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Abstract

"The U.S.-Canadian Free Trade Agreement: Implications for Fresh Vegetable Trade" uses parameter estimates from an Armington-type model to simulate the impacts of the U.S.-Canadian free trade agreement (FTA) on fresh vegetable trade between the two countries. The simulations are based on assumed increases in GDP and population. Results indicate that aggregate national vegetable demands in both countries will show larger increases with enactment of the trade agreement than without its enactment.

Introduction

The United States and Canada are each others' largest export markets. The free trade agreement between the two countries, which became effective January 1, 1989, will eliminate U.S.-Canadian bilateral tariffs over a period of ten years. Economic theory suggests that the probable effect of this agreement will be to increase competition between the two countries.

Agricultural trade between the two countries, although of less importance than that in other products, is substantial. According to United Nations data on value of trade, approximately 6 percent of U.S. agricultural exports went to Canada in 1987 and 11 percent of U.S. agricultural imports were from Canada.[1] In 1987 agricultural trade with the United States accounted for 6 percent of Canada's agricultural exports and 55 percent of agricultural imports.

Vegetables, including roots and tubers, comprise a significant proportion of this trade. In 1987, 12 percent of U.S. agricultural exports and 4 percent of its agricultural imports from Canada were vegetables. In the same year, 5 percent of Canadian agricultural exports and 17 percent of agricultural imports from the United States were in this commodity group.

From 1962 to 1987 international trade in fresh vegetables more than quadrupled from 3.69 million metric tons (mmt) to 14.83 mmt. Neither U.S. or Canadian participation grew at a comparable rate. U.S. imports increased more than 5.6 times over from .321 mmt to 1.81 mmt during the twenty-five year period. At the same time its exports grew from .687 mmt to 1.24 mmt, slightly less than doubling. Canadian imports grew from .499 mmt to 1.30 mmt, a 2.6 fold increase.[2] Canadian exports increased more than three fold from .292 mmt to .955 mmt.[3]

In recent years, Canada has decreased its imports of vegetables from the United States. In 1962 about 92 percent of Canadian vegetable imports were from the United States. In 1989 that figure was 89 percent. The balance was almost totally supplied by Latin America and the European Economic Community. Canadian exports bound for the United States, on the other hand, increased from 40 to 53 percent of its vegetable exports over the same time period.

While U.S. participation in world vegetable trade has increased, the share of U.S. vegetable exports going to Canada has decreased. U.S. exports to Canada declined from 56 to 39 percent of total exports between 1962 and 1989.

The United States primarily imports potatoes, potato seeds, carrots, and onions from Canada. In 1990 $41.7 million of fresh potatoes were imported from Canada, $18.5 million of potato seeds, $5.9 million of carrots, and $3.9 million of onions (Bureau of Census). In contrast, Canada imports all types of vegetables from the U.S. A few examples include tomatoes, broccoli, lettuce and carrots.

All of this suggests that vegetable trade between the U.S. and Canada is not insignificant. One unresolved issue is the extent to which the free trade agreement will impact this vegetable trade. In what follows a descriptive analysis of econometric simulations estimating the impact of the free trade agreement on bilateral U.S.-Canadian fresh vegetable trade is provided. The objectives are to measure the increase in the total aggregate demand for vegetables in both the U.S. and Canada and in vegetable trade between the two countries resulting from the lowering of trade barriers. In order to conduct the simulations an Armington-type model based on flows between the eight major vegetable trading regions of the world is estimated simultaneously. United Nations trade data covering 1962 - 1982 are used. The estimated model is used to simulate the impacts of lowering tariffs on vegetables between the United States and Canada. The model is based on the assumption that products differ by their geographical origin. A unique aspect of this study is that the model incorporates a Constant Ratio of Elasticities of Substitution (CRES) technical relationship in its demand functions. The CRES relationship serves to limit the number of parameters to be estimated and is a major innovation in the Armington framework. While the Appendix presents the equations of the model, a more detailed discussion is available in Sparks and Ward.

In Sparks and Ward (1992), the trade model used in the analysis is fully developed. The theoretical underpinnings of the approach are delineated. The derivation of the product demand functions which result from the imposition of the CRES technical relationship is presented. Estimation results and diagnostic statistics for all eight regions and all equations of the model are also presented and discussed. Sparks and Ward is a thorough explanation of the theory and documentation of the empirical results regarding the fresh vegetable trade modelling effort. This paper builds on the modelling effort to conduct simulations regarding the impact of the U.S.-Canadian Free Trade Agreement on fresh vegetable trade between the two countries.

Restrictions on Vegetable Trade

The United States and Canada employ tariffs on fresh vegetables to protect domestic producers. In 1989 the tariffs were at modest levels, ranging from 15 to 20 percent of a product's value for the United States and 10 to 15 percent for Canada.[4] The U.S.- Canadian free trade agreement (FTA) began eliminating these at a rate of 10 percent of the tariff per year in 1989. However, for twenty years, there is a provision allowing tariffs to snap-back to their pre-agreement level, or the most favored nation level in effect if it is lower, if imports threaten the domestic industry. There are several rules relevant to the enactment of the snap-back provision. First, import prices must be below 90 percent of the preceding five year monthly average for five working days. The highest and lowest years would be excluded from consideration. Second, planted acreage may not be higher than the previous five year average, again excluding the highest and lowest years. Third, the combined temporary and normal duty may not exceed that for the most favored nation. Finally, the temporary duty may be applied only once in a twelve month period (Normile and Goodloe, 1988). Once it is

[1] The latest U.N. trade data available for the United States is for 1987.
[2] 1989 data are used for Canada since 1987 data are not available.
[3] 1963 data are used as 1962 data are not available.
[4] Canada's tariffs on vegetables are seasonal and are in effect only during their production months.

applied, it will be rescended if prices go above 90 percent of the preceding five year monthly average for five working days, or failing that, it will automatically be rescended after 180 days.

The bilateral agreement does not establish a free trade situation between the two countries, it only addresses the tariff issue. However, tariffs are the primary means of restricting vegetable trade between the U.S. and Canada. While regulations imposed by marketing orders within the U.S. that contain an eight-E provision also apply to imports from Canada, the regulations are readily available and consequently can be conformed to by exporters.[5] This is equally true of regulations imposed by the Canada Agricultural Products Act (CAP), which applies both to Canadian and imported produce.[6] Given that tariffs are the primary impediment to vegetable trade between the U.S. and Canada, it seems reasonable to suggest that their reduction and elimination will increase vegetable trade between the two countries. The measurement of the probable increase is the purpose of this article.

Model Issues and Construction

A world trade model based on Armington's theory whereby demand for a product is predicated on its place of production was constructed and specified for eight major trading regions or countries.[7] The full specification of the structural model is shown in the Appendix and consists, for each region, of four types of behavioral relationships and six sets of identities.

The Armington model involves a two-stage allocation process in which total national demands for a commodity such as vegetables are first determined (Armington, 1969).[8] These are labelled market demands. The market demands are then independently allocated among competing sources of supply to determine the levels of product demands, which are based on point of production. Commodities of a certain type, such as vegetables, from individual supply sources are called products. Therefore, each vegetable product is distinguished by its nation of production. Canadian and U.S. produced vegetables are consequently two distinguishable products. By model construction, a country's market demand for a commodity is the sum of product demands in that particular nation.

The use of the Armington model presumes imperfect substitution between domestic and imported vegetables. Also, imported vegetables from different supply nations are presumed to be imperfect substitutes. This is unusual for a trade model. Typically commodities of a certain kind from one country are assumed to be completely substitutable for commodities of the same type from another country. Complete substitutability between products implies that the elasticities of substitution between products are infinite. Consequently, using this assumption, these substitution elasticities do not need to be estimated.

In contrast, the flexibility inherent in the Armington model due to its assumption of imperfect substitution between competing products allows for the incorporation of a great deal of information in estimating the price and income effects of demand for the vegetable products from different countries. Hence, the simulations conducted will be more accurate than if all imported vegetables were considered homogeneous, regardless of origin. However, the substitution elasticities must be estimated. Without some restrictive qualities to the substitution properties of the products, it would be impossible to empirically estimate the model due to the inordinately large number of parameters.

For this study, in order to allow vegetables from different nations to be imperfect substitutes within a market, a Constant Ratio of Elasticities of Substitution (CRES) technical relationship is assumed.[9] This relationship allows the vegetable products competing within a market to have different and distinct substitution properties between them, yet restricts that all elasticities of substitution within a market vary by a constant ratio. The use of this technical relationship reduces the number of substitution elasticities to be estimated. Empirical implementation was facilitated by use of the CRES function in that fewer parameters to be estimated allows for the use of a smaller data set.

The structure of the international trade environment as well as world economic conditions are incorporated into the model. Demand and export supply equations are specified for each of eight major trading regions. These trading regions were identified through a careful examination of the United Nations trade data. Equations linking regional CIF and market prices incorporate tariff barriers and preferential treatments. Market prices reflect exchange rates and transportation and handling costs. These along with national incomes are included in market demand equations which are specified on a per capita basis. Product demands are functionally related to levels of market demand and product prices relative to the regional average market price. All prices are in real 1962 U.S. dollars. The four functional relationships were estimated in their double-log forms by nonlinear two stage least squares using annual data from 1962 through 1982. Given the short time series and large number of exogenous variables, it is impossible to estimate the first stage using all exogenous variables as instruments. Hence first stage estimates are based on the use of principal components over the exogenous variables. The first five principal components serve as instruments.[10]

Estimation Results as Related to U.S.-Canadian Trade[11]

The United States has a negative, inelastic price response in its vegetable market demand equation. The Canadian market demand also shows a negative inelastic price as well as income response. These parameter estimates indicate that changes in price for the U.S. and price and income for Canada would result in proportionally smaller changes in demand. All of these parameters have t-statistics which indicate a statistical significance at the 5 percent level and higher.

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[5] The vegetables exported from Canada to the United States affected by these marketing order regulations are essentially only potatoes and onions.

[6] The CAP Act regulates the marketing of agricultural products in import, export, and interprovincial Canadian trade. It provides for national standards and grades of agricultural products, and for their inspection and grading.

[7] The regions are Latin America, the United States, Canada, the European Economic Community, the Middle East, the Far East, Africa, and the non-EEC Western European nations.

[8] Broad groups of commodities such as vegetables are assumed to be independent of other broad groups of commodities and their demands can therefore be measured unambiguously.

[9] In Armington's work, he imposed a Constant Elasticity of Substitution, CES, technical relationship on the system. This forces all products within a market to have the same elasticity of substitution between each other. It is a much more restrictive assumption than using the CRES specification.

[10] The trade model has 82 exogenous variables and 21 degrees of freedom. A standard instrumental variable technique would exceed the degrees of freedom and hence would not be a feasible method of estimating the first stage of the simultaneous system. The first five principal components account for 98 percent of the variation in the explanatory variables (Theil; Pindyck and Rubinfeld; Sparks).

[11] Data were obtained from various sources. Trade data are from the United Nations and include import and export quantities and values from 1962 to 1982. Gross national product statistics, consumer price indices, exchange rates, and population levels were furnished by the International Monetary Fund. Production quantities were obtained from the Food and Agricultural Organization of the United Nations. Canadian tariff rates were obtained from Agriculture Canada's Tariffs on Selected Agricultural Products. The Tariff Schedules of the U.S., Annotated, issued by the U.S. International Trade Commission, supplied U.S. tariffs.

On the product demand level, both the United States and Canada have negative, inelastic relative price responses and positive, elastic market size responses for their respective vegetable products (see Table 1). The market size responses indicate the extent to which a product demand will increase as the country's total demand for vegetables increases, i.e. its market demand increases. The results for the U.S. for both variables are not statistically significant. The results for Canada, however, suggest that reductions in tariff levels, which lower product prices, would increase demand but by a smaller percentage than the percentage tariff reduction. Also, as the Canadian vegetable market grows, the percentage composed of imports from the U.S. should increase. The parameters for Canada have t-statistics which indicate a significance at the 10 percent level.

The export supply relationship indicates that neither the free on board (FOB) price or the U.S. production level have much impact on U.S. exports of vegetables. Parameters on both of these variables are inelastic and statistically insignificant at the 10 percent level. Canada's export supply relationship shows an inelastic, positive response to price and a positive, strong response to production. The level of production apparently impacts Canada's export of vegetables more than does its FOB price. Canada's export supply parameters are significant at the 5 percent level.

The CIF import price relationships indicate that transportation and handling costs strongly affect CIF prices in Canada whereas FOB prices have little impact in either the U.S. or Canada. These conclusions are drawn from the size of the parameters. Even so, distribution costs, measured by the proxy variable Z, apparently have little effect on U.S. and Canadian vegetable demands at either the product or market level as the price responses in these relationships are inelastic. The parameters in the CIF import price relationships are all significant at the 5 percent level, with the exception of the U.S. distribution costs variable, which is insignificant.

R^2 values for the estimated equations for the United States and Canada range considerably, from 0.28 to 0.97. With one exception, however, all are high, 0. 67 and above. This indicates that the model does a reasonable job in explaining the variation in the market and product demands, export supplies, and CIF prices for the United States and Canada. The Durbin- Watson statistics range from .9 to 2.6. In those two extreme cases, there may be some serial correlation. However, in the other cases the Durbin-Watson statistic is close to 2, indicating that there probably is no serial correlation.

Simulations

The world trade model detailed above was used to simulate tariff reductions as set forth in the U.S.- Canadian Free Trade Agreement (FTA). The analysis assumes that the structural patterns of the demand and supply relationships remain unchanged. Fresh vegetables are the subject of the investigation. Alterations in trade patterns involving other regions and goods are assumed not to affect U.S.-Canadian trade in vegetables.

This is a broad assumption and is largely justified. The possible exception is Mexico, from whom the U.S. imports a large percentage of its vegetables and Canada which imports the vegetables not supplied by the U.S. However, the economic incentive of the FTA is such that both the U.S. and Canada would purchase more vegetables from each other and less from other sources, including Mexico. The simulations for the U.S. and Canada capture these increases and yield valuable insight into the impact of the FTA on these two countries.[12]

Two sets of simulations were conducted. In the first, baseline simulation, gross domestic product (GDP) and population levels for both the U.S. and Canada were allowed to grow for 10 years. The growth simulated the actual level of expansion one would expect based on historical trends in these two variables for each of the regions.[13] GDP levels were simulated to increase by 3 percent per year in each country and population by 1 percent.

To carry out the first set of simulations, GDP and population were allowed to grow along the trends described. They were then multiplied by the estimated parameters and the levels of market demand obtained. These simulated levels of market demand were then multiplied by the estimated parameters of the product demand equations. In this way, the simulated levels of product demand were obtained.

In the second simulation GDP and population levels were allowed to grow while tariff levels between the U.S. and Canada were reduced by ten percent annually. This was accomplished by reducing product prices by ten percent of the average tariff assessed on fresh vegetables in Canada and the U.S. and average market prices by somewhat smaller amounts for each of ten years.[14] These values of GDP, population, and tariffs were then multiplied by the parameter estimates of the market and product demand equations in order to obtain the simulated levels of demand.

Due to the method used in obtaining the results, the simulated levels of demand are very sensitive to the size of the parameters. The parameters, however, as noted previously, were estimated from the U.N. trade data and are good representations of the demand relationships prevailing in U.S.-Canadian vegetable trade. Consequently, the simulations should be relatively accurate representations of the implications of the FTA for bilateral fresh vegetable trade.

Percentage differences between the levels of U.S. market demand simulations are shown in Figure 1. As can be seen, the percentage differences increase linearly as the simulation horizon increases. The difference ranges from 0.9 percent in the first year of the simulated tariff reduction to 7.0 percent in the tenth and final year. These numbers indicate that the U.S.- Canadian FTA could result in a 7 percent increase in the U.S. market demand for vegetables over that which would have been demanded without the tariff reduction. In metric tons, simulations in which tariffs are not lowered but GDP and population are increased indicate that the U.S. market demand for vegetables will be 52 mmt (million metric tons) by the tenth year. Simulations in which tariffs are lowered indicate that the U.S. market demand will be approximately 56 mmt.

The percentage differences in the Canadian market demand simulations are larger than those for the U.S. They range from 6.3 in the first year to 12.7 in the final year of the tariff reductions. However, while the percentage differences are larger, the absolute quantities expected to be demanded are smaller than those for the U.S. Without the tariff reduction, simulations indicate that approximately 7 mmt of fresh vegetables will be demanded by Canada in the tenth year. With the tariff reduction, demand would be expected to be approximately 8 mmt.

U.S. demand for Canadian vegetables is simulated to increase by 10.9 percent above the baseline as a result of the reduction in tariffs. Without the tariff reduction, with expected GDP and population increases, the U.S. could be expected to demand 262,000 mt of Canadian vegetables in the tenth year of the simulation. With the reduction in tariffs that demand is expected to be 290,000 metric tons.

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[12] In order to ascertain the impact of the FTA on U.S. and Canadian vegetable trade with Mexico, the model would have to have be re-estimated. This is because in the original regional delineations, Mexico was indistinguishable from the rest of Latin America. Due to the current negotiations regarding a North American Free Trade Agreement, which would include Mexico, an exercise of this sort could be valuable. However, with respect to the U.S.-Canadian Free Trade Agreement, the specific inclusion of Mexico is not necessary for an accurate assessment of the agreement's impact on the U.S. and Canada, the two countries which would be primarily affected by the agreement.

[13] 1989 Real Gross National Product growth: U.S. 2.9%; Canada 2.6.% (International Monetary Fund, 1989). 1980-88 Average Annual change in U.S. population 1.1% (International Monetary Fund, 1990). 1983-89 Average Annual change in Canadian population 0.9% (International Monetary Fund, 1990).

[14] The average market prices were lowered by a percentage accounting for the tariff reduction and a percentage accounting for the share U.S. or Canadian vegetables hold in the market. For the U.S., this second percentage was 0.991, or 100 - (.30 * .03) where .30 is the percentage of vegetable imports received from Canada and .03 is the percentage of total demand supplied by imports. For Canada the second percentage was 0.8884, or 100 - (.93 * .12). Ninety-three percent of Canadian imports are supplied by the U.S. Twelve percent of the Canadian market is composed of imports.

In contrast, the percentage increase in Canada's demand for U.S. vegetables would be expected to be smaller, but the quantities much larger than those of U.S. demand for Canadian vegetables. The percentage difference between the baseline and the tariff reduction simulations is 8.4 percent. The quantities expected to be demanded without the tariff reduction are 868,000 mt. With the tariff reduction, 940,000 mt. These results, on both the market and product demand levels, are reasonable for the two major trading partners. When keeping in mind the importance of vegetable trade between the U.S. and Canada, the levels of increase due to the FTA are entirely credible.

Summary and Conclusions

The U.S. is Canada's primary supplier of fresh vegetables and Canada is the second largest supplier to the U.S. An Armington-type world trade model has been used to simulate the impacts of the U.S.-Canadian free trade agreement on bilateral fresh vegetable trade. Indications are that both aggregate national demands and bilateral vegetable demands will show larger increases with enactment of the trade agreement than without its enactment. The U.S. aggregate, or market, demand for vegetables will increase by approximately 7 percent while the Canadian market demand will increase by 12.7 percent over a baseline level with the tariff reductions. Tariff reduction simulations indicate that U.S. demand for Canadian vegetables will increase by 10.9 percent and Canadian demand for U.S. vegetables by 8.4 percent over the baseline. All of these percentage increases are credible given the existing levels of tariffs between the U.S. and Canada. The differential in the increase in market demands between simulations with and without the FTA could be due to shifts away from processed vegetables to fresh as these become relatively cheaper with the FTA. The differential in the product demands could be due to shifts away from Mexico as a supplier towards the U.S. or Canada. To get an analysis of the full impact of the U.S.-Canadian FTA on bilateral vegetable trade, the processed and fresh vegetable sectors would need to be modelled simultaneously. This is a possibility for future research.

An emerging issue which could be usefully investigated using a model of this sort is the implication of the proposed North American Free Trade Area for fruit and/or vegetable trade between the U.S., Canada, and Mexico. This could be modelled within a four region context with the U.S., Canada, Mexico, and the Rest of the World as trading regions. A major fruit or vegetable commodity could be selected to investigate. Demand parameters could be estimated and used to simulate the impact of lowering tariffs between the relevant trading partners. This is a subject for future research.

Table 1—Estimated Elasticities and T-Statistics for the United States and Canada

Relationship	United States	Canada
Market Demands		
Price Response	-0.35 (-2.90)[1]	-0.47 (-5.05)
Income Response	0.11 (1.13)	0.41 (5.88)
Product Demands		
Price Response	-0.17 (-0.32)	-0.50 (-4.92)
Market Size Response	1.55 (1.44)	1.16 (8.90)
Export Supplies		
Price Response	-0.78 (-1.17)	0.33 (2.34)
Production Response	0.90 (1.24)	1.15 (5.56)
CIF Prices		
Price Response	0.88 (4.93)	0.77 (5.29)
Distribution Response	12.39 (0.42)	62.67 (3.32)

[1]T-Statistics in parentheses.

Appendix
World Trade Model for Fresh Vegetables[15]

Market Demand

(1) $\ln X_{i.}/Pop_i = \delta_{0i} + \delta_{1i}\ln P_{i.} + \delta_{2i}\ln GDP_i$

Product Demand

(2) $\ln X_{ij} = \theta_{0ij} + \theta_{1ij}(\ln P_{ij} - \ln P_{i.}) + \theta_{2ij}\ln X_{i.}$

Export Supply

(3) $\ln(X_{.j} - X_{jj}) = \tau_{0j} + \tau_{1j}\ln F_{.j} + \tau_{2j}\ln X_{.j}$

CIF Import Price

(4) $\ln C_{ij} = \phi_{0ij} + \phi_{1ij}\ln F_{ij} + \phi_{2ij} Z_{ij}$

Average Market Price

(5) $P_{i.} = \Sigma_j(P_{ij}X_{ij})/X_{.j}$

Average FOB Export Price

(6) $F_{.j} = \Sigma_j(F_{ij}X_{ij})/X_{.j}$

Market Price

(7) $P_{ij} = (1 + T_{ij})C_{ij}$

Domestic Demand

(8) $X_{jj} = X_{.j} - X_{ij}$

Supply Restriction

(9) $X_{.j} = \Sigma_i X_{ij}$

Demand Restriction

(10) $X_{i.} = \Sigma_j X_{ij}$

Where

$X_{.j}$ = total vegetable production in market j (j = 1,2,...,8)
$X_{i.}$ = total market demand for vegetables in market i (i = 1,2,...,8)
$P_{i.}$ = the average market price for vegetables in market i
X_{ij} = the demand for the j^{th} vegetable product in market i
P_{ij} = the j^{th} vegetable product's price in the i^{th} market
C_{ij} = the j^{th} vegetable product's CIF price in market i
F_{ij} = the j^{th} vegetable product's FOB price bound for market i
$F_{.j}$ = the average FOB price received by region j for its product
X_{jj} = domestic demand for vegetables
Z = proxy trend variable designed to capture increasing distribution costs over time.
T_{ij} = Tariff imposed on product j imported by region i.

Effects of tariff reductions are captured in equation (7). By reducing the value of T_{ij}, the effect of the tariff on the market price of a product is captured.

The trade model has 82 exogenous variables and 21 degrees of freedom. Statistics regarding the fit and performance of the model indicate that the equations do a reasonable job representing the economic forces involved in fresh vegetable trade. The R^2 and t-statistics ranged considerably across the equations. Diagnostic statistics are available from the author upon request.

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[15] The market and product demand equations are estimated on a per capita basis. All prices are deflated by the U.S. CPI in order to work in constant U.S. dollars.

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Figure 1
US Market Demands

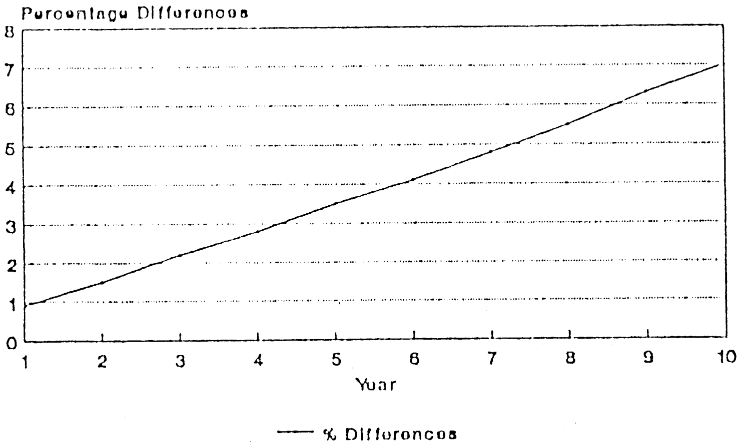

Figure 2
Canadian Market Demands

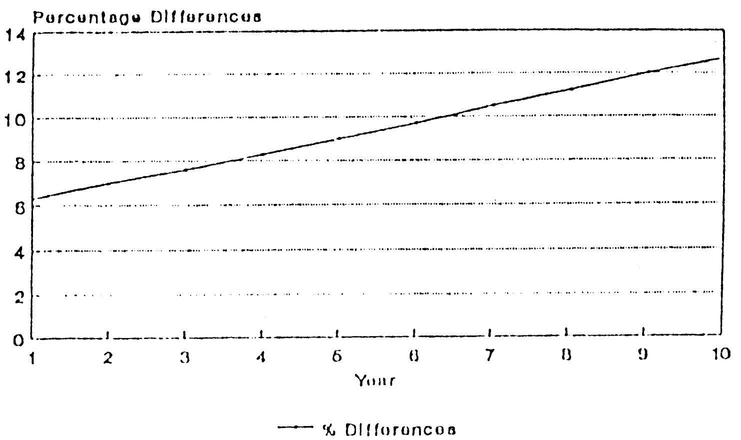

Figure 4
Canadian Demand for US Vegetables

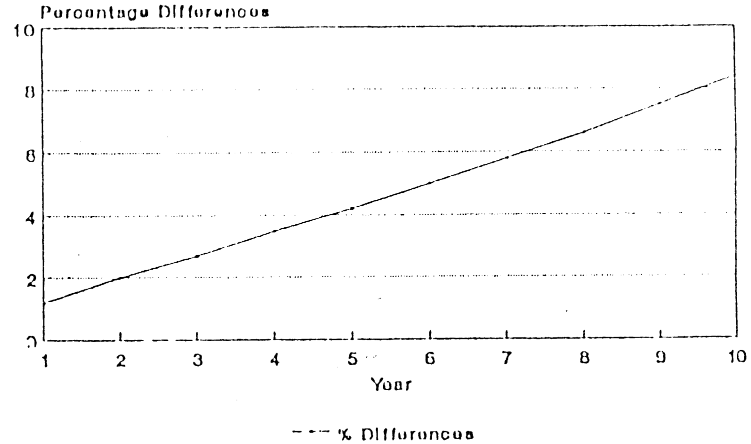

Figure 3
US Demands for Canadian Vegetables