To Regulate or Not? The Trade-off between Food Safety and Consumer Choice

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Abstract

This paper investigates welfare consequences of food safety regulations. It develops a theoretical model exploring the implications of food safety standards on the number of varieties when consumers prefer more variety to less. The issue is that strengthening food standards can result in the loss of varieties that do not meet the required standards, but still generate utility for consumers. The paper examines the relationship between standards and a loss of variety domestically and internationally; and ranks possible international trade policies (harmonisation, mutual recognition, and autarky) in terms of their welfare implications. The model shows possible welfare worsening consequences of harmonisation compared to autarky, and concludes that when consumers prefer variety, non-harmonised trade is always welfare improving relative to autarky. Thus, food safety legislation imposed in a good faith might limit consumer choice and welfare.

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1 Introduction

Food safety (or lack of it) demonstrates itself in a variety of forms: fast-acting and quickly detectable food-borne illnesses (such as diarrhoea, salmonellosis, cholera, etc); food contamination likely to lead to an illness in a longer term (for example BSE); and food safety issues with yet uncertain outcomes (for example the presence of metals). For the purposes of this paper, food safety regulations are defined to be minimum food safety criteria required in the production, processing or distribution of a market product. Some of the most controversial examples of what constitutes safe foods are raw milk cheeses and other dairy products, rare steaks and other meats, undercooked shellfish, raw and soft-boiled eggs, sushi, non-pasteurised cider, etc. The concept of food safety and consequent regulations are based on each country's historic, cultural, production, culinary and other conditions and perceptions of risks. As such, food safety regulations remain in the domestic policy jurisdiction, justifying potential differences across countries. While international efforts to align food safety (or any other) standards are under way, international recommendations are not yet developed for all areas, and even where they do exist, countries are guaranteed the right to choose standards they deem appropriate to protect human, animal, and plant health as long as they do not act as barriers to trade. Consequently, different national food safety policies imposed in a good faith often interact or even conflict in the international trade arena, and might be suspected of being non-tariff trade barriers if trading partners do not subscribe to the same definition and critical levels of food safety.

This paper investigates welfare consequences of food safety regulations. It develops a theoretical model exploring the implications of food safety standards on the number of varieties when consumers prefer more variety to less. In particular, it examines the relationship between standards and a loss of variety domestically and internationally; and ranks possible international trade policies (harmonisation, mutual recognition, and autarky) in terms of their welfare implications. For the sake of exposition, some aspects of the theoretical model are demonstrated on a simplified example of raw and pasteurised milk cheeses where the quest for uniform food safety on the market could come at the expense of losing valued varieties.

2 Model[1]

It is a matter of fact that foodstuffs are differentiated not only in the variety space, but also in the attributes space. For example, the "variety space" of "dairy products" includes an assortment of dairy products, such as fluid milk and yoghurt with different fat content, different types of cheese, crème, etc. For the purposes of this paper, each type of cheese represents a different variety. An "attribute" of, for example, soft cheese would be whether it was produced from raw or pasteurised milk. Every time a new variety (for example, of cheese) is introduced, the quantity produced of each variety (of dairy products) declines and the average cost of production rises, but the consumers gain from greater variety, ceteris paribus. Once trade opens, each country produces a set of varieties, and wants to import other varieties that have similar attributes.

In autarky, each country would determine its own standard (or lack thereof) for defining the attributes (for example, acceptance of raw milk dairy products) to meet domestic consumer preferences. Assume each country sets a certain minimum standard: that is, "everything above" the minimum standard is accepted. The implication of this assumption in the dairy example would be that if a country considers raw milk soft cheeses safe, it also accepts pasteurised milk soft cheeses. If a country only considers pasteurised dairy products safe, its tolerance level does not cover raw milk products. Due to labelling requirements introduced in many countries, consumers are informed and conditions for separating equilibrium are satisfied.

For the sake of simplification for now we also hypothesise that both attributes (raw and pasteurised versions) of the same variety are priced equally. The model presented is static, and instantaneous adjustments are made as needed. All agents have perfect foresight and perfect information. Consumers have trust in labelling schemes (if present), and are able to distinguish between attributes at no cost to them if attribute standards for like products are in place. Transportation is costless. Firms in the model do not earn any excess profits, and government does not impose any taxes. Due to the zero profit assumption producers are indifferent as to what attribute is demanded from them, so that the attribute is set at a level determined endogenously by the consumers' utility maximising decision. The "consumer decides" model seems to be well suited to describe the growing role of consumer concerns and demands in trade.

Each country, consisting of like individuals, has access to the same production technologies, and differs in their preference for attributes or in other words, "tolerance level" for what they might perceive as a minimum food safety (in a way that will be made more precise momentarily). We start with a basic Krugman (1980) model where goods are differentiated in the variety space only. Each consumer has the utility function:

[1] An abridged version of the model is presented. For general and more technical exposition of the model see Tothova (2004).

(1) $$U = \left(\sum_{j=1}^{N} \left(d_j \right)^{\theta} \right)^{\frac{1}{\theta}} \text{ where}$$

(2) $$\theta = \left(1 - \frac{1}{\sigma} \right), \sigma > 1$$

σ represents elasticity of substitution between varieties, assumed to be constant and the same for all varieties; d denotes consumption of the differentiated goods; and the subscript j denotes the variety. The consumer derives utility from a large number of varieties (indexed one to N). θ is a parameter used for ease in exposition, and does not have a direct interpretation except in terms of the elasticity of substitution (e.g. $\theta = 0$ corresponds to unitary elasticity of substitution and $\theta = 1$ corresponds to no substitutability). With scarce labour and positive fixed costs, it may be that only $n < N$ varieties are actually produced. All varieties enter the utility function symmetrically carrying the same weight.

Each consumer is endowed with one unit of labour only. There is no capital and we normalise the wage per unit of labour to one, so that consumer income consists entirely of wage earnings $w = 1$. The entire stock of labour is used in production; consumers do not derive any utility from leisure. The demand for the differentiated good is obtained through maximisation of the CES utility subject to the budget constraint:

(3) $$\underset{\{d_j\}_{j=1}^{N}}{\text{Max}} \left(\sum_{j=1}^{N} \left(d_j \right)^{\theta} \right)^{\frac{1}{\theta}} \quad s.t. \quad \sum_{j=1}^{N} p_j d_j = 1$$

Assuming an interior solution, the first-order conditions for the differentiated good maximisation problem are:

(4) $$\left(\sum_{j=1}^{N} \left(d_j \right)^{\theta} \right)^{\frac{1-\theta}{\theta}} \left(d_j \right)^{\theta-1} = \phi p_j$$

(5) $$\sum_{j=1}^{N} p_j d_j = 1$$

where ϕ is a Lagrange multiplier. Solving these two first-order conditions yields the demand for variety j where it is optimal to purchase all varieties available in equal quantities:

(6) $$d_j = \frac{p_j^{-\sigma}}{\sum_{j=1}^{n} p_j^{1-\sigma}}$$

σ represents the elasticity of substitution between pairs of varieties of the same product (i.e., dairy). The price elasticity of demand faced by producers is:

(7) $$\varepsilon^D = \sigma + \frac{p_j^{1-\sigma}}{\sum_{j=1}^{n} p_j^{1-\sigma}}(1-\sigma)$$

As n (the number of actual varieties produced[2]) is large, we make the usual assumption that the firm disregards the second component in the elasticity term, and considers σ to be the elasticity of demand it faces (Helpman and Krugman, 1985).

Up to this point the model followed closely Krugman (1980). Now assume that each variety can have one of two attributes (soft cheese made of raw or pasteurised milk). Consumers have preferences over the two attributes that imply the two are substitutes. In particular, we view quantities of the variety in "quality-adjusted units" (recall each country puts a different weight on different attributes), so that

(8) $$d_j = d_j^R + \lambda^C d_j^P$$

d_j^Q is the quantity of variety j that possesses attribute $Q = R$, for raw milk or attribute $Q = P$ for pasteurised milk, and λ^C is a country-specific parameter that converts the physical quantity of cheese made of pasteurised milk into a utility-equivalent quantity. For example, if consumers in country C prefer cheese made of pasteurised milk only ½ as much as cheese made of raw milk, then $\lambda^C = ½$ and it takes 2 units of cheese made of pasteurised milk to generate the utility equivalent to that generated by 1 unit of cheese made of raw milk.

The linear quality adjustment of equation (8) and increasing returns to scale in production ensure that in autarky each country consumes each variety in only one attribute type. To see this, think of consumers constructing their own consumption of variety j by purchasing goods with the two different attributes and putting them together. Using this interpretation, the price of a unit of variety j is the minimum cost of creating the variety from the components with the two different attributes. If

[2] In the Helpman and Krugman (1985) terminology actual varieties produced form a set of available varieties with finite price – varieties not available are considered to have an infinite price.

we let p_j^R and p_j^P represent the prices of the components with the different attributes (although both are priced equally, we keep the superscripts for the sake of exposition), then price of the bundle is $p_j = \min\left(p_j^R, p_j^P \big/ \lambda^C\right)$. This follows from the fact that it requires $1/\lambda^C$ units of the good with the attribute of "made of pasteurised milk" to provide the same utility as one unit of the good with the attribute of "made of raw milk". If $p_j^R < p_j^P \big/ \lambda^C$, then consumers only demand the attribute of "made of raw milk" for variety *j*. If the inequality is reversed, they demand only the attribute of "made of pasteurised milk" for variety *j*, and if the two are equal, consumers are indifferent (but increasing returns to scale means that only one attribute type will be produced). Since the process of the constituent components can, in principle, vary by variety, it is possible that some varieties will be constructed of only raw milk products, others of only pasteurised milk products.

Producers follow a Krugman model of monopolistic competition, assuming fixed and marginal costs are identical across raw and pasteurised milk made varieties. Increasing returns in the differentiated sector are internal to firms – an initial outlay of labour ("fixed cost") is needed to start up production, resulting in decreasing average cost; marginal costs are constant within a variety, attribute combination. Firms producing differentiated goods are assumed to be symmetric, resulting in the same price and output across varieties. The presence of the scale economies ensures that in equilibrium only a finite number of varieties are produced, each firm produces a different variety, and each variety will be produced with only one attribute (made of raw or pasteurised milk) only. Each firm producing up to a certain specification faces the same cost function regardless of its location. All varieties are perfect substitutes in production. The number of varieties produced within the economy is determined by the number of firms.[3] Firms can enter freely into the differentiated industry. The usual profit maximisation and zero-profit entry conditions apply regardless of the chosen attribute which along with consumer demands determine price and production levels. The equilibrium in production is described by the number of firms and the price level. Since only labour is used in the production, following Krugman (1980) we specify the cost functions:

$$c_i\left(y_i\right) = wl_i\left(y_i\right) = w\left(S + y_i M\right) \tag{9}$$

where $l_i\left(y_i\right)$ is the labour requirement to produce y_i units of variety *i* regardless the attribute, *S* is the fixed labour component, and *M* is the marginal labour component for producing any variety. Letting the wage equal one, we set marginal revenue equal marginal cost to find the profit-maximising price charged for variety *j*:

[3] We ignore integer issues when discussing number of firms in the economy.

(10) $$p_j = \frac{\sigma}{\sigma - 1} M$$

Since all varieties with a given attribute have the same marginal cost, the price of all varieties with the given attribute will be the same. By free entry, profits are driven to zero, so that average cost equals price. After solving the model, this implies that each firm will hire $S\sigma$ workers. If the amount of labour available is L, then the total number of varieties regardless the attribute will be:

(11) $$n = \frac{L}{S\sigma}$$

In the basic Krugman model, marginal costs impact price, while fixed costs together with the size of the economy influence the number of varieties produced in an economy.[4]

2.1 Autarky

For a single [autarkic] economy with identical consumers, only products made of raw milk are produced if $\lambda < 1$. Only products made of pasteurised milk are produced if $\lambda > 1$. Consequently, the indirect utility function (labelled V) in the country preferring "raw milk" dairy products is:

(12) $$V^R = \frac{1}{p} n^{\frac{1-\theta}{\theta}}$$

In the country putting greater weight on "pasteurised" dairy products, the indirect utility becomes:

(13) $$V^P = \frac{\lambda}{p} n^{\frac{1-\theta}{\theta}}$$

Superscripts serve merely notational purposes, R indicates only raw milk cheeses (or other dairy products) are produced, P indicates only pasteurised milk dairy products are produced. Notice λ (the weight put on the pasteurised milk attribute) is listed without a country superscript due to the single-country case. Define $W(\lambda) = max(V^R, V^P)$ to be social welfare as a function of λ the marginal rate of substitution between different attributes of the same variety. The graph $W(\lambda)$ is shown in Figure 1. For $\lambda < 1$ the country maximises welfare by producing only with the "raw milk" attribute. As λ exceeds 1, only varieties with the "pasteurised milk" attribute are produced. Social welfare increases as a function of λ since the value to consumers of the "pasteurised milk" attribute increases as λ increases.

[4] By construction of the Krugman model, larger fixed cost per variety ("start-up cost") results in smaller numbers of varieties produced. For example, if larger investments are needed to comply with food safety regulations, the number of varieties produced within the economy will be smaller.

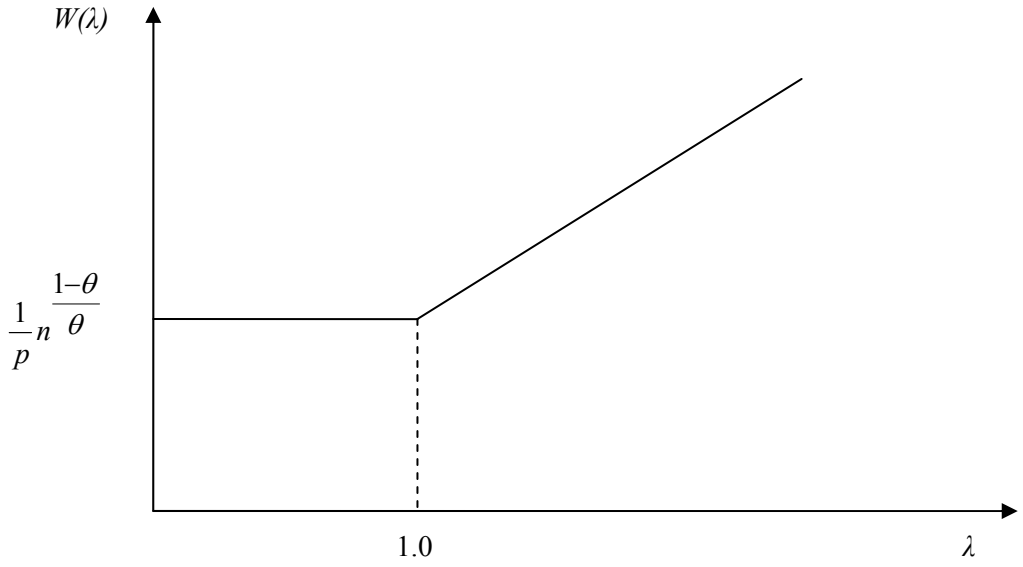

Figure 1: Social welfare as a function of weight put on the consumption of "pasteurised milk" attribute: autarky.

Any enforcement of standard different from the standard prevailing on the basis of consumer preferences for attributes (raw or pasteurised dairy products) would result in lower welfare since in case of linear preferences utility is maximised by consuming only one type of product. Consumption of other type of product or both products would locate the consumer on the lower indifference curve. So far we assumed that the cost of production is the same across attributes and varieties and thus consumers were deciding on the basis of their preferences with the cut-off point of marginal rate of substitution between attributes being one.[5]

However, assume in autarky the regulator would seek to enforce standard different from the standards a consumer chooses based on the weight he puts on the consumption of a certain attribute. For example, the regulator, maximising the social welfare function which internalises the cost of treating potential food-born illnesses from consuming dairy products made of non-pasteurised milk, would change the price structure of dairy products made of raw and pasteurised milks, making one attribute relatively more expensive than other. However, without governmental intervention adjusting the prices, the consumer would choose its preferred attribute. The discussion of open trade is based on consumers choosing different standards in different countries.

[5] The assumption of equal cost across varieties is for convenience only. In the absence of this assumption the kink on the Figure 1 would have different coordinates ($\lambda \neq 1$).

2.2 Harmonisation

'Opening trade' in a one-factor model coincides with Krugman (1980), and translates into a larger factor (labour) pool, as well as a larger product market to supply. Constant elasticity of demand assures the price levels (or, outcomes of the profit maximising conditions) do not change. The growth in the size of the market measured as an increase in the labour force does not influence the individual firm's output, but divides it among larger number of consumers, resulting in lower per capita consumption of any variety. Also due to the constant elasticity assumption, the entire increase in the stock of labour in the integrated economy is directed into production of varieties not existing in autarky, and does not increase the amount of labour directed to existing varieties. Intuitively the basic Krugman model claims that trade is good as it (at least) increases the number of available varieties, as is the case in this model, and consumers in the integrated economy benefit from a larger number of varieties available to them at the price identical with the autarky price. Therefore, having more varieties available in an open trade than in autarky is a sufficient reason to trade and integrate (Krugman, 1980).[6]

In a free trade situation, a country that can import one variety from another country can reallocate the resources previously used in the production of one variety to production of a new variety and consumers benefit from the introduction of a new variety. However, in order to trade, the country must find an exporter whose minimum attributes match (or exceed) the domestic attributes. One way to accomplish this is by adapting the domestic attributes to world market conditions or attributes, but this entails a decrease in utility (from consumption at sub-optimal attributes) since the attributes were originally set to meet domestic consumer preferences. Thus, the country must trade off the utility gained from an increase in the variety of food available with the loss in utility from sub-optimal attributes.

For open trade scenarios we assume consumers in each country are able to distinguish between attributes, "raw" and "pasteurised" dairy products are perfectly traceable, and segregation is guaranteed. Labelling schemes, if present, are costless. Possibly allowing for differently sized economies, and consequently differing numbers of varieties across countries, define n to be number of varieties in one country, and n^* to be number of varieties in the other country. When a non-harmonised trade is not a policy option, in order to trade, countries must harmonise their production (and consumption) standards. The presence of fixed costs prevents production of both attributes: if a certain variety would be produced in both attributes, the country sacrifices production of new varieties and is not producing on the highest point of its production possibilities frontier. The number of varieties produced in each country depends on the country's labour force. If trade is permitted, and all goods are standardised to the attribute "pasteurised", the indirect utility function is:

(14) $$V^P = \frac{\lambda}{p}\left(n + n^*\right)^{\frac{1-\theta}{\theta}}$$

If trade is permitted, and all goods are standardised to the attribute "raw" (recall that attribute "raw" includes both "raw" and "pasteurised" dairy products), the indirect utility function is:

(15) $$V^R = \frac{1}{p}\left(n + n^*\right)^{\frac{1-\theta}{\theta}}$$

Each harmonised indirect utility function is graphed in Figure 2 (equal size country case). ($\underline{\lambda}$, $\overline{\lambda}$) is an interval over which a country finds harmonisation beneficial and will be discussed shortly.

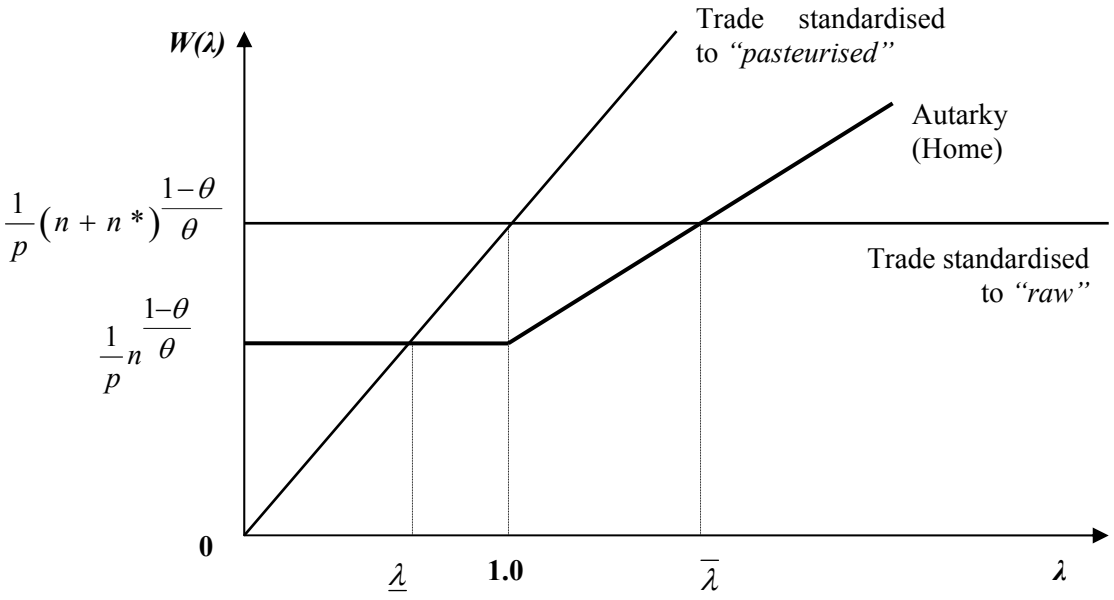

Figure 2: Social welfare as a function of λ: autarky, standardisation to "raw" and "pasteurised", equal size country case. Figure drawn from a single country perspective.

A similar diagram illustrating open trade and autarky welfares in a small and large country is graphed in Figure 3.

[6] Assuming there is a large number of varieties so that each country produces a different and non-overlapping set of varieties.

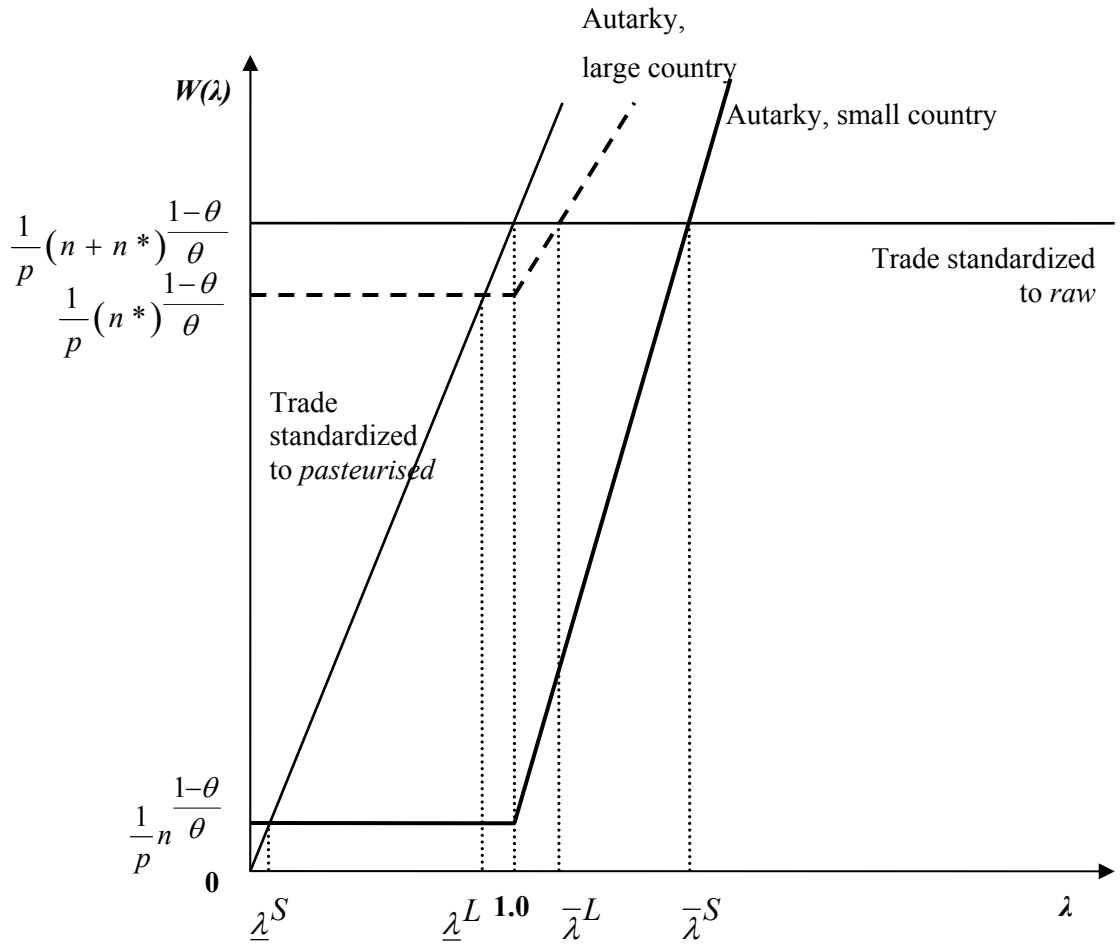

Figure 3: Social welfare as a function of λ: autarky, standardisation to "raw" and "pasteurised", small and large country.

In Figure 3, on the abscissa we notice two intervals: an interval over which the small country finds the harmonisation beneficial ($\underline{\lambda}^S, \overline{\lambda}^S$), and an interval over which the large country finds the harmonisation beneficial ($\underline{\lambda}^L, \overline{\lambda}^L$). The corresponding interval over which a country finds harmonisation beneficial in Figure 2 is ($\underline{\lambda}, \overline{\lambda}$). We will numerically analyse Figure 3. $\underline{\lambda}^S$ is the solution to

$$\frac{\lambda}{p}(n+n^*)^{\frac{1-\theta}{\theta}} = \frac{1}{p}n^{\frac{1-\theta}{\theta}} \Rightarrow \underline{\lambda}^S = \left(\frac{n}{n+n^*}\right)^{\frac{1-\theta}{\theta}} \quad (16)$$

$\overline{\lambda}^S$ is the solution to

(17) $$\frac{1}{p}(n+n^*)^{\frac{1-\theta}{\theta}} = \frac{\lambda}{p} n^{\frac{1-\theta}{\theta}} \Rightarrow \bar{\lambda}^S = \left(\frac{n}{n+n^*}\right)^{\frac{\theta-1}{\theta}}$$

Similar calculations using the autarky number of varieties of the large country (n*) apply to $\underline{\lambda}^L$ and $\bar{\lambda}^L$. Interpreting Figure 3, if the small country has $\lambda^S < \underline{\lambda}^S$, then for the small country trade standardised to "pasteurised" is worse than autarky. If the large country has $\lambda^L > \bar{\lambda}^L$, then for it trade standardised to "raw" is worse than autarky. Thus, whether the attribute is "raw" or "pasteurised", in this case one country will be worse off than autarky and will not agree to the harmonisation.

Pesticide residue standards for fruits and vegetables are examples of where the small country (e.g. Chile) agrees to the standards imposed by a larger importer (e.g. the U.S.) in order to access the U.S. market. Beef tetracycline and disease standards are similar examples.

Notice that the length of the interval over which the small country finds the unilateral harmonisation beneficial is large, while the interval over which it is favourable for the large country to change its own standard to harmonise with the small country is narrow. In addition, if the large country decides unilaterally to harmonise, the gain in social welfare from consuming open trade number of varieties is small compared to welfare gains small country would experience if it decided unilaterally to harmonise to large country standard.

2.3 Non-harmonised trade

For welfare comparison, suppose now that the countries – regardless their size – would allow trade without requiring harmonisation of attributes. One country produces (and trades) only raw milk varieties (regardless what the other country does). In that case the indirect utility function from consuming both raw and pasteurised varieties (as earlier, assuming fixed and marginal costs are attribute and variety invariant) is:

(18) $$V = \frac{1}{p}\left(n + n^* \lambda^{\frac{\theta}{1-\theta}}\right)^{\frac{1-\theta}{\theta}}$$

where n and n^* are the numbers of varieties produced in the individual countries. It is possible $n \neq n^*$ due to differing endowments across countries, not different technologies across countries. A representative consumer consumes number of varieties previously available in autarky, as well as

varieties produced in the other country. If $\theta > 0.5$, the "non-harmonised" trade social welfare is convex for $\lambda \in \langle 0,1 \rangle$, and graphed in Figure 4. If $\theta < 0.5$, the "non-harmonised" trade social welfare is concave for $\lambda \in \langle 0,1 \rangle$, and graphed in Figure 5. Non-harmonised trade is always welfare increasing regardless the weights in the linear utility function (λ).

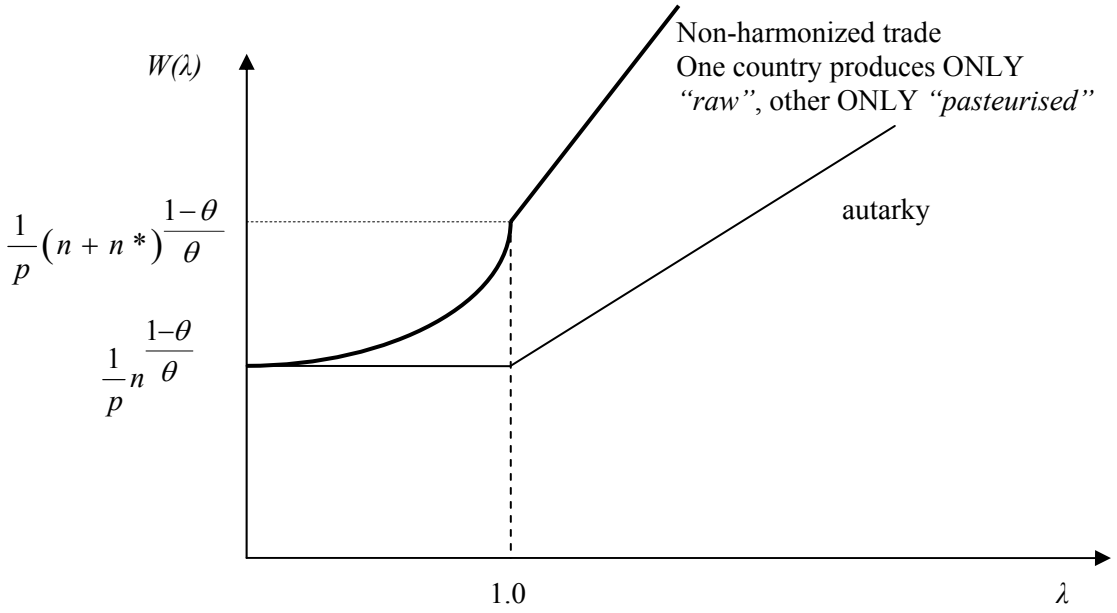

Figure 4: Social welfare as a function of weight put on the consumption of pasteurised version: autarky and non-standardised trade, $\theta < 0.5$

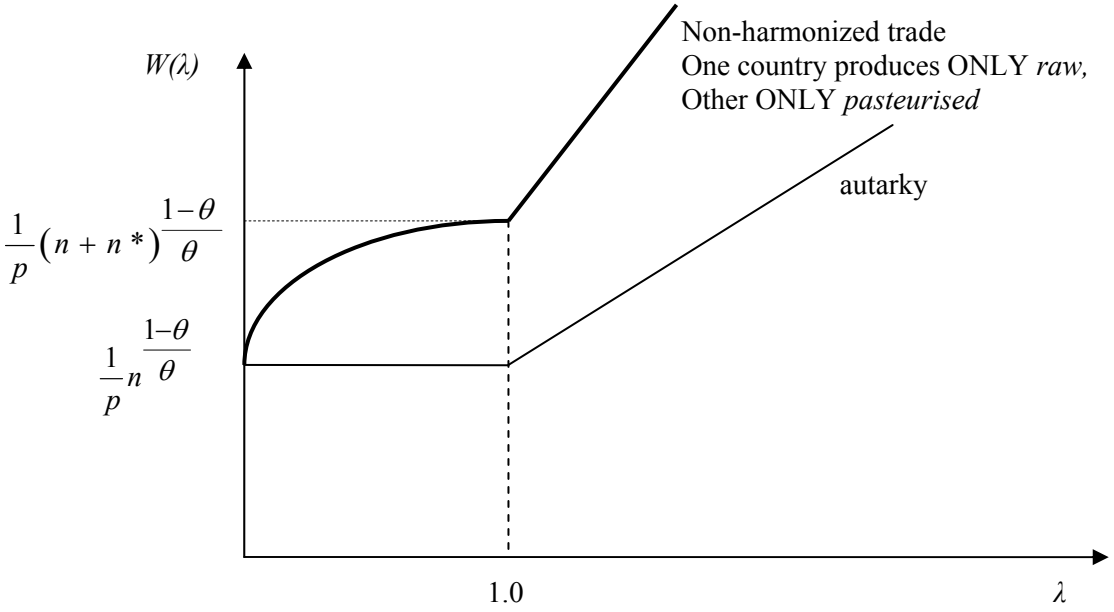

Figure 5: Social welfare as a function of the preference weight put on the consumption of varieties with the pasteurised attribute: autarky and non-harmonised trade, $\theta > 0.5$**.**

Examples of non-harmonised trade with respect to food safety are rare. Non-food examples of products with different standards include electrical appliances such as travel irons or radios that use different types of plugs or batteries, etc.

An extension of the paper (as done for standards – or lack of them – for genetically modified food in Tothova and Oehmke, 2004) is to explore de facto "clubs" of countries that adopt similar standards (or lack of standards) for food safety between countries taking countries' preferences for a particular regulatory approach as exogenous rooted in the consumer preferences. They concluded that when harmonisation of standards and regulatory approaches is required for trade to occur but countries' standards and preferences are very diverse, countries are better off maintaining different standards rather than harmonising or reaching a compromise standard. When countries do not harmonise or compromise, the model gives rise to de facto "clubs" of countries. Members of each club have similar standards and are engaged in food trade with other members of that club. Differences in standards prevent members of different clubs from trading food products, so that there is no cross-club trade in food products. This paper does not pursue the idea of polarisation of trading partners into two clubs based on standards rooted in consumer preferences and emergence of trade agreements, although clubs (or trade agreements with like-minded partners) offer an opportunity to consume larger number of varieties compared to autarky.

3 Conclusions

The model above demonstrated possible welfare worsening consequences of harmonisation compared to autarky, and concluded that in the environment that values variety, non-harmonised trade is always welfare improving relative to autarky.

In setting up domestic regulations in the area of food safety regulators take into account human, animal, and plant health. However, as this paper shows, regulations that are too tight are likely to lower welfare as they restrict number of varieties available. It appears to be difficult to set up appropriate policies and marketing channels for non-harmonised trade. At a minimum, such a situation would require some sort of identity preservation and labelling system. Even in the presence of such a system, product liability issues for the product with the less restrictive food safety standard could eliminate the incentive for suppliers to trade. Yet if harmonisation of standards is required for trade to occur, countries are risking lower welfare due to consuming varieties on a different standard as opposed to their standards that prevailed in autarky. In case of differently sized economies, a small country could choose not to harmonise if meeting the large-country standard meant a cost increase to farmers or processors relative to the traditional way in which a staple crop was produced. A small country could find harmonisation beneficial if consumers are largely indifferent between the existing standard and that required by the trading partner, and the costs of production are similar. If trade is desired, small countries might have to harmonise their standards with large countries, or produce

according to a "non-aligned" standard for the domestic market only. In the latter case, the economies of scale might not be sufficient to sustain the production, or identity preservation costs might be high, and the number of varieties would drop. Developing international guidelines setting bare minimum food safety standards would be helpful. However, food safety legislation imposed in a good faith might limit consumer choice. In addition, a country deciding to choose more stringent standards that it deems appropriate for human, animal, and plant health might be still be suspected of imposing a non-tariff trade barrier.

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