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Three essays on food quality and transaction costs

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ABSTRACT

Product quality and product differentiation have become increasingly important to producers and policymakers for explaining consumer choice over food products. Consumers are often willing to pay large price premiums for products with preferred attributes. Heterogeneity in quality increases the diversity of goods for consumers and can improve welfare. However, variation in quality also leads to higher transaction costs for consumers, producers and policymakers because quality attributes are hard to identify precisely and vary when the state of the world changes. The first essay addresses the issue of food-quality attributes driven by protectionist policy that inhibits exchange between two countries. Technical barriers to trade based on phyto-sanitary standards and their impact on food trade are investigated by accounting for quality heterogeneity based on the origin of the good (imported versus domestic) and for consumers' home-good preference. The second essay is concerned with the complex interaction between quality promotion, through brand advertising and geographical indication, and quality improving effort in the context of asymmetric information. The results show that if a producer makes the effort to improve quality level, the producer will prefer to rely on brand advertising for promoting its products and setting up its own reputation. Despite allowing the cost of promotion to be shared, a geographical indication does not sufficiently reward the effort to improve quality. The third essay addresses the effect of interaction between organic attributes, an intrinsic attribute of food and appearance, an extrinsic attribute of food. Evidence from an experimental auction shows that a majority of consumers are willing to pay more for organic than for conventional apples. However, at the first sight

of any deterioration in the appearance of the organic apples, this segment is significantly reduced. Furthermore, cosmetic damage has a larger impact on the average willingness to pay for organic apples than for conventional apples.

CHAPTER 1. GENERAL INTRODUCTION

Introduction

When products vary in quality, consumers may not observe quality differences or be fully informed about the attributes of products in the market. Consumers are often willing to pay large price premiums for products with the right attributes. As a result, product quality and product differentiation have become increasingly important to producers and policymakers as they rely on good information on consumer choices in food markets to enhance profit and structure effective regulation and public policy.

Economic theory considers such problems by classifying goods by three types of product quality characteristics: search, experience and credence characteristics (Darby and Karni, 1973; Nelson, 1970, 1974). *Search* characteristics can be ascertained before the purchase, for example, the size and color of apples. In contrast, *experience* characteristics are characteristics that can only be established by experiencing the product, for example, the taste of wine. *Credence* characteristics cannot be validated (or can be validated only at very high cost) by consumers either before or after the purchase, for example, whether a bag of apples is produced organically or not. The distinction among characteristics is useful because appropriate public policy response is needed to reduce market failure that occurs when the costs of information are high. Often the characteristics are considered using the dichotomy between intrinsic and extrinsic product attributes (Olson and Jacoby, 1972) and incorporated into multi-attribute models of choice (Ajzen and Fishbein, 1980; Cohen, Fishbein and Ahtola, 1972; Fishbein and Ajzen, 1975; Lutz and Bettman, 1977), Intrinsic attributes are attributes of the physical product, for example, type of grapes used in producing wine, or size, brix (a measure of sugar level) and cosmetic appearance of apples. Extrinsic attributes are everything else not directly associated with the physical product, for example, price, brand and origin (Japanese apples and Napa Valley wine).

It is difficult to fully describe or classify goods because characteristics, both intrinsic and extrinsic, are hard to pin down precisely and vary when the state of the world changes. Incompletely defined goods or attributes often lead to incomplete property rights as it takes resources to define goods and allocate the rights to attributes. Opportunism can arise because rents associated with the undefined or poorly defined attributes and rights are available for taking or can be contested (North, 1990; Barzel, 1989). This uncertainty inhibits exchange. Useful institutional arrangements can mitigate these transaction cost issues by better defining the attributes and, hence, lowering opportunism and transaction costs. In other words, these arrangements promote exchange. For example, third-party definition and certification of organic foods tend to promote the market for organic food by reducing asymmetric information on credence attributes.

Some institutional arrangements may also focus on or create irrelevant credence attributes not valued by consumers. This opportunism can be seen in private exchange and also in the design, implementation, and enforcement of policy agreements (North, p. 187). Opportunism can also arise and lead to increased transaction costs in exchange and, thus, inhibit exchange by introducing new required attributes, such as some arbitrary phyto-sanitary standards. This is done by policymakers to increase trade costs and prevent private agents from exchanging certain goods in order to protect competing domestic industries. The dissertation involves three essays on food quality attributes and associated transaction costs in exchange. The three essays consider quality issues and investigate market complexities that arise due to differing product quality: first, from the aspect of consumer preference for domestic goods and the corresponding policy implications in the context of international trade; second, through the producers' choice of promotion and quality-improving strategies in the context of different industrial structure; and third, in the consumers' tradeoff between organic method (a credence quality attribute) and appearance (a search quality attribute) of fresh fruit. The three essays and the relevant aspects of attributes and transaction costs are briefly summarized next. The essays themselves follow this introduction.

The first essay, **"**Tariff Equivalent of Technical Barriers to Trade with Imperfect Substitution and Trade Costs*"*, addresses the issue of food-quality attributes driven by protectionist policy that inhibits exchange between two countries. Technical barriers to trade based on phyto-sanitary standards affect food trade. Goods vary by heterogeneity in quality, origin of the good (imported versus domestic good), and consumers' home-good preference. Previous analyses of technical barriers to trade (TBT) have abstracted from differences in product quality and this leads to incorrect estimates of the tariff-equivalence of a TBT and of its trade effects, and hence to erroneous trade policy prescriptions. In particular, analysts often abstract from the heterogeneity of products' quality is often abstracted or simply address the product difference by choosing "close" substitutes to approximate perfect substitution. Then a price-wedge approach (price difference between the border and home market) is used to quantify the impact of a TBT on market equilibrium and trade.

In general, price-wedge estimates rely on the assumption of homogeneous commodities and a price arbitrage condition. By assuming that domestic and imported goods are perfect substitutes, the gap between their prices reflects trade impediments from various policies and natural protection. However, in addition to the cost associated with the TBT, transportation and other transaction costs associated with marketing may prevent full arbitrage between the two prices (Head and Mayer, 2002). Instead, as developed in this essay, a revamped tariff-equivalent estimate of a TBT allows extending the price-wedge framework by first relaxing the homogeneous commodity assumption and accounting explicitly for commodity heterogeneity and perceived quality of substitutes. By systematically exploring the robustness of the tariff-equivalent estimate to underlying assumptions on commodity heterogeneity, home-good preference, trading costs, and the chosen reference data, the analysis shows the importance of selecting best values of these key determinants (substitution elasticity, home-good preference, and trade cost) on which the policy analysis can be centered. The sensitivity of the TBT estimate is evaluated around these central values of the determinants to derive associated welfare implications.

The second essay, “How to Promote Quality Perception Wine Markets: Brand Advertising or Geographical Indications?” is concerned with the complex interaction between brand advertising (BA) and geographical indications (GI), and quality improving effort in the context of asymmetric information. The BA and GI convey extrinsic quality cues to consumers and the quality improving effort attempts to give intrinsic quality cues to consumers through their experience with the product. A parsimonious framework allows investigating the link between promotion and quality effort and market outcome.

In a two-period model, GI and BA enhance the quality perception and consumers' willingness to pay. The BA allows a seller to develop an individual reputation. The GI allows sellers to share the promotion cost and to develop a common reputation. Besides the choice of GI or BA, producers choose whether or not to make an effort to improve the real average quality level. Both signal and effort strategies influence the seller's profits. The second essay is linked to two separate strands of literature. The first strand of literature includes numerous papers on quality signaling. This research considers mainly prices (see for instance Mahenc, 2004) or advertising (see for instance, Fluet and Garella, 2002) for signaling a higher quality. The framework developed here in the second essay differs by simplifying the consumers' belief and considering GI and BA as persuasive tools that change consumers' preferences. The second strand of literature is more recent (see for instance Marette and Crespi, 2003), and focuses on the GI only. In this literature, producers' coordination or even price collusion via a GI may be necessary to improve quality when the fixed costs of certification or quality improvements are large. Here, in contrast, the framework differs by abstracting from any price collusion linked to the GI and introduces the possibility for producers to use brands. Broadly, the essay addresses the question of the efficiency of labels and professional groups compared to that of a private brand applied to the example of wine markets. The analysis shows that if the effort for improving quality is selected, a producer will prefer to rely on brand advertising for promoting its wine and set up its own reputation. Despite the sharing of the promotion cost, a geographical indication does not sufficiently reward the effort for improving quality because of the common reputation. Conversely, when the seller avoids the effort, the GI is selected. Firms take advantage of sharing of the promotion cost and collective reputation.

The third essay, “Discounting Spotted Apples: Investigating Consumers’ Willingness to Accept Cosmetic Damage in an Organic Product”, addresses the interaction effect between organic attributes, an important credence (and intrinsic) attribute of food, and appearance, an important search (and extrinsic) attribute of food. Fresh food products such as apples were at one time provided as generic products, but are now differentiated by brand, variety, origin, appearance, as well as production and processing method.

Empirical estimates of price variation due to quality factors date at least back to Waugh’s seminal study of quality factors affecting vegetable prices (Waugh, 1928). One of the most important quality factors is appearance. Appearance includes the intrinsic attributes of color, texture, and other visible differences. Most previous studies investigating consumer preference for organic foods assume that the organic products have similar cosmetic appearance as their conventionally produced counterparts (Blend and van Ravenswaay, 1999; and Loureiro, McCluskey, and Mittlehammer 2001; Larue *et al.,* 2004). Studies that focus on the effect of cosmetic problems find that consumers discount products with cosmetic damage (e.g. Thompson and Kidwell 1998, Roosen *et al.* 1998 and Baker 1999). The referenced studies find a positive effect from organic production (or nonuse of pesticides) and a negative effect of cosmetic damage. However, less well understood is the nature of the tradeoff, whether the measured response to damage is sensitive to production method, and the effect of underlying consumer attitudes on production method, environmental issues and other quality attributes.

Analysis in the third essay is based on a fourth-price sealed-bid auction to elicit consumer willingness to pay (WTP) for organic and conventional apples with different levels of blemish. Principal component factor analysis and random effect models allow the analysis of how the WTP for apples is affected by quality attributes (conventional versus organic production methods, degree of blemish and their interaction), as well as interactions among consumers' stated attitudes toward specific quality attributes (food safety concern, environmental concern, tolerance of pesticides, etc.), production method, degree of blemish, and consumers' socio-demographic characteristics. Experimental results yield a WTP premium for organic apples, a discount for various levels of spots (the cosmetic damage), information on how the spot level affects the WTP for both organic and conventional apples, and how attitude and socio-demographic variables affect these premiums. Similar to the previous studies, the main effects show a tradeoff between production methods and cosmetic damage. However, in addition, the experimental design allows the estimation of interaction effects between production method and cosmetic damage, thus testing for the effect of cosmetic damage on the premium for organic production.

The three essays are provided in the following chapters.

Policy Implications and Conclusions

The three essays address important quality issues in agricultural and food markets today and identify major findings. The rigorous investigation of the Japan-U.S. apple dispute in the first essay indicates the importance of accounting for quality heterogeneity, home-good preference, and trade costs in quantifying the effects on welfare and trade of the selected SPS regulation. Our finding of a strong home-preference for Japanese apples is consistent with similar findings in other fresh markets (e.g., the US avocado case (Orden, 2005)). A striking result in the analysis of the apple dispute is that the increase in welfare and apple imports would be small following the removal of the arbitrary SPS policies. The alleged damage in lost exports claimed by the United States at the WTO (U.S.$143.4 million) is substantially overstated. Much political goodwill has been spent on this dispute relative to the small size of the potential direct gains in agricultural exports. Ancillary benefits may exist if the United States eventually succeeds in opening the Japanese market and establishes a reputation as a persistent negotiator. Other countries or protected industries may pay attention to the United States' resolve in opening markets and may refrain from engaging in costly disputes.

The second essay explores wine producers' choice between promotional strategies (branding and GI) and quality improvement strategies and how these strategic choices affect consumers' wine purchasing decisions in the context of the international wine market. Although admittedly stylized, the model nonetheless highlights the complicated strategies for monitoring uncertain quality. The results show that the producers' choice depends on the relative efficiency of promotional strategies compared with that of making an effort to improve quality. Another important result is that if the effort for improving quality is selected, a producer would like to use branding for promoting its wine and set up its own reputation rather than relying on a GI. In spite of its advantage in allowing producers to share the cost of promotion, a GI does not sufficiently reward the effort for improving quality since it promotes a collective reputation. In this aspect, France may have erred with its wine GI system that provides limited incentive to producers to improve the average quality of their products. Quality is the key to gaining market share in the world wine market, one that has intense competition. So a reformed French policy should facilitate the emergence of branding or (branding combined with GIs) rather than GIs alone so as to reward producers for better products and eventually regain the country's "dominance" in the international wine market. Based on our model assumptions, however, brand advertising costs more than GIs to develop. The fragmented wine industry in France is composed of small individual producers lacking capital to do branding. Therefore, in the long run, a rationalization of French small wineries is a precondition to overcome their lack of capital and promote individual reputation.

The third essay finds that consumers are willing to pay a premium for organic apples, but the premium for organic apples decreases as the level of spot damage increases. The negative effect of cosmetic damage offsets the positive effect of organic production. Consumers' tolerance of cosmetic damage on apples is limited. This finding suggests the importance of quality attributes defined over cosmetic appearance as is the case today with the fruit grading system of the US Department of Agriculture, Agricultural Marketing Service, and as exists in many private contracts for produce. To a large extent, fresh fruit in US grocery stores have uniform appearance and the fruits with reduced appearance are often diverted as processed product such as to fruit juice and sauce. The finding of this essay indicates that even when there is no strict federal grading system, fresh fruit with cosmetic damage has little potential in today's retail market due to consumers' limited tolerance for reduced cosmetic attributes. Cosmetic damage also leads consumers to discount the premium they are willing to pay for the organic attribute. Even at relatively low levels of blemishes on the surface of organic apples, consumers preferred perfect looking conventional apples. The fact that consumers show little tolerance for organic goods with poor appearance supports by the entry of large processors and retailers into the organic retail market. Retailers are likely to dictate uncompromised appearance from organic product suppliers.

References

Ajzen, I. and Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*, 1st ed. Englewood Cliffs, NJ: Prentice-Hall.

Barzel, Y.(1997). *Economic Analysis of Property Rights: Political Economy of Institutions and Decisions*, 2nd ed. Cambridge, Cambridge University Press.

BBC news: "The European Commission has unveiled proposals for reform of the EU wine sector, designed to eliminate overproduction and make better use of subsidies", Thursday, June 22, 2006. http://news.bbc.co.uk/1/hi/world/europe/5107400.stm (accessed September,2006)

Cohen, J. B., Fishbein, M. and O. T.Ahtola (1972). "The nature and uses of expectancy-value models in consumer attitude research." *Journal of Marketing Research*, 9, 456-460.

Darby, M. R. and E. Karni (1973). "Free competition and the optimal amount of fraud." *Journal of Law and Economics*, 16*,* 67-88.

Fishbein, M. A. and I. Ajzen (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research.* Reading, MA: Addison-Wesley.

Fluet C. and P. Garella (2002). "Advertising and Prices as Signals of Quality in a Regime of Price Rivalry". *International Journal of Industrial Organization*, 20, 907-930.

Head, K., and T. Mayer (2002). "Illusory Border Effects: Distance Mismeasurement

Inflates Estimates of Home Bias in Trade." CEPII Working Paper 2002 -01, Centre d'Etudes Perspectives et d'Informations Internationales, Paris, January.

Lutz, R. J. and J. R. Bettman (1977). "Consumer and Industrial Buying Behavior." In Woodside A. G., Sheth J. N.and P. D. Bennett eds. *Multiattribute models in marketing: A bicentennial review*. New York, NY: Elsevier.

Marette, S., and J. Crespi (2003). "Can Quality Certification Lead to a Stable Cartel." *Review of Industrial Organization* 23(1, August): 43-64.

Nelson, P. (1970). "Information and consumer behavior." *Journal of Political Economy*, 78*,* 311-329.

Nelson, P. (1974). "Advertising as information." *Journal of Political Economy*, 82, 729-754.

North, D.C. (1990), "Institutions and a transaction-cost theory of exchange." Chapter 7, in J.E. Alt and K.A Shepsle eds. *Perspectives on Positive Political Economy*, Cambridge, Cambridge University Press, 1990.

Olson, J. C. and J. Jacoby (1972) "Cue utilization in the quality perception process." Third Annual Conference of the Association for Consumer Research, pp. 167-179. Chicago.

Orden, D. (2005) "Science, Opportunity, Traceability, Persistence, and Political Will: Necessary Elements of Opening the U.S. Market to Avocados from Mexico." *Conference on The Role of Labeling in the Governance of Global Trade: The Developing Country Perspective*, Center for Development Research (ZEF), Bonn, Germany, March 18-19, 2005.

CHAPTER 2. TARIFF EQUIVALENT OF TECHNICAL BARRIERS TO TRADE WITH IMPERFECT SUBSTITUTION AND TRADE COSTS

Abstract: The price-wedge method yields a tariff-equivalent estimate of technical barriers to trade (TBT). An extension of this method accounts for imperfect substitution between domestic and imported goods and incorporates recent findings on trade costs. We explore the sensitivity of this revamped TBT estimate to its key determinants (substitution elasticity, preference for home good, and trade cost). We use the augmented approach to investigate the recent Japan-U.S. apple trade dispute and find that removing the Japanese TBT would yield limited export gains to the United States. We then draw policy implications of our findings.

Keywords: apple, dispute, Japan, SPS, TBT, technical barriers, trade, WTO

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Introduction

Article 20 of the General Agreement on Tariffs and Trade (GATT) permits governments to set their own standards and regulations on trade in order to protect human, animal, or plant life or health, provided they do not discriminate among countries or use this motive as concealed protectionism. In addition, two specific World Trade Organization (WTO) agreements deal with food safety and animal and plant health, and with product standards: the Sanitary and Phytosanitary Measures Agreement (SPSA) and the Technical Barriers to Trade Agreement (TBTA). The SPSA allows countries to set their own standards, but it requires that the standards should not arbitrarily discriminate between countries with similar conditions. The TBTA was generated to minimize unnecessary obstacles in regulations, standards, and testing and certification procedures. In practice, however, some governments use stricter health and safety regulations than necessary to isolate domestic producers from international competition. The stricter regulations may lead to questionable impediments to imports that compete with domestic products, in addition to the existing tariff barriers. When the possibility of a disease or pest transmission is very low or threat to food safety is small, these trade impediments often cause welfare losses for importing countries and mercantilist losses for exporting countries due to reduced exports.

These issues have of course attracted the attention of economists (Anderson, McRae, and Wilson 2001; Bureau, Marette, and Schiavina 1998; Josling, Roberts, and Orden 2004; Roberts and Krissoff 2003). The growing literature on sanitary and phytosanitary (SPS) regulations and other technical barriers to trade (TBT) often uses a price wedge approach[1] to quantify the impact of a barrier on market equilibrium and trade, (e.g., Calvin and Krissoff 1998; Campbell and Gossette 1994). Although not unique or sophisticated, the method has been legitimized in the economics literature with some prescriptions and qualifiers to account for transportation cost and quality differences (Baldwin 1991; Deardorff and Stern 1998). The use of a price-wedge approach often abstracts from quality differences or simply addresses the difference by choosing "close" substitutes. Transportation costs may be reduced to the differential between cost-insurance-freight and free-on-board (CIF-FOB) prices and abstract from the internal transportation cost once imports are landed. All price-wedge estimates of which we are aware rely on the assumption of homogeneous commodities and a price arbitrage condition. By assuming that domestic and imported goods are perfect substitutes, the gap between their prices reflects trade impediments from various policies and natural protection. Border tariffs and transportation and transaction costs prevent full arbitrage between the two prices (Head and Mayer 2002). Hence, in principle, the price gap can yield an estimate of the tariff equivalent of the TBT once transportation and trade costs and other impediments have been taken into account.

In this article we derive a revamped tariff-equivalent estimate of a TBT. We extend the price-wedge framework by first relaxing the homogeneous commodity assumption, a straightforward but instrumental step overlooked in the literature on TBT measurement. We account explicitly for commodity heterogeneity and perceived quality of substitutes. Next, we incorporate recent developments and findings on large and costly border effects arising from transportation, linguistic differences, and poor infrastructure and law enforcement (Anderson and van Wincoop 2004; Head and Mayer; Hummels and Skiba 2004). Two major findings of this new literature are particularly relevant to our work. First, trading costs are very large and often greater than policy impediments and cannot be ignored. While CIF-FOB ratios have fallen over time, other transportation and trade costs have remained high and have been underestimated. Second, these costs are structured on a per-unit basis rather than following the so-called iceberg method;[2] they act as a specific tariff rather than an ad valorem tax (Hummels and Skiba). These per-unit costs shift supply in a parallel manner rather than proportionally, which influences the estimate of the TBT. We provide a consistent approach to apportion the internal-border price difference between potential sources of the difference (quality and heterogeneity of goods, border tariff, TBT, transportation and other transaction costs). This approach allows us to elucidate the respective role of each source leading to a credible estimate of the tariff equivalent of the TBT.

We systematically explore the robustness of the tariff-equivalent estimate to underlying assumptions on commodity heterogeneity, home-good preference, trading costs, and the chosen reference data. We show the importance of selecting best values of these key determinants (substitution elasticity, home-good preference, and trade cost) on which the policy analysis can be centered. We then analyze the sensitivity of the TBT estimate around these central values of the determinants and associated welfare implications. The analysis shows the value of narrowing the set of possible estimates of the TBT using available data and knowledge on the quality and heterogeneity of the domestic and competing imported goods.

Our article bridges two methods often used to estimate the trade effects of TBTs: the tariff-equivalent–price-wedge approach mentioned previously and the gravity-equation approach.[3] Recent conceptual developments have provided theoretical foundations to the gravity-equation approach and account explicitly for relative prices of traded and domestic substitutes and for trading costs. In addition, they attempt to better measure and decompose “border effects” of trade barriers and transportation costs between trade partners. These new approaches have been applied to aggregate trade data but not to individual commodities (Anderson and van Wincoop; Head and Mayer).

Calvin and Krissoff provide a tariff equivalent of phytosanitary barriers in the Japanese apple market regarding the risk of contamination by fire blight that has been the origin of a long WTO dispute between the U.S. and Japan (WTO 2002; 2003a-e; 2004a-d; 2005). The dispute has attracted much attention. Calvin and Krissoff use the law of one price under a homogeneous commodity assumption (arbitrage condition) to calculate the tariff equivalent of SPS barriers affecting apple imports in Japan to avoid damages from fire blight. By assuming that Japan’s domestic and imported apples are perfect substitutes, the gap between the prices of domestic and imported apples accounts for the border tariff and other trade impediments that prevent full arbitrage. The latter authors also abstract from other border effects (internal transportation and transaction costs), leading to a likely overstatement of the cost of a TBT barrier, other things being equal. They rely on several reference years to mitigate annual variations in the reference data used to calibrate the tariff equivalent to the TBTs. Using recent data and the proposed revamped approach, we provide a new investigation of the Japan-U.S. apple dispute. We compute the tariff equivalent of Japanese TBT regulations affecting apple trade and quantify the impact of removing these policies on welfare and apple trade flows. We also draw policy implications. The apple dispute offers an opportunity to validate our contention that departures from perfect substitution, and significant trade costs have a substantial impact on the estimate of SPS/TBT regulation and hence on welfare and policy implications derived from this estimate.

Analytical Framework

As in the gravity equation, we use the simple constant elasticity of substitution (CES) model to incorporate the heterogeneity of goods in consumers' preferences and eventually to calculate the tariff equivalent estimate of a TBT (Hummels and Skiba). Define domestic and imported apples, *D* and *I.* We assume the case of a small country facing a parametric exogenous world price of imports. The price p_D of the domestic good is determined by the domestic good market equilibrium, as explained later in the article. The representative consumer maximizes utility U subject to a budget constraint:

$$(1) \quad \underset{D,I}{Max} \quad U(D,I) = (\alpha D^{\rho} + (1-\alpha)I^{\rho})^{1/\rho} + AOG \;\; s.t. \quad p_D D + p_I I + AOG = M_T \, ,$$

where M_T is expenditure on all goods; α, ρ are parameters reflecting preferences; and p_D and p_I are consumer prices of the two goods *D* and *I*. *AOG* is the aggregate numeraire good. Home-good preference implies $\alpha > ½$. The corresponding indirect utility function deriving from consuming apples is

$$(2) \quad V(p_D, p_I, M) = (M_T - AOG^*)(\alpha^{\sigma} p_D^{1-\sigma} + (1-\alpha)^{\sigma} p_I^{1-\sigma})^{\frac{1}{\sigma-1}} ,$$

and the corresponding expenditure function is

$$(3) \quad e(p_D, p_I, u) = (u - AOG^*)(\alpha^{\sigma} p_D^{1-\sigma} + (1-\alpha)^{\sigma} p_I^{1-\sigma})^{\frac{1}{1-\sigma}} .$$

The associated Marshallian demand functions are

$$(4a) \quad D(p_D, p_I, M_T) = \left(\frac{\alpha}{p_D}\right)^{\sigma} \frac{M_T - AOG^*}{\alpha^{\sigma} p_D^{1-\sigma} + (1-\alpha)^{\sigma} p_I^{1-\sigma}} \text{, and}$$

$$(4b) \quad I(p_D, p_I, M_T) = \left(\frac{1-\alpha}{p_I}\right)^{\sigma} \frac{M_T - AOG^*}{\alpha^{\sigma} p_D^{1-\sigma} + (1-\alpha)^{\sigma} p_I^{1-\sigma}},$$

with $\sigma = \frac{1}{1-\rho}$ being the elasticity of substitution and AOG^* being the optimal consumption amount of the numeraire. Parameter α functions as a quality shift (Hummels and Klenow 2004), which lowers the effective price of *D* and increases its consumption, other things being equal. It has the opposite effects on *I*, increasing its effective price and decreasing its consumption. Observable price-quantity pairs and some additional information to select α and σ can be used to infer the tariff-equivalent estimate of the TBT and the interface between α and the tariff-equivalent estimate of the TBT.

The TBT first leads to a higher marginal cost of production because of orchard and harvest inspections and buffer requirements (measured as TBT_1). This first part of the TBT leads to a higher unit cost and price of apples exported to Japan relative to other export markets for the same apple type (size-88 extra-fancy waxed Fuji type) , because of a shift in the marginal cost for the apples going to Japan (Calvin, Krissoff, and Foster 2005). The export unit cost to Japan is $p_{US} + TBT_1$, where price p_{US}[4] represents the price/unit cost of the same U.S. apple type but going elsewhere than Japan. In addition, strict inspection requirements, vendor and ordering issues and additional requirements are added to the imported price once the apples are landed in Japan. Variable TBT_2 represents these costs in the market channel, which have been noted in the case of Japan (Gehrt et al. 2005). Therefore the import price p_I is expressed as

$$(5) \quad p_I = p_{US} + TBT_1 + TBT_2 + IT_R + Tariff + T_R = p_{US} + TBT_T + IT_R + Tariff + T_R,$$

where IT_R is the insurance and freight and other international trade costs of apples exported to Japan, $Tariff$ is the specific import tariff, T_R is the per-unit transportation and transaction cost from the harbor to the internal wholesale market, and TBT_T is the tariff equivalent of the two components of the TBT ($TBT_T = TBT_1 + TBT_2$), respectively.

If all of variables other than TBT_T in equation (5) were observable, it would be straightforward to measure TBT_T. However, since the relevant p_I cannot be observed directly, we can infer a value for p_I from p_D using some assumptions about preferences and behavior and data on D and I. One simplifying assumption could be that domestic and imported goods are perfect substitutes, but the contribution here is to address the case where they are not. From utility maximization, we know that the marginal rate of substitution is equal to the relative price of the substitute goods or

$$(6) \quad MRS = \frac{MU_D}{MU_I} = \frac{p_D}{p_I} = \frac{p_D}{p_{US} + TBT_T + IT_R + Tariff + T_R},$$

where MRS is the marginal rate of substitution, and MU_j indicates the marginal utility of good j. From (6), the tariff equivalent of the TBT, TBT_T, is solved after deriving the MRS from (1) and substituting it back into (6). TBT_T is a function of the relative cost of the two goods, their volumes, the elasticity of substitution, the preference parameter, international trade costs, internal transaction and transportation cost, and border tariff: [5,6]

$$(7) \quad TBT_T = p_D \frac{1-\alpha}{\alpha}\left(\frac{D}{I}\right)^{\frac{1}{\sigma}} - p_{US} - IT_R - Tariff - T_R .$$

Equation (7) nests the conventional technique that assumes perfect substitutes leading to the TBT in order to explain the differential between the domestic price and international price adjusted for transportation. To see this assume $\alpha = ½$ and let $\sigma \rightarrow \infty$.[7] Then the tariff-equivalent estimate of the TBT is $TBT_T = p_D - p_{US} - (IT_R + T_R) - Tariff$. If the tariff and TBT are removed, the latter expression will lead to two arbitrage conditions $p_D = p_I = p_{CIF} + T_R$, and $p_{CIF} = p_{US} + IT_R$. In real life the two prices p_D and p_I would differ because of quality differences and imperfect substitutability. To measure the sensitivity of TBT_T to preference/quality, imperfect substitutability, and transportation cost we compute the sensitivity elasticities of the TBT estimate with respect to σ, α, and transportation cost in the empirical section.

For the welfare analysis, we use the usual Equivalent Variation (EV) measure of the consumer's 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.

We use a small displacement model to determine the price of domestic apples and eventually infer the impact of removing the TBT barrier on imports and domestic market equilibrium. Let S be the retail supply of domestic apples, which is an increasing function of domestic apple price and exogenous parameter λ:

(8) $S(p_D, \lambda) = \lambda p_D^{\varepsilon_S}$,

where ε_S represents the own-price elasticity of the domestic apple supply. Decreases in parameter λ would reflect upward shifts in supply if contamination occurs and induces an increase in the cost of production. Using equations (4) and (8) the equilibrium domestic price p_D^e and quantity are determined by market equilibrium condition, or

(9) $D(p_D^e, p_I) = S(p_D^e, \lambda)$.

Equations (4), (7), and (8), and condition (9) constitute the model. With the elimination of the TBT, p_I decreases and p_D will fall if there is no risk of contamination from the increased imports. The demand for domestic products declines with the change in p_I. Then the domestic market adjusts at a lower price such that demand equals supply.

Imports expand as the direct effect of the decrease in the import price is larger than the feedback effect of the lower domestic price, by stability. If contamination occurs, the price of domestic apples may not decrease as the domestic supply shifts upward to reflect the increased cost from contamination. The domestic apple equilibrium quantity is further reduced by the contamination. Imports increase. For simplicity, we assume away feedback effects from apple suppliers into the income of the representative consumer. We turn next to our investigation of the Japan-U.S. apple dispute starting with some key stylized facts on the dispute.

The Japan-U.S. Apple Dispute

The high technical barriers to importing apples into Japan have brought repeated complaints from several exporting countries and have led to a 30-year dispute (Elms 2004). The latest episode of this dispute has taken place within the WTO. *Japan-Measures Affecting the Importation of Apples* (WTO 2002; 2003a-e; 2004a-d; 2005) relates to the United States' complaint about the Japanese requirements imposed on apples imported from the United States and their inconsistency with WTO principles. The prohibitions and requirements included, for example, the prohibition of imported apples from states other than designated areas in Oregon and Washington; the prohibition of imported apples from any orchard (whether it is free of fire blight or not) if fire blight was detected within a 500-meter buffer zone surrounding such orchard; the requirement that export orchards be inspected three times a year (at blossom, fruitlet, and harvest stages) to check if fire blight is present in order to apply the afore-mentioned prohibitions; the requirement that at the post-harvest stage, apples for export to Japan be separated from fruits for export to other markets; and chlorination of apples for export to Japan.

In 1997, the United States requested that Japan modify its import restrictions on apples based on published scientific evidence that mature, symptomless apples are not carriers of fire blight. In 2000, the United States agreed to carry out joint research proposed by Japan to confirm the results of those earlier studies. The USDA's Agricultural Research Service (ARS) and Japan's Ministry of Agriculture Forestry and Fisheries (MAFF) conducted the joint research. The research results confirmed that mature, symptomless apples are not carriers of fire blight. This finding provided additional scientific support for the U.S. position. Since the results of this research were released in February 2001, the U.S. government has repeatedly pressured Japan to modify its import restrictions. After extensive bilateral discussions with USDA scientists, Japan refused to modify its import restrictions in October 2001.

In March 2002, the United States requested WTO consultations concerning Japan's import restrictions on U.S. apples. Consultations in April 2002 failed to settle the dispute. In May 2002, the United States requested that the WTO establish a panel to consider the Japanese restrictions. In June 2002, a panel was established by the Dispute Settlement Body (DSB) of the WTO to consider this issue. Before the Panel, the United States claimed that Japan was acting inconsistently with some articles of the SPSA, certain articles of the Agreement on Agriculture, and the so-called "GATT 1994." In July 2003, the Panel found that Japan's phytosanitary measures were maintained without sufficient scientific evidence and inconsistent with Japan's obligation, did not qualify as a provisional measure, and were not based on a risk assessment. In September 2003, Japan appealed the WTO Panel ruling. In addition to Japan's appeal, the United States crossappealed the Panel Report. At the same time, third participants, such as Australia, Brazil, the European Union, and New Zealand, filed their submissions. After more investigations, in November 2003, the DSB upheld the findings of July 2003. Therefore, the Appellate Body recommended that the DSB request that Japan bring its inconsistent measures into conformity with SPSA.

Half a year later, in July 2004, the United States held that Japan failed to comply with the recommendations and rulings of the DSB by the end of the reasonable period of time. Therefore, the United States requested that the DSB establish a panel and simultaneously requested authorization on suspension of concessions and other obligations in one or more of the following: tariff concessions and related obligations under the GATT 1994 on a list of products; and concessions and other obligations under the SPS Agreement and the Agreement on Agriculture. Because Japan objected to the United States' suspension request, this matter has been referred to arbitration. The arbitration Panel's report of June 2005 mostly sided with U.S. arguments. In August 2005, Japan issued a protocol agreeable to the United States, which removed measures that had been deemed inconsistent with WTO principles (WTO 2005).

Between 1971 and 1992, Japan imported only 4,500 boxes of apples, all from South Korea and North Korea. In June of 1993, Japan permitted some import of New Zealand apples. After that, the United States and Australia also exported apples to Japan but not continuously over time. New Zealand, EU, and Korean apples have fire blight or a related form. Australia and Chile have been free of fire blight. Although Japan opened its door to foreign apples meeting the SPS and TBT standards regarding fire blight, the importing quantity has been quite low compared with the domestic production. As shown in table 1, the import shares never exceeded 0.35% between 2000 and 2002, the last period prior the constitution of the dispute panel. The low import share is partly due to the high tariff and TBT barrier increasing the cost of exporting to Japan.

In addition to the high technical barrier referred to in the dispute, the higher quality of the domestic product cannot be neglected. Fruits in general and apples in particular are an important part of the Japanese diet (Huang 2004). Japanese consumers exhibit a strong home-good preference relative to imported apples. This fact has been repeatedly established (American University n.d.; Kajikawa 1998; Shim, Gehrt, and Lotz 2002; USDA 1997). According to Japanese consumers, domestic apples have a higher quality because of their sweeter flavor and bigger size. For instance, after Japan opened its apple market to imports in 1995, U.S. apples entered Japan at much lower prices than Japanese domestic products. However, after an initial success, the sales of U.S. apples declined because Japanese consumers complained that U.S. apples were too sour and did not cater to Japanese taste (American University n.d.). Japanese consumers prefer apples with brix (a measure of sugar level) in a certain range and a specific brix-to-acid ratio, but imported apples do not meet these requirements. In addition, imports are smaller in size and less juicy (Kajikawa). For Japanese consumers who believe that apples must have an appropriate brix and acid level, firmness, juice, size, and flavor, imported apples cannot be a perfect substitute for domestic products.

Japanese farmers produce apples with great care and the production of apples is labor intensive. Leaves near each apple are usually plucked away when the fruit is still on the tree, which ensures that the apple receives enough and balanced sunlight to ensure full ripening. Several weeks before harvesting, bags are used to protect individual apples in order to prevent any kind of surface marring. This labor-intensive production leads to a higher quality and at the same time comes at a higher cost. Because of the quality difference and trade barriers, Japanese producers are able to pass the higher costs to consumers in the form of a higher price. Hence, the trade barriers do not explain the entire price wedge. A price differential reflecting the quality premium would remain under free trade. In addition, as a fresh fruit, the internal transportation cost for apples is high and cannot be ignored.

Quantifying the Apple Dispute

We apply the framework developed in section 2 to imported apples in Japan. We use all imported apples to estimate I and the average import unit cost measured as the CIF price, shown in table 1, and to compute the tariff equivalent of the Japanese TBT regulations. [8] Then we estimate the impact of eliminating the TBT. The transportation and transaction cost including both international and internal cost, IT_R+T_R, is approximately 78.33 yen/kg (Calvin, Krissoff, and Foster). The tariff rate is listed in table 2 in specific form (17% of p_{CIF}). We analyze long and short run impacts. As in Calvin and Krissoff, the long-run supply elasticity of domestic apples is assumed to be 1, whereas the short-run supply elasticity is assumed to be 0.1. We use Washington State size 88 waxed extra fancy Fuji apples as apples similar to those exported to Japan and take their price as the p_{US} (USDA, AMS n.d.). Regarding pest and disease transmission, we follow the estimate of the Queensland (Australia) Department of Primary Industries and Fisheries (Queensland Government) and assume that with the transmission of pest and disease the production of apples would decrease by a fixed proportion of 20%. We use 2SLS to estimate the parameter values for σ and α with monthly data for the period 2000-2004 (see Yue, Beghin, Jensen 2006). The estimated result for σ is 7.12 (s.d.=2.09); the estimated result for α is 0.64 (s.d. = 0.05).[9]

TBT Estimate and Sensitivity Analysis

The last two columns of table 2 show the actual tariff (in yen/kg) and (specific) tariff equivalent of the TBT across different reference years when σ and α are assigned to be 7.12 and 0.64 respectively.

To test the sensitivity of TBT_T to the elasticity of substitution σ and domestic preference/quality parameter α, we assign the central values of their estimates and consider their confidence intervals (central values plus/minus one and then two standard deviations). The TBT_T estimates are shown in table 3. We also computed values for TBT_T under the assumption of perfect substitution ($\sigma=\infty$; $\alpha=1/2$) with and without trading costs, as this latter simplifying assumption is the focus of our enquiry. As shown in table 3, in this case accounting for trading costs (IT_R and T_R) yields an estimate of the TBT that is negative (TBT_T= -11.4). This result shows the potential pitfall of abstracting from quality differences. Abstracting from these trading costs ($IT_R = T_R = 0$), the TBT estimate under the homogeneous good assumption is positive (62.48yen/kg), but much smaller than implied by the TBT estimates computed under the proper assumptions of imperfect substitution and positive trading costs as shown in table 3. Although these two assumptions work in opposite directions, they do not offset each other as shown in the table. As parameters α and σ increase, the TBT estimate decreases, holding everything else constant, and eventually becomes undefined, that is, becomes negative.

Table 4 gives the elasticity of TBT_T with respect to σ (i.e., ε_σ), holding α constant. Measures of ε_σ show that TBT_T is sensitive to σ, especially when the value of

σ is low (poor substitutes). For example, when σ=2.94, ε_σ is less than -1.35, a value which indicates TBT_T would differ a lot even if the change in σ were to be small. Thus, σ plays an important role in the calculation of TBT_T. When σ gets larger, the sensitivity decreases in absolute value. When σ=11.3, the sensitivity is about a fourth of what it is for σ=2.94. A similar sensitivity was also noted in computing the consumer tax equivalent of a tariff with imperfect substitutes (Salerian, Davis and Jomini).

Table 4 also gives the elasticity of TBT_T with respect to α (holding σ constant); TBT_T is highly sensitive to α for the smaller values of α, but this sensitivity decreases as α increases. It is about 4 times smaller for (in absolute value) α=0.74 compared to α=0.54. Good information on α appears to be critical in estimating TBT_T. This fact has implications for gravity equation analyses, which often impose α =0.5. This restriction may strongly bias the estimates of impediments to trade as the sensitivity of TBT_T with respect to α is at its highest at $\alpha = 0.5$.

Estimates of the elasticity of TBT_T with respect to transportation cost $T_R + IT_R$ show that TBT_T is sensitive to $T_R + IT_R$ when the latter gets large but goes to zero as $T_R + IT_R$ decreases (detailed estimates available from the authors). Around the central value (78.33 yen/kg) used in our computation, the elasticity of TBT_T to $T_R + IT_R$ is approximately -0.18 and hence plays some role in the calculation of the TBT_T, although less crucial than the taste parameters do. The elasticity of TBT_T with respect to the domestic and imported quantities shows TBT_T is less sensitive to the domestic and imported quantities than it is to their prices. The moderate elasticities remain nearly constant as quantity levels (D and I) change. In contrast, the elasticity of TBT_T with respect to the domestic price is always greater than one and gets larger as the domestic price increases. The elasticity of TBT_T with respect to *Tariff* indicates that the sensitivity of TBT_T increases as the value of the tariff increases, although all of the estimated values are less than 0.45 (in absolute value) for *Tariff* and range from 18.7 to 46.8 yen/kg.

Welfare Analysis of the TBT (and Tariff) Removal

The import increases induced by policy reforms are shown in table 5 for different values of σ and α. By eliminating the TBT (alone and along with the border tariff elimination), apple imports would increase substantially, between 5.24 and 218.11 10^3 MT, depending on home good preference parameter α and the assumed elasticity of substitution. These magnitudes are in a range of values comparable to those of Calvin and Krissoff (1998) although our central case shows smaller imports than theirs. These larger imports remain moderate relative to domestic apple consumption. Japan imports apples from Australia, New Zealand, South Korea, and the United States and the U.S. share of apple imports by Japan has varied widely over time. The removal of the TBT benefits the United States and all exporting countries which are not fire blight free (e.g., New Zealand). New exporters such as China may enter the Japanese market as entry is eased by the removal of the TBT (and the tariff). In 2000, the value share of U.S. apples into total apple imports was 24%. Based on the 2000 share, by elimination of both the TBT and the tariff, the expansion of U.S. imports by Japan would only amount to U.S.$4.01 million when σ=7.12 and α=0.64, and would not exceed U.S.$75.73 million, if one assumes σ=2.94 and α=0.54.[10] The losses to U.S. exporters and producers would be smaller than the value of imports, first because they would be valued at lower FOB prices and farm gate prices, respectively, and because producer surplus losses are always smaller than the gross value of forgone production opportunities. The U.S.$75.73 million figure is about half of the lost exports claimed by the United States at the WTO (U.S.$143.4 million).

Changes in welfare with elimination of the TBT and the tariff vary under different assumptions on the transmission of disease. Table 6 shows the welfare implications of eliminating the TBT and the tariff for 2000, when assigning different values to α and σ, assuming transportation plus transaction costs of 78.33 yen/kg, $\varepsilon_s = 1$ (long run response), and under the condition of no disease transmission. The table shows that the EV and the producer's surplus change dramatically with the changes of σ and α. However, when there is no disease transmission, EV net of tariff revenue loss is greater than the loss of the producer's surplus for both elimination of the TBT and elimination of the TBT and the tariff no matter what values σ and α take.

Transmission of disease implies an upward shift of the domestic supply of apples because the variable cost of producing apples has increased. Table 7 shows the welfare implications *with* disease transmission holding other conditions the same as in the previous analysis. When σ=7.12 and α=0.54, the net welfare is positive. So it is optimal to eliminate either the TBT or both the TBT and tariff in this case. But when the value of α is equal to or larger than 0.64, EV plus the change in tariff revenues do not exceed the loss of producer's surplus and net welfare consequences of the reform are negative no matter what value σ takes on. So the elimination of the TBT may not improve welfare. The same logic applies to the case when both the TBT and the tariff are eliminated.

Table 8 gives the short-run welfare implications of policy reforms for the case without disease transmission when supply of domestic apples is assumed to be very inelastic ($\varepsilon_s = 0.1$). Supply expansion of fruit trees takes time, although at the margin apples can be moved from one use to another (from processing to fresh market) on short notice. Supply contraction is more responsive since apples can be removed from the market and stored. In any case it is interesting to consider the implications of less price-responsive supply of domestic apples. As expected the decrease in domestic price caused by the domestic demand shift is more pronounced with this steeper domestic supply curve. Accordingly, EV (columns (2) and (4)) increases relative to its level in the long-run case; imports and associated tariff revenues (column (1)) do not expand as much; and the loss of producer surplus is more acute with this inelastic supply. Net welfare gains are mitigated by the larger losses of producer surplus.

Figures 1 and 2 illustrate the variation of estimates of long-run net welfare and import effects from removing the TBT as σ and α change and without disease transmission. The net welfare is EV plus change in tariff revenue net of loss of producer's surplus. The transparent horizontal plate is the zero plate, provided for reference. Figures 1 and 2 show that the net welfare import expansion increase as σ and α decrease. They decrease faster when σ and α are smaller (the surfaces are concave toward the origin ($\sigma = \alpha = 0$)). The net welfare eventually approaches zero when σ and α take on larger values.

Conclusions

Differences between prices of domestic goods and those of corresponding imported goods could come from four sources: tariffs, other barriers (TBTs), quality differences, and marketing costs (associated with taking the products from the exporting market to the border of importing countries and from the border to the equivalent internal market). In this article we have developed a methodology to apportion the price difference among these four sources.

Our analysis suggests four generic steps in this apportioning. First, stylized facts and data must be gathered to measure the price difference, the existence of barriers (TBTs, tariffs), and consumer preferences with respect to the domestic and the competing imported goods and their respective perceived quality. An important second step is to formalize and parameterize this quality difference. We specified CES preferences, derived a simple demand system for domestic and imported apples and estimated the elasticity of substitution between imported and domestic apples in the Japanese markets, as well as the preference parameter for domestic apples. As an alternative, one could borrow estimates of these taste parameters if they were available (which they were not in our case). A third step combines the data, the estimates and computes the estimate of the TBT as a function of the market data, price difference, elasticity of substitution, home preference parameter, and transportation costs. In a fourth step, sensitivity analysis is undertaken around the preferred values of the parameters to gauge the plausibility of the estimated TBT.

Through this methodology, we revamped the tariff equivalent of a TBT by relaxing the homogeneous commodity assumption, accounting for perceived quality of substitutes and trade costs. The latter are often larger than policy impediments and cannot be abstracted from them. Transportation and trade costs are structured on a per-unit basis rather than being ad-valorem. Specific (as opposed to proportional) trade costs reduce the variability of the estimate of TBT with respect to the variability of import unit value across different reference years. Their influence on the TBT estimate is mitigated as the import unit value increases. Trade costs and imperfect substitution have offsetting influences in the computation of the estimate of the TBT. Since most previous applications have ignored these two aspects, these previous applications have somewhat mitigated the error implied by the two simplifications and dissimulated the inherent sensitivity of the TBT estimate to each of these underlying parameters.

The rigorous investigation of the Japan-U.S. apple dispute first validates the approach and indicates the importance of empirical estimates of the magnitude of preferences (α and σ) which we estimated econometrically. We then explored the sensitivity of the tariff equivalent estimate of the TBT with respect to these two parameters, varying their value around the central estimates we had obtained. The TBT estimate and welfare analysis based on it are sensitive to these parameters. The sensitivity to the consumers' home preference has some implications for gravity equation models that impose restrictions of equal preference/quality for imported and domestic goods. These models are likely to provide biased measures of trade impediments and should relax this assumption.

More importantly, our research raises interesting policy implications. A striking result in the analysis of the apple dispute is that the increase in apple imports would be small (in value) no matter what parameter estimates are used. It appears that the alleged damage in lost exports claimed by the United States at the WTO (U.S.$143.4 million) is substantially overstated. If the price of exported U.S. apples was endogenous (increasing in exports), welfare gains to Japanese consumers of removing the TBT would be somewhat mitigated by the higher border prices of U.S. apples; the U.S. export expansion would be even smaller than stated in our analysis. A positive producer surplus could be computed for U.S. suppliers. Thus our analysis provides an upper bound on the welfare gains to Japan and the export expansion potential for the U.S. but without a U.S. surplus measure.

The political economy of the case is also intriguing. Much political goodwill has been spent on this dispute relative to the small size of the potential direct gains in agricultural exports. Ancillary benefits may exist if the United States eventually succeeds in opening the Japanese market and establishes a reputation as a persistent negotiator. Other countries or protected industries may pay attention to the United States' resolve in opening markets and may refrain from engaging in costly disputes.

Footnotes

1. The price wedge measures the difference between the internal price of a good and the reference price of a comparable good, such as a border price. It attributes the price difference to trade barriers and transportation cost. The price wedge can be expressed as a specific tax/tariff, or an ad valorem tax/tariff (Beghin and Bureau 2001).
2. The iceberg method refers to transportation cost being proportional to the value of a good. To export a unit value of a good it takes (1+x) unit value of that good to be shipped out. Transportation cost is equal to fraction x of the unit value of the good and "melts" away. (Note that x is nonnegative and can be made a function of distance traveled.)
3. The gravity equation approach links trade flows between two countries to observable variables such as their relative income, and to variables inhibiting trade such as distance, linguistic barriers and trade policy barriers (Anderson and van Wincoop).

4. For simplicity, p_{US} is assumed to be exogenous to the importer, implying a horizontal export supply and no producer surplus measure for the exporter. The price can easily be endogenized as an increasing function of importing quantity to reflect an upward-sloping export supply of U.S. apples.

5. Other functional forms (other than the CES) can be used. They lead to slightly different specifications of equation (7). The CES is flexible with a wide range of possible substitution between D and I. To illustrate alternatives, a linear- expenditure system (LES) specification leads to $TBT_T = p_D \frac{1-\alpha_D}{1-\alpha_I}\left(\frac{(D-\gamma_D)^{\alpha_D - 1}}{(I-\gamma_I)^{\alpha_I - 1}}\right) - p_{US} - IT_R - Tariff - T_R$, with minimum subsistence parameters γ_j and preference parameters α_j (j = *D*, *I*) to be identified with extraneous information.

6. The ad valorem tariff equivalent is $TBT_T^{\%} = \frac{p_D}{p_{CIF}}\frac{1-\alpha}{\alpha}\left(\frac{D}{I}\right)^{\frac{1}{\sigma}} - \frac{p_{US}}{p_{CIF}} - it_R - t - t_R$, where it_R is the ad valorem tariff equivalent of international transportation, insurance and transaction cost, t is the ad valorem tariff, and t_R is the internal transportation and transaction cost.

7. We thank a referee for suggesting this nesting.

8. In an alternative specification, we treat imports from different countries as imperfect substitutes using a double-nested CES model and calculate the TBT estimate. Results are quite similar to what we present in this article. For example, when we assume α=0.64, the elasticity of substitution among imports as 10, and σ=7.12, $TBT_T^{\%}$ is 65%, which is quite close to the 60% level obtained by aggregating all imports into one good.

9. Shim, Gehrt, and Lotz provide an implicit value of α =0.55 based on a survey of Japanese housewives on their preferences of U.S. and Japanese apples. The latter estimate is smaller than our econometric estimate but within its confidence interval. As we use total apple imports to derive our econometric estimate of α, this difference in data (all imports versus U.S. apple imports) may contribute to the difference in the estimates of α. We abstract from the consideration that α depends on the TBT and could decrease if the TBT was removed.

10. The incremental U.S.$4.01 million of U.S. imports come from the 2000 U.S. value share of all apple imports by Japan, or 22,249,000/92,630,000=24%, applied to the expansion in import value (11.56 10^3 MT *155.91 yen/kg), expressed in U.S.$ with an exchange rate of 107.765 yen/$.

References

American University. n.d. "US-Japan Apple Case: Apple Imports in Japan." The Mandala Projects, Environment, Statistics and Policy (ESP) Project, Case Studies. Washington DC: American University. http://www.american.edu/TED/esp/japan-apple.htm (accessed Sept. 15, 2005).

Anderson, J.E., and E. van Wincoop. 2004. "Trade Cost." *Journal of Economic Literature,* 42:691–751.

Anderson, K., C. McRae, and D. Wilson, eds. 2001. *The Economics of Quarantine and the SPS Agreement.* University of Adelaide: Centre for International Trade Studies.

Baldwin, R.E. 1991. "Measuring the Effects of Nontariff Trade-Distorting Policies." In J.

de Melo and A. Sapir, eds. *Trade Theory and Economic Reform: North, South, and East.* Cambridge MA: Basil Blackwell, pp.25–42.

Beghin J., and J.C. Bureau. 2001. "Quantitative Policy Analysis of Sanitary, Phytosanitary and Technical Barriers to Trade." *Economie Internationale* 87:107–130.

Bureau, J., S. Marette, and A. Schiavina. 1998. "Non-Tariff Trade Barriers and Consumers' Information: The Case of the EU-US Trade Dispute over Beef." *European Review of Agricultural Economics* 25:437–462.

Calvin, L., and B. Krissoff. 1998. "Technical Barriers to Trade: A Case Study of Phytosanitary Barriers and US-Japanese Apple Trade." *Journal of Agricultural and Resource Economics* 23:351–356.

Calvin, L., B. Krissoff, and W.E. Foster. 2005. "Measuring the Costs and Trade Effects of Phytosanitary Protocols: A U.S.-Japanese Example." Mimeo, U.S. Department of Agriculture, Washington DC, September.

Campbell, K., and R. Gossette. 1994. "A Study of Canada's Non Tariff Trade Barriers: The Equivalents of Quantitative Import Restrictions." Research Branch, Canadian International Trade Tribunal.

Deardorff, A.V., and R.M. Stern. 1998. *Measurement of Nontariff Barriers: Studies in International Economics*. Ann Arbor MI: University of Michigan Press.

Elms, D.K. 2004. "Large Costs, Small Benefits: Explaining Trade Dispute Outcomes." *Political Psychology* 25:241–270

Gehrt, K.C., S. Lotz, S. Shim, T. Sakano, and N. Onzo. 2005. "Overcoming Informal

Trade Barriers among Japanese Intermediaries: An Attitudinal Assessment." *Agribusiness* 21:53–63.

Greene, W.H. 2002. *Econometric Analysis*, 5th ed. Upper Saddle River NJ: Prentice-Hall.

Head, K., and T. Mayer. 2002. "Illusory Border Effects: Distance Mismeasurement Inflates Estimates of Home Bias in Trade." CEPII Working Paper 2002 -01, Centre d'Etudes Perspectives et d'Informations Internationales, Paris, January.

Huang, S.W. 2004. *Global Trade Patterns in Fruits and Vegetables.* Washington DC: U.S. Department of Agriculture, Economic Research Service, Agriculture and Trade Report No. WRS-04-06.

Hummels, D., and P.J. Klenow. 2005. "The Variety and Quality of a Nation's Exports." American Economic Review 95(3):704-723.

Hummels, D., and A. Skiba. 2004. "Shipping the Good Apples Out? An Empirical Confirmation of the Alchian-Allen Conjecture." *Journal of Political Economy* 112(6, December):1384–1402.

Japan Customs. Various. Trade Statistics online, http://www.customs.go.jp/index_e.htm (accessed Sept. 2005).

Josling, T., D. Roberts, and D. Orden. 2004. *Food Regulation and Trade: Toward a Safe and Open Global System.* Washington DC: Institute for International Economics.

Kajikawa, C. 1998. "Quality Level and Price in Japanese Apple Market." *Agribusiness: An International Journal* 14(3, May/June):227–233.

Ministry of Agriculture, Forestry and Fisheries (MAFF). Various. *Monthly Statistics of Agriculture Forestry & Fisheries*, Japan.

Monthly Statistics of Japan. Various. Database, http://www.stat.go.jp/english/data/geppou (accessed Sept. 2005).

Queensland Government, Department of Primary Industries and Fisheries, Queensland, Australia. n.d. http://www2.dpi.qld.gov.au/horticulture/5144.html (accessed Sept. 2005).

Roberts, D., and B. Krissoff. 2003. *The WTO Agreement on the Application of Sanitary and Phytosanitary Barriers.* Washington DC: U.S. Department of Agriculture, Economic Research Service.

Salerian, J., L. Davis, and P. Jomini. 1999. "The Consumer Tax Equivalent of a Tariff with Imperfect Substitutes." *The Economic Record* 75(230):295-300.

Shim, S., K. Gehrt, and S. Lotz. 2002. "Competitive Market Analysis of U.S. Apples in the Japanese Market." In F.S., Zazueta and J. Xin, eds. *Proceedings of the World Congress of Computers in Agricultural and Natural Resources.* ASAE Publication No. 701P0301, March, pp. 758–765.

U.S. Department of Agriculture. 1997. *Japan: Annual Fresh Deciduous Fruit Report.* Agricultural Trade Reports, Washington DC, Sept. 24.

U.S. Department of Agriculture, Agricultural Marketing Service. n.d. "Fruit and Vegetable Market News", http://marketnews.usda.gov/portal/fv (accessed Sept. 2005).

World Trade Organization (WTO). 2003. *Japan – Measures Affecting the Importation of Apples.* Notification of an Appeal by Japan under paragraph 4 of Article 16 of the Understanding on Rules and Procedures Governing the Settlement of Disputes

(DSU). DocumentWT/DS245/5. 28 August, Geneva, CH.

——. 2003. *Japan – Measures Affecting the Importation of Apples*: *AB 2003-4. Report of the Appellate Body.* Document WT/DS245/AB/R, 26 November, Geneva, CH.

——. 2004. *Japan – Measures Affecting the Importation of Apples: Agreement under Article 21.3(b) of the DSU.* Document WT/DS245/9, 12 February 2004a, Geneva, CH.

——. 2003. *Japan – Measures Affecting the Importation of Apple: Appellate Body Report and Panel Report, Action by the Dispute Settlement Body.* Document WT/DS245/8, 16 December 2003e, Geneva, CH.

——. 2003. *Japan – Measures Affecting the Importation of Apples: Communication from the Appellate Body.* Document WT/DS245/7, 26 November, Geneva, CH.

——. 2003. *Japan – Measures Affecting the Importation of Apples: Communication from the Appellate Body.* Document WT/DS245/6, 23 October, Geneva, CH.

——. 2005. *Japan – Measures Affecting the Importation of Apples: Notification of Mutually Agreed Solution.* Document WT/DS245/21 G/L/520/Add.1 G/SPS/GEN/299/Add.1, G/AG/GEN/50/Add.1, 2 September 2005, Geneva, CH.

——. 2004. *Japan – Measures Affecting the Importation of Apples: Recourse to Article 21.5 of the DSU by the United States, Constitution of the Panel.* Document WT/DS245/14, 30 July 2004c, Geneva, CH.

——. 2004. *Japan – Measures Affecting the Importation of Apples: Recourse to Article 21.5 of the DSU by the United States Request for the Establishment of a Panel*. Document WT/DS245/11, 20 July 2004b, Geneva, CH.

——. 2004. *Japan – Measures Affecting the Importation of Apples: Request by Japan for Arbitration under Article 22.6 of the DSU, Communication from the Arbitrator.* Document WT/DS245/16, 10 August 2004d, Geneva, CH.

——. 2002. *Japan – Measures Affecting the Importation of Apples: Request for Consultations by the United States.* Document WT/DS245/1 G/L/520 G/SPS/GEN/299 G/AG/GEN/50, 6 March, Geneva, CH.

——. n.d. Online Tariff Rate Schedules, http://www.wto.org/english/tratop_e/schedules_e/goods_schedules_e.htm (accessed Sept. 2005).

Table 1. Japanese Apple Production and Imports

Year	Domestic Production (MT)	Domestic Wholesale Quantity D (MT)	Domestic Wholesale Price p_D (yen/kg)	Import Quantity I (MT)	Import CIF Price p_{CIF} (yen/kg)	P_{US} (yen/kg)	Import Share
2000	799600	691600	238	594	156	149	0.09%
2001	930700	674600	246	2339	126	129	0.35%
2002	925800	768700	182	120	237	139	0.02%

Source: Japan Customs, USDA.

Note: MT denotes metric tons. p_{US} is price of Washington State size-88 waxed extra-fancy Fuji apples; p_{CIF} is the average CIF price of imported apples; I is quantity of all imported apples; p_D is the wholesale price of domestic apples; D is the quantity of domestic apples in wholesale market.

Table 2. TBT_T **Across Different Years (** σ **=7.12,** α **=0.64)**

Year	Tariff (yen/kg)	TBT_T [a] (yen/kg)
2000	26.52	93.86
2001	21.47	71.02
2002	40.29	92.87

Source: WTO schedules and Japan Customs.

[a] The ad valorem estimated values of $TBT_T^{\%}$ for the three years are 60%, 56%, and 39% respectively.

Table 3. TBT_T **Under Different Values of** σ **and** α

α	σ	TBT_T (yen/kg)
0.50	∞	-11.4
0.54	2.94	1970.68
	5.03	558.07
	7.12	279.48
	9.21	169.38
	11.3	111.70
0.59	2.94	1558.44
	5.03	406.07
	7.12	178.81
	9.21	88.99
	11.30	41.93
0.64	2.94	1210.61
	5.03	277.83
	7.12	93.86
	9.21	21.16
	11.3	---
0.69	2.94	913.19
	5.03	168.16
	7.12	21.23
	9.21	---
	11.30	---
0.74	2.94	655.96
	5.03	73.32
	7.12	---
	9.21	---
	11.30	---

Note: Analysis is for year 2000. Bold font denotes central values of α and σ. The shaded area denotes the central case **(**σ =7.12, α =0.64); --- denotes TBT_T negative, which is of no economic meaning.

Table 4. Elasticity of TBT_T with Respect to σ and α

σ	ε_σ (α =0.64)	α	ε_α (σ =7.12)
2.94	-1.351	0.54	-2.376
4.33	-0.917	0.57	-1.885
5.72	-0.694	0.60	-1.508
7.12	-0.558	0.64	-1.130
8.52	-0.466	0.67	-0.913
9.92	-0.400	0.70	-0.737
11.3	-0.351	0.74	-0.551

Note: Analysis is for year 2000. The shaded area denotes the results for central value of parameters.

Table 5. Increase in Imports (10^3 MT) with the Elimination of TBT (and Tariff)

($\varepsilon_s = 1$)

α	σ	Increase in Imports by Elimination of TBT	Increase in Imports by Elimination of TBT and Tariff
0.54	2.94	174.46	218.11
	7.12	71.15	118.26
	11.30	29.95	70.77
0.64	2.94	75.40	98.79
	7.12	5.24	11.56
	11.30	---	---
0.74	2.94	22.28	30.20
	7.12	---	---
	11.30	---	---

Note: Analysis is for year 2000. The shaded area denotes the central case.
--- denotes TBT_T is negative, which is of no economic meaning.

Table 6. Welfare Analysis with Elimination of the TBT (and Tariff)
($\varepsilon_s = 1$, Without Disease Transmission)

		Welfare Impact of TBT_T Removal				Welfare Impact of TBT_T + *Tariff* Removal		
α	σ	Tariff Revenue Change (1)	EV (2)	Producer Surplus Loss (3)	Net Welfare (1)+(2)-(3)	EV (4)	Producers Surplus Loss (5)	Net Welfare (4)-(5)
0.54	2.94	4640	62839	22593	44886	73958	25276	48682
	7.12	1902	13239	9050	6091	20914	13554	7360
	11.3	810	4466	3603	1673	10532	8073	2459
0.64	2.94	2014	22067	9705	14376	26636	11385	15251
	7.12	154	767	597	324	1549	1156	393
	11.3	---	---	---	---	---	---	---
0.74	2.94	606	5444	2523	3527	7017	3334	3683
	7.12	---	---	---	---	---	---	---
	11.3	---	---	---	---	---	---	---

Note: Welfare is measured in million yen (2000 prices). The shaded area indicates the central case. --- denotes TBT_T not being defined.

Table 7. Welfare Analysis with Elimination of TBT (and Tariff)
($\varepsilon_s = 1$, With Disease Transmission)

		Welfare Impact of TBT_T Removal				Welfare Impact of TBT_T +Tariff Removal		
α	σ	Tariff Revenue Change (1)	EV (2)	Producer Surplus Loss (3)	Net Welfare (1)+(2)-(3)	EV (4)	Producers Surplus Loss (5)	Net Welfare (4)-(5)
0.54	2.94	5226	49311	25323	29214	60850	28165	32685
	7.12	2865	1713	13676	-9098	11045	19245	-8200
	11.3	1739	-7637	8262	-14160	855	14614	-13759
0.64	2.94	2382	6589	11305	-2334	11613	13336	-1723
	7.12	301	-16380	706	-16785	-14330	2415	-16745
	11.3	---	---	---	---	---	---	---
0.74	2.94	738	-11016	3258	-13536	-9420	4102	-13522
	7.12	---	---	---	---	---	---	---
	11.3	---	---	---	---	---	---	---

Note: Welfare is measured in million yen (2000 prices). The shaded area indicates the central case. --- denotes TBT_T not being defined.

Table 8. Short-Run Welfare Analysis with Elimination of TBT (and Tariff) ($\varepsilon_s = 0.1$, Without Disease Transmission)

		Welfare Impact of TBT_T Removal				Welfare Impact of TBT_T +*Tariff* Removal		
α	σ	Tariff Revenue Change (1)	EV (2)	Producer Surplus Loss (3)	Net Welfare (1)+(2)-(3)	EV (4)	Producers Surplus Loss (5)	Net Welfare (4)-(5)
0.54	2.94	4092	78060	35670	46482	91231	39840	51391
	7.12	1623	17904	13638	5889	27052	19660	7392
	11.3	725	6289	5387	1627	14130	11717	2413
0.64	2.94	1871	29296	16379	14788	34942	10484	24458
	7.12	152	1183	968	367	2523	1273	1250
	11.3	---	---	---	---	---	---	---
0.74	2.94	592	7571	4560	3603	9739	5939	3800
	7.12	---	---	---	---	---	---	---
	11.3	---	---	---	---	---	---	---

Note: Welfare is measured in million yen (2000 prices). The shaded area indicates the central case. --- denotes TBT_T not being defined.

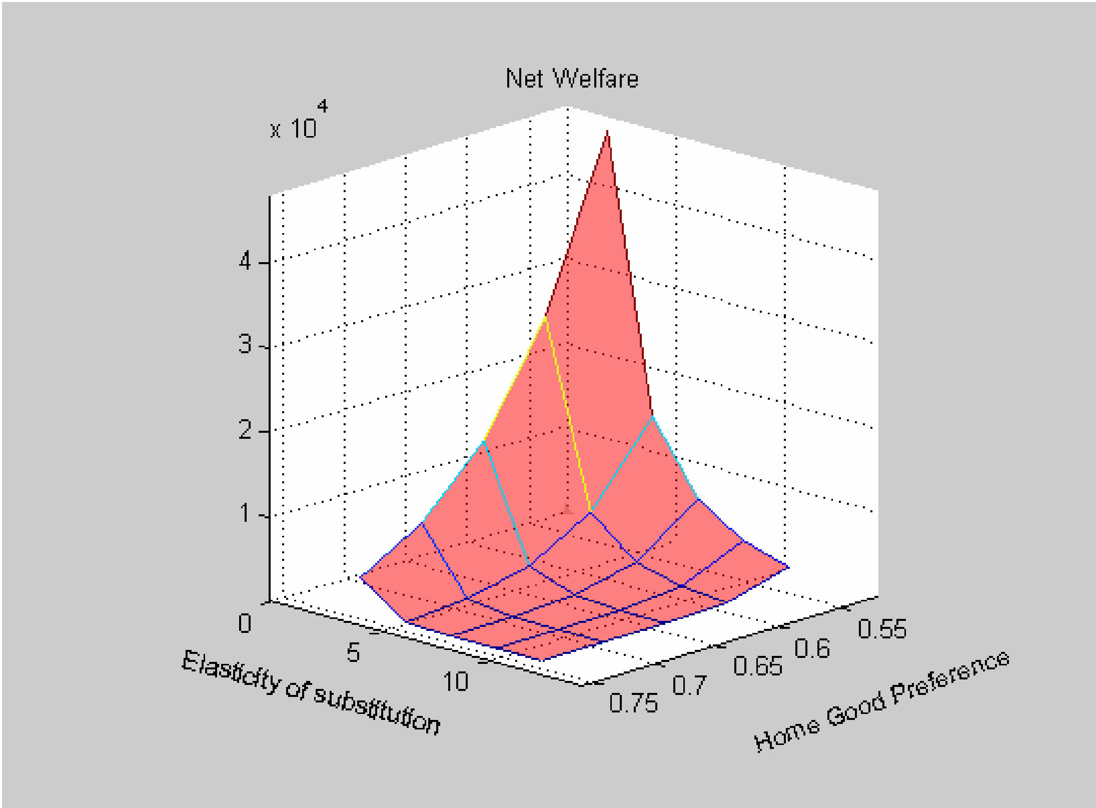


Figure 1. Sensitivity of net welfare (EV+tariff revenue-loss of producers' surplus) to σ and α with elimination of TBT(without disease transmission) (ε_s =1)

Note: For visual simplicity, the net welfare measure where TBT_T is not defined is set to be zero.

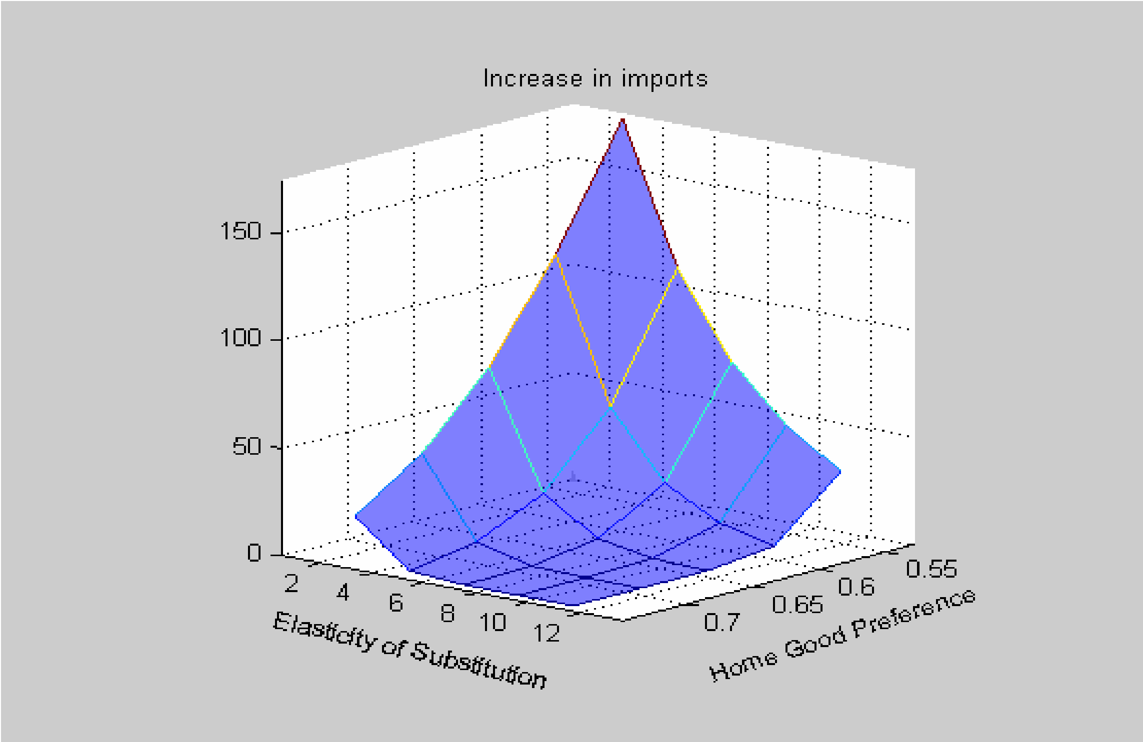


Figure 2. Increase in imports' sensitivity to σ and α with elimination of the TBT (10^3 MT)

Note: For visual simplicity, the net welfare measure where TBT_T is not defined is set to be zero.

Appendix

Estimation of Parameters σ and α

Specification

The derivation of the elasticity of substitution σ and home-good preference parameter α is as follows. First, equation system (4) is used to obtain ratio *D/I*, which is then solved for p_I:

$$\text{(A.1)}\quad p_I = \left(D/I\right)^{\frac{1}{\sigma}} \frac{(1-\alpha)}{\alpha} p_D .$$

We do not observe p_I directly as it is a function of TBT_T. We substitute p_I into equation (2) and rearrange terms to obtain:

$$\text{(A.2)}\quad \frac{M}{p_D D} - 1 = \left(I/D\right)^{1-\frac{1}{\sigma}} \left(\frac{1-\alpha}{\alpha}\right),$$

where M is the expenditure on all apples evaluated at wholesale price. The left-hand term is just the ratio of expenditure shares.

After taking natural logarithms, (A.2) becomes

$$\text{(A.3)}\quad \ln\left(\frac{M}{p_D D} - 1\right) = \left(1 - \frac{1}{\sigma}\right)\ln\left(\frac{I}{D}\right) + \ln\left(\frac{1-\alpha}{\alpha}\right).$$

Estimation Method

We run two-stage least-square regression (2SLS) on (A.3) since the right hand side variable $\ln\left(I/D\right)$ is endogenously determined.[1] In the first stage, we regress $\ln\left(I/D\right)$ on all available exogenous variables instruments and get the least-square estimator of the coefficients of the instruments and the estimated value of $\ln\left(I/D\right)$, $\widehat{\ln\left(I/D\right)}$; in the second stage, we regress the left hand side of (A.3) on $\widehat{\ln\left(I/D\right)}$ and use the regression coefficient of $\widehat{\ln\left(I/D\right)}$ and intercept to recover σ and α (Greene 2002).

Data

We use the 2000-2004 monthly data for M, D, I and p_D from Monthly Statistics of Japan; Japan Customs; and MAFF. I is the aggregate imports since the individual imports from each country are too small to derive the parameters. We have 42 data points because for some of the months, apple imports are zero. Expenditure M is computed as the sum of expenditure on both domestic imported apples. Expenditure on domestic apples is $p_D D$. Expenditure on imported apples is $p_I I$. p_I is approximated by

$p_I \approx p_{CIF} + TR + Tariff + \overline{TBT_2}$, where $\overline{TBT_2}$, an approximation of TBT_2, is assumed small (5% of the CIF price). The approximation of TBT_2 has little influence on the estimation of the parameters since the expenditure on imported apples is less than 0.35% of the total expenditure on average. $I{*}TBT_2$ represents a very small percentage of the expenditure on all apples. We have varied TBT_2 from zero to 10% of the CIF price, and the estimation results remain very close to the 5% case (see results section below). The exogenous variables are the price p_{CIF}, the Japanese real wage index, RWI, and year dummy variables in the first stage. The source for p_{CIF} and RWI is Monthly Statistics of Japan.

Results

We develop the instrument for $\ln\left(I/D\right)$ using exogenous price p_{CIF} and the Japanese real wage index, RWI, and year dummy variables in the first stage. We regress

$\ln(I/D)$ on year dummy variables year1 (which is 2000), year2, year3, year4, p_{CIF}, p_{CIF}^2, RWI, and RWI^2. The results of the first-stage estimation are shown in table A.1.

The R^2 of the regression is 0.93 and adjusted R^2 is 0.92, indicating good fit. We developed alternative instruments using other exogenous variables such as monthly dummy variables, higher orders of CIF price and *RWI*. Results are very robust to variation in instruments. From the regression results above, we get the fitted value of $\ln(I/D)$, $\widehat{\ln(I/D)}$. In the second stage, we regress the left-hand side of (A.3) on $\widehat{\ln(I/D)}$. The results are shown in table A.2.

The R^2 and adjusted R^2 of the regression are both 0.90. Combining the results in table A.2 and equation (A.3) allows us to obtain $\hat{\sigma}$ and $\hat{\alpha}$, results reported in table A.3. The estimates' standard deviations are calculated using the Delta method (Greene 2002). We also used nonlinear least square on the second stage of the estimation, the results were $\hat{\sigma}_n$=7.15 and $\hat{\alpha}_n$=0.67, quite close to those obtained using 2SLS. Further, since we do not have an exact estimate of TBT_2, there may be some measurement error in the estimating results of σ and α. The larger the approximation of TBT_2, the larger of the estimation results of the two parameters, but the difference is quite small. For instance, when TBT_2 is set to be 10% of the CIF price, $\hat{\sigma}_n$=7.14 and $\hat{\alpha}_n$=0.65.

Footnotes

1. The Hausman Test was conducted, and the P-value for the test was found to be <0.01, so $\ln(I/D)$ is endogenous. The estimation procedure used addresses the endogeneity.

Table A.1. First-Stage Estimation Results of the 2SLS

Variable	Estimated Coefficients	Standard Deviation
Constant	16.649*	2.281
year1	-2.474*	0.304
year2	-5.306*	0.613
year3	-2.457*	0.325
year4	-2.674*	0.333
p_{CIF}	-0.091*	0.020
p_{CIF}^2	0.00026*	0.00004
RWI	-0.01890*	0.00442
RWI^2	0.00004*	0.00001

Note: * the coefficient is significant at 1%.

Table A.2. Second-Stage Estimation Results of the 2SLS

Variable	Estimated Coefficients	Standard Deviation
Intercept	-0.579*	0.220
$\ln(\widehat{I/D})$	0.860*	0.041

Note: *the coefficient is significant at 1%.

Table A.3. Estimated Results of σ and α

Parameter	Estimated Value	Approximate Standard Deviation
σ	7.12*	2.09
α	0.64*	0.05

Note: *the coefficient is significant at 1%.

CHAPTER 3. HOW TO PROMOTE QUALITY PERCEPTION IN WINE MARKET: BRAND ADVERTISING OR GEOGRAPHICAL INDICATIONS?

Abstract

In the context of the wine industry, we investigate producers' choice between geographical indications and brand advertising to convey information to consumers. Producers also decide whether or not to select an effort level for improving the quality of their products. We show that if this effort level is selected, a producer will prefer to rely on brand advertising for promoting its products and setting up its own reputation. Despite allowing the cost of promotion to be shared, a geographical indication does not sufficiently reward the effort to improve quality. Finally, the selection of both instruments by producers is examined.

Key words: brand advertising, effort, geographical indication, GI, quality, wine.

Introduction

Wine promotion has been modified recently with the emergence of “new-world” wine from Australia, California, and Chile. Wineries from these countries mainly use individual brand advertising (BA) to promote quality perception, while more traditional European wineries mainly rely on geographical indications (GIs) for signaling the quality of their products. Foreign consumers in Europe are often baffled by the profusion of wine GIs. Reliance on GIs to promote food and beverage products is widespread in Europe not only for wine but also for cheese, meat, and other products. For instance, nearly 700 products are registered with the European designations system under the so-called Protected Designation of Origin and Protected Geographical Indication (EC, 2006). These differences raise the issue of the efficiency of the GI system for promoting food products relative to the merits of BA.

We analyze the complex interaction between BA and GI and the rewards to quality improvements. We identify the relative effectiveness of BA and GI to reward producers[1] for improvements in quality of their products, using a stylized framework linking product promotion and quality efforts. In a two-period model, BA and GI enhance the quality perception and the willingness to pay of consumers. The BA allows a producer to develop an individual reputation. The GI allows producers to share the cost of promotion and to develop a common reputation. Besides the choice of BA or GI, producers choose whether or not to make an effort to improve the overall quality level that affects the consumers’ purchase decision in the second period. Both signal and effort strategies influence the producers’ profits.

Wine production is notoriously stochastic, with “good” and “bad” years, and taste attributes vary. New technologies allow control of the consistency of taste attributes (e.g., controlled fermentation, varietal mix, and use of wood chips). These improvements are examples of what we mean by efforts to improve quality, i.e., investments in costly processes to improve the expected hedonic quality of a wine. We show that if the effort for improving quality is selected, a producer will prefer to rely on BA for promoting its products and setting up its own reputation. Despite the sharing of the cost of promotion, a GI does not sufficiently reward the effort for improving quality because of the common reputation. Conversely, when the producer avoids the effort, the GI is selected. Producers take advantage of sharing of the cost of promotion under collective reputation.

This article is linked to two separate strands of the literature. The first strand includes numerous papers on quality signaling. The latter mainly considers prices (e.g., Mahenc, 2004) or advertising (e.g., Fluet and Garella, 2002) to signal higher quality. The second and more recent strand focuses on GI and collective reputation (e.g., Marette and Crespi, 2003; Zago and Pick, 2004; and Winfree and McCluskey, 2005). In this literature, producers’ coordination or even price collusion through a GI may be necessary to improve quality when the fixed costs of certification or quality improvements are large. Our framework differs because we simplify the consumers’ belief in higher quality by considering BA and GI as persuasive tools that change consumers’ preferences. In addition, our framework contributes to the more recent strand of literature. Here, we abstract from any price collusion linked to a GI and introduce the possibility that producers chose to use BA. Indeed, our article addresses the question of the relative efficiency of collective signals compared to that of a private brand and the possible combination of both instruments, an issue that was previously overlooked in the literature.

The next section expands on our contention that the emergence of "new-world" wine has relied on BA in contrast to the reliance of European wine on GIs. Then, in the third section, we introduce the model. The main results are presented in the fourth section, while the fifth provides some extensions, and the final section offers conclusions. An appendix provides detailed derivations of results presented in the text.

Promotion Strategies in the Wine Market

In the last 15 years, globalization and trade liberalization have entailed a new context of competition. While world consumption of wine has been increasing (WHO, 2006), wine exports of European countries such as France and Italy have leveled off. Conversely, the exports of Australia, Chile, Argentina, and the United States have steadily gained ground, as shown in figure 1, and markedly so in recent years.[2] The European domination is being challenged by new producers from Chile and Australia. This new competition has modified strategies for signaling and promotion in the wine market (BA versus GI), accompanied by differences in cost structure, industry structure, and wine technology. The intellectual challenge is to elucidate the individual effect of these various elements. We focus on the noticeable efforts of these emerging competitors to improve quality through consistency and predictability of taste and the crucial role of their marketing strategies. The following stylized facts allow us to understand the differences between producers in Europe and in the emergent countries.[3]

First, several types of information such as the winery, the grape, or the origin are usually mentioned on most bottles. However, for a buyer, the most visible information in France is the GI for medium-quality wines, and the cumulative GI (appellation, grand cru, etc.) combined with the winery ("chateau") for high-quality wines. Conversely, the brand is the most visible information for the Australian wines (e.g., Jacob's Creek, 2005). Wine promotion in Australia, Chile, and the United States favors private BA, which facilitates individual reputation and recognition by buyers.

Second, the profusion and proliferation of GIs in Europe lead to some risks of confusion for consumers (Marette and Zago, 2003). Peri and Gaeta (1999) count more than 400 official appellations in the wine sector in Italy, 450 appellations in France, and 1,397 in the wine sector in Europe. Such profusion assures product diversity but certainly increases buyer confusion (*Consumer Reports,* 1997). The recognition of quality labels by French consumers is only 12% for Appellations d'Origine Contrôlée, the French GI system for high-quality products (Loisel and Couvreur, 2001). Berthomeau (2002) discusses the difficulty that some French GIs have in entering new export markets because of the absence of any clear specification of the label that distinguishes one appellation from another in consumers' minds.[4] In sharp contrast, Jacob's Creek and Kendall Jackson wines can be found in most U.S. grocery stores.

Third, many European GIs impose numerous restrictions that often stifle the search for commercial efficiency and innovations in quality that would improve the predictability in taste and consistency over time. Grape production is regulated, with a maximum yield allowed per unit of land. Excessive regulation for linking origin and quality seems problematic when the international competition is intense (Zago and Pick, 2004; and Ribaut, 2005). Conversely, the main features of regulations in the United States, Chile, and Australia are the lack of detailed rules and the freedom to experiment with new techniques; the production and marketing of wines according to single varieties of grapes, sometimes associated with a relatively large production region; and an intense use of marketing investments. [5]

Fourth, wineries in Australia are much bigger than the ones in Europe, and the industry in the "new world" has been dominated by relatively large producers. The average vineyard size in France is less than 2 hectares compared with 111 hectares in Australia. Four producers dominate the Australian market, namely, Foster, Southcorp, Hardy, and Orlando Wyndham. The combined production share of the four largest producers in New Zealand is 85%, while the combined production share of the two largest producers in South Africa is 80%. Unlike the industry in Australia, Chile, or other new world competing countries, the wine industry in Europe is fragmented. Indeed, apart from some notable exceptions, e.g., Champagne (*The Economist*, 2003), the wine industry in Europe is made up of many small producers that often lack adequate capital for the necessary investments in new technologies and marketing policies. In other words, small wineries are unable to reach the minimum-efficient scale since the quality improvement implies relatively large fixed costs.

Beyond these empirical facts, further effects of the origin and the role of the GI are less easily evaluated. Despite the limits previously mentioned, GI also indicates natural conditions such as the soils and the climate specific to a certain geographic area (Barham, 2003). Origins of product matters for consumers' purchase decisions. Orth et al.

(2005) show that the origin of a bottle does affect the U.S. consumers' preference, as shown in table 1. [6]

However, GIs can be an efficient tool for signaling collective reputation. The Champagne GI is an example of successful collective reputation in which the combination of famous brands (with large vineyard size and enough capital for advertising) and a prestigious GI matters for consumers ready to pay a large premium (Combris et al., 2003). Orth and Krska (2002) show that consumers rank country and region of origin at the top of wine attributes, while the producer name is lower. An "efficient" combination of brands and GI also characterizes the Napa Valley appellation, which generates a significant price premium compared to an equivalent-quality bottle with a different appellation (Bombrun and Sumner, 2003). The efficiency of GI compared to that of a private brand is an open question. Some empirical studies of wine have elucidated consumers' attitudes towards GIs and brands. With a parametric hedonic approach, Steiner (2004) shows that the decline of French wine in the British market is partly due to the consumers' low valuation of geographical appellation. Riley et al. (1999) show a positive correlation between consumers' attitudes (and perceptions) and relative brand size in the British wine market.

The debate about the strategies of producers and the appropriate regulation will likely gain momentum. This last point leads directly to the focus of our article. Although the choice among tools for improving quality raises many questions, we focus on the central link between an effort for improving quality and different tools for quality signaling (BA versus GI and a combination of both). A stylized model is used to isolate the impact of alternative ways to signal quality with and without efforts to improve quality.

The Model

We assume purchases occur in two periods (*t=1, 2*) with two producers *i* and *j* who may offer products of high quality or low quality. In the first period, producers *i* and *j* choose whether or not to promote their products and/or whether or not to improve the quality of their products. The cost of promotion is *A*. If the producers choose the GI, each producer incurs the cost *A/2* since they share the cost. If a producer individually chooses to use BA, it incurs the cost *A*. The cost of product improvement is *F*. It is assumed that other costs of production are zero. For simplicity, it is also assumed that $A = \gamma F$, with $\gamma \leq 1$.

Each consumer only purchases one unit of the good per period *t* (Mussa and Rosen, 1978). A consumer who buys one unit of the product from producer *i* at price p_i^t has an expected indirect utility equal to $\theta E(q_i^t) - p_i^t$, where $E(q_i^t)$ is the expected quality. The mass of those consumers is normalized at 1, with a uniformly distributed parameter $\theta \in$ [0, 1]. For simplicity, we assume that consumers only want to get high quality (denoted q_H) and they get no satisfaction from getting low quality ($q_\ell = 0$).

Consumers have limited knowledge about quality. In the first period (*t=1)*, the consumer has a belief about the probability of getting high quality from producer *i* equal to $\bar{\lambda} + I_i^\alpha \alpha$, with $0 \leq \bar{\lambda} + I_i^\alpha \alpha \leq 1$. Parameter $\bar{\lambda}$ is the initial belief about wine quality in the absence of promotion, and I_i^α is an indicator linked to the promotion strategy. I_i^α =1 means that producer *i* invests in promotion (BA or GI) for enhancing the consumer's perception of quality in the first period, while I_i^{α} =0 means producer *i* avoids investing in promotion. Parameter *α* is the incremental probability of purchasing wine of high quality.

In the second period (*t=2*), consumers repeat their purchases by learning the average quality of the products because of an imperfect experience. Consumers can communicate with each other after the first period, so that common knowledge is formed regarding the average quality of the products among consumers. Consumers experience the product even if they know there is residual uncertainty that limits their knowledge. They learn about the probability of getting high-quality products by using complementary information (communication among the consumers, newspapers, and so forth). The probability of getting high-quality products depends on the producer's decision for improving quality at cost *F*. The cost *F* implies an improvement of the probability of having high-quality products equal to *e*. Under BA, consumers are able to identify each producer's improvement since promotion is individual. If producer *i* chose BA, the probability of having high-quality products is $\lambda + I_i^e e$ (with $0 < \lambda + I_i^e e \leq 1$), where λ is the real probability of getting high-quality products in the absence of an effort. I_i^e is an indicator of the probability improvement (I_i^e =1 when *F* is incurred and zero otherwise). If both producers chose GI, consumers are not able to distinguish precisely the quality of both producers since the promotion is collective. Because GI leads to a collective reputation, the probability for consumers to get high-quality products in the absence of distinction between both producers is $(\lambda + I_i^e e)/2 + (\lambda + I_j^e e)/2 = \lambda + (I_i^e + I_j^e)e/2$, with $i \neq j$.

We summarize all the cases faced by producers and consumers in table 2. Recall that the low quality is q_L =0, so that the expected quality for consumers is equal to their belief regarding the probability of getting high quality multiplied by the quality level, q_H .

The game proceeds in three stages in the first period. At the first stage, the producers make their decisions for promoting their products, namely GI, BA, or no signal. In the second stage, each producer decides whether or not to make an effort to improve the probability of producing high-quality goods. In the third stage of the first period, each producer selects a quantity (Cournot competition), and consumers decide on their consumption levels. They learn partial information through consumption. Stage 4 corresponds to the second period, whereby the consumers repeat their purchase and each producer selects a quantity (Cournot competition). The timeline of the stages is shown in figure 2. We now turn to the presentation of the producers' choices.

The Producers' Choices

When producers choose the information strategy (in stage 1) and the effort strategies (in stage 2) that maximize their profits, they take into account the quantity choices in stages 3 and 4. The sub-game perfect equilibrium is detailed in Appendix 1 and 2.

The incentive for a producer to select promotion and/or an effort balances two opposing effects. An information/effort strategy leads to higher demand for its products by increasing the consumer's willingness to pay. However, this positive effect may be offset by the fixed cost induced by these strategies or by the strategic interaction with the other producer. The producers' choices depend on the efficiency of both promotion (represented by parameters $\overline{\lambda}$, α , and γ) and effort (represented by the parameter e).

The selection of the profit-maximizing strategies leads to a set of results (Propositions 1-4). The derivations are shown in the appendix. For sake of simplicity, we characterize the equilibrium strategies for alternative values of γ, namely, the relative cost of promotion compared to the cost of quality improvement (recall that $A=\gamma F$). Figures 3 and 4 illustrate the market equilibrium detailed in the propositions. The X-axis represents the quality level, q_H, and the Y-axis represents the fixed cost, *F*. The relative values of q_H and *F* determine the producers' optimal strategy and define the limits of different areas (the frontiers of these regions are detailed in the appendix). Below, we present the propositions and provide an intuitive interpretation. Let

$$(1) \qquad \gamma_1 = \frac{\alpha(4e+3\lambda)^2(36\alpha^2+56\alpha\bar{\lambda}+21\bar{\lambda}^2)}{e(4\alpha+3\bar{\lambda})^2(36e^2+56e\lambda+21\lambda^2)}.$$

PROPOSITION 1. *When the relative cost of signaling is low with* $\gamma \le \gamma_1$, *the producers' strategies are as follows (see figure 3):*

(a) both producers choose no signal and no producer makes an effort in area 1,

(b) one producer chooses BA and no producer makes an effort in area 2,

(c) one producer chooses BA and makes an effort in area 3,

(d) one producer chooses BA and both producers make an effort in area 4.

The proof is given in Appendix 1.

In area 1, making the effort or using a signal is too costly, since the respective costs represented by *F* (and γF) are relatively large. When *F* decreases in areas 2, 3 and 4, the different strategies of an effort and signal become affordable for the producer(s). When the cost of signaling is low with $\gamma \le \gamma_1$, each producer will try to use the BA alone, since it increases the perception differentiation and the profit by means of the parameter

α in the first period and the individual reputation in the second period. This market mechanism leads one producer to choose BA instead of cooperating with the other producer to select GI since the cost of signaling is relatively small.

In area 2, one producer chooses BA because of the low cost of signaling (small γ), and no producer makes an effort because of the relatively high cost of the effort compared with the signal cost. When the relative value of F decreases further (area 3), the producer choosing the BA chooses to make an effort. In area 3, the fixed cost is still quite high for the other producer to select a signal or an effort. When F is relatively small (area 4), both producers make an effort. Only one producer chooses the BA that allows a perceived increased quality differentiation in period 1.

As α, the incremental probability of purchasing wine of high quality coming from promotion, is assumed to be the same under BA and GI, the market equilibrium with the two producers selecting BA never emerges. Indeed, it is optimal for both sellers to join the GI and to share the cost of promotion.

We now turn to a situation in which the cost of promotion increases. Let

$$\gamma_2 = \frac{4\alpha^2(80e^3 + 81\alpha\lambda^2 + 24e\lambda(9\alpha+\lambda) + 4e^2(36\alpha+25\lambda))}{e(4\alpha+3\overline{\lambda})^2(16e^2+31e\lambda+15\lambda^2)} + \frac{(8\alpha\overline{\lambda}+3\overline{\lambda}^2)(60e^3+63\alpha\lambda^2+6e\lambda(28\alpha+3\lambda)+e^2(112\alpha+75\lambda))}{e(4\alpha+3\overline{\lambda})^2(16e^2+31e\lambda+15\lambda^2)} \tag{2}$$

PROPOSITION 2. *For a medium relative cost of signaling with* $\gamma_1 < \gamma \leq \gamma_2$, *area 2 in figure 3 disappears.*

The proof is given in Appendix 1.

Since signaling is more costly, no producer selects the BA without making an effort. In other words, the BA is valuable only if an effort is made. Indeed compared to

Proposition 1, area 2 disappeared when γ increased. We now turn to a situation in which the cost of promotion keeps increasing with $\gamma_2 < \gamma < \gamma_3$ [7]. Let

(3) $$\gamma_3 = \frac{4\alpha}{e}$$

(4) $$\alpha_1 = \frac{3\overline{\lambda}}{4}$$

PROPOSITION 3. *When the relative cost of signaling is of medium level with* $\gamma_2 < \gamma \leq \gamma_3$, *the producers' strategies are as follows (see figure 4):*

(a) both producers choose no signal and no producer makes an effort in area 1',

(b) both producers choose GI but no producer makes an effort in area 5,

(c) both producers make an effort; one producer chooses BA if $\alpha > \alpha_1$ *and both of them choose GI if* $\alpha < \alpha_1$ *in area 6.*

The proof is given in Appendix 1.

When the cost of promotion continues to increase, the GI becomes more attractive compared to the BA because the producers share the cost of promotion. Areas 3 and 4 from figure 3 disappear, since the cost of BA becomes too high for a single producer to afford. In figure 4, the producers lean toward [choose] GI rather than doing BA individually. Some new equilibria appear in figure 4.

In reference to area 4 of former figure 3, here, in figure 4, GI replaces BA for large values of *F.* The story in area 6 is the following: if signaling is not persuasive up to a certain level ($\alpha < \alpha_1$), producers would choose to cooperate with each other and do GI to share the fixed cost. However, if signaling is effective and α is greater than some certain level α_1, one producer would do BA to distinguish itself from the other in the first period to gain higher profit.

PROPOSITION 4. *When the relative cost of signaling is high (*$\gamma > \max\{\gamma_2, \gamma_3\}$*) the producers' strategies are as follows (see figure 4):*

(a) no producer chooses any signal strategy and no producer makes an effort in area 1',

(b) both producers make no signal but both producers make an effort in area 7, and

(c) both producers make an effort; one producer chooses BA if $\alpha > \alpha_1$ *and both of them choose GI if* $\alpha < \alpha_1$ *in area 6'.*

The proof is given in Appendix 1.

Proposition 4 is illustrated in figure 5. In this case, the cost of signaling is so large that even the effect of cost-sharing of GI does not work well. Therefore, area 5 in figure 4 disappears. As the cost of making an effort continues to decrease, producers choose to make an effort instead of signaling in area 7. In reality, this corresponds to a new technology, which decreases the fixed cost of investing in quality improvements.

From the foregoing four propositions, we can conclude that the strategies of the producers depend on the relative effectiveness of providing quality improvements and signaling. When signaling is more effective and the fixed cost of providing a quality effort is large, producers tend not to make an effort; when quality improvement is more effective and the fixed cost of signaling is large, producers tend not to signal. We also conclude that BA provides producers with a higher incentive to make an effort than GI does, since GI is a collective reputation. If the effort for improving quality is selected, a producer will prefer to rely on BA for promoting its wine and set up its own reputation. Despite the sharing of the cost of promotion, a GI does not sufficiently reward the effort for improving quality because of the common reputation. On the contrary, when the producer avoids making an effort, GI is selected to be the promotion strategy. In this case, producers take advantage of sharing of the cost of promotion and collective reputation.

Extensions

In defining the analytical framework, restrictive assumptions were made for simplicity. Some of the results of the model are robust if we consider the following extensions.

(i) In our model we abstract from the combination of GI and BA. One extension could be the incorporation of this combination. The following assumption could be made: In the first period, GI enhances the consumer's expectation by α and costs producers $\frac{A}{2}$; BA enhances the consumer's expectation by α as well but costs producers A; and the combination of the two enhances the consumer's expectation by $c\alpha$ and costs producers $\frac{3A}{2}$. When the combination of these two are effective (high $c\alpha$ compared with the cost $\frac{3A}{2}$), the producers would choose the combination; if the combination were not effective enough, producers would choose GI or BA individually, which goes back to the propositions of this article. Let

$c_1 = \min\{1, \frac{32\alpha^4 + 24\alpha^3\overline{\lambda} - 19\alpha^2\overline{\lambda}^2 - 14\alpha\overline{\lambda}^3 - 14\alpha\overline{\lambda}^3}{3(16\alpha^4 + 24\alpha^3\overline{\lambda} + 9\alpha^2\overline{\lambda}^2)}\}$ and when $c < c_1$, the combination of BA and GI is dominated by BA or GI in equilibrium and it never emerges. (See the proof in Appendix 2 [point *viii*]).

(ii) In our model, signaling has an effect only in the first period. One extension

could be the introduction of an effect of signaling on consumers' expectation in the second period. That is, the second period's expectation of consumers is the combination of the expectation of the first period and the real probability. For example, when producers choose GI, consumers' expectation in the second period is $[\varphi(\lambda + 0.5(I_i^e + I_j^e)e) + (1-\varphi)(\bar{\lambda} + \alpha)]\, q_H$, where $0 \le \varphi \le 1$. The higher the effectiveness of signals in the second period, the closer is consumers' expectation to the real probability. By doing this, we introduce an interaction effect of signaling and making an effort. We expect that producers' incentive to make an effort is lower when the second-period effectiveness of signaling is lower.

(iii) Our model abstracts from the discount of the second-period profit of the consumers. If there is a discount in the second period, the larger the discount, the lower is the producers' incentive to make an effort.

(iv) In the model, we abstracted from a context with numerous producers. Since GI has the property of cost-sharing, one natural question is, if there are numerous producers, will the producers prefer GI to BA since they could share the promotion cost by doing GI? To answer this question, we abstract from the strategy of making an effort in this extension. Suppose there are *n* producers. They could choose to do GI together to share the signal cost in the first period. When the signal cost is not quite high, the producers have the incentive to deviate to do BA by themselves. Suppose initially all producers do GI and the first producer chooses to deviate from GI to BA only if $A < \frac{n(\bar{\lambda} + \alpha)\left(\frac{(n\alpha + \bar{\lambda})^2}{(2n\alpha + (n+1)\bar{\lambda})^2} - \frac{1}{(n+1)^2}\right)}{n-1}$. The results indicate that even though by doing GI a larger number of producers lower the cost of promotion for each producer, the

producers still have an incentive to deviate to do BA if the promotion cost is not quite high. By doing GI, the producers share not only the cost but also the profit.

(v) We considered only one region. One extension of our model is the introduction of several regions. Probabilities of producing high-quality goods are different across different regions. We expect that producers in a region with high probability have more incentive to do GI.

(vi) We assumed vertical differentiation. An alternative solution is to introduce horizontal differentiation. In this context with m consumers and perfect information, m_1 consumers prefer goods from producer 1 and (m-m_1) consumers prefer goods from producer 2. Using our model we expect that as m_1 increases, producer 1's incentive to signal and make an effort increases.

(vii) We assumed the BA and GI have the same α, which is the incremental probability of purchasing wine of high quality from consumers' subjective point of view. That is, BA enhances consumers' perception in the first period in the same way as GI. This leads to the conclusion that the case in which both producers choose BA as their promotion strategy and both make an effort (or both producers make no effort) is dominated in equilibrium by the strategies that both producers choose GI and both producers make an effort (or both producers make no effort). (See the proof of point (iii) in Appendix 2.) One extension of our model is to assume that BA and GI have different effects on consumers' perception in the first period. Suppose we assume the incremental probability of purchasing wine of high quality in the first period for BA is α^{BA}, whereas for GI the value is α^{GI}. When $\alpha^{BA} - \alpha^{GI} > \frac{9A}{2}$ ($> \frac{(n+1)^2 A}{n}$ when there are n producers), the strategy that both producers choose BA emerges. That is, producers do BA instead of

GI if BA is somewhat more effective in enhancing consumers' perception in the first period than GI.

Conclusions

In the context of the international wine market, we explored producers' choice between promotional strategies (BA and GI) and quality improvement strategies and how these strategic choices affect consumers' wine purchasing decisions. Although admittedly stylistic, our model nonetheless highlights the complicated strategies for monitoring uncertain quality.

We show that the producers' choice depends on the relative efficiency of promotional strategies compared with that of making an effort to improve quality. Another important result is that if the effort for improving quality is selected, a producer would like to use BA for promoting its wine and set up its own reputation. In spite of its advantage in allowing producers to share the cost of promotion, a GI does not sufficiently reward the effort for improving quality since it promotes a collective reputation. However, when the producer chooses not to make an effort to improve the quality, a GI is selected to be the promotion strategy. In the latter case, by using a GI, producers can take advantage of the sharing of the cost of promotion and collective reputation. We further explored extensions of our analysis showing it is quite promising for further generalizations.

These results can be applied to draw some implications about the diverging fortunes of "new-world" and European wines. Emergence of wines from the new world leads to new contexts of competition that require the modification of signaling strategies. There are more incentives for producers to differentiate themselves by improving quality and revealing more information. Our article, however, shows that GI is not necessarily compatible with quality improvement. This means that producers inside a GI should revamp their strategies for promotion, as, for instance, with the development of generic advertising for the world market based on a well-identified appellation. This may also result in the concentration of wine brands and advertising. Of course, the diverging fortunes of new-world and European wines hinge on additional factors, which we abstracted from to focus on promotion and quality improvement strategies. Beyond these two aspects, access to capital, regulations, cost structure, and size—all play an important role in the evolution of the international wine market.

References

Barham, E. 2003. “Translating Terroir: The Global Challenge of French AOC Labeling.” *Journal of Rural Studies* 19:127-138.

Berthomeau, J. 2002. *Comment Mieux Positionner Les Vins Français Sur Les Marchés d’Exportation?* Ministère de l’Agriculture, Paris.

Bombrun, H., and D. A. Sumner. 2003. “What Determines the Price of Wine? The Value of Grape Characteristics and Wine Quality Assessments.” AIC Issues Brief 18, Agricultural Issues Center, University of California.

Combris, P., C. Lange, and S. Issanchou. 2003. “Assessing the Effect of Information on the Reservation Price for Champagne: What Are Consumers Actually Paying for?” In *The Economics of Wine*, O. Ashenfelter and V. Ginsburgh, eds. Princeton NJ: Princeton University Press.

Conan, E. 2005. “Le prix de l’excellence.” *L’Express*. 5 September, p. 48.

Consumer Reports. 1997. “Wine Without Fuss.” October, pp. 10-16.

Costanigro, M., J. McCluskey, and R. Mittelhammer. 2005. “Segmenting the Wine Market Based on Price: Hedonic Regression When Different Prices Mean Different Product.” Working Paper, School of Economic Sciences, Washington State University.

Echikson, W. 2005. “In Bordeaux, The Price May Not Be Right.” *Wall Street Journal*, September 2, p. W5.

Economist, The. 2003. “Blended.” January 25, p. 61.

EC (European Commission). 2006. “PDO/PGI.” Agriculture and Food, Food Quality, Brussels. http://europa.eu.int/comm/agriculture/qual/en/1bbaa_en.htm (accessed April 2006).

Fluet, C., and P. Garella. 2002. “Advertising and Prices as Signals of Quality in a Regime of Price Rivalry.” *International Journal of Industrial Organization* 20:907-930.

Giraud-Heraud, E., L. G. Soler, and H. Tanguy. 2002. “Concurrence Internationale dans le secteur viticole : quel avenir au modèle d’Appellation d’Origine Contrôlée?” *INRA-Sciences Sociales*, no. 5-6/01, Juillet.

Jacob’s Creek. 2005. http://www.jacobscreek.com/about/advertising_promotions.phtml (accessed March 2006).

Locke, M. 2005. “U.S. Winemaking Practices Irk Europe.” *Business Briefcase,* October 25.

Loisel, J. P., and A. Couvreur. 2001. *Les Français, La Qualité De L’alimentation Et L’information*. Credoc, Inc., Paris.

Mahenc, P. 2004. "Influence of Informed Buyers in Markets Susceptible to the Lemons Problem." *American Journal of Agricultural Economics* 86:649-662.

Marette, S., and J. M. Crespi. 2003. "Can Quality Certification Lead to Stable Cartel?" *Review of Industrial Organization* 23(1, August):43-64.

Marette, S., J. M. Crespi, and A. Schiavina. 1999. "The Role of Common Labeling in a Context of Asymmetric Information." *European Review of Agricultural Economics* 26(2):167-178.

Marette, S., and A. Zago. 2003. "Advertising, Collective Action and Labelling in the European Wine Markets." *Journal of Food Distribution Research* 34:117-126.

Mussa, M. and S. Rosen. 1978. "Monopoly and Product Quality." *Journal of Economic Theory* 18(2, August): 301-317.

Orth, U. R., and P. Krska. 2002. "Quality Signals in Wine Marketing: The Role of Exhibition Awards." *International Food and Agribusiness Management Review* 4:385-397.

Orth, U. R., M. M. Wolf, and T. H. Dodd. 2005. "Dimensions of Wine Region Equity and Their Impact on Consumer Preferences." *Journal of Product and Brand Management* 14(2):88-97.

Peri, C., and D. Gaeta. 1999. "Designations of Origins and Industry Certifications as Means of Valorizing Agricultural Food Products." In *The European Agro-Food System and the Challenge of Global Competition*. Milan, Italy: ISMEA,

Ribaut, J.C. 2005. "Peut-on encore garantir la qualité?" *Le Monde*, June 17, p. 23.

Riley, F. D., L. Rink, and H. Patricia. 1999. “Patterns of Attitudes and Behavior in Fragmented Markets.” *Journal of Empirical Generalisations in Marketing Science* 4:62-91.

Steiner, B. 2004. “French Wines on the Decline? Econometric Evidence from Britain.” *Journal of Agricultural Economics* 55(2, July):267-288.

UN (United Nations). 2006. Commodity Trade Statistics Database. http://unstats.un.org/unsd/comtrade (accessed March 2006).

Winfree, J., and J. McCluskey. 2005. “Collective Reputation and Quality.” *American Journal of Agricultural Economics* 87(1):206-214.

WHO (World Health Organization). 2006. http://www3.who.int/whosis/menu.cfm (accessed March 2006).

Zago, A., and D. Pick. 2004. “Labeling Policies in Food Markets: Private Incentives, Public Intervention and Welfare.” *Journal of Agricultural and Resource Economics* 29(1):150-169.

Table 1. Consumers' Preference for Wine Origin

Origin	**Mean Rank**	Standard Deviation
California	3.03	1.95
France	3.88	2.49
Italy	4.38	2.18
Australia	4.67	2.51
Oregon	4.78	2.55
Chile	5.75	2.32
Spain	5.87	1.98
Washington	6.02	2.42
New Zealand	6.51	1.89

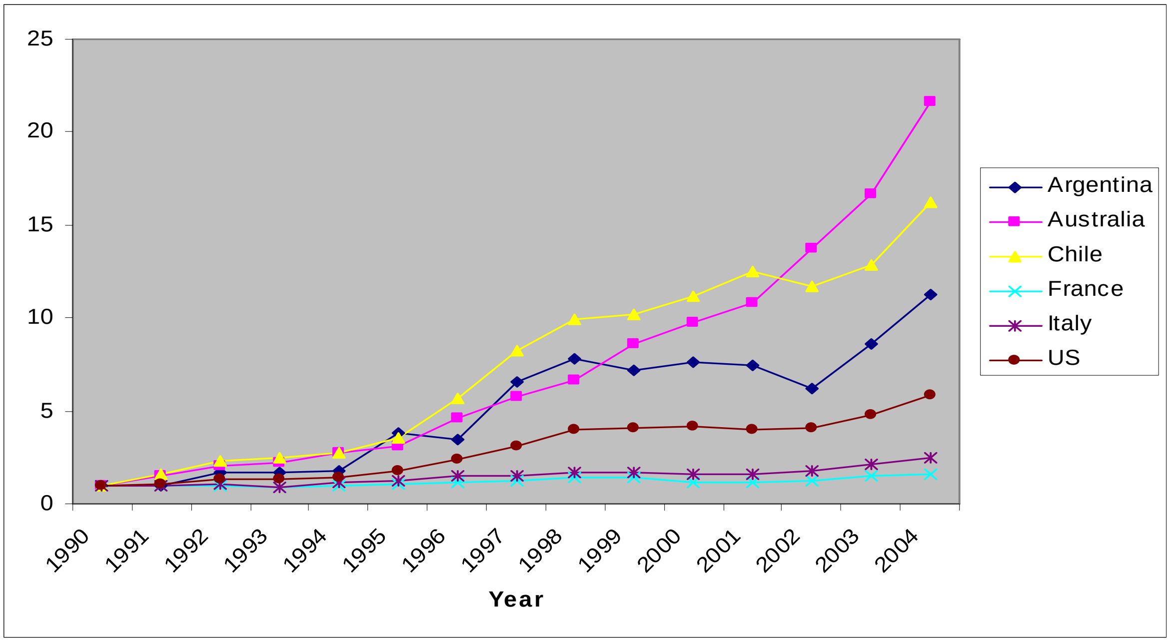
Source: Table 1 in Orth, Wolf, and Dodd 2005.
Note: Scale from 1 = most preferred to 9 = least preferred

Table 2. Producers' strategy and consumers' expectation of producers' quality

(q_L = 0)

First Period			**Second Period**
Producer *i*'s Strategy (Producer *j*'s Strategy)	**Cost Incurred by Producer *i* and *j***	**Consumer's Expected Quality of Producer *i* and *j***	**Consumer's Expected Quality of Producer *i* and *j***
No signal (No signal)*	$I_i^e F$	$\bar{\lambda}\ q_H$	$(\lambda + 0.5(I_i^e + I_j^e)e)\ q_H$
GI (GI)*	$I_i^e F + 0.5A$	$(\bar{\lambda} + \alpha)\, q_H$	$(\lambda + 0.5(I_i^e + I_j^e)e)\ q_H$
BA (BA)*	$I_i^e F + A$	$(\bar{\lambda} + \alpha)\, q_H$	$(\lambda + I_i^e e)\ q_H$
BA (No signal)**	$I_i^e F + A$ $(I_j^e F)$	$(\bar{\lambda} + \alpha)\, q_H$ $(\bar{\lambda}\ q_H)$	$(\lambda + I_i^e e)\ q_H$ $((\lambda + I_j^e e)\ q_H)$

*Identical values for *i* and *j*. **No signal/(BA) is obtained by switching the payoff rows of BA/(No signal).



Data Source: UN Commodity Trade Statistics Database.

Figure 1. Wine exports value (basis 100 in 1990)

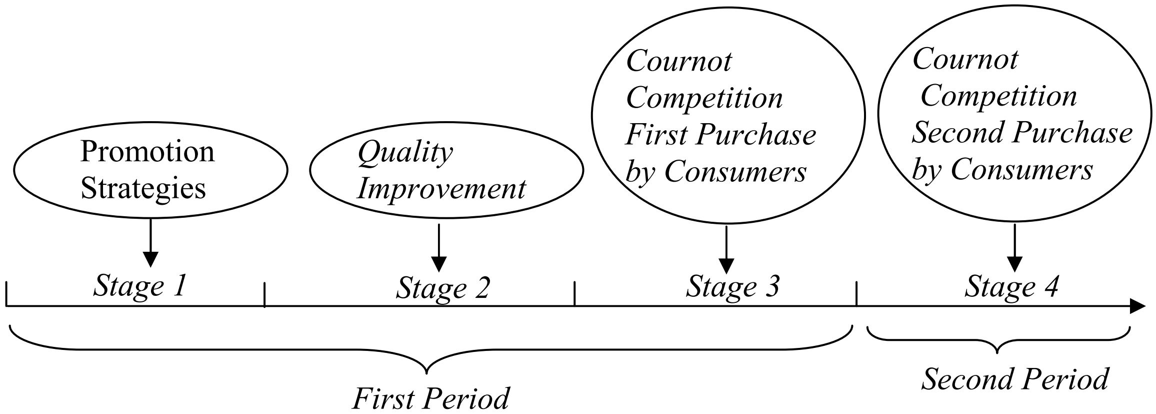


Figure 2. Timeline of the game

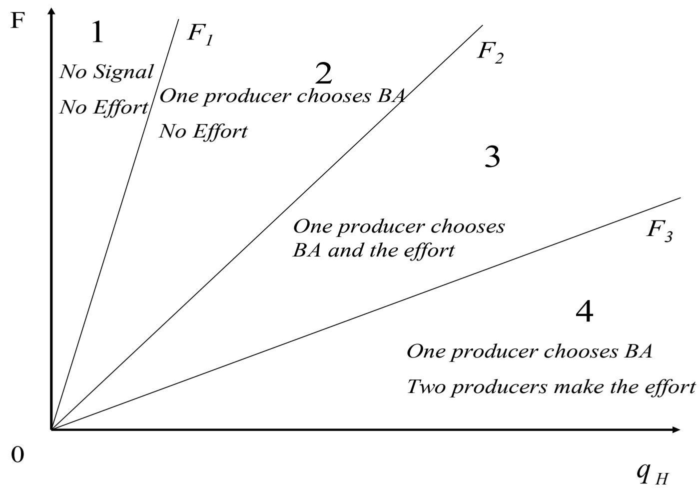


Figure 3. The strategies with low relative cost of signaling ($\gamma \leq \gamma_1$)

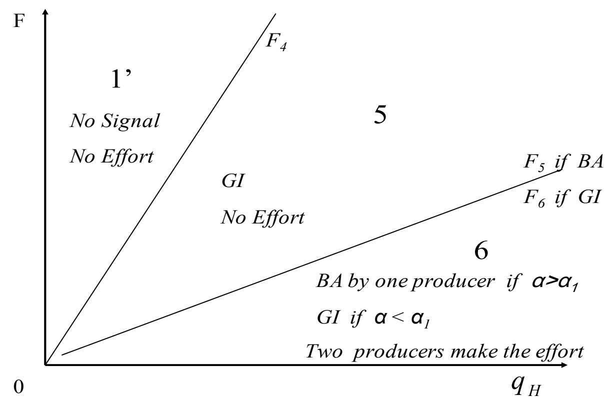


Figure 4. The strategies with medium relative cost of signaling ($\gamma_2 < \gamma \leq \gamma_3$)

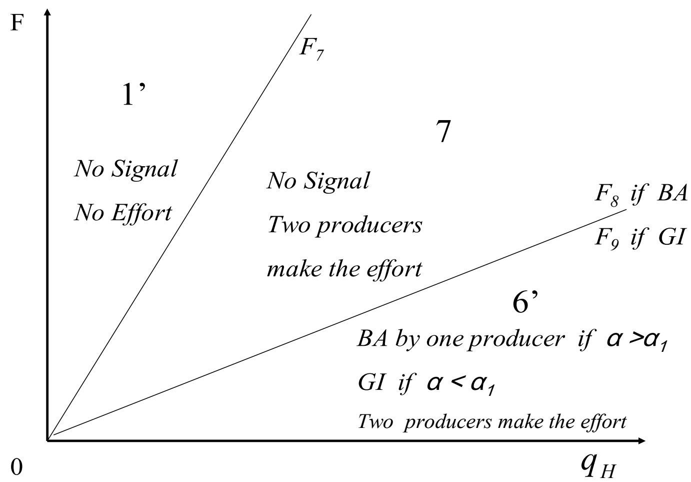


Figure 5. The strategies with high relative cost of signaling ($\gamma > \max\{\gamma_2, \gamma_3\}$)

Footnotes

[1] Producers denote the supply chain (producers, wineries, firms) supplying wine to consumers.

[2] Note that this figure exhibits aggregated volumes that neglect segmentation and quality heterogeneity.

[3] The stylized facts mainly concerned consumption wines that differ from collectible wines reserved to experts (Costanigro et al., 2005).

[4] The collective reputation of French wines plummeted during the last decade (Conan, 2005; Echikson, 2005; and Ribaut, 2005). Giraud-Heraud et al. (2002) and Ribaut (2005) mentioned the need for winery consolidation and/or reform of the French GI system.

[5] In September 2005, the United States and the European Union reached a wine-trade agreement that makes some U.S. practices, such as adding wood chips to wine barrels, legitimate in the European Union. U.S. companies will stop using some GIs, such as Champagne, Sherry, and Port. Some EU lawmakers are not satisfied with this agreement because the European wine industry is strictly regulated and emphasizes traditional practices, while the U.S. industry emphasizes new technology that allows better control of taste characteristics and their identification by consumers (Locke, 2005).

[6] It should be noted that the origin in Table 1 corresponds to countries or U.S. states, as that would be the case for GIs in France or Italy, associations that often concern sub-regions or small areas.

[7] The relative values of γ_2 and γ_3 depend on the relative values of $\lambda, \bar{\lambda}, e$, and α. If $\gamma_2 > \gamma_3$, Proposition 3 does not exist.

Appendix 1

The consumer's demand and producers' profits are presented before detailing the proof of propositions, with the characterization of the sub-game perfect Nash equilibrium of this four-stage game (solved by backward induction).

The consumer utility is $\sum_{t=1}^{2}\theta E(q_i^t)-p_i^t$ by consuming the product by producer i (i=1 or 2). In period t (t=1 or 2), if the two producers choose the same strategy, then $E(q_1^t)=E(q_2^t)=\overline{q}^t$ and $p_1^t=p_1^t=\overline{p}^t$. When $\theta\overline{q}^t-\overline{p}^t=0$, the consumer is indifferent between buying and not buying a product in period t, implying that her taste parameter is $\overline{\theta}^t=\frac{\overline{p}^t}{\overline{q}^t}$. As the distribution of preference is uniform, the demand for the product is $\overline{x}^t=1-\frac{\overline{p}^t}{\overline{q}^t}$ and $\overline{p}^t=(1-\overline{x}^t)\overline{q}^t$. In period t, if the two producers choose different strategies, then the expected quality of the products from two producers are different: $E(q_1^t)=\overline{q}_1^t$ and $E(q_2^t)=\overline{q}_2^t$. Suppose $\overline{q}_1^t>\overline{q}_1^t$ (indicating $p_1^t>p_2^t$); the consumer's demand for producer 1's product is $x_1^t=1-\frac{p_1^t-p_2^t}{\overline{q}_1^t-\overline{q}_2^t}$. The demand for producer 2's product is $x_2^t=\frac{p_1^t-p_2^t}{\overline{q}_1^t-\overline{q}_2^t}-\frac{p_2^t}{\overline{q}_2^t}$. By solving the system of equations of $x_1^t=1-\frac{p_1^t-p_2^t}{\overline{q}_1^t-\overline{q}_2^t}$ and $x_2^t=\frac{p_1^t-p_2^t}{\overline{q}_1^t-\overline{q}_2^t}-\frac{p_2^t}{\overline{q}_2^t}$ for p_1^t and p_2^t, we get $p_1^t=\overline{q}_1^t(1-x_1^t)-\overline{q}_2^t x_2^t$ and $p_2^t=\overline{q}_2^t(1-x_1^t-x_2^t)$.

In stage 2, each producer chooses a level of quantity, taking into account the quantity of the other producer. For the case in which the two producers' strategies are different, the profit for the higher expected quality producer is

$$\pi_1 = \sum_{t=1}^{2} p_1^t \overline{q}_1^t - I_1^e F - I_1^\alpha A' = \sum_{t=1}^{2} (\overline{q}_1^t (1 - x_1^t) - \overline{q}_2^t x_2^t) x_1^t - I_1^e F - I_1^\alpha A'$$

and the profit for the lower expected quality producer is

$$\pi_2 = \sum_{t=1}^{2} p_2^t \overline{q}_2^t - I_2^e F - I_2^\alpha A' = \sum_{t=1}^{2} \overline{q}_2^t (1 - x_1^t - x_2^t) x_2^t - I_2^e F - I_2^\alpha A'.$$

A' is the fixed cost associated with information strategies: $A' = A$ if BA is chosen and $A' = \frac{A}{2}$ if GI is chosen. The first-order conditions for the maximization of π_1 with respect to x_1^t (namely, $\frac{\partial \pi_1}{\partial x_1^t} = 0$) and π_2 with respect to x_2^t (namely, $\frac{\partial \pi_2}{\partial x_2^t} = 0$) lead to equilibrium prices x_1^{t*} and x_2^{t*}. The substitution of these equilibrium quantities into π_1 and π_2 leads to the following respective profits for producer 1 and producer **2:**

(A1.1)
$$\pi_1^* = \sum_{t=1}^{2} \frac{\overline{q}_1^t (2\overline{q}_1^t - \overline{q}_2^t)^2}{(4\overline{q}_1^t - \overline{q}_2^t)^2} - I_1^e F - I_1^\alpha A'$$

(A1.2)
$$\pi_2^* = \sum_{t=1}^{2} \frac{\overline{q}_2^t \overline{q}_1^{t\,2}}{(4\overline{q}_1^t - \overline{q}_2^t)^2} - I_2^e F - I_2^\alpha A'$$

A particular case of (A1.1) and (A1.2) is when both producers choose the same strategies in both periods (which leads to $\overline{q}_1^t = \overline{q}_2^t = \overline{q}^t$):

(A.2) $$\overline{\pi}_i^* = \sum_{t=1}^{2} \frac{\overline{q}^t}{9} - I_i^e F - I_i^\alpha A' \quad i=1 \text{ or } 2$$

The decision on the choice of strategies in stage 1 depends on these profits, which in turn depends on the expected quality and fixed costs listed in table 2 of the main text. In stage 1, each producer faces the choices of strategies listed in the first column of table 2. The decision depends on the comparison among the profits. Table 2 lists all the cases of the expected qualities and associated costs by choosing different strategies for the two producers. If the expected qualities for the two producers are the same, substitute them in (A2) and get the profits for the two producers. If the expected qualities for the two producers are different, substitute them in (A1.1) and (A1.2) and get the profits for the two producers.

We use $\pi^{i}_{strategy1(I_1^e)+strategy2(I_2^e)}$ to denote producer *i*'s profit, with producer 1 choosing strategy 1 and producer 2 choosing strategy 2 and an effort-making decision ($I_i^e = 1$ means making an effort; $I_i^e = 0$ means avoiding making an effort). Among the strategies, no signal is denoted by n, GI is denoted by GI, and BA is denoted by BA. For example, $\pi^2_{BA(1)+n(1)}$ denotes producer 2's profit when producer 1 chooses BA and makes an effort and producer 2 chooses no signal but makes an effort.

The Frontiers Determination and Proof of Propositions

We now turn to the equilibrium strategies that lead to Propositions 1, 2, 3, and 4.

The Nash equilibrium is such that a producer will choose a strategy that leads to a higher profit than all other available strategies given the other producer's strategy.

Proof of Proposition 1

If no signal and no effort is a Nash equilibrium, the producers have no incentive to deviate to other strategies; that is, the corresponding profits should be largest. Therefore, the following conditions have to be satisfied:

(A2.1) $\pi^1_{n(0)+n(0)} > \pi^1_{n(1)+n(0)}$ and $\pi^2_{n(0)+n(0)} > \pi^2_{n(0)+n(1)}$

(A2.2) $\pi^1_{n(0)+n(0)} > \pi^1_{BA(0)+n(0)}$ and $\pi^2_{n(0)+n(0)} > \pi^2_{n(0)+BA(0)}$;

(A2.3) $\pi^1_{n(0)+n(0)} > \pi^1_{GI(0)+GI(0)}$ and $\pi^2_{n(0)+n(0)} > \pi^2_{GI(0)+GI(0)}$.

Applying *point(i)* in Appendix 2, (A2.1) leads to the inequality

$$F > f_1 = \frac{e}{18} q_H \, ;$$

(A2.2) leads to

$$F > f_2 = \frac{\alpha(36\alpha^2 + 56\alpha\bar{\lambda} + 21\bar{\lambda}^2)}{9\gamma(4\alpha + 3\bar{\lambda})^2} q_H \, ;$$

and (A2.3) leads to

$$F > f_3 = \frac{2\alpha}{9\gamma} q_H \, .$$

No matter what value γ takes, the condition $f_2 - f_3 = \dfrac{\alpha(4\alpha^2 + 8\alpha\bar{\lambda} + 3\bar{\lambda}^2)}{\gamma(4\alpha + 3\bar{\lambda})^2} q_H > 0$ is satisfied, which implies $f_2 > f_3$. By comparing f_1 and f_3, we have when $\gamma < \gamma_3 = \dfrac{4\alpha}{e}$, $f_1 < f_3$.

If producer 1 choosing BA and no effort and producer 2 making no signal and no effort is Nash equilibrium, the following conditions have to be satisfied after applying *point (iii)* in Appendix 2 (the strategy that both producers choose BA is dominated in equilibrium)*:*

(A3.1) $$\pi^1_{BA(0)+n(0)} > \pi^1_{n(0)+n(0)}$$

(A3.2) $$\pi^1_{BA(0)+n(0)} > \pi^1_{BA(1)+n(0)}$$

(A3.3) $$\pi^1_{BA(0)+n(0)} > \pi^1_{BA(0)+n(1)}$$

(A3.4) $$\pi^1_{BA(0)+n(0)} > \pi^1_{GI(0)+GI(0)}.$$

(A3.1) leads to

$$F < f_2 = \frac{\alpha(36\alpha^2 + 56\alpha\overline{\lambda} + 21\overline{\lambda}^2)}{9\gamma(4\alpha + 3\overline{\lambda})^2} q_H;$$

(A3.2) leads to

$$F > f_4 = \frac{e(36e^2 + 56e\lambda + 21\lambda^2)}{9(4e + 3\lambda)^2} q_H;$$

$f_2 > f_4$ implies $\gamma < \gamma_1 = \dfrac{\alpha(4e + 3\lambda)^2(36\alpha^2 + 56\alpha\overline{\lambda} + 21\overline{\lambda}^2)}{e(4\alpha + 3\overline{\lambda})^2(36e^2 + 56e\lambda + 21\lambda^2)}$; otherwise, we have $f_2 < f_4$.

According to *point(iv)* in Appendix 2*,* the strategy that one producer chooses BA and makes no effort and the other producer makes no signal and makes an effort is dominated in equilibrium so (A3.3) is ignorable.

(A3.4) leads to

$$F < f_5 = \frac{8\alpha(5\alpha^2 + 8\alpha\overline{\lambda} + 3\overline{\lambda}^2)}{9\gamma(4\alpha + 3\overline{\lambda})^2} q_H;$$

$f_5 - f_2 = \dfrac{2\alpha(4\alpha^2 + 8\alpha\overline{\lambda} + 3\overline{\lambda}^2)}{9\gamma(4\alpha + 3\overline{\lambda})^2} q_H > 0$, which implies $f_5 > f_2$.

Therefore, only when $\gamma < \gamma_1 = \dfrac{\alpha(4e+3\lambda)^2(36\alpha^2+56\alpha\overline{\lambda}+21\overline{\lambda}^2)}{e(4\alpha+3\overline{\lambda})^2(36e^2+56e\lambda+21\lambda^2)}$ does the case emerge that one firm makes BA and no firm makes the effort to improve quality. By comparing γ_1 and γ_3 we have $\gamma_1 < \gamma_3$ for sure, which implies $f_2 > f_3 > f_1$ when $\gamma < \gamma_1$. Therefore, when $\gamma < \gamma_1$, we have

$$F_1 = f_2 = \frac{\alpha(36\alpha^2+56\alpha\overline{\lambda}+21\overline{\lambda}^2)}{9\gamma(4\alpha+3\overline{\lambda})^2} q_H$$

and

$$F_2 = f_4 = \frac{e(36e^2+56e\lambda+21\lambda^2)}{9(4e+3\lambda)^2} q_H .$$

So if $\gamma < \gamma_1$ when $F > F_1$, the strategy emerges in equilibrium that both producers make no signal and no effort and when $F_2 < F < F_1$, the strategy emerges in equilibrium that one producer chooses BA and makes no effort and the other producer makes no signal and no effort.

If producer 1 choosing BA and making an effort and producer 2 making no signal and no effort is Nash equilibrium, the following conditions have to be satisfied (when the second producer does not deviate to make an effort to improve quality):

(A4.1) $$\pi^1_{BA(1)+n(0)} > \pi^1_{BA(0)+n(0)}$$

(A4.2) $$\pi^2_{BA(1)+n(0)} > \pi^2_{BA(1)+n(1)}$$

(A4.3) $$\pi^1_{BA(1)+n(0)} > \pi^1_{GI(1)+GI(0)}$$

(A4.4) $$\pi^1_{BA(1)+n(0)} > \pi^1_{n(1)+n(0)} .$$

(A4.1) leads to

$$F < F_2 = f_4 = \frac{e(36e^2 + 56e\lambda + 21\lambda^2)}{9(4e+3\lambda)^2} q_H ;$$

(A4.2) leads to

$$F > f_6 = \frac{e(16e^2 + 31e\lambda + 15\lambda^2)}{9(4e+3\lambda)^2} q_H ;$$

(A4.3) leads to

$$F < f_7 = q_H \left(\frac{8\alpha^2(112e^3 + 45\alpha\lambda^2 + 16e^2(5\alpha + 11\lambda) + 6e\lambda(20\alpha + 11\lambda))}{9\gamma(4e+3\lambda)^2} + \frac{(8\alpha\overline{\lambda} + 3\overline{\lambda}^2)(168e^3 + 72\alpha\lambda^2 + 8e^2(16\alpha + 33\lambda) + 3e\lambda(64\alpha + 33\lambda))}{9\gamma(4e+3\lambda)^2} \right).$$

According to *point(vii)* in Appendix 2, (A4.4) is ignorable.

$f_4 - f_6 = \frac{e(20e^2 + 25e\lambda + 6\lambda^2)}{9(4e+3\lambda)^2} q_H > 0$, which implies $f_4 > f_6$. And we also have $f_7 > f_4$.

One producer choosing BA and making effort and the other producer choosing no signal but making effort is a Nash equilibrium when the following conditions are satisfied:

(A5.1) $$\pi^2_{BA(1)+n(1)} > \pi^2_{BA(1)+n(0)}$$

(A5.2) $$\pi^1_{BA(1)+n(1)} > \pi^1_{n(1)+n(1)}$$

(A5.3) $$\pi^1_{BA(1)+n(1)} > \pi^1_{GI(1)+GI(1)}.$$

(A5.1) leads to

$$F < f_6 = \frac{e(16e^2 + 31e\lambda + 15\lambda^2)}{9(4e+3\lambda)^2} q_H ;$$

(A5.2) leads to

$$F < f_2 = \frac{\alpha(36\alpha^2 + 56\alpha\overline{\lambda} + 21\overline{\lambda}^2)}{9\gamma(4\alpha + 3\overline{\lambda})^2} q_H .$$

According to the *point(v)* in Appendix 2, GI is dominated by BA when $\gamma < \gamma_1$; (A5.3) is ignorable. Since $f_2 > f_4$ and $f_4 > f_6$, we have $f_2 > f_6$. Therefore, we have the frontier

$$F_3 = f_6 = \frac{e(16e^2 + 31e\lambda + 15\lambda^2)}{9(4e + 3\lambda)^2} q_H .$$

Proof of Proposition 2

When $\gamma > \gamma_1, F_2 > F_1$, the strategy in which one producer chooses BA and makes no effort and the other producer makes no signal and no effort does not emerge in equilibrium, which leads to Proposition 2. The frontier F_1 becomes the border between area 1 and area 3, so when $\gamma > \gamma_1$,

$$F_1 = q_H \left(\begin{array}{l} \dfrac{4\alpha^2(144e^3 + 81\alpha\lambda^2 + 12e\lambda(18\alpha + 7\lambda) + 16e^2(9\alpha + 14\lambda))}{9(1+\gamma)(4e + 3\lambda)^2(4\alpha + 3\overline{\lambda})^2} \\ \quad + \dfrac{(8\alpha\overline{\lambda} + 3\overline{\lambda}^2)(108e^3 + 63\alpha\lambda^2 + 21e\lambda(8\alpha + 3\lambda) + 56e^2(2\alpha + 3\lambda))}{9(1+\gamma)(4e + 3\lambda)^2(4\alpha + 3\overline{\lambda})^2} \end{array} \right) .$$

We need to compare F_3 and this new F_1. Area 3 emerges only if $F_1 > F_3$; otherwise, area 3 disappears. $F_1 > F_3$ only if $\gamma < \gamma_2$, where

$$\gamma_2 = \frac{4\alpha^2(80e^3 + 81\alpha\lambda^2 + 24e\lambda(9\alpha + \lambda) + 4e^2(36\alpha + 25\lambda))}{e(4\alpha + 3\overline{\lambda})^2(16e^2 + 31e\lambda + 15\lambda^2)} + \frac{(8\alpha\overline{\lambda} + 3\overline{\lambda}^2)(60e^3 + 63\alpha\lambda^2 + 6e\lambda(28\alpha + 3\lambda) + e^2(112\alpha + 75\lambda))}{e(4\alpha + 3\overline{\lambda})^2(16e^2 + 31e\lambda + 15\lambda^2)}$$

and $\gamma_1 < \gamma_2$.

Proof of Proposition 3

When $\gamma > \gamma_2$, area 2 and area 3 in figure 3 disappear. It's possible that GI emerges in equilibrium (it was dominated when area 2 and area 3 emerge according to *point(v)* in Appendix 2). The strategy that both producers choose no signal and none of them makes an effort to improve quality emerges in equilibrium if the following conditions are satisfied:

(A6.1) $\pi^1_{n(0)+n(0)} > \pi^1_{GI(0)+GI(0)}$ and $\pi^2_{n(0)+n(0)} > \pi^2_{GI(0)+GI(0)}$;

(A6.2) $\pi^1_{n(0)+n(0)} > \pi^1_{n(1)+n(0)}$ and $\pi^2_{n(0)+n(0)} > \pi^2_{n(0)+n(1)}$.

(A6.1) leads to

$$F > f_3 = \frac{2\alpha}{9\gamma} q_H;$$

(A6.2) leads to

$$F > f_1 = \frac{e}{18} q_H.$$

When $\gamma > \gamma_2$, the strategy that both producers choose GI and none of them makes an effort to improve quality emerges in equilibrium if the following conditions are satisfied:

(A7.1) $\pi^1_{GI(0)+GI(0)} > \pi^1_{n(0)+n(0)}$ and $\pi^2_{GI(0)+GI(0)} > \pi^2_{n(0)+n(0)}$;

(A7.2) $\pi^1_{GI(0)+GI(0)} > \pi^1_{GI(1)+GI(0)}$ and $\pi^2_{GI(0)+GI(0)} > \pi^2_{GI(0)+GI(1)}$.

(A7.1) leads to

$$F < f_3 = \frac{2\alpha}{9\gamma} q_H;$$

(A7.2) leads to

$$F > f_1 = \frac{e}{18} q_H .$$

GI would emerge only if $f_1 < f_3$, which implies $\gamma < \gamma_3 = \frac{4\alpha}{e}$. We cannot rank γ_2 and γ_3. So if $\gamma_2 > \gamma_3$, GI would not emerge, either. So when $\gamma_2 < \gamma < \gamma_3$,

$$F_4 = f_3 = \frac{2\alpha}{9\gamma} q_H .$$

The strategy that both producers choose GI and both of them make an effort to improve quality emerges in equilibrium if the following conditions are satisfied:

(A8.1) $\pi^1_{GI(1)+GI(1)} > \pi^1_{n(1)+n(1)}$ and $\pi^2_{GI(1)+GI(1)} > \pi^2_{n(1)+n(1)}$;

(A8.2) $\pi^1_{GI(1)+GI(1)} > \pi^1_{GI(0)+GI(1)}$ and $\pi^2_{GI(1)+GI(1)} > \pi^2_{GI(1)+GI(0)}$;

(A8.3) $\pi^1_{GI(1)+GI(1)} > \pi^1_{BA(1)+n(1)}$ and $\pi^2_{GI(1)+GI(1)} > \pi^2_{n(1)+BA(1)}$.

(A8.1) leads to

$$F < f_3 = \frac{2\alpha}{9\gamma} q_H ;$$

(A8.2) leads to

$$F < f_1 = \frac{e}{18} q_H ;$$

(A8.3) leads to

$$\alpha < \alpha_1 = \frac{3\bar{\lambda}}{4} .$$

When $\gamma < \gamma_3$, we have $f_1 < f_3$, so

$$F_5 = f_1 = \frac{e}{18} q_H .$$

When $\alpha > \alpha_1$, F_6 is the border between area 5 and the strategy that both producers make an effort and one of them uses BA:

$$F_6 = \frac{8\alpha^2(4e+5\alpha)+(16\alpha\bar{\lambda}+6\bar{\lambda}^2)(3e+4\alpha)}{9(2+\gamma)(4\alpha+3\bar{\lambda})^2}.$$

$F_6 < F_4$ only when $\gamma > \gamma_4 = \dfrac{2\alpha(4\alpha+3\bar{\lambda})^2}{4\alpha^2(4e+\alpha)+(8\alpha\bar{\lambda}+3\bar{\lambda}^2)(3e+\alpha)}$, where $\gamma_4 < \gamma_3$.

Proof of Proposition 4

When $\gamma > \max\{\gamma_2, \gamma_3\}$, we have $f_1 > f_3$ so the strategy that both producers choose GI and make no effort does not emerge; that is, area 5 in figure 4 disappears. Both producers choose no signal and both of them make an effort to improve quality if the following conditions are satisfied:

(A9.1) $\pi^1_{n(1)+n(1)} > \pi^1_{GI(1)+GI(1)}$ and $\pi^2_{n(1)+n(1)} > \pi^2_{GI(1)+GI(1)}$;

(A9.2) $\pi^1_{n(1)+n(1)} > \pi^1_{n(0)+n(1)}$ and $\pi^2_{n(1)+n(1)} > \pi^2_{n(1)+n(0)}$;

(A9.3) $\pi^1_{n(1)+n(1)} > \pi^1_{BA(1)+n(1)}$ and $\pi^2_{n(1)+n(1)} > \pi^2_{n(1)+BA(1)}$.

(A9.1) leads to

$$F > f_3 = \frac{2\alpha}{9\gamma} q_H;$$

(A9.2) leads to

$$F < f_1 = \frac{e}{18} q_H;$$

(A9.3) leads to

$$F > f_2 = \frac{\alpha(36\alpha^2+56\alpha\bar{\lambda}+21\bar{\lambda}^2)}{9\gamma(4\alpha+3\bar{\lambda})^2} q_H.$$

So, in figure 5,

$$F_7 = f_1 = \frac{e}{18} q_H ;$$

$$F_8 = f_3 = \frac{2\alpha}{9\gamma} q_H ;$$

$$F_9 = f_2 = \frac{\alpha(36\alpha^2 + 56\alpha\bar{\lambda} + 21\bar{\lambda}^2)}{9\gamma(4\alpha + 3\bar{\lambda})^2} q_H .$$

$F_9 < F_7$ only when $\gamma > \gamma_5 = \dfrac{2\alpha(36\alpha^2 + 56\alpha\bar{\lambda} + 21\bar{\lambda}^2)}{e(4\alpha + 3\bar{\lambda})^2}$, where $\gamma_5 > \gamma_3$.

Appendix 2

The following strategies are dominated:

(i) Both producers choose no signal, and one of them chooses to make an effort.

(ii) Both producers choose GI, and one of them chooses to make an effort.

(iii) Both producers choose BA.

(iv) The strategy in which one producer chooses BA and makes no effort and the other producer makes no signal and makes an effort is dominated in equilibrium.

(v) The strategy in which both producers choose GI and make no effort is dominated by the strategy in which one producer chooses BA and makes no effort and the other producer chooses no signal and no effort if the latter strategy emerges (the emergence of the latter strategy depends on the values of the parameters).

(vi) The strategy in which both producers choose GI and make an effort is dominated by the strategy in which one producer chooses BA and the other producer chooses no signal and both producers make an effort when

$$\alpha > \alpha_1 = \frac{3\overline{\lambda}}{4}.$$

(vii) The strategies in which both producers choose GI and make an effort, or both producers choose no signal but make an effort are dominated by the strategy in which one of them could choose BA and make an effort and the other producer chooses no signal and makes no effort if the latter strategy emerges.

(viii) One producer chooses the combination of GI and BA; another producer chooses GI alone; and both of the producers choose the combination of GI and BA.

Proof of Points (i) and (ii)

The strategy in which both producers use no signal, producer 1 makes an effort, and producer 2 makes no effort is not dominated when the following conditions are satisfied. Producer 1 does not deviate to make no effort and producer 2 does not deviate to make an effort. That is,

(B1.1) $$\pi^1_{n(1)+n(0)} > \pi^1_{n(0)+n(0)}$$

(B1.2) $$\pi^2_{n(1)+n(0)} > \pi^2_{n(1)+n(1)}.$$

(B1.1) is satisfied by $F < \frac{e}{18} q_H$ and (B1.2) is satisfied by $F > \frac{e}{18} q_H$; these two cannot be satisfied at the same time, so the strategy is dominated in equilibrium. Similar proof applies to point *(ii)*.

Proof of Point (iii)

$\pi^i_{BA(1)+BA(1)} = \frac{(\bar{\lambda}+\alpha)+(\lambda+e)}{9} q_H - A - F$, which is always less than

$\pi^i_{GI(1)+GI(1)} = \frac{(\bar{\lambda}+\alpha)+(\lambda+e)}{9} q_H - \frac{A}{2} - F$, *i*=1,2. So the producers would rather choose GI and make an effort to achieve the same profit with a lower cost.

Proof of Point (iv)

The case in which producer 1 chooses BA and makes no effort and producer 2 makes no signal but makes an effort is not dominated when the following necessary conditions are satisfied: producer 1 does not deviate to make an effort and producer 2 does not deviate to make no effort. That is, (B2.1) $$\pi^1_{BA(0)+n(1)} > \pi^1_{BA(1)+n(1)}\,,$$

(B2.2) $$\pi^2_{BA(0)+n(1)} > \pi^2_{BA(0)+n(0)}\,.$$

(B2.1) is satisfied by F> $f_6 = \frac{e(16e^2 + 31e\lambda + 15\lambda^2)}{9(4e+3\lambda)^2} q_H$ and (B2.2) is satisfied by

F< $f_8 = \frac{e^2 + e\lambda}{4e+3\lambda} q_H$, but $f_6 - f_8 = -\frac{4e(5e^2 + 8e\lambda + 3\lambda^2)}{9(4e+3\lambda)^2} q_H$ <0, so the necessary

conditions cannot be satisfied.

Proof of Point (v)

The strategy in which producer 1 chooses GI and makes no effort is not dominated when the following necessary conditions are satisfied: producer 1 does not deviate to make no signal and make no effort, and producer 1 does not deviate to choose BA alone. That is,

(B3.1) $$\pi^1_{GI(0)+GI(0)} > \pi^1_{n(0)+n(0)}\,,$$

(B3.2) $$\pi^1_{GI(0)+GI(0)} > \pi^1_{BA(0)+n(0)}\,.$$

(B3.1) is satisfied by $F < f_3 = \frac{2\alpha}{9\gamma} q_H$, and (B3.2) is satisfied by

F> $f_5 = \frac{8\alpha(5\alpha^2 + 8\alpha\bar{\lambda} + 3\bar{\lambda}^2)}{9\gamma(4\alpha+3\bar{\lambda})^2} q_H$, but $f_3 < f_5$, which cannot satisfied.

Proof of Point (vi)

The case in which producer 1 chooses BA and makes an effort and producer 2 makes no signal but makes an effort is not dominated when the following necessary conditions are satisfied: producer 1 does not deviate to choose GI and make an effort and producer 2 does not deviate to choose GI and make an effort. That is, (B4.1) $$\pi^{1}_{BA(1)+n(1)} > \pi^{1}_{GI(1)+GI(1)}$$

(B4.2) $$\pi^{2}_{BA(1)+n(1)} > \pi^{2}_{GI(1)+GI(1)}.$$

(B4.1) is satisfied by $F < f_5 = \frac{8\alpha(5\alpha^2 + 8\alpha\overline{\lambda} + 3\overline{\lambda}^2)}{9\gamma(4\alpha + 3\overline{\lambda})^2} q_H$ and (B4.2) is satisfied by

$F > f_9 = \frac{2}{\gamma}\left(\frac{\overline{\lambda} + \alpha}{9} - \frac{\overline{\lambda}(\overline{\lambda} + \alpha)^2}{(3\overline{\lambda} + 4\alpha)^2}\right) q_H$. When $f_4 < f_9$ (which indicates $\alpha > \alpha_1 = \frac{3\overline{\lambda}}{4}$), the strategy in which producer 1 chooses BA and makes an effort and producer 2 makes no signal but makes an effort is not dominated, but the strategy in which both choose GI and make an effort is dominated. When $f_4 > f_5$ (which indicates $\alpha < \alpha_1 = \frac{3\overline{\lambda}}{4}$), the strategy that producer 1 chooses BA and makes an effort and producer 2 makes no signal but makes an effort is dominated, but the strategy in which both choose GI and make an effort is not dominated.

Proof of Point (vii)

Both producers choose GI and make an effort when the following necessary conditions are satisfied: producers do not deviate to make no effort and one of the producers does not deviate to choose BA and make an effort conditional on the other producer choose no signal and make no effort. That is:

(B5.1) $$\pi^{1}_{GI(1)+GI(1)} > \pi^{1}_{BA(1)+n(0)}$$

(B5.2) $$\pi^{1}_{GI(1)+GI(1)} > \pi^{1}_{GI(0)+GI(1)}.$$

(B5.1) is satisfied by

$F > f_{10} = \frac{2}{\gamma}\left(\frac{(\overline{\lambda} + \alpha)(\overline{\lambda} + 2\alpha)^2}{(3\overline{\lambda} + 4\alpha)^2} - \frac{\overline{\lambda} + \alpha}{9} + \frac{(\lambda + e)(\lambda + 2e)^2}{(3\lambda + 4e)^2} - \frac{\lambda + e}{9}\right) q_H$ and (A7.2) is satisfied by $F < f_1 = \frac{e}{18} q_H$. But

$$f_{10} - f_1 = \frac{16e^3(5-\gamma) + 45\alpha\lambda^2 + 8e^2(10\alpha + (16-3\gamma)\lambda) + 3e\lambda(40\alpha + (16-3\gamma)\lambda)}{18(3\lambda + 4e)^2} q_H > 0.$$

So the necessary conditions cannot be satisfied. Similar proof could apply to the case that both producers make no signal but make an effort.

Proof of Point (viii)

The necessary condition for producer 1 to choose the combination of GI and BA as the marketing strategy if it has no incentive to deviate to do BA alone, which means:

(B6.1) $$\pi^1_{GIBA(0)+GI(0)} > \pi^1_{BA(0)+n(0)}.$$

The condition above leads to the frontier below whereby the strategies in which one producer chooses the combination of GI and BA and another producer chooses GI alone will emerge in equilibrium.

$$f_{11} = \frac{2}{\gamma}\left(\frac{(\bar{\lambda} + c\alpha)((2c-1)\alpha + \bar{\lambda})^2}{((4c-1)\alpha + 3\bar{\lambda})^2} - \frac{(\bar{\lambda} + \alpha)(2\alpha + \bar{\lambda})^2}{(4\alpha + 3\bar{\lambda})^2}\right) q_H.$$

When this frontier is below the horizontal axis in figure 3 of the main text, the strategy that one producer chooses the combination of GI and BA, the other producer chooses GI alone, and none of them makes an effort is dominated by the strategy that one producer chooses BA, the other producer makes no signal, and none of them makes an effort. That is, f_{11}<0, which generates c< $c_{11} \approx \frac{32\alpha^4 + 24\alpha^3\bar{\lambda} - 19\alpha^2\bar{\lambda}^2 - 14\alpha\bar{\lambda}^3 - 14\alpha\bar{\lambda}^3}{3(16\alpha^4 + 24\alpha^3\bar{\lambda} + 9\alpha^2\bar{\lambda}^2)}$. The exact value of c_{11} is rather complex. The expression above gives the approximate value by ignoring the smaller order of this value. Similarly, the strategy in which both producers choose the combination of GI and BA is dominated by the one in which both of the producers choose GI in equilibrium when *c<1*. Then,

$$c_1 = \min\{1, \frac{32\alpha^4 + 24\alpha^3\overline{\lambda} - 19\alpha^2\overline{\lambda}^2 - 14\alpha\overline{\lambda}^3 - 14\alpha\overline{\lambda}^3}{3(16\alpha^4 + 24\alpha^3\overline{\lambda} + 9\alpha^2\overline{\lambda}^2)}\}$$

CHAPTER 4. DISCOUNTING SPOTTED APPLES: INVESTIGATING CONSUMERS' WILLINGNESS TO ACCEPT COSMETIC DAMAGE IN AN ORGANIC PRODUCT

Abstract

The appearance of organic produce is often less than perfect because of limited methods of avoiding plant diseases. We use an experimental auction to investigate how cosmetic damage affects consumers' willingness to pay for organic apples. We find that 75% of the participants are willing to pay more for organic than for conventional apples given identical appearance. However, at the first sight of any imperfection in the appearance of the organic apples, this segment is significantly reduced. Furthermore, we find that cosmetic damage has a larger impact on the willingness to pay for organic apples than for conventional apples.

Key words: appearance, apples, experimental auctions, organic, willingness to pay

Introduction

Until recently, fresh food products such as apples were provided to markets as generic products. Today, such products are differentiated by brand, variety, origin, and appearance, as well as by the companies' production and processing methods. Consumers are often willing to pay large price premiums for products with the right attributes. As a result, product quality and differentiation have become increasingly important to the producer.

Empirical estimates of price variation due to quality factors date back at least to Waugh's seminal study of quality factors affecting vegetable prices (Waugh, 1928). One of the most important quality factors is appearance. Appearance includes the intrinsic attributes of color, texture, size, uniformity and other visible differences. Several recent studies consider how appearance affects consumers' preference for food products; see Acebron and Dopico (2000) for beef; Alfnes et al. (2006) for salmon; and Wei et al. (2003) for mandarin oranges. Credence attributes (Darby and Karni, 1973) are other quality factors valued by consumers. For fruits, organic production method is a credence attribute since consumers cannot identify a product's method of production through their normal use of the product but have to trust the labeling.

Most previous studies investigating consumer preference for organic foods assume that the organic products are similar in appearance to their conventionally produced counterparts (Blend and van Ravenswaay, 1999; Loureiro, McCluskey, and Mittlehammer, 2001; and Larue et al*.,* 2004). Studies that focus on the effect of cosmetic problems find that consumers discount products with cosmetic damage. In a retail setting, Thompson and Kidwell (1998) found that the more cosmetic defects there were in organic produce, the less likely were shoppers to buy the organic produce. Experimental-based results from Roosen et al. (1998) show that if cosmetic attributes are the same, consumers tend to pay a positive premium for nonuse of pesticides. However, if the nonuse of pesticides results in products with reduced cosmetic quality, fewer consumers prefer nonuse of pesticides. Baker (1999) conducted a survey involving consumer preferences for food safety attributes in fresh apples (specifically, reduced or no pesticide use) and took account of the damage level on red delicious apples using pictures. Using clustering techniques, he found that cosmetic damage was most important to consumers with higher income. The three studies all find a positive effect from organic production (or nonuse of pesticides) and a negative effect of cosmetic damage. However, less well understood is the nature of the trade-off—whether the measured response to damage is sensitive to the production method, and what the effect is of underlying consumer attitudes about production method, environmental issues, and other quality attributes.

In this paper, we use a fourth-price sealed-bid auction to elicit consumer willingness to pay (WTP) for organic and conventional apples with different levels of blemish. In contrast to the consumer studies discussed earlier, we use an experimental design that allows not only the estimation of the main effects of production method and cosmetic damage but also the interaction effects between the two. What is new to the experimental auction mechanism used here is the individual drawing of a binding alternative. This allows us to combine the positive features of the incentive-compatible fourth-price auction with another feature imperative in a WTP study of products that are heterogeneous in so many ways, such as apples: the products the participants evaluated were the exact same products they would buy. The individual drawing of a binding alternative ensured that there was never more than one buyer of each alternative.

A principal component factor analysis and random effect models are used in the analysis of how the WTP for apples is affected by quality attributes (conventional versus organic production methods, degree of blemish, and their interaction), as well as interactions among consumers' stated attitudes toward specific quality attributes (food safety concern, environmental concern, tolerance of pesticides, etc.), production method, degree of blemish, and consumers' socio-demographic characteristics. Specifically, we investigate the premium for organic apples, the discount for various levels of cosmetic damage, how cosmetic damage affects consumers' WTP for both organic and conventional apples, and how attitude and socio-demographic variables affect these premiums.

Market Experiment

The experiment had a within-subject design with two production methods (organic and conventional), four appearance levels (degrees of blemish), and two elicitation methods (hypothetical and real auctions). In addition, we collected numerous socio-demographic and attitude measures.

Products

The products used for this experiment were 3-pound bags of golden delicious apples. Apples were obtained from commercial sources and from university farm orchards. Prior to the experiment, the apples were sorted according to their production method and appearance. The production methods included both conventional and organic methods. For the appearance, the apples were then sorted by the level of surface blotches (cosmetic damage). The blotches were caused by plant diseases and syndromes, namely, sooty blotch fungi and russeting, that led to changes that were strictly cosmetic and presented no harm to humans or to the taste of apples.

The conventional apples were sorted into four grades: SpotA apples were those without blotches; SpotB apples were those with about 3% blotch coverage; SpotC apples were those with about 5% blotch coverage; and SpotD were those with about 9% blotch coverage. The classification of apples was done with assistance from staff with training in plant pathology. Because of the lack of variation in their appearance, the organic apples were only sorted into two grades: SpotA, apples without blotches; and SpotB, apples with 3% blotch coverage. All of the sorted apples were packed into clear bags. We will, hereafter, refer to organic SpotA apples as Organic A, and conventional SpotA as Conventional A, and so on.

In the experiment, 12 bags of apples were placed on a large table for visual inspection. The apples were labeled as organic or conventional but were not labeled with the appearance grade. Instead, participants examined the appearance of the apples and made bids based on their own observations. Each alternative in the experiment had one specific bag of apples, and several of the alternatives had the same characteristics with respect to production method and cosmetic damage. Except for the aforementioned heterogeneous appearance, each bag contained apples that were as homogeneous as possible in other characteristics, such as number, size, and weight.

We also ran treatments in which we used pictures of apples. The apples in the pictures were 3-pound piles, sorted by appearance. In the picture treatments, we had four levels of cosmetic damage for both the organic and the conventional apples.

Experimental Procedure

We conducted fourth-price sealed-bid auctions with simultaneous bidding on 12 alternatives. A fourth-price sealed-bid auction is an auction in which the bidders submit sealed bids and the price is set equal to the fourth-highest bid; the winners are those who have bid more than the price. Vickrey (1961) showed that, in such an auction in which the price equals the first-rejected bid, it is a weakly dominant strategy for people to bid their true WTP for the offered goods. People have an incentive to truthfully reveal their private preferences because the auction separates what they say from what they pay. Consumers who underbid risk foregoing a profitable purchase, whereas consumers who overbid risk making an unprofitable purchase. In the last 15 years, experimental auctions have been used to elicit WTP for a wide variety of food quality attributes (see, e.g., Alfnes and Rickertsen, 2003; Lusk, Feldkamp, and Schroeder, 2004; Lusk et al., 2004; Melton et al., 1996; Roosen et al., 1998; Rozan, Stenger, and Willinger, 2004; Umberger and Feuz, 2004).

Recently, several studies have used a uniform *n*th price auction such as ours to elicit WTP for food quality characteristics. See, for example, Umberger and Feuz (2004) for an application of a fourth-price sealed-bid auction, and Lusk et al. (2004) for an application of a fifth-price sealed-bid auction. Compared with the frequently used second-price auction, the fourth-price and other uniform *n*th price auctions have several benefits. First, if there are multiple winners, a winning position does not lead to an exclusive winner and any auction-winning utilities not associated with the product are reduced. Second, in a fourth-price auction with seven or more participants there is a smaller difference between the median participant's valuation of the product and the price. Therefore, a bid that differs from a participant's WTP is more likely to have real economic consequences. Third, with repeated trials, extreme outliers are less likely to affect the price information that the participants receive during the multi-trial experiments.

After the auction, each participant randomly drew his or her exclusive binding alternative. The drawing was done without replacement; only one participant could draw each of the alternatives as his or her binding alternative. For this to be possible, the number of alternatives had to be higher than or equal to the number of participants in each session. The price of an alternative was equal to the fourth-highest bid for that alternative. If the participants had bid more than the price for their binding alternative they had to buy the alternative. This winning restriction allowed us to combine the attractive features of the uniform-price auction (discussed earlier) with another feature that we felt was imperative in a WTP study of appearance of a heterogeneous product such as apples: the products they evaluated were the exact same products they would buy.

At the beginning of each session, the participants were given a folder containing US$20, a consent document, and a questionnaire. There were a total of eight sessions. In six of the eight sessions, we first conducted a hypothetical auction in which the apples were represented by pictures. We asked participants to examine carefully the apples in the pictures before they made their hypothetical bids. After the hypothetical auctions, we replaced the pictures with actual apples and ran one trial with a non-hypothetical auction. In the last two sessions, we did not run a hypothetical auction. Instead, we ran two trials with real auctions.[1] To avoid income and substitution effects, we randomly drew which of the two real auction trials was to be binding and then drew individual binding products. [2]

The participants walked around the table and placed their bids on their bidding forms as they studied each alternative. The participants were not allowed to communicate with each other during the bidding process. To reduce any systematic ordering effects, the participants could start at any of the 12 alternatives on the table. In the picture treatments, we had three pictures from each of the four categories of cosmetic appearance. Half of the pictures were labeled as organic. In the second half of the sessions, the other half of the pictures were labeled as organic. Thus, all the pictures were labeled as organic in half of the sessions and as conventional in the other half. This was done to reduce any unforeseen effects from small differences in the pictures. When using real products (actual apples) we had only SpotA and SpotB organic apples but we had all four categories of conventional apples.

Experimental Subjects

The experiment was conducted at a large midwestern university in 2005. The participants were recruited by e-mail notice and advertisement in newsletters on campus. The e-mail recruitment of participants went to faculty and staff through solicitations to college-level and university units (e.g., departments, physical plant) in order to make the recruitment pool as broadly representative of the local area and state population as possible. We restricted the pool to limit participation of graduate students and did not solicit undergraduate students. The recruitment letter indicated that participants would be asked about their market decisions on apple purchases, but nothing was said about appearance or organic production.

Seventy-four people participated in the experiment, 33% male and 67% female. The ages ranged from 20 to 70 years old, with 27% in the age 20-29 category, 30% age 30-39, 14% age 40-49, 20% age 50-59, and 9% age 60 and older. The age distribution was similar to the state average (in 2000, of the share of the state's population age 20 to 65, there were 47% in the 20-39 age range compared to the sample of 57% in this range; the state had a relatively larger share of the population in their forties). The subjects' average household income was $49,220 with a standard deviation of $30,520.[3] The median income was $42,500. This compared to the state's median household income in 1999 of $40,442. Among the participants, 17% did not have a college diploma, 11% had a college diploma, 22% had some graduate school education, and 50% had a graduate degree. The recruited sample had higher average education levels than the state average.

Random Effect Model

We use three sets of variables to explain the variation in WTP. First is the variation in the product quality attributes. Second is the variation in socio-demographics and consumers' attitudes. Third is the variation in the experiment. Based on this, we specify the following econometric model to explain the consumers' WTP for the apples:

$$WTP_{ij} = \alpha\, x_j + \beta\, y_{ij} + \gamma\, z_j + \eta_i + \varepsilon_{ij} \tag{1}$$

where WTP_{ij} is individual *i*'s bid for product *j*; x_j is a vector of product quality attributes for product *j*, including *Organic*, *Spot,* and *OrgSpot*; *Organic* is a dummy that is one if the product is organic, and zero otherwise; *Spot* is defined as a continuous variable measuring the percentage of spot coverage;[4] *OrgSpot* measures the interaction effect between the two previous product attributes; y_{ij} is a vector of interaction effects between the socio-demographics and consumers' attitudes for individual *i* and the product quality attributes *Organic* and *Spot* for product *j*; z_j is a vector of design variables including *Picture*, *OrgPicture,* and *SpotPicture* where *Picture* is a dummy that is one for the pictures and zero for the real apples, *OrgPicture* is the interaction between *Organic* and *Picture,* and *SpotPicture* is the interaction between *Spot* and *Picture* ; and η_i is the random individual effect for the *i*th participants that captures the correlation between the bids made by the same participant. The measure η_i is assumed to follow a normal distribution with mean zero and standard deviation σ_η.

Results

Table 1 shows the descriptive statistics for the bids divided into two production methods (organic and conventional), four appearance levels (SpotA, SpotB, SpotC, and Spot D), and two elicitation methods (hypothetical and real auctions). There are several things that we can see directly from Table 1. First, on average, consumers are willing to pay more for organic apples than for conventional apples with the same appearance. Second, consumers on average are willing to pay more for apples with no or little cosmetic damage than for apples with more cosmetic damage. Third, consumers state higher WTP on average for all alternatives in the hypothetical auctions than in the real auction. Fourth, there are almost no zero bids for the perfect apples; in fact, none of the participants bid zero for all the apples. This indicates that the participants were willing to buy apples in the auction and that the zero bids for the spotted apples can be interpreted as zero WTP for these apples.[5] Fifth, the mean bids are below standard market prices. USDA data show the average price of fresh apples is $0.83 per pound in 1999 (Reed, Frazão, and Itskowitz, 2004), or $0.96 per pound when adjusted to 2004 apple price levels. The $0.96 price per pound would be $2.89 for three pounds. Our results are therefore likely to give conservative estimates of the WTP differences.

One of the initial tasks was to identify and develop measures of consumer attitudes and preferences based on the survey questions. In addition to direct responses to questions, several consumer attitudes toward quality attributes were measured as composite constructs based on the participants' degree of agreement with selected statements. The selection and ranking of the questions included in the composites were done by principal component factor analysis. To measure consumers' sensitivity to price (*Price*) we asked the participants if they agreed or did not agree with four statements about the trade-off between quality and price using a five-point Likert scale. For instance, one statement read, "I usually buy the lowest priced products." Consumers with a larger value of the index *Price* tend to be more sensitive to price of products. Other composites included consumers' concern with the environment (*Envir*), consumers' tolerance of pesticides (*Pest*), and consumers' attitude toward appearance of apples (*Appear*). Consumers with a larger value of the index *Envir* were more concerned about the environment and held stronger beliefs about the idea that organic production can improve the environment. The measure of consumers' tolerance of pesticides (*Pest*) was based on two statements concerning the safety of and restriction on pesticides. Consumers with a larger *Pest* index value were less tolerant of pesticides. The index on appearance of apples (*Appear*) is a construct based on consumers' concern about the importance of apple color, shape, texture, and size. Consumers with a larger value of *Appear* expressed more concerned about the appearance of apples. Principal component factor analysis indicated these composite constructs were uni-dimensional (all had alpha reliability of 0.6 or higher) (Cronbach, 1951).

Other measures of consumer attitudes are based on single statements. They include attitudes toward food safety (*Safe*), taste (*Taste*), and nutrition (*Nutrition*) of apples. Consumers with a larger value of each of these indexes were more concerned about the respective attributes. It is important to note that all of these measures of consumer attitudes are based on stated preferences, whereas the auctions elicit revealed preferences. The definitions of all the variables used in the segmentation are shown in Table 2.

Figure 1 shows the cumulative distribution of the difference in WTP between Organic A and Conventional A (OA-CA), and Organic B and Conventional A (OB-CA). OA-CA is calculated by subtracting the individual participant's mean bid for Conventional A from the same participant's mean bid on Organic A. Similarly, OB-CA is calculated by subtracting the individual participant's mean bid for Conventional A from the same participant's mean bid on Organic B.

From Figure 1, we can see that 19 (25%) of the participants bid higher for the Conventional A apples than the organic apples with the same appearance. This indicates that these consumers think that there is a negative value associated with organic production. Of the 55 (75%) participants bidding more for the Organic A than the Conventional A, 18 (24%) bid more than 50¢ more, eight (11%) bid more than $1 more, and two (3%) bid more than $2 more for the organic apples.

Comparing Organic B with Conventional A, we can see that of the 55 participants preferring the organic apples when they had the same appearance, now only 21 (28% of the total sample) still prefer the organic apples. This drastic decline in the group preferring the organic apples indicates that the appearance is very important for many consumers.

Table 3 includes information about the socio-demographic and attitude variables across the three consumer groups indicated by Figure 1. Group 1 prefers conventional to organic (Bid Conventional A > Bid Organic A), group 2 prefers organic but only if the appearance is as good as for the conventional (Bid Organic A > Bid Conventional A > Bid Organic B), and group 3 prefers the organic even when the appearance is lower than that of the conventional (Bid Organic B> Bid Conventional A). We can see that the participants in group 1 tend to be younger than those in other groups and they are less concerned about the food safety–related attributes such as environment, pesticides, food safety and so on. And they are the group that has the lowest income level and is most concerned about price; that is, they are the group with the highest sensitivity to price. The consumers in group 2 care more about appearance than do the other groups. They are almost neutral to environment and pesticides. In contrast, those in group 3 value the food safety–related attributes and taste the most, and they value appearance and price the least. Those in group 3 have the highest income and education levels, and they are the oldest compared with the other two groups.

To see if these groups differ significantly in the socio-demographics and attitudes, MANOVA and the Wilk's Λ^* test are used (Johnson and Wichern, 2002). ANOVA is employed to test if the groups differ in each of the variables. The P-values of the tests are listed in Table 3. The Wilk's Λ^* test statistic when including all the variables is 0.66, and the corresponding P-value is 0.20. So the null hypothesis that the mean vectors are the same across the groups cannot be rejected at the 5% significance level. The P-value of the Wilk's Λ^* test statistic obtained by including only the socio-demographic variables is 0.51, so the null hypothesis that the groups are the same in socio-demographic variables cannot be rejected at the 5% significance level. However, the ANOVA results show that the three groups differ in income at the 5% significance level. The P-value of the Wilk's Λ^* test statistic when including only the attitude variables is 0.04, so the null hypothesis that the groups are the same in their attitudes toward food safety–related quality attributes, price, appearance, taste, and nutrition is rejected at the 5% significance level. We find that the three groups differ in attitudes at the 5% level of significance. Thus, from the ANOVA results we conclude that the three groups differ mainly in their attitudes toward price, environment, appearance, and taste, and by their income levels.

It is useful to compare our results with those of Roosen et al. (1998); the two studies were done 10 years apart and both were conducted in the state of Iowa. Although the two studies differ in many aspects, they address a similar valuation problem. In the Roosen *et al.* study, 38% of the participants had a high degree of concern about pesticide use, and of these, 76% preferred stricter pesticides regulations. In our study, 42% of the participants were (very) concerned about pesticide use; of these, 88% think stricter pesticide regulations should be set. Furthermore, Roosen et al. find that 35% of participants consistently bid zero for all potential upgrades from conventional apples to apples produced with no pesticides. In contrast, in our study, 25% of the participants bid less for the Organic A than for the Conventional A.

The Random Effect Models

We estimated three random effects models. All three models include the product attribute and experimental design variables. In addition, Model 1 includes socio-demographic interaction effects, Model 2 includes attitude interaction effects, and Model 3 includes both socio-demographic and attitude interaction effects. We estimated the three models to check the robustness of the estimation and to avoid any identification problems.[6] The models include only the interaction effects of the socio-demographic and/or attitude variables with *Organic* and *Spot*; the effects of the socio-demographic and/or attitude variables alone have been largely captured by the individual random effect.[7] The results from the three models are quite similar, which indicates that the estimates are robust toward small changes in the model specification.

Maximum likelihood was used to estimate the parameters in equation (1). To simplify the interpretation of the parameters associated with the quality attributes, the variables that interact with them are standardized with a mean of zero and a standard deviation of one. The standardization is done by subtracting the respective variable's mean and dividing by its standard deviation. The estimated parameters from the random effects models are shown in Table 4.

From Table 4 we can see that the apple quality attributes (organic and spot) affect the consumers' WTP for apples and the results are statistically significant. The three models get almost identical results for the main effects. Also, the constant, which can be interpreted as the average bid for 3 pounds of conventional apples without any spots, is very similar among the three models: about $1.74. The production method affects consumer WTP significantly. Consumers are willing to pay more for organic apples than for conventional apples: the premium for organic apples without any spots is about $0.35 per 3 pounds ($0.12/pound). However, the interaction between organic production and cosmetic damage (level of spots) is statistically significant: the premium for organic production decreases $0.04 per 3-pound bag when the level of spot damage increases by 1%. Taking account of the combined direct and indirect effects, the consumer WTP decreases by $0.14 per 3-pound bag when the level of spot damage for conventional apples increases by 1%. For organic apples, when the level of spot damage increases by 1%, the consumer WTP decreases by $0.18. The difference in the discount between the two production methods is statistically significant.

Figure 2 summarizes the consumer WTP for 3 pounds of organic apples and conventional apples with different levels of spots used in our experiment. Note that consumers' WTP for Organic B apples is less than that for Conventional A apples; consumers' WTP for Organic D apples is less than that for Conventional C apples. We can conclude that consumers make a trade-off between production method and the blemish level of the apples. Even though, in general, consumers are willing to pay more for organic apples, when there are "too many" blemishes on the organic apples, consumers prefer to buy conventional apples. An extrapolation of the numbers shown in Figure 2 to apples with even more spots than the amounts on Spot D apples (9%) shows that consumers would not be willing to pay for such apples regardless of the production method.

As shown in Table 4, the interactions between the socio-demographic variables or attitude variables and the production methods or damage levels show some statistically significant interaction effects. Model 1 and Model 3 indicate that the interaction effect between income and organic production methods is positive and significant. Those who have higher income are willing to pay a higher price premium than those who have a lower income level. Other interactions with the production method are not statistically significant.

Model 1 and Model 3 show that two of the socio-demographic interactions with the spot damage are statistically significant. The interaction effect between gender and spot damage is negative and significant at the 5% significance level; females are more reluctant to buy apples with spots. One possible explanation for this might be that females show more concern about the aesthetics of food than do men. Or, perhaps more time and experience in grocery shopping on average (Hamrick and Shelley, 2005) contribute to females' lower bids for apples with more spots. The significant interaction effect between education level and spot level in Model 1 indicates that those with higher education levels are more willing to buy apples with spots.

Model 2 and Model 3 show that several of the interaction effects between organic production methods and attitude variables are significant. Those who are less sensitive to price (*PriceOrg*) and consumers with greater concerns about the environment (*EnvirOrg*) are willing to pay a higher price premium for organic products compared to others. Positive interaction with environmental concerns suggests positive association between organic production methods and environmental interests in the minds of consumers. In addition, consumers' concern about food safety is also positively associated with organic production (*SafeOrg*). Those who are more concerned about food safety are willing to pay a higher premium for organic apples than those who are less concerned with food safety, a result that suggests that consumers think organic products are safer than conventional products. Finally, those who are more concerned with taste (*TasteOrg*) are willing to pay a higher premium for organic product. In summary, willingness to pay more for organic products is enhanced by consumers' being less sensitive to price, more concerned with the environment, more concerned with the safety of food products, and their having high levels of interest in the "tastiness" of food products.

These results are consistent with previous studies showing that consumers associate organic production methods with a reduced health risk and may chose to reduce the risk from pesticide residues by switching to organically grown products (Williams and Hammitt, 2001; Magnusson and Cranfield, 2005). Recent survey evidence shows that consumers purchase organic foods because they perceive the foods to be fresh (68.3%), better for health, and a better source of nutrition (67.1%) (Whole Foods Market, 2005). Over 70% (70.3%) of those surveyed said they bought organic food or beverages in order to avoid pesticides.

The interaction effects between spot level and attitude constructs are less strong, though similar between Models 2 and 3. The interaction effect between concerns about appearance and spot damage (*AppearSpot*) is negative and statistically significant for Model 2 and Model 3. Those who are more concerned with appearance place a higher discount for apples with increased levels of spot damage.

Controlling for the experimental design was important. The variable *Picture* is highly significant in all three models. Relative to the average bid of $1.74 for a 3-pound bag of conventional apples without spots, participants bid about one dollar more for apples presented in pictures than for real apples. In this respect, our results are in line with the large literature on hypothetical bias in valuation studies. Because the participants did not need to pay the price they bid to buy the product when presented with pictures, they tended to overbid for pictures compared to the cases where they were presented with real products and faced the chance they would need to pay out of pocket for the real product.[8] The interaction effect between *Organic* and *Picture* (*PictureOrg*) is positive and significant in Model 2 and the interaction effect between *Spot* and *Picture* (*PictureSpot*) is negative and significant in all three models, which indicates that the hypothetical bias is not fixed with the changes in WTP. Actually, from Table 1 we get similar results. Hypothetical bias seems to be proportional to WTP. If we divide the sum of the mean WTP for apples shown in a picture by the sum of the mean WTP for real apples, we find that the WTP in the hypothetical auction is 1.6 times that of the real auction.

Both $\hat{\sigma}_\eta$ and $\hat{\sigma}_\varepsilon$ are significant. A likelihood ratio test was conducted concerning the individual random effect (null hypothesis: σ_η=0). The test statistic had values of 290 for Model 1, 295 for Model 2, and 299 for Model 3. All of the corresponding P-values were < 0.001 and the null hypothesis was rejected for each model. That is, the individual random effects cannot be ignored and need to be included in order to estimate the results accurately. The $\hat{\rho}$ value for the models was 0.37. This parameter measures the correlation between the bids on different apples by the same participants.

Conclusions

Consumers want environmental friendly production methods, but they do not want the natural consequences of the environmental friendly production: the blemished appearance of products. This result is of course very troublesome for organic producers. Organic producers are less able to avoid problems with cosmetic appearance and they are hit harder in the retail market if they produce less-than-perfect apples. At first this result is somewhat surprising, given that previous studies have shown that the majority of consumers say they buy organic products to avoid pesticides. However, since the consumers are willing to pay more for perfect organic apples than for perfect conventional apples, a percentage discount from cosmetic damage yields a higher dollar value in the discount of organic apples than for the conventional apples.

Of specific interest in this study is the premium that consumers are willing to pay for organic apples and the effect of different levels of cosmetic damage on the premium. We find that the premium for organic apples decreases as the level of spots increases, a result that supports earlier findings of Thompson and Kidwell (1998) and Roosen et al. (1998). Furthermore, our experimental design allows us to estimate interaction effects between production method and cosmetic damage. We find not only that the negative effect from cosmetic damage offsets the positive effect from organic production but also that cosmetic damage leads to discounting the premium for organic production. Consumers' tolerance of cosmetic damage on apples is limited. Even at relatively low levels of blemishes on the surface of organic apples, consumers preferred perfect-looking conventional apples. The consumers differ with respect to how they rank the importance of appearance. There is a relatively large segment of consumers in the organic market who are willing to accept a small level of cosmetic damage. However, if apple growers try to sell less-than-perfect organic apples at a price that is significantly above the going price of conventional apples, very few consumers will be willing to buy the organic apples.

This finding suggests the importance of quality attributes connected to cosmetic appearance, as is the case today with the fruit grading system of U.S. Department of Agriculture, Agricultural Marketing Service, and that exists in many private contracts for produce. To a large extent, fresh fruits in U.S. grocery stores have uniform appearance, while the fruits with imperfect appearance often are diverted as processed product such as fruit juice and sauce. Our findings show that even when there is no strict federal grading system, fresh fruits with cosmetic damage have little potential in today's retail market because of consumers' limited tolerance for imperfect cosmetic attributes. When faced with limited consumer tolerance for cosmetic damage, apple producers must account for the trade-off between production technology and cosmetic damage in their production decisions in order to ensure their profits.

Footnotes

[1] The motivation of this design is to control for any possible effects the hypothetical auction in the first round might have on the real auction in the second round. The estimation results show that the effect is negligible.

[2] The instructions are available from the authors upon request.

[3] Three of the observations had missing values on income, and these values were imputed using best-subset regression. The independent variables for the regression were

Education, Age, Gender, and Association with the university (such as faculty, staff, student, etc.). The imputation was completed using STATA7.0.

[4] The variable *Spot* is created as a continuous variable from the four graded levels and equals the average spot level in the spot categories, i.e., *Spot* equals 0 for SpotA, 3 for SpotB, 5 for SpotC, and 9 for SpotD.

[5] Roosen *et al.* (1998) asked the participants to bid for an upgrade from one endowed bag of apples to other bags of apples. Thirty-five percent of the participants bid zero for all the alternatives. Their upgrade design did not allow them to distinguish between those participants who preferred the endowed bag and those who were indifferent between the bags. Bidding on all products allows us to measure both positive and negative price premiums.

[6] We estimated the correlation between the socio-demographic variables and preference attitude variables and found that the largest correlation was 0.17. We conclude that there is no multicollinearity problem in Model 3. However, since we have only 74 participants and Model 3 includes 28 independent variables, there may be identification problems. For this reason we include both Model 1 and Model 2 in the analysis.

[7] We tried another model that included both the individual socio-demographic variables and attitude preference variables and the interaction effects. To test the model specification, a likelihood ratio test was conducted. The test statistic was 6, which is less than the critical value 19.68, so the null hypothesis that the coefficients of the individual socio-demographic variables and attitudes preference variables are zero cannot be rejected at the 0.05 significance level.

[8] We ran another model using the bids on pictures of apples only and found the constant (the average bid for 3-pound conventional perfect apples) was \$2.78 instead of \$1.74, and the premium for organic was \$0.46 instead of \$0.35 for 3 pounds of apples.

References

Acebron, L.B., and D.C. Dopico. “The Importance of Intrinsic and Extrinsic Cues to Expected and Experienced Quality: An Empirical Application for Beef.” *Food Quality and Preference* 11(2000):229–38.

Alfnes, F., and K. Rickertsen. “European Consumers’ Willingness to Pay for U.S. Beef in Experimental Auction Markets.” *American Journal of Agricultural Economics* 85, 2(2003): 396–405.

Alfnes, F., A. Guttormsen, G. Steine, and K. Kolstad. “Consumers’ Willingness to Pay for the Color of Salmon: A Choice Experiment with Real Economic Incentives.” *American Journal of Agricultural Economics* 88,4(2006):1050-1061.

Baker, G. “Consumer Preferences for Food Safety Attributes in Fresh Apples: Market Segments, Consumer Characteristics and Marketing Opportunities.” *Journal of Agricultural and Resource Economics* 24,1(1999): 80-97.

Blend, J.R., and E.O. van Ravenswaay. “Measuring Consumers’ Demand for Ecolabeled Apples.” *American Journal of Agricultural Economics* 81,5(1999): 1072–1077.

Darby, M.R., and E. Karni. “Free Competition and the Optimal Amount of Fraud.” *Journal of Law and Economics* 16(1973):67-88.

Hamrick, K., and K.J. Shelley. “Data Feature: How Much Time Do Americans Spend Preparing and Eating Food?” *Amber Waves*, magazine of the Economic Research

Service, U.S. Department of Agriculture (2005), pp. 10-11. Online. Available at http://www.ers.usda.gov/AmberWaves/November05/DataFeature/ [Accessed November 6, 2006].

Johnson, R.A., and D.W. Wichern. *Applied Multivariate Statistical Analysis*, 5th ed. Englewood Cliffs, NJ: Prentice-Hall International, 2002.

Larue, B., G.E. West, C. Gendron, and R. Lambert. "Consumer Response to Functional Foods Produced by Conventional, Organic, or Genetic Manipulation." *Agribusiness, An International Journal* 20,2 (2004):155-166.

Loureiro, M.L., J.J. McCluskey, and R.C. Mittlehammer. "Assessing Consumer Preferences for Organic, Eco-Labeled, and Regular Apples." *Journal of Agricultural and Resource Economics* 26(2001):404–16.

Lusk, J.L., T. Feldkamp, and T.C. Schroeder. "Experimental Auction Procedure: Impact on Valuation of Quality Differentiated Goods." *American Journal of Agricultural Economics* 86(2004): 389–405.

Lusk, J.L., L.O. House, C. Valli, S.R. Jaeger, M. Moore, B. Morrow, and W.B. Traill. "Effect of Information about Benefits of Biotechnology on Consumer Acceptance of Genetically Modified Food: Evidence from Experimental Auctions in United States, England, and France." *European Review of Agricultural Economics* 31(2004):179–204.

Magnusson, E., and J.A.L. Cranfield. "Consumer Demand for Pesticide Free Food Products in Canada: A Probit Analysis." *Canadian Journal of Agricultural Economics* 53,1(March 2005): 67-81.

Melton, B.E., W.E. Huffman, J.F. Shogren, and J.A. Fox. "Consumer Preferences for Fresh Food Items with Multiple Quality Attributes: Evidence from an Experimental Auction of Pork Chops." *American Journal of Agricultural Economics* 78(1996):916-923.

Reed, J., E. Frazão, and R. Itskowitz. "How Much Do Americans Pay for Fruits and Vegetables?" Agriculture Information Bulletin No. AIB790, July 2004. Electronic Report from the Economic Research Service, USDA. Online. Available at http://www.ers.usda.gov/publications/aib790/ [Accessed November 6, 2006].

Roosen, J., J.A. Fox, D.A. Hennessy, and A. Schreiber. "Consumers' Valuation of Insecticide Use Restrictions: An Application to Apples." *Journal of Agricultural and Resource Economics* 23(1998): 367-384.

Rozan, A., A. Stenger, and M. Willinger. "Willingness-to-Pay for Food Safety: An Experimental Investigation of Quality Certification on Bidding Behaviour." *European Review of Agricultural Economics* 31,4(2004):409-425.

Thompson, G.D., and J. Kidwell. "Explaining the Choice of Organic Produce: Cosmetic Defects, Prices, and Consumer Preferences." *American Journal of Agricultural Economics* 80(1998):77-287.

Umberger, W.J., and D.M. Feuz. "The Usefulness of Experimental Auctions in Determining Consumers' Willingness to Pay for Quality Differentiated Products." *Review of Agricultural Economics* 26(2004):1–16.

Waugh, F.V. "Quality Factors Influencing Vegetable Prices." *Journal of Farm Economics* 10,2(April 1928): 185-196.

Wei, S., S. Singgih, E.J.Woods, and D. Adar. "How Important Is Appearance? Consumer Preferences for Mandarins in Indonesia." *International Journal of Consumer Studies* 27(2003):406-411.

Whole Foods Market. "Nearly Two-Thirds of Americans Have Tried Organic Foods and Beverages." Press release, November 18, 2005. Online. Available at http://www.wholefoodsmarket.com/company/pr_11-18-05.html [Accessed November 6, 2006].

Williams, P.R.D., and J.K. Hammitt. "Perceived Risks of Conventional and Organic Produce: Pesticides, Pathogens, and Natural Toxins." *Risk Analysis* 21,2(April 2001): 319-330.

Table 1. Descriptive Statistics of the Bids

Production method	Auction	Statistics	SpotA	SpotB	SpotC	SpotD
Conventional	Hypothetical	Mean	2.73	2.21	1.60	0.73
		S.D.	1.60	1.26	0.98	0.74
		Median	2.25	1.90	1.38	0.59
		% zero bids	1.89%	1.89%	5.67%	37.7%
Conventional	Real	Mean	1.83	1.15	0.99	0.57
		S.D.	0.88	0.74	0.77	0.59
		Median	1.74	1.18	0.87	0.49
		% zero bids	2.06%	13.4%	18.56%	38.14%
Organic	Hypothetical	Mean	3.22	2.60	1.89	0.96
		S.D.	1.69	1.42	1.18	1.05
		Median	2.70	2.15	1.75	0.75
		% zero bids	0	0	3.77%	33.96%
Organic	Real	Mean	2.08	1.58		
		S.D.	0.95	0.88		
		Median	1.93	1.45		
		% zero bids	0	1.03%		

Table 2. Definition and Summary Statistics of Variables

Variable	Definition	Mean	S.D.	Min	Max
Product attributes					
Organic	Organically (=1) or conventionally (=0) produced	0.46	0.50	0	1
Spot	Continuous measure of percentage coverage of spots	3.64	3.34	0	9
OrgSpot	Interaction effect of variable *Organic* and variable *Spot*				
Socio-demographics					
Age[a]	Age of the participants	40.30	13.18	25	65
Gender	Male=0, Female=1	0.67	0.47	0	1
Edu[b]	Education on a 6-point scale	4.96	1.27	2	6
Income	Income in thousands of dollars	49.22	30.52	7.5	120
Attitudes					
Price[c]	Price sensitivity	0	1	-2.37	1.98
Envir[c]	Concern about environment	0	1	-2.29	1.89
Pest[c]	Pesticides risk tolerance	0	1	-2.41	2.33
Appear[c]	Attitude towards appearance of apples	0	1	-2.64	1.84
Taste[d]	Taste of apples	4.70	0.58	3	5
Safe[d]	Food safety	4.05	1.13	1	5
Nutrition[d]	Nutrition of apples	3.48	1.22	1	5

[a] The age variable has seven categories and we have used the midpoint of the categories to form a continuous variable.
[b] 1 = Some high school, 2 = High school diploma, 3 = Some college or less, 4 = College diploma, 5= Some graduate school, and 6 = Graduate degree.
[c] Factors
[d] Based on the answer to the following question: How important are the following attributes of apples when you decide which apples to buy? (5-point scale where 1 is not important and 5 is very important)

Table 3. Socio-demographics and Attitudes of the Groups

	Group 1 (19 [a])		Group 2 (34 [a])		Group 3 (21 [a])		ANOVA	MANOVA
	Mean	S.D.	Mean	S.D.	Mean	S.D.	P-value	P-value
Socio-demographics								
Age	36.05	15.23	38.23	12.24	43.10	12.49	0.21	
Gender	0.63	0.49	0.71	0.46	0.67	0.48	0.84	
Edu	4.84	1.30	5.00	1.15	5.10	1.44	0.82	
Income	36.97	22.75	41.14	31.06	58.69	32.85	0.05	0.51[c]
Attitudes								
Price[b]	0.59	1.19	-0.12	0.70	-0.34	1.08	0.01	
Envir[b]	-0.52	1.01	0.02	1.01	0.46	0.79	0.01	
Pest[b]	-0.22	1.12	-0.05	0.96	0.28	0.97	0.27	
Appear[b]	-0.17	1.10	0.27	1.01	-0.31	-0.84	0.08	
Taste[b]	-0.34	0.98	-0.01	0.94	0.37	1.06	0.08	
Safe[b]	-0.16	0.98	0.10	1.03	0.32	0.98	0.22	
Nutrition[b]	0.12	0.96	-0.18	1.07	0.02	0.94	0.35	0.04[d]
								0.20[e]

[a] Number of participants in each group.
[b] These attitudes variables are standardized.
[c] MANOVA of socio-demographic variables.
[d] MANOVA of attitude variables.
[e] MANOVA of both socio-demographic and attitude variables.

Table 4. WTP for (Organic) Apples with Spots, Random Individual Effect Models[a]

	Model 1			Model 2			Model 3		
Variables	**Coef.**	**S.D.**	**P-value**	**Coef.**	**S.D.**	**P-value**	**Coef.**	**S.D.**	**P-value**
Product attributes									
Constant	1.74***[b]	0.10	0.00	1.75***	0.09	0.00	1.74***	0.09	0.00
Organic	0.35***	0.08	0.00	0.34***	0.08	0.00	0.35***	0.08	0.00
Spot	-0.14***	0.01	0.00	-0.14***	0.01	0.00	-0.14***	0.01	0.00
OrgSpot	-0.04***	0.01	0.00	-0.04***	0.01	0.00	-0.04***	0.01	0.00
Socio-demographic interaction effects									
EduOrg[c]	-0.04	0.05	0.48				-0.04	0.05	0.46
GenderOrg	0.001	0.05	0.98				-0.05	0.05	0.32
AgeOrg	-0.07	0.06	0.19				-0.07	0.07	0.28
IncomeOrg	0.20***	0.06	0.00				0.14**	0.07	0.03
AgeSpot	-0.01	0.01	0.26				-0.01	0.01	0.24
GenderSpot	-0.02**	0.01	0.02				-0.02*	0.01	0.02
EduSpot	0.01**	0.01	0.08				0.01	0.01	0.19
IncomeSpot	0.003	0.01	0.73				0.001	0.01	0.87
Attitude interaction effects									
PriceOrg				-0.11**	0.05	0.05	-0.09*	0.06	0.10
EnvirOrg				0.20***	0.07	0.01	0.21***	0.07	0.01
SafeOrg				0.25***	0.07	0.00	0.22***	0.07	0.00
PestOrg				-0.009	0.07	0.89	-0.02	0.07	0.78
AppearOrg				0.01	0.05	0.82	0.02	0.05	0.68
TasteOrg				0.26***	0.07	0.00	0.24***	0.07	0.00
NutritionOrg				0.009	0.05	0.86	-0.005	0.05	0.92
PriceSpot				-0.01	0.01	0.19	-0.01	0.01	0.37
EnvirSpot				-0.006	0.01	0.59	-0.002	0.01	0.89
SafeSpot				0.001	0.01	0.91	0.005	0.01	0.63
PestSpot				0.008	0.01	0.43	-0.001	0.01	0.88
AppearSpot				-0.03***	0.01	0.00	-0.02***	0.01	0.00
TasteSpot				-0.001	0.01	0.92	0.005	0.01	0.64
NutritionSpot				-0.001	0.01	0.89	0.002	0.01	0.82
Experimental design effects									
Picture	1.04***	0.10	0.00	1.01***	0.10	0.00	1.04***	0.09	0.00
PictureOrg	0.14	0.11	0.18	0.18*	0.11	0.08	0.14	0.10	0.18
PictureSpot	-0.08***	0.02	0.00	-0.08***	0.02	0.00	-0.08***	0.02	0.00
Model parameters									
σ_η	0.61***	0.06	0.00	0.59***	0.05	0.00	0.60***	0.06	0.00
σ_ε	0.80***	0.02	0.00	0.78***	0.02	0.00	0.77***	0.02	0.00
ρ	0.37	0.04		0.37	0.04		0.37	0.05	

Note: The models are random individual effect models estimated with STATA 7.0.

[a] Likelihood ratio test statistics for the goodness of fit of the models are 619 for Model 1, 662 for Model 2, and 679 for Model 3, and the p-values are less than 0.0001.

[b] Single, double, and triple asterisks (*) denote significance at the 0.1, 0.05, and 0.01 levels, respectively.

[c] *EduOrg* means the interaction effect between variable *Edu* and *Organic* and *EduSpot* means the interaction effect between variable *Edu* and *Spot.* Similar definitions hold for the attitude interaction effect variables and experiment design variables as well.

Figure 1. Cumulative Distribution of the Difference in Willingness to Pay between Organic A and B and Conventional A

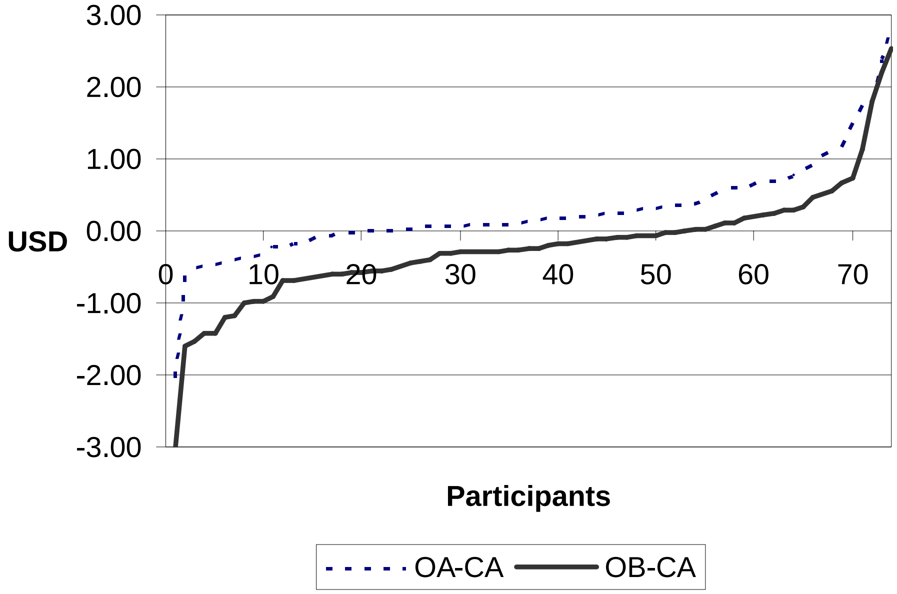
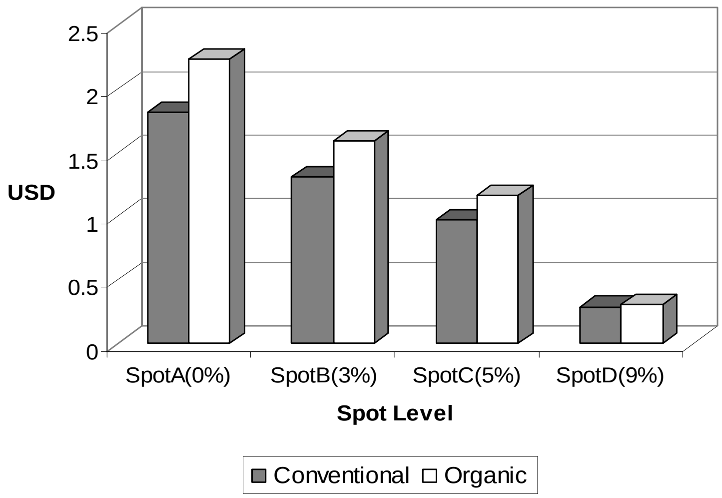


Figure 2. Consumer WTP for Apples with Different Levels of Spots



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