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The Effects of Reducing Sanitary and Phytosanitary (SPS)

Barriers to Trade on the Washington State Apple Industry

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The Effects of Reducing Sanitary and Phytosanitary (SPS)

Barriers to Trade on the Washington State Apple Industry

Lia Nogueira[1] and Hayley Chouinard[2]

Apples are the third most valuable fruit crop in the United States, behind grapes and oranges (Dimitri, Tegene and Kaufman 2003). The US produced 4.2 million metric tons of apples in 2003, following only China (Calvin and Krissoff 2005). US apple production accounts for 11 percent of the estimated world apple production. The apple industry is especially important for Washington State, nearly 60 percent of all US production occurs there. Apple production in Washington State is expected to increase 30 percent in the marketing year 2004/2005 (US Department of Agriculture, Foreign Agricultural Service (USDA/FAS) 2005).

Exports are important for the US and Washington State apple industries. Apple exports represented 18 percent of total apple production in the US in the 2003/2004 season (Calvin and Krissoff 2005). The market value of total US apple exports from July 2004 to January 2005 was $249 million dollars (USDA/FAS 2005). From 2002 to 2004 the US has been part of the top five leading exporters by value and volume of fresh apples (Belrose 2006). Washington State supplies approximately 85 percent of US exported apples. However, trade barriers affecting US apples limit the amount of US exports and reduce the revenue for the apple industry.

According to USDA/FAS (2005) "trade issues continue to be a significant barrier for US apples in certain destination markets". Sanitary and phytosanitary (SPS) barriers are import standards or regulations that reflect the country’s concern for SPS issues that could harm domestic producers of apples in this case. Specifically, SPS barriers related to fire blight,

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codling moth, apple maggot and other pests limit or prohibit US apple exports to some countries (Krissoff, Calvin and Gray 1997). The SPS barriers may also reduce the flow of apples into a country by imposing quarantine restrictions that delay shipments. Often the level of SPS requirements is set above the scientific requirements to protect the domestic producers. It should be noted that the scientific levels themselves generate significant debate.

SPS restrictions may greatly reduce the amount of US apple exports. Krissoff, Calvin and Gray (1997) estimate that removing tariffs and harmonizing the SPS requirements to the US standards would increase the value of US apples exported to Japan, South Korea and Mexico by $205 million US dollars (USD) in 1994/1995 and $280 million USD in 1995/1996. According to Northwest Horticultural Council (2004), the potential increase in exports to Australia, China, India, Japan, South Korea, Taiwan and Thailand, if the SPS barrier was removed, is $5 to $25 million in sales to each country each year and $25 to $50 million in sales to Mexico.

Although the US already exports large quantities of apples, exports may significantly increase if trade barriers could be reduced. The objectives of this article are to describe the Washington State apple industry and the situation of Washington apples in China and India, and to estimate the specific revenue changes for Washington State producers when analyzing different scenarios for SPS barriers to trade for apples in China and India. We will estimate price and quantity changes for Washington State apples given specific SPS barrier reductions. This will allow us to calculate the associated revenue changes with changes in the SPS restrictions. In addition, the results will include own price, cross price and income elasticities for Washington State apples, and the effects of tariff rates and time on quantity of Washington State apples exported to provide more accurate policy recommendations.

Some work has been done regarding the demand for US apples in other countries and the effects of removing or reducing trade barriers. Different approaches have been taken. Import demand, export demand, gravity equation and general equilibrium models are commonly used for trade estimation (Arize 2001; Calvin and Krissoff 1998 and 2005; Devadoss and Wahl 2004; Krissoff, Calvin and Gray 1997; Seale, Sparks and Buxton 1992; Yue, Beghin and Jensen 2005; etc.). The most common method used to calculate an SPS tariff equivalent is the price wedge approach (Calvin and Krissoff 1998 and 2005; Krissoff, Calvin and Gray 1997; Yue, Beghin and Jensen 2005). However, we want to estimate the complete system of equations that characterize the export model, including all stages involved. To the best of our knowledge, this is the first study to examine the export demand in particular for Washington State apples in other countries or the effects of trade barriers on Washington State producers.

The rest of the article proceeds as follows. The next section describes the relevant literature. A brief background of the Washington State apple industry and the situation of Washington apples in China and India is then presented. Subsequently, the development of the model is explained followed by the data description. After the discussion of the results, the article ends with some brief conclusions.

LITERATURE REVIEW

Demand studies for US agricultural products outside the US are often one of two types: import demand models or export demand models. Both models provide own price, cross price and income elasticities. However, these models offer a different perspective for demand.

Most studies that analyze demand for US products in other countries use import demand methods (Jin, Cho and Koo 2004; Schmitz, Schmitz and Moss 2004; Kinnucan 2003; Kaiser, Liu and Consignado 2003; Miljkovic, Marsh and Brester 2002; Dameus, Tilley and Brorsen 2001; Koo, Mao and Sakurai 2001; etc.). Specific to the apple industry, Seale, Sparks and Buxton (1992) use a Rotterdam import allocation model to estimate a geographic import demand system for US apples in Canada, Hong Kong, Singapore and the United Kingdom (UK). They report the results of the homogeneity, symmetry, autocorrelation, homotheticity and separability tests, as well as the expenditure, income and price elasticities. Some of their conclusions include that US apples are likely to be more price elastic than apples from other sources. Cerda *et al* (2004) estimate the import demand for Chilean apples in the European Union (EU) using Ordinary Least Squares (OLS). They find that demand for Chilean apples in the EU is relatively inelastic to changes in income, relative price and exchange rate.

Schmitz and Seale (2002) analyze import demand for some of Japan's most popular fruits (bananas, grapefruits, oranges and lemons and aggregating pineapples, berries and grapes or just aggregating berries and grapes) by implementing a general differential demand system. They test a general differential demand system that nests four alternatives: Almost Ideal Demand System (AIDS), Rotterdam, Central Bureau of Statistics (CBS), and National Bureau of Research (NBR) models. Depending on the good aggregation, the analysis fails to reject the Rotterdam and CBS specifications in the five-good case, and fails to reject only the Rotterdam model in the six-good case.

All these import demand models refer to demand by the importing country from different exporting countries. These studies analyze one or more importing countries and the respective sources of apples. A system of import demand equations for each importing country, independent of the other importing countries is estimated with this method. This import demand approach does not provide an accurate estimation of export opportunities to these countries and therefore, cannot be used to examine the effects of reducing the SPS barriers to trade for apples from Washington State to different importing countries.

Others have used export demand models to examine potential markets. Arize (2001) uses world income, export price and competitor's export price to determine export demand for Singapore products. He uses Singapore as a case study to test parameter instability in co-integrated models. One of his main findings is that Singapore should not be considered a small, price-taking country. He also finds that Singapore's export growth is largely explained by external demand.

Osman and Evans (2002) estimate short-run and long-run elasticities of Somalian banana and livestock exports. They model export demand as a function of relative prices and importing country's income using co-integration and error correction techniques. They find that foreign income largely explains Somalian exports. Senhadji and Montenegro (1999) do a cross-country analysis using time series techniques to estimate export demand elasticities. They use lagged exports, relative prices and an activity variable (defined as the weighted average of Gross Domestic Product (GDP) minus exports) to explain exports. They conclude that, in general, developing countries yield lower price elasticities than industrial countries. However, Asian countries have higher price elasticities than both industrial and developing countries. They also find that the activity variable and relative prices have a significant effect on exports.

Armah and Epperson (1997) estimate the export demand for US frozen concentrated orange juice (FCOJ) in France, Germany, Japan, the Netherlands and the UK. The estimation procedure in this study is OLS with White's heteroskedasticity consistent covariance matrix. They are especially interested in the impact of export promotion programs and find that these programs have a positive effect on export demand of US FCOJ. They also find that own price, exchange rate and time trend are negatively correlated with US exports of FCOJ and competitor's price (Brazil) and income of the importing country have a positive effect on US exports of FCOJ. Another study that analyzes the effect of export promotion programs is Onunkwo and Epperson (2000). They evaluate the export demand for US pecans in Asia and the EU using OLS with White's and Newey West's corrections. Their main result is that export promotion programs in Asia and the EU benefit substantially the US pecan industry. They also find positive spillover effects for the pecan industry of export promotion programs for almonds in Asia and walnuts in the EU.

Virtually none of the import or export demand models analyze trade barriers. Most of the studies of the effects of trade barriers use price and income elasticities from the literature instead of estimating the elasticities directly. Subsequently, they use those elasticities to analyze the effect of removing trade barriers on the demand for US apples. However, two studies analyzing trade barriers, Yue, Beghin and Jensen (2005) and Devadoss and Wahl (2004), estimate their own elasticities and analyze the effect of reducing barriers to trade. Yue, Beghin and Jensen (2005) specifically estimate SPS barriers to trade, whereas Devadoss and Wahl (2004) only analyze *ad valorem* tariff reductions. Krissoff, Calvin and Gray (1997) analyze the effects of removing SPS requirements in Japan, South Korea and Mexico on US apple exports to those countries. Calvin and Krissoff (1998 and 2005) quantify the SPS barriers for US apples in Japan and estimate the trade and welfare effects of removing those barriers specifically for Fuji apples. Yue, Beghin and Jensen (2005) estimate the tariff equivalent of technical barriers to trade (TBT) for apples in Japan. Afterward, they evaluate the effect of removing the Japanese TBT on US apple exports using the gravity equation. These studies yield different results, while Krissoff, Calvin and Gray (1997) and Calvin and Krissoff (1998 and 2005) find great increase in US apple exports after SPS barriers are removed, Yue, Beghin and Jensen (2005) find limited export increase for US apples after removing the barriers in Japan. All these studies use the price wedge approach to estimate the tariff equivalent of the SPS barriers to trade. Devadoss and Wahl (2004) estimate supply, demand and excess supply equations to examine welfare effects under different trade scenarios reducing the *ad valorem* tariff for apples. They conclude that India will greatly benefit from reducing trade barriers.

BACKGROUND

The Washington State Apple Industry

Washington State apple producers require the services of warehouses for the commercialization of their product. Some producers own the warehouses, while others contract for the provided services. Between 60 to 70 percent of apples go to privately owned warehouses, whereas the remaining percent go to cooperative warehouses. Approximately 40 to 50 percent of the fruit commercialized by privately owned warehouses comes from the owner's orchards. Nonetheless, warehouses do not buy the apples, they solely provide the intermediary service to the producers, and charge them for it.

Apple producers deliver the product to warehouses that are in charge of sorting, grading, packaging and storing the apples. Warehouses are also responsible for all the sales, marketing, paperwork related to exports and regulation compliance. Warehouses may contract with other companies such as a sales and marketing company, an exporter, a broker, a freight forwarder, or some mix of these companies to assist in the commercialization of the apples or they may provide all or some of these services internally. Contracting for services or internalizing usually depends on the country apples are exported to. All the SPS paperwork is done at the warehouse level. Only a few countries, like Japan, require SPS regulations that impose a direct cost on the producer by changing production. Some countries, like Mexico, pay a premium to help cover all or some of the SPS compliance costs. However, most of the time it is the producer who bears the SPS compliance costs.

The importer is responsible for paying the transportation costs from the warehouse to the importing country, even if the warehouse arranged the transportation. The importer is also responsible for paying the corresponding *ad valorem* tariffs. The importer pays directly to the warehouse FOB (free on board) prices in USD for the apples. In the case of apples the prices are FOB at the warehouse, which means that all the further transportation and paperwork required is paid by the importer. These FOB prices are determined internationally by supply and demand forces and depend on the variety, size, grade and packaging of the apples.

Exchange rate fluctuations may play an important role since the importer pays the product in USD. However, the importer does not necessarily have to achieve the currency transaction at the moment of the product transaction. The importer can be protected against these exchange rate fluctuations by buying USD in advance when the conditions are favorable.

The warehouse receives the payment from the importer that consists of the FOB prices plus transportation costs (in case that the warehouse was responsible for arranging the transportation). Subsequently the warehouse deducts its fees and the payment to the sales and marketing company, exporter, broker and/or freight forwarder accordingly from the importer's payment and sends the residual to the producer. All producers of equivalent apples receive the same price.

Situation of Washington apples in China and India

Washington apples are not considered close substitutes for Indian or Chinese domestic apples (Deodhar, Landes and Krissoff 2006; personal communication with Fred Scarlett, Northwest Fruit Exporters and Mark Powers, Vice President, Northwest Horticultural Council). In general, Indian and Chinese apples are of different varieties and have lower quality than Washington apples. This situation creates a niche market in both countries for Washington apples, allowing Washington apple exporters to receive a premium for their product.

Due to SPS concerns, China only allows the varieties Red Delicious and Golden Delicious to be exported from the US (Northwest Horticultural Council 2006). However, some other varieties like Granny Smith and Gala (that are not produced in China) are exported to Hong Kong and then are distributed in China. This situation makes it impossible to obtain an accurate analysis of US apple exports to China. Nevertheless, it provides evidence suggesting that SPS barriers are limiting or distorting US exports to China.

According to Deodhar, Landes and Krissoff (2006), "there is no evidence that purchases of high-priced imported apples by high-income consumers are weakening demand or prices for domestic apples". This statement suggests that domestic Indian apples and US apples are heterogeneous products. However, even domestic apples have a higher price than other domestic fruits, explaining the low per capita apple consumption (Deodhar, Landes and Krissoff 2006). It should be noted that the *ad valorem* tariff for apples in India is 50 percent since 2001. This is the maximum rate that the World Trade Organization authorizes. The tariff increased from 40 percent since 1999 when India removed the quantitative restrictions on apples. It is believed that SPS barriers have not been enforced in India until now (Deodhar, Landes and Krissoff 2006).

However if these SPS barriers are enforced, they pose a potential threat to Washington apple imports, as will be analyzed here.

Both China and India have high marketing costs that affect the commercialization of domestic apples, as well as the commercialization of imported apples (Deodhar, Landes and Krissoff 2006; Huang and Gale 2006). In China, the high marketing costs are due to poor handling, infrastructure and transportation, and the high markup of the numerous intermediaries. However, China's infrastructure has been readily improving in the last few years (Huang and Gale 2006). The main contributors to the high marketing costs in India are poor post-harvesting practices, infrastructure, transportation and market integration, summed to the fact that growers typically bear all the price risks (Deodhar, Landes and Krissoff 2006).

MODEL

Theoretical Background

It is common in export demand estimation to use an *ad hoc* model that incorporates all relevant variables for a particular study. These *ad hoc* models are in a reduced form combining supply and demand factors for the exported product. However, we want to analyze the complete system including all stages involved in apple exports to ultimately derive the export model from the relevant supply and demand equations.

There are three stages involved in exporting apples from the State of Washington. The first stage corresponds to the Washington State apple producers who face demand from the warehouse. The second stage is the warehouse that faces demand from the importer. Finally, the third stage corresponds to the importer who faces demand from the final consumers. We consider the warehouses as a stage on its own because they are responsible for all the commercialization process of apples. Furthermore, warehouses make all the commercializing decisions, including where to export the apples. However, through out all the commercialization process the warehouse never owns the apples. We assume that importers sell directly to the final consumer to simplify the model. Nonetheless, this is not accurate since there are wholesalers and other intermediaries between the importer and the final consumer, depending on the country.

Apple producers face demand from warehouses. Demand is a function of own price and competitors' prices. Apple producers' supply quantity to the warehouse is a function of output price, input prices, SPS barriers and warehouse services. However, warehouse services are already accounted for since output prices are FOB prices minus warehouses services. Thus, the supply quantity is a function of output price, input prices and SPS barriers.

The warehouses face demand for exports from importers as a function of own prices and competitors' prices. The warehouse's supply is a function of output price, input price and the costs of the value added activities and services (sorting, grading, packaging and storing the apples plus the sales and marketing, exporting and SPS compliance services). Given that the warehouse is charging the producer for its services and deducing these costs directly from its pay, the costs of other value added activities and services are already accounted for. Even though the warehouse charges the producer for the SPS compliance paperwork and at the end the producer is the one who bears the SPS compliance cost, these SPS compliance costs also limit the quantity exported by requiring quarantine measures or other fumigation treatments that delay shipments and thus, SPS barriers should be part of the warehouse's supply function. *Ad valorem* tariffs also affect the warehouse's supply directly and should be part of the supply function. Hence, the warehouse's supply quantity is a function of output price, input price, SPS barriers and *ad valorem* tariffs.

In the last stage, the importer companies face demand from final consumers as a function of own price, competitors' prices, SPS barriers, income and consumer preferences that will vary in each country. SPS barriers affect the demand the importer companies face since SPS barriers limit the quantity available and may increase the final price of the product. The importer's supply to the final consumer is a function of output price, input price, storage costs and *ad valorem* tariffs. However, SPS barriers should also be considered in the importer's supply function since SPS barriers limit the quantity imported as explained above.

Now that the whole system has been analyzed, we can specify the equations that characterize the export model. The export model consists on the supply function for warehouses (export supply equation) and the demand function for importers (import demand equation). These two equations are the ones directly involved in the export transaction.

Therefore, the export supply equation is a function of output price (export price), input price (producer price), SPS barriers and *ad valorem* tariffs:

(1) $$Q^{e}_{it} = f(P^{e}_{it}, W_{it}, SPS_{it}, TR_{it})$$

where the subscript *i* refers to the importing country for Washington State apple exports and subscript *t* refers to time. Q^{e}_{it} is the export quantity, P^{e}_{it} is the export price of Washington apples, W_{it} is the producer price to Washington growers, SPS_{it} is the tariff equivalent of the SPS barriers to trade and TR_{it} is the *ad-valorem* tariff rate.

The import demand is a function of own price (import price), competitors' prices, income measured as GDP, and SPS barriers:

(2) $$Q^{i}_{it} = f(P^{i}_{it}, \sum_{j} P_{jit}, GDP_{it}, SPS_{it})$$

where Q^i_{it} is the import quantity, P^i_{it} is the import price of Washington apples, $\sum_j P_{jit}$ are the prices from main competitors *j*, GDP_{it} is income measured as GDP and SPS_{it} is the tariff equivalent of the SPS barriers to trade.

Empirical Specification

The estimated export supply and import demand equations are based on the theoretical framework discussed in the previous section. These equations represent the Washington State apple industry from producer to importer. The estimated export supply equation for China and India is:

(3) $$\ln Q^e_{it} = \beta_0 + \beta_1 \ln P^e_{it} + \beta_2 \ln W_{it} + \beta_3 TR_{it} + \beta_4 TT_{it} + \varepsilon_{it}$$

where subscript *i* represents China and India, *t* is the monthly time subscript, $\ln Q^e_{it}$ represents the logarithm of the exported quantity of apples from the US to China or India at time *t*, $\ln P^e_{it}$ is the logarithm of the US export price, $\ln W_{it}$ is the logarithm of the producer price in Washington State, TR_{it} is the *ad valorem* tariff rate, TT_{it} is the monthly time trend and ε_{it} is the disturbance term.

The estimated import demand equation for China is:

(4) $$\ln Q^i_t = \alpha_1 \ln P^i_t + \alpha_2 \ln(P^i * SPS)_t + \alpha_3 \ln PNZ_t + \alpha_4 \ln PChile_t + \alpha_5 \ln GDP_t + \alpha_6 TT_t + \mu_t$$

where *t* is the monthly time subscript, $\ln Q^i_t$ represents the logarithm of the imported quantity of apples from the US to China at time *t*, $\ln P^i_t$ is the logarithm of the US import price, $\ln(P^i * SPS)_t$ is the interaction term between the US import price and the SPS tariff equivalent, $\ln PNZ_t$ is the logarithm of the NZ import price, $\ln PChile_t$ is the logarithm of the Chilean import price, $\ln GDP_t$ is the logarithm of GDP, TT_t is the monthly time trend and μ_t is the disturbance term.

The estimated import demand equation for India is:

(5) $$\ln Q_t^i = \alpha_1 \ln P_t^i + \alpha_2 \ln(P^i * SPS)_t + \alpha_3 \ln PNZ_t + \alpha_4 \ln PChina_t + \alpha_5 \ln PAUS_t + \alpha_6 \ln GDP_t + \alpha_7 TT_t + \mu_t$$

where *t* is the monthly time subscript, $\ln Q_t^i$ represents the logarithm of the imported quantity of apples from the US to India at time *t*, $\ln P_t^i$ is the logarithm of the US import price, $\ln(P^i * SPS)_t$ is the interaction term between the US import price and the SPS tariff equivalent, $\ln PNZ_t$ is the logarithm of the NZ import price, $\ln PChina_t$ is the logarithm of the Chinese import price, $\ln PAUS_t$ is the logarithm of the Australian import price, $\ln GDP_t$ is the logarithm of GDP, TT_t is the monthly time trend and μ_t is the disturbance term.

The major suppliers of apples for China are Chile, New Zealand (NZ) and the US, and for India are Australia, China, NZ and the US (Deodhar, Landes and Krissoff 2006; data from Global Trade Atlas). We imposed homogeneity in prices in the import demand equation, as is expected in demand analysis. Also, we assume separability for apples from all other food items and aggregation over all varieties of apples.

Price, quantity and GDP data for the export supply and import demand estimation were transformed to logarithmic form. This functional form allows for the direct estimation of elasticities and it is also assumed to be a better representation of the relationship between the variables included in the analysis. We added a time trend to account for the increasing trend through time observed in the data.

The first limitation of this study arose when trying to estimate the SPS tariff equivalent using the price wedge approach. As explained in the background section, imported and domestic apples in China and India are not homogeneous products. Furthermore, US apples are known to have higher prices due to higher quality than domestic apples. Hence, it is not possible to obtain an SPS tariff equivalent. To circumvent this problem, we used the SPS tariff equivalent for Japan as an upper bound, since Japan is known to have the highest standards regarding SPS regulations.

Results for the SPS tariff equivalent for Japan using the price wedge approach (Beghin and Bureau 2001; Calvin and Krissoff 1998 and 2005; Krissoff, Calvin and Gray 1997; Yue, Beghin and Jensen 2005) are consistent with the literature (Krissoff, Calvin and Gray 1997; Calvin and Krissoff 1998 and 2005), ranging from 26 percent to 101 percent on a monthly basis, and from 26 to 72 on an annual basis. Because Japan is assumed to have the highest SPS barriers, the upper bound for the SPS tariff equivalent in China is assumed to be 50 percent. We simulate the revenue change for Washington State apple producers when reducing the SPS tariff equivalent to 30 percent. The situation in India is different, as explained in the background section, since it is assumed that SPS barriers are not enforced. Consequently, we simulate the revenue change for Washington State apple producers when applying a 20 percent SPS tariff equivalent. Therefore, the values of SPS tariff equivalent used in the import demand equation are 30 percent for China and 20 percent for India. These values were chosen for this preliminary analysis with the only purpose of providing a starting point for comparison. The SPS tariff equivalents for China and India were kept constant through time in the estimation, due to lack of information regarding possible changes. For this reason, instead of including the SPS tariff equivalent as a constant, we included an interaction term of the SPS tariff equivalent and the US import price. As a result, the intercept term in the import demand equation has to be omitted.

The estimation procedure is three stage least squares implemented in Stata. This procedure allows the estimation of a system of equations that include endogenous variables as explanatory variables. We assume that the US import price is endogenous, since prices and quantities are jointly determined in the market. Hence, the US import price should be instrumented by the exogenous variables in both the export supply and the import demand equation, since these variables are assumed to be correlated with the import price. This estimation is consistent with economic theory and the literature.

DATA

The import and export data for all countries involved in the analysis were obtained from the Global Trade Atlas. These data consists on quantity in kilograms (kg) and value in USD for imports and exports of fresh apples (HS 080810) for China, India and the US. The import valuation is done in CIF (Cost, Insurance and Freight) prices and the export valuation is done in FOB prices. Unit import prices (CIF prices in USD/kg) for the US and its main competitors in each market are obtained by dividing import value by quantity imported for each country. Unit export prices (FOB prices in USD/kg) for the US to each market are obtained by dividing export value by quantity exported to each country. The data is monthly from 1995 to 2005 for China and from 1999 to 2005 for India. However, not all countries studied import apples from the US or its main competitors in all months and thus, prices and quantities are not available for the complete time series. There are also some discrepancies in the data depending on the reporting country. US apple exports (reported by the US) do not necessarily match with imports of US apples (reported by each country studied).

Producer prices by month in Washington State were obtained from the National Agricultural Statistics Service. These prices were converted from US cents/pound to USD/kg. All prices were deflated using the Consumer Price Index (CPI) for the relevant country. Producer prices and export prices were deflated using the US CPI, import prices from the US and its competitors were deflated using the CPI of the corresponding importing country. CPI monthly data for China, India and Japan, and GDP quarterly data for China (January 1999 to September 2005) and India were obtained from the International Financial Statistics Online of the International Monetary Fund. Annual GDP data for China (January 1995 to December 1998) were obtained from the World Development Indicators of the World Bank. All GDP data were converted to million USD. Information on tariffs was obtained from the Foreign Agricultural Service of the USDA, the TRAINS database of the United Nations Conference on Trade and Development and from the Northwest Horticultural Council website (www.nwhort.org).

Monthly wholesale prices for Japan were obtained from the Monthly Statistics of Japan (August 1997 – May 1998 and August 2004 – December 2005) and from Linda Calvin, Agricultural Economist at the Economic Research Service (ERS), USDA (January 1995 – July 1997 and June 1998 – July 2004). These prices were converted from Yen/kg to USD/kg. Monthly exchange rate data for Japan were obtained from the Pacific Exchange Rate Service, Sauder School of Business, University of British Columbia. Exchange rate data are reported in Japanese Yen per USD. Transportation costs were required for Japan; however, these data were not available. Instead, we approximated the transportation costs by using the US current transportation cost and we adjusted it using a labor cost index, a fuel index and the purchasing power parities. Unit labor cost monthly data (2000 equals 100) for manufacturing industries were obtained from the Main Economic Indicators database of the Organization for Economic Co-operation and Development (OECD). The wholesale price index for oil products data (annual from 1995 to 1997 and quarterly from 1998 to 2005) were obtained from the International Energy Agency. The quarterly purchasing power parities information was obtained from the Economic Outlook No. 78 of the OECD.

PRELIMINARY RESULTS

Summary statistics for all variables included in the analysis are presented in table 1 for China and table 2 for India. The number of observations used in the estimation is 51 for China and 18 for India. The number of observations used in the estimation is considerably smaller that the number of observations reported in tables 1 and 2. This is because import prices have to be available in the same month between both the US and its competitors, for estimation. If prices are not available for one country then the observation cannot be used in the analysis. The R-squared for the import demand equation is not reported since the intercept was omitted, as explained in the model section.

The estimation results for China are presented in table 3. Results from the export supply equation for China are mainly as expected. The export supply equation yields a positive and significant coefficient for export price, suggesting a positive and elastic output price elasticity of supply, as expected. As the price for US apples increases 1 percent, the supply of US apples will increase by 1.47 percent. The coefficient on producer price is negative, suggesting a negative inelastic input price elasticity. This result was also expected, however, the coefficient is not significant. The coefficient on the *ad valorem* tariff is positive and significant; suggesting that a tariff increase will increase exports to China. This is not an expected result. Finally, the coefficient on the time trend is positive and significant, suggesting an increasing trend in US apple exports to China, as found in the previous literature.

Table 1: Summary Statistics for China

Variable	Observations	Mean	St. Deviation	Minimum	Maximum
Export Quantity (kg)	135	400896	563567	0	2673969
Export Price (USD/kg)	101	0.70	0.70	0.39	7.33
Producer Price (USD/kg)	126	0.48	0.12	0.28	0.75
Ad Valorem Tariff (percent)	136	0.31	0.14	0.10	0.40
Import Quantity (kg)	135	1164549	1119578	7000	4830612
US Import Price (USD/kg)	131	0.46	0.16	0.20	0.80
NZ Import Price (USD/kg)	108	0.50	0.25	0.25	2.35
Chile Import Price (USD/kg)	75	0.52	0.17	0.30	0.80
GDP (million USD)	129	371725	89222	195980	511084

Table 2: Summary Statistics for India

Variable	Observations	Mean	St. Deviation	Minimum	Maximum
Export Quantity (kg)	87	904767	938511	0	4163292
Export Price (USD/kg)	73	0.57	0.11	0.32	0.74
Producer Price (USD/kg)	78	0.46	0.11	0.28	0.68
Ad Valorem Tariff (percent)	88	0.47	0.04	0.40	0.50
Import Quantity (kg)	81	440629	610806	0	2532015
US Import Price (USD/kg)	61	0.60	0.12	0.38	1.04
NZ Import Price (USD/kg)	45	0.65	0.11	0.39	1.05
China Import Price (USD/kg)	50	0.54	0.12	0.30	1.02
Australia Import Price (USD/kg)	46	0.64	0.19	0.31	1.29
GDP (million USD)	78	72447	9341	58538	94325

The results from the import demand equation estimation again mainly support our theoretical model. The coefficient on own price is negative but not significant. The coefficient on the interaction term between own price and SPS tariff equivalent is negative and significant. However, these two coefficients are jointly significant. They are used to calculate the own price elasticity of demand for imported apples that will be used for the simulation of revenue changes. The cross price coefficients do not have the expected sign for complements (negative sign);

nevertheless, they are not significant. US apples are expected to be complements to NZ and Chilean apples, since they have opposite growing seasons by being in different hemispheres. The coefficient on GDP is positive and significant, suggesting an inelastic positive income elasticity. As income increases 1 percent, the quantity of imported apples is expected to increase by 0.60 percent. The time trend is significant and has the expected positive sign, suggesting that US apple imports in China are increasing over time.

Table 3: Estimation Results for China

Export Supply Equation		**Import Demand Equation**	
Dependent Variable: ln Export Quantity		Dependent Variable: ln Import Quantity	
Variable	**Coefficient**	**Variable**	**Coefficient**
ln Export Price	1.47[a] (0.5543)	ln US Import Price	-9.03 (9.9521)
ln Producer Price	-0.11 (0.4562)	ln (US Import Price * SPS 30%)	-2.50[b] (1.1862)
Ad Valorem Tariff	4.49[a] (1.2264)	ln NZ Import Price	1.98 (2.5054)
Time Trend	0.03[a] (0.0067)	ln Chile Import Price	7.05 (9.1966)
Constant	9.39[a] (0.8210)	ln GDP	0.60[a] (0.2149)
R-squared	0.3079	Time Trend	0.02[c] (0.0107)

Note: standard errors are reported in parenthesis and superscripts a, b and c denote 1, 5 and 10 percent significance level, respectively.

The estimated results for India are reported in table 4. The results from the export supply equation for India are somewhat similar to the ones for China. The coefficient on export price has a positive and significant coefficient, suggesting a positive and elastic output price elasticity of supply. A 1 percent increase in the price for US apples increases the export supply of US apples by 3.34 percent. The coefficient on producer price is negative and significant as expected. This result suggests a negative input price elasticity. If input prices increase by 1 percent, the export supply of US apples will decrease by 1.02 percent. The coefficient on *ad valorem* tariff is positive and significant as in the case of China. Again, this result was not expected and it is not intuitive, since it suggests that an increase in the *ad valorem* tariff will increase exports to India. The coefficient on the time trend is not significant for India, suggesting that US apple exports have not been increasing over time.

From the import demand equation for India, we obtain some expected results. The coefficient on own price is positive and significant and the coefficient on the interaction between own price and SPS tariff equivalent is negative and significant. These two coefficients are also jointly significant and will be used to derive the own price elasticity of demand for imported apples in India. The cross prices have the opposite signs, since NZ and Australian apples are expected to be complements to US apples by being in different hemispheres (negative sign) and Chinese and US apples are expected to be substitutes (positive sign). However, only the coefficient on Chinese import price is significant. A 1 percent increase in the price of imported Chinese apples will decrease US apple exports by 2.61 percent. The coefficient on GDP is positive as expected, but not significant. As in the export supply equation, the coefficient on time trend is not significant, suggesting that US apple imports in India are not increasing over time.

Table 4: Estimation Results for India

Export Supply Equation Dependent Variable: ln Export Quantity		Import Demand Equation Dependent Variable: ln Import Quantity	
Variable	**Coefficient**	**Variable**	**Coefficient**
ln Export Price	3.34[b] (1.3418)	ln US Import Price	3.49[b] (1.4321)
ln Producer Price	-1.02[c] (0.5380)	ln (US Import Price * SPS 20%)	-5.18[a] (1.1909)
Ad Valorem Tariff	43.89[a] (11.1140)	ln NZ Import Price	2.20 (1.7614)
Time Trend	-0.01 (0.0142)	ln China Import Price	-6.87[a] (1.3357)
Constant	-6.13 (4.3059)	ln Australia Import Price	1.18 (1.1723)
R-squared	0.7053	ln GDP	0.08 (0.2226)
		Time Trend	0.01 (0.0102)

Note: standard errors are reported in parenthesis and superscripts a, b and c denote 1, 5 and 10 percent significance level, respectively.

To analyze the different scenarios for SPS barriers, own price elasticities of demand for imported apples in China and India are required. We calculated these elasticities using the coefficients on own price and the interaction term between own price and SPS tariff equivalent. The calculation yields a negative and elastic own price elasticity of demand in China of 1.6. As the price of US apples imported in China increases by 1 percent, the quantity demanded decreases by 1.6 percent. For India, we obtain a negative and inelastic own price elasticity of demand of 0.04, suggesting that a 1 percent increase in the price of US apples in India is expected to decrease quantity demanded by 0.04 percent. These elasticities were used to simulate specific revenue changes for Washington State apple producers. For China, we assume that the current situation corresponds to a 50 percent SPS tariff equivalent and we simulate the revenue change if the SPS tariff equivalent was reduced to 30 percent. For India, we assume that the current situation corresponds to a 0 percent SPS tariff equivalent and we simulate the revenue change if the SPS tariff equivalent was enforced at 20 percent.

Tables 5 and 6 show the simulated revenue for Washington State apple producers, given the described scenarios of SPS tariff equivalents for China and India, respectively. Imported quantity of US apples by year for each country was used in this calculation and adjusted to reflect that 85 percent of all apples exported from the US are produced in Washington State. Subsequently, the own price elasticities of demand discussed in the previous paragraph were used to calculate potential quantity imported under each scenario. Finally, the prices that Washington State apple producers receive were used to calculate the simulated revenue for each scenario.

The percentage increase in apple exports to China if the SPS tariff equivalent is reduced from 50 percent to 30 percent is 21.36 percent. The difference in revenue ranges approximately from $250 thousand USD to $2 million USD per year. In the case of India, the percentage decrease in apple exports if the SPS tariff equivalent is set to 20 percent is 0.77 percent. The difference in revenue ranges approximately from $1.2 thousand USD to $27 thousand USD per year. As explained in the model section, this simulation constitutes only a starting point in the analysis and the results are preliminary. However, these results do provide a comparison platform.

Table 5: Revenue Simulation for China

Year	Actual Revenue (SPS 50%)	SPS 30%	Revenue Difference
1995	$2,957,416	$3,589,203	$631,787
1996	$1,158,808	$1,406,362	$247,554
1997	$1,967,599	$2,387,933	$420,334
1998	$1,714,479	$2,080,740	$366,261
1999	$4,923,792	$5,975,652	$1,051,860
2000	$4,302,970	$5,222,205	$919,235
2001	$8,570,658	$10,401,591	$1,830,933
2002	$9,357,365	$11,356,360	$1,998,995
2003	$8,357,719	$10,143,162	$1,785,443
2004	$9,880,533	$11,991,292	$2,110,759
2005	$6,186,773	$7,508,441	$1,321,668

Table 6: Revenue Simulation for India

Year	Actual Revenue (SPS 0%)	SPS 20%	Revenue Difference
1999	$215,121	$213,463	$1,658
2000	$153,165	$151,984	$1,181
2001	$1,191,122	$1,181,939	$9,183
2002	$3,656,453	$3,628,264	$28,189
2003	$3,095,383	$3,071,520	$23,864
2004	$1,972,087	$1,956,883	$15,204
2005	$3,513,847	$3,486,757	$27,090

PRELIMINARY CONCLUSIONS

The main results of this paper include the estimation of output price elasticities of supply for apple exports to China and India of 1.47 and 3.34 percent, respectively. The income elasticity for US imported apples in China is 0.60 percent. The input price elasticity of supply for apple exports to India is -1.02 percent. The own price elasticity of demand for US apples in China is -1.6 and in India is -0.04. SPS barriers limit US exports to China and pose an important threat to exports to India. The exported quantity of apples to China could increase by approximately 21 percent if the SPS tariff equivalent were reduced from 50 to 30 percent. This translates to an approximate increase in revenue for Washington State apple producers of $250 thousand USD to $2 million USD per year. If a 20 percent SPS tariff equivalent were enforced in India, the quantity of US apples exported would decrease by 0.77 percent. The associated revenue loss for Washington State apple producers is approximately $1.2 thousand USD to $27 thousand USD per year.

These preliminary results bring some promising information to Washington State apple producers. China is confirmed as an attractive potential market for Washington apples if SPS barriers are reduced even to 30 percent. In India, we find a limited change in apple imports if an SPS tariff equivalent of 20 percent is imposed. It should be noted that the impact of the SPS barrier greatly depends on the elasticity used for the simulation. Our calculation yields a fairly elastic negative own price elasticity of demand for China, which is translated into a large revenue increase for Washington producers if SPS barriers are reduced. However, the own price elasticity of demand for India is relatively close to zero, providing small revenue decrease for Washington producers if SPS barriers are imposed.

There are many limitations to this study, starting with the reduced number of observations, especially for India. Another important drawback was that the specific characteristics of both countries studied constrained the estimation of the SPS barriers. Furthermore, the current calculation of the import demand elasticity is dependent upon the level of SPS barrier specified, affecting the revenue simulation.

There are some areas for future research derived from this study. The most important one is how to deal with SPS tariff equivalents for heterogeneous products. A better estimation of the export supply and import demand equations, including the calculation of the corresponding elasticities, is another. A common challenge faced by researchers in the trade area is the limited availability and quality of data.

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