Survival of the Fittest: Explaining Export Duration and Export Failure in the U.S. Fresh Fruit and Vegetable Market

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Abstract:
This study investigates the factors that impact the duration of trade relationships in U.S. fresh fruit and vegetable imports. We employ both the survival analysis (KM estimates and Cox PH model) as well as a count data model. The preliminary results indicate that SPS treatment requirements positively impact duration while new market access issued during the study period negatively impacts duration. Developed countries and countries located in North America experience longer duration. Other factors typically included in trade duration models were also investigated. Additionally, we employ a Heckman two-step procedure to understand the impact of duration on the probability of trading and trade volume, and find that both are positively impacted therefore suggesting that more stable trade relationships also tend to involve a higher volume of trade.

Keywords:
Fresh fruits and vegetable, U.S. imports, Survival Analysis, Count Data, Heckman Two-Step Model

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1. Introduction

In the last twenty years, US imports of fresh fruits and vegetables have increased sharply from $2.3 billion in 1989 to $10.5 billion in 2009 (USDA/FAS). During this period, fresh vegetable imports grew at an annual rate of 8.3 percent while fresh fruit imports grew at an annual rate of 7.0 percent. The factors that have contributed to this increase in US imports include increasing consumer incomes, changes in consumer preferences for year round supply of fresh produce and a greater variety of fresh fruits and vegetables, and reductions in tariffs and non-tariff barriers as well as increase market access through bi- and multi-lateral trade agreements (Aksoy and Beghin, 2005; Clemens, 2004; Lucier et al., 2006; Johnson, 2010).

Recent work by Besedeš and Prusa (2006a, 2006b) has shown that the duration of trade relationships tends to be short with numerous entries and exists (leading to multiple spells of service) in a market. This suggests that the growth in trade may be occurring more through increases in the intensive margin (e.g., increasing value of trade for existing trade relationships) rather than the extensive margin (e.g., increases in trade in new products or to new countries).

Exports of fresh fruits and vegetables to the US also exhibit a similar pattern. Defining duration as the number of consecutive years that a country exports a specific fresh fruit or vegetable commodity during our sample period, 1996-2008, or a 13 year timeframe, the average duration was 5.9 years. Duration for fresh fruits was slightly longer at 6.0 years than the duration for fresh vegetables at 5.7 years. In addition, multiple spells of service, where a country stops exporting a given fresh fruit or vegetable and then begins to export again at a later date, are also common. Between 1996 and 2008, the average number of spells per country-commodity pair was 1.45, with a maximum of 5 spells. Again, the average number of spells for fruits is slightly lower (1.42) than for vegetables (1.49).

As shown in Tables 1 and 2, there is significant variation in the average duration across the fresh fruit and vegetable commodities. For fresh fruits, duration ranges from 2.4 years for apricots to 6.0 years for grapes. For fresh vegetables, duration ranges from 1.9 years for potatoes to 5.4 years for asparagus. In addition, even for a commodity that has a relatively long average duration, there is variability in duration and the number of spells between exporting countries. For example, consider the case of apples that has an average duration of 5.1 years. Of the 16 countries that exported apples to the US between 1996 and 2008, only 5 exported at least $10,000 per year throughout the entire period (See Table 3). Hence, those five countries (Argentina, Canada, Chile, Japan and New Zealand) had one spell of service each, which lasted for 13 years. Eight exporting countries had one spell of service each that lasted between 1 and 5 years. Finally, 3 exporting countries had multiple spells of service.

Given the high-level of dynamism observed in US fresh fruit and vegetable imports, the main objective of this paper is to identify the factors that affect the duration of trade in US fresh fruit and vegetable imports. To our knowledge, this is the first study on trade duration in fresh fruits and vegetables. In addition to considering how factors such as differences in trade costs (e.g., transportation costs, tariffs, etc.) may affect trade duration, we will also determine whether U.S. regulatory and trade policy affects trade duration.

To prevent the introduction of plant pests and diseases from the importation of fresh fruits and vegetables, the Animal and Plant Health Inspection Service (APHIS) has the authority to promulgate import regulations by country and commodity under the Plant Protection Act of

2000. Each exporting country must petition APHIS before being permitted to export a specific product to the United States. If the exporting country has identified pest risks and has not developed approved mitigation practices, APHIS can deny the petition. However, if mitigation measures that reduce the risk of pest or disease outbreaks can be identified, APHIS will recommend that the product be allowed to enter subject to a set of phytosanitary (SPS) measures. If no pest risks are identified, then APHIS will recommend that the product be allowed to enter subject to routine inspection requirements. In this paper, we will focus our attention on the effects of phytosanitary treatments, such a methyl bromide fumigation or cold treatment, on duration because these treatments are costly for exporters to implement. A second policy related issue we will investigate is whether countries that gained new market access for a specific fresh fruit or vegetable have shorter trade duration than established exporters. Between 1996 and 2008, APHIS granted new import permits to 67 country-product pairs.

Several different methodologies have been utilized to analyze trade duration. The most commonly used method is survival analysis. However, Hess and Persson (2010) argue that this method may not be appropriate for a variety of factors. First, there are numerous spells of service with exactly the same duration and continuous time methods face difficulties in dealing with this issue leading to biased coefficient estimates as well as biased standard errors. It is also difficult to properly control for unobserved heterogeneity in survivor analysis and the assumption of proportional hazards may not be appropriate in all application. As a robustness check, we will use a Cox Proportional Hazards (PH) model (survival analysis method) and a Poisson (count data) model to identify the factors that affect trade duration. However, because neither of these models can provide any insight on what factors affect the decision to export, we also use a two-step Heckman procedure to understand how duration impacts the decision to export a commodity, as well as the volume of exports.

2. Literature Review on Trade Duration

In their seminal work Besedeš and Prusa (2006a) have found that the duration of trade of a given product between two countries is, on average, relatively short lived and there are a large number of entries and exits. They compared US imports during two different periods, from 1972 to 1988 and from 1989 to 2001.[2] During both periods of analysis, more than half of trade relationships fail after one year of service and about 70% fail within two years of service. The mean spell length is about 3 years but the median spell length is only 1 year. Despite the fact that the majority of trade relationships seem to be very short lived, Besedeš and Prusa find that the conditional probability of failure decreases with duration, where failure is defined as exit from the market. More specifically, using a nonparametric approach and estimating the Kaplan Meier (KM) survivor function[3], the authors conclude that relationships with exporters from North America have the highest rate of survival with 78 percent of the relationships surviving the first year. On the other hand, the relationships with exporters from Africa have the lowest rate of survival with only 52 percent of the relationships surviving after the first year and only 29 percent after four years of service. The results are robust across different model specifications (Besedeš and Prusa, 2006a).

In subsequent work, Besedeš and Prusa (2006b) analyzed whether there are differences in the duration of trade between differentiated and homogeneous goods. They hypothesized that

[2] Data used in this as well as the rest of the studies that will be discussed in this review are all country-level data unless otherwise indicated, mostly because of the lack of widely available import/export data at the firm level.
[3] The Kaplan-Meier estimator is "a non parametric estimate of the survivor function $S(t)$, which is the probability of survival past time t or, equivalently, the probability of failing after t." (Cleves et al. 2010, p.93).

import spells of differentiated goods have a higher chance of survival than import spells of homogeneous goods. They also hypothesized that trade duration is positively correlated with the size of initial transaction for both types of goods. Using the nonparametric approach (KM estimates) they find that the probability of survival to year two for spells of differentiated goods is higher (69 percent of those relationships survive) than for homogeneous goods (55 percent of those relationships survive to year two). This finding is confirmed by estimating the hazard rate[4] through a Cox proportional hazard (PH) model. They find that spells of homogeneous goods have a 23 percent higher hazard rate compared to differentiated goods. Similarly, the authors find evidence that trade relationships with smaller initial transaction size have a lower survival rate than those with larger initial transactions, for both product types. When the sample includes only spells of service for which the initial transaction size is at least $100,000, 69 percent and 55 percent of trade relationships involving differentiated and homogeneous goods respectively, survive to year two. However, when the sample is restricted to spells of service with initial transaction size exceeding $1 million, 99 percent of relationships involving differentiated goods and 75 percent of relationships involving homogeneous goods survive to year two. The Cox PH model results give a similar picture (Besedeš and Prusa, 2006b).

In the U.S. data, only three percent of the trade relationships between the U.S. and another country that have more than $1 million in initial sales fail after one year, but almost 50 percent of trade relationships with initial sales of less than $10,000 fail by the second year (Besedeš, 2008). One explanation for this is that relationships with higher search costs, which may include uncertainty and lack of information, will begin with lower initial sales and will be more likely to

[4] The hazard function or hazard rate is "the (limiting) probability that the failure event (in our case, exit from the market) occurs in a given interval, conditional upon the subject (in our case, spell of service) having survived to the beginning of that interval, divided by the width of the interval." (Cleves *et al.* 2010, p.7).

fail. Besedeš (2008) uses a set of four variables to approximate the search costs incurred for a trade relationship: distance between the U.S. and exporting country, common language, contiguity, and number of potential suppliers in the market.[5] In addition, variables measuring supplier reliability, relative cost of trading, and initial transaction size are also included in a stratified[6] Cox PH model.[7] The author finds that the lower the search costs, the lower is the hazard rate (or conversely, the higher the conditional probability of survival). For example, trade relationships with Mexico have a 28 percent lower hazard rate due to its contiguity with the U.S., while trade relationships with English speaking countries face a 3 percent lower hazard rate compared to those from non-English speaking countries. Distance on the other hand does not have a significant impact on the hazard rate, increasing the distance of the exporting country from the U.S. by 1,000 kilometers leads to a 0.015 percent increase in the hazard rate. Finally, increasing the number of potential suppliers to the U.S. interestingly decreases the hazard rate. The author also finds that more reliable exporters, as measured by a higher GDP per capita and a lower number of spells of service per country-commodity pair, face a lower hazard rate. The cost of trading as measured by the transportation costs and changes in the exchange rate also has the expected impact, although the impact of higher transportation costs is much lower than that of the exchange rate (Besedeš, 2008). In subsequent studies, Besedeš also explores the impact of NAFTA on duration of trade partnerships between the U.S., Canada and Mexico (2011b), as well as offering a view on how the findings in trade duration can be incorporated on the debate of the role of extensive versus intensive margin of trade (Besedeš and Prusa, 2010).

[5] Since firm characteristics are not observed, the author uses a combination of country characteristics as well as the number of other potential suppliers as proxies of the search costs incurred (Besedeš, 2008).
[6] The stratified Cox model allows the baseline hazards to differ by group, but the coefficients of the covariates are restricted to be the same (Cleves et al. 2010, p.144).
[7] The model was stratified by region and one-digit SITC industries (Besedeš, 2008).

Pursuing the same topic in another region, Nitsch (2009) conducted a similar analysis for German imports over the period of time 1995-2005. He also found that on average, trade relationships between countries for a given product tend to be short-lived with numerous entries and exits. In studying the factors that impact duration[8], he concluded that Gravity model variables that were successful in explaining the duration of U.S. import relationships, also do well in explaining the duration of German import relationships. For example, trade relationships with countries with higher GDP have lower hazard rates hence their spells of service have longer duration. On the other hand, the spells of service from countries further away are shorter. Contrary to what one would expect, spells of service from richer countries (as measured by GDP per capita) have higher hazard rates. As in the case with U.S. import relationships, spells of service from countries bordered with Germany or those that share a common language last longer. The author further finds that the impact of exchange rate is not statistically distinguishable from zero; neither does membership of the exporting country in the EU have any impact on the hazard rates (Nitsch, 2009).

In addition to Nitsch (2009), other studies on trade duration have focused on trade relationships for countries in East and West Africa (Cadot *et al*., 2011) and East Asia (Obashi, 2010). While the results vary a little bit qualitatively, the overall short duration and dynamism remain similar. In contrary to most studies on the topic, Cadot *et al.* (2011) use firm level rather than country level data. Additionally, Besedeš (2011a) analyzes the duration of trade partnerships among the transition countries of Central and Eastern Europe. Several studies have also explored the factors that impact trade duration for developing country exporters (Brenton *et al.* 2009, Brenton *et al.* 2010). While several authors have explored the problem of trade duration

[8] The author employs both the Kaplan-Meier estimate method as well as the stratified Cox proportional hazard model. He stratified the Cox model by World Bank regions and 1-digit industries (Nitsch, 2009).

for different regions involving diverse sets of trading partners, to the best of our knowledge our study is the first to focus exclusively on a very narrow group of commodities.

3. Empirical Methods

3.1. Survival Analysis

Survival Analysis is the method of analyzing the time until the occurrence of an event. It is widely used in the field of Medicine to understand the risk from different diseases, reactions to medicine, and whether different medical treatments lead to different rates of survival among patients with a given medical condition. In Economics, survival analysis has been used to understand the factors that lead to exit from unemployment[9] and more recently to understand the duration in trade relationships. Our analysis falls into the latter category, to understand what factors impact the duration of the spells of service of U.S. FF&V imports.

Let T be a nonnegative random variable denoting the time to a failure[10] event with a probability density function $f(t)$ and a cumulative distribution function of $F(t)$. The survival function $S(t)$ is then defined as:

$$S(t) = 1 - F(t) = Pr(T > t). \tag{1}$$

Thus, the survivor function is simply the reverse cumulative distribution function of T (Cleves *et al.* 2010, p.7). The hazard function, $h(t)$, is defined as the probability that the failure event occurs in a given interval, conditional upon the subject having survived to the beginning of that interval, divided by the width of the interval. Specifically:

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[9] See for example Mills (2000).

[10] Failure can be defined in many different ways. In Medicine, failure can be the event of a patient dying. In the unemployment duration literature, failure is the event of exiting unemployment (e.g. finding a job). In trade duration literature, failure occurs when an exporter stops exporting (i.e. the spell of service ends).

$$h(t) = \lim_{\Delta t \to 0} \frac{Pr(t + \Delta t > T > t \mid T > t)}{\Delta t} = \frac{f(t)}{S(t)}. \tag{2}$$

For example, if we would like to know the hazard function for time $t = 10$ it will be: $h(t = 10) = \Pr(11 > T > 10 | \mathrm{T} > 10)$. Based on the assumptions about the form of the survivor function and the impact of the covariates on the survival experience, the survival analysis method includes three sub-methods: nonparametric, semiparametric and parametric[11] approaches.

In the nonparametric approach, no assumptions are made about the functional form of the survivor function and nonparametric tests, such as the log-rank or Wilcoxon test are used to determine if there are differences between subgroups of individuals in the sample. Most previous studies on trade duration have used the Kaplan-Meier (KM) estimator of the survivor function (Besedeš and Prusa 2006a, Besedeš and Prusa 2006b, Nitsch 2009). The KM estimator is defined as:

$$\hat{S}(t) = \prod_{j \mid t_j < t} \left(\frac{n_j - d_j}{n_j} \right) \tag{3}$$

Where n_j is the number of individuals at risk at time t_j and d_j is the number of failures at time t_j. The KM estimate is product over all failure times less than or equal to t.

The main limitation of this approach is that one can only consider pair-wise comparisons. If there is heterogeneity among the individuals in each subgroup, it is not possible to hold any additional factors constant (e.g., *ceteris paribus*) when making the pair-wise comparison. It is

[11] For a detailed explanation of the parametric approach, see Cleves *et al*. (2010). This approach will not be explained here since its assumption of parameterization of both the hazard function as well as the impact of the covariates makes it of limited usefulness in our problem. Also, to the best of our knowledge, it has not been used in the trade duration literature.

also difficult to make comparisons across subgroups or factors that are continuous (e.g. GDP, GDP per capita, distance, production level, etc.). However, the KM estimates of the survivor function may still be able give some useful insights on how the survivor function differs between country-commodity pairs that have SPS treatment requirements and those that do not and between country-commodity pairs that received new market access (NMA) between 1996 and 2008 and those that had market access in 1996. However, the main part of our analysis using the survival analysis method will be focused on the Cox PH model.

In semiparametric models (i.e. Cox PH model) the effect of the covariates is parameterized to alter the baseline hazard function (Cleves *et al*., 2010). However, the survivor function is not given a parametric form; hence we do not need to assume that the baseline hazard function has a specific shape (Royston and Lambert, 2011). This model therefore allows us to understand how covariates impact the hazard function. Suppose we only have one covariate x in our analysis,[12] then the hazard function can be expressed as a product of two functions: $h(t, x, \beta) = h_0(t)r(x, \beta)$, where $h_0(t)$ is the baseline hazard function which expresses how the hazard function changes as a function of survival time. The function $r(x, \beta)$ expresses how the hazard function changes as the covariates change (Hosmer *et al*., 1999). The hazard function may equal the baseline hazard function, that occurs when $r(x = 0, \beta) = 1$, which in our case would mean that the value of all the covariates equals zero. We cannot imagine a case where variables such as GDP, distance, production levels, etc., all equal zero. Hence, that case is not interesting to us, and it's not interesting in most empirical applications. Instead, the Cox PH model allows us to gain an understanding of the hazard function and the impact of the covariates without even

[12] The explanation can very easily extend for multiple covariates.

estimating the baseline hazard function. Using the notation of Hosmer *et al.* (1999) consider the ratio of the hazard functions for two subjects with covariate values denoted x_1 and x_0:,

$$HR(t, x_1, x_0) = {h(t, x_1, \beta)}\Big/{h(t, x_0, \beta)}$$

$$HR(t, x_1, x_0) = {h_0(t) r(x_1, \beta)}\Big/{h_0(t) r(x_0, \beta)}$$

$$HR(t, x_1, x_0) = {r(x_1, \beta)}\Big/{r(x_0, \beta)} \tag{4}$$

Therefore, the hazard ratio depends only on the function $r(x, \beta)$, and it is generally easy to interpret. Given this insight, Cox (1972)[13] proposed a model with the following parameterization of the impact of the covariates:

$$h(t, x, \beta) = h_0(t) e^{t\beta} \tag{5}$$

where the hazard ratio is:

$$HR(t, x_1, x_2) = e^{\beta(x_1 - x_0)} \tag{6}$$

Hence, when the covariate is a binary variable (for example, SPS treatment requirement where $x_1 = 1$ which denotes required SPS treatment(s) and $zero\ otherwise$, the hazard ratio estimated by the Cox PH model becomes: $HR = e^{\beta}$. If for example the value of the coefficient is estimated to be: $\beta = \ln(2)$, then the interpretation is that spells of service for commodities for which SPS treatments are required are failing (ending) at twice the rate of those for which there are no SPS treatment requirements. Note that both the hazard function as well as the hazard ratios can be easily extended to include multiple covariates.

[13] We continue to use the notation as Hosmer *et al*. (1999).

Following the literature on duration, we will also estimate a Cox PH model. We will consider covariates such as: GDP per capita, transportation costs, tariff rates, , U.S. production of the given commodity, exporting country production levels and its global share of production for the given commodity, international prices, SPS treatment requirements, and NMA permits. An issue that deserves some attention in the discussion of Cox PH model, is that of data censorship and truncation. There are several types of data censorship and truncation (Cleves *et al.*, 2010), however only two types are applicable to our case: right censoring and left censoring. Right censoring occurs when a subject (spell of service) is not observed to have failed (ended) by the time the study period ends. Left censoring occurs when a spell begins before the analysis period, prior to 1996, in our sample. While the Cox PH model can handle right-censored observations, it is less clear in the literature how left-censored observations should be handled.

Hence, we run the Cox PH model in four variations of our sample. The samples include: the full sample, first spell of service only, left-censored observations excluded, and gap adjusted sample that "fills" all one year gaps between two spells of service. While the Cox proportional hazard model is useful as it allows us to understand the impact of the factors of interest, *ceteris paribus*, Hess and Persson (2010) identify several limitations in its use for trade duration analysis. They recommend a discrete-time model specification. Hence, in addition to the Cox proportional hazard model, we employ a discrete time model (Count Data model) and compare the results between the two approaches.

3.2. Count Data Model

Consider a random variable $N(t)$ which describes the number of occurrences during the interval $(0, t)$, where $t > 0$. The count data framework is used to model $N(T)$ for a specific time interval (T). For a fixed interval of time, if the probability distribution of $N(T)$ is a Poisson distribution, then a Poisson model is appropriate.[14] Hence, we estimate a Poisson model where the dependent variable is defined as the total number of years the U.S. imports a commodity from a given country. In the case of multiple spells, the numbers of years are added across all spells of service. However, to control for ins and outs in the count of trade, we also include a variable to control for multiple spells. In the case of fresh apples, Table 3 shows that Argentina exported for 13 years, Australia for 3 years, Brazil for 8 years, and so on. Hence, the dependent variable does not include information on the number of spells of service. The same set of explanatory variables used in the Cox PH model is also used in the Poisson model. In addition, we will explore the impact of several interaction terms between the binary variables for multiple spells of service, NMA, SPS treatment requirements, and the rest of the explanatory variables.

The main limitation of the Poisson distribution model is the independence assumption. Namely the probability of an event happening in a certain time interval is independent of an event happening in another non overlapping time interval. In our case, this means that the probability of a country exporting a commodity to the U.S. in 1996 is independent from the probability of a country exporting the same commodity to the U.S. in 1997. This is highly unlikely. In fact, most likely the probabilities of these events occurring are related. To address this limitation, we employ a Heckman two-step procedure, as explained in the next section.

3.3. Heckman Two-step Model

The Heckman two-step procedure is used in applications where the selection into an activity and the intensity of the activity are not necessarily impacted by the same factors in the same manner. The typical example is that of the decision to work and the wage rate. While

[14] Winkelmann (1994) offers an extensive review of Count Data Models.

education and experience are likely to impact both the decision to work as well as the wage rate (though they do not necessarily impact these two factors in the same way), the number of children might impact the decision on whether to work or not, but is highly unlikely that it will impact the wage rate. In order to carry on one of the objectives of this study, we will employ the Heckman two-step procedure in order to understand how duration and the number of the spells of service impact both the decision to export FF&V to the U.S. in any given year, as well as the amount exported (as measured by the total customs value) once a country decides to export. We will use common language as the exclusion factor.

4. Results

4.1. Survival Analysis

A nonparametric approach allows one to make pair-wise comparisons of the survival function between different groups within the sample. For example, does the survival function differ between exporter/commodity pairs subject to an SPS treatment (e.g., fumigation with methyl bromide or cold treatment) as a condition of entry into the U.S. compared to those that are not? As shown in Figure 3, for the 1,258 country/commodity/spell observations in our sample, the conditional probability of survival is higher in all years for the country/commodity pairs with SPS treatment requirements (*Treat*) compared to those that do not. This may indicate that countries which already have invested in the necessary technologies to perform the required SPS treatments have an incentive to remain in the market for a longer duration. Note that the difference between the two groups in this case is statistically significant, according to the log-rank test.

One of the provisions of the Agreement on Agriculture (AoA) from the Uruguay Round of WTO negotiations is that member countries provide increased market access to other member countries. Between 1996 and 2008, the US has granted new market access to 67 country/commodity pairs (Jankovska *et al.*, 2011). Figure 2 shows how the survival function differs between country/commodity pairs that were granted new market access between 1996 and 2008 (*NMA*) and those country/commodity pairs that had market access throughout the period. The survival rate decreases more rapidly for country/commodity pairs that gained new market access . This may indicate that new entrants have a more difficult time in deepening relationships with buyers/retailers in the US compared with existing suppliers. However, the difference between the two groups is not statistically significant according to the log-rank hypothesis test, likely due to the low number of observations associated with NMA.

As with any non-parametric analysis, the pair-wise comparisons are not able to hold all other variables constant. So while one can identify correlations between the survivor function and the variable of interest, it is not possible to prove causality. To do so, requires a semi-parametric method. We estimated a non-stratified Cox PH model that included a binary variable to account for multiple spells in addition to the explanatory variable identified in the previous section.[15] Table 4 contains the results for each sample considered. Note that if a coefficient is positive (negative), the hazard rate increases (decreases) by the associated percentage. Table B.1 in Appendix B contains variable descriptions along with units of measurements.

Across the different sample specifications, the estimated coefficients that are statistically different than zero are robust.[16] If a trade partnership experiences more than one spell of service during the period considered, the impact is positive in the hazard rate for two samples. That is, country-commodity pairs with more than one spell of service have a 39-49% higher hazard rate

[15] We also estimated stratified Cox proportional hazard models stratified by spell, as well as non-stratified and not including a variable to check for the impact of higher order spells – the results were similar to the ones reported here and are available upon request.

[16] Note that since the coefficients for the traditional gravity model variables were not statistically significant in other model specifications considered, they were not included in the Cox PH model specifications.

than those that only have one spell of service. This is an expected result because relationships with multiple spells of service tend to be more unstable, as demonstrated by the frequent movement in and out of the market. Receiving new market access increases the hazard rate in three of the four samples considered, but the impact is not statistically significant with the exception of the First Spell Only Sample. Fruits tent to have a higher survival rate than vegetables. On average, the hazard rate for fruits is 21% lower than the hazard rate for vegetables (in the Full Sample). As most fruits are perennial, it is likely that a country will continue to export regardless of the price level because producers in that country will not readily switch to producing other commodities. Country-commodity pairs that are required to use a SPS treatment have a 41.7-47.0% lower hazard rate than county-commodity pairs that are not required to use a SPS treatment. This is a significant result because it implies that countries that are required to implement a phytosanitary treatment for fresh fruits or vegetables are able to remain in the market for an average of 7 years compared to only 5.6 years for those that do not. This may indicate that once a country has invested in human resources and infrastructure to fulfill the SPS requirements; they are more likely to continue exporting the given commodity.

With the exception of North America, the regional hazard rates are not statistically significant. Hence all other regions were dropped from the model and we only check whether countries in North America experience different hazard rates than the rest of the world. Compared to other exporting countries, exporting countries located in North America have a 26.2-31.1% lower hazard rate, and the impact is statistically significant in three samples. When only considering the first spell, high-income countries have a 64.7% lower hazard rate than low-income countries. This results suggests that it may be more difficult for low income countries to establish longer lasting trade relationships possibly due to lower product quality as well as higher uncertainty associated with suppliers from such regions.

The average value of exports per country-commodity pair is highly correlated with the average quantity exported, and both variables have a statistically significant impact on the hazard rate. In order to remove the price effect, we use the average quantity variable to measure whether countries that tend to export more, experience a higher or lower hazard rate. Increasing the quantity exported (in metric tons) by 1% decreases the hazard rate by approximately 20.7-37%, and the impact is statistically significant across all four samples. This variable as well may be considered a measure of the stability of the relationship, hence the more stable an exporting relationship, the higher the quantity exported and hence the longer the duration of the relationship. The impacts of transportation costs and tariff rates are not statistically significant.

An increase in the average (across the whole time period) U.S. production of a commodity surprisingly decreases the hazard rate. The impact ranges from 5.8-8.8% for a 1% increase in U.S. production – and the impact is statistically significant across samples. As we do not have a measure of demand for the specific commodities, this variable may be capturing the impact of an increase in demand. The share of world exports of a certain commodity also has a negative impact on the hazard rate. This is expected as a greater share of exports for a certain commodity indicates that a country is a bigger player in the world market for that commodity, hence its trade relationships more stable and longer lasting. On the other hand, increasing the average U.S. domestic producers' price (measured in $/ton) by 1%, decreases the hazard by 16.9-30.5% across the four samples, and this impact is highly statistically significant. Thus, countries that export a commodity that has a higher value in the US market will be more likely to survive than countries exporting lower valued products. This variable is highly correlated with the average global price in our data, and when considered separately both have a similar impact.

Two additional variables that lead to statistically significant changes in the hazard rate are: *AvgNoProductsUS* and *AvgNoOfPartners.* If a country exports an additional commodity to the U.S. on average, the hazard rate decreases by 2.6-3.8% This indicates that experience with a country leads to longer duration of trade relationships with that country. Further, as the average number of countries that export any given commodity to the U.S. increases by 1 additional country, the hazard rate decreases by 5.3-7.5% in all samples considered. This indicates that as the U.S. increases the number of suppliers for any given commodity, the probability of survival for all the exporters increases – a counterintuitive results since it suggests that more competition between suppliers increases duration.

Overall, the results indicate that the hazard rate increases when trade relationships experience multiple spells of service, when exporting countries are classified as "low income" and are not close to the U.S. (i.e. not in North America), and when the NMA permits has been issued during the study period rather than before the study period begins. On the other hand, SPS treatment requirements decrease the hazard rate, and so does an increase in the production capacity of the exporting country and an increase in prices, etc. Changes in tariff rates and transportation costs were found to be statistically insignificant to explaining the hazard rate in FF&Vs.

4.2. Count Data Model

The results for ten variations of the Poisson model are given in Table 5. [17] Variation 1 and Variation 2 control for five main variables: whether the commodity is a fruit or a vegetable, whether a new market access was granted during the period considered, whether any SPS treatment is required, whether the exporting country is located in North America and the natural log of the average GDP per capita of the exporting country. In addition, these two variations consider the role of spells in trade duration. Hence, Variation 1 includes binary variables for observations with 2 spells of service, and 3 or more spells of service (a very low number of observations experiences more than 3 spells, hence we grouped them together), hence keeping the one-spell observations in the control group. Variation 2 includes a binary variable for observations with any number of spells higher than one, again keeping the one-spell observations in the control group. Variation 3 expands the model to include interaction terms between four variables (*NMA*, *Treat*, *NorthAmerica* and *LnAvgGDPperCapita*) and the variable *MultipleSpellsD*. Variations 4 and 5 are similar to Variations 2 and 3, except that instead of using a binary variable for higher order spells and its interaction, we use a variable that includes the number of spells of service for each observation and also interacts that variable with the main four variables mentioned. This helps us understand whether it matters if a relationship experienced one versus multiple spells of service, or whether we can derive some insight from the exact number of spells (in the case of multiple spells) and their impact on trade duration. Variations 5 and 6 include more explanatory variables, such as: average transportation cost, average U.S. production of any given commodity, etc. The difference between the two variations is that while the former includes the average quantity and a measure of growth of the quantity exported for all country-commodity pairs, the later includes the average customs value of the

[17] Table B.1 in Appendix B contains the list of the explanatory variables used in the model along with their associated descriptions.

exports as well as the growth rate of the customs value. Variation 7 and 8 are similar to variations 5 and 6 except that the interaction terms are added back to the model as in Variation 3. Finally, variations 9 and 10 include the variable on the total number of spells (instead of the binary variable for multiple spells). The difference between the two is that again, variation 9 includes the two variables on quantity exported, whereas variation 10 includes the two variables on the customs value of the exports.

Of all the variables considered, the four main variables (*NMA, Treat, NorthAmerica* and *LnAvgGDPperCapita*) were all statistically significant across all the variations of the model. On the other hand, there were no statistically significant differences in trade duration for fruits versus vegetables in any of the variations considered. New market access reduces the duration of trade, However, this variable interacted with any of the measures of multiple spells (*NmaMsInter, SpellNMAInter*) has a positive impact on duration. This suggests that for country-commodity pairs with new market access, the impact is negative overall, however if there are multiple spells of service the impact becomes positive leading to longer duration in trade. On the other hand, SPS requirements lead to a higher duration in trade. The intuitive explanation is that once a country invests on the necessary equipment and human capital to fulfill the SPS treatment requirements, they are less likely to stop exporting (because of the high investment that has already been incurred). Again, the interaction terms with the multiple spells variables (*TreatMSInter* and *SpellTreatInter*) have the opposite sign in Variations 3 and 4 and they are statistically significant at the 1% level of significance. This suggests that while SPS treatments have a positive impact on duration, country-commodity pairs that experience more than one spell of service tend to experience a shorter duration. Conversely, if the exporting country is located in North America, the duration tends to be longer and the impact is statistically significant across all variations. Notice however that the impact is smaller as we control for additional variables in variations 5-10. Again, the interaction terms with multiple spells of service have a negative sign indicating that the duration is reduced if a country experiences more than 1 spells of service. Richer exporting countries, as measured by GDP per capita, experience longer duration, but duration declines with multiple spells of service. The impact of multiple spells of service seems to be primarily negative across the different variations. Variation 1 however, suggests that the impact of the second spell of service is stronger than the proceeding spells beyond the second.

As indicated above, quantity and customs value are highly positively correlated – hence it is not surprising that they both have a similar impact on the results. Both a higher average quantity of exports as well as a higher average customs value lead to longer duration – however the impact of customs value is larger than that of quantity. Both variables are statistically significant at 1% level of significance. Higher growth rates of both the quantity exported and of the customs value, contrary to intuition, lead to lower trade duration. These results are also statistically significant in all the variations (5-10) of the Model. Among the other control variables included, an increase in the average transportation cost leads to a higher duration of trade and so do higher average tariff rates. Both results are statistically significant across several model variations. These results are counterintuitive and do not coincide with the results from the Cox PH model where these variables were found to be statistically insignificant. As an exporting country exports more commodities to the U.S., the overall duration increases. Similarly, a higher number of exporting partners for any given commodity leads to a longer duration, although the impact is relatively small. Both results are similar to the results obtained from the Cox PH model. Overall the results are strikingly similar with the results obtained from the survival analysis methodology. Namely, factors that decrease the hazard rate based on the results from the

Cox PH model, also lead to longer duration as measured by the total number of years a country exports a given commodity as indicated by the results of the Count data model. While the results cannot be compared strictly quantitatively as the interpretation of the coefficients in the two models is not the same, qualitatively they tell the same story.

4.3. Heckman Two-Step Model

In order to understand how different covariates impact the probability that a country exports a certain commodity to the U.S., as well as how covariates impact the total volume of trade, we estimate a Heckman two-step model. The results from the two model specifications are given in Table 6.[18] In explaining the results we will concentrate on the benchmark Variations (1a and 2a), but we also report the results from an alternative specification of the sample in Table 6.[19] The dependent variable in our model is the natural log of customs value.

In Variation 1 we include five main variables of interest. *YearsOfService1/2* and *SpellCount1/2* are two variables that measure duration, namely the total number of years exporting (up to that point) and the total number of spells (up to that point) respectively. We include these two variables in all our model specifications, because as indicated in our objectives, we want to understand the impact of duration on the probability of selecting to trade as well as on the volume of trade. In addition, Variation 1 of the model also includes binary variables for *Fruit*, *NMA* and *Treat*, and the exclusion variable in the selection model is *ComLangOff* which is a binary variable indicating whether the exporting country and the U.S.

[18] For the Heckman two-step model we use the full panel sample hence the variables are kept as they are (rather than averaged out across years as for the two Cox PH model and Poisson distribution model. The dataset for the Heckman model contains 14,551 observations (country-commodity-year pairs), although some of the observations are lost in Variations 2 and 3 of the model as a result of missing data on the explanatory variables.

[19] Note that in Table 6 we report both the benchmark results (where the observations for which the customs value of imports is <$10,000 are coded as 0) – Variations 1a and 2a.; as well as the results from the original sample (where the customs value of imports is left as it is) – Variations 1b and 2b..

share a common official language or not. While having a common official language might facilitate initial contacts and decrease search costs (hence impacting the probability to export) it likely has no impact on the volume of trade once a country decides to export. In addition to these variables, Variation 2 of the model includes additional explanatory variables such as: transportation costs, tariff rate, the existence of a free trade agreement between the U.S. and exporting country, U.S. and exporting country real GDP, level of production in the U.S. and exporting country, etc. In addition, interaction terms between *Treat* and *Fruit* as well as *Treat* and *NMA* are included. The selection equation in addition to the binary variable on common language as an exclusion factor, also includes binary variables indicating whether the exporting country is an island or landlocked.

The results are quite consistent across the two sample specifications. An increase in the years of service has a positive impact both on the probability of exporting as well as on the volume of exports. One additional year of exports (in the past) increases the probability of exporting that given year by 33 – 40% and increases the volume of trade for that year by 3-10% (Variations 1 and 2). An increase in the total number of spells positively impacts the probability to export but negatively impacts the volume of exports. These results are statistically significant across both samples and model specifications. They indicate that while a larger number of years and spells of service both increases the chances that a country exports to the U.S., the former also increases the volume of trade while the later leads to a decrease in the volume of trade. In some way, these two variables can be considered a measure of the stability of a trade relationship. That is, the longer a country has been exporting a commodity to the U.S., the more stable that relationship is and hence the greater the probability that the relationship will continue and will grow stronger as measured by the volume of trade. But a higher number of spells of service indicates that the country has been in and out of the market more frequently, hence the relationship is not that stable and therefore the volume of trade of such relationships is smaller. The interesting result however is that contrary to what one might expect, a higher number of spells actually increases the probability that a country decides to export to the U.S.

NMA has a positive impact on the selection to trade, but the effect on the volume of trade is not statistically significant. However, countries with NMA which are required SPS treatments are less likely to export compared to those that are not required SPS treatments. In general, SPS treatment requirements negatively impact the volume of trade (Variation 2), a result which is statistically significant in both samples. There are no statistically significant differences for fruits versus vegetables except for Variation 1 of the model, which indicate that the volume is higher for fruits. The impact of SPS treatment requirements for fruits indicate a positive effect on the volume of trade. Hence, for vegetables SPS treatment requirements lead to a smaller volume of trade, for fruits such requirements lead to a larger volume of trade. In both cases, the impact on selection is not statistically significant.

The existence of a free trade agreement between the U.S. and the exporting country, as expected, positively impacts both the selection to trade as well as the volume of the imports. Interestingly, as the U.S. GDP increases, the probability of selecting to export to the U.S. goes down. However, an increase in the GDP of the exporting country increases the probability of selecting to export to the U.S., but decreases the volume of exports for FF&V. Since we are not controlling for the production of other commodities, it may be the case that as exporting countries develop (as measured by the increase in the GDP) they move away from producing agricultural goods to other sectors, hence the decrease in the volume of FF&V exports. Indeed increases in the production in exporting countries increases both the probability of selecting to export as well as the volume of exports. Similarly, a higher price leads to a higher volume of exports as suppliers in exporting countries try to take advantage of the better prices in the U.S. market versus the home market. The exclusion variables are not statistically significant.

Overall, the Heckman two-step procedure results indicate that duration matters when it comes to countries selecting to trade, as well as in the volume of trade. Hence, not surprisingly, countries that strive to remain in the market, also generally do better in the intensity of trade. Other factors also impact the probability as well as the intensity of trade, amongst which SPS treatment requirements and NMA permits.

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Figure 1 Survival Function for Full Sample

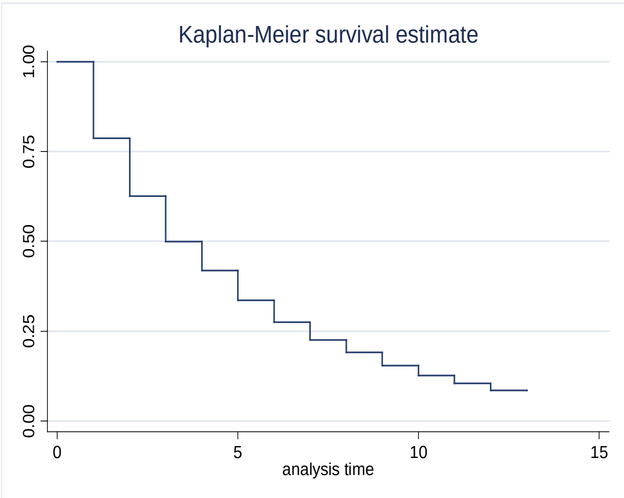
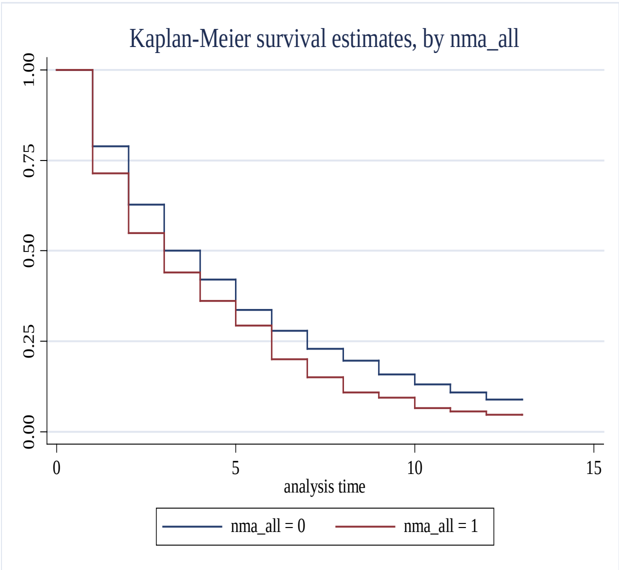


Figure 2 Survival function grouped by *NMA* **Figure 3 Survival function grouped by *Treat***



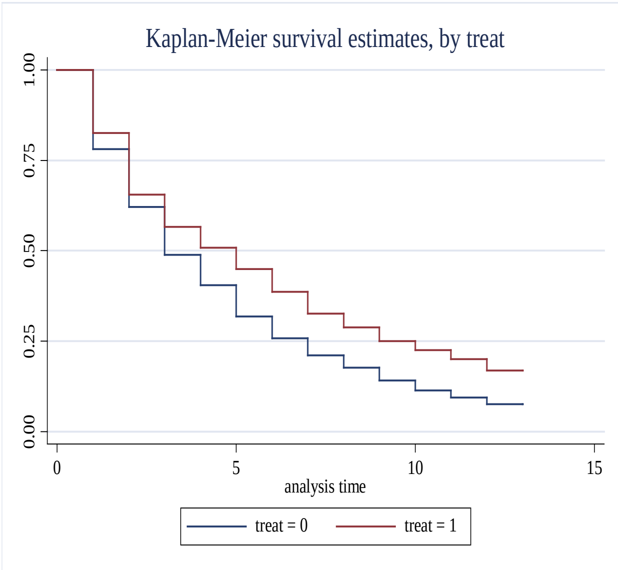


Table 1. Trade Volume and Duration of Fresh Fruits, 1996-2008

	Fresh Fruits	No. of Countries Exporting Commodity	Average Value of Exports per Year Across all Exporting Countries	Average Number of Spells per Relationship	Average Duration
1	Apples	16	$7,410,408	1.31	5.10
2	Apricots	13	$301,374	1.69	2.41
3	Avocados	11	$17,800,000	1.18	5.23
4	Bananas	30	$36,500,000	1.20	5.20
5	Cherries	17	$1,405,269	1.41	2.75
6	Cranberries & Blueberries	18	$6,238,960	1.39	3.88
7	Currants	8	$118,848	1.75	2.07
8	Grapefruit	9	$317,081	1.22	3.73
9	Grapes	15	$45,100,000	1.27	6.00
10	Kiwifruit	13	$2,890,464	1.54	3.80
11	Lemons	28	$909,126	1.82	2.71
12	Limes	18	$4,792,394	1.61	4.00
13	Mandarins & Clementines	19	$6,301,940	1.42	5.15
14	Mangoes	24	$6,874,637	1.42	5.21
15	Melon	24	$8,536,714	1.38	5.88
16	Oranges	22	$2,904,761	1.41	4.65
17	Papayas	18	$3,229,224	1.39	4.16
18	Peaches & Nectarines	12	$4,248,674	1.33	4.25
19	Pears & Quinces	18	$4,377,982	1.11	5.80
20	Pineapples	29	$7,648,794	1.45	4.52
21	Plums & Sloes	24	$1,295,749	1.38	2.76
22	Raspberries & Blackberries	15	$4,129,668	1.47	4.00
23	Strawberries	21	$3,599,202	1.52	3.19
24	Watermelons	14	$6,337,864	1.29	5.72

(UN Comtrade, 2010)

Note: The statistics only include trade relationships for which the customs value is greater than or equal to $10,000.

Table 2. Trade Volume and Duration of Fresh Vegetables, 1996-2008

	Fresh Vegetables	No. of Countries Exporting Commodity	Average Value of Exports per Year Across all Exporting Countries	Average Number of Spells per Relationship	Average Duration
1	Asparagus	20	$8,014,970	1.35	5.37
2	Broccoli	7	$4,251,773	1.29	5.00
3	Brussels Sprouts	7	$976,355	1.29	4.67
4	Cabbage	17	$796,207	1.29	3.09
5	Carrots	9	$3,247,427	1.67	4.07
6	Cauliflower	11	$520,575	1.45	3.25
7	Cucumbers	20	$12,700,000	1.50	4.30
8	Eggplants	20	$1,718,106	1.35	3.56
9	Fresh Beans	27	$1,281,631	1.48	3.20
10	Garlic	36	$1,613,435	1.53	3.29
11	Globe Artichoke	11	$195,035	1.27	3.00
12	Head Lettuce	10	$2,043,264	1.70	3.59
13	Jicamas, Pumpkins, Breadfruit	20	$921,536	1.25	4.80
14	Leaf Lettuce	12	$1,391,306	1.67	3.70
15	Leeks	11	$491,919	1.27	4.79
16	Mushrooms And Truffles	38	$1,611,274	1.55	3.92
17	Okra	15	$917,695	1.73	2.54
18	Onions	35	$5,123,894	1.80	3.95
19	Peppers	37	$14,400,000	1.46	4.13
20	Potatoes	15	$5,012,395	1.53	1.91
21	Spinach	7	$730,783	1.29	3.67
22	Squash	21	$7,230,488	1.62	4.09
23	Tomatoes	20	$46,200,000	1.45	4.62

(UN Comtrade, 2010)

Note: The statistics only include trade relationships for which the customs value is greater than or equal to $10,000.

Table 3. Trade Duration by Country for APPLES, 1996-2008

	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Argentina	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Australia					✓	✓	✓						
Brazil	✓	✓		✓	✓			✓	✓			✓	✓
Canada	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Chile	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
China							✓	✓	✓	✓	✓		
Guatemala					✓							✓	
Japan	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Korea								✓					
Mexico									✓	✓			
New Zealand	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
South Africa	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Switzerland					✓								
Thailand											✓	✓	
Uruguay	✓	✓	✓	✓	✓								
Vietnam													✓

(UN Comtrade, 2010)

Table 4. Cox Proportional Hazard Model Results

	Full Sample	First Spell Only Sample	Left-Censored Dropped Sample	Gap Adjusted Sample
	$\hat{\beta}$	$\hat{\beta}$	$\hat{\beta}$	$\hat{\beta}$
MultipleSpellsD	0.328***		-0.11	0.396**
	(0.115)		(0.116)	(0.165)
Fruit	-0.237**	-0.134	-0.121	-0.219*
	(0.114)	(0.132)	(0.128)	(0.128)
NMA	0.277	0.632***	-0.21	0.101
	(0.214)	(0.244)	(0.218)	(0.236)
Treat	-0.597***	-0.554***	-0.539***	-0.634***
	(0.172)	(0.206)	(0.193)	(0.196)
NorthAmerica	-0.372**	-0.353*	-0.304*	-0.308
	(0.176)	(0.197)	(0.183)	(0.198)
LowerMiddleIncome	-0.373	-0.666***	-0.392	-0.35
	(0.291)	(0.247)	(0.277)	(0.301)
UpperMiddleIncome	-0.33	-0.750***	-0.268	-0.315
	(0.296)	(0.253)	(0.278)	(0.311)
HighIncome	-0.482	-1.042***	-0.296	-0.365
	(0.299)	(0.263)	(0.289)	(0.311)
LnAvgQuantity	-0.408***	-0.462***	-0.232***	-0.400***
	(0.025)	(0.027)	(0.032)	(0.027)
LnAvgTc	-0.151	0.0729	-0.35	0.0548
	(0.275)	(0.302)	(0.327)	(0.296)
LnAvgTar	-1.193	-0.413	-0.737	-1.065
	(1.409)	(1.784)	(1.445)	(1.651)
LnAvgUsProd	-0.0601**	-0.0920***	-0.0649**	-0.0822**
	(0.030)	(0.034)	(0.032)	(0.034)

Table 4. Continued

	Full Sample	First Spell Only Sample	Left-Censored Dropped Sample	Gap Adjusted Sample
	$\hat{\beta}$	$\hat{\beta}$	$\hat{\beta}$	$\hat{\beta}$
LnAvgGdpExCo	-0.0127	0.0131	-0.0703	-0.0149
	(0.041)	(0.048)	(0.045)	(0.045)
LnAvgShrExCo	-0.0409*	-0.0306	-0.0212	-0.0476*
	(0.023)	(0.027)	(0.023)	(0.025)
LnAvgUsPrice	-0.270***	-0.364***	-0.186**	-0.248***
	(0.075)	(0.088)	(0.082)	(0.084)
AvgNoOfCountries	-0.00423	-0.00838	-0.00194	-0.00679
	(0.005)	(0.006)	(0.006)	(0.006)
AvgNoProductsUs	-0.0277***	-0.0265***	-0.0072	-0.0384***
	(0.008)	(0.009)	(0.009)	(0.009)
AvgNoOfPartners	-0.0683***	-0.0784***	-0.0540***	-0.0754***
	(0.012)	(0.014)	(0.012)	(0.013)
Observations	1,080	746	766	922
Log pseudolikelihood	-3572.3731	-2281.8121	-2649.4036	-2803.8298

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 4. Poisson Distribution (Count data) Model Result

Total Years	Variation 1	Variation 2	Variation 3	Variation 4	Variation 5	Variation 6	Variation 7	Variation 8	Variation 9	Variation 10
MultipleSpellsD		-0.0303	1.286***		-0.215***	-0.140***	0.329	0.332		
		(0.031)	(0.245)		(0.039)	(0.040)	(0.273)	(0.275)		
2SpellsD	-0.0894**									
	(0.036)									
3OrMoreSpellsD	0.0861*									
	(0.046)									
NoOfSpells				0.846***					0.322*	0.340**
				(0.144)					(0.166)	(0.166)
Fruit	0.0362	0.035	0.0239	0.0289	0.034	0.017	0.0413	0.024	0.037	0.018
	(0.029)	(0.029)	(0.029)	(0.029)	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
NMA	-0.170***	-0.167***	-0.310***	-0.451***	-0.200***	-0.153**	-0.410***	-0.333***	-0.539***	-0.423***
	(0.062)	(0.062)	(0.090)	(0.145)	(0.065)	(0.066)	(0.095)	(0.095)	(0.151)	(0.152)
NmaMsInter			0.324**				0.393***	0.328**		
			(0.126)				(0.133)	(0.133)		
SpellNMAInter				0.178**					0.192**	0.149*
				(0.077)					(0.080)	(0.080)
Treat	0.386***	0.383***	0.475***	0.599***	0.187***	0.143***	0.179***	0.138**	0.233**	0.181*
	(0.041)	(0.041)	(0.050)	(0.089)	(0.047)	(0.048)	(0.057)	(0.057)	(0.095)	(0.095)
TreatMsInter			-0.234***				0.0321	0.016		
			(0.089)				(0.093)	(0.092)		
SpellTreatInter				-0.134**					-0.028	-0.027
				(0.054)					(0.055)	(0.055)
NorthAmerica	0.551***	0.549***	0.675***	1.011***	0.151***	0.158***	0.132**	0.146***	0.253***	0.255***
	(0.030)	(0.030)	(0.035)	(0.067)	(0.045)	(0.044)	(0.053)	(0.052)	(0.089)	(0.087)
NaMsInter			-0.470***				0.0313	0.024		
			(0.067)				(0.077)	(0.077)		

Table 5. Continued

Total Years	Variation 1	Variation 2	Variation 3	Variation 4	Variation 5	Variation 6	Variation 7	Variation 8	Variation 9	Variation 10
SpellNAInter				-0.333***					-0.070	-0.063
				(0.043)					(0.051)	(0.050)
LnAvgGDPperCapita	0.086***	0.088***	0.127***	0.205***	0.033**	0.023	0.058***	0.044**	0.107***	0.091***
	(0.013)	(0.013)	(0.015)	(0.027)	(0.016)	(0.016)	(0.019)	(0.019)	(0.032)	(0.032)
LnAGdpCMsInter			-0.130***				-0.068**	-0.059*		
			(0.027)				(0.030)	(0.030)		
SpellLnAGdpC				-0.082***					-0.045**	-0.042**
				(0.016)					(0.018)	(0.018)
QGrowth					-0.003**		-0.003**		-0.003**	
					(0.001)		(0.001)		(0.001)	
LnAvgQuantity					0.072***		0.073***		0.079***	
					(0.008)		(0.008)		(0.008)	
CGrowth						-0.050***		-0.047***		-0.048***
						(0.013)		(0.013)		(0.013)
LnAvgCvalue						0.114***		0.113***		0.122***
						(0.009)		(0.009)		(0.009)
LnAvgTc					0.397***	0.453***	0.398***	0.457***	0.436***	0.497***
					(0.088)	(0.088)	(0.089)	(0.090)	(0.089)	(0.090)
LnAvgTar					0.703	0.924*	0.744	0.941**	0.752	0.989**
					(0.476)	(0.480)	(0.475)	(0.479)	(0.477)	(0.481)
LnAvgUsProd					-0.008	-0.006	-0.007	-0.006	-0.009	-0.008
					(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)
LnAvgShrExCo					0.029***	0.018**	0.028***	0.018**	0.027***	0.015*
					(0.007)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
LnAvgUsRowPRatio					-0.036	-0.030	-0.042	-0.035	-0.043	-0.035
					(0.026)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)

Table 5. Continued

Total Years	Variation 1	Variation 2	Variation 3	Variation 4	Variation 5	Variation 6	Variation 7	Variation 8	Variation 9	Variation10
AvgNoOfCountries					6.43E-05	-0.001	0.0002	-0.0009	0.0006	-0.0006
					(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
AvgNoProductsUs					0.006***	0.003	0.007***	0.003	0.006***	0.003
					(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
AvgNoOfPartners					0.016***	0.008*	0.017***	0.009**	0.016***	0.008**
					(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Constant	0.758***	0.748***	0.337**	-0.487**	0.556***	0.189	0.315	-0.006	-0.176	-0.540*
	(0.117)	(0.117)	(0.142)	(0.245)	(0.197)	(0.206)	(0.221)	(0.229)	(0.320)	(0.327)
Observations	861	861	861	861	555	555	555	555	555	555

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 6. Heckman Two-Step Model Results

	Variation 1a		Variation 2a		Variation 1b		Variation 2b	
	LnCvalue1	Select	LnCvalue1	Select	LnCvalue2	Select	LnCvalue2	Select
YearsOfService1/2	0.0289	0.332***	0.0956**	0.396***	-0.0296	0.303***	0.115**	0.374***
	(0.030)	(0.007)	(0.048)	(0.009)	(0.038)	(0.006)	(0.056)	(0.008)
SpellCount1/2	-2.034***	0.384***	-1.690***	0.678***	-2.037***	0.140***	-1.654***	0.532***
	(0.081)	(0.022)	(0.116)	(0.031)	(0.073)	(0.019)	(0.115)	(0.027)
Fruit	0.343***	0.0243	-0.103	-0.0586	0.542***	-0.0127	0.0468	-0.0348
	(0.072)	(0.028)	(0.082)	(0.042)	(0.078)	(0.025)	(0.083)	(0.038)
NMA	0.0382	0.117	0.303	0.627***	0.375*	0.071	0.809***	0.493***
	(0.174)	(0.074)	(0.225)	(0.117)	(0.205)	(0.070)	(0.235)	(0.112)
Treat	0.0513	0.304***	-0.827***	0.164	0.194	0.309***	-0.379**	0.0697
	(0.104)	(0.044)	(0.179)	(0.105)	(0.125)	(0.041)	(0.186)	(0.101)
TreatFruitInter			1.638***	0.109			1.571***	0.154
			(0.208)	(0.125)			(0.221)	(0.120)
NmaTreatInter			-0.667**	-0.156			-1.070***	-0.0299
			(0.330)	(0.206)			(0.357)	(0.195)
FTA			1.058***	0.122*			1.114***	0.129**
			(0.103)	(0.066)			(0.108)	(0.061)
LnTc			-0.376**				-0.505***	
			(0.175)				(0.157)	
LnTar			-4.340***				-3.142***	
			(0.798)				(0.788)	
LnUsRealGdp			-0.104	-4.382***			0.449	-4.511***
			(0.760)	(0.138)			(0.914)	(0.126)
LnExCoRealGdp			-0.106***	0.0528***			-0.113***	0.0490***
			(0.025)	(0.012)			(0.025)	(0.011)

Table 6. Continued

	Variation 1a		Variation 2a		Variation 1b		Variation 2b	
	LnCvalue1	Select	LnCvalue1	Select	LnCvalue2	Select	LnCvalue2	Select
LnUsProd			-0.0497***	-0.0322***			-0.0368*	-0.0223**
			(0.019)	(0.011)			(0.020)	(0.010)
LnExCoProd			0.327***	0.0331***			0.322***	0.0330***
			(0.017)	(0.009)			(0.018)	(0.008)
LnUs_ExCo_Price			0.497***	0.0294			0.564***	0.0131
			(0.062)	(0.035)			(0.063)	(0.031)
NorthAmerica			0.735***	0.394***			1.074***	0.346***
			(0.110)	(0.057)			(0.112)	(0.052)
ComLangOff		-0.0324		-0.0799		-0.0412		0.00573
		(0.032)		(0.052)		(0.029)		(0.047)
Island				0.0777				-0.0687
				(0.066)				(0.058)
Landlocked				0.0353				0.0449
				(0.136)				(0.112)
Constant	16.76***	-1.578***	15.26	68.13***	16.97***	-1.195***	5.453	70.34***
	(0.362)	(0.028)	(11.730)	(2.223)	(0.438)	(0.027)	(14.120)	(2.028)
Observations	14,551	14,551	9,564	9,564	14,551	14,551	9,564	9,564
Mills Lambda	-2.383		-1.634		-3.534		-1.882	
	(0.214)		(0.240)		(0.286)		0.287	
Rho	-0.862		-0.738		-1.000		-0.753	
Sigma	2.765		2.214		3.534		2.497	

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: In Variations 1a and 2a observations for which Cvalue<10,000USD were replaced with 0. In Variations 1b and 2b Cvalue is left unmodified.

Appendix A: Sample Exporting Countries

Table A.1 List of Exporting Countries of FF&V

#	Country	ISO3	#	Country	ISO3	#	Country	ISO3
1	Afghanistan	AFG	31	Ghana	GHA	61	Peru	PER
2	Argentina	ARG	32	Greece	GRC	62	Philippines	PHL
3	Australia	AUS	33	Grenada Is	GRD	63	Poland	POL
4	Bahamas	BHS	34	Guatemala	GTM	64	Portugal	PRT
5	Bangladesh	BGD	35	Haiti	HTI	65	Romania	ROU
6	Belgium	BEL	36	Honduras	HND	66	Russia	RUS
7	Belize	BLZ	37	Hong Kong	HKG	67	Saudi Arabia	SAU
8	Bolivia	BOL	38	Hungary	HUN	68	Serbia/Montenegro	SCG
9	Bosnia-Hercegov.	BIH	39	India	IND	69	Singapore	SGP
10	Brazil	BRA	40	Indonesia	IDN	70	South Africa	ZAF
11	Bulgaria	BGR	41	Iran	IRN	71	Spain	ESP
12	Cambodia	KHM	42	Ireland	IRL	72	Sri Lanka	LKA
13	Cameroon	CMR	43	Israel	ISR	73	St Lucia Is	LCA
14	Canada	CAN	44	Italy	ITA	74	St Vinc. & Gren.	VCT
15	Chile	CHL	45	Jamaica	JAM	75	Sweden	SWE
16	China	CHN	46	Japan	JPN	76	Switzerland	CHE
17	Colombia	COL	47	Korea	KOR	77	Syria	SYR
18	Costa Rica	CRI	48	Lebanon	LBN	78	Taiwan	TWN
19	Cote d`Ivoire	CIV	49	Macedonia	MKD	79	Tanzania	TZA
20	Croatia	HRV	50	Madagascar	MDG	80	Thailand	THA
21	Denmark	DNK	51	Malaysia	MYS	81	Tonga	TON
22	Dominican Rep.	DOM	52	Mexico	MEX	82	Trin. & Tobago	TTO
23	Ecuador	ECU	53	Morocco	MAR	83	Turkey	TUR
24	Egypt	EGY	54	Mozambique	MOZ	84	United Arab Em.	ARE
25	El Salvador	SLV	55	Netherlands	NLD	85	United Kingdom	GBR
26	Estonia	EST	56	New Zealand	NZL	86	Uruguay	URY
27	Ethiopia	ETH	57	Nicaragua	NIC	87	Venezuela	VEN
28	Fiji	FJI	58	Nigeria	NGA	88	Vietnam	VNM
29	France	FRA	59	Pakistan	PAK	89	Zimbabwe	ZWE
30	Germany	DEU	60	Panama	PAN			

(Karov *et al.*, 2009; Jankovska *et al.*, 2011)

Appendix B: Explanatory Variables’ Descriptions

Table B.1 Cox Model and Count Data Model Explanatory Variables' Descriptions

Variable	Description
MultipleSpellsD	Dummy variable: 1 if multiple spells of service; 0 if 1 spell of service.
2SpellsD	Dummy variable: 1 if two spells of service; 0 otherwise.
3OrMoreSpellsD	Dummy variable: 1 if 3 or more spells of service; 0 otherwise.
NoOfSpells	Number of total spells of service by country-commodity pairs. A discrete variable.
Fruit	Dummy variable: 1 if product is a fruit; 0 otherwise
NMA	Dummy variable: 1 if Exporting country was awarded new market access; 0 otherwise.
NmaMsInter	Interaction term of NMA and MultipleSpellsD.
SpellNMAInter	Interaction term of NMA and NoOfSpells.
Treat	Dummy variable: 1 if any phytosanitary treatment is required; 0 otherwise.
TreatMsInter	Interaction term of Treat and MultipleSpellsD.
SpellTreatInter	Interaction term of Treat and NoOfSpells.
NorthAmerica	Dummy variable: 1 if Exporting country is located in North America; 0 otherwise.
NaMsInter	Interaction term of NorthAmerica and MultipleSpellsD.
SpellNAInter	Interaction term of NorthAmerica and NoOfSpells.
LnAvgGDPperCapita	Natural log of the average GDP per capita by exporting country.
LnAGdpCMsInter	Interaction term of LnAvgGDPperCapita and MultipleSpellsD.
SpellLnAGdpC	Interaction term of LnAvgGDPperCapita and NoOfSpells.
LowerMiddleIncome	Dummy variable: 1 if Exporting country is categorized as Lower-Middle income by the World Bank; 0 otherwise.
UpperMiddleIncome	Dummy variable: 1 if Exporting country is categorized as Upper-Middle income by the World Bank; 0 otherwise.
HighIncome	Dummy variable: 1 if Exporting country is categorized as High income by the World Bank; 0 otherwise.
LnAvgQuantity	Natural log of average U.S. Imports quantity by country and commodity.
Qgrowth	The growth rate of imports (quantity) by country commodity, measured as: ((Value of Imports in Ending Period/Value of Imports in the Beginning Period)^(1/(No. of Periods-1))-1.
LnAvgCvalue	Natural log of average value (Free on Board) of exports to the U.S. by country and commodity.
Cgrowth	The growth rate of imports (customs value) by country commodity, measured as: ((Value of Imports in Ending Period/Value of Imports in the Beginning Period)^(1/(No. of Periods-1))-1.

Table B.1 Continued

Variable	Description
LnAvgTc	Natural log of average of Transportation Cost (CIF/Customs Value) during the period a country exported a certain commodity to the U.S.
LnAvgTar	Natural log of average of Tariff Rate (LDPV/CIF) during the period a country exported a certain commodity to the U.S.
LnAvgUsProd	Natural log of average U.S. production in metric tons, by commodity.
LnAvgGdpExCo	Natural log of average Exporting country's real GDP (Base year 2005) during the period a country exported a certain commodity to the U.S.
LnAvgShrExCo	Natural log of average share of exporting country compared to the rest of the world (in terms of exports for a certain commodity).
LnAvgUsPrice	Natural log of average U.S. Domestic Producers' price (USD/tonnes) by commodity.
LnAvgUsRowPRatio	Natural log of average ratio of the U.S. price to the global price (USD/tonnes) by commodity.
AvgNoOfCountries	Average number of countries a commodity was exported to in any given year (measuring experience with a product).
AvgNoProductsUS	Average number of commodities exported to the U.S. in any given year (measuring experience with the U.S.).
AvgNoOfPartners	Average number of partners exporting any given commodity to the U.S.