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Non-tariff Barriers to Trade Caused by SPS Measures and Customs Procedures with Product Quality Changes

Lan Liu and Chengyan Yue

This study develops a methodology to quantify the combined effects of two major non-tariff barriers (NTBs), sanitary and phytosanitary (SPS) measures and customs and administrative procedures. We employ a constant elasticity of substitution (CES) utility function with factor-augmenting technical progress to incorporate changes in the quality of goods. We then estimate the effects of these two NTBs in the Japanese cut flower market. Results show that estimates of SPS are biased without considering product quality changes caused by the customs and administrative procedures for highly perishable agricultural products. If these Japanese NTBs were removed, findings suggest there would be a significant increase in cut flower imports by Japan.

Key words: customs and administrative procedures, cut flowers, Japan, non-tariff barriers, sanitary and phytosanitary measures, technical barriers to trade, trade

Introduction

Non-tariff barriers (NTBs) refer to a broad range of trade barriers and policy interventions that restrict and distort trade but are not in the usual form of a tariff. NTBs encompass a wide range of measures, including import quotas, customs and administrative procedures, countervailing duties, technical barriers to trade (TBT), sanitary and phytosanitary (SPS) measures, and rules of origin. In recent years, NTBs have increased as tariffs have fallen worldwide (Beghin, 2008). While some NTBs address market failures such as externalities and information asymmetries between consumers and producers, there are concerns that many NTBs may exist as disguised protectionism. These NTBs may also be discriminatory and unjustified among World Trade Organization (WTO) members who have made commitments to the Agreement on the Application of Sanitary and Phytosanitary Measures, or to the Agreement on Technical Barriers to Trade (Wilson, 2001).

The WTO Agreement on the Application of Sanitary and Phytosanitary Measures recognizes the rights of governments to protect human, animal, or plant life or health on the basis of scientific evidence. SPS measures that are stricter than necessary may lead to questionable impediments to trade and cause economic losses for the importing countries. Customs and administrative procedures are meant to smooth the application of trade and other policies. However, lengthy customs and administrative procedures

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to move a product across borders may unnecessarily "thicken" those borders and hinder trade between countries (Wilson, 2007). Time delays due to lengthy customs and administrative procedures not only reduce trade volumes, but more importantly prevent many firms from entering export markets (Nordas, Pinali, and Grosso, 2006). The negative consequences of customs and administrative procedures are especially serious for highly perishable agricultural goods, such as cut flowers, because time delays caused by lengthy customs and administrative procedures can severely deteriorate product quality, which in turn decreases product market prices in the importing countries. In such cases it is possible for trade not to occur because the market prices for those products of lower quality are too low in the importing countries to make the trade profitable (Barrett, Li, and Bailey, 2000). Sometimes imported products can be in such poor condition by the time they clear customs that they cannot be sold at all.

In the past, much theoretical and empirical research has recognized the importance of product quality in global bilateral trade and economic development. Flam and Helpman (1987) studied the theoretical impact of product quality on international trade. They developed a model to incorporate differentiation in product quality. Their model predicted a pattern of trade dynamics, i.e., the appearance of new and high-quality products, and the disappearance of old and low-quality products. Based on their model, they also predicted that richer countries export higher quality goods. Hummels and Klenow (2005) empirically investigated the cross-sectional elasticity of quality with respect to country size and income and found results consistent with Flam and Helpman's hypothesis that richer countries export higher quality goods. Hallak and Schott (2008) developed a method to identify product qualities across countries and how the qualities changed over time. Estimating manufacturing quality for the world's 43 largest exporters from 1989 to 2003, they found product quality varied across countries as well as over time and that the quality gap between high- and low-income countries narrowed over time. Considering the importance of product quality in international trade, we account for product quality changes over time and the impact of customs and administrative procedures on product quality when we estimate SPS measures.

NTBs have drawn the attention of many economists (e.g., Anderson, McRae, and Wilson, 2001; Beghin, 2008; Bureau, Marette, and Schiavina, 1998; Roberts, Josling, and Orden, 1999). One study conducted by the Organization for Economic Cooperation and Development (OECD, 2005) identified customs and administrative procedures as one of the most problematic NTBs encountered by developing countries. Research by Nordas, Pinali, and Grosso (2006) suggested that time delay is also a trade barrier, and removing barriers to timely delivery is therefore of great importance. Wilson (2007) estimated the impacts of customs and administrative procedures on trade flows using a gravity model and found that all countries can benefit from more efficient customs and administrative procedures.

The growing literature on SPS regulations and TBT often employs a price-wedge approach to quantify the impact of SPS measures or TBT on market equilibrium and trade (Calvin and Krissoff, 1998; Yue, Beghin, and Jensen, 2006). The price wedge measures the difference between the internal price of a good and the reference price of a comparable good. The price wedge can be caused by quality differences, transportation and transaction costs, and NTBs. Consequently, in order to estimate NTBs, we need to account for the impact of other factors on the price gap. The price wedge can be expressed as a specific tax/tariff, or as an ad valorem tax/tariff (Beghin and Bureau, 2001). The body of literature on SPS or TBT has evolved from extremely crude estimates of SPS or TBT to more and more refined efforts to separate out different types of trade impediments such as trade costs and SPS or TBT (Calvin and Krissoff, 1998; Yue, Beghin, and Jensen, 2006). Calvin and Krissoff first used a price-wedge method to estimate SPS measures in the U.S.-Japan apple trade by assuming that domestic and imported goods were perfect substitutes without considering transportation costs. They found the estimate of the tariff equivalent of SPS measures in Japan's apple imports was around 46% between 1994 and 1997. Yue, Beghin, and Jensen extended the basic price-wedge methodology by assuming domestic and imported goods were not perfect substitutes and by taking into account transportation costs and product quality differences. They also investigated the SPS measures in the U.S.-Japan apple trade and estimated the tariff equivalent of the SPS measures to be approximately 52% between 2000 and 2002.

These previous studies considered only one type of NTB, SPS, in their models without addressing customs and administrative procedures. Unlike apples, some agricultural products, such as cut flowers, are highly perishable, making efficient customs and administrative procedures critical to product quality. Our investigation extends the framework of Yue, Beghin, and Jensen (2006) and explicitly estimates two types of NTBs—SPS and customs and administrative procedures—when they are jointly in place for highly perishable agricultural products.

Several types of NTBs often coexist. When several NTBs are jointly in place, e.g., the coexistence of SPS measures and customs and administrative procedures, considering only one type of NTB may lead to a biased estimation of the NTB, especially when the coexisting policies have opposite effects on the price wedge. For example, lengthy customs and administrative procedures generally result in significant delays in shipments, which can be disastrous for agricultural products with limited shelf life such as cut flowers. The customs and administrative delays usually decrease the quality of imported products and hence decrease the products' market prices in the importing countries. However, SPS measures typically increase the cost of production, thereby increasing the price of the imported products. Therefore, some existing price-wedge methodologies focusing on only one type of NTB may generate a biased estimation of the NTB by potentially omitting other types of NTBs that may significantly contribute to the price wedge.

In this paper, we incorporate two major NTBs—SPS measures and customs and administrative procedures—into the extended price-wedge framework. Estimation is performed separately for these two types of NTBs' tariff equivalents and their impacts on welfare. One contribution of this paper to the existing literature is the consideration of additional costs in customs such as lost quality, not just fees. As well as taking into account the two types of NTBs, we also account precisely for quality differences between imports and domestic products and explicitly assess the impacts of customs and administrative procedures on the quality of the imported products.

We consider the case when the quality of imported products changes relative to that of domestic products over time. Therefore, differing from Yue, Beghin, and Jensen's (2006) model, we employ a constant elasticity of substitution (CES) model with factor-augmenting technical progress to account for the changes of product quality over time. This study also examines the impact of removing the two NTBs on import price as shown in previous studies (Calvin and Krissoff, 1998; Yue, Beghin, and Jensen, 2006) as well as on product quality. Using recent data, we provide a policy-relevant investigation of Japan's SPS measures and customs and administrative procedures imposed on imports of fresh cut flowers. Further, the tariff equivalents of the SPS measures using our model are compared with the estimation results from other models that incorporate just one type of NTB, such as SPS measures.

Our empirical analysis results have important policy implications for Japan as well as for cut flower exporting countries. The strict Japanese agricultural SPS measures and lengthy customs and administrative procedures increase the costs of exporting cut flowers to Japan and make it very difficult for exporters to get delicate fresh products to the final consumer market before the products' quality deteriorates. Using our model, if Japan's NTBs were removed, it is estimated that the increase in cut flower imports by Japan would be quite high, and the Japanese cut flower market would become a profitable market for many cut flower exporters.

The remainder of the paper is organized as follows. First, an overview is provided of the Japanese cut flower market and the existing NTBs imposed on Japan's cut flower imports. The analytical model is then introduced, followed by a presentation of the data and estimation results. Conclusions are highlighted in the final section, along with a discussion of the important policy implications based on our estimation results.

Background

Japan is a major producer as well as a prominent consumer in the world cut flower industry. Japan, the United States, and the Netherlands are considered the three leading countries in cut flower production. In 2007, 5.8 billion stems of cut flowers were traded in the Japanese wholesale market, representing a value of about $2.9 billion (MAFF, 2008). The average wholesale price in Japan was $0.48 per unit, which was almost double the per unit price in the Netherlands (Lim-Camacho, 2006). The United States, the European Union (mainly Germany, the United Kingdom, the Netherlands, and France), and Japan are the world's largest importers of cut flowers. Japan started importing cut flowers in the late 1960s, and the consumption of imported cut flowers has been significantly increasing (except during the period when Japan experienced an economic recession in the early 1990s), while consumption of domestic cut flowers has been significantly decreasing over the past years. The country imported 34.9 million kg of cut flowers in 2007, valued at $238 million (Japan Customs, 2008). While Japan is a major flower importer, imported cut flowers still account for a very small percentage of total sales in the Japanese wholesale market. Table 1 lists Japan's top five cut flower import countries (Malaysia, China, the Republic of Korea, Thailand, and Colombia) and the import quantities and values from these countries in 2007.

The Japanese market is very attractive to cut flower growers across the world because of large demand and high prices for high-quality cut flowers. Japan's higher wholesale market prices make the Japanese market profitable for foreign cut flower producers even after incurring transportation and other trade costs. However, Japan's strict SPS measures and lengthy customs and administrative procedures have become impediments for foreign cut flower growers to export to Japan.

Japan's SPS regulations prohibit imports of numerous plants considered as hosts for pests. Around 15 species are on the list of prohibited pests that could infect cut flowers, among which the Mediterranean fruit fly, the oriental fruit fly, the Queensland fruit fly, and the melon fly are the most serious and destructive (Jensen and Malter, 1995). Even when some pests are cosmopolitan, i.e., common to both exporters and Japan, Japan

Table 1. Japan's Cut Flower Import Quantity and Value from Its Top Five Import Countries in 2007

Import Country	Trade Quantity (kg)	Trade Value ($)
Malaysia	8,214,078	53,276,257
China	5,635,344	23,329,948
Republic of Korea	5,056,748	11,824,755
Thailand	4,077,519	33,707,510
Colombia	3,378,148	33,378,198

Source: United Nations, Commodity Trade Statistics Database (2008).

continues to restrict imports of many fresh horticultural products that might harbor these pests. If any sort of prohibited pest is detected in a shipment, the shipment is fumigated with either hydrocyanic gas or methyl bromide. These fumigation practices can damage cut flowers significantly (Jensen and Malter, 1995). Alternatively, customs officials sometimes just destroy the entire shipment.

Additionally, Japan's lengthy, zero-tolerance quarantine inspection procedures and its preferential treatment of Japanese freight forwarders result in protracted delays (Coalition Against Agricultural Barriers to Trade, 1998). According to a database compiled by the World Bank, the average time taken by customs and administrative procedures to move products across Japan's border is approximately 11 days. In contrast, it takes only five days to move products through the United States' border (World Bank, 2008). The delays in Japan make it extremely difficult to get delicate fresh cut flowers to final consumers before the quality of the flowers deteriorates. Quality is very important to Japanese consumers, who will purchase nothing less than the highest quality fresh products. Consequently, less than premium goods simply do not get into distribution. If the existing NTBs were removed, cut flower growers from other countries, whose products would be of higher quality, would likely benefit from the premium prices in the Japanese cut flower market.

Analytical Framework

This analysis employs a CES utility function with factor-augmenting technical progress to incorporate product heterogeneity in quality and the changes of product quality over time. A study by Reid and Jiang (2005) showed that poor temperature control and low humidity during long-distance transportation can greatly decrease the quality of imported cut flowers. In recent years, however, cut flower packing methods, pre-cooling technologies, and temperature management systems have improved. In addition, the industry has been developing new storage procedures for cut flowers. All of this technological progress has resulted in longer vase life and higher quality of imported cut flowers. Yet, these new technologies have had relatively smaller impacts on domestic cut flowers due to the shorter transportation distance compared to imported products. We therefore assume that the quality of imported cut flowers has been increasing at a relatively higher rate than that of domestic cut flowers over time.

Following Hallak and Schott (2008), we specify a linear time path for changes in imported and domestic cut flower quality. This method has also been widely used in the production literature. Many studies have adopted the CES production function with factor-augmenting technical progress to estimate the impacts of different types of technical progress on production (e.g., Beckmann and Sato, 1969; Sato, 1977). Similarly, we introduce changes in the quality of imported and domestic cut flowers over time to the basic CES utility function to account for the different rates of progress in the quality of imported and domestic cut flowers.

Domestic and imported cut flower quantities are defined as D and I, respectively. A representative consumer maximizes the following utility function, assumed to be separable in cut flower purchases, subject to a budget constraint:

(1)
$$\max_{D,I} U(D,I) = \left[(\lambda_D * D)^{\rho} + (\lambda_I * I)^{\rho}\right]^{1/\rho},$$
$$\text{s.t.: } P_D D + P_I I = M,$$

(2)
$$\lambda_D = \lambda_D(0) * e^{\varepsilon_D t},$$

(3)
$$\lambda_I = \lambda_I(0) * e^{\varepsilon_I t},$$

where M is the expenditure on all cut flowers; P_I and P_D are consumer prices of imported and domestic cut flowers, respectively; λ_I and λ_D are quality indicators of imported and domestic cut flowers, respectively, capturing product quality and the combined effects of all product characteristics other than price on consumers' valuation of a product; ε_I and ε_D measure the rates of change in product quality of imported and domestic cut flowers, respectively; and $\rho = 1 - 1/\sigma$, with σ measuring the elasticity of substitution. The indirect utility function is given by

(4)
$$V(P_D, P_I, M) = M\left[\left(\frac{P_D}{\lambda_D(0) * e^{\varepsilon_D t}}\right)^{1-\sigma} + \left(\frac{P_I}{\lambda_I(0) * e^{\varepsilon_I t}}\right)^{1-\sigma}\right]^{1/(\sigma-1)},$$

and the corresponding expenditure function is written as

(5)
$$e(P_D, P_I, U) = U\left[\left(\frac{P_D}{\lambda_D(0) * e^{\varepsilon_D t}}\right)^{1-\sigma} + \left(\frac{P_I}{\lambda_I(0) * e^{\varepsilon_I t}}\right)^{1-\sigma}\right]^{1/(1-\sigma)}.$$

The expenditure function and indirect utility function are used to estimate consumer welfare. We can decompose observed consumer prices into quality and quality-adjusted price components. Specifically, the observed consumer price (P_I) can be decomposed into quality (λ_I) and quality-adjusted price (P_I/λ_I), where $P_I = \lambda_I * P_I/\lambda_I$. According to Hallak and Schott (2008), the observed consumer price (P_I) is referred to as an "impure" price since it is "contaminated" by quality. Correspondingly, the quality-adjusted price (P_I/λ_I) is denoted the "pure" price. Following Hallak and Schott, we assume that the observed P_D and P_I are impure prices, and P_D/λ_D and P_I/λ_I are pure prices. Based on the definition above, indirect utility and expenditure functions depend only on pure prices.

The associated Marshallian demand functions are specified as:

(6)
$$D = \frac{M}{P_D + P_I * \left(\frac{P_I}{P_D}\right)^{-\sigma} * \left(\frac{\lambda_D(0) * e^{\varepsilon_D t}}{\lambda_I(0) * e^{\varepsilon_I t}}\right)^{1-\sigma}}$$

and

(7)
$$I = \frac{M}{P_I + P_D * \left(\frac{P_D}{P_I}\right)^{-\sigma} * \left(\frac{\lambda_I(0) * e^{\varepsilon_I t}}{\lambda_D(0) * e^{\varepsilon_D t}}\right)^{1-\sigma}}.$$

These demand functions are used to estimate the new equilibrium quantities of imported and domestic cut flowers. The consumer price of imported cut flowers (P_I) can be decomposed into an export unit cost, trade costs arising from distance (transportation cost, insurance, and other international trade costs), and NTBs. We consider two kinds of NTBs—SPS measures and customs and administrative procedures. The SPS measures lead to a higher marginal cost of production involved in producing a product in order to comply with phytosanitary requirements. The SPS measures increase the unit cost and thus the price of cut flowers exported to Japan relative to the same cut flowers exported to other countries. The SPS measures include the higher marginal production costs incurred to satisfy the strict Japanese SPS standards before export, the costs in the market channels, and the costs incurred by the additional requirements after the shipments arrive in Japan, such as additional fumigation of cut flowers[1] (Yue, Beghin, and Jensen, 2006).

Upon arrival of the imported cut flowers in Japan, the shipments are subject to lengthy delays caused by customs and administrative procedures. These customs procedures and administrative practices, measured as *CP*, can serve to greatly decrease the quality of imported cut flowers because of these flowers' highly perishable characteristics. Thus, the prices of imported cut flowers decrease in Japanese wholesale and retail markets due to deteriorated product quality. The salvage value of ruined cut flowers is close to zero. The wholesale price of imported cut flowers is expressed as:

(8)
$$P_I = P_W + SPS + IT_R + Tariff - CP,$$

where P_W is the world price, the average export price of the same types of cut flowers to other countries[2]; IT_R includes the insurance, international transportation costs, transportation costs from the port to the internal wholesale market, customs fees, and other international trade costs of cut flowers exported to the Japanese wholesale market.

Parameter k is defined as the percentage decrease in import prices due to deteriorated product quality. The price of imported cut flowers is lowered by $100 * k\%$ when customs and administrative procedures are in place. Based on the above assumption,

(9)
$$P_I = (P_W + SPS + IT_R + Tariff)(1-k).$$

The relevant P_I usually cannot be observed directly, but we can infer a value for P_I from P_D. The marginal rate of substitution equals the relative price of the substitute goods, or:

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[1] Additional fumigation also affects the cut flowers' quality. However, fumigation is applied only when certain prohibited pests are detected, so we don't consider its impact on product quality here.

[2] Other countries may also apply SPS measures, which are already reflected in P_W. In this paper the SPS measure includes Japan's SPS requirements that are additional to the standard SPS requirements by other countries. Similarly, customs and administrative procedures are a measure of Japan's customs and administrative procedures compared with those of other countries.

(10) $$MRS = \frac{MU_D}{MU_I} = \frac{P_D}{P_I},$$

where MRS is the marginal rate of substitution, and MU_I and MU_D indicate the marginal utility of imported and domestic cut flowers, respectively. Calculating MRS from (1) and substituting it back into (10) gives:

(11) $$P_I = P_D * \left(\frac{D}{I}\right)^{1/\sigma} * \left(\frac{\lambda_I(0) * e^{\varepsilon_I t}}{\lambda_D(0) * e^{\varepsilon_D t}}\right)^{(\sigma-1)/\sigma}.$$

Substituting (11) back into (9) and rearranging, we obtain:

(12) $$SPS = \frac{P_D}{1-k} * \left(\frac{D}{I}\right)^{1/\sigma} * \left(\frac{\lambda_I(0) * e^{\varepsilon_I t}}{\lambda_D(0) * e^{\varepsilon_D t}}\right)^{(\sigma-1)/\sigma} - P_W - IT_R - Tariff$$

and

(13) $$CP = P_D * \left(\frac{D}{I}\right)^{1/\sigma} * \left(\frac{\lambda_I(0) * e^{\varepsilon_I t}}{\lambda_D(0) * e^{\varepsilon_D t}}\right)^{(\sigma-1)/\sigma} * \frac{k}{1-k}.$$

Equations (12) and (13) are used to estimate SPS and CP, respectively. For the welfare analysis, we use equivalent variation (EV) to measure consumer welfare, with $EV = e(\tilde{p}_0, u_1) - m_0$, where $\tilde{P} = (P_D, P_I)$ and subscripts 0 and 1 indicate initial and new prices, respectively.

We use a small displacement model to determine the price and quantity of domestic cut flowers and infer the impact of removing the SPS measures and customs and administrative procedures on imports and the domestic market equilibrium. Because the two barriers of SPS measures and customs and administrative procedures have been separated, we can examine the impact of removing them individually.

Let S be the wholesale supply of Japanese domestic cut flowers, which is an increasing function of the prices of domestic cut flowers and exogenous parameter α:

(14) $$S(P_D, \alpha) = \alpha P_D^{\varepsilon_s}.$$

Parameter ε_I represents the own-price elasticity of the domestic cut flower supply. A decrease in parameter α reflects upward shifts in the supply curve if phytosanitary contamination occurred because of infested imports and leads to an increase in the cost of domestic production. Equilibrium domestic price P_D^e and quantity D are determined by the market equilibrium condition:

(15) $$D(P_D^e, P_I) = S(P_D^e, \alpha).$$

Substituting equation (6) into the left-hand side of equation (15) and substituting equation (14) into the right-hand side of equation (15), we can derive the new equilibrium domestic price P_D and quantity D after the removal of SPS measures and/or customs and administrative procedures. With the elimination of customs and administrative procedures, the quality of imported cut flowers increases, which is reflected by an increase in λ_I. With the elimination of SPS measures, the production costs and prices of imported flowers decrease.

We substitute equation (11) into the budget constraint in equation (1) and rearrange the new equation to obtain:

$$\frac{M}{P_D D} - 1 = \left(\frac{I}{D}\right)^{1-(1/\sigma)} \left(\frac{\lambda_I(0) * e^{\varepsilon_I t}}{\lambda_D(0) * e^{\varepsilon_D t}}\right)^{1-(1/\sigma)}. \tag{16}$$

Taking natural logarithms of (16), equation (16) then becomes:

$$\ln\left(\frac{M}{P_D D} - 1\right) = \beta_0 + \beta_1 \ln\left(\frac{I}{D}\right) + \beta_2 t, \tag{17}$$

where

$$\beta_0 = \beta_1 * \ln\left(\frac{\lambda_I(0)}{\lambda_D(0)}\right), \; \beta_2 = \beta_1 * (\varepsilon_I - \varepsilon_D).$$

Equation (17) is estimated using ordinary least squares. We regress the left-hand side of equation (17) on $\ln(I/D)$ and t, and use the regression coefficients of $[\ln(I/D), t]$ and intercept to recover parameters σ, $(\varepsilon_I - \varepsilon_D)$, and λ_I/λ_D. The estimates' standard deviations are derived using the Delta method. Substituting the estimated parameters back into equations (12) and (13), we can calculate the tariff equivalents of SPS measures and customs and administrative procedures.

Empirical Analysis

SPS and CP Estimation

We apply the framework developed in the analytical framework section to the case of imported cut flowers in Japan. Since three types of cut flowers (roses, carnations, and chrysanthemums) account for about 50% of Japanese cut flower domestic production and imports, we estimate the parameters σ and λ_I/λ_D, *SPS*, and *CP* based on the aggregated data of these three types of cut flowers. Japanese domestic roses, carnations, and chrysanthemums are aggregated to estimate D and the average price is then used to estimate P_D. Similarly, aggregated import quantities of the three types of flowers are used to estimate I. We use the wholesale value of these three types of cut flowers to estimate M. The parameters σ and λ_I/λ_D are estimated using monthly data between 2002 and 2007 from MAFF (2008). Since the observed monthly data of price and quantity are based on the unit "stem," we convert the unit "stem" to "kilogram" by assuming that the average weight of cut flowers per stem is 0.04 kg (IDEA, 2001). The estimated results for σ and quality indicator parameters using equation (17) are reported in table 2. The R^2 and adjusted R^2 of the regression are 0.9268 and 0.9258, respectively, indicating a good fit of the model.

According to our estimation results, the parameter $\varepsilon_I - \varepsilon_D$ is statistically significant and positive, revealing that the quality of imported cut flowers relative to domestic cut flowers has been increasing over time t. This result is consistent with the earlier findings of Reid and Jiang (2005) that the quality of imported cut flowers has been improving over time due to the development of more advanced pre-cooling, packing, and storage technologies. The increase in import quality (λ_I) leads to an increase in consumption of imported cut flowers in Japan.

Table 2. Estimated Elasticity of Substitution and Quality Indicators

Parameter	Estimated Value	Approximate Standard Deviation
σ	3.381***	0.409
$\varepsilon_I - \varepsilon_D$	0.080***	0.014
$\lambda_I(0)/\lambda_D(0)$	0.201***	0.035

Note: *** denotes statistical significance of the coefficient at the 1% level.

Japan's top five cut flower importing countries are Malaysia, China, Korea, Thailand, and Colombia. We derive these countries' prices of exported fresh cut flowers by dividing the total export value (valued at FOB prices) by total export weight (measured in kg). Next, we average these export prices weighted by each country's share of Japan's cut flower imports to estimate P_W. These countries' trade data between 2002 and 2007 are from the United Nations' Comtrade database (United Nations, 2008),[3] and prices are converted from U.S. dollars/kg to Japanese yen/kg. Yearly exchange rates between the U.S. dollar and the Japanese yen are obtained from the PACIFIC Exchange Rate Service (2008).

To estimate IT_R, we also consider the five countries' bilateral IT_{Rj} between 2002 and 2007 and then average them weighted by each country's share of Japan's imports. For simplicity, the unit rate of IT_R is assumed to be the same across different countries, so the bilateral IT_R is proportional to the distance between the exporting and the importing countries. The average unit cost for international transportation and insurance and other trade costs from Australia to Japan was estimated to be $2.235/kg (Ekman, Eyr, and Joyce, 2008). This value is used to estimate the unit rate of IT_R. Based on the distance between Japan and the exporting countries and the exporting countries' share of Japan's cut flower imports, we are able to calculate IT_R across different years. The estimated P_W ranges from $2.97/kg to $3.48/kg, with a mean of $3.29/kg between 2002 and 2007. The estimated IT_R ranges from $1.44/kg to $1.53/kg, with a mean of $1.49/kg over 2002–2007.

Following Wilson (2007), we use the database provided by the World Bank to estimate the times needed to cross borders. As mentioned in the background section, it usually takes 11days for imported products to pass through the border in Japan compared to five days in the United States. If we assume the United States is efficient in customs and administrative procedures, then five days is necessary, and the extra six-day delay in Japan is due to customs and administrative practices. It generally takes approximately one week longer to transport the cut flowers from Australia to Japan by sea than by air. The one-week longer transportation time decreases the quality and reduces the vase life of cut flowers, so the prices of cut flowers shipped by sea are approximately 10% lower compared to the prices of their counterparts shipped by air (Ekman, Eyr, and Joyce, 2008). We use this 10% value to estimate parameter k, which measures the percentage decrease in import prices due to deteriorated product quality. Since the delay caused by Japan customs and administrative procedures is about the same as the time

[3] We use monthly data to estimate the parameters in equation (17); annual data are used to estimate P_W, IT_R, consumer welfare, and producer welfare.

Table 3. Tariff Equivalents of SPS and Customs and Administrative Procedures Across Different Years, 2002–2007

Year	CIF Price[a] ($/kg)	SPS ($/kg)	SPS Rate	CP ($/kg)	CP Rate
2002	6.8	5.5	81%	1.0	15%
2003	6.7	5.7	85%	1.1	16%
2004	7.0	6.1	87%	1.1	16%
2005	7.0	5.9	84%	1.1	15%
2006	6.6	6.2	94%	1.1	17%
2007	6.8	6.4	94%	1.1	16%

Source: Japan Customs (2008).
[a] CIF price is cost, insurance, and freight price.

difference between transporting cut flowers by air and by sea, the parameter k is assumed to equal 10% in our analysis.[4]

Imports of all types of cut flowers into Japan are duty free for all countries. *SPS* and *CP* are estimated using equation (12) and equation (13), respectively. The estimation results of tariff equivalents of SPS measures and customs and administrative procedures across different years are shown in table 3. The tariff equivalent of SPS measures is relatively larger than that of customs and administrative procedures.

Welfare Analysis

We analyze the impacts of SPS measures and customs and administrative procedures on imports of cut flowers and the welfare of Japanese flower consumers and flower growers. The supply elasticity of chrysanthemums is around 0.8, and for carnations around 0.3 (Steen, 2006). These two estimates are used to represent supply elasticity in the following welfare analysis. We first consider the removal of customs and administrative procedures. If the customs and administrative procedures were removed, the time delays would decrease, and thus the quality of the imported cut flowers (λ_I) would increase. If the quality of imported cut flowers increases and the pure price of imported cut flowers declines, demand for domestic cut flowers will decline due to the substitution effect. The domestic flower price will decrease due to the decreased demand until demand equals supply. Imports of cut flowers will expand as long as the demand for the higher quality imported cut flowers is larger than the feedback effect of the lower domestic flower price. The domestic producer welfare decreases, while consumers are better off. The total change in social welfare depends on the relative changes of consumer welfare and producer welfare but with net expected gains. The vase life of cut flowers is the primary measurement of cut flower quality. In many instances, an increase in the cut

[4] Ten percent is only an approximation; the price decline could be greater. We assume the export day to be the first day after cut flowers are transported beyond the farm gates, and it takes 11 days to go through Japan's border. If cut flowers are shipped by air, the transit time is one day and the time to pass through Japan's border is 11 days, so cut flowers reach the domestic wholesale markets on the 12th day. If cut flowers are shipped by sea, the transit time is seven days, so on the 18th (7 + 11) day the cut flowers arrive at the domestic wholesale markets. If cut flowers are shipped by air, the price difference caused by customs and administrative procedures should be the price difference of flowers on day six (1 + 5 for the United States) and day 12 (1 + 11 for Japan). If cut flowers are shipped by sea, the price difference associated with customs and administrative procedures is the price difference of flowers on day 12 (7 + 5 for the United States) and day 18 (7 + 11 for Japan).

Table 4. Increase in Imports from the Elimination of Customs and Administrative Procedures Across Different Years, 2002–2007

	$\varepsilon_s = 0.3$		$\varepsilon_s = 0.8$	
Year	Quantity (1,000 kg)	Value ($ millions)	Quantity (1,000 kg)	Value ($ millions)
2002	5,697	53.4	5,833	54.7
2003	8,013	76.0	8,294	78.7
2004	10,440	103.8	10,837	107.7
2005	11,241	109.7	11,772	114.9
2006	11,927	112.8	12,610	119.2
2007	11,295	115.1	11,920	121.5

Table 5. Welfare Analysis of the Elimination of Customs and Administrative Procedures Across Different Years, 2002–2007 ($ millions)

	$\varepsilon_s = 0.3$			$\varepsilon_s = 0.8$		
Year	EV	Producer Surplus Loss	Net Welfare	EV	Producer Surplus Loss	Net Welfare
2002	66.3	40.1	26.2	56.3	30.2	26.1
2003	99.7	59.8	39.9	84.6	44.9	39.7
2004	133.6	76.3	57.3	116.3	59.4	56.9
2005	146.4	83.3	63.1	126.2	63.6	62.6
2006	156.7	89.1	67.6	134.0	66.9	67.1
2007	159.0	88.8	70.2	137.9	68.2	69.7

flower transportation and storage time results in a subsequent decrease in vase life. The vase life of cut flowers typically decreases by 22% on average after one week of storage (Ekman, Eyr, and Joyce, 2008). Since the customs and administrative procedures in Japan also lead to an approximate one-week delay, we assume that λ_I, which is the quality indicator when the customs and administrative procedures are in place, would increase to $\lambda_I/(1-22\%)$ if the customs and administrative procedures were removed.

The increases in imports resulting from the elimination of customs and administrative procedures across different years are reported in table 4. When the supply elasticity of domestic cut flowers is assumed to be 0.3, the average quantity of all kinds of cut flowers imported from all countries would rise by around 11.3 million kg, amounting to $115.1 million in 2007. When the supply elasticity of domestic cut flowers is assumed to be 0.8, the increase in imports amounts to approximately 11.9 million kg, valued at $121.5 million in 2007. The estimated increases in imports are not very sensitive to the supply elasticity of domestic cut flowers.

Table 5 and figure 1 show the welfare changes that coincide with the elimination of customs and administrative procedures under supply elasticity scenarios of 0.3 and 0.8. In 2007, the net welfare increase amounted to $70.2 million under a supply elasticity of 0.3, and $69.7 million under a supply elasticity of 0.8.

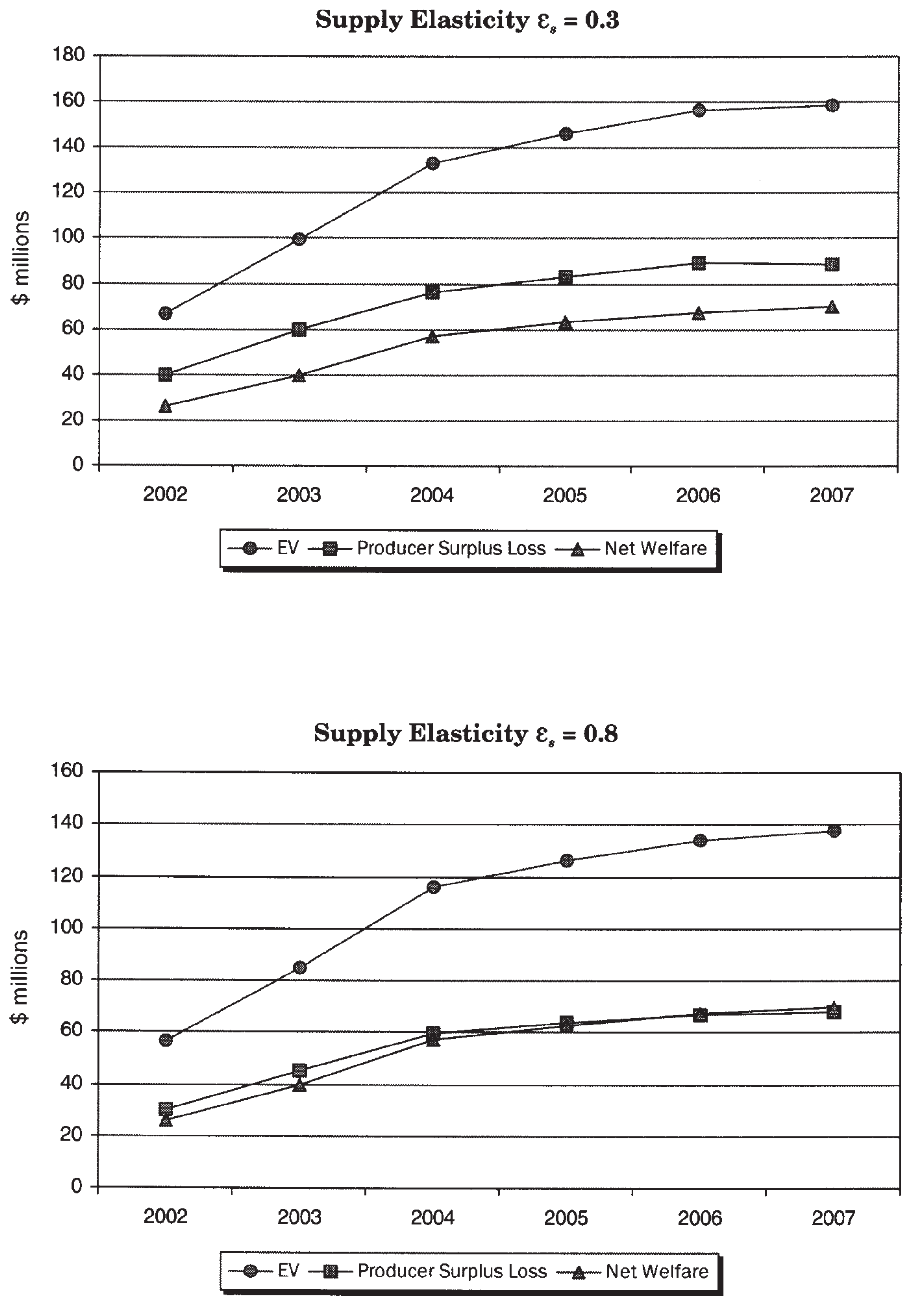

Figure 1. Welfare analysis of the elimination of customs and administrative procedures across different years, 2002–2007 ($ millions)

Table 6. Increase in Imports from the Elimination of SPS and Customs and Administrative Procedures for Year 2007

	$\varepsilon_s = 0.3$		$\varepsilon_s = 0.8$	
Domestic Supply Reduction	Quantity (1,000 kg)	Value ($ millions)	Quantity (1,000 kg)	Value ($ millions)
0%	159,864	613.2	173,786	675.7
10%	173,591	729.3	185,015	784.7
20%	188,814	860.8	197,571	906.3
30%	205,981	932.8	211,595	961.4
40%	225,417	997.1	227,601	987.7
50%	247,670	1,071.7	246,058	1,064.0

Table 7. Welfare Analysis of the Elimination of SPS and Customs and Administrative Procedures for Year 2007 ($ millions)

	$\varepsilon_s = 0.3$			$\varepsilon_s = 0.8$		
Domestic Supply Reduction	EV	Producer Surplus Loss	Net Welfare	EV	Producer Surplus Loss	Net Welfare
0%	1,166.7	471.8	694.9	1,060.2	376.5	683.7
10%	1,147.3	560.9	586.4	1,061.2	436.8	624.4
20%	1,108.2	662.8	445.4	1,043.8	503.8	540.0
30%	967.5	718.2	249.3	930.9	534.8	396.1
40%	800.8	752.2	48.6	788.7	549.4	239.3
50%	675.6	824.7	–149.1	683.5	592.1	91.4

If SPS measures were removed, disease or pest transmission might occur. If there were no disease or pest transmission, the consumer prices of imported cut flowers would decrease and the demand for domestic cut flowers would decline, which would lead to a decrease in domestic flower prices. Imports of cut flowers would expand and the domestic producer welfare would decrease. Consumers would be better off due to the lowered prices. In the case of disease or pest transmission, the price of domestic cut flowers might not decrease because domestic supply would also decrease.

As there are no data about the effects of pest or disease transmission on domestic production, we consider hypothetical cases of decreases in domestic supply ranging from 10% to 50%. Increases in imports resulting from removing SPS measures and customs and administrative procedures for year 2007 are presented in table 6 for $\varepsilon_s = 0.3$ and $\varepsilon_s = 0.8$. When $\varepsilon_s = 0.3$, imports would increase by around 159.9 million kg, or $613.2 million in 2007, provided no disease or pest transmission occurred. When $\varepsilon_s = 0.8$, imports would increase by 173.8 million kg or $675.7 million in 2007, if no transmission occurred. The results are not very sensitive to the supply elasticity of domestic cut flowers.

Table 7 shows the welfare changes resulting from the removal of SPS measures and customs and administrative procedures in 2007 for $\varepsilon_s = 0.3$ and $\varepsilon_s = 0.8$. We find that when $\varepsilon_s = 0.3$, even with disease or pest transmission, the increase in consumer welfare

Table 8. Tariff Equivalents of SPS Across Different Years, 2002–2007 (not considering vs. considering customs and administrative procedures)

		SPS Rate	
Year	CIF Price ($/kg)	Not Considering Customs and Administrative Procedures	Considering Customs and Administrative Procedures
2002	6.8	65%	81%
2003	6.7	69%	85%
2004	7.0	71%	87%
2005	7.0	69%	84%
2006	6.6	77%	94%
2007	6.8	78%	94%

would be larger than the loss of the producer welfare if the reduction of domestic supply did not exceed 40% in 2007. When $\varepsilon_s = 0.8$, the increase of consumer welfare is larger than the decrease of producer welfare even if a disease or pest transmission reduced the domestic supply by 50% in 2007.

One contribution of our paper is that we consider the effect of product quality changes caused by customs and administrative procedures on the estimation of SPS measures. Table 8 shows the SPS estimates without considering product quality changes caused by customs and administrative procedures (column 3) and the SPS estimates by taking into account product quality changes caused by customs and administrative procedures (column 4). Without considering quality changes, the SPS estimation results are found to be biased and are much smaller than the SPS estimation results that do consider the impact of customs and administrative procedures on product quality. The import increases and welfare gains resulting from removing NTBs are also underestimated. These results show that it is very important to consider the impact of customs and administrative procedures on product price and quality when estimating the SPS measures, especially for highly perishable products. Not taking into account the effect of customs and administrative procedures on the quality of highly perishable imports could lead to a biased estimation of both SPS measures and welfare gains.

Conclusion

The price wedge between domestic and imported goods usually comes from tariffs, NTBs, quality differences, and trade costs (freight costs, insurance, and other international trade costs). We develop a methodology to apportion the price wedge that is caused by different types of NTBs when these NTBs are jointly in place. Two major NTBs are considered—the SPS measures and customs and administrative procedures. While SPS measures directly increase the cost of production and thus a product's price, customs and administrative procedures generally decrease a product's quality and thus the product's price. We employ a CES utility function with factor-augmenting technical progress to incorporate and parameterize changes in the quality of imported and domestic goods over time and derive a demand system for domestic and imported goods. The most recent data are used to estimate the elasticity of substitution between imported and domestic cut flowers in the Japanese market and the quality ratio between imported and domestic cut flowers across different years. Then, we estimate the tariff equivalents of the SPS measures and the customs and administrative procedures.

SPS measures and customs and administrative procedures typically have offsetting influences on the price wedge. Using our methodology, we estimate the tariff equivalents of the barriers and compute the foregone trade effects associated with these barriers by considering their respective natures and contributions to the price gap. Most previous studies have neglected the influence of customs and administrative procedures on the price wedge, which somewhat mitigated the impact of NTBs, especially for highly perishable agriculture products.

The rigorous investigation of Japanese cut flower imports validates the approach. More importantly, our research raises policy implications. The tariff equivalents of the Japan SPS measures and customs and administrative procedures are high (around 88% and 16%, respectively), and the tariff equivalent of SPS measures is relatively larger than that of the customs and administrative procedures. If all these Japanese NTB measures were removed, the increase in cut flower imports by Japan would be quite high. Additionally, the gains in Japanese consumer welfare would be high enough to compensate for the losses in the welfare of domestic producers if the impact of any increased disease transmission on domestic supply is moderate. One concern is that the NTB measures also have the potential to enhance public welfare by providing public goods that might not otherwise be available. These policies could signal consumers in the importing market that a product is safe, thereby reducing consumer uncertainty associated with inadequate information. Therefore, our estimate may provide an upper boundary of welfare gains from removing NTBs.

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