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Country of Origin Labeling with Horizontal Differentiation and Cost Variability

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Abstract

This paper studies whether a seller achieves higher profits by providing consumers with information that allows them to distinguish between products from different countries, and how mandatory provision of such information impacts welfare. We analyze a model of multi-product monopoly with horizontal differentiation and random country-specific input costs. We find that if the variability in the input costs is sufficiently high and the share of consumers with high valuations is in some intermediate range, the seller prefers to withhold information about product origin. Mandatory labeling of products with their country of origin may reduce or increase welfare depending on the share of consumers with high valuations. We also discuss extensions of the basic model that allow for continuous distributions of valuations and input costs, and consumer learning.

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1. Introduction

Until recently voluntary country-of-origin labeling of food products was relatively uncommon in the U.S. even though the aggregate import share grew to 7% of value and 15% of volume of domestic food consumption in 2005 (Jerardo 2008).[1] In 2009, the mandatory country of origin labeling (MCOOL) regulation contained in the 2002 and 2008 Farm Security and Rural Investment Acts took effect (Federal Register 2009). This labeling regulation requires food retailers to notify their customers of the country of origin of various muscle cuts and ground meats, fish, perishable agricultural commodities (fresh and frozen fruits and vegetables), and nuts.[2] The goal of this paper is to evaluate the impact of the MCOOL policy on welfare in markets in which product origin provides an important cue to consumers who have different rankings of products from different countries.[3]

While the food imported into the U.S. is subjected to the same safety standards as domestically grown food, production methods may still vary across exporting countries (Krissoff et al 2004).[4] Such variability tends to result in unique flavor or nutritional content (and other experience or credence attributes) of food products from different countries (Umberger et al 2002). For example, several recent studies tested whether there were sensory and value differences among U.S. consumers for grass-fed Argentine and Australian, grain-fed Canadian, and U.S. corn-fed beef. Umberger et al (2002) found that

[1] An example of voluntary labeling of food products with their country of origin are lamb imports from Australia and New Zealand (Clemens and Babcock 2004). Also, there are many examples of the use of geographical origin within the U.S. as a basis for branding commodities such as Main lobster, Kona coffee, Idaho potatoes, Napa Valley wine, Vidalia onions, Washington State apples, Texas Ruby Red grapefruits, and Florida orange juice (Agarwal and Barone 2005, Babcock et al 2007, Babcock and Clemens 2004).

[2] In 2001, the U.S. imported 11.6% of beef, 83.3% of fish and shellfish, 23.1% of fruits, and 16.6% of vegetables covered under MCOOL (GAO 2003, p. 19).

[3] A comprehensive survey of the various arguments put forth by proponents and opponents of MCOOL is provided in Krissoff et al (2004). More recent discussions are available in Lusk et al (2006), Carter et al (2006), and Verbeke and Roosen (2009).

[4] Required country of origin labeling does not directly improve food safety or traceability since as explained by the U.S. Department of Agriculture "the COOL program is neither a food safety or traceability program, but rather a *consumer information* program. Food products, both imported and domestic, must meet the food safety standards of the FDA and FSIS. Food safety and traceability are not the stated intent of the rule and the COOL program does not replace any other established regulatory programs that related to food safety or traceability." (Federal Registar 2009, p. 2679, italics added).

62% of consumers preferred U.S. beef, 23% preferred Argentine beef, and 15% were indifferent. Sitz et al (2005) reported similar results for U.S. and Australian beef. They also found that, when offered to choose between U.S. and Canadian beef, 44% of consumers preferred the domestic sample, 29% preferred the Canadian sample, and 27% were indifferent. In their experiments, consumers bid, on average, from 30% to 60% more for their preferred variety of beef.

To the extent that these estimates reflect real-world consumer preferences, and using the (upper) estimate of the average increase in the total costs due to country of origin labeling of 5.6% (Federal Register 2009, p.2690)[5], it appears that retailers forego considerable profits by not labeling beef with the country of origin.[6] Why do U.S. retailers prefer to "commoditize" beef as well as other products with experience or credence attributes that are country-specific by withholding information about product origin (Krissoff et al 2004)?[7]

Most of the previous studies of product origin labeling in markets with vertical differentiation consider producers who cannot credibly signal some characteristics of their products and use geographical indications (GIs) as a means of costly credible certification of quality (e.g., Zago and Pick 2004, Lence et al 2007, Langinier and Babcock 2008, Moschini et al 2008).[8] In such cases labeling regulation (GIs) allows

[5] This is the sum of the percentage increases in operating costs following the introduction of MCOOL for producers (1.3%), processors (2.1%), and retailers (2.2%) of beef, lamb, and goat. USDA projects that the costs of implementing MCOOL will fall over time (Federal Register 2009, p. 2690).

[6] As Umberger et al (2002), p.492 pointed out: "Most of the beef imported into the United States is not labeled as imported beef; it is marketed as generic beef, and it is not distinguishable from domestic beef in the retail meat case. Yet, the flavor of imported grass-fed beef may be very unique to domestic consumers. If consumers can taste flavor differences in beef from different countries, and if not all consumers prefer the same flavor, then country-of-origin labeling may be beneficial from a differentiated, branded product perspective." A similar remark about potential for differentiating beef from US and Canada is also made in Feuz et al (2007).

[7] The question is particularly puzzling given that the U.S. food marketing systems delivers about 300,000 food products each year (Harris et al 2002). In 2008, a typical food retailer was estimated to carry 47,000 distinct products (Brat et al 2009). Even with MCOOL, suppliers may be able to market a differentiated product as generic. For example, according to Kay (2008), "retailers and packers plan to use the catch-all label that says "Product of the U.S., Country X, and/or (as applicable) Country Y" on as much beef as possible. This label will apply to beef from animals that might have been foreign-born but were part raised and then processed in the U.S. But the label can also be used on beef from cattle exclusively born, raised and slaughtered in the U.S. In fact, the second-largest beef processor, Tyson Fresh Meats, has already told its customers it will adopt the catch-all label for all its beef. […] The bulk of beef sold at retail will remain a commodity."

[8] Geographical indications (GIs) such as Protected Designation of Origin or Protected Geographical Indication have long been used by agricultural producers in the European Union. GIs not only indicate

suppliers to transmit information about product attributes to consumers, which they could not do prior to regulation. However, as discussed in Krissoff et al (2004), there is little evidence that consumers systemically lack trust in the country-of-origin information provided by the U.S. food marketing system.[9]

When credible *voluntary* product origin labeling is possible, analyzing the effects of MCOOL requires assessing its scope. That is, we need to allow the provision of information about product origin to be endogenously determined, identify conditions under which no information is provided in equilibrium, and compare equilibria with and without labeling (Carter et al 2006). Such an economic analysis involves several modeling decisions that need justification. First, because, unlike GIs, country of origin labeling (by itself) typically does not entail significant changes in production practices other than collecting information and keeping records about product movement (Federal Register 2009), we abstract from the vertical relations in the industry and assume that the labeling decision is made by a retailer. Specifically, we consider a (local) monopoly firm that can source a good from two countries.[10]

Second, we consider a model of horizontal differentiation in which information about product origin provides an important cue to consumers who cannot identify the country of origin without labeling. Thus the analysis does not apply to differentiation based on product attributes about the desirability of which all consumers agree (such as safety). The present model applies to products with heterogeneity in individual match values (as in the case of beef from different countries described above), but it can be extended to include vertical differentiation as well.

Third, we assume that the production costs (or wholesale prices) for products from different countries are subject to *country-specific* random shocks that are *not observable* to consumers. Most of the commodities covered by the mandatory labeling policy (muscle cuts and ground meats, and fruits and vegetables) are characterized by

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origin of the food product but also convey a certain quality and product specification (European Commission 2007).

[9] For example, it is telling that there were no retailers who participated in the voluntary labeling programs for beef and other products that were offered by USDA before the mandatory policy went into effect (Federal Register 2009, p. 2682). This supports the assertion that the observed lack of COOL was not caused by the absence of credible third-party certification services (Krissoff et al 2004).

[10] See Bonanno and Lopez (2009) for recent evidence of monopoly pricing by supermarkets. The model can be extended to allow for competition among spatially differentiated retailers on a Hotelling line.

relatively short shelf-life and seasonal variations in supply. When domestic supply is low or unavailable, and storage is costly, off-season demand is met by imports (Huang and Huang 2007).[11] The imported and domestic varieties are typically marketed during different (possibly overlapping) time periods, and the likely primary reason why imports occur is *not* to offer additional varieties but to assure continuous consumer access to a "generic" product and stabilize retailer's input costs throughout the year.[12] For example, several surveys of Belgium consumers found that origin-labeled meat products were perceived as less convenient to purchase due to reduced availability: "We might have to drive further to find this product"; "We don't think it is available at our local butcher or in the supermarket we usually visit." (cited in Verbeke and Roosen 2009, p. 28).

We find that when the costs of sourcing similar (non-storable) products from different countries are variable, the strategy of product differentiation and segmenting the market by branding products with their country of origin is *not* always optimal. Withholding information about country of origin from consumers may allow the seller to achieve higher profits by enhancing his ability to take advantage of the changes in input prices and more frequently source the products from the low-cost country. When wholesale prices for products from different countries exhibit idiosyncratic volatility and sources of supply can be adjusted to minimize input costs, the seller faces the following tradeoff when deciding whether to provide information about the product's country of origin. On the one hand, consumers who find their preferred variety are willing to pay more when the uncertainty about product origin is reduced, and the seller may achieve higher profits by raising the price of the labeled products. On the other hand, consumers who do not find the variety that they prefer are willing to pay less, and may stay out of the market altogether.

In contrast with the previous literature on labeling policies in food markets, in which information disclosure is incomplete due to certification costs, we show that a seller may prefer to *withhold* information about product attributes even when the cost of

[11] This is true for many fruits and vegetables (and, to a smaller extent, beef and other meats) that are covered by the new labeling regulation.

[12] This assertion is indirectly supported by the observed opposition of retailers to MCOOL and the relative dearth of such labeling at the retail level. As reported in Kay (2008), "…any additional segregation of livestock and finished product will translate into higher wholesale prices and *reduced product availability*, Tyson warns." (italics added)

labeling (and certification of origin) is *zero*. This result holds when (i) the dispersion of idiosyncratic shocks to wholesale prices in each country is sufficiently great, (ii) the correlation between shocks is sufficiently low, and (iii) the dispersion in consumer valuations for products from different countries is in some intermediate range.

The intuition is as follows. The first two conditions assure that the seller, on average, obtains significant cost savings by sourcing products from the low-cost country. The third condition assures that the seller achieves higher profits by keeping consumers ignorant about which variety is currently offered for sale. More information about products increases the variability in the willingness to pay of consumers who differentiate between products based on the country of origin. Specifically, the dispersion in the willingness to pay of the "choosy" consumers, whose actual valuations for different varieties are significantly different (i.e. high for some varieties but low for others), will increase by more than that for "indifferent" consumers whose valuations for different varieties are similar (i.e. uniformly high or uniformly low). Whether or not this "uneven" increase in dispersion of consumer valuations allows the seller to achieve higher profits depends on the share of the "choosy" consumers in the market.

If the share of the "choosy" consumers is sufficiently large, the seller achieves higher profits by *withholding* information about product origin as long as the social surplus from trade between the seller and consumers with low valuations is positive. Then the market price equals the expected valuation of a "choosy" consumer (who does not know which variety she encounters on a given shopping occasion). Targeting uninformed "choosy" buyers allows the seller to extract more of the consumer surplus. Providing information about product origin increases neither the efficiency of allocation (the total surplus from trade) nor the seller's profit when only products from the low-cost country are available for sale.[13]

[13] If the share of the "choosy" consumers is sufficiently small, the seller achieves higher profits by *providing* information about product origin. When the share of consumers who are indifferent between varieties is large, the profit-maximizing seller targets an "indifferent" consumer. Note that an "indifferent" consumer is well informed about her actual willingness to pay even without labeling since her willingness to pay varies little with variety. As a result, the seller achieves higher profits when the "choosy" consumers are also informed about their actual valuations. Then the seller's gain from increasing sales to the "choosy" consumers who encountered their preferred variety will offset the loss from the foregone sales to the "choosy" consumers who encountered an undesirable variety (and discovered this before purchase).

We also investigate how *mandatory* labeling affects welfare when the seller prefers to withhold information about product origin in the voluntary labeling regime. We identify three effects of mandatory labeling on welfare. First, consumer welfare may increase or decrease depending on the profit-maximizing pricing strategy for labeled products; we refer to this as the *price effect*. Second, under mandatory labeling consumers can access a greater number of product varieties if the seller prefers to supply not only products from the low-cost country but also products from the high-cost country; we refer to this as the *more varieties effect*. Third, under mandatory labeling there is more efficient matching between consumers (with idiosyncratic tastes) and goods because consumers can identify the country of origin (variety) of a labeled product before purchase; we refer to this as the *better matching effect*. While the more varieties and better matching effects of mandatory labeling on welfare are positive, the price effect can be either positive or negative.

Our main result is that under certain conditions the price effect dominates, and mandatory labeling of products with country of origin (MCOOL) *reduces* (*increases*) welfare when the share of consumers with high valuations is sufficiently large (small). The intuition is that under mandatory provision of information about product origin, the seller cannot target the segment of uninformed "choosy" consumers since all consumers are informed about product variety, and is forced to either target consumers with low or high valuations. Because the valuations of informed consumers are more dispersed, the equilibrium price may either increase or decrease compared with the equilibrium price without labeling. Since the monopolist tends to undersupply compared with the efficient allocation, welfare increases or decreases depending on whether the profit-maximizing pricing strategy under mandatory labeling calls for *lower* or *higher* prices of the labeled (*branded*) products compared with the price of the unlabeled (*generic*) product.

We also comment on two extensions of the basic model. We demonstrate that in a model with continuous distributions of valuations, consumer welfare can increase under mandatory labeling policy even if the equilibrium price remains unchanged. This happens because information rent retained by consumers is greater when they know which variety they purchase. We also discuss the effects of mandatory labeling on profits and the pricing strategy in a dynamic overlapping generations model with consumers who

are initially uninformed and learn their valuations by purchasing and trying the product (Bergemann and Valimaki 2006). In a dynamic model with learning there are two additional effects of labeling on long-run profits. On the one hand, product origin labeling increases profits because inexperienced consumers are willing to pay more if they know which variety they buy since this will allow them to make better purchasing decisions in the future, and the informed choosy consumers are willing to pay more if their valuations happen to be high. On the other hand, product origin labeling lowers profits because consumers with negative experiences (i.e. those with low valuations for one or both varieties) purchase less frequently.[14]

1.1. Literature review

Our paper is closely related to Wolinsky (1987). The author is concerned with explaining the co-existence of, and price differentials between, the brand-name and generic (or private label) products. In contrast with Wolinsky's setting in which selling only unlabeled products cannot be a profit-maximizing marketing strategy, in our model all of the supply may be unlabeled in equilibrium. The difference in equilibrium outcomes is due to the differences in the structure of consumer preferences and production technology. We consider a model with random production costs that are private information to the seller and are not observable by the buyers. Also, in our model "indifferent" buyers (who attribute relatively less importance to the differences between the brands) are not restricted to have a lower willingness to pay than that of "choosy" buyers for their preferred brand.

While it is an empirical question, consumer willingness to pay for products with *multiple* experience and credence characteristics (e.g., flavor, nutritional content, product origin, and production practices) is perhaps better modeled using the demand structure proposed by Perloff and Salop (1985) rather than the *one-dimensional* spatial Hotelling's model of horizontal differentiation. Also, wholesale prices of many agricultural commodities covered under MCOOL are subjected to country-specific supply and

[14] The analysis of a dynamic model depends on whether, without labels, consumers can tell which varieties they have already tried. If they cannot, withholding product origin information benefits the seller because consumers with low valuations buy more frequently and stay in the market longer since they are not sure whether or not they have encountered both varieties in their previous trials and keep on hoping that the variety that they like is still out there.

demand shocks, have high storage costs, and are not available off-season, which is consistent with the supply-side *volatility* in our model.

As mentioned before, our paper complements recent studies (Zago and Pick 2004, Langinier and Babcock 2008, Moschini et al 2008) in the economics of GIs as credible quality certification devices in markets with vertical differentiation. In contrast with these papers, which assume that credence (or experience) attributes cannot be credibly conveyed in the absence of regulation, we model the labeling decision as a profit-maximizing marketing strategy and do not appeal to certification costs to explain the lack of voluntary labeling.

The issue of whether a seller prefers to provide all of the relevant information about experience or credence attributes of a product is studied in Lewis and Sappington (1994), Johnson and Maytt (2006), and Saak (2008). These authors identify conditions under which the seller achieves higher profits by releasing or withholding an informative signal (such as country of origin) which is *private* information to the buyer and not observable by the seller (in the sense that the seller does not know how country of origin affects the valuation of a particular buyer). In contrast, we consider a multi-product seller with random production costs that are private information to the seller.[15]

The rest of the paper is organized as follows. In Section 2 we present a very simple model with a binary distribution of valuations. In Section 3 we find conditions under which the seller prefers to withhold information about product origin when labeling is voluntary. In Section 4 we analyze the effect of mandatory labeling policy on welfare. In Section 5 we discuss several extensions of the basic model with continuous distributions of valuations and consumers who learn about their valuations over time. Section 6 concludes.

[15] In general, country of origin information likely falls in between the settings with purely private and purely public (the seller knows how country of origin affects the valuation of a given buyer) information. The latter setting applies when consumers have common values (or more generally, when the distributions of valuations for products from different countries are asymmetric). Ottaviani and Prat (2001) demonstrated that the monopolist always benefits from the release of public affiliated information. And so, a greater asymmetry between products from different countries tends to make voluntary labeling more profitable.

2. Model

Supply Side

A monopolist (a grocery store) offers two varieties that are differentiated by country of origin, A and B, for sale in a market consisting of a continuum of risk-neutral consumers with mass normalized to one. The constant marginal production costs (wholesale prices) of both varieties c_i, $i = A, B$, are random and take two values: $\underline{c} = 0$ and $\bar{c} = c > 0$, where $\Pr((c_A, c_B) = (0,0)) = \Pr((c_A, c_B) = (c,c)) = (1+\rho)/4$, $\Pr((c_A, c_B) = (0,c)) = \Pr((c_A, c_B) = (c,0)) = (1-\rho)/4$ and $\rho \in [-1,1]$.[16] The parameter ρ is the coefficient of correlation between the random shocks in countries A and B. For example, $\rho \geq 0$ (positive correlation) may better describe the wholesale prices for beef produced in the U.S. and Canada, while $\rho < 0$ (negative correlation) may better describe the wholesale prices for grapes produced in the U.S. and Chile which are typically not available at the same time (Huang and Huang 2007). We assume that the realizations of (c_A, c_B) are observable only to the monopolist but not to consumers.[17]

Demand Side

Buyers can consume one unit of variety A or one unit of variety B or stay out of the market and obtain a reservation utility of zero. Every consumer is characterized by his idiosyncratic willingness to pay for varieties A and B, that are denoted by θ_A and θ_B, where $\theta_i \in \{L, H\}$, $0 < L < H$, and $L < c$. For simplicity, we assume that preferences are symmetric in the sense that aggregate preferences for each variety are independently and identically distributed (Perloff and Salop 1985). The buyer's valuation for each variety is either high H with probability x or low L with probability $1-x$, where $x \in (0,1)$, so that the shares of the "indifferent" consumers with $(\theta_A, \theta_B) = (H, H)$ and (L, L) are, respectively, x^2 and $(1-x)^2$, and the share of the "choosy" consumers with $(\theta_A, \theta_B) = (L, H)$ or (H, L) is $x(1-x)$. The valuations θ_A and θ_B are private information to each buyer, but the monopolist knows the distribution of valuations.

[16] That is, the cost function in country i is $C(y_i, c_i) = c_i y_i$, where y_i is the output in country i.

[17] That is, consumers do not observe prices in the input markets and do not know how the sources of supply switch between domestic and imported varieties over time.

Product Labeling

We consider two information regimes: voluntary and mandatory labeling of products with variety (i.e., their country of origin). To focus on the demand side of the model, we assume that labeling of each product with variety is costless. We assume that, if provided, labeling is truthful. In the voluntary labeling regime, the monopolist decides whether or not to label products with variety (country of origin). In the mandatory labeling regime, the monopolist must label each product with its variety (country of origin). If a product is not labeled with its variety, a buyer cannot tell which variety she will buy. For example, different varieties of meats, fruits, and vegetables can be similar in appearance but differ in flavor or other experience and credence attributes such as crunchiness, toughness, or nutritional content.

Timing of decisions

First, the monopolist decides whether to label products with variety and commits to the chosen labeling strategy. Second, the monopolist observes his production costs c_A and c_B. If the monopolist decided to label, he sets the price for each variety, $p_A(c_A, c_B)$ and $p_B(c_A, c_B)$. If the monopolist decided not to label, he sets the price of the unlabeled product, $p^N(c_A, c_B)$. Third, if the products are labeled, each consumer, upon seeing the variety and its price, decides whether to purchase or not. If the products are not labeled, each consumer decides whether to purchase upon seeing only the price but not the product variety. Fourth, the monopolist produces to satisfy demand.

3. Voluntary Labeling

3.1. Equilibrium with Labeling

Consider an equilibrium in which the monopolist labels the products with variety. A consumer with (θ_A, θ_B) buys variety i, $i = A, B$, if

(1) $\theta_i - p_i \geq 0$, and

(2) $\theta_i - p_i \geq \theta_j - p_j$, $j = A, B$, $j \neq i$.

Clearly, the seller's (total) profits can only be maximized when the price for each variety offered for sale equals $p_i(c_A, c_B) = L$ or H, $i = A, B$, since at optimum (1) and (2) cannot be slack for all consumers.

Next we will characterize (ex post) equilibrium for different realizations of production costs (wholesale prices) for products from different countries. We focus on a symmetric equilibrium with $p_A(c_A, c_B) = p_B(c_A, c_B)$ when the production costs do not vary across countries, $c_A = c_B$.[18] If the seller sets $p_A = p_B = L$ then all consumers buy one unit of one of the varieties. If the seller sets $p_A = p_B = H$, then the share of consumers who purchase one unit of variety A or one unit of variety B is

(3) $\quad x^2 + x(1-x) + (1-x)x = 1 - (1-x)^2,$

which is an aggregation over all consumers with (H, H) who are indifferent between purchasing variety A or B, plus all consumers with (H, L) who buy variety A, plus all consumers with (L, H) who buy variety B.

And so, if the costs for products from both countries are low, $(c_A, c_B) = (0,0)$, using (3), the seller earns

(4) $\quad \pi^L(0,0) = \max[L, (1-(1-x)^2)H].$

If the production costs (wholesale prices) for products from both countries are high, i.e. $(c_A, c_B) = (c, c)$, the seller offers both varieties at $p_A(c,c) = p_B(c,c) = H$ if $c \le H$, and earns

(5) $\quad \pi^L(c,c) = (1-(1-x)^2)\max[H - c, 0].$

If the production costs (wholesale prices) vary across countries, i.e. $(c_A, c_B) = (0, c)$ or $(c_A, c_B) = (c, 0)$, the optimal price for the product from a high-cost country, if it is offered for sale, must be $H \ge c$, and there are three possible profit-maximizing pricing strategies.

For concreteness, suppose that $(c_A, c_B) = (0, c)$. (i) If the seller sets $p_A(0,c) = L$ and offers only products from country A for sale then all consumers buy one unit of

[18] If we assume that the marginal costs are strictly increasing, e.g. $C(y_i, c_i) = c_i h(y_i)$, where $h(y_i)$ is a strictly increasing and convex function, the average total cost is minimized by evenly splitting supply between the two countries whenever the cost shocks do not vary across countries. The assumption that the marginal cost is constant simplifies the presentation, and does not affect the qualitative nature of the results.

variety A and the seller earns L. (ii) If the seller sets $p_A(0,c) = L$, $p_B(0,c) = H$ and offers products from both countries for sale (but at different prices), then the share of consumers who purchase one unit of variety A is

(6) $\quad x^2 + x(1-x) + (1-x)^2 = x^2 + 1 - x$,

which is an aggregation over all consumers with (H,H) plus all consumers with (H,L) plus all consumers with (L,L). The share of consumers who purchase variety B is $(1-x)x$, which includes all consumers with (L,H). (iii) Finally, the seller may offer products from both countries for sale at equal prices, $p_A(0,c) = p_B(0,c) = H$. Then the share of consumers who purchase one unit of variety A is given by

(7) $\quad x^2 + x(1-x) = x$,

which includes all consumers with (H,H) and (H,L), while the share of consumers who buy variety B is the same as in case (ii).

And so, using (6) and (7), the seller earns

(8) $\quad \pi^L(0,c) = \pi^L(c,0) = \max[L, (x^2 + 1 - x)L + x(1-x)\max[H-c,0],$
$\qquad\qquad xH + x(1-x)\max[H-c,0]]$.

Aggregating over all possible realizations of production costs and using (4), (5), and (8), we obtain the expected profits when the products are labeled with their country of origin:

(9) $\quad E[\pi^L(c_A,c_B)] = \sum_{a\in\{0,c\}}\sum_{b\in\{0,c\}} \Pr((c_A,c_B) = (a,b))\pi^L(a,b)$.

3.2. Equilibrium without Labeling

Now suppose that in equilibrium the monopolist does not label the products with variety (country of origin). We assume that the seller is equally likely to supply unlabeled products from country A or B when $c_A = c_B$. Because without labeling the seller cannot commit to supplying the more expensive variety and supplies only the cheaper variety if the production costs vary across countries, in a symmetric equilibrium variety *A* and variety *B* are equally likely to be supplied (since $\Pr(c_A = a) = \Pr(c_B = a)$ for $a \in \{0,c\}$). This implies that consumers, who purchase an unlabeled product, expect that they are equally likely to buy a product from country A or B. However, in equilibrium only "choosy" consumers, who value varieties differently, make their purchasing decision

while being uncertain about their actual valuation for the purchased product which could turn out to be either the preferred or not preferred variety. Without labeling the expected valuation for a consumer with (L,L) is L, the expected valuation for a consumer with (L,H) or (H,L) is $0.5L+0.5H$, and the expected valuation for a consumer with (H,H) is H.

Clearly, when the products are not labeled the seller's profits can only be maximized if the price equals $p^N(c_A,c_B)=L$, $0.5(L+H)$, or H:

$$(10)\quad E[\pi^N(c_A,c_B)]=\frac{1}{4}(3-\rho)\max[L,(1-(1-x)^2)(\frac{1}{2}L+\frac{1}{2}H),x^2H]$$
$$+\frac{1}{4}(1+\rho)\max[(1-(1-x)^2)\max[\frac{1}{2}L+\frac{1}{2}H-c,0],x^2\max[H-c,0]].$$

To understand (8) note that with probability $\Pr(\min[c_A,c_B]=0)=\Pr(c_A,c_B)=(0,0))$ $+\Pr(c_A,c_B)=(0,c))+\Pr(c_A,c_B)=(c,0))=(3-\rho)/4$ the seller sources products at a cost of zero, and with the complementary probability the input costs in both countries are high, $\Pr((c_A,c_B)=(c,c))=(1+\rho)/4$. If the seller sets $p^N(c_A,c_B)=0.5(L+H)$, all consumers except for those with $(\theta_A,\theta_B)=(L,L)$ buy the unlabeled products, and if the seller sets $p^N(c_A,c_B)=H$ only consumers with $(\theta_A,\theta_B)=(H,H)$ make a purchase. Note that the profit-maximizing price of the unlabeled products offered for sale is independent of the realizations of production costs c_A and c_B when they vary across countries, i.e. $p^N(0,c)=p^N(c,0)$. And so, the price of the unlabeled product does not reveal information about product origin to consumers.

Comparing the expected profits with labeling in (9) and without labeling in (10) gives

Proposition 1. (Voluntary labeling) *There exists a threshold* $\hat{\rho}>-1$ *such that whenever the correlation coefficient is lower than that threshold,* $\rho<\hat{\rho}$*, in equilibrium the products are not labeled with variety, only if*

$$(11a)\quad c>(H-L)\frac{1-(1-x)^2}{2x(1-x)},\ \textit{and}$$

(11b) $$\frac{x^2}{1-(1-x)^2} < \frac{L}{H} < \frac{1-(1-x)^2}{1+(1-x)^2}.$$

Otherwise, in equilibrium the products are labeled with variety.

We find that the seller prefers not to label products when (i) the cost variability (volatility of wholesale prices) is sufficiently high, i.e. (11a) holds, (ii) the correlation between the country-specific shocks is sufficiently low (the supply is "sufficiently" seasonal and countries are geographically dispersed), and (iii) the dispersion in consumer valuations is not too high or too low, i.e. (11b) holds.[19] To understand the intuition, note that the monopolist earns *lower* profits without labeling when the production costs for products from different countries are the *same* (or sufficiently similar), i.e. $\pi^L(c_A, c_B) \geq \pi^N(c_A, c_B)$ if $c_A = c_B$. This is because by offering products from different countries that are labeled with their country of origin, the seller can segment the market and raise the prices at *no additional* cost.

However, if the input cost is *lower* in one of the countries, $(c_A, c_B) = (0, c)$ or $(c, 0)$, the monopolist may earn higher profits by *supplying the cheaper variety and withholding information* about its identity from consumers, i.e. $\pi^L(c_A, c_B) < \pi^N(c_A, c_B)$ when (11) holds. In the absence of information about country of origin of the variety offered for sale, there are three types of consumers: the consumer with uniformly low valuations, the *uninformed* "choosy" consumer, and the consumer with uniformly high valuations. By targeting the uninformed "choosy" consumer the profit-maximizing seller achieves a balance between the volume of sales, which is higher than that obtained when the seller targets consumers with uniformly high valuations, and a price, which is higher than the willingness to pay of the consumers with uniformly low valuations. These are optimal labeling and pricing strategies when the distribution of valuations is not too concentrated or dispersed, i.e. (11b) holds, and the wholesale price in the high-cost country is sufficiently high, i.e. (11a) holds. And so, if the probability that the input costs

[19] There exists a range of parameters such that Proposition 1 continues to hold when $\rho \geq 0$ but not too large. For example, if we assume that the country-specific shocks are independent, i.e. $\rho = 0$, and $c \geq H$, condition (11b) becomes more restrictive, $\frac{1}{3}\frac{2x+x^2}{1-(1-x)^2} < \frac{L}{H} < \frac{1-(1-x)^2}{1+3(1-x)^2}$.

are different across countries is high (i.e. ρ is not too high), the monopolist achieves higher *expected* profits by withholding information about product origin from consumers.

On the other hand, if the population of consumers is dominated by consumers with either high or low valuations (i.e. x is sufficiently close to 0 or 1), the seller achieves higher profits by providing information about product origin even when the entire supply is sourced from a single (low-cost) country.[20] Because the seller always achieves higher profits by offering and labeling products from different countries when the input cost are similar across countries, providing information about product origin becomes a profit-maximizing marketing strategy.

4. Mandatory Labeling and Welfare

By the usual revealed preference argument, the monopolist's profits cannot increase under mandatory labeling. If the share of consumers with high valuations is sufficiently small or large, i.e. (11b) does not hold, or the dispersion in input costs is too small, i.e. (11a) does not hold, or country-specific shocks are too strongly positively correlated, mandatory labeling policy has trivially no effect since in equilibrium the seller either voluntarily labels the products with variety or the provision of information about origin does not change the equilibrium outcome and welfare (see footnote 19). However, if the share of consumers with high valuations is in some intermediate range, i.e. (11b) holds, the dispersion in input costs is sufficiently great, i.e. (11a) holds, and the correlation between the country-specific shocks is sufficiently low, the expected social welfare may increase or decrease under mandatory labeling.

Proposition 2. (Mandatory labeling and welfare) *Suppose that there is no labeling in equilibrium with voluntary labeling, i.e. (11) holds and the correlation coefficient* ρ *is not too high. The effect of mandatory labeling on welfare is*

- *positive, if* $L \geq xH$ *and* $c \geq H - \dfrac{L - xH}{x(1-x)}$;

[20] If $c \geq H$ and $L \geq xH$, i.e. the seller never sources products from high-cost countries and covers the market when the input costs are low, the seller is indifferent between labeling and not labeling. However, this indifference is special to the binary setting, and does not occur in a more general model with continuous distributions of valuations and input costs (see Section 5.1).

- negative, if $L < xH$, c is sufficiently large, and ρ is sufficiently small.

When the seller prefers to withhold the product origin information in the voluntary labeling equilibrium, mandatory labeling affects welfare via its effects on (i) the equilibrium *price* (the "price effect"), (ii) the *number* of varieties offered for sale (the "more varieties effect"), and (iii) the efficiency of *matching* between the "choosy" consumers and their preferred varieties (the "better matching effect"). As shown in Proposition 1, if in equilibrium with voluntary labeling the monopolist does not label, he sets $p^N(c_A, c_B) = 0.5(L+H)$ for all c_A, c_B such that $\min[c_A, c_B] = 0$, and the share of consumers who derive utility H from consumption is

$$(12) \qquad \frac{1}{2}(x^2 + x(1-x)) + \frac{1}{2}(x^2 + (1-x)x) = x,$$

while the share of consumers who derive utility L from consumption is

$$(13) \qquad \frac{1}{2}(1-x)x + \frac{1}{2}(1-x)x = x(1-x).$$

If $\min[c_A, c_B] = c$, the seller may prefer to set $p^N(c_A, c_B) = H$ so that only consumers with (H, H) buy the unlabeled product.

It is easy to verify that in the outcomes in which the input costs are the *same* across countries, $(c_A, c_B) = (0,0)$ or (c, c), mandatory labeling necessarily *raises* (ex post) welfare.[21] Even though under mandatory labeling the seller may raise the prices for products from different countries when the input costs are the same, there are *more varieties* offered for sale and *better matching* between goods and consumers. As a result, the number of consumers who participate in the market remains unchanged or increases compared with the equilibrium without labeling. This is because "choosy" consumers are able to find their *preferred* variety when products from both countries are offered for sale. This prevents the amount of trade from falling due to higher equilibrium prices. However, as we will see next, the effect of mandatory labeling on welfare is ambiguous when the input costs *differ* across countries, i.e. $(c_A, c_B) = (0, c)$ or $(c, 0)$.

[21] As shown in the proof of Proposition 2 in Appendix, $W^{ML}(c_A, c_B) = (1-(1-x)^2)\max[H - c_i, 0] \geq W^{VL}(c_A, c_B)$ for $(c_A, c_B) = (0,0)$ and (c, c), where $W^k(c_A, c_B)$, $k = ML, VL$, is social welfare in the mandatory and voluntary labeling regimes.

To isolate the "price effect" of mandatory labeling on expected welfare, we consider a special case with $\rho = -1$ and $c \geq H$. When $c \geq H$, the seller supplies only products from a country with $c_i = 0$ because selling products from a country with $c_i = c$ cannot generate positive surplus from trade. Hence, the "more varieties effect" of mandatory labeling on welfare is absent when the input costs differ across countries because with and without labeling all of the supply comes from a country with $c_i = 0$. When, in addition, $\rho = -1$, there are only two possible outcomes: $(c_A, c_B) = (0, c)$ and $(c, 0)$. Hence, the "better matching effect" of mandatory labeling on welfare also vanishes because consumers never have access to products from both countries at the same time.[22] And so, the only remaining effect of mandatory labeling on welfare is the "price effect", which can be positive or negative. It is analyzed next.

Using (12) and (13) to aggregate utilities over all consumers, welfare in equilibrium without labeling is $W^{VL}(c_A, c_B) = xH + x(1-x)L$ for $(c_A, c_B) = (0, c)$ or $(c, 0)$, since all consumers except for those with (L, L) buy the unlabeled product. Hence, expected welfare when the monopolist does not to label is[23]

(14) $\quad E[W^{VL}(c_A, c_B)] = xH + x(1-x)L$.

First, we consider the case with $xH < L$. When the input costs vary across countries, by (8), the introduction of mandatory labeling leads to a lower price of the offered variety with $c_i = 0$, $p_i(c_A, c_B) = L < p^N(c_A, c_B)$, and welfare increases:

(15) $\quad W^{ML}(c_A, c_B) = xH + (1-x)L > xH + x(1-x)L = W^{VL}(c_A, c_B)$

for $(c_A, c_B) = (0, c)$ or $(c, 0)$. Under mandatory labeling, the share of consumers who derive utility H from consumption is the same as in (12), and the share of consumers who derive utility L from consumption is

(16) $\quad \frac{1}{2}((1-x)x + (1-x)^2) + \frac{1}{2}(x(1-x) + (1-x)^2) = 1 - x$.

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[22] As discussed above, both of these effects of mandatory labeling on welfare are *positive*, i.e. if the prices of labeled products were set to equal the price of the unlabeled product, expected welfare would necessarily increase under mandatory labeling.

[23] Recall that in a special case with $\rho = -1$ and $c \geq H$, in equilibrium only one variety is supplied at a time because $\Pr((c_A, c_B) = (0, c)) = \Pr((c_A, c_B) = (c, 0)) = 1/2$ and sourcing products from a high-cost country cannot generate positive profits.

Aggregating utilities over all consumers, using (12) and (16), gives overall welfare under mandatory labeling in (15). Expected welfare increases, $E[W^{ML}(c_A, c_B)]$ $> E[W^{VL}(c_A, c_B)]$, because consumers with (L, L) participate under mandatory labeling, and the social surplus from trade between the seller and each consumer (even those with uniformly low valuations) is positive. And so, if there is a large share of consumers with low valuations and sufficiently dispersed input costs, the introduction of mandatory labeling leads to *lower* equilibrium prices and makes consumers better off.

On the other hand, when $L < xH$ and the input costs vary across countries, by (8), the introduction of mandatory labeling leads to a *higher* equilibrium price of the offered variety with $c_i = 0$, $p_i(c_A, c_B) = H > p^N(c_A, c_B)$, and welfare falls:

$$W^{ML}(c_A, c_B) = xH < xH + x(1-x)L = W^{VL}(c_A, c_B)$$

for $(c_A, c_B) = (0, c)$ or $(c, 0)$. Now under mandatory labeling consumers with $\theta_i = L$, who are offered variety i, $i = A, B$, do not participate in the market. This reduces welfare because in the efficient allocation the seller trades with all consumers.[24] Since the amount of trade is reduced while the number of varieties and the efficiency of matches between consumers and products are unchanged, there is also a *reduction* in overall welfare when the input costs *vary* across countries.

However, recall that welfare is necessarily higher under the mandatory labeling policy when input costs are the same in each country, $W^{ML}(c_A, c_B) \geq W^{VL}(c_A, c_B)$ for $(c_A, c_B) = (0,0)$ and (c, c). Therefore, even if there are realizations of input costs such that labeled product prices rise following the introduction of mandatory labeling, *expected* welfare will decrease *only if* similar input costs are sufficiently unlikely (i.e. the correlation coefficient ρ is sufficiently low).

[24] Even though consumers are better informed about their valuations under mandatory labeling, they do not obtain information rents because in a binary setting the seller is able to extract all surplus from trade when $p_i(c_A, c_B) = H$, $i = A, B$. A more general model in which consumers retain positive information rents is analyzed in Section 5.1.

5. Extensions

5.1. More general distribution of consumer valuations

In this section we show that the seller may prefer to withhold information about product origin, and that mandatory labeling policy may increase or decrease welfare in a more general setting with continuous distributions.

We now suppose that the space of consumer valuations is an interval: $\theta_i \in [L, H]$ with $0 \le L < H$, and θ_i is continuously distributed on $[L, H]$ in accordance with the marginal distribution function $F(\theta_i)$, $i = A, B$. As before, the valuations of each consumer, θ_A and θ_B, are drawn independently. Let $v = \int \theta dF(\theta)$. Also, suppose that the input costs c_A and c_B are distributed on $[0, \bar{c}] \times [0, \bar{c}]$ and are drawn from the continuous symmetric distribution function $G(c_A, c_B)$, where $G(c_A, c_B) = G(c_B, c_A)$ for all c_A, c_B and $\bar{c} > 0$.

If the products are labeled, by (1) and (2), the measure of consumers who purchase variety i is now given by

$$D_i(p_A, p_B) = (1 - F(p_i))F(p_{-i}) + \int_{p_{-i}} (1 - F(\theta - p_{-i} + p_i))dF(\theta),$$

where $-i = A$, if $i = B$ and $-i = B$, if $i = A$, and the seller earns

$$\pi^L(c_A, c_B) = \max_{p_A, p_B} \sum_{i=A,B} D_i(p_A, p_B)(p_i - c_i). \tag{17}$$

Let $\hat{p}_i(c_A, c_B) : [0, \bar{c}] \times [0, \bar{c}] \to \Re_+$ denote a solution to (17), $i = A, B$. When the products are labeled with variety, welfare for given realizations of the input costs (c_A, c_B) is given by

$$W^L(c_A, c_B) = \sum_{i=A,B} F(\hat{p}_{-i}) \int_{\hat{p}_i} (\theta - c_i)dF(\theta) + \int_{\hat{p}_{-i}} \int_{\theta_{-i} - \hat{p}_{-i} + \hat{p}_i} (\theta_i - c_i)dF(\theta_i)dF(\theta_{-i}).$$

If the seller does not label products with variety, all consumers with

$$0.5(\theta_A + \theta_B) - p^N \ge 0 \tag{18}$$

purchase because $\Pr(\min[c_A, c_B] = c_i) = 0.5$ for each $i = A, B$, and an unlabeled product is equally likely to originate in country A or B. By (18), the measure of consumers who purchase unlabeled products is given by

$$D^N(p^N) = \int_L^H (1 - F(2p^N - \theta))dF(\theta),$$

and the seller's profits become

(19) $$\pi^N(c_A, c_B) = \max_{p^N} D(p^N)(p^N - \min[c_A, c_B]).$$

Let $\hat{p}^N(c_A, c_B) : [0,\bar{c}]\times[0,\bar{c}] \to \Re_+$ denote a solution to (19). Note that $\hat{p}^N(c_A, c_B) = \hat{p}^N(c_B, c_A)$ so that consumers cannot update their beliefs about the origin of unlabeled products after observing the price. When the products are not labeled, welfare for given realizations of the input costs (c_A, c_B) is given by

$$W^N(c_A, c_B) = \int_{2\hat{p}^N} \int (\frac{1}{2}\theta_A + \frac{1}{2}\theta_B - c^m)dF(\theta_A)dF(\theta_B)$$

$$+ \int^{2\hat{p}^N} \int_{2\hat{p}^N - \theta_B} (\frac{1}{2}\theta_A + \frac{1}{2}\theta_B - c^m)dF(\theta_A)dF(\theta_B)$$

$$= (1 - F(2\hat{p}^N)(v - c^m) + \int^{2\hat{p}^N} \int_{2\hat{p}^N - \theta_B} (\theta_A - c^m)dF(\theta_A)dF(\theta_B),$$

where $c^m = \min[c_A, c_B]$. The following example illustrates.

Example. Suppose that the distribution of valuations is given by $F(\theta) = 1 - e^{-\theta}$ for $\theta \in [0,\infty)$. Then, when the products are labeled, demand for products from country i is $D_i(p_A, p_B) = e^{-p_i} - 0.5e^{-p_A - p_B}$, and for a particular realizations of the input costs and product prices welfare is $W^L(c_A, c_B, p_A, p_B) = \sum_{i=A,B}(1 + p_i - c_i)e^{-p_i} - 0.5(p_i - c_i)$ $e^{-p_A - p_B}$. For any fixed c_A and very large c_B, the profits when the products are labeled become:

$$\lim_{c_B \to \infty} \pi^L(c_A, c_B) = (1 - F(\hat{p}_A(c_A, c_B)))(\hat{p}_A(c_A, c_B) - c_A) = e^{-(1+c_A)},$$

since $\lim_{c_B \to \infty} \hat{p}_B(c_A, c_B) = \infty$, and it is easy to verify that for all c_B that are sufficiently large the profit-maximizing price for (labeled) products from country A is approximately

$$\lim_{c_B \to \infty} \hat{p}_A(c_A, c_B) = 1 + c_A.$$

When the products are not labeled, demand for the unlabeled products is $D^N(p^N) = e^{-2p^N}(1 + 2p^N)$ and ex post welfare is $W^N(c_A, c_B, p^N) = e^{-2p^N}$

$(1+2p^N(1+p^N))-D^N(p^N)c^m$, where $c^m=\min[c_A,c_B]$. The profit-maximizing price of the unlabeled products is $\hat{p}^N(c_A,c_B)=(2+4c^m+\sqrt{(2+4c^m)^2+16})/8$. Evaluating profits with and without labeling at $c_A=0$ and letting $c_B\to\infty$ yields

$$\lim_{c_B\to\infty}\pi^L(0,c_B)=e^{-1}\approx 0.37<0.42\approx e^{-2\cdot 0.8}(1+2\cdot 0.8)\cdot 0.8=\pi^N(0,c_B)$$

Because $\pi^N(0,c_B)$ does not depend on c_B, continuity of the profit functions in c_A, c_B implies that the monopolist achieves higher *expected* profits without labeling as long as the distribution of the input costs is sufficiently dispersed and the realizations with different costs across countries are sufficiently likely (i.e. the random shocks are independent or negatively dependent). Also, when the input cost in one of the countries is sufficiently high ($c_B\to\infty$), welfare is higher without labeling because the price of the unlabeled products is lower, $\hat{p}^N(0,c_B)=(2+\sqrt{20})/8<1=\lim_{c_B\to\infty}\hat{p}_A(0,c_B)$, and the monopolist supplies only products from country A with or without labeling:

$$\lim_{c_B\to\infty}W^L(0,c_B,\hat{p}_A(0,c_B),\hat{p}_B(0,c_B))=2e^{-1}\approx 0.736<0.779\approx W^N(0,c_B,\hat{p}^N(0,c_B)).$$

When c_A is small and c_B is large, the mandatory labeling policy decreases welfare because the negative "price" effect dominates the positive "more varieties" and "better matching" effects. When, under mandatory labeling, the market shares of products from different countries are very different (e.g., the market share of country B's products goes to zero as $c_B\to\infty$), the "more varieties" effect vanishes and the gains in matching efficiency are lower since most consumers either purchase the cheaper variety or stay out of the market.

However, as shown in Figure 1, when the outcomes with similar input costs across countries are likely, the effect of mandatory labeling on welfare is ambiguous and depends on the degree of the dispersion of the input costs. Figure 1 plots the expected profits and welfare with and without labeling when the input cost in each country is drawn independently from a uniform distribution on $[0,\bar{c}]$ for different values of $\bar{c}$ (a

measure of dispersion in the input costs).[25] When the dispersion is sufficiently small, $\bar{c} < 67$, the monopolist achieves higher expected profits with labeling, and mandatory labeling policy has trivially no effect on welfare since labeling is provided voluntarily. When the dispersion is in some intermediate range, $67 \le \bar{c} < 108$, mandatory labeling increases welfare. However, for $\bar{c} \ge 108$, mandatory labeling decreases welfare.

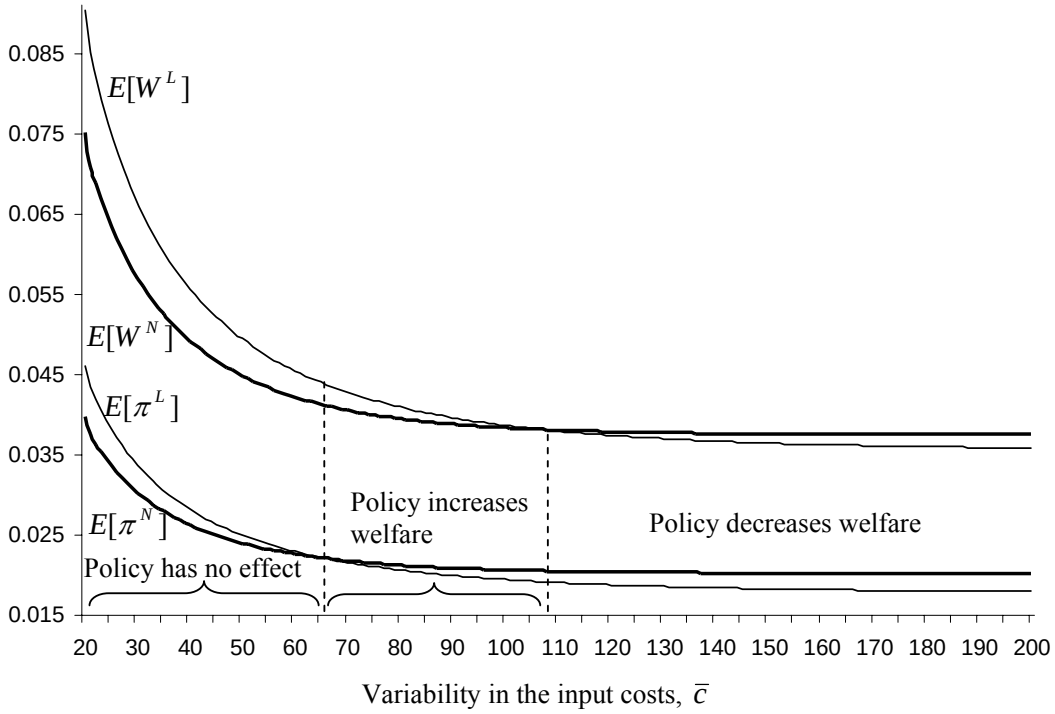

Figure 1. Profits and welfare with and without labeling and variability in the input costs

When the dispersion is not too high ($\bar{c} < 108$), mandatory labeling assures that products from *both* countries are purchased by a *large* number of consumers sufficiently frequently. Then the increase in welfare due to *more varieties* and *better matching* of goods and consumers (since consumers know their actual valuation before they purchase a labeled product) offsets the decrease in welfare due to *higher prices* for the labeled products. However, as the dispersion in the input costs increases, the products from the lower-cost country are more likely to have a significant share of the market, and there are fewer consumers who gain from access to products from different countries. Then the

[25] For example, the expected difference between the input costs in the high-cost and low-cost country is increasing in $\bar{c}$ since $E[\max[c_A, c_B] - \min[c_A, c_B]] = \frac{2}{3}\bar{c} - \frac{1}{3}\bar{c} = \frac{1}{3}\bar{c}$.

decrease in welfare due to *higher prices* for the labeled products is more likely to offset the increase in welfare due to *more varieties* and *better matching*. ■

Allowing for a more general distribution of tastes also reveals a new effect of mandatory labeling on consumer welfare that is absent in the setting with binary valuations: increase in the *information rent*. That is, even if, upon the introduction of mandatory labeling policy, the profit-maximizing price remains unchanged, $\hat{p}^N(c_A, c_B) = \hat{p}_i(c_A, c_B)$ for some (c_A, c_B), consumers will be made strictly better off. By (18), the average consumer surplus (information rent) in equilibrium without labeling is

$$(20) \qquad \int_L^H \int_L^H \max[0.5(\theta_A + \theta_B) - \hat{p}^N, 0] dF(\theta_A) dF(\theta_B) \le \int_L^H \max[\theta - \hat{p}^N, 0] dF(\theta),$$

where the right-hand side is the average consumer surplus (information rent) with labeling when $\hat{p}^N = \hat{p}_i(c_A, c_B)$. Formally, the inequality follows because function $\max[.,0]$ is subadditive, i.e. $\max[a+b,0] \le \max[a,0] + \max[b,0]$ for all a, b, so that

$$(21) \qquad \max[0.5(\theta_A + \theta_B) - \hat{p}^N, 0] \le 0.5 \max[\theta_A - \hat{p}^N, 0] + 0.5 \max[\theta_B - \hat{p}^N, 0]$$

holds for all $\theta_A, \theta_B, \hat{p}^N$. Aggregating (21) over all possible valuations (θ_A, θ_B) gives (20). The intuition is that a consumer who knows whether his valuation for the product is θ_A or θ_B, can make a wiser purchasing decision compared with the consumer who only knows the average of the possible actual valuations, $0.5(\theta_A + \theta_B)$.

To simplify the presentation we assumed that the marginal distributions of valuations and input costs for products from different countries are the same. The analysis can be easily extended to allow for asymmetric distributions. Because the seller is constrained to set the same price for both varieties when the products are not labeled, but can vary prices in the labeling regime, the seller is more likely to achieve higher profits with labeling when the distributions of valuations and input costs differ across varieties (also, see footnote 15).

5.2. Consumer learning from experience and dynamic pricing

In the basic setting in Section 3 we assumed that consumers (privately) know their valuations for each variety. A more realistic assumption is that consumers are initially

uninformed about their match values for different varieties and learn from the previous consumption experience. Next we discuss how our analysis in the static setting can be extended to a dynamic model with forward-looking agents (Bergemann and Valimaki 2006).

Consider a stationary discrete-time model with $-\infty < t < \infty$ and a positive discount rate $\delta \in [0,1)$. As in the static model, in each period a monopolist (privately) observes the realizations of the input costs and offers two varieties, *A* and *B*, of a non-durable, non-storable good for sale in a market consisting of a unit continuum of consumers. A consumer that is alive at date t remains in the market up to date $t+1$ with probability $\lambda \in (0,1)$. For each consumer who exits the market a new consumer arrives, so that the size of the population of consumers remains constant but there is a constant renewal of the customer base. For example, due to changes in income, health conditions, or dietary restrictions, consumers may flow in and out of the market for red meats. The production and labeling technologies are the same as in the basic model.

In contrast with the basic model, we now assume that when a consumer first enters the market she only knows the distribution of valuations (the common prior) rather than her actual tastes. Then forward-looking consumers will view a purchase (at least, initially) not only as providing immediate utility of consumption but also as providing information about the expected benefits from future purchases. One can show that for sufficiently high values of the discount rate δ (i.e. when consumers are sufficiently patient) and sufficiently low values of the turnover rate $(1-\lambda)/\lambda$ (i.e. when the consumers are sufficiently long-lived), the steady state equilibrium converges to a static equilibrium in Section 3. And so, the static model can be viewed as the steady state of the dynamic model with very long-lived consumers.

However, with forward-looking consumers, the provision of information about product origin has two additional "dynamic" effects that are absent in the static setting: (i) Inexperienced consumers (i.e. those who have not tried one or both varieties) are willing to pay *more* because they will be able to make better purchasing decisions *in the future* if they know which variety they buy today; (ii) Incompletely experienced consumers (i.e. those who have tried only one variety) with a negative experience (i.e.

those with low valuations for one or both varieties) may buy *less frequently* since they stop buying the variety for which they have low valuations as soon as they learn about it.

It can be shown that in sufficiently stable markets (i.e. with a low turnover rate $(1-\lambda)/\lambda$), the second effect dominates when the conditions in (11) hold, and the seller achieves higher steady-state profits by withholding information about product origin. Then the profit-maximizing pricing strategy is to target a segment of consumers who found out that they have low valuations for one of the varieties but are yet to experience the other variety. Using this pricing strategy, the monopolist increases sales because *incompletely informed* consumers with actual uniformly low valuations buy *more frequently* when the products are unlabeled.

6. Conclusions

In this paper, we have shown that in a setting with private valuations the multi-product monopolist prefers to provide or withhold information about product variety (country of origin) depending on the distributions of valuations and input costs (country-specific wholesale prices). No information about product origin is provided in equilibrium when idiosyncratic input price volatility is sufficiently great, and the dispersion of consumer valuations is not too small or too great. We have also found that, in a simple binary setting, MCOOL increases or decreases welfare depending on the share of consumers with high valuations. We have discussed several extensions of the basic model that allow for more general distributions of valuations and input costs, and consumers learning their valuations by buying and trying the products in a dynamic framework.

We have endogenized the provision of COOL under voluntary labeling, and our explanation of the lack of voluntary COOL on a large scale does not hinge on the costs of labeling. We have demonstrated that a *market failure* in the provision of COOL may, indeed, occur with the attending need for policy intervention, which may or may not be the MCOOL policy. A common finding in the previous empirical studies of COOL (e.g., Lusk and Anderson 2004, Brester et al 2004, Awada and Yanika 2006, Alejandro et al 2008) is that a sufficient increase in demand for the products labeled with the country of origin is necessary for MCOOL to have a positive effect on welfare due to the implementation costs imposed by the policy. In contrast, our model shows that even

when the implementation cost is zero, MCOOL may have a negative effect on welfare. However, we also find that under plausible conditions such as intermediate levels of dispersion in consumer valuations and input costs the effect of MCOOL on welfare is positive.

Many agricultural markets are characterized by aggregate uncertainty relating to the quality attributes of food products rather than idiosyncratic uncertainty studied in the paper. A recurring pattern of food safety failures and contaminated food products indicates that a model with common values for the seller's products is perhaps more suitable for studying the conditions under which the seller prefers to provide or withhold information about product origin and analyzing the welfare implications of mandatory provision of such information. Nonetheless, even in such settings quality differentiation and wholesale price volatility of agricultural products from different countries (regions) may be important determinants of the seller's labeling decision.

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Appendix

Proof of Proposition 1: From (9) and (10) it follows that the monopolist can achieve higher profits when the products are not labeled only if the profit-maximizing price without labeling is $p^N(c_A, c_B) = 0.5(L + H)$ for all c_A, c_B such that $\min[c_A, c_B] = 0$, i.e. if $0.5(1-(1-x)^2)(L+H) > \max[L, x^2 H]$. So we suppose that this is the case. Then when the products are labeled, the monopolist sets the prices at $p_i(0,0) = H$, $i = A, B$, when $(c_A, c_B) = (0,0)$, because, by assumption, $(1-(1-x)^2)H > 0.5(1-(1-x)^2)(L+H)$ $> L$. And so, using (4) and (5), it is easy to verify that $\pi^L(c_A, c_B) \geq \pi^N(c_A, c_B)$ for $(c_A, c_B) = (0,0)$ and (c, c). Also, by (8), it follows that $\pi^L(c_A, c_B) < \pi^N(c_A, c_B)$ for $(c_A, c_B) = (0, c)$ and $(c, 0)$ if both conditions in (11) hold. Therefore, by (9) and (10), we have

$$E[\pi^L(c_A, c_B)] < E[\pi^N(c_A, c_B)] \text{ when } \rho = -1,$$

$$E[\pi^L(c_A, c_B)] > E[\pi^N(c_A, c_B)] \text{ when } \rho = 1,$$

and

$$E[\pi^L(c_A, c_B)] - E[\pi^N(c_A, c_B)] \text{ is increasing in } \rho.$$

Hence, by continuity, it follows that there exists $\hat{\rho} > -1$ such that for all $\rho \in [-1, \hat{\rho})$ the monopolist achieves higher profits without labeling, i.e. $E[\pi^L(c_A, c_B)] < E[\pi^N(c_A, c_B)]$, only if (11) holds. ■

Proof of Proposition 2: If the monopolist does not label products when labeling is voluntary, by Proposition 1, (11) must hold. Then under mandatory labeling the seller sets $p_i(0,0) = H$, $i = A, B$ since, by (11b), $(1-(1-x)^2)H > L$. Also, when $(c_A, c_B) = (0, c)$ or $(c_A, c_B) = (c, 0)$ the monopolist either offers only products from a low-cost country with $c_i = 0$ or sets $p_A(c_A, c_B) = p_B(c_A, c_B) = H$ when products from both countries are offered for sale since

$$\pi^L(0, c) = \pi^L(c, 0) = \max[L,\ xH + x(1-x)\max[H - c, 0]]$$

$$> (x^2 + 1 - x)L + x(1-x)\max[H - c, 0],$$

where the inequality follows by (11b). And so, under mandatory labeling welfare for different realizations of input costs (c_A, c_B) is given by

(A1a) $W^{ML}(0,0) = (1-(1-x)^2)H$,

(A1b) $W^{ML}(0,c) = W^{ML}(c,0)$

$$= \begin{cases} xH + x(1-x)\max[H-c,0], \text{ if } xH + x(1-x)\max[H-c,0] \geq L \\ xH + (1-x)L, \text{ if otherwise} \end{cases},$$

(A1c) $W^{ML}(c,c) = (x^2 + 2x(1-x))\max[H-c,0]$.

When labeling is voluntary and the monopolist prefers not to label, welfare for different realizations of the input costs (c_A, c_B) is given by

(A2a) $W^{VL}(0,0) = W^{VL}(0,c) = W^{VL}(c,0) = xH + x(1-x)L$,

$$\text{(A2b) } W^{VL}(c,c) = \begin{cases} x(H-c) + x(1-x)(L-c), \text{ if } \hat{p}^N(c,c) = 0.5(H+L) \\ x^2(H-c), \text{ if } \hat{p}^N(c,c) = H > c \\ 0, \text{ if } H \leq c \end{cases}.$$

It is straightforward to verify that $W^{ML}(c_A, c_B) \geq W^{VL}(c_A, c_B)$ for all c_A, c_B when $L > xH$ and $c > \hat{c} \equiv H - \frac{L - xH}{x(1-x)}$. Hence, we have $E[W^{ML}(c_A, c_B)] \geq E[W^{VL}(c_A, c_B)]$ for all ρ and $c > \hat{c}$.

Now suppose that $L < xH$ and $c \geq H$. Then, by (A1) and (A2), we have

$$E[W^{ML}(c_A, c_B)] = \frac{1}{4}(1+\rho)(1-(1-x)^2)H + \frac{1}{2}(1-\rho)xH$$

$$< \frac{1}{4}(3-\rho)(xH + x(1-x)L) = E[W^{VL}(c_A, c_B)]$$

for all $\rho < -\frac{H-3L}{H+L} \in (-1,1)$. Hence, from (A1) it follows that, by continuity of $W^{ML}(c_A, c_B)$ in c_A and c_B, the inequality continues to hold for all c that are sufficiently close to H and all ρ that are sufficiently close to -1. ■