THREE - THEORETICAL FRAMEWORK

This chapter presents the theoretical considerations underlying the economic model used in this research. To obtain an adequate economic model to analyze economic integration in Central America, an extensive exercise is developed. First, a review of the most recent advancements in international trade theory is presented. Secondly, the theory underlying international economic integration is reviewed. Motivation to enter international economic agreements, expected benefits from economic integration, and the forms of economic integration are reviewed. Third, theoretical considerations underlying economic integration among developing countries, as is the case of Central American countries, are assessed. Fourth, since economic policies play a crucial role in determining the success of any integration agreement, a theoretical analysis of policies and their effects on income, prices, and consumers' welfare is developed in the context of developing countries. Fifth, since this research will use a game theoretical framework to analyze economic integration in Central America, a review of game theory is included. Finally, since much of the research will be based on the use of the political preference function (PPF), its derivation is also presented in this chapter.

Current Situation in International Trade Theory

The theory of international trade is crucially important in helping analysts and policy makers understand trade patterns. With the help of international trade theory it is possible to analyze the reasons for trade among countries in a concise manner. Traditionally, there has been a set of assumptions taken into account to make the analysis of international trade patterns clear and effective. Effective analysis refers to an appropriate prediction of trade patterns under specific conditions. The analysis of international trade

patterns is made by relaxing some assumptions required for a no trade or autarky situation. There are five main assumptions for no trade between countries. These assumptions are constant returns to scale, identical tastes and preferences, identical relative endowment of resources, identical production functions, and no distortions (Markusen et al, 1995).

Mainstream International Trade Theory

Until recently, international trade theory analyzed trade patterns by relaxing some of the assumptions of no trade (Markusen, 1995). Classical or orthodox trade theory focused on trade patterns that arise from differences in production functions and differences in resource endowment. Traditionally, three general equilibrium models have been used to analyze these differences. In addition, a partial equilibrium framework has been used to analyze the impact of distortions on international trade. Finally, the assumption of constant returns to scale is relaxed under what is known as the new international trade theory (NITT) (Krugman, 1986; Scherer et al, 1994).

The use of general equilibrium models has made a great contribution to the development of international trade theory. For example, under a general equilibrium framework, the Ricardian model deals with differences in technology and the Heckscher-Ohlin model deals with differences in resource endowment. The very simplistic assumptions of the Ricardian model are used to predict that countries should specialize in production of goods based on productivity differences that lead to comparative advantage. By the same token, according to assumptions of the Heckscher-Ohlin model, countries should export goods that use more intensively resources that are relatively more abundant in a given country when compared to trade partners. Finally, the specific factor model has been used to analyze trade patterns that arise from assuming mobile and fixed factors of production. To some degree, this model is an extension of the Heckscher-Ohlin model.

As was mentioned above, the assumption about distortions is relaxed and analyzed in a partial equilibrium framework. Thus, various governmental policies, such as taxes, subsidies, tariffs, and quotas, are widely used to shape international trade relations and their analysis is a very important subject in international trade theory (Markusen et al, 1995).

New International Trade Theory (NITT)

The discussion above indicates that classical international trade theory relies on the assumption of perfect competition and constant returns to scale in production. However, as empirical evidence shows, the applicability of the classical theory to predict actual patterns of trade is limited (Krugman, 1986). For example, the Leontieff paradox showed that the Heckscher-Ohlin model was inconsistent with patterns of trade it predicted when the model was tested empirically (Krugman, 1986). In addition, if the assumption of constant returns to scale is relaxed several complications for the use of the classical framework arise. For example, increasing returns to scale may lead to monopolistic competition in international markets and to the use of strategic behavior in trade relations. Under monopolistic assumptions firms are no longer price takers. Therefore, in deciding their actions, firms will take other firms' actions into account as well. This situation has hardly been analyzed by classical theorists of international trade.

Recently, new developments in international trade theory have created the opportunity to analyze actual patterns of trade in a more adequate and realistic setting than under the classical view (Krugman, 1986). However, it seems that there is a division between supporters of the classical view and supporters of the newest ideas developed into the theory of international trade. It is widely accepted that the analysis of trade under perfect competitive markets leads to different conclusions from those obtained when the

analysis is made under the assumption of imperfectly competitive markets. However, scientists are discussing whether the objective is to defend the theory that advocates free trade or a theory that acknowledges that free trade is not always possible and, therefore, it proposes some ideas about how to deal in a world of imperfect competition.

On the other hand, there is a confrontation, as often there is in economic theory, about what the central object of analysis in international trade theory should be. Should economic theory analyze what is really happening in the real world or what the situation ought to be? This is a struggle between the positive and normative views of economic theory.

This confrontation easily extends to international trade theory. If the objective is to analyze patterns of trade under ideal conditions, then the approach used in the last 100 years is probably appropriate. This approach is mainly based on what the patterns of trade ought be, given resources and initial comparative advantage. These models include the Ricardian model, the Heckscher-Ohlin model, and the specific factor models. However, if the objective is to predict the patterns of international trade actually seen, then various factors of trade such as economies of scale, research and development (R&D), and imperfect competition should be analyzed using what is now referred to as "strategic trade policy" or NITT (Krugman, 1986).

At this point, it seems appropriate to describe NITT in a detailed manner. Scherer et al (1994) mentioned that NITT focused on five main features. These features are economies of scale, technology and R&D, the product life cycle, intra-industry trade, and oligopoly. In addition, strategic behavior has an important place within this new theoretical framework.

One of the differences in the assumptions made under NITT is that comparative advantage can be shaped and is not static, as assumed by orthodox theory. This is directly related to technology and R&D. The relationship between comparative advantage and technology in international trade is not a novelty. However, the fact that the trade balance has been shown to be systematically correlated with intensities of technological innovations efforts, is a new discovery in international trade theory (Scherer et al, 1994).

The product life cycle theory is used to further the analysis of patterns of trade based on the assumption of a changing comparative advantage. Since it is assumed that comparative advantage is something that is fought for, product life cycle theory explains that developed countries have comparative advantage in the creation and development of new goods but later the comparative advantage in the production of the good is lost. One explanation is that as production gets standardized, developing countries gain comparative advantage in the production of the same goods. This gain in comparative advantage is due to cheap labor and raw materials. Therefore, developing countries end up being net exporters of goods for which they were initially net importers.

Intra-industry trade is another situation that has come to challenge the traditional views on international trade patterns. The Heckscher-Ohlin model became very popular after it was published in 1933 and for the following 30 years it became a fundamental model to analyze international trade. According to the Heckscher-Ohlin model, countries should specialize based on factor endowment. Thus, in the early European Union (EU), economists expected Germany to specialize in exports of automobiles, Italy in the exports of labor-intensive goods such as textiles and vegetables, and France in the exports of wine and haute couture. However, Germany, France and Italy resumed exporting automobiles,

cheese and wine. This situation in the sixties and seventies indicated that the Heckscher-Ohlin model was limited in explaining patterns of trade. This is because a great deal of intra-industry trade arose during the sixties and seventies and countries exported various products close in technology to each other and the Heckscher-Ohlin model could not predict such a pattern of trade.

Analysts have started to consider economies of scale when looking for an explanation for the patterns of trade actually observed. Economies of scale are present due to several reasons. First, the production of a given good may require very high initial costs or front-end commitment of resources. Then, unit cost will fall as output volume rises. Secondly, market size is important because the greater the market to be supplied, the lower the per unit costs of production will be. Third, "learning by doing" or the learning curve is likely to be present as the quantity produced increases. The learning curve helps to reduce costs as more units of the same good are produced because of the gains in experience and the fine-tuning of the process of production.

Finally, the presence of economies of scale may lead to a situation in which few suppliers of the good will exist. When there are few suppliers of a given good then the question about oligopolistic competition arises. Oligopoly generates two difficulties in analyzing patterns of trade. First, oligopoly means that perfect competition is no longer present and, therefore, traditional methods of analysis are no longer adequate. Secondly, under oligopolistic competition, comparative advantage depends on the strategies of R&D, plant location, pricing, product advertising, and so forth. This means that comparative advantage is no longer exogenous to the economic system but something that is fought for and won.

In the NITT views, strategic trade policy seems to be an alternative to free trade given present international trade relations among countries. It is true that negotiations under the General Agreement on Tariffs and Trade (GATT) and World Trade Organization (WTO), have led to countries reaching an agreement to lower tariffs. However, other kinds of barriers still remain. For example, hygienic standards, production standards and other regulations have come to replace tariff barriers. As a result, bureaucracy has increased, barriers to trade seem to be the same and, in some cases, the situation is worse than it was before reaching the agreements.

Thus, it is not a coincidence that Scherer et al (1994) proposed that a strategic behavior in setting tariffs and targeting markets needed to be developed. In addition, "trade enhancing national policies" are proposed to cope with a world in which free trade is still assumed to be a dream. It is believed, under this view, that government intervention in international trade relations can be beneficial from the domestic standpoint. Accordingly, twelve such policies are mentioned. These policies are commodity export subsidies, export financing, government favors tied to export performance, learning curve pricing, home market protection, coercive market-opening measures, cartel formation and dumping, coordination of industry investments, provision of cheap raw materials, subsidies to R&D, intellectual property protection, and subsidies to workers' education.

Significance of NITT for Developing Countries

The expectations of developing countries regarding trade liberalization can be helpful to understand the significance of NITT for developing countries. Historically, developing countries have been unable to influence international trade negotiations, Therefore, until recently the role of developing countries in international trade negotiations

has been limited. Moreover, it is reasonable to assume that developing countries do not expect to be able to change their situation in international trade negotiations. So, it is reasonable to expect that developing countries will not enjoy free trade in the near future. Under this light, NITT could be appealing for developing countries.

Even if NITT has appeal in developing countries, the pros and cons of the theory should be weighed in implementing trade policies according to NITT. Some aspects of NITT can be named as positive. For example, it is argued that NITT is more realistic than orthodox theory of international trade (Krugman, 1986). In addition, it is common knowledge that national trade policy decisions usually respond to the influence of special interest groups and, therefore, NITT could be appealing in shaping national policies (Krugman, 1986).

On the contrary, some aspects of NITT can have a detrimental impact on the policy outcome of developing countries. Alam (1995) argued that developing countries could be unable to derive benefits from the use of strategic policies. First, an imperfect market structure is more pervasive in the industrial sectors of developing countries than in those of developed countries. This happens because ISI strategies and lack of antitrust laws lead to oligopolistic market structure. Secondly, the small size of developing countries reduces their ability to use strategic trade policies. For example, a restriction from a small developing country against a large developed country could generate a small loss for the latter. However, if the large country retaliates, then losses could be great for the small developing country. Third, developing countries may not benefit from economies of scale for several reasons. NITT indicates R&D expenditures are instrumental in generating economies of scale but most developing countries lack the ability to spend money on R&D.

In addition, since the market size of most developing countries is small when taken individually, there is small room to exploit economies of scale because it requires, among other aspects, a large market size.

There are still some other strong arguments against using NITT in trade policy in developing countries. Since it is widely accepted that trade policy decisions are strongly affected by interest groups, there is a risk regarding the possibility that interest groups may use NITT concepts to gain at the expense of their own country (Grossman, 1986). On the other hand, it has been argued that great care should be taken when using strategic behavior to decide what productive sectors to promote. If the wrong sector is chosen, then, in the long run, the country's welfare will be negatively affected (Krugman, 1986).

Finally, it is important to mention that policy makers of developing countries should be convinced of what international economic order will prevail before engaging in any sort of policy making process. If policy makers believe that free trade is a very long term goal, then NITT could be the only alternative to propel national social-economic development in the short and middle term. However, it has been indicated that developing countries will be better off if they follow a free trade strategy (Alam, 1995). So, it seems that the only plausible outcome is a mix of both the free trade approach and the strategic trade policy making approach.

International Economic Integration

Consider why countries may want to get into international economic integration agreements. A probable answer to this question is that countries expect to get some benefits or gains by entering an international agreement. Delener (1999) mentioned that countries may be encouraged to form international trading blocs as a result of the sense of

community, strategic alliances, norms, and rules. These reasons can be termed non-economic reasons. In addition, international trading blocs are usually formed to make up for shortcomings in international trade relationships. This reason can be termed the economic reason. Among the economic and political reasons, several factors can be mentioned as important in forming international trading blocs. First, members can perceive that economic benefits can be achieved from a more efficient production structure as a result of the new economic environment triggered by the economic integration agreement. Second, members may pursue non-economic objectives such as political ties, stabilization, etc. Third, an internationally integrated region may improve its bargaining power in multilateral trade negotiations. Moreover, small countries forming trading alliances may improve their position in securing market access. In addition, international economic integration opens a possibility to exploit economies of scale (Robson, 1984). From the previous discussion it can be inferred that member countries' welfare improvement is one of the main objective of international economic integration agreements. International trade theory analyzes this improvement in welfare as gains from trade liberalization through international economic integration agreements (Krugman, 1997).

Gains From Trade

Gains from trade has been one the most important factors that influence trade flows and patterns of trade (Krugman, 1997). In general, trade liberalization through international economic integration agreements may lead to improvement in the welfare of member countries (Robson, 1984). In addition, it is assumed that trade increases the welfare of countries when the production of goods is increased by means of specialization induced by comparative advantage. Gains from trade can be explained in a very concise manner with

the help of Figure 3.1. Suppose there is a two-country world. In addition, assume that there are only two commodities produced, namely, *X* and *Y*. Let the curve PPF_i, for i=1,2 represent the production possibility frontier (PPF) of each country. Disregard inputs for the time being. The way both PPF are drawn indicates that production of *X* is more intensive in country *1* than in country *2*. By the same token *Y* is more intensive in production in country *2* than in country *1*.

Consider the situation without trade. Under autarky (no trade), equilibrium production and consumption in country *1* is given at point *A*. At this point, country *1* is consuming its own production. For example, production of *X* (X_1^A) equal consumption (C_{1X}^A). By the same token, production of *Y* (Y_1^A) equals consumption (C_{1Y}^A). The community indifference curve (CIC) is given by U_1^A. Relative prices are given by the line P_1^A. The same situation applies for country *2*. Point *B* shows the point of production and consumption of country *2*. PPF_2 shows that production of *Y* is more intensive than in country *1*. The community indifference curve (CIC) is given by U_2^A. production of *X* (X_2^A) equal consumption (C_{2X}^A) and production of *Y* (Y_2^A) equals consumption (C_{2Y}^A). Relative prices are given by P_2^A.

Now consider the situation when countries engage in trade. With the opportunity of increased demand for good given the presence of a greater market, countries will increase production of the good in whose production they have comparative advantage. This may lead to either a complete or a partial specialization in the production of the good in whose production there is comparative advantage. Therefore, after countries open up their economies, terms of trade between countries changes and a common relative price line ($P_1^F=P_2^F$) is obtained. In addition, trade leads to a high degree of specialization in the

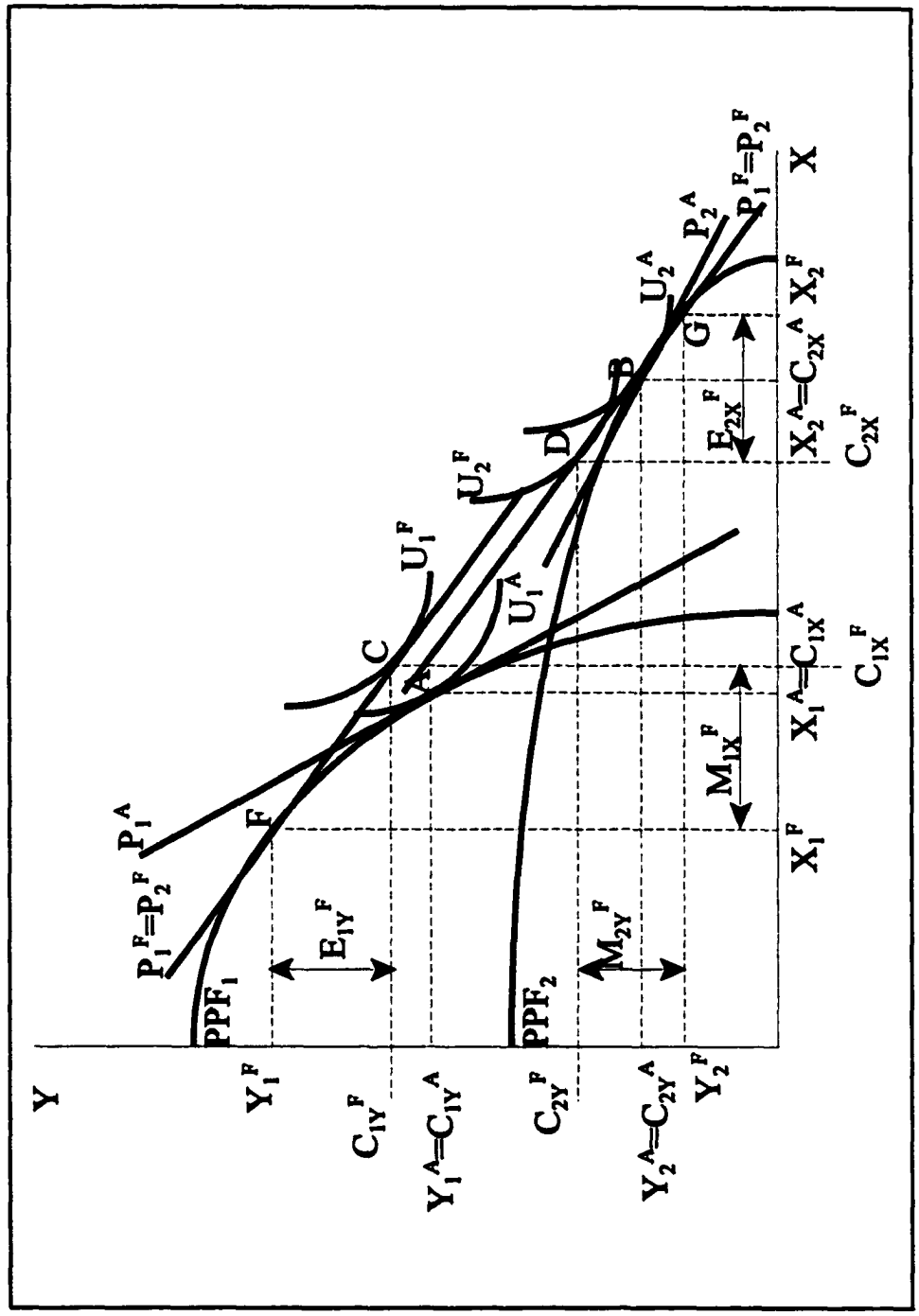

Figure 3.1. Gains From Trade

production of one good. However, there is not complete specialization. This is conditioned by the shape of the PPF curve in both countries and international prices.

Under these new relative world prices, total production of each good increases and welfare of countries improves. This improvement is shown by the shift of the CIC upward to U_i^F, for i=1,2. Thus, for country 1the new point of production is *F*. At this point, country 1 produces X_1^F and Y_1^F. However, consumption is at point *C* along U_1^F. This new CIC conveys a higher level of utility or welfare since it lies to the northeast of the CIC under autarky. This is possible because under free trade countries have a greater supply of goods *X* and *Y* than under autarky. Moreover, this new higher level of consumption is possible because of export and import possibilities that countries obtained after engaged in trade.

Import and export of goods are crucial in increasing the welfare of countries. In Figure 3.1 this is shown explicitly. Under free trade, country 1 ended up producing X_1^F and Y_1^F and consuming C_{1X}^F and C_{1Y}^F. Moreover, $X_1^F < C_{1X}^F$ and $Y_1^F > C_{1Y}^F$. This implies that country 1 imports *X* and exports *Y*. The opposite is true for country 2. Thus, M_{1X}^F shows how much *X* is imported by country 1. By the same token, M_{2Y}^F shows how much of *Y* is imported by country 2. On the contrary, E_{1Y}^F shows how much of *Y* is exported by country 1 and E_{2X}^F shows how much of *X* is exported by country 2.

In summary, countries gain by trading with each other. First, as countries open their economies, increased production possibilities are obtained. Second, increased levels of production and specialization lead to a greater supply of goods. Third, trade leads to a greater supply of goods and more favorable terms of trade which in turn allows countries to increase their welfare. Finally, import and export possibilities become new sources of increased consumption and, consequently, increased levels of welfare.

Theoretical Considerations in International Economic Integration

International economic integration is generally used as a means for domestic economic development. However, there must exist a set of conditions to secure a successful economic integration (Robson, 1984). First, if the trade barriers prior to implementation of the agreement are high, then there is an increased opportunity for a successful integration. Secondly, if in the post-economic integration scheme common external tariffs (CET) are lower than before economic integration takes place, it is less likely that trade diversion will be present. Third, the larger the number and the area of the economic integration, the greater the scope for net trade creation since there is an increase in the likelihood that low-cost consumers and producers will join the agreement. Fourth, trade creation is more likely to result as the competitiveness of the member countries increases. This is so because if economies are competitive, then there are increased opportunities for specialization and net trade creation. Finally, if member countries are located geographically close, then welfare is more likely to increase because of lower transportation costs than those of countries located far from one another.

Given the previous discussion, it is worthwhile to assess what specific benefits may be obtained by member countries when entering an integration agreement. Static and dynamic benefits from international economic integration are usually mentioned in international trade literature (Robson, 1984). Several benefits can be mentioned as static benefits. First, benefits are derived from the elimination of customs and border officers. Secondly, terms of trade usually improve under an integration agreement. Third, the new formed economic bloc may exert bargaining power in international negotiations in a more effective way than member countries did individually. Robson (1984) mentioned the effects

of market enlargement on the efficiency of factor utilization and on output and its rate of growth through its impact on the location and rate of investment as sources of dynamic benefits. Thus, dynamic benefits of integration are more likely to be seen in the long run. Thus, economies of scale, investment stimulation, increased competition, and better utilization of economic resources encompass dynamic benefits expected from an integration agreement.

International economic integration may take different forms and it depends on the intended degree of economic integration (Robson, 1984). Depending on the degree of integration there are free trade areas, custom unions, common markets and economic unions. A free trade area involves the free movement of product in the area, i.e, it involves elimination of trade barriers between the members of the free trade area. In addition, each member retains it own tariff with respect of the rest of the world. By contrast, a customs union involves not only the free movement of products in the area, but also a common external tariff (CET) against the rest of the world. A common market is a deeper form of integration. A common market contains the elements of a custom union and additionally allows for free labor and capital flow in the area. Thus, in a common market factor and product market are integrated. Presently, the deepest form of international integration is represented by an economic union. An economic union contains all the elements of a common market and a high degree of unification of monetary, fiscal and other policies. In this case, depending on the degree of integration a wide spectrum of forms of integration can be seen. Finally, political integration refers to the formation of a single nation with one political authority. In this case, members are no longer sovereign states but part of a single country. The degree of integration mostly will depend on the degree of harmonization

policies among the members. In general, most agreements on international integration are focused on the suppression of discrimination among members, the maintenance of discrimination against the rest of the world, and the lasting character of the agreements which limits the use of certain instruments of economic policy.

Trade Diversion and Trade Creation in a Customs Union

Since the objective of Central American countries appears to be the creation of an adequate customs union for the area, it seems relevant for this research to pay special attention to the theory of customs union. According to Robson (1984) there are three features in a customs union. First, tariffs on imports from member countries are removed. Secondly, a common external tariff (CET) on imports from the rest of the world is imposed. Finally, member states divide customs revenue according to an agreed upon formula.

Robson (1984) argued that gains and losses arise from the impact of the customs union on several factors. First, a customs union has impact on resource allocation and international specialization. Secondly, economies of scale are likely to be present. Third, a customs union affects terms of trade. Fourth, productivity of factors is also affected by a customs union. Fifth, economic integration in the form of a customs union may affect economic growth of member countries. Sixth, economic stability may be one of the objectives of economic integration and it may be affected by a customs union. Finally, the formation of a customs union will surely affect the distribution of income in member countries.

As it was mentioned in the previous discussion, resource allocation is one of the most important aspects for assessing the success of a customs union creation. In general, the theory of customs union analyzes resource allocation in terms of *trade creation* and

trade diversion (Robson, 1984). Accordingly, trade creation is represented by a shift from the consumption of higher-cost domestic production to lower-cost products of partner countries. There are two aspects of this shift. First, domestic production of goods that are identical with those produced abroad is reduced or eliminated. This effect is termed the saving effect. Secondly, there is an increase in consumption of import of the goods that were previously purchased at higher prices. This second effect is referred to as the consumption effect. On the other hand, trade diversion is a shift in the source of imports from lower-cost external sources to higher-cost partner sources. Trade diversion has two aspects. First, there is an increase in the cost of goods previously imported from abroad. Secondly, because of the higher price of goods, there is a loss in consumer surplus. Finally, if a customs union is on balance trade creating, then it is assumed to be beneficial. A trade diverting customs union is assumed to be detrimental.

To get a clear idea about trade creation and trade diversion, the formation of a customs union is analyzed in Figure 3.2-3.4. For this purpose, consider a three-country world. In addition, for purposes of the analysis, assume there is only one traded good. Also, for simplicity purposes, assume no terms of trade effects and constant returns to scale. According to Figure 3.2, countries *1* and *2* are exporters of the commodity and country *3* is the importer. Therefore, Figure 3.2 shows the excess supply of country *1* and *2* (ES_1 and ES_2) and excess demand for country *3* (ED_3). If free trade (FT) is allowed, an equilibrium is obtained where the excess supply curve (ES_{1+2}^F) and the excess demand curve (ED_3) intersect. Point *A* shows the equilibrium price (P_w^F) and quantity (Q_{1+2}^F). However, suppose, as in many real world situations, that exporters face a tariff *T* from the importer (Figure 3.3). Call this situation status quo (SQ). Under SQ the excess supply of country *1* and *2* is

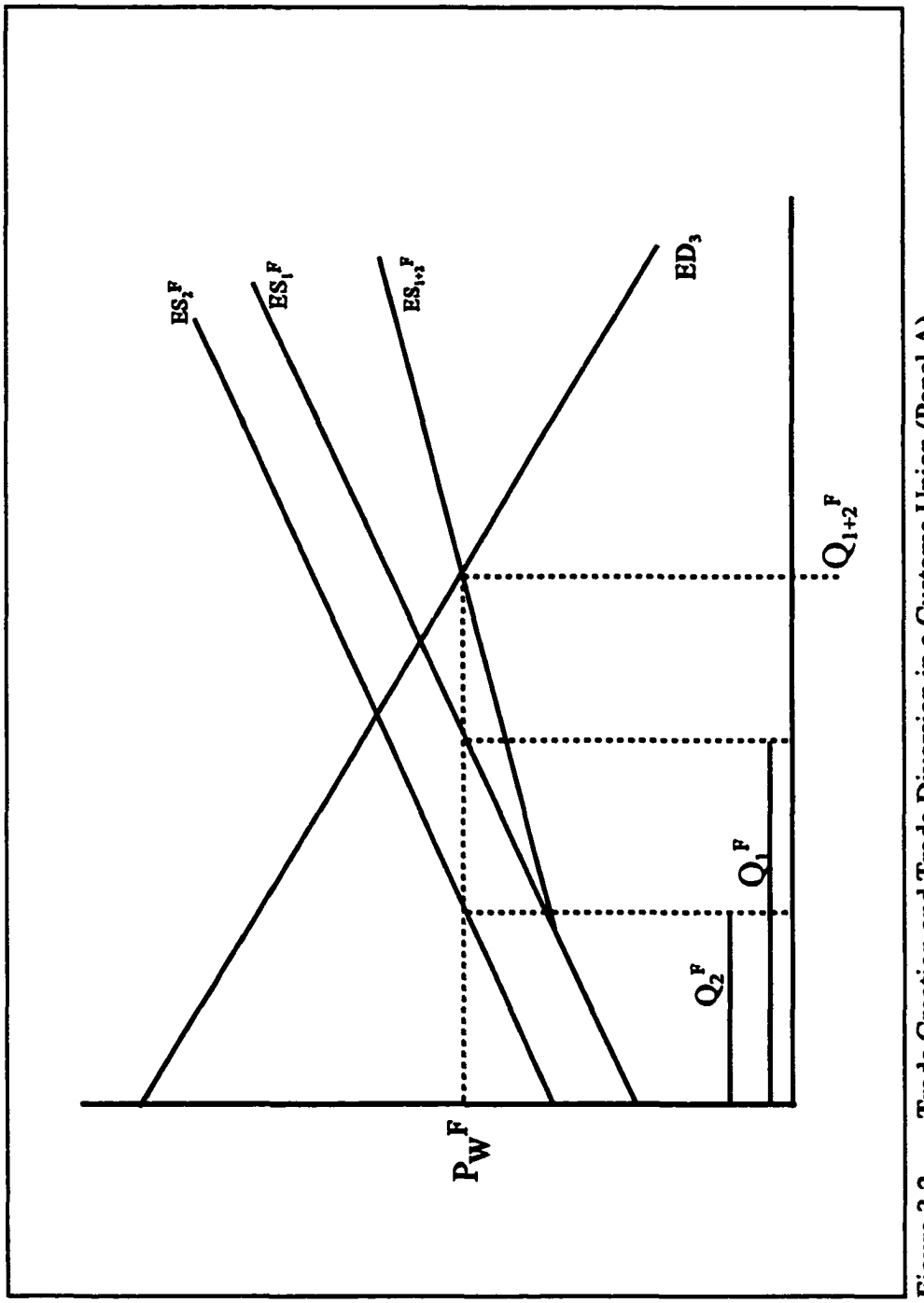

Figure 3.2. Trade Creation and Trade Diversion in a Customs Union (Panel A)

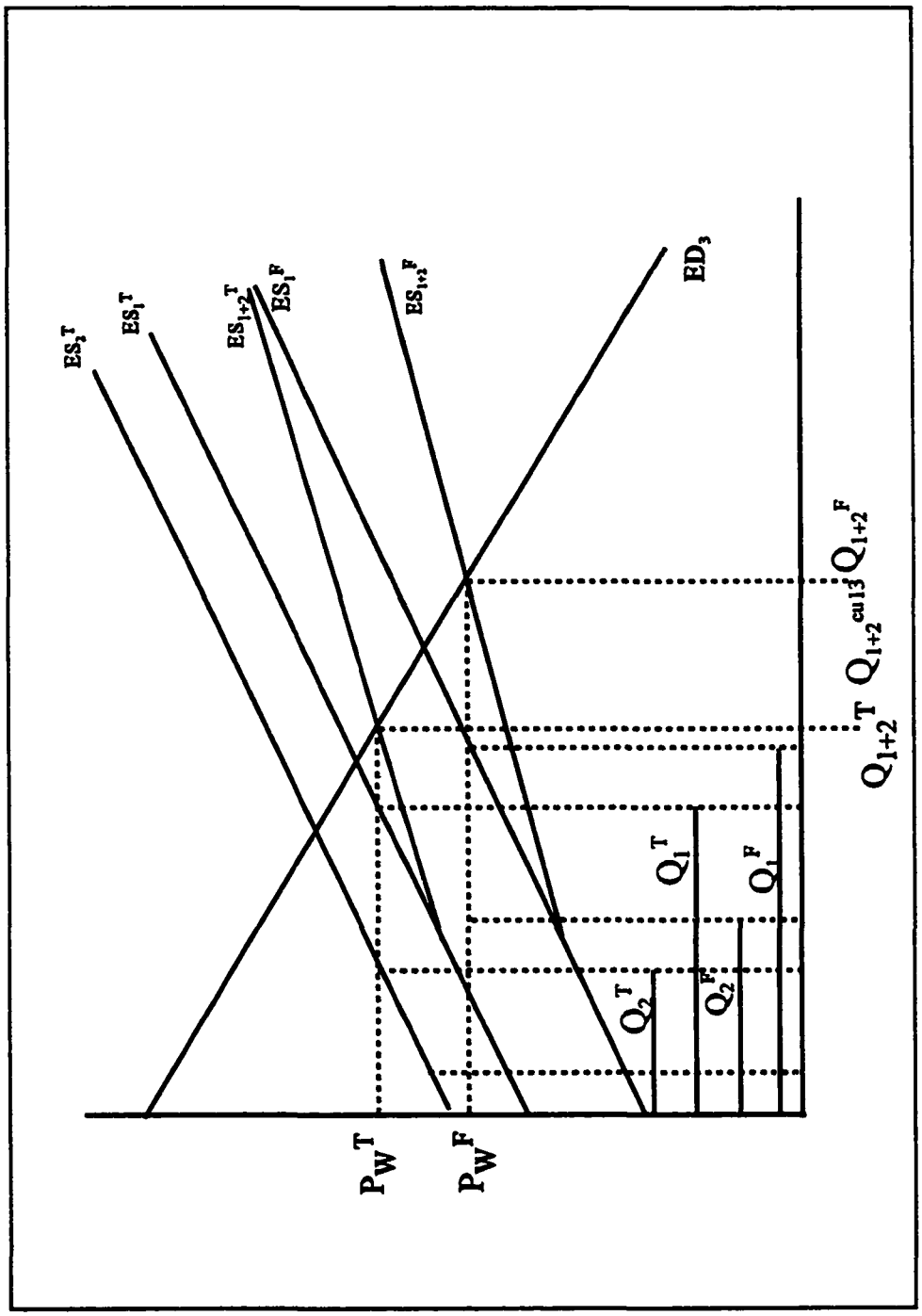

Figure 3.3. Trade Creation and Trade Diversion in a Customs Union (Panel B)

given by ES_{1+2}^{T}. Point *B* shows the equilibrium outcome under tariff with price P_w^{T} and quantity Q_{1+2}^{T}. Now suppose that country *1* and *3* decide to form a customs union (Figure 3.4). Then, country *1* will not longer face the tariff from country *3* since trade barriers between them will be removed. However, country *2* still faces this tariff. Under the customs union (CU) situation, the new excess supply is given by ES_{1+2}^{cu13}. The new equilibrium point is *C*. the new price is P_w^{cu} and quantity is Q_{1+2}^{cu13}.

Consider the quantity supplied by each exporter under each situation. Under SQ country *1* export the amount corresponding to segment Q_1^{T} and country *2* exports the segment Q_2^{T}. If FT prevailed, then both exporters would have experience an increase in their exports. Thus, country *1* would have exported the segment Q_1^{F} and country *2* would have supplied Q_2^{F}. Notice that under FT the quantity exported by each country is greater than under SQ and, consequently, the price is lower than under SQ. Under the CU situation, country *1* exports the segment Q_1^{cu13} and country *2* exports Q_2^{cu13}. It is clear that the total quantity exported under CU is greater than under SQ ($Q_{1+2}^{cu13} > Q_{1+2}^{T}$). Thus, the customs union has caused overall trade to increase and price to decrease with respect to the SQ situation. The segment *TC* indicates how much trade was created by the customs union. However, it is clear that country *2* under CU is exporting less than under SQ since $Q_2^{T} > Q_2^{cu13}$. This reduction in exports is shown by the segment *TD* which is how much trade was diverted by country *1* from country *2* when the customs union was implemented. Thus, *TD* is trade diversion. Finally, the customs union benefits or losses are assessed. If trade creation is greater than trade diversion, then the customs union is said to be beneficial for member countries. On the other hand, as is was mentioned before, a customs union is said to be detrimental if trade diversion is greater than trade creation.

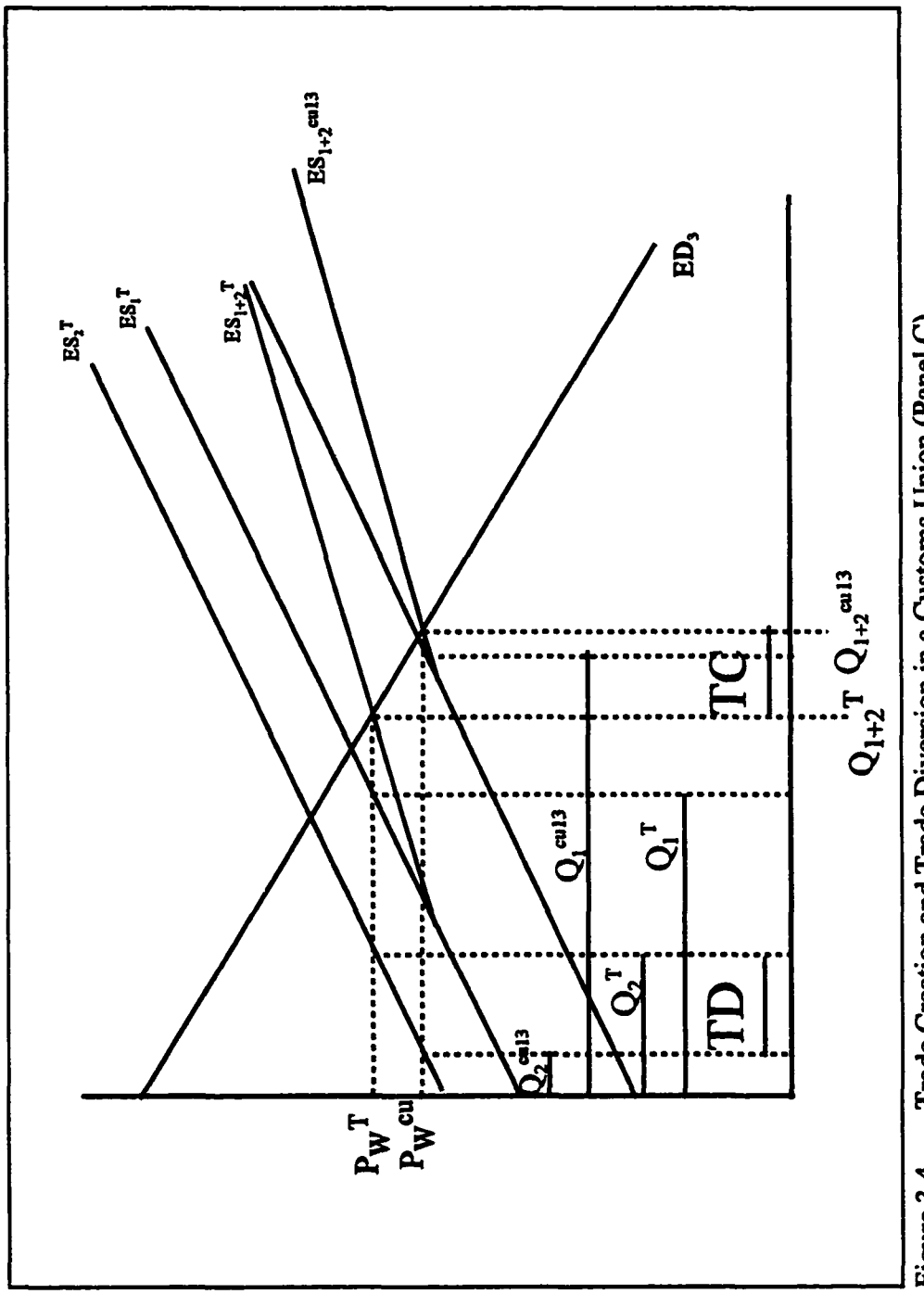

Figure 3.4. Trade Creation and Trade Diversion in a Customs Union (Panel C)

Further Considerations on the Theory of Customs Union

Since exploitation of economies of scale is often mentioned as one of the key objectives when developing countries enter economic integration schemes (Robson, 1984), it seems reasonable to analyze the possible effect of economies of scale on a customs union. In analyzing economies of scale, orthodox theory is of little help since in its analysis it assumes constant returns to scale. Therefore, some modifications of the theory are in order to get some insight when economies of scale are present. Markusen et al (1995) employ extensions to international trade of imperfect competitive models such as the Cournot and the Bertrand models to explain how economies of scale can lead to a strategic trade policy setting. Robson (1984) uses a case by case situation and a graphical approach without referring to any of the afore mentioned models to explain the effects of economies of scale on the welfare of countries entering an economic integration agreement. This approach will be followed here.

The analysis of the effects of economies of scale is as follows. First, suppose there are two countries, namely, H and F entering a customs union, and a passive rest of the world (ROW). Second, suppose there is only one homogeneous product being traded. Third, assume that countries set a common external tariff (CET) to equate average costs to tariff-inclusive import price. In this case, there will be no tariff revenues and excess profits, and all gains or losses will accrue to consumers. In addition, suppose that two situations are possible regarding production of the good. Either there is production in one country or in both countries. Let us consider each case in turn.

Assume initially that, in the pre-union situation, there is production in both countries. After the union is enforced it is likely that one of the countries, either H or F, will

capture the entire market. For purposes of the analysis, suppose that *H* captures the whole market. Since there are economies of scale, the average costs of country *H*'s producers will be less than their costs when they supplied only its home market. Moreover, country *H* production costs will be lower than cost in country *P*. Thus, the union domestic price will be less than the pre-union price. Therefore, the CET rate will be lower than the pre-union levels and consumers in both countries will gain from the implementation of the integration scheme. In country *P*, there will be a trade creation effect due to replacement of dearer domestic production by cheaper imports from country *H*. In addition, there will be an increase in consumption of the good induced by the reduced price. In country *H* there are also gains in consumers' surplus due to reduced prices. In addition, quantity supplied by domestic producers increases.

Let us now assume that in the pre-union situation, there is production only in one country, say, country *H*. If country *H* captures the whole market, this will be a result from country *P* imposing a tariff and not from trade liberalization, otherwise country *H* would not have needed a tariff to compete in the market of country *P*. Under this situation, the domestic price in country *P* will rise. Since price increased in country *P*, then quantity demanded will be lower than the pre-union level. Thus, there is a loss in consumer surplus due to higher prices. In addition, there is trade diversion since country *P* shifted from a cheaper source of the good to a more expensive one.

From the previous analysis, several problems arise. First, if in the pre-union situation the good whose production is subject to economies of scale is produced in both countries, then, after the union is implemented, it is expected that one firm will take over the whole market. However, it is not clear which country it will be. The final result will

depends on 'dynamic' factors such as the nature of oligopolistic competition, the reaction functions of the firms, and other factors (Robson, 1984). In this regard, it is argued that trade liberalization will not necessarily produce optimal specialization and, instead, it may lead to "perverse specialization". Perverse specialization occurs when the firms with the highest average costs curve takes over the whole market because of oligopolistic competition. Moreover, it is argued that in the presence of economies of scale, specialization may fail to occur because the price mechanism may fail to promote specialization if equilibrium is stable in the pre-union situation. Thus, trade liberalization through economic integration is a necessary but not a sufficient condition to secure the benefits that can be derived from free trade (Robson, 1984).

In summary, the theory of customs union within the traditional or orthodox approach warns about the benefits and losses countries may incur when entering a customs union. Overall benefits are represented by net trade creation and losses by net trade diversion. In addition, the formation of a customs union may lead to the presence of economies of scale. In this case, orthodox theory has to be modified to deal with this situation. A closer analysis of the effects of economies of scale on the welfare of countries entering a customs union is then made under a oligopolistic market competition structure. The analysis showed that when economies of scale are present, there is a real possibility of no specialization or 'pervasive specialization' which negatively affect the welfare of member countries. Finally, this analysis is very relevant for Central American countries since one of the stated objectives of economic integration is to exploit economies of scale. Nonetheless, the previous analysis indicates that to reap any possible benefits, countries will have to negotiate and reach agreements about country specialization through planning and supplementation of market forces through regional policies and compromises.

Does a Customs Union Lead to Free Trade?

Several questions arise when countries form trading blocs. One of the most important questions is whether or not a customs union is an adequate path toward free trade. Experiences around the world have shown that economic integration has been used as a means to develop regional trade and to attain a more solid position in international trade relations when is not possible to achieve that as individual countries. Moreover, depending on the stage of development of countries, the formation of a customs union may impact trade relationships differently. For example, the formation of the EEC and the subsequent implementation of the protectionist common agricultural policy (CAP) made the EEC become a net exporter of wheat. This change in the pattern of trade of wheat affected international prices and quantities of wheat traded.

On the other hand, the Central American Common Market (CACM) never had the opportunity of implementing protective policies to develop domestic agricultural and industrial sectors of member countries. Thus, after the creation of the CACM there was not significant change in the terms of trade and trade patterns with the rest of the world. However, regional trade increased considerably under the CACM. Thus, a customs union is a move toward free trade because barriers to trade among member countries are removed. At the same time, the formation of a customs union is a move away from free trade because restrictions on trade with the rest of the world are solidified. The theory of the second best warns analysts regarding this issue. Although the elimination of tariffs may increase total world welfare, the implementation of piecemeal tariff reductions may lower overall world welfare (McMillan, 1986).

Game Theory in International Trade

This section analyzes the importance of game theory in international trade theory and in analyzing real life situations in international trade negotiations. A basic description of the game theory analytical framework is then introduced.

Importance of Game Theory in International Trade Issues

According to McMillan (1986), game theory has an important place in international trade. Every time there is a situation in which an agent's utility depends not only on his own actions but also on the actions of other agents and all agents take these interdependence into account, game theory is a powerful tool of analysis. Therefore, many important trade issues can be modeled within a game theoretic framework. These include negotiations over mutual tariff reductions, indebtedness of less developed countries such as Brazil and Mexico, the formation and preservation of customs unions, and others. In all the examples mentioned, there is strategic interdependence; one agent's action depends on other agent's action and vice versa. So, when there is strategic behavior involved, game theory is an appropriate framework of analysis.

Basic Concepts of Game Theory

According to Rasmusen (1996), the paradigm of game theory is that the analyst assigns payoff functions and strategy sets to players, and considers what happens when players select strategies to maximize their payoffs. Accordingly, the essential elements of a game are *players, actions, information, strategies, payoffs, outcomes,* and *equilibria*. *Players* are the individuals who make the decisions. Each player's goal is to maximize his utility by choice of action. In international trade, individual countries or blocs of countries are the players. An *action* or *move* by player *i*, denoted a_i, is a choice the player can make.

By the same token, player *i's action set*, denoted $A_i=\{a_i\}$, is the entire set of actions available to him or her. In addition, an *action profile* is an ordered set, denoted $a=\{a_i\}\ \forall\ i=1,...,n$, of one action for each of *n* players in the game. The *information set* is formed by the knowledge at a particular time of the values of different variables, i.e., it is the different values the player thinks possible. If the information set has many elements, there are many values the player cannot rule out; if there is one element, the player knows the value exactly. Player *i's strategy* s_i is a rule that tells the player which action to choose at each instant of the game, given the player's information set. Player *i's strategy set* or *strategy space* $S_i=\{s_i\}$ is the set of strategies available to the player. By the same token, a *strategy profile* $s=\{s_i\}\ \forall\ i=1,...,n$, is an ordered set consisting of one strategy for each of the *n* players in the game. The player *i's payoff* $p_i(s_1,...,s_n)$ is defined as the utility or expected utility player *i* receives after all players have picked their strategies and the game has been played out. The *outcome* of the game is the set of interesting elements that the analyst picks from the values of the actions, payoffs, and other variables after the game is played out. Finally, an *equilibrium* $s^*=\{s^*_1,...,s^*_n\}$ is a strategy profile consisting of a best strategy for each of the *n* players of the game.

From the previous definitions, it is clear that a *game* or more formally a *game in strategic form* consists of a set of agents, a set of strategies for each agent, and a utility function for each agent. Because it is a game, each agent's utility, u^i, depends on every agents' strategy, i.e., $u^i=u^i(a_1,...,a_n)$ (McMillan, 1986).

Since strategic behavior may take various forms, games may also vary. Therefore, games can be *cooperative* or *non-cooperative*, played in *pure* or *mixed* strategies. In addition, there could be *zero-sum and non-zero-sum* games. Also, games may be *static* or

dynamic (McMillan, 1986). If an agent randomizes his choice of strategy, he is said to be using a mixed strategy. On the contrary, if the choice is made non-stochastically, the player is said to be using a pure strategy. A *zero-sum* game is a game of pure conflict: what one agent wins, some other agents must lose. So, the sum of all agents' utilities is always zero. A *non-zero-sum* game has elements of both conflict and cooperation. For example, oligopolistic firms have a common interest in keeping total output low and market price high. However, it is in the interest of each firm to have a large market share.

It has been stated that different games have different types of equilibria (McMillan, 1986). For example, it is argued that the equilibrium of a *cooperative* game is Pareto optimal (McMillan, 1986). By contrast, *non-cooperative* games lead to non-Pareto optima. In this case, the concept of *dominant strategies* and *dominant strategy equilibria* become important. Thus, the strategy s^*_i is a *dominant strategy* if it is a player's strictly best response to any strategies the other players might choose. This means that whatever strategies the other players pick, player *i's* payoff is highest with s^*_i. The players inferior strategies are termed *dominated strategies*. A *dominant strategy equilibrium* is a strategy profile consistent of each player's dominant strategy. This equilibrium is called a *Nash equilibrium*.

After having defined all the terms involved in the stipulation of games to be played, some formal definitions are in order. For this purpose, assume that the games are played by two players.

Definition 3.1: the normal-form representation of a two-player game specifies the player's *action spaces* $\mathbf{A^1}$ and $\mathbf{A^2}$ and their *payoff functions* $\mathbf{P^1}$, $\mathbf{P^2}$. This game is denoted by $G=\{\mathbf{A^1}, \mathbf{A^2}, \mathbf{P^1}, \mathbf{P^2}\}$.

Definition 3.2: In the normal-form game $G=\{A^1, A^2, P^1, P^2\}$ let A^1_i and A^1_j, $\forall\, i \neq j$, be feasible strategies for player *1*, i.e., A^1_i and A^1_j are members of A^1. Action A^1_j is strictly dominated by A^1_i if, for all actions available to the other player, player *1*'s payoff from playing A^1_j is strictly less than the payoff from playing A^1_i, such that: $P^1(A^1_j, A^2_i) < P^1(A^1_i, A^2_i)$ $\forall\, A^2_i \in A^2$.

If a unique solution to a two-player normal-form game non-cooperative game is to be found, it must be self-enforcing. Since there are no appropriate authorities to enforce international agreements, this is clearly the situation in any international trade negotiation. Thus, each player's predicted action must be that player's best response to the predicted action of the other player. This is the Nash equilibrium definition given earlier (Kennedy, 1996).

Definition 3.3: In the two-player normal-form game $G=\{A^1, A^2, P^1, P^2\}$, the actions (A^{1*}, A^{2*}) are a Nash equilibrium if, for players *1* and *2*, A^{1*} is player *1*'s best response to the actions specified for the other player, *2*, and vice versa, such that: $P^1(A^{1*}, A^{2*}) \geq P^1(A^1, A^{2*})\ \forall\, A^1_i \in A^1$.

Derivation of the Political Preference Function (PPF)

The political preference function (PPF) is the tool used in this research to estimate the payoffs of the countries analyzed given their chosen actions. So, the description of the PPF follows as a logical sequence in the development of the theoretical framework used in this research. The framework underlying this analysis is based on Johnson et al. (1993) and Kennedy et al. (1996). In this model, countries produce, consume and trade N number of commodities. The aggregate level of production, consumption, and trade in country i is provided by vectors of supply, demand, and excess demand. Farmers in country i produce a subset of the N traded commodities in order to maximize profit, given prices, technology, and endowments. Aggregate supply is given by (3.1)

$$Y(P_f, Z_f), \ldots Y_n(P_f, Z_f) \tag{3.1}$$

where $P_f=(P_{f1}, ...P_{fN})$ is the vector of the producer prices of the N traded commodities, and Z_f is a vector of exogenous factors, such as prices of inputs and factor endowments. Demand for agricultural commodities is given by the vector of demand functions (3.2)

$$X(P_c,Z_c) = (X_1(P_c;Z_c),...X_N(P_c;Z_c)), \tag{3.2}$$

the corresponding indirect utility function is given by (3.3)

$$U(P_c;Z_c) \tag{3.3}$$

where $P_c=(P_{c1}, P_{c2}, P_{c3}, ..., P_{cN})$ is the vector of consumer prices for the N commodities, and Z_c is a vector of exogenous variables. Trade in N commodities is summarized by excess demand (3.4)

$$E(P_f,P_c;Z_f,Z_c) = X(P_c,Z_c) - Y(P_f;Z_f). \tag{3.4}$$

Governments intervene in the domestic markets through price instruments and demand/supply shift instruments. Price instruments, denoted by A^p_{fn} for producers (f) and A^p_{cn} for consumers (c) of commodity N, affect the farm and consumer prices directly or indirectly. Let us assume that P_{wn} is the world price of commodity N. Then the following domestic price functions are defined (3.5a)

$$P_{fn} = P_{fn}(A^p{}_{fn}, P_{wn}), \tag{3.5a}$$

and (3.5b)

$$P_{cn} = P_{cn}(A^p{}_{cn}, P_{wn}), \quad \forall n = 1,...N. \tag{3.5b}$$

If world prices are functions of the actions of the two governments, then (3.6)

$$P_w = P_w(A^p{}_{f1}, A^p{}_{c1}, A^s{}_{f1}, A^s{}_{c1}, A^p{}_{f2}, A^p{}_{c2}, A^s{}_{f2}, A^s{}_{c2}; Z_1, Z_2, Z_3). \tag{3.6}$$

where A^s_{fn} and A^s_{cn} are shift instruments that shift supply and demand functions, such as input subsidies and acreage reduction programs.

When governments choose agricultural policies, they consider the effects of their policies on the welfare of various groups, such as producers, consumers, and taxpayers. Since agricultural policies, like any other policies, can make some groups better off at others expense, governments must weigh the welfare gains of one group against the welfare losses of others. These trade-offs are represented by a political payoff function (PPF) which is a weighted additive function of producer quasi-rents, indirect utilities of consumers, and the cost of agricultural policies of the two governments. Let -i represent other country, let $A_i = (A_{fi}, A_{ci}) = (A^p_{fi}, A^s_{fi}, A^p_{ci}, A^s_{ci})$, and suppress Z_1, Z_2, Z_3. Producers are aggregated by commodity group. The welfare of each producer group is the profit obtained from the production and sale of the commodity. Thus, assuming differentiability, the welfare associated with the production of the n^{th} commodity is the line integral (3.7)

$$\Pi_n(P_n) = \int_0^{pn} P_n Y_n(p)\, dp, \tag{3.7}$$

as commodity N is a net output or net input, respectively. Let (3.8a)

$$\Pi(P_f; Z_f) = (\Pi_1(P_f; Z_f), \ldots, \Pi_N(P_f; Z_f)), \tag{3.8a}$$

be the vector of quasi-rents as a function of the policies of the government, then substitute for P_f by using equation (3.5a) and (3.5b), suppressing Z_f and substitute for P_w by using equation (3.6) to obtain (3.8b)

$$\Pi_i(A_i, A_{-i}) = \Pi_i(A^p_{fi}, P_w(A_i, A_{-i})), A^s_{fi}). \tag{3.8b}$$

By the same token, substituting the domestic price function into equation (3.3), we can obtain indirect utility (3.9)

$$U_i(A_i, A_{-i}) = U_i(P_{ci}(A^p{}_{ci}, P_w(A_i, A_{-i})), A^s{}_{ci}). \tag{3.9}$$

In order to define the government budget in the N agricultural commodities, let t denote a transpose. Then, aggregate consumer expenditures are $P_c X^t$, producers receive $P_f Y^t$, and excess demand is purchased at world markets at prices P_w for $P_w E^t$. Thus, using equations (3.1) and (3.2) and substituting for E with equation (3.4), the budget is (3.10a)

$$B(P_f, P_c, P_w; Z) = (P_c - Pw) * X^t(P_c; Z_c) - (P_f - P_w) * Y^t(P_f; Z_f). \tag{3.10a}$$

After making the proper substitutions for P_f, P_c, P_w, and Z as before, the budget of government i becomes a function of both governments agricultural policies as in (3.10b)

$$B_i(A_i, A_{-i}) = B_i(P_{fi}(A^p{}_{fi}, P_w), P_{ci}(A^p{}_{ci}, P_w), P_w(A^s{}_{fi}, A_{ci}). \tag{3.10b}$$

Finally, normalizing on the budget and using equations (3.8a), (3.9) and (3.10a), the PPF is shown as (3.11)

$$V_i(A_{i,-i}) = \prod_i(A_{i,-i}) * \lambda_{fi} + U_i(A_{i,-i}) * \lambda_{ci} + B_i(A_{i,-i}) \tag{3.11}$$

where λ_{fi} is an N by one strictly positive vector and λ_{ci} is a positive scalar. The $(\lambda_{fi}, \lambda_{ci})$ are the political weights of the respective commodity groups and the aggregate consumer in country *i*.

Equation (3.10a) explicitly links the policies of two governments with their objectives. However, the way either government chooses its agricultural policies also must be determined. An equilibrium point can be constructed such that in formulation of the

polices, a government chooses policies to maximize its PPF given the policies of the other. In this case, a best response correspondence is defined for each government. Then, the equilibrium is defined using the best response correspondence. For a given A_{-i}, government i chooses A_i^*, which is a best response to A_{-i}, such that (3.12)

$$V_i(A_i^*, A_{-i}) \geq V_i(A_i, A_{-i}) \forall A_i \in \mathbf{A}_i. \tag{3.12}$$

where A_i is the set of actions or policies available to government i. Therefore, every A_i A_{-i} has a set of actions in A_i that satisfy equation (3.12). This set defines the best response correspondence of A_{-i}. A pair of actions (A_1^*, A_2^*) is an equilibrium if A_1^* is a best response to A_2^* and vice versa. Thus, (A_1^*, A_2^*) satisfies equation 3.12 for all *i*. Now consider the differentiable case of the model. In this case, differentiating equation (3.11) with respect to A_{fi} and A_{ci}, the first order necessary conditions for a maximum are given in (3.13)

$$\begin{bmatrix} \frac{\partial V_i}{\partial V_{fi}} \\ \frac{\partial V_i}{\partial V_{ci}} \end{bmatrix} = \begin{bmatrix} \frac{\partial \prod_i}{\partial A_{fi}} & \frac{\partial U_{ai}}{\partial A_{fi}} \\ \frac{\partial \prod_i}{\partial A_{ci}} & \frac{\partial U_{ai}}{\partial A_{ci}} \end{bmatrix} * \begin{bmatrix} \lambda_{fi} \\ \lambda_{ci} \end{bmatrix} + \begin{bmatrix} \frac{\partial B_i}{\partial A_{fi}} \\ \frac{\partial B_i}{\partial A_{ci}} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \tag{3.13}$$

For a given A_{-i}, if V_i is concave in A_i, then any A_i^* that solves equation (3.13) maximizes V_i, so it is a best response to A_{-i}. Thus, equation (3.13) implicitly defines the best response correspondence as $A_i^*(A_{-i})$. The $A_i^*(A_{-i})$ is a function if and only if V_i is

$$\begin{bmatrix} \frac{\partial V_1}{\partial A_1} \\ \frac{\partial V_2}{\partial A_2} \end{bmatrix}_{|(A_1^*, A_2^*)} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}. \tag{3.14}$$

strictly concave in A_i for all values of A_{-i}. (A_1^*, A_2^*) is a Nash equilibrium (Johnson et al., 1993) if (3.14)

Suppose the governments of two countries or trading blocs negotiate to improve their positions relative to the one period equilibrium that they currently pursue. If both governments are rational, then no treaty will be signed or complied with that does not make both governments at least as well off as prior to the agreement. Also, if governments can delay agreement, a necessary condition for a treaty to be signed and complied with would be existence of actions (A_1', A_2') such that (3.15)

$$V_1(A_1', A_2') \geq V_1(A_1^*, A_2^*) \text{ and } V_2(A_2', A_1') \geq V_2(A_2^*, A_1^*). \quad (3.15)$$

The set of actions that satisfy equation 3.15 are called the treaty action space and the elements of this space treaty actions.

Estimation of PPF Weights

In order to estimate the PPF weights, it is assumed that the observed policies are a single period Nash equilibrium of a non-cooperative game (Kennedy, 1996). The countries of Central America included in this research choose their policies such that they maximize their PPF given the action of other. Given differentiable indirect profit and utility functions, inference of $\partial\pi/\partial A_i$ and $\partial U/\partial A_i$ can be calculated from observable demand and supply functions (Johnson et al., 1993). Let A_i, for i=1,...,5 be the instruments set by the five Central American countries in the base year. The weights λ_i are estimated using approximations of partial differentials of profits of producers and utility of consumers with respect to producer and consumer protection instruments. The approximation of the differentials is obtained by taking small changes in A_{fi} and A_{ci} in the MISS model. Considering the discrete approximation of equation (3.13), the weights can be calculated

by rearranging equation (3.13), such that (3.16)

$$\begin{bmatrix} \lambda_{fi} \\ \\ \lambda_{ci} \end{bmatrix} = \begin{bmatrix} \frac{\Delta \Pi_i}{\Delta A_{fi}} & \frac{\Delta U_{ai}}{\Delta A_{fi}} \\ \frac{\Delta \Pi_i}{\Delta A_{ci}} & \frac{\Delta B_i}{\Delta A_{ci}} \end{bmatrix}^{-1} * \begin{bmatrix} \frac{\Delta B_i}{\Delta A_{fi}} \\ \frac{\Delta B_i}{\Delta A_{ci}} \end{bmatrix}. \tag{3.16}$$

The weights calculated according to the above formula represent the political influence of various producer groups and consumers as an aggregate in the agricultural policy formulation of Central American countries.

CHAPTER FOUR - SUPPLY AND DEMAND ELASTICITIES

The empirical model used in this study requires estimates of elasticities of demand and supply. Since these elasticities are not readily available, it is necessary to estimate them through modeling tools. In this chapter, elasticities of supply and demand for eight commodities included in this study are estimated. The theoretical as well as empirical considerations are included prior to elasticity estimation. The first section of this chapter includes the estimation of supply elasticities. The second section includes the estimation of demand elasticities. Finally, an evaluation of the validity of the estimates is developed as a conclusion for this chapter.

It is important to mention that the empirical estimation of economic relationships is often a very difficult task. Lack of reliable data, limited number of observations, and incomplete data sets have been mentioned as serious limitations in dealing with modeling production in developing countries (Fischer et al, 1980). Therefore, the researcher is compelled to exercise a high degree of creativity when the research is focused on developing countries. On one hand, the researcher should keep in mind that the basic economic relationships are the basis for any model to be acceptable. On the other hand, traditional supply and demand relationships are not readily established because of the problems mentioned above.

Supply Elasticities

Theoretical Considerations

A supply curve is based on the assumption that producers seek to maximize net returns (Tomek and Robinson, 1990). This is obtained by equating marginal costs to marginal revenue. Since the individual firm is assumed to be a price taker in a competitive

industry, the firm's marginal revenue is the prevailing market price. Marginal cost is defined as the increment in total cost associated with producing one more unit of output. For an individual firm, the supply curve consists of the portion of the marginal cost curve

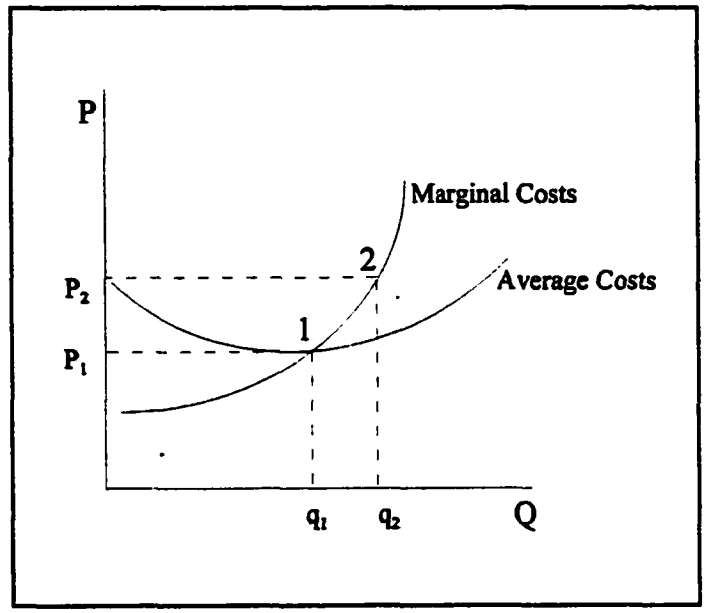

Figure 4.1 Marginal and Average Costs

above the average cost curve as shown in figure 4.1. Economic theory suggests that in the long run the individual firm will produce at point *1* where average and marginal costs are equal, because at this point all costs are covered. At point 2 the firm would be making a profit given by the distance between the average cost curve and the marginal cost curve. The firm would prefer to produce at this point instead of at point 1 but free market conditions would move production to point 1.

At this point, it is important to mention the factors affecting production and supply of goods. In general, two kinds of factors affect supply. A change in the price of a product will cause a change in the quantity supplied, such that quantity supplied and price move in

the same direction. On the other hand, there are several factors that cause the supply curve to shift. Changes in inputs or factor prices, changes in the returns of commodities that compete for the same resources, changes in technology, institutional constraints, and changes in the level of price and yield risk faced by producers are among the most important factors that shift the supply curve.

The supply elasticity is usually used to evaluate the effects of the factors mentioned above on the supply of goods and services through price signaling . The supply elasticity is defined as the percentage change in the quantity supplied of a given commodity or service given a percentage change in the price of the commodity or service. The own price elasticity refers to changes in the price of the commodity or service. The cross price refers to changes in prices of commodities that compete or complement the commodity under scrutiny. In general, the elasticity of supply is given by 4.1:

$$e_{ij}^{s} = \frac{\%\Delta q_i}{\%\Delta p_j} = \frac{\partial \log(q_i)}{\partial \log(p_j)}, \forall\, i, j = 1, \ldots, n \qquad (4.1)$$

where e^{s}_{ij} is the elasticity of supply (s) of commodity q_i with respect to price p_j. The elasticities can also be obtained as the derivative (∂) of the natural logarithm (log) of quantity with respect to the logarithm of price. The own price supply elasticity is obtained if $i=j$, cross-price supply elasticities are obtained otherwise. In general, the own-price elasticity of supply is expected to be positive. The cross-price elasticities are positive if commodities are complements and negative if commodities are substitutes in production.

Empirical Estimation of Supply Elasticities

A considerable amount of creativity must be exercised to estimate supply elasticities of the commodities under analysis in the present research. The empirical

estimation must adhere to the theoretical framework. However, as often happens, because of data problems or problems of other sorts, the direct empirical estimation of the theoretical model is not possible. Therefore, other means must be resorted to if we are to overcome such limitations.

In this study, after a literature review, the basic empirical considerations to estimate the supply elasticities of commodities were taken and simplified from the Linked Basic Model (LBM) modeling framework. Fischer and Frohberg (1980) and Fischer et al (1988) proposed the LBM as a tool of international food policy analysis. The LBM model is a national level model that includes a supply module, a demand module, and an exchange module. Accordingly, in the supply module, production is a function of labor, fertilizer and capital as in 4.2:

$$Q = f(L, F, K) \tag{4.2}$$

where Q is the quantity produced, L is labor, and K is capital. There is a representative producer who must allocate these scarce resources among the production of the commodities produced. To do so, the producer is assumed to maximize expected net returns. The net expected returns maximization problem can be expressed as in equation (4.3) where $\overline{NR_i}$ is net expected returns, for $i = 1$ to $n-1$ net revenues correspond to crops and, for i=n, net revenue corresponds to cattle production (beef), A_i is acreage for crop i, M is quantity produced of beef, H is number of cattle stock or number of sacrificed heads and L, K, F, are the maximum quantities of labor, capital, and fertilizer, respectively.

In an initial step (figure 4.2), labor, capital, and fertilizer requirements had to be established in order to generate a production function for each commodity under analysis.

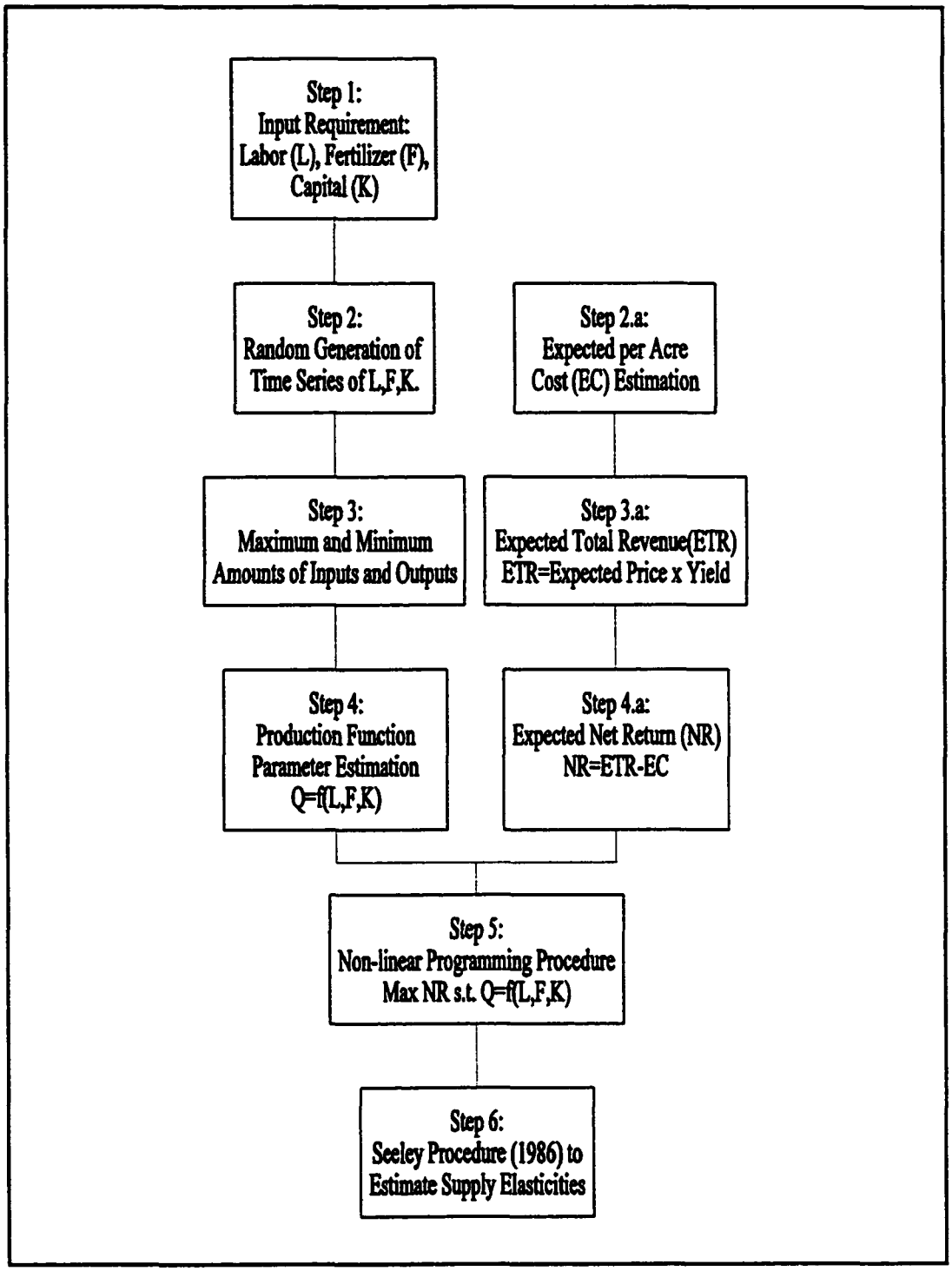

Figure 4.2 Estimation Procedure of Central American Countries Supply Elasticities Based on Fischer et al (1980).

$$
\begin{aligned}
&\underset{L,F,K\geq 0}{Max} \sum_{i=1}^{n-1} \overline{NR_i} * A_i + \overline{NR_n} * M \\
&\textit{Subject to:} \\
&A_i = f(L_i, F_i, K_i) \\
&M = f(L_i, H, K_i) \\
&\sum_{i=1}^{n} L_i \leq L \\
&\sum_{i=1}^{n} K_i \leq K \\
&\sum_{i=1}^{n} F_i \leq F
\end{aligned}
\tag{4.3}
$$

This was done by using data from several Nicaraguan sources. The assumption made is that all Central American countries are similar in technology and, therefore, the use of the same technological requirement for each crop for all countries is acceptable. Thus, Table 4.1 shows the technological structure and input requirements for all Central American countries. Once input requirements were established for each commodity under several technologies, a random data generating process was used to create time series of weighted average requirements of inputs for 15 years. The normal distribution was used for that purpose (appendix D). This procedure made it possible to relate output to inputs, i.e., estimation of the production function for each commodity in each country. Step 4 dealt with the estimation of the production functions parameters to be used (Appendix D). For this purpose, Cobb-Douglas production function were assumed and the parameters estimates for fertilizer (f), labor (l), and capital (K) were estimated using ordinary least squares estimation (OLS). The tests for autocorrelation showed small autocorrelation coefficient (less than 0.3) and, therefore, no further corrections were deemed necessary (Table A2-A7).

Table 4.1. Input Prices and Input Requirements for Eight Commodities in Five Central American Countries

Input Prices					Rice					
C	S	G	H	N	Techno.	1	2	3	4	5
					Yield	20	28	35	70	55
7.15	2.97	4.0	1.9	1.3	Labor	54	28	34.5	19.0	18.0
12.0	15.0	12.0	14.0	6.0	Animal	0	5	5	0	0
35.0	40.0	30.0	40.0	25.0	Machine	0	0	0	8	6
12.92	14.0	10.9	9.26	11.2	Fertilizer	1	1	2	4	4
Beans						Corn				
Techno.	1	2	3	4	5	1	2	3	4	5
Yield	12	20	25	---	---	20	70	80	---	---
Labor	50	39	45	---	---	47	54	5	---	---
Animal	0	5	0	---	---	4	12	0	---	---
Machine	0	0	4	---	---	0	0	10	---	---
Fertilizer	0	1	1	---	---	0	3	5	---	---
Sorghum						Coffee				
Yield	50	50	---	---	---	22	20	15	5	---
Labor	61	20	---	---	---	175	133	114	39	---

(Continued...)

Table 4.1. (Continued)

Sorghum						Coffee				
Technolo	1	2	3	4	5	1	2	3	4	5
Animal	5	0	---	---	---	0	0	0	0	---
Machine	0	7	---	---	---	0	0	0	0	---
Fertilizer	2	4	---	---	---	9.0	8.0	6	0	---
Bananas						Sugar Cane				
Yield	72.1	---	---	---	---	55	45	---	---	---
Labor	54	---	---	---	---	19	18	---	---	---
Animal	0	---	---	---	---	30	19	---	---	---
Machine	.3	---	---	---	---	10	8	---	---	---
Fertilizer	8	---	---	---	---	2	2	---	---	---

Source: FNI, 1993; INTA, 1995; INTA 1997; INTA 1999; BND, 1997; BND, 1998; ECLAC-Mexico, 1999.

Note: Countries: C=Costa Rica, S=El Salvador, G=Guatemala, H=Honduras, N=Nicaragua
Yield: Rice, Beans, Corn, Sorghum, Coffee: cwt/manzana (mz); 1cwt=100 Lb1,1mz=0.7 Ha. Bananas, Sugar Cane: TM/mz.
Input Requirement: Labor=person-days, Animal force=animal-days, machinery=hours, fertilizer=cwt.
Input Prices: Local average 1995-97 in US$/unit of measurement.

On the other hand, In steps 2.a-4.a, expected net returns were estimated on the basis of total expected returns and expected per acre costs as described in Appendices B, B1, and C. Expected net returns were obtained for each commodity in each country and then used to maximize expected net returns (Table A1). These expected returns were obtained on the assumption that the producer has naive expectations, i.e., the producer expects that the price prevailing at the moment of production decisions (planting decisions, breeding decisions, and so forth) and the price at the moment of the sale of the producer's production output in the future will be the same. This generates a series of lagged prices. For perennial crops, such as coffee, or cattle production, this lag could be several years. For other commodities, the lag is usually one year.

In the next step (step 3) the minimum and maximum output of each commodity under analysis were obtained from data from the Economic Commission for Latin America of the United Nations Organization (ECLAC) (Appendix E). In step five, the model in equation 4.3 was optimized using nonlinear programming because the production function is assumed to have a flexible form, i.e., a nonlinear form. A non-linear estimation procedure to estimate equation (4.3), as described in Appendix G., was used to estimate quantity-price relations in supply of the commodities included in this study. Finally, in step 6, estimates of the supply elasticities are obtained using a procedure recommended by Seeley (1985, 1986). Initially, an optimum solution for the maximization problem is estimated. Then, the price of each commodity is changed by 10% one at a time and the model is optimized. Finally, the percentage change in output of all commodities given a 10% change in the price of only one commodity gives an estimate of own-price and cross-price elasticities of supply. The elasticities estimated in this fashion are to be considered

long-run supply elasticities because they reflect the full change in price without taking into account time and other factors.

To obtain the short-run elasticities the following assumptions were used. First, it is reasonable to expect that elasticities are smaller in short-run than in the long-run. This is so because long-run supply is more elastic, i.e., the supply curve has a smaller slope than in the short-run. Secondly, the estimation of the long-run elasticities is based on the assumption of the representative farmer, i.e., a farmer who produces all commodities at the same time. However, in real life, climatic, equipment limitations, and other conditions cause producers to focus on the production of a small number of commodities. So, in real life, cross-price responsiveness should be smaller than under the assumption of a representative farmer. Third, profit maximization was the only criterion used in the non-linear procedure. Therefore, it is expected that responsiveness of supply to prices will be more sensitive when a sole criterion is used to estimate elasticities. Therefore, it was assumed that the long-run elasticity estimates are upper bound estimates of the true elasticities. Four, a review of elasticity estimates by other authors (Dargay et al, 2000; Lass et al, 1996; etc) indicate that short run elasticities are 40-80% lower than long-run estimates. In conclusion, based on the facts mentioned above, it was determined that for purposes of this study, it would be reasonable to assume that short run elasticities are one third of the estimates obtained in the non-linear procedure estimates.

Empirical Results of Supply Elasticities Estimation

Although, technologically speaking, Central American countries are assumed to be very similar, the responsiveness to changes in commodity prices is different for all countries as it is shown in Tables 4.2-4.6. It seems reasonable to expect perennial crops

(coffee and bananas) to be less responsive to changes in prices than annual crops. In addition, export commodities have kept a fairly stable production despite strong oscillations in world prices of those commodities (coffee, sugar, beef, and bananas). In most countries, bananas and coffee were not responsive to prices. In those cases, the elasticity estimates for other countries or from other sources were used. In general, the estimates of the elasticities are close to those of Gardiner(1989) and Tyers et al (1986).

Table 4.2. Guatemala Supply Elasticities

Product	Rice	Beans	Corn	Sorghum	Bananas	Coffee	Sugar	Beef
Rice	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Beans**	-0.00	0.39	0.00	0.00	0.00	-0.01	0.00	-0.01
Corn	1.09	1.10	1.46	-0.30	0.00	1.09	-0.34	-0.03
Sorghum	-0.21	-0.21	-0.54	0.51	1.19	-0.21	-1.76	0.99
Bananas	0.00	0.00	0.00	0.00	1.52	0.00	0.00	0.00
Coffee	0.00	0.00	0.00	0.00	0.00	* 0.40	0.00	0.00
Sugar	0.00	0.00	0.00	-0.02	0.00	0.00	0.17	0.00
Beef	-0.96	-0.95	-1.18	-1.7+3	0.00	-0.96	-2.02	0.92

*: Source: Elaborated from Gardiner (1986) and results for Central America.
**: Elasticities for Honduras

Table 4.3. El Salvador Supply Elasticities

Product	Rice	Beans	Corn	Sorghum	Coffee	Sugar	Beef
Rice	0.21	0.21	0.20	0.21	0.21	0.20	0.20
Beans	0.00	0.45	-0.01	-0.08	0.00	0.03	0.00
Corn	0.00	0.00	0.05	0.00	0.00	-0.00	0.00
Sorghum	-0.00	-0.07	-0.02	0.60	-0.00	0.05	-0.00
Coffee	0.00	0.00	0.00	0.00	* 0.40	0.00	0.00
Sugar	0.00	-0.00	-0.00	-0.00	-0.00	0.23	-0.00
Beef**	0.00	0.00	0.18	0.00	0.06	-0.05	0.14

*: Source: Elaborated from Gardiner (1986) and results for Central America.
**: Elasticities for Costa Rica

Table 4.4. Honduras Supply Elasticities

Product	Rice	Beans	Corn	Sorghum	Bananas	Coffee	Sugar	Beef
Rice	0.75	-0.20	0.01	-0.35	-0.20	0.61	-0.30	0.49
Beans	-0.00	0.39	0.00	0.00	0.00	-0.01	0.00	-0.01
Corn	-0.00	0.00	0.04	-0.00	0.00	-0.02	-0.00	-0.02
Sorghum	0.02	-0.03	0.00	0.04	-0.03	0.75	-0.15	0.76
Bananas	0.00	-0.03	0.00	0.00	* 0.40	-1.11	-0.04	-0.85
Coffee	0.00	0.00	0.00	0.00	0.00	* 0.40	0.00	0.00
Sugar	0.00	-0.01	0.00	-0.17	-0.01	0.11	0.08	0.09
Beef	0.03	-0.04	0.00	-0.14	-0.04	0.94	-0.15	1.29

*: Source: Elaborated from Gardiner (1986) and results for Central America.

Table 4.5. Nicaragua Supply Elasticities

Product	Rice	Beans	Corn	Sorghum	Bananas	Coffee	Sugar	Beef
Rice	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Beans	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Corn	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00
Sorghum	0.01	0.03	-0.41	1.32	0.00	0.02	0.01	0.01
Bananas	-0.05	-0.02	0.02	-1.27	0.40	-0.14	-0.02	-0.03
Coffee	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00
Sugar	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00
Beef	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.05

*: Source: Elaborated from Gardiner (1986) and results for Central America.

Table 4.6. Costa Rica Supply Elasticities

Product	Rice	Beans	Corn	Sorghum	Bananas	Coffee	Sugar	Beef
Rice	0.24	0.00	-0.10	0.00	0.00	-0.03	0.02	0.00
Beans	0.00	0.29	-0.13	0.00	0.00	-0.05	0.03	0.00
Corn	-0.00	-0.00	0.56	-0.00	-0.00	0.07	-0.05	-0.00
Sorghum	0.00	0.00	-0.57	0.30	0.00	-0.19	0.15	0.00
Bananas	0.00	0.00	2.70	0.00	* 0.40	0.00	0.00	0.00
Coffee	0.00	0.00	0.00	0.00	0.00	* 0.40	0.00	0.00
Sugar	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.00
Beef	0.00	0.00	0.18	0.00	0.00	0.06	-0.05	0.14

*: Source: Elaborated from Gardiner (1986) and results for Central America.

Demand Elasticities

Theoretical Considerations

Economic theory assumes that consumers purchase goods and services to maximize their utility (Varian, 1992). At the same time, consumers maximize utility subject to an income constraint. Thus, the consumer's problem can be depicted as a constrained optimization problem. Mathematically, the problem can be specified as in 4.4:

$$\underset{x \geq 0}{Max}\ u(\mathbf{x})\ s.t.\ \mathbf{px} \leq m \tag{4.4}$$

where $u(x)$ is utility u as a function of the vector of goods $\mathbf{x}$, $\mathbf{p}$ is the vector of prices, and m is consumer income. Economic theory indicates that $u(x)$ in 4.4 should meet a set of

mathematical properties to be an adequate representation of utility. First, the function should be continuous. Second, the economic axiom of non-satiation, i.e., "more is preferred to less", indicates that *u(x)* should have a positive first derivative. Third, since the consumer's objective is to maximize utility, then *u(x)* should have a non-positive second derivative to reach a maximum, i.e., the function should be concave or quasi-concave.

Demand equations should be obtained from the optimization problem in order to estimate demand elasticities. Accordingly, non-linear programming is commonly used as a tool to estimate optimal demand functions when the utility function is non-linear, which is commonly the case. The Lagrangian function is used and from the first order conditions the optimal demands (**x***) as a function of prices and income are derived as in 4.5:

$$x_i^* = f(\mathbf{p}, m) \tag{4.5}$$

As in the supply side, there are two types of factors that affect the quantity demanded of a good. A change in the price of a good will cause the quantity demanded to move in the opposite direction of, i.e., an opposite movement along the demand curve as shown in figure 4.3. On the other hand, changes in population, income, and tastes and preferences have been mentioned to cause a shift in the demand curve.

As in the supply side, the elasticity of demand is mainly used to evaluate the impact of various factors on the quantity demanded and the demand curve through price signaling. Therefore, it is important to estimate these elasticities for many economic questions and decisions. The elasticity of demand is defined similar to the elasticity of supply, i.e., it is the percentage change in quantity demanded given a percentage change in prices as in 4.6:

$$e_{ij}^d = \frac{\%\Delta q_i}{\%\Delta p_j} = \frac{\partial \log(q_i)}{\partial \log(p_j)}, \forall\, i, j = 1, \ldots, n \tag{4.6}$$

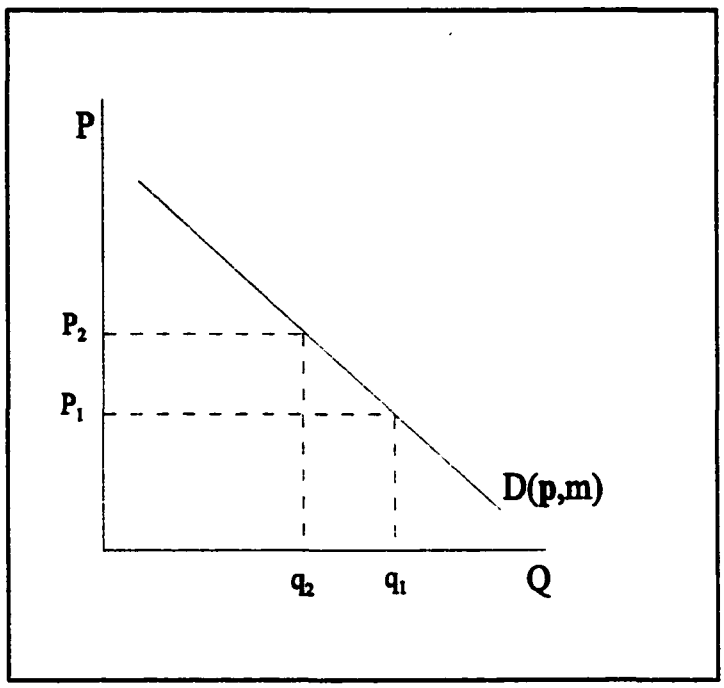

Figure 4.3 Effect of Price Changes on Quantity Demanded

where *d* stand for demand and the definition of the remaining variables is the same as in equation 4.1. As it is shown in Figure 4.2, the slope of the demand curve is negative, so it is expected that the own-price demand elasticity will be negative, i.e., when *i=j*. For cross-price elasticities the sign will be positive for complements and negative for substitutes.

Empirical Estimation of Demand Elasticities

Although many models have been proposed to estimate demand relationships, in this study elasticities of demand were estimated with the Linear Approximate (LA) of the Almost Ideal Demand System (AIDS) proposed by Deaton and Muellbauer (1980). The AIDS model assumes a flexible utility function and non-separability. These assumptions are convenient in this study because agricultural commodities and, specifically, food are sensitive to own- and cross-relationships of commodities. The demand functions in budget form according to the AIDS model are specified as in equation 4.7:

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} * \log p_j + \beta_i * \log\left(\frac{E}{P}\right), \forall\, i, j = 1,\ldots,n \qquad (4.7)$$

where w_i is the budget share of commodity i, $\log p_j$ is the logarithm of price of commodity j, E is total expenditures on the group of commodities under analysis, P is a price index, and α_i, γ_{ij}, and β_i are parameters to be estimated. The use of the Stone's index (Deaton and Muellbauer, 1980) makes the model linear as defined in 4.8:

$$\log P = \sum_{i=1}^{n} w_i * \log p_{i,t} \qquad (4.8)$$

Therefore, the model which uses Stone's price index is called the *Linear Approximate* AIDS (LA/AIDS) model. Thus, equation 4.7 implies that the budget shares of various commodities are linearly related to the logarithm of the real total expenditure and relative prices. In addition, the general demand restrictions of adding-up, homogeneity, and symmetry are satisfied by the following parametric restrictions on the AIDS model:

$$\begin{aligned} &\textit{Adding-up:} && \sum_{i=1}^{n} \alpha_i = 1, \quad \sum_{i=1}^{n} \gamma_{ij} = 0, \quad \sum_{i=1}^{n} \beta_i = 0 \\ &\textit{Homogeneity:} && \sum_{j=1}^{n} \gamma_{ij} = 0, \\ &\textit{Symmetry:} && \gamma_{ij} = \gamma_{ji} \end{aligned} \qquad (4.9)$$

To estimate the elasticities of demand for all commodities in all countries included in this study, some preliminary data estimation were needed. First, individual consumption of all commodities for all countries were obtained from the FAO Food Balance Sheet (FAO, 1993, 1995). However, there was not a time series for all the years under analysis (1985-1998). Therefore, a random number generating process was used to create the data

sets (Fischeret al, 1980) (Appendix H). Secondly, once the data for personal consumption were estimated, the expenditure share of each commodity was calculated by multiplying personal consumption by price and dividing this product by the sum of the expenditures on all commodities. Third, since the data set only included 15 observations, some strong assumptions had to be made for the sake of the statistical properties of the model. For example, it was assumed that there were no price relationships between basic staples (rice, beans, corn, and sorghum) and three of the four export commodities (bananas, sugar, coffee). This assumption could be imposed for two reasons. First, since Central American agriculture is divided into domestic and export sectors, it could be safely assumed that there is a small cross-price relationship between those two groups of commodities (Alonso, 1994). Secondly, the elimination of unimportant parameters in the econometric equations increases the number of degrees of freedom which is a convenient condition to improve the statistical properties of the results of the estimated model (Judge et al, 1988). Finally, based on tables A7-A11, elasticities were estimated as (4.10):

$$\varepsilon_{ij} = -\delta_{ij} + \frac{\hat{\gamma}_{ij}}{\overline{w}} + \hat{\beta}\left(\frac{\overline{w}_j}{\overline{w}_i}\right) \qquad (4.10)$$

where $\delta=1$ for $i=j$, and $\delta=0$ otherwise.

Empirical Results of Demand Elasticities Estimation

The estimation of the statistical model proposed above yielded encouraging results despite the limitations mentioned earlier. For most countries and commodities, own-price elasticities were negative, as economic theory would suggest. It is true that during the estimation process the level of significance of the parameter estimates was low (not shown) and therefore the results should be interpreted as a rough approximation of the true elasticities. Tables 4.7.- 4.11. reveal that the elasticities estimates are in the range of

elasticities estimates for other countries by various authors (Gardiner, 1989; Tyers et al., 1986; Mahe et al, 1988). In addition, to assure compliance with economic theory, in cases when the parameter estimates were different from those expected (positive sign for own-price elasticities, absolute magnitude too large, and so forth), elasticity estimates were replaced by those estimated for other Central American countries which were deemed to be more reliable, accurate, and more appropriate for each country and commodity case.

Table 4.7. Guatemala Demand Elasticities

Product	Rice	Beans	Corn	Sorghum	Bananas	Coffee	Sugar	Beef
Rice*	-0.27	-1.59	-0.41	1.65	0.00	0.00	0.00	-0.10
Beans	-0.20	-0.93	-0.34	0.25	0.00	0.00	0.00	0.23
Corn	0.10	0.07	-1.14	-0.16	0.00	0.00	0.00	0.02
Sorghum	0.29	-0.11	-0.06	-0.80	0.00	0.00	0.00	0.42
Bananas	0.00	0.00	0.00	0.00	-0.28	0.15	-1.26	0.00
Coffee	0.00	0.00	0.00	0.00	0.00	-0.06	-0.41	-0.45
Sugar**	0.00	0.00	0.00	0.00	0.31	-0.27	-1.08	0.00
Beef	0.47	-2.02	-1.16	1.63	0.00	0.00	0.00	-0.08

*: Elasticities for Honduras. **: Elasticities for Costa Rica.

Table 4.8. El Salvador Demand Elasticities

Product	Rice	Beans	Corn	Sorghum	Bananas	Coffee	Sugar	Beef
Rice*	-0.27	-1.59	-0.41	1.65	0.00	0.00	0.00	-0.10
Beans	-0.26	-0.09	-0.73	-0.14	0.00	0.00	0.00	0.00
Corn	0.10	-0.39	-0.63	0.08	0.00	0.00	0.00	-0.09
Sorghum	0.47	-0.42	-0.59	-0.90	0.00	0.00	0.00	0.30
Bananas	0.00	0.00	0.00	0.00	-0.14	0.15	-1.08	0.00
Coffee	0.00	0.00	0.00	0.00	0.00	-0.28	-0.38	-0.21
Sugar	0.00	0.00	0.00	0.00	-0.32	-0.42	-0.07	0.00
Beef	0.05	-0.28	-0.53	0.29	0.00	0.00	0.00	-0.42

*: Elasticities for Honduras

Table 4.9. Honduras Demand Elasticities

Product	Rice	Beans	Corn	Sorghum	Bananas	Coffee	Sugar	Beef
Rice	-0.27	-1.59	-0.41	1.65	0.00	0.00	0.00	-0.10
Beans	-0.61	-2.66	-0.47	3.03	0.00	0.00	0.00	0.19
Corn	0.21	0.63	-0.89	-0.98	0.00	0.00	0.00	-0.15
Sorghum	0.29	-0.11	-0.06	-0.80	0.00	0.00	0.00	0.42
Bananas	0.00	0.00	0.00	0.00	-0.34	-0.09	-0.86	0.00
Coffee	0.00	0.00	0.00	0.00	0.00	-0.67	0.15	-0.34
Sugar**	0.00	0.00	0.00	0.00	0.31	-0.27	-1.08	0.00
Beef*	-0.57	-0.39	-0.37	0.08	0.00	0.00	0.00	-2.52

*: Elasticities for Nicaragua. **: Elasticities for Costa Rica.

Table 4.10. Nicaragua Demand Elasticities

Product	Rice	Beans	Corn	Sorghum	Bananas	Coffee	Sugar	Beef
Rice	-0.31	-0.37	-0.01	-0.05	0.00	0.00	0.00	1.35
Beans	-0.09	-0.02	-0.53	0.08	0.00	0.00	0.00	-0.01
Corn	-0.22	-0.10	-0.48	0.06	0.00	0.00	0.00	-0.33
Sorghum	0.29	-0.11	-0.06	-0.80	0.00	0.00	0.00	0.42
Bananas*	0.00	0.00	0.00	0.00	-0.34	-0.13	-0.73	0.00
Coffee	0.00	0.00	0.00	0.00	0.00	-0.62	2.60	3.83
Sugar*	0.00	0.00	0.00	0.00	0.31	-0.27	-1.08	0.00
Beef	-0.57	-0.39	-0.37	0.08	0.00	0.00	0.00	-2.52

*:Elasticities for Costa Rica

Table 4.11. Costa Rica Demand Elasticities

Product	Rice	Beans	Corn	Sorghum	Bananas	Coffee	Sugar	Beef
Rice*	-0.27	-1.59	-0.41	1.65	0.00	0.00	0.00	-0.10
Beans	-0.49	-0.17	-0.12	-0.23	0.00	0.00	0.00	-0.02
Corn	-3.27	0.41	-0.45	0.19	0.00	0.00	0.00	0.85
Sorghum	-1.59	-0.09	-0.15	-0.01	0.00	0.00	0.00	0.55
Bananas	0.00	0.00	0.00	0.00	-0.34	-0.13	-0.73	0.00
Coffee	0.00	0.00	0.00	0.00	0.00	-0.48	-0.58	-0.07
Sugar	0.00	0.00	0.00	0.00	0.31	-0.27	-1.08	0.00
Beef	0.05	-0.28	-0.53	0.29	0.00	0.00	0.00	-0.42

*: Elasticities for El Salvador

Summary and Conclusions

This chapter focused on the estimation of supply and demand elasticities of eight commodities for five Central American countries. The commodities included are rice, beans, corn, sorghum, bananas, coffee, sugar and beef. The countries are Guatemala, El Salvador, Honduras, Nicaragua, and Costa Rica. The first section focused on the estimation of supply elasticities. For this purpose, a theoretical model of supply was developed and the empirical estimation was based on the model proposed by Fischeret al (1980, 1988). Since the adaptation of the LBM to the present research generated a model that allowed for the full adjustment to changes in prices, the elasticities were interpreted as long-run elasticities. An adjustment mechanism based on the strength and limitations of the model was used to obtain short-run elasticities. The resulting short-run elasticities are in agreement with estimates from other authors.

Having estimated supply elasticities, the second section focused on the estimation of demand elasticities. For this purpose, a theoretical model of demand was developed. Later, the linear approximation of the Almost Ideal Demand Model (LA/AIDS) was used as the empirical model to estimate the demand elasticities of the commodities under analysis. The estimation had to be done taking into account data limitations, statistical properties of the model, and economic theory. The results showed that the parameter estimates were in the range of estimates obtained by various authors.

Finally, it is important to mention that there have been few attempts to estimate supply and demand elasticities for Central America. The results showed that it is difficult to estimate these elasticities (Gabriele, 1994). So, this chapter is one of many attempts by serious researchers to deal with the difficulties of empirical work. The supply and demand elasticity estimates should be interpreted as an attempt to obtain approximations of rough quantity-price relationships in Central American countries. The resulting elasticities should be used with caution.

CHAPTER FIVE - GAMES SIMULATION RESULTS

This chapter presents the results of the simulated games of various levels of agricultural trade liberalization in Central America. The first section includes a concise description of the MISS model. The second section gives the justification for the use of the nominal protection coefficient (NPC) as the main criterion to model trade liberalization in Central America. The third section deals with the data used. The fourth section describes the empirical results of several game simulations based on a set of government actions from each country perspective. Finally, the last section concludes the chapter with a summary and discussion of the results.

Description of the MISS Model

In order to examine the effects of agricultural trade liberalization for Central American countries and various trade policy strategies, the previously developed PPF theoretic framework will be used. Analysis of the effects of various scenarios is implemented using *Modele International Simplifie de Simulation* (MISS) (Mahe et al, 1988). MISS is a partial equilibrium trade model that simulates, in a comparative static framework, the effects of various policy decisions. The model operates on the principle of Walrasian equilibrium. The model takes a change of policy by a country and identifies the corresponding changes in world prices, production, and consumption.

The description of the model is as follows. Quantity supplied will equal quantity demanded plus initial stocks in the world markets. The initial equilibrium is given by (5.1)

$$\Sigma_k S_{ik} = \Sigma_k D_{ik} + \Sigma_k Q_{ik} + \Sigma_k I_{ik} \qquad (5.1)$$

for all i=1, ...N, where i represents commodity and, k represents the country. S_{ik}, D_{ik}, Q_{ik} represent production, derived demand, and total demand, respectively, for commodity i

in country k for the base year, I_{ik} represents initial stock of commodity i in country k.

Change in supply is given by (5.2)

$$\Delta S_{ik} = \sum_j (E^{*}_{jk} \cdot P^{s}_{jk} + E^{**}_{ijk} \cdot P^{D}_{jk}) + \sigma_{ik}, \tag{5.2}$$

for all i=1,...N, where E^{*}_{ijk}, (E^{**}_{ijk}) represent the matrix of supply elasticities with respect to output (input) prices, P^{s}_{jk} and P^{D}_{jk} represent the domestic price for production and derived demand i in country k, and σ_{ik} represents a quantity shifter for production.

Change in derived demand is given by (5.3)

$$\Delta D_{ik} = \sum_j (F^{*}_{ijk} \cdot P^{s}_{jk} + F^{**}_{jk} \cdot P^{D}_{jk}) + \delta_{ik}, \tag{5.3}$$

while change in final demand is given by (5.4)

$$\Delta Q_{ik} = \sum_j G_{ijk} \cdot P^{Q}_{jk} + \xi_{ik}, \tag{5.4}$$

for all i=1, ...N, where G_{ijk} represents the matrix of final demand elasticities with respect to consumer prices, P^{Q}_{jk} represents the domestic price for final demand for commodity i in country k, ξ_{ik} represents a quantity shifter for final demand for commodity i in country k.

The domestic /world price linkage is shown by the equation (5.5)

$$P^{N}_{jk} = P^{W}_{j} \cdot C_k \cdot T^{N}_{jk} \cdot W_k \tag{5.5}$$

or in logarithmic terms W_k is fixed so it disappears as in (5.6)

$$P^{N}_{jk} = \ln P^{W}_{j} + \ln C_k + \ln t^{N}_{jk}; \quad \forall \, N = (S, D, Q), \tag{5.6}$$

where P^{W}_{j} represents world price of commodity i, C_k represents the currency exchange rate, and W_k are the margin coefficients representing transportation costs, freight, insurance, or

other costs. The final equilibrium of the model, using previous equations is given by (5.7)

$$\Sigma_k S_{ik} \cdot \Delta S_{ik} = \Sigma_k D_{ik} \cdot \Delta D_{ik} + \Sigma_k Q_{ik} \cdot \Delta Q; \forall \text{ i} = 1, \ldots \text{N}. \quad (5.7)$$

Net budget costs for country k are shown as in (5.8)

$$BC_k = \Sigma (P_{ik}^s - P_{ik}^B) \cdot S_{ik} - \Sigma_i (P_{ik}^B) D_{ik} - \Sigma_i (P_{ik}^Q - P_{ik}^B) \cdot Q_{ik} \quad (5.8)$$

where P^B_{ik} represents the border price of commodity i in country k. The system in equation (5.2)-(5.7) can be viewed as an N dimensional vector valued function of M variables (5.8a):

$$\begin{aligned} &F_N (x_1 \ldots x_M) = 0, \quad n = 1, \ldots, N; \quad M \geq N \\ &Or\ F_N (x_1 \ldots x_N \mid x_{N+1} \ldots x_M) = 0 \end{aligned} \quad (5.8a)$$

when N independent relations are available, $(M\text{-}N)$ arbitrary exogenous policy variables can be specified. There is no a priori rigidity that the price should be exogenous and taxes (or quantities) endogenous. In addition, domestic prices, demand, and supply changes are derived endogenous variables as implied in the system in equations (5.2)-(5.7). Therefore, World prices are the only primary endogenous variables and the system reduces to (5.8b):

$$F_n (p^w \mid t^S .., t^D .., t^Q ..) = 0; \quad n = 1 \ldots\ldots I \quad (5.8b)$$

where I is the number of commodities in country n. Equation (5.8b) indicates that world prices are mainly a function of the rates protection t. This outcome leads to a more efficient and faster solution of the system.

Solution Algorithm: The Tatonnement Process

The MISS model makes use of the tatonnement process to attain a solution for the system in equations (5.2)-(5.7). Therefore, it is worthwhile to describe how this algorithm

works. Walras stated that a collection of interrelated markets can achieve a perfect balance of supply and demand (Cheng et al, 1995). The idea is that such equilibria could be realized through a price-adjustment process called "*tatonnement*", "*groping*", or "*tentative proceedings*" (Cheng et al, 1995). In this process, agents respond to price signals for the individual goods. The agents' interactions are thought to be coordinated by a central "auctioneer", who adjusts the general price levels toward a general balance, announcing interim prices to elicit responses from the agents. Competitive agents receive a price signal, and report their excess-demand at these prices to the central auctioneer. The auctioneer then adjusts the prices incrementally in proportion to the magnitude of excess demand, and announces the new incrementally adjusted price level. In each round, agents recalculate their excess demands upon receiving the newly adjusted prices signal, and report these to the central auctioneer. No trade is allowed until the equilibrium vector is found (Silberberg, 1990). The process continues until the prices finally converge to an equilibrium and a price p^e would be located (Cheng et al, 1995). The tatonnement process can be given in mathematical terms (Silberberg, 1990). Let excess demand be (5.9):

$$E(p) = D(p,M) - S(p) \tag{5.9}$$

where $E(p)$ is excess demand, $D(p,M)$ is the quantity demanded as a function of price p and income M, and $S(p)$ is quantity supplied as function of its own price p. Now suppose that the rate of change of prices move directly with excess demand (5.10)

$$p' = \frac{dp}{dt} = g(D(p, M) - S(p)) = g(E(p)) \tag{5.10}$$

where t is time, g is the derivative of price with respect to time. Assuming that the

tatonnement process is successful, at least in prices in the neighborhood of p^e, the mechanism in (5.10) generates a path of prices which will approach p^e as t increases (5.11)

$$\lim_{t\to\infty} p(t) = p^e \tag{5.11}$$

relation in (5.11) is called *stability*. If p^e is unique, the system is called *globally stable*. If there is more than one equilibrium price vector, the system is called *system stable*. A model is *locally stable* if (5.11) holds for all prices p in some neighborhood of p^e. At prices "close" to p^e, the function $g(E(p^e))$ can be represented by a Taylor series expansion. Neglecting terms of order 2 and above, (5.10) becomes (5.12)

$$\frac{dp}{dt} = g(E(p^e)) + g'E'(p^e)(p - p^e) + \ldots \tag{5.12}$$

Since $E(p^e)=0$ by definition of $E(p)$, the adjustment mechanism becomes the differential equation (5.13):

$$\frac{dp}{dt} = (g'E')(p - p^e) \tag{5.13}$$

The solution of this differential equation is giving by (5.14)

$$p(t) = p^e + (p^0 - p^e)e^{(g'E')t} \tag{5.14}$$

where the initial price p^0 is the arbitrary constant of integration, presumably the old equilibrium price. The assertion of stability requires that the exponential term approach zero as $t \to \infty$. This will occur if the exponent $g'E' < 0$. Since $g' > 0$. Therefore, asserting Walrasian local stability is the assertion that (5.15) holds in some neighborhood of p^e:

$$E' = D_p(p,M) - S_p(p) < 0 \tag{5.15}$$

Solution Procedure in MISS

MISS follows directly the description given earlier of the "tatonnement" process in order to reach an equilibrium solution. Figure 5.1 shows the sequence of the iteration procedure used by MISS to reach a solution. Initially, an initial equilibrium is given, i.e., a base equilibrium is specified in which quantities supplied and demanded are provided as well as world prices, transportation margin coefficients, initial protection levels, world stocks, supply and demand elasticities, and exchange rates. Then policies changes are specified. Changes in the level of protection are the only policies used in the present study (changes is protection rates). MISS estimates changes in quantities supplied and demanded of all commodities and in all countries upon the changes in the rates in protection using the "tatonnement" algorithm explained earlier. Thus, a new equilibrium vector of prices, quantities demanded and supplied, trade balances, and protection levels are obtained. In addition, MISS allows for the estimation of a large number of indicators such as budget costs of policies, changes in consumer and producer surplus, the values of the PPF function used as actions' payoffs in the present study, changes in terms of trade, and others.

The Nominal Protection Coefficient (NPC) and Trade Liberalization

This research uses the NPC to analyze trade liberalization. A logical question is: Why use the nominal protection coefficient (NPC) to analyze trade liberalization instead of another criteria? The use of the NPC in this research is based on the following reasoning. First, the NPC shows the relationship between domestic producer price and border price and this is a very concise way to see how distorting trade policies are in a country. The NPC is defined as in (5.10)

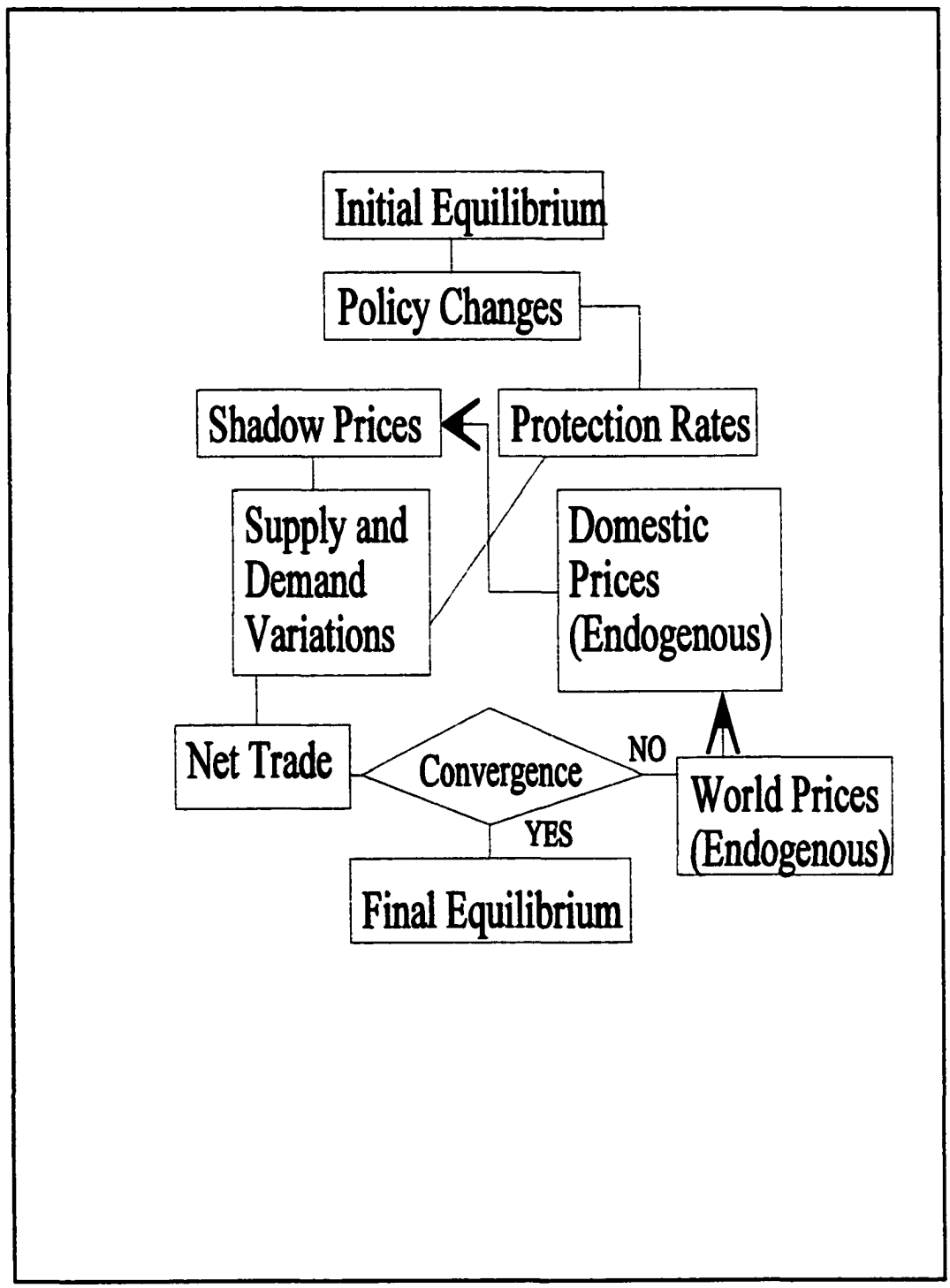

Figure 5.1. Iterations Structure for MISS Resolution
Source: Mahe et al, 1988

$$NPC_i = \frac{P_i^d}{P_i^b} \tag{5.10}$$

where NPC_i is the nominal protection coefficient of commodity i, P^d_i is the domestic price received by producers of commodity i, and P^b_i is the border price of commodity i. For an import commodity, the border price is the price at the border or port of departure plus the cost of freight and insurance, i.e., the CIF price in the importing country. For an export commodity the border price is the price on the domestic border or port of shipment or the FOB price (free on board), i.e, the CIF price in the country of destination minus the cost of freight and insurance. Secondly, most policies directed to affect specific industries have to deal with mechanisms to change price relationships. For example, the government may have in effect target prices, procurement prices, loan rates, etc. Third, although the NPC may not show all the price distorting policies implemented in a given country, it usually shows at least the most important effect of such policies.

The practical meaning of the use of the NPC as the criterion to model trade liberalization is intuitive. For example, for a dis-protected sector (or taxed sector) a movement toward an NPC equal to one will indicate that not only taxes are reduced or eliminated but also that some policies are directed to improve production conditions in that sector. Those policies may include transfer of technology, reduction or elimination of taxes, improvement in infrastructure (Roads, storage capacity, etc.) which would lead to lower transportation and other costs, policies directed to lower the cost of capital (interest rate, finance charges, etc.). The case of staple foods may illustrate how these changes may work. Central American countries are net importers of beans and rice, two main staples. On one

hand, the lack of attention to these sectors from the respective or relevant institutions (Ministry of Agriculture, the Institute of Agricultural Technology, etc) has led these sectors to the use of inefficient production technologies. Therefore, these sectors have not been able to compete with foreign producers and their market share has been reduced. On the other hand, as economic theory would suggest, when sectors are taxed, smaller quantities are produced than without taxes (Krugman, 1998).

By contrast, for a "protected" sector, i.e., a commodity with an NPC larger than one, an NPC movement toward one should indicate that any price support policy is eliminated. However, in developing countries, for import commodities such as basic staples, and NPC movement towards one may imply the need for a movement along the average cost curve and a downward shift of the average cost curve as well. This movement and shift of the average cost curve implies an increase in the supply of staples at a lower per unit production cost until the point, assuming perfect competition in the international market, where average costs equal border price. This shift and movement along the average costs curve may be conditioned by the implementation of policies directed to technological change and to lower the costs of inputs and capital.

Data

The MISS model requires a considerable amount of data to estimate the PPF payoffs of various government actions. Initially, a base year was chosen. The base year chosen is the last year before any integration agreement is enforced. In our case, 1990 is the base year. Then, data on quantity demanded and supplied, domestic and international prices, and quantities of imports and exports were obtained from the most reliable sources. These sources included the Food and Agricultural Organization of the United Nations (FAO), the

Economic Commission for Latin America of the United Nations (ECLAC-Mexico), the International Monetary Fund (IMF), and the World Bank. Transportation costs between countries were estimated accordingly as the difference between the value of exports declared in one country and the value of imports reported by the country of destination (IMF, 1998). Table 5.1. shows the transportation margin coefficient between Central American countries. In general, Central American countries are considered to have very high transportation costs (Caceres, 1994) and this situation may influence the outcome of integration agreements. For example, the average transportation cost for Honduras is 42% of the value of exports whereas for Guatemala it is 5%. A transportation cost higher than 10% is considered high (IMF, 1999)

Besides the data requirement mentioned above, the MISS model also requires estimates of the elasticities of supply and demand for the eight commodities analyzed in this study. The literature review revealed that there were no estimates of these elasticities in other studies. Therefore, the required elasticities were estimated as described in Chapter four .Protection levels were estimated as defined in the MISS model. Initially, the border

Table 5.1. Transportation Margin Coefficients of Five Central American Countries, weights of the Value of Exports, 1990.

From\To	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua	Average
Costa Rica	------	0.03	0.26	0.18	0.09	0.14
El Salvador	0.04	------	0.21	0.10	0.14	0.12
Guatemala	0.10	0.01	------	0.01	0.10	0.05
Honduras	0.66	0.38	0.10	------	0.54	0.42
Nicaragua	0.25	0.07	0.39	0.18	------	0.22

prices of the commodities were estimated and the nominal protection coefficient (NPC) was used to represent the level of price protection in each country for each commodity included

in the analysis. The coefficients shown in Table 5.2 indicate that export products are less protected than commodities for domestic consumption. It is important to mention that in developing countries agricultural production is taxed and therefore there are not "protected commodities." The nominal protection coefficients (NPC) shown in Table 5.2 indicate that imported commodities (corn, rice, beans, sorghum) have a higher local price than world price but this is because importers have to pay for the high costs of transportation, import duties, and taxes. So, in the base period (1990) agricultural producers did not receive any support as is seen in many developed countries.

Table 5.2. Average Nominal Protection Coefficients (NPC) For Five Central American Countries, 1990-92.

Commodity	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua
Rice	1.05	0.67	1.09	0.59	0.64
Beans	1.20	0.95	0.97	1.29	0.64
Corn	1.71	2.05	1.77	1.05	1.09
Sorghum	1.04	1.63	1.37	2.09	1.81
Bananas	0.58	1.00	0.43	1.42	0.57
Coffee	0.66	0.71	0.70	0.97	1.19
Sugar	1.25	1.20	0.86	0.49	0.90
Beef	1.18	0.93	0.60	1.50	1.20

Empirical Results of Game Simulations

This section consists of four games. Every game shows the dominant strategy and the Nash equilibrium from each country's perspective given a set of various governmental policy actions. Initially, each game includes a set of protection reductions: no reduction or status quo (SQ); 25% reduction in protection or dis-protection (25); 50% reduction in protection or dis-protection (50); 75% reduction in protection or dis-protection (75); and

100% reduction in protection or dis-protection which implies a free trade situation (FT).

The games were designed based on the following conditions. Based on the importance of each commodity group to the government, games are simulated using PPF weights equal to and different from one. In addition, since variations in the exchange rate may affect equilibrium outcomes, scenarios with PPF weights equal and different from one are simulated with a 5% depreciation of the exchange rate.

The exchange rate is an important tool in international trade. Schuh (1974) analyzed the role of the exchange rate on trade and the development of U.S. agriculture. He argued that an overvalued US dollar tended to depress the price of agricultural output domestically during the mid-seventies because it became more expensive for foreign countries to buy US agricultural commodities. Schuh (1974) argued that the exchange rate had a significant impact on the increase of agricultural prices during the mid-seventies. De Franco (1996) notes that the exchange rate should be managed appropriately without overvaluation or undervaluation to make agricultural production more competitive in the international market. De Franco observed that an overvalued real exchange rate tends to increase costs of production, in turn reducing the ability of commodities to compete in international markets.

The games are set as follows. Game one analyzes agricultural trade liberalization with PPF weights equal to one. Game two includes the results when PPF weights are different from one. Game three analyzes the effects of an exchange rate depreciation with PPF weights equal to one. Finally, game four analyzes the effects of an exchange rate depreciation with PPF weights different from one. In all games, the payoffs are given in millions of US dollars. A positive magnitude indicates a gain for the player and a negative

magnitude indicates losses. The first number in the cell indicates the payoff of the country (row player) and the second number indicates the payoff of the rest of Central American countries (column player).

Game One: Simulations with PPF Weights equal to one

In game one, the commodity groups are assumed to have the same importance for the government, i.e., their weights in the PPF are identical, or in this case, equal to one. The results in Tables 5.3-5.7 includes the outcome of the game from the perspective of each country. The results, as indicated by the Nash equilibrium show that all countries with the exception of Guatemala will choose free trade when the rest of Central American countries choose 50% reduction in protection. The Nash equilibrium solution is shown in the darkened cells of the results tables. The results indicate that all countries have the incentive towards trade liberalization and that any country will choose free trade given that the rest of the other countries choose 50% reduction in protection. This outcome is in agreement with the fact that Central American countries have taken several steps toward trade agreements at this very moment.

Table 5.3. Political Payoff Function Values for Alternative Levels of Reduction in Protection with Weights equal to one, Costa Rica Versus Rest of Central America

		Rest of Central America				
Costa Rica	Actions	SQ	25	50	75	FT
	SQ	0 ; 0	-16 ; 157	-34 ; 262	-51 ; -135	-61 ; -41
	25	29 ; -6	13 ; 150	-5 ; 255	-23 ; 141	-34 ; -47
	50	48 ; -11	31 ; 144	13 ; 248	-5 ; -147	-16 ; -53
	75	57 ; -16	41 ; 138	22 ; 241	4 ; -152	-6 ; -59
	FT	58 ; -20	42 ; 133		5 ; -157	-5 ; -64

Table 5.4. Political Payoff Function Values for Alternative Levels of Reduction in Protection with Weights equal to one, El Salvador Versus Rest of Central America.

El Salvador	Rest of Central America					
	Actions	SQ	25	50	75	FT
	SQ	0 ; 0	-7 ; 161	-13 ; 259	-19 ; -134	-20 ; -70
	25	10 ; -2	4 ; 159	-2 ; 257	-8 ; -137	-9 ; -72
	50	19 ; -4	12 ; 223	6 ; 254	0 ; -147	-1 ; -75
	75	26 ; -6	19 ; 155	13 ; 252	-6 ; -142	6 ; -77
	FT	-9 ; -8	24 ; 153	[illegible]	12 ; 144	11 ; -79

Table 5.5. Political Payoff Function Values for Alternative Levels of Reduction in Protection with Weights equal to one, Guatemala Versus Rest of Central America.

Guatemala	Rest of Central America					
	Actions	SQ	25	50	75	FT
	SQ	0 ; 0	-4 ; 157	-8 ; 266	-10 ; -134	-15 ; -40
	25	153 ; -6	147 ; 150	142 ; 255	132 ; -141	131 ; -47
	50	288 ; -11	281 ; 144	[illegible]	152 ; -146	261 ; -53
	75	-83 ; -15	-89 ; 138	-94 ; 241	-98 ; -152	-140 ; -59
	FT	-332 ; -20	-39 ; 133	-45 ; 236	-48 ; -156	-59 ; -64

Table 5.6. Political Payoff Function Values for Alternative Levels of Reduction in Protection with Weights equal to one, Honduras Versus Rest of Central America.

Honduras	Rest of Central America					
	Actions	SQ	25	50	75	FT
	SQ	0 ; 0	-14 ; 168	-40 ; 278	-60 ; -89	-66 ; -30
	25	18 ; -2	-2 ; 159	-23 ; 275	-44 ; -91	-49 ; -31
	50	29 ; -5	9 ; 162	-12 ; 254	-33 ; -93	-39 ; -34
	75	17 ; -2	-2 ; 164	-23 ; 275	-45 ; -14	-50 ; -32
	FT	40 ; -10	-20 ; 164	[illegible]	-24 ; 103	-30 ; -79

Table 5.7. Political Payoff Function Values for Alternative Levels of Reduction in Protection with Weights equal to one, Nicaragua Versus Rest of Central America.

		Rest of Central America				
Nicaragua	Actions	SQ	25	50	75	FT
	SQ	0 ; 0	-2 ; 162	-4 ; 262	-6 ; -143	-7 ; -82
	25	3 ; -1	1 ; 161	-1 ; 261	-3 ; 144	-4 ; -82
	50	4 ; -1	2 ; 162	-1 ; 260	-3 ; -144	-3 ; -82
	75	2 ; -1	0 ; 161	-2 ; 261	-4 ; -144	-4 ; -83
	FT	21 ; 0	8 ; 172	[illegible]	15 ; -145	14 ; -83

Game Two: Simulation with PPF Weights not Equal to One

Game two makes the realistic assumption that the government assigns different degrees of importance to various agricultural commodity groups. Although the MISS model allows for the estimation of PPF weights as explained earlier, the weights used in this research were estimated in a different way. This is because the weights that can be estimated by the MISS model may not reflect the reality of the relationships between governments and various economic sectors and groups. In addition, there is an accepted view that because of political instability of developing countries, PPF weights estimated with the MISS program may also be wrong because the MISS model assumes political stability (Johnson, 1993).

For this reason, a procedure following the reasoning for collective action (Olson, 1965) is developed to estimate such weights. Initially, a subjective set of criteria were chosen to measure the possible importance of each commodity group in the view of the government. The criteria were chosen based on various factors of political relevance in Central America. Commodity groups were ranked based on four criteria. First, it is

reasonable to expect that government will devote more attention to commodity groups with the highest generation of tax revenue. Secondly, the level of organization within a commodity group is a determinant factor to achieve a group goal (Olson, 1965). So, commodity groups are also ranked by level of organization.

Third, hard currency earnings are important for developing countries. Hard currency is important because developing countries rely greatly on imports to satisfy country needs in many goods. Developing countries, such as the Central American countries, have to purchase their imports not in local currency but in foreign currency, usually in United States dollars (De Alonso, 1994). Thus, for Central American countries hard currency earnings are crucial. It is reasonable to expect that governments will place more importance on commodity groups from which a higher percentage of the revenue generated is in hard currency than to commodity groups generating revenue mostly in local currency.

Since developing countries rely greatly on hard currency, it is reasonable to expect that governments will likely be influenced by commodity groups which actually generate hard currency earnings or have the potential for hard currency generation. So, from the government stand point, a commodity group with a potential of generating exchange rate earnings will be more important than other commodity groups which generate revenue in local currency. This can be the case even if the amount of revenue generated in local currency by the domestic market commodity group is higher than the amount generated by the export oriented commodity group. The justification for this behavior is the instability of the local currency and its tendency toward devaluations and inflation against a stable hard currency.

After the basis for ranking commodity groups has been established, the numerical rank of the groups was designed. Since the ranking of the groups is based on observation,

the ranking is subject to bias. However, a careful design is used in order to reduce or avoid bias in the ranking procedure. First, in game one it was shown that if a commodity group has a PPF weight of one, it means that the government gives the same importance to the commodity group in question as to itself. On the contrary, a PPF greater than one means that the government values a commodity group higher than itself. The opposite applies to PPF weights lower than one. In addition, the commodity group with the highest PPF weight is considered more important relative to the government but also relative to other commodity and consumer groups.

A consistent procedure was designed to increase or decrease a commodity group's importance relative to the government. In order to reduce bias, a normalized PPF weight of one is assigned to the government. Table 5.8 shows the criteria for ranking, they are revenue generation, organization level, and the share of exports in revenue generated by each commodity. There is one more criterion, whether the sector is mainly oriented to exports (0.10) or to domestic consumption (-0.05). As Table 5.8 shows, government revenue generation is the most important criterion since it may add up to 0.4 to the importance of a given commodity group. Next is the level of organization. Organization level is important because the more united a group is, the more effective in reaching its goals it is. Third is the share of revenue generated in hard currency. This criterion is important but it is less important than the total amount of revenue generated and the level of organization.

The sign of the values assigned to the criteria has an important meaning. First, all the values for revenue generation are positive but they can be negative for the other criteria. In practice, this means that the government will not penalize any sector that generates revenue. By contrast, if a sector has a low organizational level or has a small share of hard

currency in the revenue generated, then the government may decrease the sector importance relative to the government by weighting the sector lower than itself.

Table 5.8. Ranking Criteria for PPF Weight Estimation for Central American Countries

Government Revenue Generation by Commodity Group		Commodity Group Organization Level		Share of Government Revenue Generated by Exports	
Rank	Value	Rank	Value	Rank	Value
Very High	0.33-0.40	Monopoly/sony	0.25	≥75%	0.15
High	0.25-0.32	Strong Union	0.15	51-74%	0.10
Moderate	0.17-0.24	Moderate	0.0	25-50%	0.0
Low	0.09-0.16	Weak	-0.05	15-24%	-0.05
Very Low	0.0 - 0.08	No Organization	-0.10	≤14%	-0.10

After a careful implementation of the ranking procedure explained earlier, Table 5.9 summarizes the resulting PPF weights by commodity and country. As it seems reasonable to expect, export commodities obtained the highest PPF weights for most countries. This is in agreement with the historical importance of export commodities in Central American countries (De Alonso, 1994). The weight used for consumers is the average value of the PPF weights for all commodity groups. Although consumers are poorly organized in Central American countries, a rough idea of their importance to the government may be drawn from the average value of the PPF for each country. This is so, because it is important to remember that producers are also consumers and by the way producers are treated an idea can be obtained about how important consumers are for the government. This is achieved by pooling all producers together and seeing them as consumers. In addition, consumers are also taxpayers and vote to elect government officials. Therefore,

although consumers are not organized in interest groups, their voice is heard at in election time and thus consumers become important for the government and their weight might be higher than that of the government itself as Table 5.9. shows.

Table 5.9. PPF Weights for Five Central American Countries.

Commodity	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua
Rice	0.91	1.09	0.91	0.82	1.03
Beans	0.81	0.93	0.75	0.84	0.77
Corn	0.89	1.40	1.01	0.99	1.50
Sorghum	0.75	0.85	0.80	0.84	0.85
Bananas	1.63	0.95	1.33	1.85	1.36
Coffee	1.70	1.63	1.80	1.55	1.43
Sugar	1.43	1.48	1.54	1.38	1.52
Beef	1.19	1.06	1.06	1.25	1.24
Consumers	1.16	1.17	1.15	1.19	1.21

After the estimation of the PPF weights, the MISS model was used to obtain the payoffs for the set of government actions specified earlier. The results included in Table 5.10-5.14 indicate that little changes occur from game one. The new equilibrium for Honduras is the only considerable change in game two with respect to game one. With PPF weights different from one, the new equilibrium for Honduras is status quo/50% (SQ/50) instead of free trade/50% (FT/50) of game one. In general, the outcome of game two indicates that, from each country perspective, the political influence of commodity groups does not appear to be an obstacle to trade liberalization in Central America. This is an important result as it indicates the benefits for Central American countries to open trade among them even if government is under the pressure from producers of various commodity groups.

Table 5.10. Political Payoff Function Values for Alternative Levels of Reduction in Protection with Weights not Equal to One Costa Rica Versus Rest of Central America

Costa Rica \ Rest of Central America	SQ	25	50	75	FT
SQ	0 ; 0	-22 ; 118	-47 ; 188	-71 ; -167	-84 ; -223
25	103 ; -10	79 ; 107	32 ; 176	26 ; -178	12 ; -235
50	200 ; -18	174 ; 98	145 ; 165	117 ;-187	102 ;-245
75	291 ; -26	264 ; 89	234 ; 155	205; -196	188; -254
FT	377 ; -33	349 ; 80	[illegible]	287; -204	270; -263

Table 5.11. Political Payoff Function Values for Alternative Levels of Reduction in Protection with Weights not Equal to One, El Salvador Versus Rest of Central America

El Salvador \ Rest of Central America	SQ	25	50	75	FT
SQ	0 ; 0	-10 ; 182	-18 ; 303	-127 ; 20	-28 ; -9
25	17 ; -3	8 ; 179	-2 ; 299	-10 ; 17	-12 ; -13
50	35 ; -6	24 ; 175	14 ; 296	5 ; 13	4 ; -18
75	51 ; -8	40 ; 172	30 ; 292	-1 ; 43	18 ; -22
FT	5 ; -11	55 ; 166	[illegible]	34 ; 5	33 ; -25

Table 5.12. Political Payoff Function Values for Alternative Levels of Reduction in Protection with Weights not Equal to One, Guatemala Versus Rest of Central America

Guatemala \ Rest of Central America	SQ	25	50	75	FT
SQ	0 ; 0	-5 ; 118	-10 ; 188	-12 ; 167	-19 ; -224
25	195 ; -10	188 ; 107	181 ; 176	170 ;-178	168 ;-235
50	391 ; -18	381 ; 98	[illegible]	249 ;-187	355 ; -25
75	7 ; -26	-2 ; 89	-9 ; 155	-15 ; -196	-76 ; -254
FT	-182;-335	102 ; 80	92 ; 146	88 ; -204	73 ; -263

Table 5.13. Political Payoff Function Values for Alternative Levels of Reduction in Protection with Weights not Equal to One, Honduras Versus Rest of Central America

		Rest of Central America				
Honduras	Actions	SQ	25	50	75	FT
	SQ	0 ; 0	-34 ; 275	[illegible]	-112; 195	-124; 391
	25	-51 ; -3	-85 ; 272	-123; 495	-163; 192	-174; 389
	50	-108; -2	-143; 268	-181; 492	-222; 190	-234; 385
	75	-51 ; -3	-85 ; 272	-123; 495	-164; 206	-176; 388
	FT	242; -12	-278; 261	-317; 483	-358; 183	-371; 378

Table 5.14. Political Payoff Function Values For Alternative Levels of Reduction in Protection with Weights not Equal to One, Nicaragua Versus Rest of Central America

		Rest of Central America				
Nicaragua	Actions	SQ	25	50	75	FT
	SQ	0 ; 0	-3 ; 190	-1 ; 320	-9 ; 26	-10 ; 6
	25	1 ; -0.5	-335;189	-6 ; 319	-9 ; 26	-11 ; 6
	50	-3 ; -1	-1 ; 360	-9 ; 320	-12 ; 25	-13 ; 9
	75	-8 ; -1	-11 ; 189	-14 ; 682	-17 ; 25	-18 ; 5
	FT	12 ; -1	-7 ; 206	[illegible]	3 ; 25	269; 5

Game Three: Simulation with PPF Weights Equal to One and a 5% Exchange Rate Depreciation

In game three, PPF weights are equal to one, as in game one, but the exchange rate of each country is depreciated by five percent. As was mentioned earlier, exchange rate variations can be used to promote exports when necessary. A depreciation of the exchange rate lowers the international price of export commodities. This price decrease may cause export growth and greater exchange rate earnings than prior to the exchange rate

depreciation and improve the overall social gain. It was decided to decrease the exchange rate by five percent to examine the likelihood that countries will be more inclined to liberalize trade than with a higher exchange rate. The exchange depreciation did not adversely affect the outcome in game three relative to game one. The results included in Tables 5.15-5.19 indicate that a five percent depreciation in the exchange rate will affect the Nash equilibrium outcome of Costa Rica and the rest of Central America and Guatemala and the rest of Central America toward a greater trade liberalization than in game one but not that of the remaining countries.

Table 5.15. Political Payoff Function Values for Alternative Levels of Reduction in Protection with Weights Equal to One and an Exchange Rate Depreciation of 5%, Costa Rica Versus Rest of Central America

		Rest of Central America				
Costa Rica	Actions	SQ	25	50	75	FT
	SQ	0 ; 0	3 ;157	-16 ; 262	-33 ; -56	-44 ; -40
	25	46 ; -6	30 ; 150	11 ; 254	-7 ; -140	-17 ; -46
	50	62 ; -11	46 ; 144	27 ; 247	9 ; -146	-2 ; -52
	75	69 ; -16	52 ; 138	[illegible]	16 ; -151	5 ; -58
	FT	67 ; -20	51 ; 133	32 ; 235	14 ; -155	4 ; -63

Table 5.16. Political Payoff Function Values for Alternative Levels of Reduction in Protection with Weights Equal to One and an Exchange Rate Depreciation of 5%, El Salvador Versus Rest of Central America

		Rest of Central America				
El Salvador	Actions	SQ	25	50	75	FT
	SQ	0 ; 0	-4 ; 163	-10 ; 261	-16 ; -132	-17 ; -68
	25	13 ; -1	6 ; 161	1 ; 259	-5 ; -135	-6 ; -70
	50	22 ; -3	15 ; 159	9 ; 256	4 ; -138	3 ; -73
	75	29 ; -4	22 ; 157	17 ; 254	-3 ; -140	10 ; -75
	FT	-9 ; -7	28 ; 155	[illegible]	16 ; -142	15 ; -77

Table 5.17. Political Payoff Function Values for Alternative Levels of Reduction in Protection with Weights Equal to One and an Exchange Rate Depreciation of 5%, Guatemala Versus Rest of Central America

		Rest of Central America				
Guatemala	Actions	SQ	25	50	75	FT
	SQ	0 ; 0	21 ; 61	17 ; 94	16 ; 82	11 ; 133
	25	161 ; -27	156 ; 26	151 ; 59	141 ; 47	142 ; 99
	50	280 ; -65	273 ; -13	245 ; 20	157 ; 9	256 ; 60
	75	365 ; -106	358 ; -54	351 ; -22	348 ; -33	[illegible]
	FT	-296; -115	207 ; -65	199; -32	197; -43	185; 9

Table 5.18. Political Payoff Function Values for Alternative Levels of Reduction in Protection with Weights Equal to One and an Exchange Rate Depreciation of 5%, Honduras Versus Rest of Central America

		Rest of Central America				
Honduras	Actions	SQ	25	50	75	FT
	SQ	0 ; 0	-20 ; 165	-42 ; 275	-64; -91	-69 ; -31
	25	17 ; -5	-4 ; 162	-27 ; 272	-49 ; -93	-53 ; -33
	50	28 ; -7	7 ; 159	-16 ; 269	-39 ; -95	-45 ; -35
	75	35 ; -62	14 ; 162	-9 ; 270	-28 ; -105	-55 ; 8
	FT	40 ; -13	19 ; 153	[illegible]	-28 ; -100	-34 ; -41

Table 5.19. Political Payoff Function Values For Alternative Levels of Reduction in Protection with Weights Equal to One and an Exchange Rate Depreciation of 5%, Nicaragua Vs. Rest of Central America

		Rest of Central America				
Nicaragua	Actions	SQ	25	50	75	FT
	SQ	0 ; 0	-3 ; 166	-5 ; 262	-7 ; -144	-7 ; -81
	25	3 ; -1	1 ; 162	-2 ; 261	-3 ; -144	-4 ; 82
	50	5 ; -1	3 ; 161	1 ; 261	-2 ; -145	-2 ; -83
	75	6 ; -2	3 ; 160	1 ; 261	-1 ; -145	-2 ; -83
	FT	6 ; -2	-8 ; 170	[illegible]	0 ; -145	-1 ; -83

Game Four: Simulation with PPF Weights not Equal to One and a 5% Exchange Rate Depreciation

Game four is similar to game two in that both assign PPF weights different from one to commodity groups and to consumers but in game four an exchange rate depreciation of five percent is also modeled. As the results of the game simulation included in Tables 5.20-5.24 indicate, small changes were obtained for Guatemala and Nicaragua relative to game two. For Guatemala and the rest of Central America, a five percent exchange depreciation leads to a Nash equilibrium with more trade liberalization than in game two (75/75). However, a five percent exchange rate depreciation adversely affect the results for Nicaragua relative to game two. In game four, the Nash equilibrium for Nicaragua is reached at 25/50 versus FT/50 of game two. So, it seems that exchange rate depreciation reduces the likelihood of Nicaragua liberalizing its agricultural protection. For all other countries, the results are the same as in game two.

Table 5.20. Political Payoff Function Values for Alternative Levels of Reduction in Protection with Weights not Equal to One and an Exchange Rate Depreciation of 5%, Costa Rica Versus Rest of Central America

		Rest of Central America				
Costa Rica	Actions	SQ	25	50	75	FT
	SQ	0 ; 0	19 ; 118	-7 ; 187	-32 ; -165	-46 ; -222
	25	148 ; -11	123; 107	96 ; 175	69 ; -176	54 ; 234
	50	248 ; -19	222 ; 97	192 ; 164	164; -186	148; -243
	75	343; -27	316 ; 88	285 ; 154	255; -195	238; -253
	FT	433 ; -35	405 ; 79	[illegible]	340; 135	323; -261

Table 5.21. Political Payoff Function Values for Alternative Levels of Reduction in Protection with Weights not Equal to One and an Exchange Rate Depreciation of 5%, El Salvador Versus Rest of Central America

		Rest of Central America				
El Salvador	Actions	SQ	25	50	75	FT
	SQ	0 ;0	3 ; 184	-6 ; 306	-14 ; 24	-15 ; -6
	25	30 ; -1	21 ; 18	12 ; 10	3 ; 20	2 ; -10
	50	49 ; -3	38 ; 178	29 ; 299	19 ; 16	18 ; -14
	75	66 ; -6	55 ; 175	45 ; 295	13 ; 12	33 ; -18
	FT	17 ; -8	71 ; 172	[illegible]	50 ; 9	49 ; -22

Table 5.22. Political Payoff Function Values for Alternative Levels of Reduction in Protection with Weights no Equal to One and an Exchange Rate Depreciation of 5%, Guatemala Versus Rest of Central America

		Rest of Central America				
Guatemala	Actions	SQ	25	50	75	FT
	SQ	0 ; 0	35 ; 70	31 ; 112	28 ; 247	22 ; 182
	25	252 ; -43	255 ; 15	209; 56	198; 189	197; 123
	50	303; -103	395; -47	353; -9	275; 125	371; 55
	75	572; -169	561; -115	552; -78	[illegible]	476; -18
	FT	-143; -185	451; -133	439; -96	435; 35	418; -34

Table 5.23. Political Payoff Function Values for Alternative Levels of Reduction in Protection with Weights not Equal to One and an Exchange Rate Depreciation of 5%, Honduras Versus Rest of Central America

		Rest of Central America				
Honduras	Actions	SQ	25	50	75	FT
	SQ	0 ; 0	18 ; 272	[illegible]	-65 ; 193	-78 ; 389
	25	-4 ; -5	-40 ; 100	-81 ; 338	-123; 224	-134;386
	50	-68; -8	-104; 265	-145; 487	-188; 187	-201; 382
	75	-137; 5	-175; 268	-216; 492	-288; 170	-137; 386
	FT	-213; -15	-251; 257	-292; 478	-336; 180	-349; 374

Table 5.24. Political Payoff Function Values For Alternative Levels of Reduction in Protection with Weights not Equal to One and an Exchange Rate Depreciation of 5%, Nicaragua Vs. Rest of Central America

		Rest of Central America				
Nicaragua	Actions	SQ	25	50	75	FT
	SQ	0 ; 0	-1 ; 190	-4 ; 320	-7 ; 25	-10 ; 6
	25	3 ; -1	-1 ; 360		-6 ; 25	-7 ; 5
	50	1 ; -1	-2 ; 190	-5 ; 319	-8 ; 25	-9 ; 5
	75	-2 ; -1	-5 ; 189	-9 ; 319	-11 ; 25	-13 ; 5
	FT	-7 ; -1	-27 ; 202	-13 ; 319	-15 ; 25	-17 ; 5

Summary and Discussion of the Results

This chapter dealt with the central issue of this research, which was agricultural trade liberalization. Initially, the MISS model was introduced as the technique to analyze trade liberalization in Central America. Secondly, the NPC, the criterion used to measure trade liberalization, was defined and described. Third, data and data sources were discussed. Fourth, trade liberalization scenarios and actions were defined and the results presented. Since this research focuses on the influence of various economic groups on the governmental decisions relative to trade liberalization, the importance of these groups was identified and used to model four simulated games. Four games were modeled. In game one, PPF weights were assumed to be one, i.e., there was not a difference in importance among economic groups in the view of government interests. In game two, PPF weights were assumed to be different from one, i.e., government assigned different degrees of importance to some groups relative to other groups and to itself. In addition, game three included a 5% exchange rate depreciation when PPF weights were equal to one. Finally,

game four included a 5% depreciation exchange rate when PPF weights were different from one. The variations in exchange rate were included to analyze possible advantages or disadvantages of exchange rate variations in Central American countries when entering agreements to liberalize agricultural trade.

The results of the games simulated in this study, summarized in Table 5.25, indicate that, in general, Central American countries will benefit from agricultural trade liberalization. Game one indicated that from each country's perspective, a 50% reduction in protection in the rest of countries will be enough incentive it to choose free trade. This outcome indicates that there is enough incentive for Central American countries to liberalize agricultural trade among themselves. The results for game two indicated again that Central American countries will choose a considerable degree of trade liberalization (FT), as in game one, even if governments assign various level of importance to commodity groups. This outcome indicates that commodity group influence may be irrelevant in governmental decisions concerning trade liberalization. This is because assigning different values to the PPF weights led to very minor changes in the outcome of the simulated games. Some degree of agricultural trade liberalization appears to be the most reasonable choice for Central American countries despite the influence various commodity groups may exert on their governments. The results of game three indicated, as economic theory would suggest (Houck, 1994), that exchange rate depreciation may lead to a greater degree of agricultural trade liberalization, as the cases of Costa Rica and Guatemala show. However, as the results of game four indicated, exchange rate depreciation seems to be harmful for trade liberalization in Honduras and Nicaragua and beneficial for Costa Rica when PPF weights are different from one. This outcome is likely to occur because of adverse changes

in welfare of the latter countries when PPF and exchange rate depreciations. Exchange rate depreciations appear to lead to the worsening of trade balance.

Table 5.25. Nash Equilibrium Results of Four Trade Liberalization Games Simulation For Five Central American Countries.

Countries	Game One	Game Two	Game Three	Game Four
C/R	FT/50	FT/50	75/50	FT/50
S/R	FT/50	FT/50	FT/50	FT/50
G/R	50/50	50/50	75/FT	75/75
H/R	FT/50	SQ/50	FT/50	SQ/50
N/R	FT/50	FT/50	FT/50	25/50

Note: C=Costa Rica, S=El Salvador, G=Guatemala, H=Honduras, N=Nicaragua, and R=Rest of Central American countries.

Changes in terms of trade may give some explanation for the case of Nicaragua. Terms of trade worsen when the exchange rate depreciates. Thus, for a country relying on imports, as is the case of Nicaragua, the reduction in terms of trade may lead to social losses greater than the exchange revenue gains generated by the increase of exports due to exchange rate depreciation. Therefore, although exchange rate depreciation is generally beneficial because it boosts exports and may generate large hard currency earnings, that may not be the case for Nicaragua.

Until this point, the analysis of country actions have been done from each country perspective and not from the regional standpoint. However, it seems reasonable to expect countries to jointly decide the level of trade liberalization. Therefore, it is important to analyze what action countries will more likely choose when all countries face the same choices. For this purpose, the payoffs for joint actions, i.e., the outcome when all countries face SQ, 25, 50, 75, and 100% reductions in protection together served as the criterion for each country decision. The resulting selected action for each game for each country are

included in Table 5.26. The results in Table 5.26 show that El Salvador and Honduras have a dominant strategy. However, in all games, El Salvador gain the most (loses the least) by choosing free trade whereas Honduras is better off if it chooses status quo (SQ).

The results are mixed for the rest of countries. For example, changes in PPF weights seem to be more important in Costa Rica than variation in the exchange rate. In both games one and three, the outcome is the same as for game two relative to game four. In the case of Costa Rica, it seems interesting to observe that when government assigns various levels of importance to commodity groups, the outcome get closer to free trade. In the case of Nicaragua, the results are not adversely affected by differences in the PPF weights assigned to commodity groups. However, exchange rate variations seem to adversely affect trade liberalization. This is probably in connection with a worsening in terms of trade in games three and four with respect to the first two games. Finally, changes in PPF weights seem to be less important than variations in exchange rate in the case of Guatemala. According to the results in Table 5.26, Guatemala moves closer to free trade under an exchange rate depreciation than without it.

Table 5.26. Best Choices Given All Five Countries Simultaneous Protection Reductions.

Country	Game One	Game Two	Game Three	Game Four
Costa Rica	25	FT	25	FT
El Salvador	FT	FT	FT	FT
Guatemala	50	50	75	75
Honduras	SQ	SQ	SQ	SQ
Nicaragua	FT	FT	25	SQ

An important question is by how much countries want and should liberalize trade. Results of Table 5.26 indicate that none of the five actions under analysis satisfies all

countries simultaneously. Therefore, it is reasonable to expect countries to negotiate the terms of trade liberalization. For example, Honduras, the country that loses the most when trade is liberalized, will probably require compensation from the remaining countries in order to participate in an agreement. Nicaragua may be another candidate for compensation. If all countries are to participate in any trade agreement, some kind of differentiated treatment should be given to countries not initially benefitting from the agreement. This outcome is in agreement with the results from the first integration agreement from 1960. Honduras was the loser then and it withdrew in 1969 from the agreement. Nicaragua followed to weaken the agreement in the mid-seventies. This happened because none of these countries was compensated for losses from trade liberalization by the rest of Central American countries.

Sensitivity Analysis of the Results

Since the estimates to the elasticities used to model trade liberalization in Central America presented limitations, it seems reasonable to develop a sensitivity analysis to test the stability of the results. For this purpose, the following procedure was implemented. First, the supply and demand elasticities were increased and reduced by 10, 25 and 50%. Since own price elasticities of demand are expected to be negative and those of supply be positive, a movement in the same direction, as figure 5.2 shows, makes elasticities either more negative (less positive) or more positive (less negative). For example, a 10% increase in elasticities means that negative elasticities were made 10% less negative and positive elasticities 10% more positive. The logic of this decision is, as in any given interval, to move all variables in the direction of the lower or upper bound simultaneously. Secondly, to make a comparisons with elasticities from other sources, a set of elasticities were

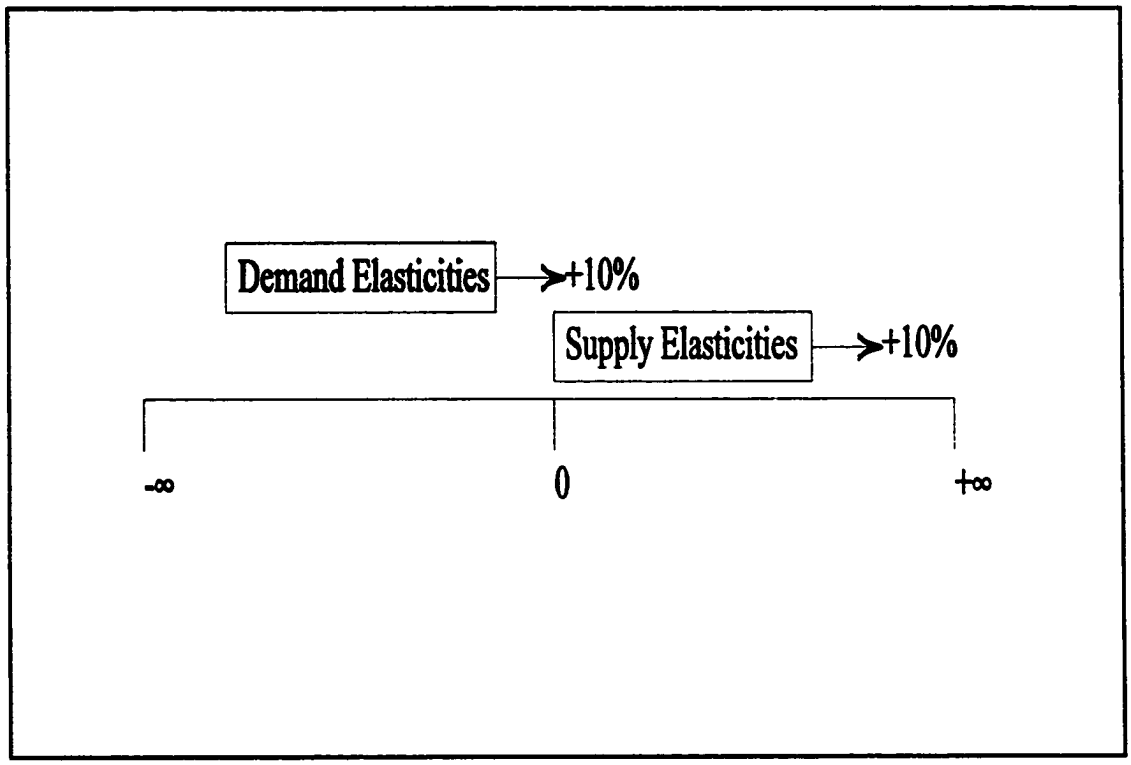

Figure 5.2. A Ten Percent Positive Change in Elasticities

obtained from Gardiner et al, (1989). The same set of supply and demand elasticities were used for all Central American countries because Gardiner et al (1989) estimated elasticities for the entire region and not for each country individually (Table A12-A13). Third, the sensitivity analysis was done for games one and two because they seem to be the most relevant scenarios in the present study. The results of the sensitivity analysis are included in tables 5.27-5.28. The results show that, in general, considerable changes in elasticity values do not affect adversely trade liberalization. Thus, when elasticities were shocked by 10% in either direction, results changed in the direction of more trade liberalization in the region. Additional percentage changes in elasticities did not provide different results. The results from the inclusion of elasticities elicited from Gardiner et al, (1989) indicated that, using another set of elasticities, considerably different from those estimated in the present research, did not affect adversely the results obtained with the base set of elasticities.

Moreover, the results indicated that using the same set of elasticities for all countries does not affect the main outcome of the results obtained earlier. Finally, the results of the sensitivity analysis indicate that, although elasticities may be important in the estimation procedure of the games analyzed, the outcome of the games will not vary considerably when elasticities are changed.

Table 5.27 Sensitivity analysis Results: Percentage change in Supply and Demand Elasticities for Central American Countries, PPF Weight Equal One.

Games	BASE	TLIB	Percentage Changes in Elasticities from Base					
			-50	-25	-10	+10	+25	+50
C/R	FT/50	FT/75	FT/75	FT/75	FT/75	FT/75	FT/75	FT/75
S/R	FT/50	FT/75	FT/75	FT/75	FT/75	FT/75	FT/75	FT/75
G/R	50/50	FT/FT	FT/75	FT/75	FT/75	FT/75	FT/75	50/FT
H/R	SQ/50	SQ/FT	SQ/FT	SQ/FT	SQ/FT	SQ/FT	SQ/FT	SQ/FT
N/R	FT/50	75/FT	SQ/FT	50/75	50/75	50/75	50/75	50/75

Note: C=Costa Rica, S=El Salvador, G=Guatemala, H=Honduras, N=Nicaragua, and R=Rest of Central American countries; TLIB=Elasticities from the Trade liberalization Database by Gardiner et al, 1989.

Table 5.28 Sensitivity analysis Results: Percentage change in Supply and Demand Elasticities for Central American Countries, PPF Weight Not Equal One.

Games	BASE	TLIB	Percentage Changes in Elasticities from Base					
			-50	-25	-10	+10	+25	+50
C/R	FT/50	75/FT	FT/FT	FT/FT	FT/FT	FT/FT	FT/FT	FT/FT
S/R	FT/50	FT/FT	FT/FT	FT/FT	FT/FT	FT/FT	FT/FT	FT/FT
G/R	50/50	FT/FT	FT/FT	FT/FT	FT/FT	FT/FT	FT/FT	50/FT
H/R	FT/50	FT/75	50/FT	FT/FT	FT/FT	FT/FT	FT/FT	FT/FT
N/R	FT/50	FT/FT	FT/75	FT/FT	75/FT	FT/FT	FT/FT	FT/FT

Note: C=Costa Rica, S=El Salvador, G=Guatemala, H=Honduras, N=Nicaragua, and R=Rest of Central American countries; TLIB=Elasticities from the Trade liberalization Database by Gardiner et al, 1989.

CHAPTER SIX - SUMMARY AND CONCLUSION

This chapter is organized as follows. The first section summarizes what was done in the research. The second section emphasizes the implications of the present study. The third section analyzes the limitations of the present study. The last section summarizes the most important conclusions to be drawn from this empirical research.

Summary

Will a second attempt of Central American countries to liberalize trade in the area and create a trading bloc with respect to the rest of the world, i.e., the formation of a customs union, be successful? An answer for this question is the main objective of this study. A first integration attempt, started in 1960, failed and this experience may help to secure a successful second integration attempt if the lessons from the past are taken into account. There is a general agreement that the first attempt failed because of social-political problems within each country (Alonso, 1994; Institute of Latin American Studies, 1988; McClelland, 1972; Schmitter, 1972). These problems spilled over the whole regional integration process in such a way that the integration process was gradually weakened and, ultimately, virtually over. So, it seems relevant for Central American countries to assess the chances of a successful integration if the mistakes made in the past are taken into account.

This research was developed with these ideas in mind. Initially, a thorough literature review was presented. Chapter two showed that Central American countries are prone to problems of various natures. Moreover, the literature revealed that the CACM, created in 1960, faced many problems. These problems caused the CACM to disintegrate by the mid-eighties. The analysis in chapter two also revealed that little of the first integration experience of 1960 has been taken into account when the second integration wave started

in 1990. The export promotion policies strategy, as the strategy of the second integration attempt, can be thought of as the main change in the integration process of the nineties relative to 1960. No information is available to support the idea that other lessons were learned from the past. Thus, Central American countries continue to face the same obstacles toward integration they faced in the sixties and seventies. In this research, an attempt is made to show the influence of the most relevant factors for a successful trade liberalization in Central America. The assumption made here is that the political influence of various producer groups is the crucial factor in shaping national decisions regarding trade liberalization.

One of the objectives of the present research was to analyze, from a partial equilibrium perspective, how national decisions may be shaped by the interest of various economic groups and by the implementation of agricultural policies. To do so, the present research focused on national decisions when entering an international trade liberalization agreement. Five Central American countries, eight important commodity groups, a consumer group, and the government perspective were included in the analysis. Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua were the countries under analysis. Beans, rice, corn, sorghum, bananas, coffee, sugar, and beef were the commodity groups included in this research.

Initially, it was hypothesized that government decisions are considerably affected by the influence of various important economic sectors. Various studies have shown this to be a realistic hypothesis (Rausser and Freebairn, 1974; Oehmke and Yao, 1990; Mahe et al, 1988; Abler and Sukhatme, 1998; Johnson et al, 1993; Kennedy, 1995). These studies have also shown that a game theoretic framework can represent, in an adequate manner, the

relationships under analysis. In addition, most of these studies have used the political preference function to empirically analyze the influence of commodity groups on government decisions. Thus, chapter three presented the theoretical model under which trade liberalization in Central America was analyzed.

The model chosen is a game theoretic framework. As the various studies mentioned above have shown, a game theoretic framework was appropriate for the topic under analysis. The political preference function (PPF) was chosen to estimate the payoffs for the actions to be analyzed. The actions included five levels of reduction in level of protection: no reduction or status quo (SQ), 25% reduction in protection or dis-protection (25),50% reduction in protection or dis-protection (50), 75% reduction in protection or dis-protection (75), and 100% reduction in protection or dis-protection, which implies a free trade situation (FT). The empirical estimation of the payoff using the PPF was done using *Modele International Simplifie de Simulation* (MISS), a partial equilibrium trade model (Mahe et al, 1988).

In order to use MISS to estimate the payoffs of the government actions specified above, some preliminary data were needed. Data on quantity demanded and supplied, domestic and international prices, and quantities of imports and exports were obtained from the most reliable sources. These sources included the Food and Agricultural Organization of the United Nations (FAO), the Economic Commission for Latin America of the United Nations (ECLAC-Mexico), the International Monetary Fund (IMF), and the World Bank. The literature review revealed that there were no estimates of elasticities of supply and demand. Therefore, these elasticities were estimated as described in Chapter four. Finally, protection levels were defined and estimated in chapter five.

The results of the empirical model were presented and discussed in chapter five. In general, the results showed that there are good possibilities for trade liberalization in Central America but in doing so, several factors should be considered. First, the results showed that the political influence of the producer groups included in the analysis does not deter countries from trade liberalization. Second, exchange rate depreciations serve as even a greater stimulus for trade liberalization, with the exception of Nicaragua. In the case of Nicaragua, exchange rate depreciation appears to worsen greatly the terms of trade and, therefore, at the present stage, it is not a desirable measure to boost exports. Third, if all countries are to choose the same level of reduction in protection, i.e., the same action, then Honduras and possibly Nicaragua should be compensated. This is because the analysis showed that Nicaragua and Honduras gain the least or lose the most when entering a trade liberalization agreement. So, for the agreement to be successful, some compensatory measures should be implemented.

Implications

Several implications can be drawn from the present research. The main implication of the present research is that the political influences of various producer, and consumer groups on the government sector are not harmful to the process of agricultural trade liberalization. The results of the present research imply that there is a potential for Central American agricultural trade liberalization. However, agricultural trade liberalization should be accompanied by corrective measures to secure a successful process. The results also imply that several agricultural policies at the domestic level should be implemented in order to ease the way toward trade liberalization. For example, the analysis showed that many commodities are considerably protected or dis-protected, as shown by the nominal

protection coefficients. Better infrastructure, cheaper and wider access to credit and financial institutions, technological improvement, and education are needed in order to reduce the gap between world and domestic prices. These policies, however, may prove to be very costly and only achievable in the long run. The main implication is that countries should undertake long-term plans in order to secure a successful agricultural trade liberalization. In addition, if the costs of implementation of agricultural policies are higher than the benefits from trade liberalization, then countries may find themselves choosing a status quo (SQ) situation. There are many factors to be taken into account when governments decide to enter an international agreement. If some of those factors appear to be an obstacle to trade liberalization, governments should take into account long-run rather than short run gains when considering an agreement. In addition, agreements among countries under the GATT and WTO negotiations indicate an overall movement toward free trade around the world. Central America may be ready to join the rest of the world in this effort.

Limitations

As any other study, this research has several limitations that should be taken into account when used to address real world issues. A first limitation of the present study is that many strong assumptions had to be made in order to estimate the empirical model. Any time a researcher uses a partial equilibrium framework, the strong assumption of "other factors constant" has to be made. Economic processes are dynamic and interrelated in nature, so the "*ceteris paribus*" assumption is a strong one.

Secondly, data limitations are always a problem in research involving developing countries (Fischer et al, 1980), and the present study is not an exception. Data limitations

were present mostly in the estimation of elasticities of supply and demand of the products analyzed. This situation may lead to undesirable consequences. On the other hand, the sensitivity analysis showed that large variations in the value of elasticities (-50%, +50%) did not change considerably the results obtained with the base set of elasticities. Moreover, the use of elasticities from other sources (Gardiner et al, 1989) did not result in large changes from the outcome obtained earlier. Thus, the sensitivity analysis showed that results are robust and insensitive to large variations in elasticities estimates. However, it is recommended to interpret the elasticities of supply and demand, estimated in this research, as an approximation to the true values of these elasticities. If the true values of the elasticities are very different from those used, results may vary substantially. Therefore, readers are advised to use the results of the present research with caution. In addition, it seems better to analyze the results under a "*what-if*" situation, i.e., this research indicates what the results would be if the elasticities presented here were the true ones. It is important to mention that in the preliminary stages of estimation, supply and demand elasticities were shocked by ten percent up and down and the results did not change significantly. So, if the true elasticities are in the range of ten percent interval, then the results are still very valuable.

Conclusions

The following conclusions can be drawn from the present research. First, this study showed that agricultural trade liberalization is a feasible and beneficial alternative for Central American countries. The results showed that Central America gains from trade liberalization. Secondly, the political influences of producers of rice, beans, corn, sorghum, bananas, coffee, sugar cane, and beef, are not a real obstacle toward agricultural trade liberalization in Central American countries. Third, the theoretical and empirical models

used in the present research were appropriate to estimate the relationships under analysis. Four, the results of the present research should be used with caution when addressing real life issues and questions regarding agricultural trade liberalization in Central American countries.

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APPENDICES

APPENDIX A: EXPLANATION OF INCLUDED APPENDICES

Appendix A includes all tables which were cited in the main contents but not presented there. Appendix B deals with estimations of costs of production and net returns for all five Central American countries included in this study. Appendix C is a supplemental program of Appendix B. Appendices D, E, F, G, H, and I, include programs codes used to estimate supply and demand elasticities for each country. Only the codes and programs for Guatemala are included because similar programs were used for the rest of countries.

Table A.1. Costs of Production and Expected Net Returns Estimates in Central American Countries for the Years 1984-1998 for Rice, Beans, Corn, Sorghum, Bananas, Coffee, Sugar Cane, and Beef.

Country	Product	T*	Labor	Machinery	Animal Force	Ferti lizer	Total Cost	Net Return
Guatemala	Rice	0	217.08	0.00	0.00	10.86	227.94	-40.74
Guatemala	Rice	1	112.56	0.00	60.00	10.86	183.42	78.66
Guatemala	Rice	2	138.69	0.00	60.00	21.72	220.41	107.19
Guatemala	Rice	3	76.38	240.00	0.00	43.44	359.82	295.38
Guatemala	Rice	4	72.36	180.00	0.00	43.44	295.80	219.00
Guatemala	Beans	0	201.00	0.00	0.00	0.00	201.00	92.76
Guatemala	Beans	1	156.78	0.00	60.00	10.86	227.64	261.96
Guatemala	Beans	2	180.90	120.00	0.00	10.86	311.76	300.24
Guatemala	Corn	0	188.94	0.00	48.00	0.00	236.94	-74.94
Guatemala	Corn	1	217.08	0.00	144.00	32.58	393.66	173.34
Guatemala	Corn	2	20.10	300.00	0.00	54.30	374.40	273.60
Guatemala	Sorghum	0	245.22	0.00	60.00	21.72	326.94	73.56
Guatemala	Sorghum	1	80.40	198.00	0.00	43.44	321.84	198.81
Guatemala	Bananas	0	217.08	9.00	0.00	86.88	312.96	277.54
Guatemala	coffee	0	703.50	0.00	0.00	92.53	796.03	2298.71
Guatemala	coffee	1	458.28	0.00	0.00	65.16	523.44	1586.61
Guatemala	coffee	2	156.78	0.00	0.00	0.00	156.78	546.57

*Note: T=technology

Continue....

Table A.1. (Continued)

Country	Product	T	Labor	Machinery	Animal Force	Ferti-lizer	Total Cost	Net Return
Guatemala	coffee	3	534.66	0.00	0.00	88.62	623.28	2190.12
Guatemala	sugarcane	0	120.60	300.00	0.00	21.72	442.32	300.18
Guatemala	sugarcane	1	76.38	240.00	0.00	21.72	338.10	269.40
El_Salvador	Rice	0	160.38	0.00	0.00	13.98	174.36	0.24
El_Salvador	Rice	1	83.16	0.00	75.00	13.98	172.14	72.30
El_Salvador	Rice	2	102.47	0.00	75.00	27.96	205.43	100.12
El_Salvador	Rice	3	56.43	320.00	0.00	55.92	432.35	178.75
El_Salvador	Rice	4	53.46	240.00	0.00	55.92	349.38	130.77
El_Salvador	Beans	0	148.50	0.00	0.00	0.00	148.50	244.62
El_Salvador	Beans	1	115.83	0.00	75.00	13.98	204.81	450.39
El_Salvador	Beans	2	133.65	160.00	0.00	13.98	307.63	511.37
El_Salvador	Corn	0	139.59	0.00	60.00	0.00	199.59	-24.99
El_Salvador	Corn	1	160.38	0.00	180.00	41.94	382.32	228.78
El_Salvador	Corn	2	14.85	400.00	0.00	69.90	484.75	213.65
El_Salvador	Sorghum	0	181.17	0.00	75.00	27.96	284.13	39.87
El_Salvador	Sorghum	1	59.40	264.00	0.00	55.92	379.32	41.88
El_Salvador	Bananas	0	160.38	12.00	0.00	111.84	284.22	-284.22
El_Salvador	coffee	0	519.75	0.00	0.00	119.11	638.86	2453.90

*Note: T=technology

Continue...

Table A.1. (Continued)

Country	Product	T	Labor	Machinery	Animal Force	Ferti-lizer	Total Cost	Net Return
El_Salvador	coffee	1	338.58	0.00	0.00	83.88	422.46	1686.24
El_Salvador	coffee	2	115.83	0.00	0.00	0.00	115.83	587.07
El_Salvador	coffee	3	395.01	0.00	0.00	114.08	509.09	2302.51
El_Salvador	sugarcane	0	89.10	400.00	0.00	27.96	517.06	423.44
El_Salvador	sugarcane	1	56.43	320.00	0.00	27.96	404.39	365.11
Honduras	Rice	0	102.06	0.00	0.00	9.26	111.32	57.88
Honduras	Rice	1	52.92	0.00	70.00	9.26	132.18	104.70
Honduras	Rice	2	65.20	0.00	70.00	18.52	153.72	142.38
Honduras	Rice	3	35.91	320.00	0.00	37.04	392.95	199.25
Honduras	Rice	4	34.02	240.00	0.00	37.04	311.06	154.24
Honduras	Beans	0	94.50	0.00	0.00	0.00	94.50	346.14
Honduras	Beans	1	73.71	0.00	70.00	9.26	152.97	581.43
Honduras	Beans	2	85.05	160.00	0.00	9.26	254.31	663.69
Honduras	Corn	0	88.83	0.00	56.00	0.00	144.83	44.17
Honduras	Corn	1	102.06	0.00	168.00	27.78	297.84	363.66
Honduras	Corn	2	9.45	400.00	0.00	46.30	455.75	300.25
Honduras	Sorghum	0	115.29	0.00	70.00	18.52	203.81	228.19
Honduras	Sorghum	1	37.80	264.00	0.00	37.04	338.84	222.76

*Note: T=technology

Continue...

Table A.1. (Continued)

Country	Product	T	Labor	Machinery	Animal Force	Ferti-lizer	Total Cost	Net Return
Honduras	Bananas	0	102.06	12.00	0.00	74.08	188.14	1304.33
Honduras	coffee	0	330.75	0.00	0.00	78.90	409.65	2051.49
Honduras	coffee	1	215.46	0.00	0.00	55.56	271.02	1407.03
Honduras	coffee	2	73.71	0.00	0.00	0.00	73.71	485.64
Honduras	coffee	3	251.37	0.00	0.00	75.56	326.93	1910.47
Honduras	sugarcane	0	56.70	400.00	0.00	18.52	475.22	173.23
Honduras	sugarcane	1	35.91	320.00	0.00	18.52	374.43	156.12
Nicaragua	Rice	0	68.58	0.00	0.00	11.18	79.76	111.04
Nicaragua	Rice	1	35.56	0.00	30.00	11.18	76.74	190.38
Nicaragua	Rice	2	43.81	0.00	30.00	22.36	96.17	237.72
Nicaragua	Rice	3	24.13	200.00	0.00	44.72	268.85	398.95
Nicaragua	Rice	4	22.86	150.00	0.00	44.72	217.58	307.12
Nicaragua	Beans	0	63.50	0.00	0.00	0.00	63.50	345.82
Nicaragua	Beans	1	49.53	0.00	30.00	11.18	90.71	591.49
Nicaragua	Beans	2	57.15	100.00	0.00	11.18	168.33	684.42
Nicaragua	Corn	0	59.69	0.00	24.00	0.00	83.69	69.31
Nicaragua	Corn	1	68.58	0.00	72.00	33.54	174.12	361.38
Nicaragua	Corn	2	6.35	250.00	0.00	55.90	312.25	299.75

*Note: T=technology

Continue...

Table A.1. (Continued)

Country	Product	T	Labor	Machinery	Animal Force	Ferti-lizer	Total Cost	Net Return
Nicaragua	Sorghum	0	77.47	0.00	30.00	22.36	129.83	198.67
Nicaragua	Sorghum	1	25.40	165.00	0.00	44.72	235.12	191.93
Nicaragua	Bananas	0	68.58	7.50	0.00	89.44	165.52	139.46
Nicaragua	coffee	0	222.25	0.00	0.00	95.25	317.50	2587.16
Nicaragua	coffee	1	144.78	0.00	0.00	67.08	211.86	1768.59
Nicaragua	coffee	2	49.53	0.00	0.00	0.00	49.53	610.62
Nicaragua	coffee	3	168.91	0.00	0.00	91.23	260.14	2380.46
Nicaragua	sugarcane	0	38.10	250.00	0.00	22.36	310.46	620.14
Nicaragua	sugarcane	1	24.13	200.00	0.00	22.36	246.49	514.91
Costa_Rica	Rice	0	386.10	0.00	0.00	12.92	399.02	-157.82
Costa_Rica	Rice	1	200.20	0.00	60.00	12.92	273.12	64.56
Costa_Rica	Rice	2	246.68	0.00	60.00	25.84	332.51	89.59
Costa_Rica	Rice	3	135.85	280.00	0.00	51.68	467.53	376.67
Costa_Rica	Rice	4	128.70	210.00	0.00	51.68	390.38	272.92
Costa_Rica	Beans	0	357.50	0.00	0.00	0.00	357.50	-8.66
Costa_Rica	Beans	1	278.85	0.00	60.00	12.92	351.77	229.63
Costa_Rica	Beans	2	321.75	140.00	0.00	12.92	474.67	252.08

*Note: T=technology

Continue...

Table A.1. (Continued)

Country	Product	T	Labor	Machinery	Animal Force	Ferti-lizer	Total Cost	Net Return
Costa_Rica	Corn	0	336.05	0.00	48.00	0.00	384.05	-204.05
Costa_Rica	Corn	1	386.10	0.00	144.00	38.76	568.86	61.14
Costa_Rica	Corn	2	35.75	350.00	0.00	64.60	450.35	269.65
Costa_Rica	Sorghum	0	436.15	0.00	60.00	25.84	521.99	-521.99
Costa_Rica	Sorghum	1	143.00	231.00	0.00	51.68	425.68	-425.68
Costa_Rica	Bananas	0	386.10	10.50	0.00	103.36	499.96	122.98
Costa_Rica	coffee	0	1251.25	0.00	0.00	110.08	1361.33	1539.37
Costa_Rica	coffee	1	815.10	0.00	0.00	77.52	892.62	1085.13
Costa_Rica	coffee	2	278.85	0.00	0.00	0.00	278.85	380.40
Costa_Rica	coffee	3	950.95	0.00	0.00	105.43	1056.38	1580.62
Costa_Rica	sugarcane	0	214.50	350.00	0.00	25.84	590.34	444.21
Costa_Rica	sugarcane	1	135.85	280.00	0.00	25.84	441.69	404.76

*Note: T=technology

Table A2. Production Functions Parameter Estimates, Costa Rica, 1984-1998

Product/ Input	Estimate	Std. Error	P-Value	Estimate	Std. Error	P-Value
	Rice			Beans		
Capital	0.009	0.128	0.946	-0.049	0.054	0.383
Labor	0.471	0.108	0.001	0.698	0.123	0.000
Fertilizer	0.173	0.106	0.131	0.306	0.108	0.016
Constant	-4.849	1.250	0.003	-9.043	1.493	0.000
R-Square			0.832			0.891
	Corn			Sorghum		
Capital	-0.150	0.099	0.159	0.169	0.152	0.316
Labor	0.617	0.173	0.004	0.219	0.116	0.119
Fertilizer	0.378	0.153	0.031	0.543	0.127	0.008
Constant	-7.964	1.158	0.000	-7.704	0.542	0.000
R-Square			0.961			0.998
	Bananas			Coffee		
Capital	0.453	0.106	0.001	0.118	0.072	0.132
Labor	0.068	0.089	0.460	0.135	0.084	0.134
Fertilizer	0.210	0.095	0.049	0.143	0.084	0.114
Constant	-6.288	1.098	0.000	-0.996	2.219	0.662
R-Square			0.915			0.376
	Sugar Cane			Beef		
Capital	0.340	0.073	0.001	1.163	0.098	0.000
Labor	-0.098	0.091	0.305	0.213	0.188	0.280
Fertilizer	0.173	0.108	0.136	*-0.167	0.236	0.493
Constant	-0.124	1.613	0.940	-12.907	3.586	0.004
R-Square			0.697			0.932

*: Parameter estimate for cattle stock (H)

Table A3. Production Functions Parameter Estimates, El Salvador, 1984-1998

Product/ Input	Estimate	Std. Error	P-Value	Estimate	Std. Error	P-Value
	Rice			Beans		
Capital	0.183	0.056	0.008	0.083	0.057	0.171
Labor	0.789	0.109	0.000	0.231	0.163	0.184
Fertilizer	-0.034	0.152	0.826	0.171	0.147	0.267
Constant	-8.988	1.333	0.000	-2.025	2.258	0.389
R-Square			0.911			0.521
	Corn			Sorghum		
Capital	0.444	0.075	0.565	-0.005	0.045	0.918
Labor	0.083	0.102	0.436	0.038	0.119	0.753
Fertilizer	0.166	0.141	0.265	0.121	0.085	0.183
Constant	1.508	2.737	0.593	2.721	2.022	0.206
R-Square			0.183			0.167
	Bananas			Coffee		
Capital	--	--	--	-0.024	0.018	0.215
Labor	--	--	--	0.116	0.039	0.014
Fertilizer	--	--	--	0.035	0.044	0.447
Constant	--	--	--	3.010	1.028	0.014
R-Square			--			0.479
	Sugar Cane			Beef		
Capital	0.192	0.105	0.095	0.788	0.091	0.000
Labor	0.374	0.077	0.001	-0.331	0.106	0.010
Fertilizer	0.273	0.106	0.026	*-0.805	0.188	0.001
Constant	-6.310	0.854	0.000	3.433	2.319	0.167
R-Square			0.940			0.911

*: Parameter estimate for cattle stock (H)

Table A4. Production Functions Parameter Estimates, Guatemala, 1984-1998

Product/ Input	Estimate	Std. Error	P-Value	Estimate	Std. Error	P-Value
	Rice			Beans		
Capital	0.070	0.032	0.049	0.070	0.123	0.581
Labor	0.400	0.109	0.004	0.589	0.082	0.000
Fertilizer	0.373	0.138	0.021	0.022	0.097	0.825
Constant	-7.176	1.144	0.000	-5.410	1.738	0.010
R-Square			0.878			0.907
	Corn			Sorghum		
Capital	-0.195	0.146	0.205	-0.105	0.151	0.500
Labor	0.193	0.129	0.162	0.202	0.153	0.212
Fertilizer	0.017	0.110	0.872	0.647	0.180	0.004
Constant	5.541	3.729	0.165	-5.658	2.210	0.027
R-Square			0.263			0.712
	Bananas			Coffee		
Capital	0.357	0.107	0.006	0.001	0.036	0.979
Labor	0.098	0.131	0.470	0.087	0.082	0.309
Fertilizer	0.110	0.102	0.305	0.131	0.089	0.170
Constant	-4.634	1.146	0.002	2.180	1.923	0.281
R-Square			0.850			0.269
	Sugar Cane			Beef		
Capital	0.341	0.091	0.003	0.939	0.034	0.000
Labor	0.176	0.097	0.097	0.036	0.081	0.660
Fertilizer	0.213	0.143	0.165	* 0.240	0.162	0.167
Constant	-4.003	1.622	0.031	-9.223	1.282	0.000
R-Square			0.931			0.986

*: Parameter estimate for cattle stock (H)

Table A5. Production Functions Parameter Estimates, Honduras, 1984-1998

Product/ Input	Estimate	Std. Error	P-Value	Estimate	Std. Error	P-Value
	Rice			Beans		
Capital	0.023	0.080	0.782	-0.011	0.131	0.934
Labor	0.726	0.202	0.004	0.162	0.157	0.323
Fertilizer	0.064	0.191	0.743	0.127	0.140	0.384
Constant	-7.57	0.904	0.000	0.699	2.876	0.812
R-Square			0.9243			0.194
	Corn			Sorghum		
Capital	0.168	0.047	0.005	0.186	0.073	0.027
Labor	-0.026	0.096	0.788	0.213	0.010	0.55
Fertilizer	0.253	0.072	0.005	0.243	0.105	0.041
Constant	0.964	1.388	0.502	-3.793	1.466	0.025
R-Square			0.830			0.789
	Bananas			Coffee		
Capital	-0.012	0.030	0.706	0.092	0.071	0.219
Labor	0.053	0.029	0.099	0.669	0.155	0.001
Fertilizer	-0.026	0.036	0.489	0.172	0.130	0.213
Constant	2.809	0.679	0.002	-9.756	2.570	0.003
R-Square			0.273			0.779
	Sugar Cane			Beef		
Capital	0.058	0.031	0.088	0.006	0.003	0.000
Labor	0.124	0.040	0.011	0.001	0.004	0.022
Fertilizer	-0.018	0.083	0.835	*0.032	0.021	0.147
Constant	1.716	1.025	0.122	0.741	1.563	0.645
R-Square			0.523			0.995

*: Parameter estimate for cattle stock (H)

Table A6. Production Functions Parameter Estimates, Nicaragua, 1984-1998

Product/ Input	Estimate	Std. Error	P-Value	Estimate	Std. Error	P-Value
	Rice			Beans		
Capital	-0.031	0.050	0.554	-0.016	0.044	0.721
Labor0.699	0.185	0.185	0.003	0.241	0.176	0.197
Fertilizer	0.213	0.111	0.080	0.407	0.177	0.042
Constant	-8.165	1.641	0.000	-3.498	1.859	0.087
R-Square			0.864			0.694
	Corn			Sorghum		
Capital	-0.069	0.051	0.200	-0.025	0.065	0.711
Labor	0.187	0.231	0.435	0.601	0.165	0.004
Fertilizer	0.247	0.172	0.179	0.377	0.161	0.040
Constant	-0.128	3.854	0.974	-9.063	1.139	0.000
R-Square			0.291			0.925
	Bananas			Coffee		
Capital	0.101	0.089	0.280	0.107	0.047	0.042
Labor	0.103	0.060	0.112	0.122	0.091	0.206
Fertilizer	0.344	0.089	0.003	0.088	0.114	0.455
Constant	-4.908	1.132	0.001	-0.041	1.820	0.982
R-Square			0.818			0.557
	Sugar Cane			Beef		
Capital	0.086	0.044	0.076	0.946	0.133	0.001
Labor	0.356	0.090	0.002	0.209	0.275	0.482
Fertilizer	0.078	0.056	0.193	*0.335	0.399	0.440
Constant	-2.873	1.141	0.029	-12.163	5.684	0.085
R-Square			0.766			0.921

*: Parameter estimate for cattle stock (H)

Table A.7. AIDS Parameter Estimates for Costa Rica, 1984-1998.

Product	Estimate	Std. Error	P-value	Product	Estimate	Std. Error	P-value
	Rice				Beans		
Rice	0.645	0.371	0.125	Rice	-0.054	0.210	0.805
Beans	-0.105	0.097	0.315	Beans	0.092	0.055	0.139
Corn	-0.115	0.234	0.638	Corn	-0.014	0.133	0.920
Sorghum	-0.150	0.105	0.197	Sorghum	-0.025	0.060	0.683
Beef	-0.147	0.119	0.257	Beef	-0.003	0.067	0.965
Expenditure	0.002	0.012	0.860	Expenditure	-0.001	0.007	0.911
Constant	0.470	0.279	0.136	Constant	0.030	0.158	0.856
R-Square	0.562			R-Square	0.496		
	Corn				Sorghum		
Rice	-0.209	0.085	0.043	Rice	-0.008	0.009	0.397
Beans	0.026	0.022	0.274	Beans	-0.000	0.002	0.874
Corn	0.093	0.054	0.127	Corn	-0.001	0.005	0.900
Sorghum	0.012	0.024	0.622	Sorghum	0.005	0.002	0.084
Beef	0.053	0.027	0.094	Beef	0.003	0.003	0.272
Expenditure	-0.001	0.003	0.643	Expenditure	0.001	0.000	0.093
Constant	-0.029	0.064	0.662	Constant	-0.000	0.006	0.992
R-Square	0.562			R-Square	0.696		
	Beef				Bananas		
Rice	-0.535	3.115	0.868	Bananas	0.087	0.079	0.298
Beans	-0.034	0.815	0.968	Coffee	-0.017	0.019	0.378
Corn	-2.332	1.969	0.275	Sugar	-0.097	0.090	0.307
Sorghum	1.115	0.885	0.248	Expenditure	-0.002	0.007	0.772
Beef	1.599	0.999	0.153	Constant	0.178	0.031	0.000
Constant	-0.075	0.100	0.476	R-square	0.470		
Expenditure	-2.107	2.345	0.399				
R-Square	0.540						
	Coffee				Sugar		
Coffee	0.138	0.025	0.000	Bananas	0.089	0.173	0.621
Sugar	-0.160	0.093	0.117	Coffee	-0.082	0.041	0.076
Beef	-0.028	0.069	0.691	Sugar	-0.025	0.197	0.903
Expenditure	-0.009	0.009	0.330	Expenditure	0.001	0.015	0.974
Constant	0.119	0.159	0.471	Constant	0.449	0.069	0.000
R-square	0.772			R-square	0.453		

Table A.8. AIDS Parameter Estimates for El Salvador, 1984-1998.

Product	Estimate	Std. Error	P-value	Product	Estimate	Std. Error	P-value
	Rice				Beans		
Rice	0.058	0.028	0.075	Rice	-0.051	0.082	0.556
Beans	0.005	0.016	0.781	Beans	0.170	0.046	0.008
Corn	-0.078	0.041	0.095	Corn	-0.148	0.121	0.258
Sorghum	-0.027	0.046	0.573	Sorghum	-0.029	0.136	0.835
Beef	0.014	0.015	0.356	Beef	-0.007	0.043	0.883
Expenditure	-0.021	0.014	0.177	Expenditure	-0.022	0.042	0.613
Constant	0.104	0.074	0.205	Constant	0.107	0.221	0.643
R-Square	0.620			R-Square	0.730		
	Corn				Sorghum		
Rice	0.046	0.085	0.606	Rice	0.039	0.040	0.360
Beans	-0.140	0.048	0.022	Beans	-0.038	0.023	0.141
Corn	0.185	0.125	0.183	Corn	-0.053	0.059	0.400
Sorghum	0.040	0.142	0.788	Sorghum	0.008	0.067	0.911
Beef	-0.009	0.045	0.845	Beef	0.023	0.021	0.313
Expenditure	0.091	0.044	0.076	Expenditure	-0.008	0.021	0.715
Constant	0.197	0.229	0.417	Constant	0.120	0.109	0.307
R-Square	0.630			R-Square	0.515		
	Beef				Bananas		
Rice	0.018	0.128	0.890	Bananas	0.120	0.089	0.212
Beans	-0.061	0.072	0.426	Coffee	0.019	0.050	0.711
Corn	-0.111	0.189	0.577	Sugar	-0.159	0.136	0.272
Sorghum	0.090	0.214	0.687	Expenditure	-0.025	0.031	0.440
Beef	0.188	0.068	0.028	Constant	0.099	0.204	0.640
Constant	0.093	0.066	0.202	R-square	0.413		
Expenditure	-0.498	0.346	0.193				
R-Square	0.775						
	Coffee				Sugar		
Coffee	0.069	0.022	0.013	Bananas	-0.058	0.082	0.497
Sugar	-0.041	0.057	0.497	Coffee	-0.074	0.046	0.142
Beef	-0.026	0.026	0.340	Sugar	0.156	0.125	0.242
Expenditure	-0.017	0.019	0.394	Expenditure	0.012	0.028	0.687
Constant	0.063	0.125	0.624	Constant	0.326	0.187	0.114
R-square	0.810			R-square	0.488		

Table A.9. AIDS Parameter Estimates for Guatemala, 1984-1998.

Product	Estimate	Std. Error	P-value	Product	Estimate	Std. Error	P-value
	Rice				Beans		
Rice	0.041	0.013	0.018	Rice	-0.029	0.022	0.228
Beans	-0.007	0.054	0.902	Beans	0.008	0.089	0.935
Corn	-0.044	0.036	0.258	Corn	-0.055	0.060	0.387
Sorghum	0.008	0.061	0.894	Sorghum	0.035	0.102	0.742
Beef	-0.002	0.018	0.918	Beef	0.031	0.029	0.328
Expenditure	-0.003	0.024	0.900	Expenditure	-0.013	0.039	0.745
Constant	0.052	0.144	0.727	Constant	0.148	0.239	0.557
R-Square	0.650			R-Square	0.470		
	Corn				Sorghum		
Rice	0.062	0.048	0.232	Rice	0.001	0.001	0.684
Beans	0.054	0.195	0.788	Beans	-0.003	0.005	0.611
Corn	-0.023	0.131	0.864	Corn	-0.004	0.003	0.308
Sorghum	-0.092	0.222	0.689	Sorghum	0.007	0.006	0.257
Beef	0.026	0.064	0.691	Beef	-0.001	0.002	0.390
Expenditure	0.097	0.086	0.294	Expenditure	-0.002	0.002	0.328
Constant	-0.018	0.521	0.974	Constant	0.023	0.013	0.119
R-Square	0.430			R-Square	0.340		
	Beef				Bananas		
Rice	0.084	0.039	0.066	Bananas	0.015	0.007	0.063
Beans	-0.372	0.158	0.051	Coffee	0.003	0.006	0.586
Corn	-0.233	0.106	0.064	Sugar	-0.027	0.013	0.065
Sorghum	0.296	0.180	0.144	Expenditure	-0.001	0.008	0.856
Beef	0.159	0.052	0.018	Constant	0.016	0.045	0.732
Constant	-0.039	0.069	0.588	R-square	0.520		
Expenditure	0.501	0.422	0.274				
R-Square	0.820						
	Coffee				Sugar		
Coffee	0.060	0.015	0.003	Bananas	-0.155	0.045	0.007
Sugar	-0.032	0.031	0.325	Coffee	-0.040	0.036	0.292
Beef	-0.034	0.011	0.011	Sugar	0.184	0.081	0.050
Expenditure	-0.025	0.022	0.290	Expenditure	-0.020	0.050	-0.694
Constant	0.097	0.134	0.489	Constant	0.434	0.288	0.166
R-square	0.850			R-square	0.620		

Table A.10. AIDS Parameter Estimates for Honduras, 1984-1998.

Product	Estimate	Std. Error	P-value	Product	Estimate	Std. Error	P-value
	Rice				Beans		
Rice	0.026	0.012	0.063	Rice	-0.018	0.009	0.075
Beans	-0.058	0.034	0.136	Beans	-0.047	0.025	0.109
Corn	-0.031	0.006	0.001	Corn	-0.030	0.004	0.000
Sorghum	0.059	0.032	0.102	Sorghum	0.084	0.023	0.009
Beef	-0.007	0.011	0.512	Beef	0.001	0.008	0.879
Expenditure	-0.021	0.009	0.045	Expenditure	-0.023	0.006	0.009
Constant	0.177	0.049	0.009	Constant	0.169	0.036	0.002
R-Square	0.944			R-Square	0.910		
	Corn				Sorghum		
Rice	0.166	0.066	0.041	Rice	-0.005	0.001	0.014
Beans	0.477	0.196	0.045	Beans	-0.011	0.004	0.037
Corn	0.176	0.032	0.001	Corn	-0.006	0.001	0.000
Sorghum	-0.736	0.180	0.005	Sorghum	0.019	0.004	0.002
Beef	-0.088	0.060	0.187	Beef	0.002	0.001	0.226
Expenditure	0.129	0.050	0.036	Expenditure	-0.005	0.001	0.004
Constant	0.139	0.279	0.634	Constant	0.031	0.006	0.001
R-Square	0.917			R-Square	0.953		
	Beef				Bananas		
Rice	0.005	0.100	0.958	Bananas	0.364	0.125	0.017
Beans	-0.176	0.297	0.572	Coffee	-0.009	0.109	0.934
Corn	-0.120	0.049	0.044	Sugar	-0.202	0.107	0.091
Sorghum	0.104	0.272	0.713	Expenditure	0.151	0.161	0.374
Beef	0.191	0.091	0.073	Constant	-0.728	0.639	0.284
Constant	0.013	0.076	0.872	R-square	0.594		
Expenditure	-0.224	0.422	0.612				
R-Square	0.757						
	Coffee				Sugar		
Coffee	0.029	0.037	0.448	Bananas	-0.051	0.023	0.051
Sugar	0.014	0.053	0.806	Coffee	-0.029	0.020	0.175
Beef	-0.028	0.055	0.625	Sugar	0.096	0.019	0.001
Expenditure	0.008	0.047	0.866	Expenditure	-0.029	0.029	0.352
Constant	0.057	0.302	0.855	Constant	0.340	0.117	0.017
R-square	0.288			R-square	0.878		

Table A.11. AIDS Parameter Estimates for Nicaragua, 1984-1998.

Product	Estimate	Std. Error	P-value	Product	Estimate	Std. Error	P-value
	Rice				Beans		
Rice	0.179	0.042	0.004	Rice	-0.023	0.029	0.450
Beans	-0.093	0.034	0.030	Beans	0.193	0.024	0.000
Corn	-0.001	0.049	0.981	Corn	-0.111	0.034	0.015
Sorghum	-0.013	0.014	0.365	Sorghum	0.016	0.010	0.144
Beef	0.349	0.195	0.116	Beef	-0.008	0.136	0.954
Expenditure	0.009	0.010	0.396	Expenditure	-0.018	0.007	0.043
Constant	-2.772	1.534	0.114	Constant	-0.263	1.076	0.814
R-Square	0.816			R-Square	0.922		
	Corn				Sorghum		
Rice	-0.059	0.038	0.164	Rice	0.006	0.006	0.326
Beans	-0.026	0.031	0.426	Beans	-0.002	0.005	0.608
Corn	0.137	0.044	0.018	Corn	-0.001	0.007	0.843
Sorghum	0.016	0.012	0.237	Sorghum	0.004	0.002	0.054
Beef	-0.088	0.176	0.632	Beef	0.009	0.026	0.753
Expenditure	0.000	0.009	0.974	Expenditure	-0.001	0.001	0.668
Constant	0.612	1.387	0.672	Constant	-0.075	0.209	0.731
R-Square	0.868			R-Square	0.675		
	Beef				Bananas		
Rice	-0.168	0.091	0.106	Bananas	0.093	0.036	0.031
Beans	-0.114	0.074	0.168	Coffee	-0.028	0.020	0.196
Corn	-0.107	0.107	0.351	Sugar	0.045	0.034	0.224
Sorghum	0.023	0.030	0.460	Expenditure	-0.004	0.004	0.296
Beef	-0.457	0.424	0.316	Constant	-0.467	0.248	0.093
Constant	0.020	0.022	0.391	R-square	0.551		
Expenditure	5.878	3.340	0.122				
R-Square	0.862						
	Coffee				Sugar		
Coffee	0.200	0.075	0.025	Bananas	0.283	0.146	0.084
Sugar	0.324	0.191	0.124	Coffee	-0.142	0.080	0.111
Beef	0.473	0.294	0.142	Sugar	0.255	0.138	0.098
Expenditure	-0.041	0.017	0.041	Expenditure	-0.013	0.016	0.444
Constant	-6.493	3.398	0.088	Constant	-1.552	1.000	0.155
R-square	0.534			R-square	0.400		

Table A.12. Demand Elasticities, Central American and Caribbean Countries

Product	Rice	Beans	Corn	Sorghum	Bananas	Coffee	Sugar	Beef
Rice	-0.65	0.00	0.04	0.00	0.00	0.00	0.00	0.00
Beans	0.00	-0.30	0.00	0.00	0.00	0.00	0.00	0.00
Corn	0.05	0.00	-0.30	0.00	0.00	0.00	0.00	0.00
Sorghum	0.00	0.00	0.00	-0.30	0.00	0.00	0.00	0.00
Bananas	0.00	0.00	0.00	0.00	-0.40	0.00	0.00	0.00
Coffee	0.00	0.00	0.00	0.00	0.00	-0.40	0.00	0.00
Sugar	0.00	0.00	0.00	0.00	0.00	0.00	-0.30	0.00
Beef	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.80

Source: Elaborated from Gardiner et al (1989)

Table A.13. Supply Elasticities, Central American and Caribbean Countries

Product	Rice	Beans	Corn	Sorghum	Bananas	Coffee	Sugar	Beef
Rice	0.58	0.00	-0.03	0.00	0.00	0.00	0.00	0.00
Beans	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.00
Corn	-0.04	0.00	0.22	-0.01	0.00	0.00	0.00	0.00
Sorghum	-0.05	0.00	-0.04	0.28	0.00	0.00	0.00	0.00
Bananas	0.00	0.00	0.00	0.00	0.40	0.00	0.00	0.00
Coffee	0.00	0.00	0.00	0.00	0.00	0.40	0.00	0.00
Sugar	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00
Beef	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40

Source: Elaborated from Gardiner et al (1989)

APPENDIX B: C CODE TO ESTIMATE COSTS OF PRODUCTION AND EXPECTED NET RETURNS IN CENTRAL AMERICAN COUNTRIES FOR THE YEARS 1984-1998 FOR RICE, BEANS, CORN, SORGHUM, BANANAS, COFFEE, SUGAR CANE, AND BEEF.

```
#include <stdio.h>
#include <math.h>
#define INPUTS 4
int main()
{
        FILE *outp;
        outp=fopen("a:costs.out","w");
        double wl[5][7][5],wo[5][7][5],wm[5][7][5],wf[5][7][5];
        double wage[4][5]=
        {{4.02,2.97,1.89,1.27,7.15},
        {12,15,14,6,12},
        {30,40,40,25,35},
        {10.86,13.98,9.26,11.18,12.92}};
        double price[5][7]=
        {{10.4,27.2,9.0,8.9,9.1,156.3,15},
        {9.7,36.4,9.7,7.2,0,156.2,19.0},
        {9.4,40.8,10.5,9.6,23.0,124.3,13.1},
        {10.6,37.9,8.5,7.3,4.7,146.7,18.8},
        {13.4,32.3,10.0,0,9.6,146.5,20.9}};
        double rice_tech[5][5]={{20,28,35,70,55},{54,28,34.5,19,18},
                {0,5,5,0,0},{0,0,0,8,6},{1,1,2,4,4}};
        double bean_tech[5][3]={{12,20,25},{50,39,45},{0,5,0},{0,0,4},{0,1,1}};
        double corn_tech[5][3]={{20,70,80},{47,54,5},{4,12,0},{0,0,10},{0,3,5}};
        double sorghum_tech[5][2]={{50,65,},{61,20},{5,0},{0,6.6},{2,4}};
        double banana_tech[5]={72.1,54,0,0.3,8};
        double coffee_tech[5][4]={{22,15,5,20},{175,114,39,133},{0,0,0,0},{0,0,0,0},
                {8.52,6,0,8.16}};
        double sugar_tech[5][2]={{55,45},{30,19},{0,0},{10,8},{2,2}};
        double area[7][5]={{18.89,12.5,15.48,82.22,91.87},{176.93,89.6,112.04,206.9,
                54.0},{836.38,355,634.74,325.18,24.14},{60.1,144.7,116.9,31.0,0},{24.14,
                0,31.81,2.56,72.85},{387.7,232.7,284,126.38,150.2},
                {116.4,115,63.9,65.3,69.6}};
        char countries[5][15]={"Guatemala","El_Salvador", "Honduras", "Nicaragua",
                "Costa_Rica"};
        char    products[7][10]={"Rice",    "Beans","Corn","Sorghum",    "Bananas",
"coffee","sugarcane"};
        int technology;
/*Starting the loop for the set of countries */
        int i=0;
        for(i=0;i<5;++i)
        {
/*Starting the loop for the set of products */
                int j=0;
                for(j=0;j<7;++j)
                {
/*Starting the loop for the set of technologies */
                        if(j==0)
                                technology=5;
                        else
                        if(j==1)
                                technology=3;
                        else
```

```
if(j==2)
        technology=3;
else
if(j==3)
        technology=2;
else
if(j==4)
        technology=1;
else
if(j==5)
        technology=4;
else
        technology=2;

int k=0;
for(k=0;k<technology;++k)
{
        double cost=0, total_cost=0, oxen1=0, mach=0, fert=0,
        labor1=0,net_return=0;
        if(j==0)
        {
                int m=0;
                for(m=0; m<INPUTS; ++m)
                {
                        cost=wage[m][i]*rice_tech[m+1][k];
                        total_cost=total_cost+cost;

                        if(m==0)
                        {
                                labor1=cost;
                                wl[i][j][k]=labor1*area[j][i];
                        }
                        else
                        if(m==1)
                        {
                                oxen1=cost;
                                wo[i][j][k]=oxen1*area[j][i];
                        }

                        else
                        if(m==2)
                        {
                                mach=cost;
                                wm[i][j][k]=mach*area[j][i];
                        }
                        else
                        {
                                fert=cost;
                                wf[i][j][k]=fert*area[j][i];
                        }
                }/*closing the loop for the set of inputs */

net_return=rice_tech[0][k]*.9*price[i][j]-total_cost;

fprintf(outp,"%12s%10s%3d%8.2f%8.2f%8.2f%8.2f%9.2f%9.2f%11.2f%11.2f%11.2f%11.2f\n",count
ries[i],products[j],k,labor1,mach,
oxen1,fert,total_cost,net_return,wl[i][j][k],wo[i][j][k],wm[i][j][k],wf[i][j][k]);
```

```
                        }
                        else
                        if(j==1)
                        {
                                int m=0;
                                for(m=0; m<INPUTS; ++m)
                                {
                                        cost=wage[m][i]*bean_tech[m+1][k];
                                        printf("%8.2f%8.2f%8.2f\n",
wage[m][i],bean_tech[m+1][k],cost);
                                        total_cost=total_cost+cost;

                                        if(m==0)
                                        {
                                                labor1=cost;
                                                wl[i][j][k]=labor1*area[j][i];
                                        }
                                        else
                                        if(m==1)
                                        {
                                                oxen1=cost;
                                                wo[i][j][4]=oxen1*area[j][i];
                                        }
                                        else
                                        if(m==2)
                                        {
                                                mach=cost;
                                                wm[i][j][k]=mach*area[j][i];
                                        }
                                        else
                                        {
                                                fert=cost;
                                                wf[i][j][k]=fert*area[j][i];
                                        }
                                }/*closing the loop for the set of inputs */

net_return=bean_tech[0][k]*.9*price[i][j]-total_cost;

fprintf(outp,"%12s%10s%3d%8.2f%8.2f%8.2f%8.2f%9.2f%9.2f%11.2f%11.2f%11.2f%11.2f\n",count
ries[i],products[j],k,labor1,mach,
oxen1,fert,total_cost,net_return,wl[i][j][k],wo[i][j][k],wm[i][j][k],wf[i][j][k]);
                        }
                        else
                        if(j==2)
                        {
                                int m=0;
                                for(m=0; m<INPUTS; ++m)
                                {
                                        cost=wage[m][i]*corn_tech[m+1][k];
                                        total_cost=total_cost+cost;

                                        if(m==0)
                                        {
                                                labor1=cost;
                                                wl[i][j][k]=labor1*area[j][i];
                                        }
                                        else
```

```
                        if(m==1)
                        {
                                oxen1=cost;
                                wo[i][j][k]=oxen1*area[j][i];
                        }
                        else
                        if(m==2)
                        {
                                mach=cost;
                                wm[i][j][k]=mach*area[j][i];
                        }
                        else
                        {
                                fert=cost;
                                wf[i][j][k]=fert*area[j][i];
                        }
                }/*closing the loop for the set of inputs */


net_return=corn_tech[0][k]*.9*price[i][j]-total_cost;

fprintf(outp,"%12s%10s%3d%8.2f%8.2f%8.2f%8.2f%9.2f%9.2f%11.2f%11.2f%11.2f%11.2f\n",count
ries[i],products[j],k,labor1,mach,
oxen1,fert,total_cost,net_return,wl[i][j][k],wo[i][j][k],wm[i][j][k],wf[i][j][k]);


        }
        else
        if(j==3)
        {
                int m=0;
                for(m=0; m<INPUTS; ++m)
                {
                        cost=wage[m][i]*sorghum_tech[m+1][k];
                        total_cost=total_cost+cost;

                        if(m==0)
                        {
                                labor1=cost;
                                wl[i][j][k]=labor1*area[j][i];
                        }
                        else
                        if(m==1)
                        {
                                oxen1=cost;
                                wo[i][j][k]=oxen1*area[j][i];
                        }
                        else
                        if(m==2)
                        {
                                mach=cost;
                                wm[i][j][k]=mach*area[j][i];
                        }
                        else
                        {
                                fert=cost;
                                wf[i][j][k]=fert*area[j][i];
```

```
                                        }
                                    }/*closing the loop for the set of inputs */

net_return=sorghum_tech[0][k]*.9*price[i][j]-total_cost;

fprintf(outp,"%12s%10s%3d%8.2f%8.2f%8.2f%8.2f%9.2f%9.2f%11.2f%11.2f%11.2f%11.2f\n",count
ries[i],products[j],k,labor1,mach,
oxen1,fert,total_cost,net_return,wl[i][j][k],wo[i][j][k],wm[i][j][k],wf[i][j][k]);

                                }
                                else
                                if(j==4)
                                {
                                        int m=0;
                                        for(m=0; m<INPUTS; ++m)
                                        {
                                                cost=wage[m][i]*banana_tech[m+1];
                                                total_cost=total_cost+cost;

                                                if(m==0)
                                                {
                                                        labor1=cost;
                                                        wl[i][j][k]=labor1*area[j][i];
                                                }
                                                else
                                                if(m==1)
                                                {
                                                        oxen1=cost;
                                                        wo[i][j][k]=oxen1*area[j][i];
                                                }
                                                else
                                                if(m==2)
                                                {
                                                        mach=cost;
                                                        wm[i][j][k]=mach*area[j][i];
                                                }
                                                else
                                                {
                                                        fert=cost;
                                                        wf[i][j][k]=fert*area[j][i];
                                                }
                                    }/*closing the loop for the set of inputs */


net_return=banana_tech[0]*.9*price[i][j]-total_cost;

fprintf(outp,"%12s%10s%3d%8.2f%8.2f%8.2f%8.2f%9.2f%9.2f%11.2f%11.2f%11.2f%11.2f\n",count
ries[i],products[j],k,labor1,mach,
oxen1,fert,total_cost,net_return,wl[i][j][k],wo[i][j][k],wm[i][j][k],wf[i][j][k]);


                                }/*closing if statement*/
                                else
                                if(j==5)
                                {
                                        int m=0;
                                        for(m=0; m<INPUTS; ++m)
```

```
                                {
                                        cost=wage[m][i]*coffee_tech[m+1][k];
                                        total_cost=total_cost+cost;

                                        if(m==0)
                                        {
                                                labor1=cost;
                                                wl[i][j][k]=labor1*area[j][i];
                                        }
                                        else
                                        if(m==1)
                                        {
                                                oxen1=cost;
                                                wo[i][j][k]=oxen1*area[j][i];
                                        }

                                        else
                                        if(m==2)
                                        {
                                                mach=cost;
                                                wm[i][j][k]=mach*area[j][i];
                                        }
                                        else
                                        {
                                                fert=cost;
                                                wf[i][j][k]=fert*area[j][i];
                                        }
                                }/*closing the loop for the set of inputs */

net_return=coffee_tech[0][k]*.9*price[i][j]-total_cost;
                                fprintf(outp,"%12s%10s%3d%8.2f%8.2f%8.2f%8.2f%9.2f%
9.2f%11.2f%11.2f%11.2f%11.2f\n",countries[i],products[j],k,labor1,mach,oxen1,fert,total_
cost,net_return,wl[i][j][k],wo[i][j][k],wm[i][j][k],wf[i][j][k]);
                                }/*closing if statement */
                                else
                                {
                                        int m=0;
                                        for(m=0; m<INPUTS; ++m)
                                        {
                                                cost=wage[m][i]*sugar_tech[m+1][k];
                                                total_cost=total_cost+cost;

                                                if(m==0)
                                                {
                                                        labor1=cost;
                                                        wl[i][j][k]=labor1*area[j][i];
                                                }
                                                else
                                                if(m==1)
                                                {
                                                        oxen1=cost;
                                                        wo[i][j][k]=oxen1*area[j][i];
                                                }

                                                else
                                                if(m==2)
                                                {
```

```
                                        mach=cost;
                                        wm[i][j][k]=mach*area[j][i];
                                }
                                else
                                {
                                        fert=cost;
                                        wf[i][j][k]=fert*area[j][i];
                                }
                        }/*closing the loop for the set of inputs */

net_return=sugar_tech[0][k]*.9*price[i][j]-total_cost;
                        fprintf(outp,"%12s%10s%3d%8.2f%8.2f%8.2f%8.2f%9.2f%
9.2f%11.2f%11.2f%11.2f%11.2f\n",countries[i],products[j],k,labor1,mach,oxen1,fert,total_
cost,net_return,wl[i][j][k],wo[i][j][k],wm[i][j][k],wf[i][j][k]);
                        } /*closing if statement */
                }/*closing loop of technologies*/
        }/*closing loop of products*/
}/*closing loop of countries*/
fclose(outp);
int quit;
printf("press any number and enter to finish\n");
scanf("%d", quit);
return 0;
}/*closing main*/
```

APPENDIX C: C CODE TO ESTIMATE CHANGES IN EXPECTED NET REVENUE IN THE BASE PERIOD AND WHEN PRICES ARE SHOCKED BY 10% FOR RICE, BEANS, CORN, SORGHUM, BANANAS, COFFEE, SUGAR CANE, AND BEEF.

```
#include <stdio.h>
#include <math.h>
int main()
{
        FILE *outp;
        outp=fopen("a:wnr.out","w");
        double net_base[20][5]=
        {{-19.94,       19.64,          76.68,          132.24, -131.02},
        {107.78,        99.46,          131.02, 220.06, 102.08},
        {143.59,        134.07, 175.28, 274.82, 136.49},
        {368.18,        246.65, 265.05, 473.15, 470.47},
        {276.20,        184.12, 205.94, 365.42, 346.62},
        {125.40,        288.30, 395.10, 391.30, 30.10},
        {316.36,        523.19, 663.03, 667.29, 294.23},
        {368.24,        602.37, 765.69, 779.17, 332.83},
        {-56.94,        -5.59,          65.17,          86.31,          -184.05},
        {236.34,        296.68, 437.16, 420.88, 131.14},
        {345.60,        291.25, 384.25, 367.75, 349.65},
        {118.06,        75.87,          276.19, 235.17, -521.99},
        {256.66,        88.68,          285.16, 239.38, -425.68},
        {343.15,        -284.22,        1470.16,        173.35, 192.20},
        {2642.57,       2797.54,        2324.95,        2909.90,        1861.67},
        {1821.06,       1920.54,        1593.48,        1988.64,        1304.88},
        {624.72,        665.17, 547.79, 683.97, 453.65},
        {2502.72,       2614.91,        2159.07,        2673.86,        1873.62},
        {382.68,        527.94, 245.28, 723.54, 559.16},
        {336.90,        450.61, 215.07, 599.51, 498.81}};

        double net_10[20][5]=
        {{-40.74,       0.24,           57.88,          111.04, -157.82},
        {78.66, 72.30,          104.70, 190.38, 64.56},
        {107.19,        100.12, 142.38, 237.72, 89.59},
        {295.38,        178.75, 199.25, 398.95, 376.67},
        {219.00,        130.77, 154.24, 307.12, 272.92},
        {92.76, 244.62, 346.14, 345.82, -8.66},
        {261.96,        450.39, 581.43, 591.49, 229.63},
        {300.24,        511.37, 663.69, 684.42, 252.08},
        {-74.94,        -24.99, 44.17,          69.31,          -204.05},
        {173.34,        228.78, 363.66, 361.38, 61.14},
        {273.60,        213.65, 300.25, 299.75, 269.65},
        {73.56, 39.87,          228.19, 198.67, -521.99},
        {198.81,        41.88,          222.76, 191.93, -425.68},
        {277.54,        -284.22,        1304.33,        139.46, 122.98},
        {2298.71,       2453.90,        2051.49,        2587.16,        1539.37},
        {1586.61,       1686.24,        1407.03,        1768.59,        1085.13},
        {546.57,        587.07, 485.64, 610.62, 380.40},
        {2190.12,       2302.51,        1910.47,        2380.46,        1580.62},
        {300.18,        423.44, 173.23, 620.14, 444.21},
        {269.40,        365.11, 156.12, 514.91, 404.76}};

        double area[7][5]={     {18.89,12.5,15.48,82.22,91.87},
                                {176.93,89.6,112.04,206.9,54.0},
```

```
                        {836.38,355,634.74,325.18,24.14},
                        {60.1,144.7,116.9,31.0,0},
                        {24.14,0,31.81,2.56,72.85},
                        {387.7,232.7,284,126.38,150.2},
                        {116.4,115,63.9,65.3,69.6}};
        double w_ave_b[5][7],w_ave_10[5][7];
        int i=0;
        for(i=0;i<5;++i)
        {
                int j=0;
                for(j=0;j<7;++j)
                {

                        if(j==0)/*rice*/
                        {
                                double total_sumb=0, total_sum10=0,revenueb=0,
revenue10=0;
                                int k=0;
                                for(k=0;k<5;++k)
                                {
                                        if(k==0)
                                        {
                                                revenueb=net_base[k][i]*0.05*area[j][i];
                                                revenue10=net_10[k][i]*0.05*area[j][i];
                                        }
                                        else
                                        if(k==1)
                                        {
                                                revenueb=net_base[k][i]*0.05*area[j][i];
                                                revenue10=net_10[k][i]*0.05*area[j][i];
                                        }
                                        else
                                        if(k==2)
                                        {
                                                revenueb=net_base[k][i]*0.3*area[j][i];
                                                revenue10=net_10[k][i]*0.3*area[j][i];
                                        }
                                        else
                                        if(k==3)
                                        {
                                                revenueb=net_base[k][i]*0.3*area[j][i];
                                                revenue10=net_10[k][i]*0.3*area[j][i];
                                        }
                                        else
                                        {
                                                revenueb=net_base[k][i]*0.3*area[j][i];
                                                revenue10=net_10[k][i]*0.3*area[j][i];
                                        }
                                        total_sumb=total_sumb+revenueb;
                                        total_sum10=total_sum10+revenue10;
                                }
                                w_ave_b[i][j]=total_sumb/area[j][i];
                                w_ave_10[i][j]=total_sum10/area[j][i];
                                fprintf(outp,
"%10.2f%10.2f\n",w_ave_b[i][j],w_ave_10[i][j]);
                        }
                        else
```

```
                    if(j==1) /* beans*/
                    {
                            double total_sumb=0, total_sum10=0,revenueb=0,
revenue10=0;
                            int k=5;
                            for(k=5;k<8;++k)
                            {
                                    if(k==5)
                                    {
                                            revenueb=net_base[k][i]*0.3*area[j][i];
                                            revenue10=net_10[k][i]*0.3*area[j][i];
                                    }
                                    else
                                    if(k==6)
                                    {
                                            revenueb=net_base[k][i]*0.2*area[j][i];
                                            revenue10=net_10[k][i]*0.2*area[j][i];
                                    }
                                    else
                                    {
                                            revenueb=net_base[k][i]*0.5*area[j][i];
                                            revenue10=net_10[k][i]*0.5*area[j][i];
                                    }

                                    total_sumb=total_sumb+revenueb;
                                    total_sum10=total_sum10+revenue10;
                            }
                            w_ave_b[i][j]=total_sumb/area[j][i];
                            w_ave_10[i][j]=total_sum10/area[j][i];
                            fprintf(outp,
"%10.2f%10.2f\n",w_ave_b[i][j],w_ave_10[i][j]);
                    }
                    else
                    if(j==2) /*corn*/
                    {
                            double total_sumb=0, total_sum10=0,revenueb=0,
revenue10=0;
                            int k=8;
                            for(k=8;k<11;++k)
                            {
                                    if(k==8)
                                    {
                                            revenueb=net_base[k][i]*0.3*area[j][i];
                                            revenue10=net_10[k][i]*0.3*area[j][i];
                                    }
                                    else
                                    if(k==9)
                                    {
                                            revenueb=net_base[k][i]*0.2*area[j][i];
                                            revenue10=net_10[k][i]*0.2*area[j][i];
                                    }
                                    else
                                    {
                                            revenueb=net_base[k][i]*0.5*area[j][i];
                                            revenue10=net_10[k][i]*0.5*area[j][i];
                                    }
```

```
                        }
                        total_sumb=total_sumb+revenueb;
                        total_sum10=total_sum10+revenue10;
                        w_ave_b[i][j]=total_sumb/area[j][i];
                        w_ave_10[i][j]=total_sum10/area[j][i];
                        fprintf(outp,
"%10.2f%10.2f\n",w_ave_b[i][j],w_ave_10[i][j]);
                }
                else
                if(j==3)/*sorghum*/
                {
                        double total_sumb=0, total_sum10=0,revenueb=0,
revenue10=0;
                        int k=11;
                        for(k=11;k<13;++k)
                        {
                                if(k==11)
                                {
                                        revenueb=net_base[k][i]*0.5*area[j][i];
                                        revenue10=net_10[k][i]*0.5*area[j][i];
                                }
                                else
                                {
                                        revenueb=net_base[k][i]*0.5*area[j][i];
                                        revenue10=net_10[k][i]*0.5*area[j][i];
                                }

                        }
                        total_sumb=total_sumb+revenueb;
                        total_sum10=total_sum10+revenue10;
                        w_ave_b[i][j]=total_sumb/area[j][i];
                        w_ave_10[i][j]=total_sum10/area[j][i];
                        fprintf(outp,
"%10.2f%10.2f\n",w_ave_b[i][j],w_ave_10[i][j]);
                }
                else
                if(j==4) /*banana*/
                {
                        w_ave_b[i][j]=net_base[13][i];
                        w_ave_10[i][j]=net_10[13][i];
                        fprintf(outp,
"%10.2f%10.2f\n",w_ave_b[i][j],w_ave_10[i][j]);
                }
                else
                if(j==5)/*coffee*/
                {
                        double total_sumb=0, total_sum10=0,revenueb=0,
revenue10=0;
                        int k=14;
                        for(k=14;k<18;++k)
                        {
                                if(k==14)
                                {
                                        revenueb=net_base[k][i]*0.05*area[j][i];
                                        revenue10=net_10[k][i]*0.05*area[j][i];
                                }
                                else
```

```
                                        if(k==15)
                                        {
                                                revenueb=net_base[k][i]*0.05*area[j][i];
                                                revenue10=net_10[k][i]*0.05*area[j][i];
                                        }
                                        else
                                        if(k==16)
                                        {
                                                revenueb=net_base[k][i]*0.3*area[j][i];
                                                revenue10=net_10[k][i]*0.3*area[j][i];
                                        }
                                        else
                                        {
                                                revenueb=net_base[k][i]*0.3*area[j][i];
                                                revenue10=net_10[k][i]*0.3*area[j][i];
                                        }

                                }
                                total_sumb=total_sumb+revenueb;
                                total_sum10=total_sum10+revenue10;
                                w_ave_b[i][j]=total_sumb/area[j][i];
                                w_ave_10[i][j]=total_sum10/area[j][i];
                                fprintf(outp,
"%10.2f%10.2f\n",w_ave_b[i][j],w_ave_10[i][j]);
                        }
                        else /*sugarcane*/
                        {
                                double total_sumb=0, total_sum10=0,revenueb=0,
revenue10=0;
                                int k=18;
                                for(k=18;k<20;++k)
                                {
                                        if(k==18)
                                        {
                                                revenueb=net_base[k][i]*0.5*area[j][i];
                                                revenue10=net_10[k][i]*0.5*area[j][i];
                                        }
                                        else
                                        {
                                                revenueb=net_base[k][i]*0.5*area[j][i];
                                                revenue10=net_10[k][i]*0.5*area[j][i];
                                        }
                                }
                                total_sumb=total_sumb+revenueb;
                                total_sum10=total_sum10+revenue10;
                                w_ave_b[i][j]=total_sumb/area[j][i];
                                w_ave_10[i][j]=total_sum10/area[j][i];
                                fprintf(outp,
"%10.2f%10.2f\n",w_ave_b[i][j],w_ave_10[i][j]);
                        }/*closing last if (k)statement*/
                }/*     closing product loop (j)*/
        } /*closing country loop (i)*/
        fclose(outp);
        return 0;
} /*closing main*/
```

APPENDIX D: SAS PROGRAM FOR THE ESTIMATION OF LABOR, FERTILIZER, AND CAPITAL REQUIREMENT FOR THE PRODUCTION OF RICE, BEANS, CORN, SORGHUM, BANANAS, COFFEE, SUGAR CANE, AND BEEF IN CENTRAL AMERICAN COUNTRIES FOR THE YEARS 1984-1998.

```
data Guatema;
array guate{15,60} guate1-guate900;
array seed{60} seed1-seed60;
do i=1to 60;
seed{i}=10+i;
end;
do i=1 to 15;
do j=1 to 60;

if j=1
then guate{i,j}=54*.75+54*.2*normal(seed{1});

else if j=2
then guate{i,j}=1*.75+1*.2*normal(seed{2});

else if j=3
then guate{i,j}=2.25+0.34*normal(seed{3});

else if j=4
then guate{i,j}=28*.75+28*.2*normal(seed{4});

else if j=5
then guate{i,j}=1*.75+1*0.2*normal(seed{5});

else if j=6
then guate{i,j}=2.25+0.34*normal(seed{6});

else if j=7
then guate{i,j}=34.5*.75+34.5*.2*normal(seed{7});

else if j=8
then guate{i,j}=2*.75+2*.2*normal(seed{8});

else if j=9
then guate{i,j}=2.25+0.34*normal(seed{9});

else if j=10
then guate{i,j}=19*.75+19*.2*normal(seed{10});

else if j=11
then guate{i,j}=4*.75+4*.2*normal(seed{11});

else if j=12
then guate{i,j}=2.25+0.34*normal(seed{12});

else if j=13
then guate{i,j}=18*.75+18*.2*normal(seed{13});

else if j=14
then guate{i,j}=4*.75+4*.2*normal(seed{14});

else if j=15
```

```
then guate{i,j}=2.25+0.34*normal(seed{15});

else if j=16
then guate{i,j}=50*.75+50*.2*normal(seed{16});

else if j=17
then guate{i,j}=0;

else if j=18
then guate{i,j}=2.25+0.34*normal(seed{18});

else if j=19
then guate{i,j}=39*.75+39*.2*normal(seed{19});

else if j=20
then guate{i,j}=1*.75+1*.2*normal(seed{20});

else if j=21
then guate{i,j}=2.25+0.34*normal(seed{21});

else if j=22
then guate{i,j}=45*.75+45*.2*normal(seed{22});

else if j=23
then guate{i,j}=1*.75+1*.2*normal(seed{23});

else if j=24
then guate{i,j}=2.25+0.34*normal(seed{24});

else if j=25
then guate{i,j}=47*.75+47*.2*normal(seed{25});

else if j=26
then guate{i,j}=0;

else if j=27
then guate{i,j}=2.25+0.34*normal(seed{27});

else if j=28
then guate{i,j}=54*.75+54*.2*normal(seed{28});

else if j=29
then guate{i,j}=3*.75+3*.2*normal(seed{29});

else if j=30
then guate{i,j}=2.25+0.34*normal(seed{30});

else if j=31
then guate{i,j}=5*.75+5*.2*normal(seed{31});

else if j=32
then guate{i,j}=5*.75+5*.2*normal(seed{23});

else if j=33
then guate{i,j}=2.25+0.34*normal(seed{33});

else if j=34
```

```
then guate{i,j}=61*.75+61*.2*normal(seed{34});

else if j=35
then guate{i,j}=2*.75+2*.2*normal(seed{35});

else if j=36
then guate{i,j}=2.25+0.34*normal(seed{36});

else if j=37
then guate{i,j}=20*.75+20*.2*normal(seed{37});

else if j=38
then guate{i,j}=4*.75+4*.2*normal(seed{38});

else if j=39
then guate{i,j}=2.25+0.34*normal(seed{39});

else if j=40
then guate{i,j}=54*.75+54*.2*normal(seed{40});

else if j=41
then guate{i,j}=8*.75+8*.2*normal(seed{41});

else if j=42
then guate{i,j}=2.25+0.34*normal(seed{42});

else if j=43
then guate{i,j}=175*.75+175*.2*normal(seed{43});

else if j=44
then guate{i,j}=8.52*.75+8.52*.2*normal(seed{44});

else if j=45
then guate{i,j}=2.25+0.34*normal(seed{45});

else if j=46
then guate{i,j}=114*.75+114*.2*normal(seed{46});

else if j=47
then guate{i,j}=6*.75+6*.2*normal(seed{47});

else if j=48
then guate{i,j}=2.25+0.34*normal(seed{48});

else if j=49
then guate{i,j}=39*.75+39*.2*normal(seed{49});

else if j=50
then guate{i,j}=0;

else if j=51
then guate{i,j}=2.25+0.34*normal(seed{51});

else if j=52
then guate{i,j}=133*.75+133*.2*normal(seed{52});

else if j=53
```

```
then guate{i,j}=8.16*.75+8.16*.2*normal(seed{53});

else if j=54
then guate{i,j}=2.25+0.34*normal(seed{54});

else if j=55
then guate{i,j}=30*.75+30*.2*normal(seed{55});

else if j=56
then guate{i,j}=2*.75+2*.2*normal(seed{56});

else if j=57
then guate{i,j}=2.25+0.34*normal(seed{57});

else if j=58
then guate{i,j}=19*.75+19*.2*normal(seed{40});

else if j=59
then guate{i,j}=2*.75+2*.2*normal(seed{59});

else guate{i,j}=2.25+0.34*normal(seed{60});

end;
end;
run;
proc print;
var guate1-guate900;
run;
```

APPENDIX E: SHAZAM! PROGRAM FOR OUTPUT MAXIMA AND MINIMA IN THE PRODUCTION OF RICE, BEANS, CORN, SORGHUM, BANANAS, COFFEE, SUGAR CANE, AND BEEF IN CENTRAL AMERICAN COUNTRIES USING DATA FOR THE YEARS 1984-1998.

```
set nocolor
sample 1 9
file screen a:\guatema\gminmax.out
read(a:\guatema\gminmax.txt) l h
genr min=l*1.42*.75
genr max=h*1.42*1.25
format(2f8.2)
print min max / format
sample 1 7
genr tmin=sum(min)
genr tmax=sum(max)
print tmin tmax / format
stop
```

APPENDIX F: SHAZAM! PROGRAM FOR PARAMETER ESTIMATION OF PRODUCTION FUNCTIONS OF RICE, BEANS, CORN, SORGHUM, BANANAS, COFFEE, SUGAR CANE, AND BEEF IN CENTRAL AMERICAN COUNTRIES USING DATA FOR THE YEARS 1984-1998.

```
set nocolor

file screen a:\guatema\guatema.out

sample 1 15


read(a:\guatema\guatlkf.txt) r1l r1f r1k r2l r2f r2k r3l r3f &
r3k r4l r4f r4k r5l r5f r5k &
b1l b1f b1k b2l b2f b2k b3l b3f b3k c1l c1f c1k c2l c2f c2k &
c3l c3f c3k s1l s1f s1k s2l s2f s2k g1l g1f g1k k1l k1f k1k &
k2l k2f k2k k3l k3f k3k k4l k4f k4k z1l z1f z1k z2l z2f z2k m1l m1k

read(a:\guatema\guataqp.txt) ar ab ac as ag ak az qr qb qc qs &
qg qk qz pr pb pc ps pg pk pz qm tm sm pm

**********************************************************************

*ESTIMATING FERTILIZER USE FOR RICE*
genr rtf1=ar*1.42*.05*r1f*1000
genr rtf2=ar*1.42*.05*r2f*1000
genr rtf3=ar*1.42*.3*r3f*1000
genr rtf4=ar*1.42*.3*r4f*1000
genr rtf5=ar*1.42*.3*r5f*1000
genr rtf=rtf1+rtf2+rtf3+rtf4+rtf5

*ESTIMATING FERTILIZER USE FOR BEANS*
genr btf1=ab*1.42*.3*b1f*1000
genr btf2=ab*1.42*.2*b2f*1000
genr btf3=ab*1.42*.5*b3f*1000
genr btf=btf1+btf2+btf3

*ESTIMATING FERTILIZER USE FOR CORN*
genr ctf1=ac*1.42*.3*c1f*1000
genr ctf2=ac*1.42*.2*c2f*1000
genr ctf3=ac*1.42*.5*c3f*1000
genr ctf=ctf1+ctf2+ctf3

*ESTIMATING FERTILIZER USE FOR SORGHUM*
genr stf1=as*1.42*.5*s1f*1000
```

```
genr stf2=as*1.42*.5*s2f*1000
genr stf=stf1+stf2

*ESTIMATING FERTILIZER USE FOR BANANAS*
genr gtf=ag*1.42*g1f*1000

*ESTIMATING FERTILIZER USE FOR COFFEE*
genr ktf1=ak*1.42*.4*k1f*1000
genr ktf2=ak*1.42*.2*k2f*1000
genr ktf3=ak*1.42*.3*k3f*1000
genr ktf4=ak*1.42*.1*k4f*1000
genr ktf=ktf1+ktf2+ktf3+ktf4

*ESTIMATING FERTILIZER USE FOR SUGARCANE*
genr ztf1=az*1.42*.5*z1f*1000
genr ztf2=az*1.42*.5*z2f*1000
genr ztf=ztf1+ztf2

**************************************
***TOTAL FERTILIZER CONSUMPTION******
**************************************
genr tf=rtf+btf+ctf+stf+gtf+ktf+ztf
format(3x, 8f13.2)
print tf / format
print  rtf btf ctf stf gtf ktf ztf / format
************************************************************

*ESTIMATING LABOR USE FOR RICE*
genr rtl1=ar*1.42*.05*r1l*1000
genr rtl2=ar*1.42*.05*r2l*1000
genr rtl3=ar*1.42*.3*r3l*1000
genr rtl4=ar*1.42*.3*r4l*1000
genr rtl5=ar*1.42*.3*r5l*1000
genr rtl=rtl1+rtl2+rtl3+rtl4+rtl5

*ESTIMATING LABOR USE FOR BEANS*
genr btl1=ab*1.42*.3*b1l*1000
genr btl2=ab*1.42*.2*b2l*1000
genr btl3=ab*1.42*.5*b3l*1000
genr btl=btl1+btl2+btl3

*ESTIMATING LABOR USE FOR CORN*
genr ctl1=ac*1.42*.3*c1l*1000
genr ctl2=ac*1.42*.2*c2l*1000
genr ctl3=ac*1.42*.5*c3l*1000
```

```
genr ctl=ctl1+ctl2+ctl3

*ESTIMATING LABOR USE FOR SORGHUM*
genr stl1=as*1.42*.5*s1l*1000
genr stl2=as*1.42*.5*s2l*1000
genr stl=stl1+stl2

*ESTIMATING LABOR USE FOR BANANAS*
genr gtl=ag*1.42*g1l*1000

*ESTIMATING LABOR USE FOR CATTLE-BEEF*
genr mtl=sm*m1l*1000

*ESTIMATING LABOR USE FOR COFFEE*
genr ktl1=ak*1.42*.4*k1l*1000
genr ktl2=ak*1.42*.2*k2l*1000
genr ktl3=ak*1.42*.3*k3l*1000
genr ktl4=ak*1.42*.1*k4l*1000
genr ktl=ktl1+ktl2+ktl3+ktl4

*ESTIMATING LABOR USE FOR SUGARCANE*
genr ztl1=az*1.42*.5*z1l*1000
genr ztl2=az*1.42*.5*z2l*1000
genr ztl=ztl1+ztl2

**************************************
***TOTAL LABOR CONSUMPTION***********
**************************************
genr tl=rtl+btl+ctl+stl+gtl+ktl+ztl+mtl
print tl / format
print rtl btl ctl stl gtl ktl ztl mtl / format

************************************************************

*ESTIMATING CAPITAL USE FOR RICE*
genr rtk1=qr*.05*pr*r1k
genr rtk2=qr*.05*pr*r2k
genr rtk3=qr*.3*pr*r3k
genr rtk4=qr*.3*pr*r4k
genr rtk5=qr*.3*pr*r5k
genr rtk=rtk1+rtk2+rtk3+rtk4+rtk5

*ESTIMATING CAPITAL USE FOR BEANS*
genr btk1=qb*.3*pb*b1k
genr btk2=qb*.2*pb*b2k
```

```
genr btk3=qb*.5*pb*b3k
genr btk=btk1+btk2+btk3

*ESTIMATING CAPITAL USE FOR CORN*
genr ctk1=qc*.3*pc*c1k
genr ctk2=qc*.2*pc*c2k
genr ctk3=qc*.5*pc*c3k
genr ctk=ctk1+ctk2+ctk3

*ESTIMATING CAPITAL USE FOR SORGHUM*
genr stk1=qs*.5*ps*s1k
genr stk2=qs*.5*ps*s2k
genr stk=stk1+stk2

*ESTIMATING CAPITAL USE FOR BANANAS*
genr gtk=qg*pg*g1k

*ESTIMATING CAPITAL USE FOR CATTLE-BEEF*
genr mtk=qm*pm*m1K

*ESTIMATING CAPITAL USE FOR COFFEE*
genr ktk1=qk*.4*pk*k1k
genr ktk2=qk*.2*pk*k2k
genr ktk3=qk*.3*pk*k3k
genr ktk4=qk*.1*pk*k3k
genr ktk=ktk1+ktk2+ktk3+ktk4

*ESTIMATING CAPITAL USE FOR SUGARCANE*
genr ztk1=qz*.5*pz*z1k
genr ztk2=qz*.5*pz*z2k
genr ztk=ztk1+ztk2

**************************************
***TOTAL CAPITAL  CONSUMPTION********
**************************************
genr tk=rtk+btk+ctk+stk+gtk+ktk+ztk+mtk
print tk / format
print rtk btk ctk stk gtk ktk ztk mtk / format

******************************************************
**************************************************
* ESTIMATING LEAST SQUARES **********************
**********************************************
**********************************************
```

```
genr lnqr=log(qr)
genr lnpr=log(pr)
genr lnar=log(ar)
genr lnrtk=log(rtk)
genr lnrtl=log(rtl)
genr lnrtf=log(rtf)

genr lnqb=log(qb)
genr lnab=log(ab)
genr lnpb=log(pb)
genr lnbtk=log(btk)
genr lnbtl=log(btl)
genr lnbtf=log(btf)


genr lnqc=log(qc)
genr lnac=log(ac)
genr lnpc=log(pc)
genr lnctk=log(ctk)
genr lnctl=log(ctl)
genr lnctf=log(ctf)

genr lnqs=log(qs)
genr lnas=log(as)
genr lnps=log(ps)
genr lnstk=log(stk)
genr lnstl=log(stl)
genr lnstf=log(stf)

genr lnqg=log(qg)
genr lnag=log(ag)
genr lnpg=log(pg)
genr lngtk=log(gtk)
genr lngtl=log(gtl)
genr lngtf=log(gtf)

genr lnqk=log(qk)
genr lnak=log(ak)
genr lnpk=log(pk)
genr lnktk=log(ktk)
genr lnktl=log(ktl)
genr lnktf=log(ktf)

genr lnqz=log(qz)
genr lnaz=log(az)
```

```
genr lnpz=log(pz)
genr lnztk=log(ztk)
genr lnztl=log(ztl)
genr lnztf=log(ztf)

genr lnqm=log(qm)
genr lntm=log(tm)
genr lnsm=log(sm)
genr lnpm=log(pm)
genr lnmtk=log(mtk)
genr lnmtl=log(mtl)

format(2x, 2f8.2)

ols ar rtk rtl rtf
ols lnar lnrtk lnrtl lnrtf / predict=lnarhat
print lnar lnarhat / format

ols ab  btk btl btf
ols lnab lnbtk lnbtl lnbtf  / predict= lnabhat
print lnab lnabhat / format

ols ac ctk ctl ctf
ols lnac lnctk lnctl lnctf  / predict= lnachat
print lnac lnachat / format

ols as stk stl stf
ols lnas lnstk lnstl lnstf  / predict= lnashat
print lnas lnashat / format

ols ag gtk gtl gtf
ols lnag lngtk lngtl lngtf  / predict= lnaghat
print lnag lnaghat / format

ols ak ktk ktl ktf
ols lnak lnktk lnktl lnktf  / predict= lnakhat
print lnak lnakhat / format

ols az ztk ztl ztf
ols lnaz lnztk lnztl lnztf  / predict= lnazhat
print lnaz lnazhat / format

************************************************
**beef estimation*********************************
```

```
ols qm mtk mtl tm
ols lnqm lnmtk lnmtl lntm  / predict= lnqmhat
print lnqm lnqmhat / format

ols qm mtk mtl sm
ols lnqm lnmtk lnmtl lnsm  / predict= lnqmhat1
print lnqm lnqmhat1 / format

stop
```

APPENDIX G: SAS PROGRAM FOR NON-LINEAR ESTIMATION PROCEDURE OF SUPPLY ELASTICITIES OF RICE, BEANS, CORN, SORGHUM, BANANAS, COFFEE, SUGAR CANE, AND BEEF IN CENTRAL AMERICAN COUNTRIES USING DATA FOR THE YEARS 1984-1998.

```
data Guatema;
proc nlp tech=QUANEW  MAXITER=1000 MAXFUNC=1000;
parms
ar ab ac as ag ak az av
nr nb nc ns ng nk nz nv
kr kb kc ks kg kk kz kv
lr lb lc ls lg lk lz lv
fr fb fc fs fg fk fz
pop=12000000;
bounds
11700 <= ar <= 46150,
68000 <= ab <= 3070000,
582560 <= ac <= 1356100,
36210 <= as <= 124250,
7880 <= ag <= 30180,
259860 <= ak <= 484570,
74550 <= az <= 323050,
39410 <= av <= 120700,
0 <= pop <= 573320,
0 <= kr <= 21805.02,
0 <= kb <= 129380.74,
0 <= kc <= 437394.71,
0 <= ks <= 23044.03,
0 <= kg <= 414321.92,
0 <= kk <= 1259388.34,
0 <= kz <= 68814.94,
0 <= kv <= 61625.84,
0 <= lr <= 388657.0,
0 <= lb <= 6359631.42,
0 <= lc <= 17537624.48
0 <= ls <= 1991181.89,
0 <= lg <= 1215453.83,
0 <= lk <= 43129113.3,
0 <= lz <= 4378645.54,
0 <= lv <= 1389471.2,
0 <= fr <= 43050.64,
0 <= fb <= 94764.78,
0 <= fc <= 2735649.27,
0 <= fs <= 127115.57,
0 <= fg <= 239756.79,
0 <= fk <= 1264781.07,
```

```
0 <= fz <= 313980.05,
0 <= nr nb nc ns ng nk nz nv;
nlincon
nlc1-nlc19 >= 0.,

0 <= nlc9  <= 240.78,
0 <= nlc10 <= 285.01,
0 <= nlc11 <= 172.80,
0 <= nlc12 <= 128.33,
0 <= nlc13 <= 343.15,
0 <= nlc14 <= 750.82,
0 <= nlc15 <= 168.45,
0 <= nlc16 <= 150.1;

max f;

f=nr*ar+nb*ab+nc*ac+ns*as+nk*ak+nz*az+nv*av;

nlc1=ar-(exp(-7.176)*(lr**0.400)*(kr**0.070)*(fr**0.373));
nlc2=ab-(exp(-5.410)*(lb**0.589)*(kb**(0.070))*(fb**0.022));
nlc3=ac-(exp(5.540)*(lc**(0.193))*(kc**(-0.196))*(fc**0.017));
nlc4=as-(exp(-5.658)*(ls**0.202)*(ks**(-0.105))*(fs**0.646));
nlc5=ag-(exp(-4.634)*(lg**0.098)*(kg**(0.357))*(fg**(0.109)));
nlc6=ak-(exp(2.180)*(lk**0.087)*(kk**0.001)*(fk**0.131));
nlc7=az-(exp(-4.003)*(lz**0.176)*(kz**0.341)*(fz**(0.213)));
nlc8=av-(exp(-9.223)*(lv**0.036)*(kv**0.931)*(pop**(0.239)));

nlc9 = ar-((240.78-nr)/0.001);
nlc10 = ab-((285.01-nb)/0.0001);
nlc11 = ac-((172.80-nc)/0.00012);
nlc12 = as-((128.33-ns)/0.001);
nlc13 = ag-((343.15-ng)/0.001);
nlc14 = ak-((750.82-nk)/0.0001);
nlc15 = az-((168.45-nz)/0.0001);
nlc16 = av-((150.1-nv)/0.001);

nlc17 = 75000304.73-(lr**0.400)-(lb**0.589)-(lc**(0.193))-(ls**0.202)-
(lg**0.098)-(lk**0.087)-(lz**0.176)-(lv**0.036);
nlc18 = 2332334.68-(kr**0.007)-(kb**(0.007))-(kc**(-0.196))-(ks**(-0.105))-
(kg**(0.357))-(kk**0.001)-(kz**0.341)-(kv**0.931);
nlc19 = 4819098.16-(fr**0.373)-(fb**0.022)-(fc**0.017)-(fs**0.646)-
(fg**(0.109))-(fk**0.131)-(fz**(0.239));
run;
quit;
```

APPENDIX H: SAS CODE TO ESTIMATE DOMESTIC CONSUMPTION OF RICE, BEANS, CORN, SORGHUM, BANANAS, COFFEE, SUGAR CANE, AND BEEF IN CENTRAL AMERICA COUNTRIES FOR THE YEARS 1984-1998.

```
data Guatema;
array guate{15,8} guate1-guate120;
array seed{8} seed1-seed8;
do i=1to 8;
seed{i}=10+i;
end;
do i=1 to 15;
do j=1 to 8;

if j=1
then guate{i,j}=4.6+4.6*.2*normal(seed{1});

else if j=2
then guate{i,j}=8.4+8.4*.2*normal(seed{2});

else if j=3
then guate{i,j}=110.15+110.15*.2*normal(seed{3});

else if j=4
then guate{i,j}=1.25+1.25*.2*normal(seed{4});

else if j=5
then guate{i,j}=3.4+3.4*0.2*normal(seed{5});

else if j=6
then guate{i,j}=1.1+1.1*.2*normal(seed{6});

else if j=7
then guate{i,j}=42.2+42.2*.2*normal(seed{7});

else guate{i,j}=4.45+4.45*.2*normal(seed{8});

end;
end;
run;
proc print;
var guate1-guate120;
run;
```

APPENDIX I: SHAZAM! PROGRAM TO ESTIMATE DEMAND ELASTICITIES OF RICE, BEANS, CORN, SORGHUM, BANANAS, COFFEE, SUGAR CANE, AND BEEF IN CENTRAL AMERICAN COUNTRIES USING DATA FOR THE YEARS 1984-1998.

```
set nocolor
file screen a:\honduras\hdemand.out
sample 1 15
read(a:\honduras\hdemand.txt) npr npb npc nps npg npk npz npm dr db dc ds &
dg dk dz dm gdpcu gdpco pop cpi

format(3x,8f10.2)
genr cr=dr*pop
genr cb=db*pop
genr cc=dc*pop
genr cs=ds*pop
genr cg=dg*pop
genr ck=dk*pop
genr cz=dz*pop
genr cm=dm*pop

write(a:\honduras\hconsumo.txt)cr cb cc cs cg ck cz cm / format

genr t=time(0)

genr pr=npr/cpi
genr pb=npb/cpi
genr pc=npc/cpi
genr ps=nps/cpi
genr pg=npg/cpi
genr pk=npk/cpi
genr pz=npz*11/cpi
genr pm=npm/cpi

genr expr=dr*pr
genr expb=db*pb
genr expc=dc*pc
genr exps=ds*ps
genr expg=dg*pg
genr expk=dk*pk
genr expz=dz*pz
genr expm=dm*pm

genr expt=expr+expb+expc+exps+expk+expz

genr wr=expr/expt
```

```
genr wb=expb/expt
genr wc=expc/expt
genr ws=exps/expt
genr wg=expg/expt
genr wk=expk/expt
genr wz=expz/expt
genr wm=expm/expt

stat wr wb wc ws wg wk wz wm / means=mexp
matrix wbar=mexp
matrix wrbar=mexp(1)
matrix wbbar=mexp(2)
matrix wcbar=mexp(3)
matrix wsbar=mexp(4)
matrix wgbar=mexp(5)
matrix wkbar=mexp(6)
matrix wzbar=mexp(7)
matrix wmbar=mexp(8)

genr lnpr=log(pr)
genr lnpb=log(pb)
genr lnpc=log(pc)
genr lnps=log(ps)
genr lnpg=log(pg)
genr lnpk=log(pk)
genr lnpz=log(pz)
genr lnpm=log(pm)

genr lagwr=lag(wr)
genr lagwb=lag(wb)
genr lagwc=lag(wc)
genr lagws=lag(ws)
genr lagwg=lag(wg)
genr lagwk=lag(wk)
genr lagwz=lag(wz)
genr lagwm=lag(wm)

genr lnwr=log(wr)
genr lnwb=log(wb)
genr lnwc=log(wc)
genr lnws=log(ws)
genr lnwg=log(wg)
genr lnwk=log(wk)
genr lnwz=log(wz)
genr lnwm=log(wm)
```

```
sample 2 15

genr
lnindex=lagwr*lnpr+lagwb*lnpb+lagwc*lnpc+lagws*lnps+lagwg*lnpg+lagwk*lnpk+la
gwz*lnpz+lagwm*lnpm

genr index=exp(lnindex)

genr lnexp=log(expt/index)
************************************************************
*********ESTIMATING ELASTICITIES FOR RICE*****************
************************************************************
ols wr lnpr lnpb lnpc lnps lnpm lnexp / coef=rice
matrix r=rice
gen1 brr=r(1)
gen1 brb=r(2)
gen1 brc=r(3)
gen1 brs=r(4)
gen1 brm=r(5)
gen1 bre=r(6)
gen1 rint=r(7)
gen1 err=-1+(brr/wrbar)-bre
gen1 erb=(brb/wrbar)-bre*(wbbar/wrbar)
gen1 erc=(brc/wrbar)-bre*(wcbar/wrbar)
gen1 ers=(brs/wrbar)-bre*(wsbar/wrbar)
gen1 erm=(brm/wrbar)-bre*(wmbar/wrbar)
print err erb erc ers erm
************************************************************
*********ESTIMATING ELASTICITIES FOR BEANS****************
************************************************************
ols wb lnpr lnpb lnpc lnps lnpm lnexp / coef=bean
matrix b=bean
gen1 bbr=b(1)
gen1 bbb=b(2)
gen1 bbc=b(3)
gen1 bbs=b(4)
gen1 bbm=b(5)
gen1 bbe=b(6)
gen1 bint=b(7)
gen1 ebb=-1+(bbb/wbbar)-bbe
gen1 ebr=(bbr/wbbar)-bbe*(wrbar/wbbar)
gen1 ebc=(bbc/wbbar)-bbe*(wcbar/wbbar)
gen1 ebs=(bbs/wbbar)-bbe*(wsbar/wbbar)
gen1 ebm=(bbm/wbbar)-bbe*(wmbar/wbbar)
```

```
print ebr ebb ebc ebs ebm

**********************************************************
*********ESTIMATING ELASTICITIES FOR CORN*****************
**********************************************************
ols wc lnpr lnpb lnpc lnps lnpm lnexp / coef=corn
matrix c=corn
genl bcr=c(1)
genl bcb=c(2)
genl bcc=c(3)
genl bcs=c(4)
genl bcm=c(5)
genl bce=c(6)
genl cint=c(7)
genl ecc=-1+(bcc/wcbar)-bce
genl ecr=(bcr/wcbar)-bce*(wrbar/wcbar)
genl ecb=(bcb/wcbar)-bce*(wbbar/wcbar)
genl ecs=(bcs/wcbar)-bce*(wsbar/wcbar)
genl ecm=(bcm/wcbar)-bce*(wmbar/wcbar)
print ecr ecb ecc ecs ecm

**********************************************************
*********ESTIMATING ELASTICITIES FOR SORGHUM**************
**********************************************************
ols ws lnpr lnpb lnpc lnps lnpm lnexp / coef=sorg
matrix s=sorg
genl bsr=s(1)
genl bsb=s(2)
genl bsc=s(3)
genl bss=s(4)
genl bsm=s(5)
genl bse=s(6)
genl sint=s(7)
genl ess=-1+(bss/wsbar)-bse
genl esr=(bsr/wsbar)-bse*(wrbar/wsbar)
genl esb=(bsb/wsbar)-bse*(wbbar/wsbar)
genl esc=(bsc/wsbar)-bse*(wcbar/wsbar)
genl esm=(bsm/wsbar)-bse*(wmbar/wsbar)
print esr esb esc ess esm

**********************************************************
*********ESTIMATING ELASTICITIES FOR BANANA***************
**********************************************************
ols wg lnpg lnpk lnpz lnexp / coef=guin
matrix g=guin
```

```
gen1 bgg=g(1)
gen1 bgk=g(2)
gen1 bgz=g(3)
gen1 bge=g(4)
gen1 gint=g(5)
gen1 egg=-1+(bgg/wgbar)-bge
gen1 egk=(bgk/wgbar)-bge*(wkbar/wgbar)
gen1 egz=(bgz/wgbar)-bge*(wzbar/wgbar)
print egg egk egz

*************************************************************
*********ESTIMATING ELASTICITIES FOR COFFEE**************
*************************************************************
ols wk lnpk lnpz lnpm lnexp / coef=cafe
matrix k=cafe
gen1 bkk=k(1)
gen1 bkz=k(2)
gen1 bkm=k(3)
gen1 bke=k(4)
gen1 kint=k(5)
gen1 ekk=-1+(bkk/wkbar)-bke
gen1 ekz=(bkz/wkbar)-bke*(wzbar/wkbar)
gen1 ekm=(bkm/wkbar)-bke*(wmbar/wkbar)
print ekk ekz ekm

*************************************************************
*********ESTIMATING ELASTICITIES FOR SUGAR***************
*************************************************************
ols wz lnpg lnpk lnpz lnexp / coef=sugar
matrix z=sugar
gen1 bzg=z(1)
gen1 bzk=z(2)
gen1 bzz=z(3)
gen1 bze=k(4)
gen1 zint=k(5)
gen1 ezz=-1+(bzz/wzbar)-bze
gen1 ezg=(bzg/wzbar)-bze*(wgbar/wzbar)
gen1 ezk=(bzk/wzbar)-bze*(wkbar/wzbar)
print ezz ezg ezk


*************************************************************
*********ESTIMATING ELASTICITIES FOR BEEF****************
*************************************************************
ols wm lnpr lnpb lnpc lnps lnpm lnexp / coef=meat
```

```
matrix m=meat
genl bmr=m(1)
genl bmb=m(2)
genl bmc=m(3)
genl bms=m(4)
genl bmm=m(5)
genl bme=m(6)
genl mint=m(7)
genl emm=-1+(bmm/wmbar)-bme
genl emr=(bmr/wmbar)-bme*(wrbar/wmbar)
genl emb=(bmb/wmbar)-bme*(wbbar/wmbar)
genl emc=(bmc/wmbar)-bme*(wcbar/wmbar)
genl ems=(bms/wmbar)-bme*(wsbar/wmbar)
print emm emr emb emc ems

*************************************************************
***CREATING MATRIX OF ELASTICITIES OF DEMAND**************
*************************************************************
format(3x,8f8.4)
matrix eta=iden(8)
matrix eta(1,1)=err
matrix eta(1,2)=erb
matrix eta(1,3)=erc
matrix eta(1,4)=ers
matrix eta(1,5)=0
matrix eta(1,6)=0
matrix eta(1,7)=0
matrix eta(1,8)=erm
matrix eta(2,1)=ebr
matrix eta(2,2)=ebb
matrix eta(2,3)=ebc
matrix eta(2,4)=ebs
matrix eta(2,5)=0
matrix eta(2,6)=0
matrix eta(2,7)=0
matrix eta(2,8)=ebm
matrix eta(3,1)=ecr
matrix eta(3,2)=ecb
matrix eta(3,3)=ecc
matrix eta(3,4)=ecs
matrix eta(3,5)=0
matrix eta(3,6)=0
matrix eta(3,7)=0
matrix eta(3,8)=ecm
matrix eta(4,1)=esr
```

```
matrix eta(4,2)=esb
matrix eta(4,3)=esc
matrix eta(4,4)=ess
matrix eta(4,5)=0
matrix eta(4,6)=0
matrix eta(4,7)=0
matrix eta(4,8)=esm
matrix eta(5,1)=0
matrix eta(5,2)=0
matrix eta(5,3)=0
matrix eta(5,4)=0
matrix eta(5,5)=egg
matrix eta(5,6)=egk
matrix eta(5,7)=egz
matrix eta(5,8)=0
matrix eta(6,1)=0
matrix eta(6,2)=0
matrix eta(6,3)=0
matrix eta(6,4)=0
matrix eta(6,5)=0
matrix eta(6,6)=ekk
matrix eta(6,7)=ekz
matrix eta(6,8)=ekm
matrix eta(7,1)=0
matrix eta(7,2)=0
matrix eta(7,3)=0
matrix eta(7,4)=0
matrix eta(7,5)=ezg
matrix eta(7,6)=ezk
matrix eta(7,7)=ezz
matrix eta(7,8)=0
matrix eta(8,1)=emr
matrix eta(8,2)=emb
matrix eta(8,3)=emc
matrix eta(8,4)=ems
matrix eta(8,5)=0
matrix eta(8,6)=0
matrix eta(8,7)=0
matrix eta(8,8)=emm
print eta / format
stop
```

VITA

Jorge Luis Icabalceta Mairena was born in Matagalpa, Nicaragua. He received his High School diploma and a high school level degree in agriculture in 1984 from the Instituto Agropecuario "Santiago Baldovinos" of Matagalpa, Nicaragua.

In 1986 he was granted a scholarship and went to the USSR to study agricultural economics in the Agricultural Academy "Timiriazev" of Moscow. Jorge received a bachelor of science degree in agricultural economics in 1991.

After returning to Nicaragua, he worked from 1991 to 1993 as a coordinator of a environmental project and, from 1993 to 1995 as an economic analyst for the coffee research station of the Nicaraguan Union of Coffee Producers (UNICAFE).

In 1995, he was granted a Fulbright program scholarship to attend graduate school at Louisiana State University. He graduated with a master of science degree in agricultural economics in December 1997. In August 1997, Jorge Icabalceta was awarded an assistantship to pursue a doctoral degree in agricultural economics at Louisiana State University. Presently, he is a candidate for the degree of Doctor of Philosophy in agricultural economics.

DOCTORAL EXAMINATION AND DISSERTATION REPORT

Candidate: Jorge Luis Icabalceta Mairena

Major Field: Agricultural Economics

Title of Dissertation: The Influence of Agricultural Policy on Economic Integration Among Central American Countries: A Game Theoretic Analysis

Approved:

P. Lynn Kennedy
Major Professor and Chairman

Dean of the Graduate School

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Date of Examination:

9 March 2001