AN ABSTRACT OF THE THESIS OF

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Title: A Market Share Analysis of U.S. Demand for Selected Domestic and Mexican Frozen Vegetables

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This study examines the link between policy-induced changes in the relative prices of Mexican and U.S. frozen vegetables and their shares of the U.S. market. Several scenarios were examined in order to assess the impacts on quantities demanded of both U.S. and Mexican produced frozen vegetables caused by changes in their relative prices.

An econometric model incorporating a two-stage budgeting process based on Armington's model of demand for commodities differentiated by kind and origin was used to estimate the U.S. demand for frozen vegetables. This was accomplished by first deriving an overall, or total U.S. demand relationship for frozen vegetables and then estimating the U.S. demand relationships for frozen vegetables by country of origin (U.S. and Mexico). The relative price elasticities estimated by the model were used to investigate how changes in the relative prices of frozen vegetables by country affect the composition of demand for frozen vegetables in the U.S.

The scenarios examined relative price changes resulting from different economic and political developments. These included such things as reductions in

U.S. tariff rates brought about by further trade liberalization (such as the proposed North American Free-Trade Agreement), changes in the minimum wage rate in both countries, and increased technology transfer from the U.S. to Mexico.

Applying the estimated model parameters to these scenarios suggested that relative price changes in frozen vegetables from, say Mexico, not only affected the price and quantity demanded by U.S. consumers of Mexican frozen vegetables, but it also affected the price and quantity demanded of U.S. produced frozen vegetables by U.S. consumers. Demand for frozen vegetables produced in Mexico was estimated to be relative price inelastic at -0.6375, while demand for frozen vegetables produced in the U.S. was relative price elastic with a value of -1.3445.

According to the model projections, price changes in frozen vegetables produced in either country tend to have a greater effect proportionately on the quantity demanded of frozen vegetables produced in Mexico. This can be attributed to Mexico's relatively small share of the frozen vegetable market in comparison to the United States.

The effect of a relative price change caused by a free-trade agreement, which lowers the price of Mexican frozen vegetables through tariff removal, would increase Mexico's market share and decrease the United States' market share in the U.S. frozen vegetable market. But when one looks at the quantities of frozen vegetables implied by these market share changes one discovers that they are relatively small compared to the total volume of frozen vegetables in the market.

A Market Share Analysis of U.S. Demand for Selected Domestic and Mexican Frozen Vegetables

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TABLE OF CONTENTS

Chapter		Page
I	INTRODUCTION	1
	Background	1
	Problem Statement	3
	Research Objectives	4
	Thesis Organization	5
II	PRODUCTION AND PROCESSING OF FROZEN VEGETABLES IN THE UNITED STATES AND MEXICO	7
	U.S. Production Sector	7
	U.S. Processing Sector	9
	Mexican Production Sector	12
	Mexican Processing Sector	15
	Comparison of Production and Processing Costs	17
	Conclusions	19
III	THEORETICAL CONSIDERATIONS AND LITERATURE REVIEW	21
	Theoretical Considerations	21
	Rationale for International Trade	21
	Demand for Differentiated Commodities	24
	Derived Demand	25
	Demand Elasticities	26

Chapter		Page
	Literature Review	31
	U.S.-Mexico Trade	31
	Differentiated Products Trade	35
IV	METHODOLOGY AND MODEL SPECIFICATIONS	39
	The Armington Model	39
	General Form of Demand Functions	41
	Specific Form of Demand Functions	43
	Description of Data	45
V	MODEL RESULTS	48
	Estimation of First-Stage Demand Function	48
	Estimation of Second-Stage Demand Functions	52
	Estimated Relative Price Elasticities	55
	Relative Price Elasticities and Market Shares	59
VI	SUMMARY AND CONCLUSIONS	68
	Summary	68
	Conclusions	69
	Research Recommendations	71
Bibliography		73
Appendix A - Calculation of Implicit Price Indexes		79
Appendix B - Economic Data		81

LIST OF TABLES

Table 5.1 - First-Stage Total U.S. Frozen Vegetable Demand 49

Table 5.2 - Second-Stage U.S. Derived Demand for Frozen Vegetables Produced in the United States 53

Table 5.3 - Second-Stage U.S. Derived Demand for Frozen Vegetables Produced in Mexico 55

Table 5.4 - Results of Proposed Scenarios 62

Table 5.5 - Market Share Changes 63

Table 5.6 - Implied Price Elasticities 66

LIST OF APPENDIX TABLES

Table 1 - U.S. Annual Pack of Select Frozen Vegetables 82

Table 2 - U.S. Total Imports of Frozen Vegetables, Quantity 83

Table 3 - U.S. Total Imports of Frozen Vegetables, Value 85

Table 4 - U.S. Imports of Frozen Vegetables from Mexico, Quantity 87

Table 5 - U.S. Imports of Frozen Vegetables from Mexico, Quantity 89

Table 6 - U.S. Imports of Frozen Vegetables from ROW, Quantity 91

Table 7 - U.S. Imports of Frozen Vegetables from ROW, Value 93

Table 8 - Miscellaneous Statistics 95

A MARKET SHARE ANALYSIS OF U.S. DEMAND FOR SELECTED DOMESTIC AND MEXICAN FROZEN VEGETABLES

I. INTRODUCTION

Background

During the past decade, agricultural trade between the United States and Mexico has increased more than 73 percent, growing from $2.4 billion in 1982 to over $4 billion in 1988 (USGAO, 1990). Mexico's frozen vegetable industry is one of the agricultural industries responsible for this increase in trade.

Frozen vegetable imports from Mexico represented 8.5 percent of all frozen vegetables consumed in the United States in 1988, up from 2 percent in 1982, and were valued at $56.4 million (see Appendix B, Tables 2-5). Two frozen vegetables which have contributed to this rise in imports are broccoli and cauliflower. During the years 1982-88 imports of frozen broccoli increased from 32 to 178 million pounds while imports of frozen cauliflower rose from 20 to 50 million pounds (see Appendix B, Table 2).

Many reasons have been given for Mexico's increased exports of frozen vegetables to the United States, including a recent liberalization of trade policies. This started with its accession to the General Agreement on Tariffs and Trade (GATT) in 1986. In November of 1987 the U.S. and Mexican governments went one step further by signing a bilateral framework agreement aimed at providing additional trade liberalization measures (USDA, FAS, 1988). This was followed by a 1989 agreement between the U.S. Department of Agriculture and its Mexican counterpart, which established binational technical groups aimed at expanding agricultural trade and investment relations (USGAO, 1990).

The most recent action the two governments have taken towards further trade liberalization is the August 1990 initiation of negotiations on a United States - Mexico Free Trade Agreement, corresponding to the one signed by the United States and Canada in 1988 (USDA, FAS, 1990). Since the August 1990 announcement it has been confirmed that Canada will also participate in the negotiations, with the intent to create a North American Free Trade Agreement (NAFTA) (Scott, 1991). NAFTA negotiators hope to agree on a framework by mid-1991 and reach a final agreement by no later than 1993 (Stokes, 1990). Given that the purpose of a free trade agreement is to reduce trade barriers between countries, the implementation of a NAFTA may result in the lowering and eventual removal of the U.S. import tariffs on Mexican frozen vegetables and thus allow further market expansion for these products. This then calls into question the potential for continuing competitiveness of U.S. producers and processors of frozen vegetables and how a NAFTA would effect them.

Although all of these trade liberalization policies have contributed to Mexico's ability to compete in the U.S. frozen vegetable market, recent studies point to other factors which have influenced this market expansion as well. Lower costs of production, primarily due to lower wage rates, along with the involvement of multinational firms in providing new technology and U.S. market access were two such factors mentioned in studies by Moulton and Runsten in 1986, the U.S. International Trade Commission (USITC) in 1988, and the U.S. General Accounting Office (USGAO) in 1990. The USGAO added that Mexico's efforts to increase revenues from non-petroleum exports and the devaluation of the peso had also given frozen vegetable exports a boost.

A 1988 study by Buckley, et al., pointed to the fact that changing U.S. consumer attitudes and demographics may have added to Mexico's recent volume increase in exports of frozen vegetables. They contended that changes in consumer tastes and preferences, away from canned vegetables to frozen and fresh vegetables, and the presence of more women in the work force demanding more convenient foods had also played a role in increasing demand for frozen vegetables.

Problem Statement

The above mentioned studies are very thorough in analyzing and comparing the frozen vegetable production and processing industries of the United States and Mexico. And in doing so they have identified many factors responsible for Mexico's recent increase in exports of frozen vegetables to the United States. But each of these descriptive studies has failed to look at the interrelationships between frozen vegetable prices, and in particular how imports of frozen vegetables from Mexico (at any given price), affect the price and market share of domestic (U.S.) frozen vegetables.

In an attempt to better understand the market relationships between U.S. and imported frozen vegetables this study addresses the following question: How do changes in the relative prices of frozen vegetables from Mexico affect market shares of U.S. produced frozen vegetables?

Research Objectives

In an effort to better understand the link between policy-induced changes in relative prices of Mexican and U.S. frozen vegetables and their shares of the U.S. market the following research objectives will be addressed:

1. Derive the overall U.S. demand relationship for frozen vegetables including own price elasticities;

2. Derive the U.S. demand relationships for frozen vegetables by country of origin (U.S. and Mexico);

3. Test the hypothesis that changes in the relative prices of Mexican frozen vegetables entering the U.S. market will have an effect on the quantity demanded of U.S. frozen vegetables;

4. Test the hypothesis that U.S. and Mexican frozen vegetables are close but not perfect substitutes (perfect substitutes would imply infinite cross price elasticities, and thus complete switching); and

5. Use the estimated demand relationships to predict market share effects of relative price changes caused by selected policy/economic developments such as the North American FTA, increased transportation costs from the Middle East crisis, real exchange rate changes, changes in processing costs, technology transfer, etc.

Thesis Organization

The remainder of this thesis is divided into five chapters, with the bibliography and appendices following. Chapter II is a short overview and comparison of the production and processing of frozen vegetables in the United States and Mexico. Chapter III is divided into two parts, with the first part consisting of a discussion of the economic theory employed in this study and the second part a review of relevant literature. The methodology and the specifications of the model used in performing the market share analysis are then outlined in chapter IV. Model results and interpretations, including analysis of prospective changes in relative prices caused by different economic or political changes, are presented in chapter V followed by a thesis summary and conclusions in chapter VI.

II. PRODUCTION AND PROCESSING OF FROZEN VEGETABLES IN THE UNITED STATES AND MEXICO

U.S. Production Sector

Production of vegetables for processing takes place in some 38 states throughout the United States, with California, Wisconsin, Minnesota, Oregon and Ohio leading the nation in the production of vegetables for freezing. Principal vegetables grown in these states include green peas, snap beans and sweet corn. Other important vegetables of interest include broccoli, cauliflower, asparagus, carrots and cucumbers (Carman and French, 1988).

The growing sector for these vegetables consists primarily of a large number of independent growers dispersed throughout the country (USITC, 1988). And similar to the national trend, the number of small independent operations (annual sales of less than $10,000) producing vegetables for freezing has declined over time (USITC, 1988). In 1964 this sector of growers made up over 75 percent of the total number of growers producing vegetables for processing, but by 1982 they made up just 50 percent of all farmers, while the percentage of farms in all other size sectors increased.

To gain a better understanding of the size of farm that produces vegetables for freezing, one can look at the average size of farms producing asparagus, broccoli and cauliflower. In most states in 1987 the average farm harvested just under 50 acres, while the same farm in

California averaged 120-220 acres (USITC, 1988). This difference in scale of operation is consistent with the fact that the state of California produces one-third of the nation's vegetables for freezing.

Although growth has taken place in the production of vegetables for freezing, it has not been uniform across vegetable types. As can be seen in Appendix B, Table 1, production of broccoli, carrots, cauliflower and sweet corn for freezing has increased over the past 20 years while production of snap beans and green peas has stayed fairly stable.

Relationships between producers of vegetables for freezing and processors are normally formalized with some type of contract, which may vary by the type of processor, be it a private proprietary processor, a large multinational, or a cooperative. These contracts are normally in place before the vegetable is planted and specify a given tonnage of the vegetable in question to be supplied to the processor (Carman and French, 1988). Contracts between producers and processors may also specify a variety of issues surrounding the production of the commodity, such as; which variety will be planted, the schedule for applying herbicides and pesticides and which ones are to be used, harvest and delivery schedules, grading procedures, and the dates and method of payment and the price or means of determining the price (Carman and French, 1988).

U.S. Processing Sector

The beginning of the U.S. frozen vegetable industry can be traced back to the late 1920's and 1930's when a "quick freezing" method of preserving food was developed for use with berry crops (Northwest Food Processors, 1988). Adoption of frozen food technology was slow until World War II, as it was limited by the expense of providing retail freezer space and the lack of investment in home freezers (McCorkle, 1988). These types of impediments began to disappear following World War II, with growth in personal income and improved freezer technology. Demand for frozen foods, including vegetables, went up and the industry began to grow (Runsten and Moulton, 1988).

Over the years the industry expanded until roughly 25 years ago, when the total number of processors began to decline (Carman and French, 1988; USITC, 1988). This reduction in frozen vegetable processors has come in the form of either firms going out of business or mergers. The main reason for this decline can be linked to increased operating costs in the form of higher energy costs, increasing interest rates, higher labor rates compared with foreign competitors, and increasing costs associated with meeting Environmental Protection Agency (EPA) and Occupational and Safety Health Act (OSHA) regulations (Carman and French, 1988).

Today the majority of vegetable freezers are located in most of the same states producing the majority of vegetables for freezing: California, Wisconsin, Minnesota, Oregon and Washington (Carman and French, 1988). A few of these firms are cooperative in nature, such as the two larger vegetable freezers in Oregon Agripac and Norpac, while the remainder are either small family run operations or large multinational firms which normally process an assortment of vegetables (USITC, 1988). Of the 200 or so firms which were in existence in 1987, a relatively small number could be considered primary freezers (USITC, 1988)[1].

To get an idea of where U.S. firms freezing vegetables obtain their raw products, one can look at the suppliers of broccoli and cauliflower. According to survey results published in the 1988 USITC report entitled **Competitive Conditions in the U.S. Market for Asparagus, Broccoli, and Cauliflower**, primary freezers of broccoli and cauliflower procure most of their supply from domestically grown fresh products. This can be compared with non-primary freezers which receive four-fifths of their broccoli supplies and two-thirds of their cauliflower supplies from foreign sources (USITC, 1988).

The frozen vegetable packs produced by U.S. processors are normally categorized into three different styles; retail, food service or institutional, and bulk. In the U.S. frozen broccoli and cauliflower industries in 1987, the style accounting for the largest share of shipments was retail size containers, both in vegetable mixes and unmixed (USITC, 1988).

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[1] A processor is considered a primary freezer if it is one which receives, cleans, grades, blanches and freezes fresh vegetables opposed to a firm which only receives and processes bulk frozen vegetables.

The U.S. consumer market for frozen vegetables can most easily be broken down into intermediate and final consumers. Intermediate consumers could then be classified as those buyers who purchase vegetables they will then alter in some manner before reselling them. A repacker who buys bulk containers of frozen vegetables and either repackages them into smaller containers or buys many types of frozen vegetables and creates frozen vegetables mixes is one example (USITC, 1988). Many U.S. processors buy bulk sized packages of frozen vegetables from Mexico and repackage them here in the United States. Another example of an intermediate consumer would be a reprocessor who buys bulk or retail size containers of frozen vegetables and adds sauces or breading. Although some smaller supermarkets and distributors do not usually alter the products they work with, they are also considered intermediate consumers because they provide services such as marketing and distribution (USITC, 1988).

Under the category of final consumers there are two major groups, retail and institutional (USITC, 1988). An example of retail consumers would be households purchasing frozen vegetables at a supermarket. Restaurants, schools, hospitals, the military, etc., are considered to be institutional final consumers . This latter type of consumers normally make their purchases through a wholesale distributor (USITC, 1988).

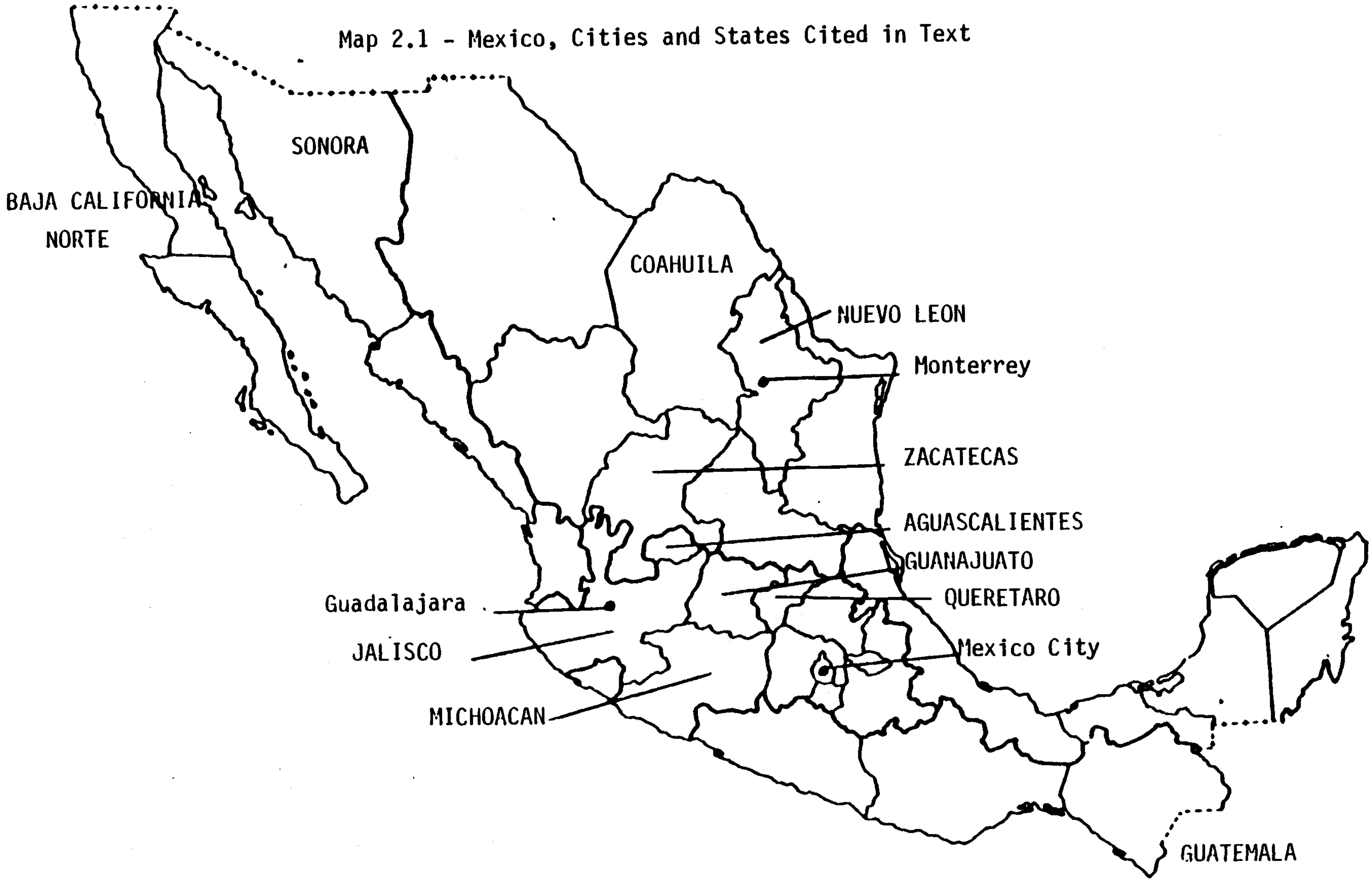
Mexican Production Sector

Vegetable production in Mexico takes place primarily in the Northwestern states of Baja California Norte and Sonora, the Northeastern states of Nuevo Leon and Coahuila, and in the central region (see map 2.1) (USITC, 1988). Production of vegetables for freezing is more heavily concentrated in this central region, which is more commonly referred to as the Bajio. This region of Mexico, located approximately 250 miles north of Mexico City in a series of interconnected valleys at the 5,000 to 6,000 feet level, has traditionally been considered one of the most fertile areas of the country. It consists of parts of the states of Guanajuato (which was responsible for 79% of frozen vegetable production in 1984), Michoacan (10%), Aguascalientes (9%), and Queretaro, Jalisco, and Zacatecas, which were responsible for the remaining 2% of frozen vegetable production (Moulton and Runsten, 1988).

Production of vegetables in the Bajio region began in the late 1950's and early 1960's when several U.S. canners located there in order to better serve the internal market (USITC, 1988). They brought with them new vegetable crops and the technology necessary for producing them. At this time the Bajio region was viewed as an ideal location given that it is situated almost half-way between Mexico City and Guadalajara with the Pan American Highway crossing the region.

As time went by and these firms slowly lost the canned vegetable market to Taiwan, they began to see the potential for exporting frozen vegetables to the United States and

Map 2.1 - Mexico, Cities and States Cited in Text



began working towards the establishment of that industry (Moulton and Runsten, 1988). By the mid 1980's production of vegetables for freezing in the Bajio region was oriented towards broccoli (75% of exports in 1983-84) and cauliflower (23%). Carrots, okra, zucchini, and green beans made up the remaining 2 percent of exports in 1983-84 (Moulton and Runsten, 1988).

Most vegetables produced for freezing are grown during the late winter and early spring months as this time period provides the most favorable conditions. Attempts have been made over the years to extend the growing season into the summer months, but this has proven to be rather risky (Moulton and Runsten, 1988). Although the rainy season is May through September many times there is insufficient rainfall for growing vegetables.

The Mexican growing sector for vegetables for freezing is made up of a large number of farms which range in size from 10 to 100 acres and a small number of integrated growing operations which usually control between 1,100 to 7,400 acres, not all of which are planted in vegetables for freezing (USITC, 1988). On the whole, most vegetable farmers in Mexico are not as diversified in crop production as their U.S. counterparts, but many have begun moving towards marketing more of their vegetables in the fresh market (USITC, 1988).

Similar to contractual relationships between producers and processors in the United States, in Mexico these relationships also vary depending on the type of processor. If the processor is a U.S. multinational firm, the vegetables it receives are usually provided under contract with smaller producers. And similar to the processor located in the United States, the multinational provides technical assistance and helps guide the farmer in the production of the vegetables (USITC, 1988).

The other type of producer-processor relationship found in Mexico is the family or grower owned integrated operation. In this situation a family or group of growers owns the processing facility and provides the vegetables necessary for the operation (Moulton and Runsten, 1988). These integrated grower-processor operations normally control a large number of acres and do not have to contract with smaller landholders.

Mexican Processing Sector

Like the production sector, processors of frozen vegetables in Mexico are primarily located in the Bajio region of central Mexico. The location of these processors in this region is a direct result of U.S. strawberry freezing plants started there in the 1950's, and a number of U.S. firms which located fruit and vegetable canneries there in the late 1950's and early 1960's. The frozen vegetable industry started in the late 1960's when one of these U.S. firms converted a dehydrating plant into a vegetable freezer and began exporting the product to the United States (Runsten and Moulton, 1988).

At first U.S. multinationals contracted with large growers in the region, offering needed technical assistance in growing the vegetables. But over time these larger growers saw the potential profitability of selling frozen vegetables in the United States and began building their own freezers or converting old strawberry freezers so that they could handle vegetables (Runsten and Moulton, 1988).

Currently vegetable processing in the Bajio is made up of both U.S. multinational firms and private national companies owned by either families or growers. Many of these private national firms are vertically integrated, from raw-product production up through wholesale frozen processed-product sales (USITC, 1988). But given the fact that their access to U.S. markets is not as extensive as the multinationals, they produce more bulk, food-service size packs. These packs are then either sold to wholesalers who repack them, reprocess them, or sell the packs as they are (USITC, 1988). U.S. multinationals, on the other hand, produce more retail size frozen vegetable packs. These packs are either sold directly to supermarkets through the processor's U.S. marketing channels or are transported to a U.S. based processor where they are either reprocessed or repacked (USITC, 1988).

Growth in the frozen vegetable industry of Mexico has been a direct result of U.S. involvement. Technology transferred between the United States and Mexico, through either personnel or investments in machinery, has enabled the industry to become more efficient and reduce costs (Runsten and Moulton, 1988). But one factor which continues to hinder the industry and its producers is the lack of adequate research on adapting vegetable varieties to specific locations. Little is done beyond the minimal growth trials of multinational firms (Runsten and Moulton, 1988).

Given that Mexico has traditionally not had the infrastructure necessary for selling frozen food, as freezers are not common in households or in supermarkets, most frozen vegetables produced in the country are destined for export. However, recent anecdotal evidence suggests that U.S. based multinationals are supplying Mexico City supermarkets with freezer units for frozen vegetables[2]. Such investments in combination with household income and female labor force participation increases may ultimately create a domestic frozen vegetable market.

Comparison of Production and Processing Costs

Comparisons of production and processing costs across countries are often used as indicators of relative competitiveness. However, the use of such costs to draw inferences about the competitiveness of a country should be carried out with the understanding that limitations do exist. Unless a time series is present, most cost comparisons are static and represent one particular point in time. They are also normally reported as average costs per acre or hectare for a geographically defined area and represent the average costs of firms of varying sizes with different technologies. But despite these limitations, cost comparisons do allow one to gain a better

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[2] I observed such vegetable freezer units marked with company logos while in Mexico City in 1990.

understanding of how producer and processor cost structures differ across countries by identifying various input costs. Thus, one can acquire a preliminary "feel" for how production and processing take place in each country.

To get an idea of the differences in production costs between a typical vegetable operation in Mexico and one in the United States, a few assumptions have to be made. The vegetable produced is broccoli for freezing and the grower in the United States is located in California while the Mexican producer is in the Bajio region in the state of Guanajuato. The year is 1986 and the costs included in both operations are land preparation, planting, irrigating, procuring and applying fertilizer, herbicide, and pesticide along with hoeing, weeding, and cultivating.

For the operation in Mexico, the total direct pre-harvest costs are $268.77/acre[3]. This can be compared to the California grower's costs of $872.34/acre, which represent an additional cost of $603.57/acre. When harvesting and transporting costs are included they increase the total cost facing the Mexican producer to $333.39/acre. This additional $64.62/acre is relatively small compared to the $350/acre the California grower must pay, which makes the total direct post-harvest cost equal to $1222.34/ acre. The major cost advantage for the Mexican producer is the availability of low-cost labor. This is especially evident in labor intensive activities such as irrigating and harvesting.

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[3] All figures in this section come from Moulton and Runsten, 1988.

Differences in processor costs between the United States and Mexico are also primarily based on lower wage rates, but the differences are not as great as those associated with producers. To see this we can look at a representative frozen broccoli operation in both the United States and Mexico in 1987. Costs are quoted in cents per pound and include the cost of the raw material along with plant costs, which are made up of both a labor category and an "other" category. A transportation cost figure equal to the cost of transporting the product from the processor to the border is also included in the Mexican processor's costs.

Taking all of this into account the total cost to the Mexican processor shipping to the United States is equal to 24.6 cents/lb. When the U.S. tariff on imported broccoli is added (17.5% ad valorem) the total cost is still only 28.9 cents/lb. for the Mexican producer, while the U.S. processor incurs costs totalling 41.8 cents/lb. (USITC, 1988). As can be seen, the costs facing Mexican processors are 44 percent lower than those for U.S. processors. This is especially true for such labor intensive activities as trimming broccoli spears.

Conclusions

A comparison of frozen vegetable production and processing in the United States and Mexico points to both similarities and differences. The involvement of U.S. multinational processors in Mexico is responsible for many of the similarities, since they provide technology in the form of both machines and personnel. This has resulted in Mexican producers growing some of the same varieties of frozen vegetables as their U.S. counterparts, and at times employing the same methods of production. Mexican processors use the same equipment and have access to technological advancements taking place in the United States through direct contacts with U.S. processors.

The one factor which has resulted in most of the differences between the two industries, labor wage rates, is also somewhat responsible for the existence of the Mexican industry. Lower wage rates initially attracted multinational processors to Mexico and to some extent has resulted in the differentiation of the two industries. Production and processing of vegetables for freezing are much more labor intensive in Mexico which can lead to lower costs of production and a more specialized end product (hand cut broccoli florets as opposed to machine cut spears).

III. THEORETICAL CONSIDERATIONS AND LITERATURE REVIEW

Theoretical Considerations

Rationale for International Trade

The basic economic phenomenon of concern in this research is the exchange of commodities between countries, namely exports of frozen vegetables from Mexico to the United States. Before the analysis of this trade is presented it may be helpful to look at why this trade takes place, according to economic theory. What are the benefits that countries receive from commodity exchange?

International trade theory was initiated during the 16th century with the advent of the philosophy of mercantilism (Daniels and Radebaugh, 1987). This theory suggested that nations strive for self-sufficiency and the accumulation of wealth. Exports were encouraged while imports were discouraged.

In the late 18th century Adam Smith challenged this viewpoint contending that the wealth of a country is not based on the treasures it holds, rather wealth consists of the goods and services available to a country's consumers (Daniels and Radebaugh, 1987). He supported this idea with the theory of absolute advantage, a theory based on the concept that each particular country will have an absolute cost advantage in the production of one commodity, while another country will have an absolute cost advantage in the production of some other commodity (Milner and Greenaway, 1979). He argued that if goods were free to move between countries without restrictions, countries would specialize in the production of those commodities for which they had an absolute advantage. This theory appeared to suffice until economists asked the question, "Could a country with an absolute cost advantage in the production of all commodities benefit from trade?"

In the early 1800's David Ricardo addressed this question and came up with the theory of comparative advantage. He believed that when analyzing trade between countries, comparative cost differences within each country were more important in determining trade than absolute cost differences across countries (Milner and Greenaway, 1979). A country should specialize in the production of those commodities it can produce most efficiently, exporting its excess production so that the commodities it produces relatively inefficiently can be imported.

With these two theories Smith and Ricardo demonstrated that a country's overall output increased when it specialized in the production of commodities for which it had an advantage (Daniels and Radebaugh, 1987). But these theories did little in helping to identify the types of commodities a country would most likely produce. They both assumed that a free market would lead countries to produce those commodities they produce most efficiently since they were unable to compete in markets for the others (Daniels and Radebaugh, 1987).

In an attempt to answer the question of which commodities a country is most likely to produce, Eli

Heckscher and Bertil Ohlin developed the factors proportion theory. Unlike the previous two theories which assumed just one factor of production, labor, the Heckscher-Ohlin theory addressed the situation where more than one factor of production is available (Milner and Greenaway, 1979). Heckscher and Ohlin contended that differences in factor endowments between countries would explain the differences in factor costs (Daniels and Radebaugh, 1987). A country would excel in the production and export of commodities which used its abundant and cheap factors of production. Thus a labor abundant country with little capital stock would be better off producing mainly labor intensive commodities and trading these for capital intensive commodities from a more capital abundant, labor scarce country.

Another reason for trade occurring is provided in a recent book on agricultural trade policy: trade often occurs between countries because it allows access to goods that would otherwise be unavailable or much too expensive for consumers, such as bananas and coffee consumed in the United States (Houck, 1986).

Although the preceding discussion is by no means an exhaustive review of international trade theory, it does provide one with a sense of why trade takes place. However, while trade theory points to the fact that trade betters a nation's economy as a whole, it may not always be beneficial to every individual within that economy.

In using trade theories to help understand why countries exchange commodities, one should remember that theories are simplifications of reality. Many more factors influence the exchange of commodities than can ever be included in a theoretic trade model. But this abstraction allows us to sort out useful information and provides the basis for empirical analysis.

Demand for Differentiated Commodities

The quantity demanded of a particular commodity, say frozen vegetables, is influenced by several factors. These may include the price of the commodity, the level of consumer income, consumer tastes and preferences, and the number of potential consumers (Tomek and Robinson, 1981). One other factor of demand that may influence the price of a commodity is the price of a substitute commodity. Normally two commodities are regarded as substitutes if they are similar but not the same commodity. Consumption of these commodities is usually an either-or choice since they are fairly similar (Browning and Browning, 1989). There may be times when importers view otherwise identical commodities as not being perfectly homogenous by country of origin (Johnson, et al., 1977).

Commodities normally thought of as perfect substitutes, such as frozen broccoli produced in the United States and frozen broccoli produced in Mexico, may in fact be imperfect substitutes for their purchasers. This differentiation of seemingly identical commodities can be the result of several factors and can take place at either the wholesaler or consumer level. Wholesalers may choose suppliers with familiar languages and customs or those suppliers who have proven reliable over time. Consumers and wholesalers may perceive a quality difference between the same commodity supplied by two different countries. Although a difference in quality may be more psychological than physical, the perception that one is inferior will result in the two commodities being differentiated in demand.

Recognizing that at times importers do differentiate commodities by country of origin, researchers have developed methods for estimating import demand functions for such commodities. Some of these methods will be discussed in the Literature Review section of this chapter.

Derived Demand

The term derived demand indicates a demand schedule for inputs which are used in producing a final good (Tomek and Robinson, 1981). Since consumers of frozen vegetables do not eat vegetables straight out of the field but instead consume the end product, the demand for vegetables at the farm level is said to be derived from the processor level demand which, in turn, is derived from the end user demand for frozen corn, broccoli, cauliflower, etc. The demand for these end products at the retail level is known as primary demand.

Demand for frozen vegetables from Mexico could also be viewed as derived, as a large part of these vegetables are either reprocessed or repackaged in the United States before retail sale. Demand for Mexican frozen vegetables by U.S. processors, wholesalers, etc., is ultimately derived from retail level consumer demand in the United States.

Demand Elasticities

The notion of a demand schedule provides us with a description of the relationship between the price of a commodity and the quantity consumers are willing and able to buy at that price. Applying price theory suggests that an inverse relationship exists between the price and quantity demanded of a particular commodity (Tomek and Robinson, 1981). That is to say that if the price of a commodity increases then the quantity demanded of that commodity will decrease. But knowledge of this inverse relationship alone does not provide us with the information necessary to understand how responsive the quantity demanded is to a particular price change.

The concept of demand elasticities allows us to better understand this relationship between prices and quantities. It allows us to measure the quantity demanded of a particular commodity due to a change in one of its demand determinants. As mentioned earlier, these may include the price of the commodity, the prices of related commodities, consumer income, and the number of consumers. Included in the concept of demand elasticities is the assumption of ceteris paribus. It specifies that when one is examining the relationship between a demand determinant and the quantity demanded of a particular commodity, all other demand determinants be held constant.

Mathematically the definition of demand elasticity is:

$$E = \frac{\text{\% Change in Quantity Demanded}}{\text{\% Change in a Demand Determinant}}$$

The elasticity coefficient (E) is always calculated in relative or percentage terms rather than absolute or unit terms (Tomek and Robinson, 1981). This allows comparison of demand sensitivities for different commodities regardless of their units of measure.

The value of a demand elasticity for a given commodity falls into a range from zero to plus or minus infinity. The demand for a good is said to be:

1. "Elastic" if a given percentage change in price results in a greater percentage change in quantity demanded. The value of the coefficient of elasticity is greater than 1 in absolute value;

2. "Inelastic" if a given percentage change in price results in a smaller percentage change in quantity and the value of the coefficient of elasticity falls between zero and 1 in absolute value; and

3. "Unitary Elastic" if a given percentage change in price results in an equal percentage change in quantity demanded and the value of the

coefficient of elasticity is equal to 1 in absolute value.

When the demand determinant is the price of the commodity in question we call this elasticity measure the own-price elasticity. The own-price elasticity of demand for a commodity can be interpreted as the percentage change in quantity demanded of a commodity given a percentage change in the price of the same commodity, other factors held constant (Tomek and Robinson, 1981). The own-price elasticity coefficient used to measure price responsiveness is:

$$Ep = \frac{\%\ \text{Change in Quantity Demanded}}{\%\ \text{Change in Price}}$$

The own-price elasticity coefficient (Ep) is always negative since price and quantity demanded are inversely related, such that when price increases the quantity demanded decreases and vice-versa (Tomek and Robinson, 1981).

Two other useful measures of demand elasticity are income elasticity and cross-price elasticity. The income elasticity of demand can be thought of as the measure of the responsiveness of the quantity demanded of a commodity given changes in consumer income, other factors held constant (Tomek and Robinson, 1981).

Mathematically this can be expressed as:

$$Ey = \frac{\%\ \text{Change in the Quantity Demanded}}{\%\ \text{Change in Income}}$$

This measurement can be interpreted as the percentage change in quantity demanded of a commodity corresponding to a one percent change in income. Normally the income elasticity coefficient (Ey) is positive, which is consistent with the idea that as a person's income increases they will buy more of most products. But there are cases when a commodity will have a negative income elasticity coefficient (Tomek and Robinson, 1981).

The cross-price elasticity of demand measures how the quantity demanded of a commodity responds to changes in the price of another commodity, other factors held constant (Tomek and Robinson, 1981). This can be defined as:

$$Eij = \frac{\text{\% Change in Quantity Demanded of Commodity i}}{\text{\% Change in Price of Commodity j}}$$

It may be interpreted as the percentage change in the quantity demanded of commodity i in response to a one percent change in the price of commodity j.

Three types of cross-price elasticity relationships are normally identified: the commodities may be substitutes, complements, or independent. The definition of each of these relationships is based on the substitution effect of the price change of j (Tomek and Robinson, 1981).

When commodities are thought of as substitutes the substitution effect is positive. If the price of j increases then the quantity demanded of i also increases as i is substituted for j. The same holds true if the price of j decreases; the relatively cheaper commodity j will be substituted for i. In either case, the relationship between the price of j and the quantity demanded of i is positive (Tomek and Robinson, 1981).

For commodities regarded as complements the substitution effect is negative. In this case when the price of j goes up the quantity demanded of i goes down. Complementary commodities are thought of as being consumed together so that the consumption of both tends to rise or fall simultaneously. An example of two such commodities might be coffee and sugar. A decrease in the price of coffee means that the quantity demanded of coffee will increase, and thus result in an increase in the consumption of sugar. In this case there is a negative relationship between the price of coffee and the quantity of sugar consumed.

For commodities which are independent in consumption the substitution effect is zero. In this case no substitution or complementary relationship exists between the two commodities (Tomek and Robinson, 1981).

As suggested by these examples it can be said that, in general, substitute commodities have positive cross-price elasticities, complementary commodities have negative cross-price elasticities, and independent goods have zero cross-price elasticities (Tomek and Robinson, 1981)[4].

International trade theory is useful in explaining why the exchange of commodities across national boundaries takes place. Extensions of demand theory beyond homogeneous products accommodates the observed fact that

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[4] In the case where the income effect of the price change for j outweighs the substitution effect this may not hold.

countries such as the United States simultaneously import and produce domestically the "same" good, in this case frozen vegetables. In order to analyze the sensitivity of demand for imported and domestic versions of this product to policy-induced price and/or income changes the concept of elasticities is both convenient and useful. An example of this would involve using the own-price elasticity measure to help analyze the effect of a price change in Mexican frozen vegetables on the quantity demanded. Using the concept of cross-price elasticities one could also analyze how this price change in Mexican frozen vegetables would effect the quantity demanded of U.S. produced frozen vegetables.

Literature Review

U.S.-Mexico Trade

As mentioned in chapter I, several studies have recently been published which deal with the status of the U.S. and Mexico's trade in agriculture. In part this is a result of Mexico's proximity to the United States and the large volume of trade between the two countries, $4 billion in 1988. This interest in trade can also be attributed to Mexico's recent accession to the GATT and the prospects of a North American FTA (Free Trade Agreement). Many questions remain unanswered regarding how three nations with a combined population of 360 million inhabitants and economic production totaling $6 trillion will interact together with freer trade (Scott, 1991).

A recent USGAO report on U.S.-Mexico Trade was requested in part in anticipation of the upcoming FTA negotiations (USGAO, 1990). It points to the fact that Mexico was the fourth largest market for U.S. agricultural exports in 1988, at $2.2 billion, and was the third largest supplier of agricultural imports totaling $1.8 billion. With Mexico's increasing importance in U.S. agricultural trade, especially as a source of imports, it is not surprising that many domestically produced commodities are experiencing increased competition. Although coffee, one of Mexico's larger exports to the United States, is not produced domestically in significant quantities, many others are. Fruits and vegetables, both fresh and processed, along with live cattle, processed foods, and beverages are all exported to the United States (USGAO, 1990).

A 1986 report by Buckley, et al., looked specifically at this increased competition between Florida and Mexico in the winter fresh vegetable market. It focused on vegetables such as tomatoes, peppers, cucumbers, green beans, squash, and eggplant. The researchers used weighted average prices received by growers and processors along with enterprise budgets to assess the cost and price advantages of producing winter fresh vegetables in Florida and the western Mexico state of Sinaloa. They then used the calculated cost and price advantages to measure the competitive advantage of producing each vegetable and supplying the U.S. market.

The results indicated that Florida was the dominant supplier of the six vegetables during the months of May and June (1984-85), but during the months of December - April, the main period of competition, Mexico held a competitive advantage over Florida in all but one vegetable. This was achieved by Mexico in spite of high transportation costs to the eastern markets and high border fees.

The share of the U.S. market supplied by Sinaloa in these six vegetables has also increased during the past production seasons as price advantages have shifted to Mexico. These have come in the form of a devalued peso and lower wage rates. The report went on to mention that any reduction in border fees could easily increase the cost advantage enjoyed by Sinaloan producers.

Another study concerned with Mexico's competition in the U.S. fresh vegetable market was published by the University of California Agricultural Issues Center in 1988. This study points out that although California has appeared to have the comparative advantage in the production of some fruit and vegetable crops, the rapid "internationalization" of markets has brought new regions into competition with California. One of them being Mexico.

This report also detailed the competition between California and Mexico in individual vegetable sectors. Increased competition between these two areas was normally attributed to changes taking place in Mexico such as; improved transportation and communication, deregulation of financial markets, and technological innovations. But it was reported that a large share of this increased competition is the result of technology being transferred from California to its competitors. Analysis looked at the production of certain fruits and vegetables in both Mexico and California along with its cost, the cost of transportation, the quantities imported of the commodities, and their value.

According to a short report on cost competition between California and Mexico in the Federal Reserve Bank of San Fransico's Weekly Letter, "Mexican imports are no longer serving solely to supplement U.S. production during winter months"(1989, 1).

Not only has there been concern with the increased competition some regions of the United States have experienced from Mexico, there has also been concern with Mexico's rapid growth in the production of frozen vegetables and how that will effect the entire United States. As stated by Moulton and Runsten in their 1986 paper,

> "Mexico has become a significant factor in the U.S. market for frozen cauliflower and broccoli. The speed with which this has occurred...emphasizes the need, on both sides of the border, for a closer look at the Mexican industry"(1).

This study, along with one published by the USITC in 1988, identifies factors such as lower wage rates, relatively abundant labor, transferred technology from U.S. multinationals, and devaluation of the peso, which have increased Mexico's ability to compete in the U.S. frozen vegetable market. Just as the earlier mentioned studies focused on establishing which country had the competitive advantage for a given commodity, these latter studies have done the same. None have taken the next step to estimate quantitative relationships for use in policy and market analysis.

Differentiated Products Trade

Guidance for the development of an estimable quantitative model which looks at trade flows and incorporates demand functions for commodities differentiated by country of origin, in this case U.S. and Mexican frozen vegetables, is available in the literature.

In 1969, Paul Armington published a paper in which he presented a general theory of demand for products which are distinguished by kind and place of production. Coupled with this theory was a specific model for use in analysis of such cases. This type of specification allows products from different regions or countries to be treated as separate products within a market rather than the same commodity, i.e. demand for U.S. or Mexican frozen vegetables rather than total demand for frozen vegetables.

In this model import demand is determined in a two-stage budgeting approach. First the importer decides how much of a particular commodity to import and in the second stage, given the total amount imported, the importer decides how much to import from each source. An advantage of the Armington model is that it permits the calculation of the cross-price elasticities between imports from all sources using estimates of the aggregate price elasticity of demand for imports, a single elasticity of substitution, and trade shares.

Armington applied his model in an analysis of the trade of manufactured goods between the major industrial countries of that time, to examine how a change in the price level in a single country would effect trade between any two countries, as well as the internal trade of each country. He found that if country X experienced an increase in the price of manufactured goods, country X's exports would decline in value while all other countries' exports increased in value. He also concluded that the percentage gain in world market share for any other country would first depend on country X's market share, and second on the extent to which the markets in which country X's share is relatively high happen to be important markets for the other country's exports.

Johnson, Grennes, and Thursby (1977) used the Armington approach to develop a trade model for grains distinguishing them by their place of origin. This approach allowed importing countries to distinguish among U.S., Canadian, and Australian wheat, purchasing some of each at different prices. Wheat prices from different countries were also isolated to see how different variables, such as a dollar devaluation or increased shipping costs, would affect them. They found that just as a dollar devaluation tends to increase the price of wheat in the United States, so does a decline in the cost of transporting exported wheat.

In 1983, Alex Sarris used Armington's trade model to assess how Spain, Greece, and Portugal's accession to the

European Community would effect world trade patterns and prices of fruits and vegetables. Using the Armington methodology he developed a world trade model that differentiated five classes of fruits and vegetables according to their country of origin. Sarris then used this model to project future trade patterns and terms of trade with and without EC enlargement.

In his 1987 paper Ronald Babula used an Armington model to estimate import demand for U.S. cotton by Japan, South Korea, the EC and a residual rest of the world. As he indicated, using this theory of demand for commodities differentiated by kind and origin accomplished three things. It enabled him to: endogenize the two-stage optimization procedure which he claims is frequently observed in world trade; theoretically justify using two-stage optimization without violating Hicksian consumer theory; and use the assumptions of the theory to come up with "a specific form for the relation between demand for a product, the size of the corresponding market and relative prices."

Babula refers to the four advantages of Armington's model: 1) the manner in which the two-stage importer optimization procedure is endogenized is consistent with the one-stage process and does not violate Hicksian consumer theory; 2) the model's characteristic of weak separability may lead to reduced multicollinearity in that estimating a product's demand involves only that product's market related parameters and not those of the entire consumption set; 3) the process of indexing prices in both stages of the two-stage optimization may lead to further reductions in multicollinearity; and 4) price elasticities can be estimated indirectly using trade share information, the elasticity of substitution estimate, and an estimate of the price elasticity of demand for imports.

Using this model as a basis, Babula was able to estimate a price elasticity of world demand along with a set of region-specific price elasticities of demand for U.S. cotton. He was also able to test the forecasting performance of his estimates "out of sample" and found that they predicted region-specific imports of U.S. cotton and world forecasts of U.S. cotton exports fairly well.

In a 1990 paper by Duffy, et al., an Armington model was used to develop estimates of the elasticity of foreign demand for U.S. cotton. Their reasons for using this model were twofold; it provided a simple method for formulating models and it had been referred to as a powerful method for modeling U.S. crop exports.

Armington's approach to trade modeling can be seen throughout the literature as an important tool when estimating demand for commodities viewed as being differentiated by kind and/or origin. Although its assumptions (which will be addressed in chapter IV) have at times been criticized for being too restrictive (Alston, et al., 1990), results of estimated elasticities have proven fairly reliable (Babula, 1987) and the consistency with demand theory is an attractive feature.

IV. METHODOLOGY AND MODEL SPECIFICATIONS

Specification of the link between policy-induced changes in the relative price of frozen vegetables produced in Mexico and how they affect market shares of the same frozen vegetables produced in the United States necessitates the development and estimation of an appropriate quantitative model. To accomplish this an overall, or total U.S. demand relationship for frozen vegetables will be derived along with U.S. demand relationships for frozen vegetables distinguished by source. Together these will enable one to separate determinants of the total size of the market from those affecting shares within that market.

The approach taken in this study focuses on the demand side determinants of the frozen vegetable market as opposed to the supply side determinants. This choice was made because demand factors appear to explain Mexico's rising market share, and evidence supporting the idea that domestic production is constraining the supply of frozen vegetables does not exist (Buckley, et al., 1988; Moulton and Runsten, 1986; and USITC, 1988).

The Armington Model

To maintain consistency with the assumption that importers of frozen vegetables do not view all frozen vegetables as perfectly homogenous by country of origin, I have chosen to use Armington's model of demand for commodities differentiated by kind and origin as a basis for my analysis. This approach was chosen primarily because it is a proven methodology that is linked to economic theory and is applicable to the frozen vegetable market, and because it is specifically designed to establish market share demands in instances where there is limited data. Armington's model was developed to analyze import demand, but it can just as easily be applied to any market where products are differentiated by country of origin, as is hypothesized to be the case in the U.S. frozen vegetable market.

The Armington approach specifies the demand for any product as a function of consumer income, the price of each product, and the price of that product relative to the price of other products in the same market. It assumes that consumers perform a two-stage budgeting procedure. In the first stage consumers maximize their utility subject to a budget constraint. This determines the total demand for a particular commodity, in this case frozen vegetables. In the second stage buyers minimize expenditures on all frozen vegetables, by source, subject to their first-stage demand or utility level, determining the optimal levels of frozen vegetables to be purchased (Armington 1969a).

Armington's theory of demand for products differentiated by kind and origin rests on three basic assumptions (Armington, 1969a). First, the preferences of buyers are assumed to be homogeneously separable. This implies that commodities can be partitioned into groups so that preferences within one group can be described independently of those in another group. Another way to say this is that the buyers' preferences for different products of any given kind (i.e. U.S. frozen vegetables and Mexican frozen vegetables) are independent of their purchases of products of any other kind. As demonstrated in Deaton and Muellbauer (1989) weak separability, a condition implied by homogeneous separability, is required to incorporate two-stage budgeting.

The second assumption is that the elasticity of substitution between any two products in one market equals the elasticity of substitution between any other pair of products competing in the same market. This implies that there is a common elasticity of substitution for all product pairs within a particular market.

Third, the elasticity of substitution between any two products in a given market is constant. As stated in Babula (1987), taken together these three assumptions imply "a utility function that is homogeneously separable, and has a constant elasticity of substitution (CES)."

General Form of Demand Functions

Following the assumption that buyers perform a two-stage budgeting procedure, Armington derived a demand model consisting of the following equations. The first equation represents the first-stage of the budgeting procedure, in which consumers are maximizing utility subject to an income constraint. The second equation corresponds to stage two at which point buyers minimize their expenditures on each product group subject to their first stage demand or utility level[5]. Equation 2b is equation two's natural logarithmic form and that which is actually estimated.

General Form

(1) $x_i = h^i(RLY, p_1, \ldots, p_i, \ldots, p_n)$

(2) $x_{ij} = g^{ij}(x_i, p_{i1}, \ldots, p_{ij}, \ldots, p_{im})$

restated as:

Functional Form

(2a) $x_{ij} = b_{ij}^{oi} x_i (p_{ij}/p_i)^{-oi}$

(2b) $\ln(x_{ij}) = oi*\ln(b_{ij}) + \ln(x_i) - oi*\ln(p_{ij}/p_i)$

where i = 1,..., n and j = 1,...,m and n represents the goods or markets (for example frozen vegetables) and j is the supplying regions. x_i is the demand for the ith good from all sources (the first-stage demand), RLY is the real per capita income, and x_{ij} is the second-stage demand for the ith good purchased from the jth region. p_i is the index of m numbers of real prices for the ith good, p_{ij} is the real price for the ith commodity supplied by the jth exporting region, b_{ij} is the intercept for the x_{ij} demand, oi is the buyer's constant elasticity of substitution

[5] To make the link between consumer income referred to in the first-stage and buyer (processor) in the second-stage, one needs to invoke derived demand which is discussed in chapter III.

associated with each product pair in the ith market, and ln is the natural logarithm operator.

Specific Form of Demand Functions

Applying Armington's model to the case of U.S. domestic demand for frozen vegetables would result in the following hypothesized relationships. In the first equation the U.S. consumer maximizes real income-constrained utility to determine a total demand for frozen vegetables. In this stage the dependent variable (the quantity of all frozen vegetables demanded by U.S. consumers) is said to be explained by the consumer's real income, the price index of the dependent variable (frozen vegetables), and the price index of a substitute good (fresh vegetables).

In the second set of equations the U.S. buyer (processor level) minimizes expenditures on all frozen vegetable products (in this case frozen vegetables produced in the United States and Mexico). In this stage a log linear functional form has been specified to test the hypothesized relationships of the dependent variables (the quantity demanded of U.S. and Mexican produced frozen vegetables) to the explanatory variables. These include the first-stage dependent variable (ALLQ) and the appropriate ratio of the real price index of the dependent variables (frozen vegetables) to the real U.S. consumer price index of all frozen vegetables[6]. The first-stage dependent variable, ALLQ, is included in the second-stage equation as it serves as a proxy, incorporating the effect of real per capita income, the price of all frozen vegetables, and the price index of the substitute good, fresh vegetables.

Specific Form

(1) $ALLQ = a_0 + a_1 RLINC + a_2 FRZPI + a_3 FSHPI + e_t$

(2a) $\ln(USQ) = b_0 + b_1 * \ln(ALLQ) + b_2 * \ln(USALL) + e_{us}$

(2b) $\ln(MEXQ) = c_0 + c_1 * \ln(ALLQ) + c_2 * \ln(MEXALL) + e_{mex}$

where:

ALLQ = The quantity of all frozen vegetables demanded by U.S. consumers;

USQ = The quantity of U.S. produced frozen vegetables demanded by U.S. consumers;

MEXQ = The quantity of Mexican produced frozen vegetables demanded by U.S. consumers;

RLINC = Real U.S. per capita disposable income;

FRZPI = Real U.S. consumer price index of all frozen vegetables;

[6] USALL and MEXALL are defined as "real" price indexes even though in calculating them the fact that they are ratios cancels out any deflating effects. This is done to maintain consistency between the first and second-stage equations.

FSHPI = Real U.S. consumer price index of all fresh vegetables;

USALL = A ratio of the real price index of U.S. frozen vegetables to FRZPI;

MEXALL = A ratio of the real price index of Mexican frozen vegetables to FRZPI;

e = The residual error term associated with the total (t), United States (us) and Mexican (mex) demands for frozen vegetables.

In the model just presented the notion of a single elasticity of substitution equated with equations 2a and 2b will not be imposed. This is done for three reasons: 1.) this analysis is only concerned with two countries and the quantity of frozen vegetables they are supplying; 2.) enough data is available to separately estimate demand relationships; and 3.) there is no a priori reason to believe that the substitution relationships will be symmetric.

Description of Data

Data used in this analysis were obtained from a variety of sources, and in all cases the data were reported on an annual basis for the years 1968 through 1988. The variable ALLQ, the quantity of all frozen vegetables demanded by U.S. consumers, is composed of USQ and data on total U.S. imports of frozen vegetables obtained from the

Bureau of the Census, U.S. Department of Commerce (1970-90)[7]. Data for USQ, the quantity of U.S. produced frozen vegetables, were obtained from U.S. frozen vegetable annual pack data published by USDA (1990). Data for MEXQ, the quantity of Mexican produced frozen vegetables, also come from the Bureau of the Census import data.

Real U.S. per capita disposable income, RLINC, was derived by taking U.S. disposable income figures from an Economic Research Service publication (Putnam, 1990), and dividing these figures by U.S. population data from the same publication. The results were then deflated by dividing them by a U.S. consumer price index (CPI) reported by the U.S. Department of Labor (1969-89). FRZPI, the real U.S. CPI of frozen vegetables, and FSHPI, the real U.S. CPI of fresh vegetables, were both obtained from the same U.S. Department of Labor publication.

Although average price information on Mexican frozen vegetables can be obtained from the U.S. Bureau of the Census import data, the same information for U.S. produced frozen vegetables is unavailable. This is presumably due to a confidentiality problem with U.S. processors, but whatever the reason, the only data available are quantity of production data. Because of this lack of price data I have had to substitute price indexes for actual price data.

USALL and MEXALL are both figures composed of a real price index of the respective frozen vegetable (U.S. or Mexican) divided by FRZPI. As was mentioned earlier, FRZPI is a data series reported by the U.S. Department of Labor,

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[7] All frozen vegetable quantity information is reported in thousands of pounds.

but since the price index for frozen vegetables is not broken down by country, these other two price indexes had to be calculated. A description of the method used in calculating the real price indexes of frozen vegetables produced in the United States and Mexico can be found in Appendix A, and a complete list of the data series which are represented by the variables just described can be found in Appendix B.

In this chapter I have outlined a model which will enable me to use a two-stage budgeting process to estimate the U.S. demand for frozen vegetables. The first-stage will be used to determine total U.S. demand for frozen vegetables while the second-stage estimates the U.S. demand for frozen vegetables by country of origin, in this case the United States and Mexico. Although this model is based on Armington's model of import demand which assumes that buyers differentiate commodities by kind and origin using a two-stage budgeting process, it does differ in a few respects.

In the next chapter I will present the results of estimating this model and address the question of how changes in the relative prices of frozen vegetables produced in Mexico affect market shares of frozen vegetables produced in the United States.

V. MODEL RESULTS

Estimation of First-Stage Demand Function

The results of estimating the U.S. demand for all frozen vegetables (ALLQ) using ordinary least squares (OLS) regression are listed in table 5.1[8]. Included in this table are the names of the variables, their estimated coefficients, the value of the standard errors of each coefficient, its calculated t-statistic, and its elasticity at the mean. The significance of each estimated coefficient is listed as a letter beside the estimated coefficient[9]. Reported below the table are the coefficient of determination (R-squared), the adjusted R-squared, the calculated f-statistic, and the Durbin-Watson (D-W) statistic.

The three independent variables: real U.S. per capita disposable income; real U.S. consumer price index of all frozen vegetables; and real U.S. consumer price index of all fresh vegetables all exhibit the expected signs. The R-squared for the entire equation also indicates that these three variables explain 83 percent of the variation in the annual volume of frozen vegetables demanded by U.S.

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[8] The model was estimated using the computer program SHAZAM, version 5.13.

[9] The t-values listed in this and subsequent tables are calculated t-values for a two-sided test of the regression coefficients; a indicates significance at the 99% level (t_c=2.921) and b indicates significance at the 95% level (t_c=2.120).

consumers. The f-statistic indicated that the equation is statistically significant at the 99 percent level of confidence (F_c=4.72). When one looks at the statistical significance of the coefficients for each independent variable, the only significant coefficient is RLINC. The rest of the estimated coefficients are not statistically different from zero at the 95 percent level of confidence.

Table 5.1

First-Stage Total U.S. Frozen Vegetable Demand

Variable Name	Estimated Coefficient	Standard Error	T-Stat	Elasticity at Mean
RLINC	4.8850a	0.5375	9.032	2.5064
FRZPI	(1.2463)	0.9003	(1.384)	(0.6501)
FSHPI	0.1151	0.5723	0.201	0.0594
Constant	(18113)	9393.2	(1.928)	

Sample Period 1968-1988
F Stat From Mean = 27.946
R-squared = .8314
Adjusted R-squared = .8017
Durbin-Watson Stat = 1.662

An attempt was made to include a trend variable in the model which would account for the increase in the use of microwave ovens by U.S. households. It was included to test the assumption that increases in the number of households with microwave ovens have a positive effect on the consumption of frozen vegetables. But after estimating the first-stage demand equation the coefficient was determined to be statistically insignificant and was not retained in the equation.

Under the assumption of the classical linear regression model the error terms (disturbances) have uniform variance and are not correlated with one another. When successive error terms follow each other in either a positive or negative pattern a condition known as autocorrelation may exist. The consequence of autocorrelation is a loss in efficiency, in that the estimated coefficients no longer exhibit minimum variance (Johnson, et al., 1987).

The D-W statistic is one method that can be used to detect the presence of positive or negative autocorrelation. The range of this statistic is from zero to four, with a value close to zero but less than two indicating positive autocorrelation and a value near four but greater than two indicating negative autocorrelation. A D-W statistic approaching two indicates a low probability of autocorrelation.

The calculated D-W statistic for the equation which estimates the first-stage total U.S. frozen vegetable demand is reported as 1.662. This value indicates that negative autocorrelation is not present while testing inconclusive for positive autocorrelation at the 95 percent level of confidence[10].

The insignificance of the estimated coefficients may indicate a lack of economic significance which could be attributed to the existence of multicollinearity. The

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[10] For this particular D-W test d_L=0.73 and d_u=1.83. The calculated value of 1.662, although falling in the inconclusive region, is towards the upper end, close to the region where the null hypothesis of no autocorrelation is not rejected.

problem of sample multicollinearity usually exists when two or more independent variables are highly correlated, and its presence can make it difficult to interpret the separate effects of the independent variables accurately.

Another possible problem may be misspecification. Although this would not lead to insignificant coefficients, other explanatory variables may exist which help explain U.S. demand for frozen vegetables but have not been identified and included in the equation. Factors which are hard to quantify, such as changes in consumer tastes and preferences, are missing from the demand function and may also be relevant. A third possibility is that consumer level demand is not sensitive to marginal changes in price.

Although the estimated coefficient on the frozen vegetable price variable, real U.S. consumer price index of all frozen vegetables, tests to be insignificant at any level greater than 70 percent, its reported elasticity at the mean is a point estimate of the own-price elasticity for frozen vegetables. The Ep value of -0.65 possesses the expected sign and is inelastic, which is consistent with that found for most agricultural products (Tomek and Robinson, 1981). This value suggests that a one percent increase in the price of frozen vegetables would result in a 0.65 percent decrease in the quantity demanded, ceteris paribus.

Estimation of Second-Stage Demand Functions

The results of estimating the second-stage demand functions can be found in tables 5.2 and 5.3. Listed in the first table are the results of estimating the U.S. demand for frozen vegetables produced in the United States, while the second table contains results of estimating the U.S. demand for frozen vegetables produced in Mexico. The method used in estimating the equations involved estimating them both as a set, instead of separately. This was done to avoid the problem of contemporaneous correlation, which is present when demands are correlated through their error terms. This can lead to inefficient OLS estimates (Babula, 1987). When one believes contemporaneous correlation may exist it is more appropriate to use a Generalized Least Squares estimation process in place of OLS. One option is to use the Seemingly Unrelated Regression (SUR) technique. This method jointly estimates sets of equations in an attempt to rid the function of correlation in the error terms across equations so that the estimates of the coefficients are more efficient.

The second-stage demand functions were first estimated in log-linear form using OLS and then SUR. In comparing the results of the two estimation techniques it was found that the estimated coefficients differed, indicating the presence of contemporaneous correlation. Using SUR provided estimates which had the expected signs and were statistically significant, but testing for autocorrelation using the D-W test indicated the presence of positive autocorrelation in both equations. To correct for this both equations were re-estimated in logarithmic form using a non-linear estimation technique which allows for the estimation of a system of linear equations while correcting for autocorrelation (White, et al., 1990).

Turning to table 5.2 and the U.S. demand for frozen vegetables produced in the United States, the two explanatory variables, the U.S. demand for all frozen vegetables and the ratio of the real price index of U.S. frozen vegetables to the real U.S. CPI of all frozen vegetables, both exhibit the expected signs and are statistically significant at the 99 percent confidence level (as indicated by a two-sided t-test of the regression coefficients explained in footnote nine). The R-squared for the entire equation also indicates that these two variables explain 99 percent of the change in demand for U.S. produced frozen vegetables by U.S. consumers.

Table 5.2

Second-Stage U.S. Derived Demand for Frozen Vegetables Produced in the United States

Variable Name	Estimated Coefficient	Standard Error	T-Statistic
ALLQ	1.0147a	0.0114	89.2650
USALL	(1.3445)a	0.2436	(5.5199)
Constant	12.681	4.6403	2.7328

Sample Period 1968-88 R-squared = .9993
Durbin-Watson Stat = 1.980

But the presence of an unusually high R-squared and t-statistic for the variable ALLQ, the quantity of frozen vegetables demanded by the U.S. consumers, may be a function of the composition of that same variable. The explanatory variable ALLQ is partially composed of the dependent variable USQ, and the fact that during many periods the percentage of ALLQ accounted for by USQ is very high may help explain these figures[11] .

The calculated value of the D-W statistic for this particular equation is reported as 1.980. When compared to the critical values of the D-W table it can be determined that neither positive nor negative autocorrelation exists at the 95 percent level of significance[12].

Table 5.3 presents the results of estimating the U.S. demand for frozen vegetables produced in Mexico. The two explanatory variables in this equation are the demand for all frozen vegetables and a ratio of the real price index for Mexican frozen vegetables to the deflated U.S. CPI of all frozen vegetables. Both estimated coefficients exhibit the expected signs and are statistically significant (please see footnote nine). The R-squared statistic for the equation indicates that the two explanatory variables

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[11] Inclusion of the variable ALLQ was suggested by the Armington model. The high proportion of ALLQ accounted for by USQ calls into question the validity of the Gauss-Markov assumption that the explanatory variables are uncorrelated with one another.

[12] For this particular test d_L=0.92 and d_u=1.54 at a 95 percent level of significance. The calculated value of 1.98 falls in the region where the null hypothesis of no autocorrelation is not rejected.

account for 95 percent of the change in demand for Mexican produced frozen vegetables by U.S. consumers.

Table 5.3

Second-Stage U.S. Derived Demand for Frozen Vegetables Produced in Mexico			
Variable Name	Estimated Coefficient	Standard Error	T-Statistic
ALLQ	0.1890a	0.3480	9.8565
MEXALL	(0.6373)b	0.2976	(2.1411)
Constant	(0.4089)	89.5110	(0.0046)

Sample Period 1968-88 R-squared = .9499
Durbin-Watson Stat = 2.317

For this equation the calculated D-W statistic is reported as 2.317. Comparing this value to the critical values of the D-W table indicates that neither positive nor negative autocorrelation exists at the 95 percent level of significance[13].

Estimated Relative Price Elasticities

Although Armington's model provides for calculating own and cross-price elasticities, the equations used to do

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[13] For this particular test d_L=3.08 and d_u=2.46 at the 95 percent level of significance. The calculated value of 2.32 falls in the region where the null hypothesis of no autocorrelation is not rejected.

this require the researcher to assume values for the elasticity of substitution and the overall elasticity of demand. To avoid making these additional assumptions I have elected to interpret the elasticities calculated during estimation of the second-stage demand equations.

As mentioned in the previous section, the second-stage demand equations are specified in log-linear form. A benefit of estimating demand equations in this form is that the estimated coefficient is also the elasticity estimate for the particular variable in question. In this case one can interpret the estimated coefficients for the variables USALL and MEXALL as own relative price elasticities of demand for frozen vegetables produced in the United States and Mexico respectively. But one must be careful in interpreting these elasticities because USALL and MEXALL are composite variables. An interpretation of either one of these relative own-price elasticities can be thought of as a change in the quantity demanded of frozen vegetables (produced in either the United States or Mexico) with respect to its price, relative to the other prices. But a one percent increase in the price of MEXQ will not result in a 0.6373 decrease in the quantity demanded of the same commodity. The effects of a price change must be analyzed with respect to all other prices.

To understand these elasticities one must look at the different variables which make up these equations. As an example one could look at USALL. This variable is the ratio of the price index of U.S. produced frozen vegetables

(PI_{us}) to the CPI of all frozen vegetables consumed in the United States (FRZPI)[14]. Mathematically this looks like:

$$USALL = \frac{PIus}{FRZPI}$$

But one must look at the composition of FRZPI to really understand what this elasticity means. The variable FRZPI is composed of the volume based share figure multiplied by the price index for that particular source of frozen vegetables. This value is then added to other values calculated in an identical manner distinguished by source of frozen vegetables (Mexico and the rest of the world). In mathematical form this equation can be represented by:

$$FRZPI = ((USQ/ALLQ)*PI_{us}) + ((MEXQ/ALLQ)*PI_{mex}) + ((ROWQ/ALLQ)*PI_{row})$$

To fully understand these elasticities a base year may be chosen and the values of USALL and MEXALL obtained. In a particular year such as 1988, the equations representing the variables USALL and MEXALL look like this[15]:

$$USALL = \frac{116.8}{(.86*116.8) + (.09*76.5) + (.05*102.9)} = 1.038$$

$$MEXALL = \frac{76.5}{(.86*116.8) + (.09*76.5) + (.05*102.9)} = 0.680$$

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[14] For MEXALL simply substitute PI_{us} with PI_{mex}, the price index of Mexican produced frozen vegetables.

[15] Individual quantity and price index variables can be found in Appendix B.

Once a base year value has been calculated any percentage change in a price index can be applied to the equations and new values for USALL and MEXALL are calculated. The percentage difference between the base year value and the new value can then be used along with the elasticity value to measure the percentage change in quantity demanded of the variable in question. Doing this one can look at both the own and cross-price effects of a change in price index. This is possible because a change in the price index of one particular frozen vegetable also affects the value of the other ratio and thus the relative price of the other frozen vegetable[16].

Using these estimated elasticities it can be shown that a change in the relative price of Mexican frozen vegetables entering the U.S. market does have an effect on the quantity demanded of the same vegetables produced in the United States. It can also be seen by the values of the coefficients on MEXALL and USALL that they are not perfect substitutes. If that were the case any increase in the relative price of one variable would result in complete switching to the other variable. This would imply infinite cross-price elasticities, but as can be seen the two relative price elasticities are not large numbers. In the next section it will be assumed that relative price changes do occur and it will be shown that complete switching to the other source does not take place. One would also expect price changes to affect FRZPI, but due to the

[16] Examples presented in the next section should further clarify this relationship.

insignificant coefficient on FRZPI I will not consider first-stage changes in demand.

Relative Price Elasticities and Market Shares

By looking at the relative price elasticities, and the equations which represent the variables corresponding to these elasticities, a few preliminary assessments can be made. First, given the sign on the elasticities any increase (decrease) in the relative price of frozen vegetables produced in either country will result in a decrease (increase) in the quantity demanded of the same commodity. This same increase (decrease) in, say USALL, will also affect the quantity demanded of MEXQ. Looking at the equations it can be seen that this increase (decrease) will result in the entire ratio composing MEXALL to decrease (increase) causing an increase (decrease) in the quantity demanded of MEXQ. To determine whether a change in the price index will result in a larger or smaller relative change in the quantity demanded one has to determine whether the relative price elasticity is elastic or inelastic. The implied price elasticity is higher for Mexico than for the United States, as would be expected theoretically (see Table 5.6). But looking at tables 5.2 and 5.3 the relative price elasticity of USALL can be seen to be elastic while that for MEXALL is inelastic. In chapter III it was shown that for a commodity with elastic demand a change in its price will result in a proportionately greater change in its quantity demanded, and a product with inelastic demand will experience the opposite effect. As an example, a given percentage change in MEXALL will result in a smaller percentage change in MEXQ.

Using the above information, relative price changes caused by selected policy and economic developments can now be analyzed to see how they affect the market shares of frozen vegetables produced both in the United States and Mexico[17]. To facilitate the analysis of these developments and their effects, one case of a price change will be presented in detail, including calculations. The effects of other assumed price changes are then presented in table form, with an accompanying discussion.

Recent discussions between the United States and Mexico point to the fact that a North American FTA between these two countries and Canada is a very likely occurrence. If this agreement is signed there exists the possibility that tariffs currently imposed by the United States on Mexican frozen vegetables could be reduced or eliminated. Assuming this were to result in a 17.5 percent (the current U.S. tariff on imported frozen vegetables) decrease in PI_{mex} we can now ask: how would it affect the quantity demanded of both U.S. and Mexican frozen vegetables[18]? Using 1988

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[17] In interpreting the relative price elasticities it will be assumed that in the short run changes in one price index will not directly cause a change in the other price index and the base year will be 1988. It will also be assumed throughout this analysis that the quantity demanded of frozen vegetables from the rest of the world will remain constant.

[18] A 17.5 percent decrease is the limiting case, not the expected case, as it implies a vertical demand curve which is inconsistent with the negative slope found empirically.

actual values as the base, calculating the new values for USALL and MEXALL would result in the following equations:

$$USALL = \frac{116.8}{(.86*116.8) + (.09*63.1) + (.05*102.9)} = 1.049$$

$$MEXALL = \frac{63.1}{(.86*116.8) + (.09*63.1) + (.05*102.9)} = 0.567$$

This represents a 1.1 percent increase in USALL from the base year and a 16.6 percent decrease in MEXALL. So a 17.5 percent decrease in the price index of frozen vegetables produced in Mexico is projected to result in a 16.6 percent decrease in the relative price. Combining this with the relative own-price elasticity value of -.6373 we see that this increases the quantity demanded of Mexican frozen vegetables by 10.6 percent. This same 17.5 percent decrease in the price index of frozen vegetables produced in Mexico is also expected to result in a 1.1 percent increase in the relative price of U.S. produced frozen vegetables and decrease the quantity demanded of the same vegetables by 1.5 percent. Stated in another way, this would be expected to result in 1 percent increase in market share for frozen vegetables produced in Mexico and a 1 percent decrease in market share for the same vegetables produced in the United States.

A recent increase in the U.S. minimum wage rate combined with the water availability problems part of the nation is experiencing, in particular California, may result in an increase in the price of U.S. frozen vegetables. If this were to result in a 5 percent increase in the price of U.S. produced frozen vegetables how would it affect the quantity demanded of frozen vegetables produced in both the United States and Mexico?

Table 5.4 Results of Proposed Scenarios

Proposed Change	Relative Price of USQ	Quantity of USQ	Relative Price of MEXQ	Quantity of MEXQ
5% increase in PIus from a min. wage increase	0.58 % increase	0.78% decrease	4.26% decrease	2.71% increase
5% decrease in PImex from tech. transfer	0.39% increase	0.52% decrease	4.85% decrease	3.09% increase
5% increase in PImex from a min. wage increase	0.29% decrease	0.39% increase	4.70% increase	2.99% decrease
10% decrease in PIus in response to 17.5% PImex decrease	0.10% increase	0.13% decrease	8.38% decrease	5.34% increase

As can be seen in table 5.4, this price increase results in a 0.58 percent increase in the relative price of U.S. produced frozen vegetables. Using the own relative price elasticity of U.S. produced frozen vegetables we see that this percentage increase in price is projected to result in a 0.78 percent decrease in the quantity demanded of the same commodity. This price increase will also have an effect on the price of Mexican frozen vegetables and thus the quantity demanded. A 5 percent increase in PI_{us} will result in a 4.26 percent decrease in the relative price of Mexican frozen vegetables and a 2.71 percent increase in the quantity demanded of these same vegetables. According to the model this will result in a 0.3 percent increase in the market share of frozen vegetables produced in Mexican and a 0.3 percent decrease in the share of U.S. frozen vegetables (see Table 5.5).

Table 5.5 Market Share Changes

Proposed Change	Change in U.S. Frozen Vegetable Market Share	Change in Mexican Frozen Vegetable Market Share
5% increase in PIus from a min. wage increase	0.3% decrease	0.3% increase
5% decrease in PImex from tech. transfer	0.3% decrease	0.3% increase
5% increase in PImex from a min. wage increase	0.25% increase	0.25% decrease
10% decrease in PIus in response to 17.5% PImex decrease	0.4% decrease	0.4% increase

Another possible scenario would be a decrease in the price of Mexican produced frozen vegetables as a result of new technology from the United States, enabling Mexican processors to reduce production costs. Assuming a 5 percent reduction in price, one can look at table 5.4 to see the effects it would be expected to have on the relative prices and quantities demanded of frozen vegetables produced in Mexico and the United States.

This price decrease is expected to result in a 4.85 percent decrease in the relative price of Mexican frozen vegetables and a 0.39 percent increase in the relative price of the same frozen vegetables produced in the United States. Applying the own relative price elasticities of U.S. and Mexican produced frozen vegetables we see that this percentage decrease in price is projected to result in a 0.52 percent decrease in the quantity demanded of U.S. frozen vegetables and a 3.09 percent increase in the demand for frozen vegetables from Mexico. Looking at the market shares of each commodity, this price decrease will result in a 0.3 percent increase in the market share of frozen vegetables produced in Mexican and a 0.3 percent decrease in the market share of U.S. frozen vegetables.

One other possible development would be an increase in the minimum wage rate in Mexico which results in an increase in the processing costs for Mexican processors. If processors were to pass this on as a 5 percent increase in the price of Mexican produced frozen vegetables, how would it affect the quantity demanded of frozen vegetables produced in both the United States and Mexico?

Looking back at table 5.4 we see that this price increase results in a 4.70 percent increase in the relative price of Mexican produced frozen vegetables. Using the own relative price elasticity of Mexican produced frozen vegetables we see that this percentage increase in price is projected to result in a 2.99 percent decrease in the quantity demanded of the same commodity. This price increase will also be expected to have an effect on the price of U.S. frozen vegetables and thus the quantity demanded. A 5 percent increase in PI_{mex} will result in a 0.29 percent decrease in the relative price of U.S. frozen vegetables and would be expected to induce a 0.39 percent increase in the quantity demanded of these same vegetables. According to the model this will result in a 0.25 percent decrease in the market share of frozen vegetables produced in Mexico and a 0.25 percent increase in the share of U.S. frozen vegetables.

In an attempt to achieve a more realistic scenario one can relax the assumption which states that in the short-run a price change in one variable will not directly effect the price of another. Assuming once again that a North American FTA is signed, resulting in a 17.5 percent decrease in the price of Mexican frozen vegetables, one can assume the price of U.S. frozen vegetables will also decrease. If this decrease in U.S. price were to equal 10 percent what would be the resulting outcome?

It was determined in the first scenario that a 17.5 percent decrease in the price of Mexican frozen vegetables is projected to result in a 10.6 percent increase in their demand, while at the same time reducing the quantity demanded of U.S. frozen vegetables by 1.5 percent. Looking back at table 5.4 one can see that a 17.5 percent decrease in the price of Mexican frozen vegetables coupled with a 10 percent decrease in the price of U.S. frozen vegetables is projected to result in a 0.10 percent increase in the relative price of U.S. produced frozen vegetables and an 8.38 percent decrease in the relative price of Mexican produced frozen vegetables. This translates into a 0.13 percent decrease in the quantity demanded of U.S. frozen vegetables and a 5.34 percent increase in the demand for Mexican frozen vegetables. Again, according to the model results this will result in a 0.4 percent increase in the market share of frozen vegetables produced in Mexico and a 0.4 percent decrease in the market share of U.S. frozen vegetables.

As demonstrated in the preceding scenarios, price changes in frozen vegetables produced in either Mexico or the United States are expected to not only have an effect on the relative price and quantity demanded of frozen vegetables from one country, but also on the relative price and quantity demanded of frozen vegetables from the other country. In all cases the effect was greater on Mexican frozen vegetables. This can be attributed to the fact that Mexican frozen vegetables make up a relatively small proportion of all frozen vegetables consumed in the United States.

Given that the relative price elasticity is constant but market shares can change over time, the price elasticities will change with changes in market shares. Using results from table 5.4, which are based on 1988 shares, the following implied price elasticities can be calculated.

Table 5.6 Implied Price Elasticities

	Own Price	Cross Price
United States	0.78/5 = (0.16)	0.39/5 = 0.08
Mexico	3.09/5 = (0.62)	2.71/5 = 0.54

As can be seen, all are inelastic when calculated from 1988 shares. Imports from Mexico are much more sensitive to price changes than is demand for domestically produced frozen vegetables.

The next chapter summarizes the thesis along with providing conclusions and recommendations for further research.

VI. SUMMARY AND CONCLUSIONS

Summary

As mentioned in the first chapter, U.S. imports of frozen vegetables from Mexico have grown considerably over the past decade. Numerous studies have attempted to explain this occurrence. Some of the reported findings point to the fact that imports have increased as a result of liberalized trade policy between the United States and Mexico, while others point to such things as new technology and market access for Mexican processors through U.S. multinationals. Still others attribute this increase in imports to changing U.S. consumer attitudes and demographics. While each of these studies has attempted to trace this growth in imports of Mexican frozen vegetables to certain factors, none of them has attempted to explain how it affects U.S. produced frozen vegetables, in particular how changes in the relative price of frozen vegetables from Mexico affect market shares of U.S. produced frozen vegetables.

To accomplish this task a model was derived which enabled me to first estimate the overall U.S. demand relationship for frozen vegetables and then derive the U.S. demand for frozen vegetables by country of origin (U.S. and Mexico). With these demand relationships and the subsequent relative price elasticities I was able to investigate how changes in the relative price of frozen vegetables from one country affect the demand for the same frozen vegetables and the relative price and demand for frozen vegetables from the other country.

Plausible relative price changes in either U.S. or Mexican frozen vegetables as the result of different economic or political developments were then analyzed to assess the market effects predicted using the estimated parameters. These included such things as reductions in U.S. tariff rates brought about by further trade liberalization, changes in the minimum wage rate in both countries, and increased technology transfer from the United States to Mexico.

Conclusions

The overall objective of this research was to gain a better understanding of the market relationships between U.S. and Mexican frozen vegetables. Considering the above mentioned economic and political developments in view of the estimated demand relationships, the model projected that relative price changes in frozen vegetables from, say Mexico, not only affected the quantity demanded by U.S. consumers of Mexican frozen vegetables, but it also affected the relative price and quantity demanded of U.S. produced frozen vegetables by U.S. consumers. To determine the extent of the effect of a price change on the quantity demanded of the same frozen vegetable I used the relative price elasticity estimated by the model. Demand for frozen vegetables produced in Mexico was estimated to be relative price inelastic at -0.6373, while demand for frozen vegetables produced in the United States was relative price elastic with a value of -1.3445.

Looking back at table 5.4 it can be seen that price changes in either U.S. or Mexican frozen vegetables tend to have a greater effect on the quantity demanded of frozen vegetables produced in Mexico. This can be attributed to the fact that in the base year, 1988, Mexico's share of the U.S. frozen vegetable market was relatively small, 9 percent, in comparison to the United States at 86 percent.

Concerning relative price changes and their effect on market shares; a policy development such as a free-trade agreement, which lowers the price of Mexican frozen vegetables, would increase Mexico's market share by 1 percent and decrease the United States' market share by the same percentage in the U.S. frozen vegetable market. But when one looks at the quantity of frozen vegetables that would make up these market share changes (U.S.= 32 million lbs.; Mexico = 22 million lbs.) one discovers that they are relatively small compared to the total volume of frozen vegetables in the market (2.5 billion lbs.).

Constraints also exist on Mexico's ability to increase the supply of frozen vegetables to the U.S. market. Quality land and water supplies are limited, and when either becomes available there is almost always demand to use such resources to produce food for Mexico's internal consumption. Investment capital is also scarce caused by high interest rates. This continually presents a problem to producers who wish to increase the size of their operation (USITC, 1988).

Again looking at the effects of a free-trade agreement, even though U.S. processors may experience a decrease in the quantity demanded of their products, and Mexican processors experience an increase in the quantity demanded of their products, the overall effects would be relatively small.

Research Recommendations

Further research may be of interest with the objective of disaggregating frozen vegetables and the specific regions within the United States where they are grown. As can be seen in Appendix B, Table 2, the growth in imports of certain frozen vegetables has been faster than others. Estimation of import demand equations for specific frozen vegetables would enable growers and processors to more accurately understand how political and economic developments would affect them. Although I attempted to do this and was unable due to data constraints, a researcher who was willing to wait a few years would have access to the necessary information. Disaggregated information on U.S. imports of frozen vegetables begins in 1978.

The ability to identify import demand for either aggregated or disaggregated frozen vegetables with specific regions within the United States would also be very useful. The concentration of and manner in which processors operate across the United States varies by region. Estimating a demand equation for a specific region such as Oregon could prove to be useful to Oregon processors, providing them with information on how something such as a free-trade agreement with Mexico would affect them. Again, this was something I had attempted to build into my model but was unable to do. There exists the possibility that the necessary information exists, but given time constraints I was unable to acquire such region specific data.

One other area of research which would help U.S. processors to assess their impact on the Mexican processing industry would be research focused on the transfer of technology. Many studies point to the transfer of technology as a key factor in enabling the Mexican frozen vegetable industry to arrive at a point where it is competitive with the U.S. industry. A study focusing on how the transfer of technology from U.S. processors to their Mexican counterparts has affected the industries growth, and possibly continues to influence its growth, may be of interest to processors in the United States.

Political and economic relations between the United States and Mexico continue to grow stronger, with many questions remaining as to how this will affect individual industries in both countries. Hopefully this research begins to answer a few of these questions by providing some of the necessary tools for analyzing the frozen vegetable industry.

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APPENDICES

Appendix A - Calculation of Implicit Price Indexes

Price index numbers were calculated for frozen vegetables by place of origin using the years 1982-1984=100 as the base year average. Price indexes for Mexico, the rest of the world and all imports were calculated using a unit price obtained from dividing their respective total values by total quantities found in tables 2-7.

The formula employed to calculate the price index for each source is:

PI in Year i = (unit price of item in year i)/ (base year unit price) * 100

i = 1968-1988

The base year unit price is a weighted average price for the years 1982-84, and was arrived at using the following formula:

Weighted Average Price, 1982-84 =
[(P82*Q82)/(TQ82-84)] + [(P83*Q83)/(TQ82-84)] +
[(P84*Q84)/(TQ82-84)]

where:

P82 = Price in 1982
Q82 = Quantity in 1982
TQ82-84 = Total Quantity for the Years 1982-1984

The price index for frozen vegetables produced and consumed in the United States was obtained by separating the price index for frozen vegetables from all sources into two parts; U.S. frozen vegetables and all imported frozen vegetables.

FRZPI in Year i = [(IMQi/ALLQi) * FRZIMPIi] +
[(USQi/ALLQi) * FRZUSPIi]

where:

i = 1968- 1988

IMQ = Total Quantity of Imported Frozen Vegetables

USQ = Total Quantity of U.S. Frozen Vegetables

ALLQ = IMQ + USQ

FRZIMPI = Price Index of Imported Frozen Vegetables

FRZUSPI = Price Index of U.S. Frozen Vegetables

FRZPI = Price Index of All Frozen Vegetables

Rearranging the above equation we get:

FRZUSPI = [FRZPI - ((IMQ/ALLQ)*FRZIMPI)] /
[(USQ)/(ALLQ)]

Appendix B - Economic Data

Table 1 - U.S. Annual Pack of Select Frozen Vegetables (x1000 lbs.), 1968-88

Year	Snap beans	Broccoli	Carrots	Cauli-flower	Sweet corn	Green peas	Onions	Total
1968	210,500	173,000	162,300	67,600	334,500	429,300	--	1,377,200
1969	185,000	153,800	150,900	69,700	289,300	367,300	--	1,216,200
1970	201,092	185,157	173,054	59,782	296,986	344,520	52,205	1,312,796
1971	209,563	189,600	143,681	67,659	333,728	348,418	75,882	1,368,531
1972	241,084	234,344	165,879	94,070	406,840	340,075	110,672	1,592,964
1973	268,252	213,165	213,688	96,098	461,053	387,749	114,679	1,754,684
1974	238,242	245,285	248,081	93,754	450,554	416,682	111,228	1,803,826
1975	210,139	191,638	165,869	76,056	471,448	400,587	121,101	1,636,838
1976	181,420	201,513	181,277	67,807	469,973	340,366	148,963	1,591,319
1977	230,477	314,395	263,769	96,670	525,956	333,954	152,718	1,917,939
1978	263,680	276,519	238,415	127,513	610,234	357,717	154,080	2,028,158
1979	264,315	298,618	263,080	101,130	580,070	427,461	167,239	2,101,913
1980	236,453	290,657	191,151	84,766	529,098	315,577	156,081	1,803,783
1981	247,886	306,755	269,845	105,161	619,372	333,888	159,874	2,042,781
1982	281,426	335,516	296,679	111,644	834,343	404,830	182,344	2,446,782
1983	248,911	285,358	212,500	100,541	661,219	354,480	139,637	2,002,646
1984	248,255	365,764	255,585	102,106	673,643	423,740	156,482	2,225,575
1985	271,927	356,806	254,586	94,617	783,623	485,985	142,088	2,389,552
1986	293,973	324,519	270,363	89,120	756,845	373,605	185,458	2,293,883
1987	230,703	312,460	294,596	77,758	840,017	400,231	188,021	2,343,786
1988	215,790	289,446	294,673	78,762	769,208	358,779	157,212	2,163,870

Source: Vegetable and Specialties Situation and Outlook Yearbook, ERS, USDA, 1990
-- not available

Table 2 - U.S. Total Imports of Frozen Vegetables, Quantity (lbs), 1968-88

Year	Asparagus	Broccoli	Brussel Sprouts	Cauli-flower	Okra
1968	--	--	--	--	--
1969	--	--	--	--	--
1970	--	--	--	--	--
1971	--	--	--	--	--
1972	--	--	--	--	--
1973	--	--	--	--	--
1974	--	--	--	--	--
1975	--	--	--	--	--
1976	--	--	--	--	--
1977	--	--	--	--	--
1978	515,876	15,461,754	3,728,453	14,169,919	14,963,514
1979	866,343	15,450,991	2,633,730	10,009,808	10,748,978
1980	1,302,513	23,898,446	2,391,664	9,720,377	11,598,232
1981	418,961	27,822,940	3,982,366	13,573,703	14,557,742
1982	396,635	31,870,425	3,773,708	20,570,025	24,175,388
1983	1,216,910	33,550,808	5,729,805	21,085,376	22,308,673
1984	529,412	65,404,438	8,067,324	30,834,702	18,237,042
1985	563,922	77,147,296	7,913,409	36,823,083	19,423,399
1986	999,025	117,149,539	4,502,003	37,843,231	14,759,585
1987	220,065	194,817,518	8,161,781	58,513,383	18,332,108
1988	476,424	178,152,408	5,805,117	50,250,236	11,146,782

Source: Bureau of the Census, U.S. Department of Commerce, U.S. Imports for Consumption and General Imports: TSUSA Commodity by Country of Origin, 1970-90.
-- not available

...Continued

Table 2 - continued

Year	Green peas	Broc, Caul-flwr & Okra	Other	Total
1968	177,547	--	11,000,681	11,178,228
1969	282,270	--	18,643,660	18,925,930
1970	223,428	--	19,767,365	19,990,793
1971	196,075	--	23,013,940	23,210,015
1972	262,189	--	31,592,172	31,854,361
1973	1,094,741	--	31,998,430	33,093,171
1974	829,848	--	41,182,559	42,012,407
1975	933,983	--	33,765,041	34,699,024
1976	574,820	27,880,652	15,685,274	44,140,746
1977	4,999,347	33,418,887	21,481,912	59,900,146
1978	9,518,806	--	27,027,233	85,385,555
1979	8,811,568	--	25,246,177	73,767,595
1980	8,711,600	--	15,108,213	72,731,045
1981	9,930,713	--	13,562,133	83,848,558
1982	17,397,612	--	10,395,072	108,578,865
1983	17,205,970	--	11,417,218	112,514,760
1984	24,341,534	--	20,646,158	168,060,610
1985	18,275,785	--	31,157,044	191,303,938
1986	19,382,920	--	32,665,133	227,301,436
1987	26,160,006	--	36,949,268	343,154,129
1988	40,858,383	--	49,284,932	335,984,282

Source: Bureau of the Census, U.S. Department of Commerce
-- not available

Table 3 - U.S. Total Imports of Frozen Vegetables, FOB Value (US$), 1968-88

Year	Asparagus	Broccoli	Brussel Sprouts	Cauliflower	Okra
1968	--	--	--	--	--
1969	--	--	--	--	--
1970	--	--	--	--	--
1971	--	--	--	--	--
1972	--	--	--	--	--
1973	--	--	--	--	--
1974	--	--	--	--	--
1975	--	--	--	--	--
1976	--	--	--	--	--
1977	--	--	--	--	--
1978	229,000	3,201,000	945,000	3,364,000	3,571,000
1979	417,000	3,475,000	726,000	2,571,000	2,787,000
1980	578,000	6,912,000	787,000	2,967,000	3,320,000
1981	257,000	9,334,000	1,573,000	4,639,000	4,702,000
1982	244,000	9,670,000	1,536,000	7,089,000	7,761,000
1983	625,000	10,964,000	2,097,000	6,973,000	6,944,000
1984	234,000	21,288,000	2,750,000	10,288,000	4,457,000
1985	381,000	25,666,000	2,508,000	11,518,000	5,275,000
1986	430,000	34,495,000	1,257,000	10,753,000	4,093,000
1987	189,000	49,701,000	2,593,000	15,039,000	4,877,000
1988	189,000	47,993,000	1,693,000	14,057,000	2,966,000

Source: Bureau of the Census, U.S. Department of Commerce, U.S. Imports for Consumption and General Imports: TSUSA Commodity by Country of Origin, 1970-90.

-- not available

...Continued

Table 3 - continued

Year	Green peas	Broc, Caul-flwr & Okra	Other	Total
1968	59,808	--	936,622	996,430
1969	95,714	--	1,617,273	1,712,987
1970	80,096	--	2,567,352	2,647,448
1971	66,372	--	3,280,254	3,346,626
1972	85,414	--	4,692,649	4,778,063
1973	315,942	--	4,916,933	5,232,875
1974	278,000	--	7,401,000	7,679,000
1975	327,000	--	6,736,000	7,063,000
1976	249,000	6,070,000	3,134,000	9,453,000
1977	1,442,000	7,400,000	4,576,000	13,418,000
1978	3,887,000	--	5,937,000	21,134,000
1979	4,163,000	--	5,934,000	20,073,000
1980	4,421,000	--	3,814,000	22,799,000
1981	4,919,000	--	3,860,000	29,284,000
1982	8,539,000	--	3,237,000	38,076,000
1983	7,978,000	--	3,341,000	38,922,000
1984	12,052,000	--	5,040,000	56,109,000
1985	8,042,000	--	7,496,000	60,886,000
1986	10,490,000	--	8,274,000	69,792,000
1987	13,449,000	--	9,604,000	95,452,000
1988	19,970,000	--	13,631,000	100,499,000

Source: Bureau of the Census, U.S. Department of Commerce
-- not available

Table 4 - U.S. Imports of Frozen Vegetables from Mexico, Quantity (lbs), 1968-88

Year	Asparagus	Broccoli	Brussel Sprouts	Cauliflower	Okra
1968	--	--	--	--	--
1969	--	--	--	--	--
1970	--	--	--	--	--
1971	--	--	--	--	--
1972	--	--	--	--	--
1973	--	--	--	--	--
1974	--	--	--	--	--
1975	--	--	--	--	--
1976	--	--	--	--	--
1977	--	--	--	--	--
1978	448,355	13,929,733	2,388,534	11,807,883	5,277,665
1979	717,913	13,213,456	2,332,915	5,887,482	2,553,425
1980	1,005,998	19,109,574	2,043,477	6,059,804	616,314
1981	345,846	22,541,993	3,253,805	10,412,308	3,021,669
1982	262,015	26,759,398	2,558,674	13,305,738	3,067,832
1983	1,206,351	27,747,100	1,719,230	17,571,002	911,915
1984	481,442	55,318,443	2,155,054	27,559,230	188,165
1985	430,403	63,375,780	1,207,250	32,868,614	--
1986	767,837	96,811,643	1,811,848	34,347,375	--
1987	--	164,377,611	1,728,494	55,877,091	--
1988	428,424	153,076,773	959,403	47,936,288	627,747

Source: Bureau of the Census, U.S. Department of Commerce, U.S. Imports for Consumption and General Imports: TSUSA Commodity by Country of Origin, 1970-90.

-- not available

...Continued

Table 4 - continued

Year	Green peas	Broc, Caul-flwr & Okra	Other	Total
1968	0	--	8,544,887	8,544,887
1969	0	--	15,495,574	15,495,574
1970	0	--	13,945,676	13,945,676
1971	0	--	14,072,076	14,072,076
1972	0	--	16,460,428	16,460,428
1973	0	--	19,036,353	19,036,353
1974	0	--	23,466,825	23,466,825
1975	0	--	20,410,776	20,410,776
1976	0	19,111,987	3,849,295	22,961,282
1977	0	20,177,274	5,053,383	25,230,657
1978	0	--	7,162,039	41,014,209
1979	0	--	5,601,405	30,306,596
1980	0	--	1,615,400	30,450,567
1981	0	--	4,871,674	44,447,295
1982	0	--	3,097,908	49,051,565
1983	0	--	2,281,016	51,436,614
1984	0	--	1,281,095	86,983,429
1985	0	--	5,038,578	102,920,625
1986	0	--	5,852,275	139,591,078
1987	0	--	9,001,393	230,984,589
1988	0	--	10,282,169	213,310,804

Source: Bureau of the Census, U.S. Department of Commerce
-- not available

Table 5 - U.S. Imports of Frozen Vegetables from Mexico, FOB Value (US$), 1968-88

Year	Asparagus	Broccoli	Brussel Sprouts	Cauliflower	Okra
1968	--	--	--	--	--
1969	--	--	--	--	--
1970	--	--	--	--	--
1971	--	--	--	--	--
1972	--	--	--	--	--
1973	--	--	--	--	--
1974	--	--	--	--	--
1975	--	--	--	--	--
1976	--	--	--	--	--
1977	--	--	--	--	--
1978	209,000	2,791,000	573,000	2,761,000	1,207,000
1979	342,000	2,820,000	630,000	1,427,000	689,000
1980	333,000	5,430,000	682,000	1,931,000	192,000
1981	203,000	7,609,000	1,313,000	3,587,000	1,080,000
1982	134,000	8,007,000	1,133,000	4,604,000	1,022,000
1983	617,000	9,111,000	764,000	5,689,000	309,000
1984	197,000	17,828,000	817,000	9,132,000	671,000
1985	231,000	21,143,000	462,000	10,477,000	--
1986	238,000	28,001,000	555,000	9,881,000	--
1987	--	40,122,000	582,000	14,275,000	--
1988	147,000	39,860,000	285,000	13,368,000	134,000

Source: Bureau of the Census, U.S. Department of Commerce, U.S. Imports for Consumption and General Imports: TSUSA Commodity by Country of Origin, 1970-90.
-- not available

...Continued

Table 5 - continued

Year	Green peas	Broc, Caul-flwr & Okra	Other	Total
1968	0	--	602,669	602,669
1969	0	--	1,240,387	1,240,387
1970	0	--	1,867,578	1,867,578
1971	0	--	2,081,960	2,081,960
1972	0	--	2,585,551	2,585,551
1973	0	--	3,001,077	3,001,077
1974	0	--	4,322,000	4,322,000
1975	0	--	4,417,000	4,417,000
1976	0	4,301,000	1,011,000	5,312,000
1977	0	4,371,000	1,889,000	6,260,000
1978	0	--	1,516,000	9,057,000
1979	0	--	1,246,000	7,154,000
1980	0	--	461,000	9,029,000
1981	0	--	1,452,000	15,244,000
1982	0	--	1,130,000	16,030,000
1983	0	--	820,000	17,310,000
1984	0	--	565,000	29,210,000
1985	0	--	1,333,000	33,646,000
1986	0	--	1,476,000	40,151,000
1987	0	--	1,958,000	56,937,000
1988	0	--	2,576,000	56,370,000

Source: Bureau of the Census, U.S. Department of Commerce
-- not available

Table 6 - U.S. Imports of Frozen Vegetables from ROW, Quantity (lbs), 1968-88

Year	Asparagus	Broccoli	Brussel Sprouts	Cauliflower	Okra
1968	--	--	--	--	--
1969	--	--	--	--	--
1970	--	--	--	--	--
1971	--	--	--	--	--
1972	--	--	--	--	--
1973	--	--	--	--	--
1974	--	--	--	--	--
1975	--	--	--	--	--
1976	--	--	--	--	--
1977	--	--	--	--	--
1978	67,521	1,532,021	1,339,919	2,362,036	9,685,849
1979	148,430	2,237,535	300,815	4,122,326	8,195,553
1980	296,515	4,788,872	348,187	3,660,573	10,981,918
1981	73,115	5,280,947	728,561	3,161,395	11,536,073
1982	134,620	5,111,027	1,215,034	7,264,287	21,107,556
1983	10,559	5,803,708	4,010,575	3,514,374	21,396,758
1984	47,970	10,085,995	5,912,270	3,275,472	18,048,877
1985	133,519	13,771,516	6,706,159	3,954,469	19,423,399
1986	231,188	20,337,896	2,690,155	3,495,756	14,759,585
1987	220,065	30,439,907	6,433,287	2,636,292	18,332,108
1988	48,000	25,075,635	4,845,714	2,323,948	10,519,035

Source: Bureau of the Census, U.S. Department of Commerce, U.S. Imports for Consumption and General Imports: TSUSA Commodity by Country of Origin, 1970-90.
-- not available

...Continued

Table 6 - continued

Year	Green peas	Broc, Caul-flwr & Okra	Other	Total
1968	177,547	--	2,455,794	2,633,341
1969	282,270	--	3,148,086	3,430,356
1970	223,428	--	5,821,689	6,045,117
1971	196,075	--	8,941,864	9,137,939
1972	262,189	--	15,131,744	15,393,933
1973	1,094,741	--	12,962,077	14,056,818
1974	829,848	--	17,715,734	18,545,582
1975	933,983	--	13,354,265	14,288,248
1976	574,820	8,768,665	11,835,979	21,179,464
1977	4,999,347	13,241,613	16,428,529	34,669,489
1978	9,518,806	--	19,865,194	44,371,346
1979	8,811,568	--	19,644,772	43,460,999
1980	8,711,600	--	13,492,813	42,280,478
1981	9,930,713	--	8,690,459	39,401,263
1982	17,397,612	--	7,297,164	59,527,300
1983	17,205,970	--	9,136,202	61,078,146
1984	24,341,534	--	19,365,063	81,077,181
1985	18,275,785	--	26,118,466	88,383,313
1986	19,382,920	--	26,812,858	87,710,358
1987	26,160,006	--	27,947,875	112,169,540
1988	40,858,383	--	39,002,763	122,673,478

Source: Bureau of the Census, U.S. Department of Commerce
-- not available

Table 7 - U.S. Imports of Frozen Vegetables from ROW, FOB Value (US$), 1968-88

Year	Asparagus	Broccoli	Brussel Sprouts	Cauliflower	Okra
1968	--	--	--	--	--
1969	--	--	--	--	--
1970	--	--	--	--	--
1971	--	--	--	--	--
1972	--	--	--	--	--
1973	--	--	--	--	--
1974	--	--	--	--	--
1975	--	--	--	--	--
1976	--	--	--	--	--
1977	--	--	--	--	--
1978	20,000	410,000	372,000	603,000	2,364,000
1979	75,000	655,000	96,000	1,144,000	2,098,000
1980	245,000	1,482,000	105,000	1,036,000	3,128,000
1981	54,000	1,725,000	260,000	1,052,000	3,622,000
1982	110,000	1,663,000	403,000	2,485,000	6,739,000
1983	8,000	1,853,000	1,333,000	1,284,000	6,635,000
1984	37,000	3,460,000	1,933,000	1,156,000	3,786,000
1985	150,000	4,523,000	2,046,000	1,041,000	5,275,000
1986	192,000	6,494,000	702,000	872,000	4,093,000
1987	189,000	9,579,000	2,011,000	764,000	4,877,000
1988	42,000	8,133,000	1,408,000	689,000	2,832,000

Source: Bureau of the Census, U.S. Department of Commerce, U.S. Imports for Consumption and General Imports: TSUSA Commodity by Country of Origin, 1970-90.

-- not available

...Continued

Table 7 - continued

Year	Green peas	Broc, Caul-flwr & Okra	Other	Total
1968	59,808	--	333,953	393,761
1969	95,714	--	376,886	472,600
1970	80,096	--	699,774	779,870
1971	66,372	--	1,198,294	1,264,666
1972	85,414	--	2,107,098	2,192,512
1973	315,942	--	1,915,856	2,231,798
1974	278,000	--	3,079,000	3,357,000
1975	327,000	--	2,319,000	2,646,000
1976	249,000	1,769,000	2,123,000	4,141,000
1977	1,442,000	3,029,000	2,687,000	7,158,000
1978	3,887,000	--	4,421,000	12,077,000
1979	4,163,000	--	4,688,000	12,919,000
1980	4,421,000	--	3,353,000	13,770,000
1981	4,919,000	--	2,408,000	14,040,000
1982	8,539,000	--	2,107,000	22,046,000
1983	7,978,000	--	2,521,000	21,612,000
1984	12,052,000	--	4,475,000	26,899,000
1985	8,042,000	--	6,163,000	27,240,000
1986	10,490,000	--	6,798,000	29,641,000
1987	13,449,000	--	7,646,000	38,515,000
1988	19,970,000	--	11,055,000	44,129,000

Source: Bureau of the Census, U.S. Department of Commerce
-- not available

Table 8 - Miscellaneous Statistics, 1968-88

	Derived Price Index for Frozen Vegetables Consumed in the U.S. by Source, 1982-84 = 100				CPI-U 1982-84 = 100		
Year	U.S.	Mexico	Rest of World	All Imports	Frozen Veg.	Fresh Veg.	All Items
1968	35.2	20.6	42.8	26.5	35.1	34.8	34.8
1969	35.4	23.5	40.0	26.5	35.3	36.8	36.7
1970	36.5	38.2	37.1	38.2	36.6	39.4	38.8
1971	39.1	44.1	40.0	41.2	39.2	40.4	40.5
1972	40.8	47.1	40.0	44.1	40.9	42.9	41.8
1973	45.3	47.1	45.7	47.1	45.4	52.4	44.4
1974	64.9	52.9	51.4	52.9	64.7	56.2	49.3
1975	62.3	64.7	54.3	58.8	62.2	55.6	53.8
1976	65.5	67.6	57.1	61.8	65.4	58.0	56.9
1977	66.6	73.5	60.0	64.7	66.6	65.3	60.6
1978	68.5	64.7	77.1	73.5	68.7	70.5	65.2
1979	71.1	70.6	85.7	79.4	72.0	72.6	72.6
1980	77.1	88.2	94.3	91.2	77.6	79.0	82.4
1981	86.7	100.0	102.9	102.9	87.4	93.7	90.9
1982	96.2	97.1	105.7	102.9	96.5	94.2	96.5
1983	100.2	100.0	100.0	102.9	100.3	97.6	99.6
1984	103.6	100.0	94.3	97.1	103.2	108.2	103.9
1985	107.9	97.1	88.6	94.1	106.9	103.5	107.6
1986	109.3	85.3	97.1	91.2	107.7	107.7	109.6
1987	114.6	73.5	97.1	82.4	110.5	121.6	113.6
1988	116.8	76.5	102.9	88.2	113.0	129.3	118.3

Source: CPI - Frozen Veg., Fresh Veg., All Items - CPI Detailed Report, Bureau of Labor Stats., U.S. Dept. of Labor, 1969-89
PI - U.S., Mexico, ROW, All Imports - Calculated, see Appendix A