Economics Bulletin

Volume 32, Issue 2

Tariff equivalent of Japanese sanitary and phytosanitary: Econometric estimation of protocol for U.S.-Japanese apple trade

Keiichiro Honda
Graduate School of Economics, Osaka University

Abstract

This paper econometrically estimates the tariff equivalent of sanitary and phytosanitary (SPS) to U.S. apple imports in Japan. Many studies calculate the tariff equivalent of the Japanese SPS to imports of U.S. apple using the price differential between the domestic price and export prices, but this method is problematic when the SPS measures are prohibitive. This study uses a method that can econometrically estimate the tariff equivalent of the prohibitive technical barriers to trade suggested by Yue and Beghin (2009). This approach overcomes the lack of observed data on bilateral trade flows caused by prohibitive SPS measures and accounts for goods differentiated by the place of origin. My estimated results show that the ad-valorem tariff equivalent of the Japanese prohibitive SPS measures is extremely high, and its average effect on U.S. apples over the entire period is 118.9%. The Japanese SPS policy regarding overseas apples is too stringent to exceed 100% in tariff equivalent.

The author thanks John Beghin for making his R code available to me and the following for their helpful comments: Kanemi Ban, Kenzo Abe, Tsunehiro Otsuki, Takahiro Ito, the participants at the 2011 Japanese Economic Association Autumn Meeting, and an anonymous referee.
Citation: Keiichiro Honda, (2012) "Tariff equivalent of Japanese sanitary and phytosanitary: Econometric estimation of protocol for U.S.-Japanese apple trade", *Economics Bulletin*, Vol. 32 No. 2 pp. 1226-1237.
Contact: Keiichiro Honda - kgp802hk@mail2.econ.osaka-u.ac.jp.
Submitted: August 02, 2011. **Published:** April 17, 2012.

1. Introduction

This paper econometrically estimates the tariff equivalent of sanitary and phytosanitary regulations (SPS) to U.S. apple imports in Japan. Many studies have calculated the tariff equivalent of the Japanese SPS to the imports of U.S. apples using the price differential between the domestic and export prices. This method is known as the price-wedge approach. This study uses an alternative method suggested by Yue and beghin (2009), that can econometrically estimate the tariff equivalent of the prohibitive technical barriers to trade. This approach overcomes the lack of observed data on bilateral trade flows caused by prohibitive SPS measures and accounts for goods differentiated by the place of origin.

Before 1993, the Plant Protection Act in Japan had restricted the imports of apple from countries where codling moth and fire blight disease had occurred in apple production. Due to the Act, Japan prohibited apple imports from the United States. In 1994, as communicable disease control across countries became established, apple imports from the United States started, but were quarantined by the Japanese inspection agency. The United States complained that the Japanese measures on apple imports were too stringent in 1997 and 2002 and filed a suit in the WTO. The WTO has identified the Japanese quarantine for imported apples as a violation of the WTO agreement. Reflecting that decision, the Japanese government decided to relax the SPS control. But, even after ending the embargo, the imports of apple are restricted by the presence of the SPS.

Several studies have used the price-wedge approach to address the cost of the Japanese SPS regarding U.S. apples. Calvin and Krissoff (1998) first analyzed this case assuming perfect substitution between domestic and imported goods. They estimated the tariff equivalent at approximately 27.2% over four years from 1994 to 1998. Yue, Beghin, and Jensen (2006) generalized the basic price-wedge approach for cases where goods are imperfectly substitutable. Their estimate was approximately 51.7% over 3 years from 2000 to 2002, but the estimated result was sensitive to the given parameters of substitution and preferences. The two studies described above were limited to a case in which all phytosanitary protocols were removed. Calvin, Krissoff, and Foster (2007) used a participation model to measure the economic costs of SPS measures and their approach enables an estimation of the costs of fire blight and codling moth protocols separately. Although the estimates are sensitive to parameter assumptions, they showed that, during seven years from 1998 to 2004, the cost of fire blight was 3 cents per pound and the cost of methyl bromide fumigation and other costs were 8 cents per pound when a U.S. grower's price was 50 cents per pound. However, the price-wedge method used in previous studies has a problem because bilateral trade flows are not observed when SPS measures are prohibitive and the results might be underestimated.

This study attempts to econometrically estimate the tariff equivalent of the Japanese SPS measures as prohibitive trade barriers. In the empirical analysis of international trade flows, one of the most important problems is the presence of zero trade flows. Yue and Beghin (2009) applied Wales and Woodland's Kuhn-Tucker approach to the Australian SPS barriers to New Zealand apple imports. They calculated the tariff equivalent of these technical barriers to trade at around 99%. This study uses this approach to econometrically estimate the tariff equivalent of the Japanese SPS measures when a zero trade flow is considered.

I consider two scenarios to estimate more realistic and detailed effects of the Japanese SPS to avoid the simple average of tariff equivalent across export countries and periods. One scenario is that the Japanese government imposes the identical stringency of SPS against imports from all of the countries. In this scenario, I assume that there are two terms: the periods of actual prohibition on imports and the periods of actual quarantine limitations on import. The second scenario is that the Japanese government imposes different levels of SPS measure against the United States and other countries.

2. Model for the Econometric Estimation of SPS Measures

This study uses the approach suggested by Yue and Beghin (2009). They derived a method to econometrically estimate the tariff equivalent and forgone trade effects of a prohibitive TBT on the basis of the Kuhn-Tucker approach of Wales and Woodland (1983).

In this model, I assume that the representative global consumer maximizes utility by consuming three types of apples (U.S. apples, Japanese apples, and aggregated other apples) and other goods subject to a budget constraint:

$$\max_{\mathbf{x},AOG} U = \sum_j \exp\left(\eta_j GDP + \delta_j + \varepsilon_j\right) \ln\left(x_j + \omega_j\right) + \upsilon(AOG)$$
$$\text{s.t.} \quad \sum_j p_j x_j + AOG \le I, \quad AOG \ge 0, \quad x_j \ge 0 \tag{1}$$

where j is the index of the origin of apples, in this model, us, jp, and $other$. x_j is the quantity of apples from j and $\mathbf{x}$ are the vectors of these. AOG is a composite of all other consumer goods, assumed to be the numeraire. GDP is the gross domestic product per capita and is the socio-demographic information of the importing country having an impact on preferences for x_j through parameters η_j. δ_j is the parameter of preference not based on socio-demographics. ε_j indicates the unobserved error components. ω_j is the parameter that indicates that minimum consumption does not depend on the taste of consumers. These parameters construct the preferences. In the budget constraint, p_j is the consumer price faced by the importing country. This price includes trade costs, for instance, transportation costs and trade barriers. I is the income of the representative consumer.

The consumer price p_j can be decomposed into an export price, transportation cost, tariffs, and technical barriers to trade. In this analysis, the technical barrier to apple trade is the SPS:

$$p_j = \left(wp_j + \gamma d_j\right)\left(1 + t_j + SPS_j\right) \qquad (2)$$

where wp_j is an export price and d_j represents the distance between exporting countries and destinations, affecting consumer price through parameter γ (unit rate of transportation cost).[1] t_j is the ad-valorem tariff of the importing country. Finally, SPS_j represents the ad-valorem tariff equivalents of the SPS trade barrier. This analysis focuses on the Japanese SPS measures to imports from the U.S., so SPS is the only set for which the Japanese consumer price is decomposed.

The corresponding first-order necessary and sufficient Kuhn-Tucker conditions are obtained as follows.

$$U_{x_j} = \frac{\partial U(\cdot)}{\partial x_j} \leq \lambda\left(wp_j + \gamma d_j\right)\left(1 + t_j + SPS_j\right), \quad x_j \geq 0 \qquad (3)$$

$$x_j\left[U_{x_j} - \lambda\left(wp_j + \gamma d_j\right)\left(1 + t_j + SPS_j\right)\right] = 0 \qquad (4)$$

$$U_{AOG} = \frac{\partial U(\cdot)}{\partial AOG} \leq \lambda, \quad AOG \geq 0 \qquad (5)$$

[1] For simplicity, I assume the unit rate of transportation to be the same per unit of distance.

$$AOG[U_{AOG} - \lambda] = 0 \tag{6}$$

where λ is the marginal utility of income. Rearranging these conditions (3) to (6) and solving for ε_j, I have the following equations for observation $i = 1, \cdots, N$:

$$\varepsilon_j^i = \ln\left[v'(AOG)\left(wp_j^i + \gamma d_j^i\right)\left(1 + t_j^i\right)\left(x_j^i + \omega_j\right)\right] - \delta_j - \eta_j GDP^i \quad \text{when} \quad x_j^i > 0 \tag{7}$$

$$\varepsilon_j^i \leq \ln\left[v'(AOG)\left(wp_j^i + \gamma d_j^i\right)\left(1 + t_j^i\right)\left(x_j^i + \omega_j\right)\right] - \delta_j - \eta_j GDP^i \quad \text{when} \quad x_j^i = 0 \tag{8}$$

and define for simplicity:

$$g_j^i \equiv \ln\left[v'(AOG)\left(wp_j^i + \gamma d_j^i\right)\left(1 + t_j^i\right)\left(x_j^i + \omega_j\right)\right] - \delta_j - \eta_j GDP^i \quad \text{when} \quad j = us, jp \tag{9}$$

$$g_{other}^i \equiv \ln\left[v'(AOG) p_{other}^i\left(x_{other}^i + \omega_{other}\right)\right] - \delta_{other} - \eta_{other} GDP^i \tag{10}$$

In equation (10), import price p_{other}^i is used in place of export price plus transport cost because of multiple sourcing and distances associated with other imported apples. For observation in Japan, equations (9) and (10) are modified to include the tariff equivalent as follows:

$$g_j^{jp} \equiv \ln\left[v'(AOG)\left(wp_j^{jp} + \gamma d_j^{jp}\right)\left(1 + t_j^{jp} + SPS_j^{jp}\right)\left(x_j^{jp} + \omega_j\right)\right] - \delta_j - \eta_j GDP^{us} \tag{11}$$

Suppose that consumer's contribution to the likelihood function is given by the joint probability distribution as follows:

$$f = \int_{-\infty}^{g_1} \cdots \int_{-\infty}^{g_K} f_\varepsilon(\varepsilon_1, \cdots, \varepsilon_K, g_{K+1}, \cdots, g_M) \times |\mathbf{J}| d\varepsilon_1 \cdots d\varepsilon_K \tag{12}$$

where subscripts 1 to K indicate commodities that consumption is zero and subscripts

$K+1$ to M indicate commodities that consumption is positive.[2] $\mathbf{J}$ denotes the determinant of the Jacobian matrix for the transformation from $\boldsymbol{\varepsilon}$ to $(\varepsilon_1, \cdots, \varepsilon_K, x_{K+1}, \cdots, x_M)$. Using equations and definitions (7) to (12) for observations i, the following variables are defined for simplicity:[3]

$$X_{us}^i \equiv \begin{cases} \phi(g_{us}^i) \cdot |J_{us}^i| & \text{when} \quad x_{us}^i > 0 \\ \Phi(g_{us}^i) & \text{when} \quad x_{us}^i = 0 \end{cases} \tag{13}$$

$$X_{jp}^i \equiv \begin{cases} \phi(g_{jp}^i) \cdot |J_{jp}^i| & \text{when} \quad x_{jp}^i > 0 \\ \Phi(g_{jp}^i) & \text{when} \quad x_{jp}^i = 0 \end{cases} \tag{14}$$

$$X_{other}^i \equiv \begin{cases} \phi(g_{other}^i) \cdot |J_{other}^i| & \text{when} \quad x_{other}^i > 0 \\ \Phi(g_{other}^i) & \text{when} \quad x_{other}^i = 0 \end{cases} \tag{15}$$

where $|J_j^i|$ is the absolute value of the Jacobian for the transformation from g_j^i to x_j^i. Φ is the cumulative density function and ϕ is the density function of standard normal distribution for the goods that are consumed. Using definitions (13) to (15), the log-likelihood function of this analysis is as follows:

$$l = \sum_{i=1}^{N} \ln\left(X_{us}^i \cdot X_{jp}^i \cdot X_{other}^i\right) \tag{16}$$

By maximizing equation (16), the parameter SPS that represents the ad-valorem tariff equivalent of the Japanese SPS to the imports of apples and other parameters $\left(v'(AOG), \gamma, \omega_j, \delta_j, \text{and } \eta_j\right)$ are estimated. The optimization method used in maximum likelihood estimation is the Newton-Raphson method.

In estimation, I take account of two different scenarios for estimating the tariff equivalent of the Japanese SPS. In the first scenario, the same stringency of SPS is assumed for all of the countries, but the Japanese government imposes different levels of SPS between the periods of actual prohibition on imports before 1993 and the periods of actual quarantine limitations on import after 1994: i.e. $SPS_{us}^{jp} = SPS_{other}^{jp}$ in all of the periods but $SPS_{1991-1993}^{jp} \neq SPS_{1994-2007}^{jp}$. In the second scenario, I assume the same

[2] Whether consumption of each goods is zero or positive is different by each country. Thus, subscripts of commodities are written in a general formal and are sorted by amount of consumption.
[3] For more details, refer to Yue and Beghin (2009).

parameters for all of the periods, but different parameters between the restriction on U.S apples and other apples: i.e. $SPS_{us}^{jp} \neq SPS_{other}^{jp}$ but $SPS_{1991-1993}^{jp} = SPS_{1994-2007}^{jp}$. This second scenario is unrealistic from the viewpoint that actual external policy must be imposed on all countries equally. However, it is justified that the SPS measures have relatively different effects on different countries as per the domestic levels of quarantine for apples.

3. Data

This framework is applied to the Japanese SPS measures. Three types of apples are considered. To estimate the tariff equivalent of the Japanese SPS, I consider the entire world and incorporate unbalanced pooled data from 148 countries from 1991 to 2007, including 1117 observations. The countries included in the data set are listed in Table 1.

This approach requires apple consumption per capita from each point of origin, GDP per capita as the socio-demographic information of the importing countries, export unit price, distance between the importing and exporting countries, and the tariff rate. The apple consumption per capita is derived from the trade flow data on apple imports and domestic production data. Bilateral export quantities and export prices (FOB price) data come from the UN Comtrade database. Domestic production data is reported by FAO. Outside of the U.S. and Japan, the price of aggregated other apples is a consumption weighted average of other imported fresh apples and domestically produced apples. I use the import CIF price reported by FAO instead of FOB prices plus transportation cost to overcome multiple sourcing and distances with respect to other imported apples. Data regarding the population and GDP per capita are derived from the World Development Indicators. Distance data comes from CEPII. Finally, the tariff rates are obtained from the TRAINS database. The descriptive statistics are shown in Table 2.

4. Estimation Results

The estimation results of the first scenario are shown in Table 3. All the parameters have problem-free signs and statistical significance of at least 10%. In addition, these parameters are statistically significant at the 1% level, except δ_{jp} and ω_{jp}. During prohibitive periods, the ad valorem equivalent of the SPS barriers to the FOB price, inclusive of transportation cost, is approximately 966.9%. After the prohibition was removed and the SPS measure were implemented in 1994, the tariff equivalent is diminished to 120.0%. The estimated constant terms are in decreasing order of magnitude: U.S. apples, other apples, and Japanese apples. Moreover, the preference parameters with respect to GDP per capita of importing countries $\hat{\eta}$ are in decreasing order of magnitude: other apples (0.000116), Japanese apples (0.0000372), and U.S. apples (0.0000123). These imply that the consumers prefer U.S. apples initially, but the preference changes to apples from other countries as the consumer's income increases. All the threshold minimum consumption levels that do not depend on tastes (ω) are positive and significant. The average unit fee for transportation and insurance parameter γ is significant and estimated to be \$0.0581/(km*kg). Finally, the point estimate of the marginal utility of AOG is positive and significant.

The estimation results of the second scenario are shown in Table 4. Most of the preference parameters are similar to those in scenario 1 in terms of sign, magnitude, and significance except δ_{jp}. The average tariff equivalent of the SPS to U.S. apples is approximately 118.9%. This estimated value is considerably higher than the previous results (approximately from 18.1% to 51.7%)[4], and is considered to be the result of including the prohibitive effect of the Japanese SPS, particularly, from 1991 to 1993 as well as the difference of the sample period and functional form. The average tariff equivalent of the SPS to other apples is approximately 281.0%. This suggests that U.S. apples are less regulated in comparison to other apples. In any case, the Japanese SPS measures for overseas apples are too stringent and exceed 100% in tariff equivalent.

5. Conclusion

Previous studies use the price-wedge method to evaluate the tariff equivalent of the Japanese SPS, but it is inappropriate when the SPS is prohibitive. In this study, I attempt to econometrically estimate the tariff equivalent of these as prohibitive trade barriers. Yue and Beghin (2009) derive a method to econometrically estimate the tariff equivalent and forgone trade effects of a prohibitive TBT. My estimated results show that the ad-valorem tariff equivalent of the Japanese prohibitive SPS measures is extremely high, and its average effect on U.S. apples for the entire period is 118.9%.

[4] In Table 5, there is comparison of estimated results with previous estimates.

References

Calvin, L. and B. Krissoff (1998) "Technical Barrier to Trade: A Case Study of Phytosanitary Barriers and U.S.-Japanese Apple Trade," *Journal of Agricultural and Resource Economics* 23(2), pp.351–366.

Calvin, L., B. Krissoff, and W. Foster (2007) "Measuring the Costs and Trade Effects of Phytosanitary Protocols: A U.S.-Japanese Apple Example," *Review of Agricultural Economics* 30(1), pp.120–135.

Wales, T. J. and A. D. Woodland (1983) "Estimation of Consumer Demand System with Binding Nonnegativity Constraints," *Journal of Econometrics* 21, pp.263–285.

Yue, C. and J. Beghin (2009) "Tariff Equivalent and Forgone Trade Effects of Prohibitive Technical Barriers to Trade," *American Journal of Agricultural Economics* 91(4), pp.930–941.

Yue, C., J. Beghin, and H. H. Jensen (2006) "Tariff Equivalent of Technical Barriers to Trade with Imperfect Substitution and Trade Costs," *American Journal of Agricultural Economics* 88(4), pp.947–960.

Table 1. Countries included in the data set

Countries	# of obs.	Countries	# of obs.	Countries	# of obs.
Albania	5	France	15	Nigeria	2
Algeria	6	Gabon	5	Norway	5
Angola	3	Georgia	5	Pakistan	9
Antigua and Barbuda	4	Germany	16	Panama	7
Argentina	14	Ghana	4	Paraguay	15
Armenia	1	Greece	16	Peru	9
Australia	3	Grenada	3	Philippines	13
Austria	16	Guatemala	7	Poland	16
Azerbaijan	3	Guinea	1	Portugal	16
Bangladesh	9	Guyana	4	Romania	5
Barbados	5	Haiti	1	Russian Federation	4
Belarus	2	Honduras	8	Rwanda	2
Belgium	8	Hungary	15	Saudi Arabia	8
Belize	6	Iceland	6	Senegal	7
Benin	7	India	5	Seychelles	5
Bermuda	2	Indonesia	10	Slovak Republic	14
Bolivia	14	Ireland	16	Slovenia	15
Bosnia and Herzegovina	2	Israel	1	Solomon Islands	2
Botswana	2	Italy	16	South Africa	3
Brazil	17	Jamaica	6	Spain	16
Brunei Darussalam	8	Japan	15	Sri Lanka	9
Bulgaria	5	Jordan	6	St. Kitts and Nevis	2
Burkina Faso	7	Kazakhstan	1	St. Lucia	7
Burundi	2	Kenya	7	St. Vincent and the Grenadines	7
Cambodia	5	Kuwait	4	Sudan	3
Cameroon	6	Kyrgyz Republic	5	Swaziland	1
Canada	14	Lao PDR	6	Sweden	16
Cape Verde	2	Latvia	15	Switzerland	10
Central African Republic	4	Lebanon	7	Tajikistan	2
Chad	2	Libya	2	Tanzania	7
Chile	2	Lithuania	15	Thailand	7
China	14	Luxembourg	8	Togo	7
Colombia	14	Madagascar	3	Trinidad and Tobago	9
Congo, Dem. Rep.	3	Malawi	6	Turkey	8
Congo, Rep.	5	Malaysia	9	Turkmenistan	2
Costa Rica	8	Maldives	7	Uganda	9
Cote d'Ivoire	9	Mali	6	Ukraine	3
Croatia	5	Malta	16	United Arab Emirates	4
Cuba	7	Mauritius	7	United Kingdom	16
Cyprus	13	Mexico	11	United States	16
Czech Republic	14	Moldova	4	Uruguay	12
Denmark	16	Mongolia	3	Uzbekistan	2
Djibouti	2	Morocco	8	Vanuatu	3
Dominican Republic	1	Mozambique	8	Venezuela, RB	11
Ecuador	12	Namibia	5	Vietnam	9
Egypt, Arab Rep.	5	Nepal	7	Yemen, Rep.	2
El Salvador	10	Netherlands	16	Zambia	5
Estonia	15	New Zealand	6	Zimbabwe	7
Ethiopia	4	Nicaragua	9		
Finland	16	Niger	7		

Table 2. Descriptive statistics

Variables	Unit	Obs	Mean	Std. Dev.	Min	Max
x_{jp}	kg	1117	0.095	0.823	0.000	8.350
x_{us}	kg	1117	0.407	1.546	0.000	14.736
x_{other}	kg	1117	7.324	11.254	0.000257	68.238
p_{jp}	$/kg	1117	5.020	2.160	0.562	15.620
p_{us}	$/kg	1117	0.708	0.252	0.152	5.638
p_{other}	$/kg	1117	0.673	0.473	0.0462	6.286
t_{jp}		1117	0.134	0.146	0.000	1.000
t_{us}		1117	0.141	0.146	0.000	1.000
t_{other}		1117	0.134	0.146	0.000	1.000
d_{jp}	km	1117	10196.960	3696.476	0.000	18740.370
d_{us}	km	1117	8500.901	3512.908	0.000	16357.830
GDP per capita	$	1117	9073.752	11031.210	83.00292	72295.980

Table 3. Estimation results (Scenario 1)

Parameters	Coef.	Std. Err.	z-value	p-value
SPS during prohibitive periods	9.669	2.438	3.97	0.000
SPS during quarantine periods	1.200	0.355	3.38	0.001
$v'(AOG)$	2.907	0.0215	135.17	0.000
η_{us}	0.0000123	0.00000413	2.98	0.003
η_{jp}	0.0000372	0.00000502	7.41	0.000
η_{other}	0.000116	0.00000629	18.38	0.000
δ_{us}	5.00499	0.0826	60.57	0.000
δ_{jp}	-0.682	0.378	-1.80	0.071
δ_{other}	0.476	0.0852	5.59	0.000
ω_{us}	0.102	0.00874	11.63	0.000
ω_{jp}	0.00203	0.000831	2.45	0.014
ω_{other}	0.176	0.0191	9.21	0.000
γ	0.0581	0.000692	84.05	0.000

Table 4. Estimation results (Scenario 2)

Parameters	Coef.	Std. Err.	z-value	p-value
SPS to U.S. apples	1.189	0.589	2.02	0.043
SPS to other apples	2.810	1.0173	2.76	0.006
v'(AOG)	4.595	0.0446	103.04	0.000
η_{us}	0.0000119	0.00000426	2.79	0.005
η_{jp}	0.0000372	0.00000502	7.40	0.000
η_{other}	0.000116	0.00000650	17.85	0.000
δ_{us}	5.474	0.0834	65.63	0.000
δ_{jp}	-0.220	0.384	-0.57	0.567
δ_{other}	0.932	0.0858	10.86	0.000
ω_{us}	0.102	0.00873	11.68	0.000
ω_{jp}	0.00203	0.000828	2.45	0.014
ω_{other}	0.176	0.0193	9.11	0.000
γ	0.0586	0.000456	128.60	0.000

Table 5. Comparison of the tariff equivalents of the Japanese SPS[5]

	Period	Tariff equivalent
Estimated results		
Scenario1: During prohibitive periods	1991–1993	966.9%
Scenario1: During quarantine periods	1994–2007	120.0%
Scenario2: SPS to U.S. apples	1991–2007	118.9%
Scenario2: SPS to other apples	1991–2007	281.0%
Previous results		
Calvin, and Krissoff (1998)	1994/95–1997/98	27.2%
Yue, Beghin, and Jensen (2006)	2000–2002	51.7%
Calvin, Krissoff, and Foster (2007)	1998/99–2003/04	18.1%

Note: Calvin and Krissoff (1998) and Calvin, Krissoff, and Foster (2007) use the marketing year; for example, 1994/95 implies August 1994 to July 1995.

[5] Calvin and Krissoff (1998) calculate the ad valorem equivalent in marketing year 1994/94, 1995/96 and 1996/97, respectively. Yue, Beghin, and Jensen (2007) estimate the tariff equivalent values and the ad valorem equivalent in 2000, 2001, and 2002, respectively. The tariff equivalent in this figure is the average of these results. Calvin, Krissoff, and Foster (2007) show the economic cost of transaction costs ($k = 33$) and phytosanitary costs ($C_{PP} = 15$) at cents per pounds. Using these results and the exporter's price ($P_{us} = 50$), I calculate the tariff equivalent of SPS: $C_{PP}/(P_{us} + k) = 15/(50 + 33) = 0.1807$.