Abstract: Traceability regulations are a way to protect consumers by forcing firms to identify and track products step-by-step through all stages of production, processing, and distribution. Traceability is often used in conjunction with country-of-origin labelling where products explicitly identify where production takes place. However, such country-of-origin regulations can conflict with WTO provisions. This paper analyzes the impact on consumer welfare of traceability and country-of-origin in an international trading regime to assess whether such regulations actually improve consumer welfare. The paper constructs a theoretical model that highlights the potential market failure that arises from traceability. The paper then introduces a simple international trade regime to identify impacts on consumer surplus. The paper compares outcomes with, and without, traceability and country-of-origin regulations. Given the inherent free-rider problem, the paper shows that, as long as costs associated with traceability are low enough, mandatory regulations are welfare improving. Free trade, in the absence of foreign traceability, can lower consumer welfare so provides a rationale for country-of-origin rules. However, mandatory country-of-origin rules need not be welfare enhancing. We show that country-of-origin rules are similar to import barriers and so are third-best solutions. The better solution is international adoption and recognition of traceability rules which would make country-of-origin rules moot.

Keywords: traceability; country-of-origin labelling; international trade; consumer surplus; market failure

1. Introduction

Traceability regulations are a way to protect consumers. They force firms to identify and track products step-by-step through all stages of production, processing, and distribution [1]. The goal is to protect consumers from fraud and producers from unfair competition; to facilitate and monitor traceback to enhance food safety; and to address consumer information gaps about food safety and quality [2]. For food safety, step-by-step tracking allows firms to reduce the time it takes to identify and remove unsafe food products.

Country-of-origin labelling (COOL) is a common practice to help consumers identify potential country-specific differences in perceived product quality. Proponents argue that consumers have the right to know where their products come from (see [3–5]). The assumption is that consumers may prefer domestically produced goods “either due to perceived quality or safety differences or through an ethnocentric desire to support domestic industries” [6] (p. 1). Alternately, consumers may value imported goods (such as German-made cars, French wines, or New Zealand dairy) more and so benefit from such labelling.

Opponents of country-of-origin rules argue that consumers, in fact, may have little interest in country-of-origin labelling per se, so it constitutes a wasteful regulation. Further, the cost of labelling may be high [7]. Although the General Agreement on Tariff and Trade (GATT) provisions allow individual contracting parties to set rules-of-origin, the provisions do not clearly deal with the potential risks of increasing political utilization of rule-of-origin
requirements [8] (p. 14). Countries have abused origin requirements because there has been an increased legal restriction by the WTO on the use of other direct trade measures [ibid].

This paper is motivated by examples of contaminated food products. A recent example relates to a French dairy company forced to recall 12 million boxes of powdered baby milk from 83 countries [9]. This follows a 2008 incident in China where infant formula was deliberately contaminated with melamine to artificially raise protein levels [10]. This resulted in the death of six children and sickness in 300,000 others and harmed the reputation of China’s food exporters [11]. Another example is the widely publicized outbreak of Escherichia coli (E. coli) disease in Germany and other parts of Europe in 2011 [12]. E. coli contamination was later linked to bean sprouts which consumers unwittingly bought.

Second are the WTO decisions against the United States’ mandatory country-of-origin labelling (MCOOL) regulations. See [13] for a thorough discussion. The 2002 Farm Bill required food suppliers to provide American consumers with country-of-origin information. Canada challenged the regulation as discriminatory and unnecessary. A WTO Panel upheld the challenge. They found that MCOOL violated Article 2.1 of the Technical Barriers to Trade (TBT) Agreement by according less favourable treatment to imported Canadian cattle and hogs than to like domestic livestock [ibid]. The panel found that the regulation did not offer sufficient benefits in terms of consumer information (which was minimal) to support the detrimental impact on imported livestock. Though the US subsequently changed the regulations, a second panel also ruled against it. Congress repealed the provisions for beef, pork, and chicken in 2015 [ibid].

One reading of the WTO ruling is that, as long as there is sufficient benefit to consumers and the regulation is not discriminatory, then the WTO may have rejected the complaint against MCOOL and let it stand. There is support for this view [14] discussed below. Regulations, based on product characteristics, are not necessarily in violation of GATT articles controlling processes and production methods (PPMs). Hence, requiring all domestic sales to meet traceability and country-of-origin regulations can be WTO compliant.

The above suggest that traceability regulations in conjunction with country-of-origin labelling can have a legitimate basis in improving food safety. Second, WTO rules would not necessarily preclude such regulations forced upon foreign producers as long as they satisfy Article 2.2 of the TBT Agreement (discussed below).

The paper assumes these two principles as a starting point for modelling while recognizing that actual implementation may be difficult. The paper uses a partial equilibrium model showing how traceability regulations affect consumer welfare in a closed economy. This paper differs from existing economic literature by modelling traceability as a free-rider problem where industry reputation matters. The paper then extends the modelling to analyze the welfare implications of country-of-origin labelling when the importing country has already implemented domestic traceability regulation.

Modelling shows that mandatory traceability may fail to be socially desirable and identifies conditions under which this is the case. The modelling also identifies the possibility of market failures where traceability regulation is, in fact, socially desirable but would not arise spontaneously from individual firm choices. In the model, such market failure arises because firms can free-ride on industry reputation.

Modelling then moves to an international context. The model assumes that traceability regulation, in the absence of international trade, is desirable. The model shows that country-of-origin regulations, under free trade, can, but need not, raise consumer welfare. Further, modelling shows that country-of-origin rules are similar to direct import restrictions such as quotas or tariffs so local industry would support them as a form of protection. However, where country-of-origin labelling is combined with traceability, the more efficient policy remains the adoption of traceability across countries and not country-of-origin labelling per se.
2. Methods

This section begins with a review of the institutional context for traceability. The section then reviews country-of-origin rules as motivation for the subsequent modelling. The section finishes with a discussion of the admissibility of traceability requirements in international trade.

Traceability, under the European General Food Law, refers to “the ability to track and follow a food, feed-producing animal or substance through all stages of production, processing and distribution” [15]. Benefits of traceability include: protection of public good through emergency management, food safety, public and animal health; industry support through market access and gaining of consumer confidence to build industry reputation; supply chain coordination and management; and reduction in information asymmetry along the supply chain [16].

The European Union (EU) and Japan implemented mandatory traceability systems in response to consumer concerns about food safety [17] (p. 7). Similarly, the industry-managed traceability system in Canada is aimed at identification of animals for emergency management purposes in the event of disease problems. Meanwhile, traceability systems in Australia, Brazil, and Argentina are aimed at sustaining and increasing export shares in international markets. The consumer’s quest to know the origin of their products has been a primary driver for the adoption of voluntary private sector traceability systems in France, Germany, Norway, and Scotland [18].

Rapid identification and withdrawal from circulation of food products that pose safety concerns is a primary reason for traceability. For example, in Canada, the Canadian Cattle Identification Agency (CCIA) requires all cattle to have an approved CCIA ear tag showing their herd-of-origin [19]. In the United States, the MCOOL regulations required retailers to clearly identify country-of-origin on red meats (beef, lamb, and pork); fish and shellfish; fresh and frozen fruits and vegetables; and peanuts [20], while exempting processed foods and food service establishments (restaurants, food stands, and retail stores). This, according to USDA, is to enhance traceability should there be any safety breach along the supply chain [ibid].

In addition to food safety arguments, traceability systems have been extended along the food supply chain (i.e., beyond simple animal traceability) to cover other agricultural products for other reasons such as ensuring authenticity of products delivered to end users, and for enhancement and protection of the collective reputation of an industry. Traceability systems are also encouraged by governments to correct market failure [21], enhance ex-ante quality verification, reduce costs associated with food safety incidence, and establish liability for food safety problems [22].

There are three dimensions of traceability that influence costs and benefits [21]: (i) precision, which describes the size of products to be identified, ranging from a single product to a collection of products produced by the firm; (ii) breadth, which describes the amount (type) of relevant information to be collated on a product; and (iii) depth, which shows how far back or forward the system can trace the needed information on the product.

The complex nature of the food supply chain makes it difficult to identify the origin of infected food products [23]. This implies that traceability is costly, see [24–26]. Costs of traceability depend on several factors, including: the regulatory environment in which the firm operates; firm size; product characteristics; nature of technology used by the firm; production process; and type of information needed to be collected and stored [27,28]. In addition, traceability costs associated with the Italian fish supply chain include “time and effort, equipment and software, training, external consultants, materials and, certification and audits” [29]. Canada’s mandatory traceability system in the livestock sector involves the purchase of electronic tags for calves, wand/stick readers, internet access, computer and software, and staff training, among others [30]. An analysis of the traceability program shows that costs of traceability range from $6.91 per head in a 50-cow herd size to $6.29 for a 1500-cow herd size [ibid].
It is common for countries to implement country-of-origin labelling for agricultural products as many of these products are *credence goods*. Credence attributes are those relevant product characteristics that are difficult to ascertain even after consumption takes place [31]. The label, if credible, allows consumers to make informed decisions about perceived product quality that they could not ascertain themselves. This can be essential given consumer fears of foodborne diseases and contamination. The rationale is that products themselves, though they may appear identical, are, in fact, different due to different production processes that can differ at the firm level. Indeed, past incidences of wine adulteration and French concern about geographical origin led to the development of the Appellation D’Origine Controlee (literally “controlled place of origin”). This system defines the places where and how wines can be made [32]. The success of this model has led to its adoption in other jurisdictions such as Italy’s Denominazione di Origine Controllata, the Spanish Denominacion de origin, and Scottish whiskey [33].

There are many other examples of country-of-origin rules in agriculture (see [34]), such as the European Union (EU) through its regulation (EEC) 2081/92 and (EEC) 2082/92, fostering labelling policies of agricultural products. The EU’s regulation No.1760/2000 requires that all member countries indicate the country-of-origin of beef and beef products. Similarly, Japan requires country-of-origin for all grocery products under its amended agricultural standards law. Mexico also requires country-of-origin labelling on more than 400 products under its certification labelling decree.

According to the United States Department of Commerce Trade Compliance Centre, “rules of origin are the laws, regulations and administrative guidelines that governments use to determine an imported product’s country of origin, and can be used in setting duty rates (including anti-dumping and countervailing duties, granting tariff preferences, administering government procurement policies and applying safeguards” [35].

According to Article 2 of the WTO Agreement [36], rules of origin should be used as follows:

(a) To implement measures and instruments of commercial policy such as anti-dumping duties and safeguard measures;
(b) To determine whether imported products shall receive most-favoured nation (MFN) treatment or preferential treatment;
(c) For the purpose of trade statistics;
(d) For the application of labelling and marking requirements;
(e) For government procurement.

Article 2(b) of the General Agreement on Tariffs and Trade (GATT) prohibits the utilization of rule-of-origin as an instrument to promote trade objectives (i.e., using rule-of-origin to protect the domestic industry against import competition or favouring imported products of one member over imported goods of another). The WTO Agreement states that: rules of origin must apply equally for all purposes of non-preferential treatment; be objective, understandable, and predictable; not be used directly or indirectly as instruments to pursue trade objectives; and not in and of themselves, have a restrictive, or discriminative influence on trade.

This corresponds to two of the GATT’s main obligations—the prohibition of favouring domestic products to the detriment of imported products (the National Treatment Principle—GATT, Article III), and the prohibition of favouring products of one member over goods of another (the Most Favoured Nations Principle—GATT, Article I) [37].

Restrictions based on processes and production methods (PPMs) are generally not acceptable to the WTO. The issue arises since traceability is a processing requirement and does not directly relate to product characteristics per se. Hence, on the face of it, import restrictions that require foreign traceability to gain access to local markets are not permitted.

However, this blanket interpretation against PPM regulations may not be accurate. Charnovitz [14] provides a framework for identifying different PPMs (though he also points out that such a dichotomy is problematic). *Product-related PPMs* relate to the functionality of a product (p. 65). Food safety is a classic example as “such PPMs help assure that
consumers receive a product at the anticipated quality level”. Non-product-related PPMS are “designed to achieve a social purpose that may or may not matter to a consumer” (p. 65). Charnovitz gives the example of driftnets that impose ecological harm but may have no impact on the quality or safety of landed fish.

Charnovitz goes on to provide a taxonomy of PPMS [14] (p. 67). These are the how-produced standard, the government policy standard, and the producer characteristic standard. The how-produced standard can be less contentious since they act like simple product-standards (p. 69). This lack of contention arises since these regulations do not directly coerce foreign governments to comply with domestic rules nor penalize foreign firms if they do comply. As long as these how-produced standards have legitimate benefits and are not a hidden barrier to trade, they should be admissible.

3. Results

The paper models traceability first in a closed economy setting, thereby abstracting from international trade concerns. The model then considers an economy that has introduced mandatory traceability and face imports that are not using traceability protocols. The model identifies two broad cases where industry reputation determines whether consumers are willing to pay a premium on domestic goods or not. The model then introduces country-of-origin labelling, for each of the broad cases, as a way to help consumers distinguish high-quality domestic goods from low-quality imports.

3.1. The Model

Consider the case where consumers use information about the underlying risk or, more generally, process and product attributes of products. Consumers generally cannot personally verify product safety as it depends on the production process, which they cannot directly observe [25] (p. 124).

The model assumes that consumers are willing to pay a premium $\delta$ if the product meets a minimum safe standard. Of course, consumers may be insensitive to some food recalls due to habit persistence and other behavioural responses [38]. Hence, perceptions of a small safety risk may have no impact on consumer behavior. However, if the risk rises above a certain level, consumers will still buy the product, but will not pay a premium. For example, a higher risk product may entail more careful home preparation or a restricted usage (e.g., not offered to infants) and so offers lower utility to the consumer. This approach follows from [25] and [39] as they assume current demand is based on past safety events, though they assume demand varies continuously with risk/quality.

Firms can lower consumer risk by investing in traceability. However, in the absence of reliable third-party certification, a consumer’s willingness to pay a premium depends on their risk assessment of the entire industry. Think of this as related to industry reputation [40]. If a consumer feels that they face a high risk of unsafe foods, then, regardless of the individual product characteristic (e.g., whether or not the firm invested in traceability), they will not be willing to pay any premium. If the consumer feels that they face a low risk of harm, then they will be willing to pay the premium. In effect, “when unsafe food cannot be traced to its origin, all farms are considered the potential supplier of unsafe food” [25] (p. 126). Indeed, the French milk recall was a “bid to contain the fallout from a health scare that risks damaging France’s strategic agribusiness in overseas markets” [9].

Consumers gauge product risk as a decreasing function of industry adoption of traceability. If the industry has a poor reputation for safety due to a small fraction of firms adopting traceability, then consumers will not pay a premium. Denote the share of firms adopting traceability as $\omega$. If all firms in the industry adopt traceability ($\omega = 1$), then individuals are willing to pay a premium. However, if only a small fraction of firms adopts traceability, then consumers will not pay the premium. Denote the critical threshold fraction of firms as $\Omega$ for which industry reputation induces a change in demand. This is modelled as a vertical shift upwards of the demand curve by $\delta$ for $\omega \geq \Omega$. By assumption, all firms receive the same price but that price depends on collective industry reputation,
which, in turn, is determined by widespread adoption of traceability. For simplicity, the model assumes linear demand:

- For high-risk goods ($\omega < \Omega$): $P = a - bQ$, where $Q$ is industry sales;
- For low-risk goods ($\omega \geq \Omega$): $P = [a - bQ] + \delta$.

The model assumes firms are perfectly competitive. It takes market output as well as the fraction of firms investing in traceability as exogenous and known to all agents. Firms have two decisions to make. The first is whether to invest in traceability (invest $K = 1$ with fixed cost $F$) or not ($K = 0$). Further, traceability is assumed to be verifiable so firms cannot game the system by misrepresenting their activities. Firms’ second problem is to choose output ($q$) given the prevailing price and their own investment in traceability. The prevailing price will have a premium or not depending on $\omega$ relative to $\Omega$. Note that this differs from other analyses in the literature, such as [40] or [39], in that they assume that firms can adopt different levels of quality. In this model, firms adopt the best available traceability technology or they do not.

Denote the cost of production as $c(q,K)$ with marginal costs $c_q > 0$ and $c_{qq} > 0$ (e.g., increasing marginal costs of production). If there is no investment in traceability, then $c(q,0) = c_qq$. With traceability, $c(q,1) = F + (c_qq + \alpha q)$. That is, there are no economies of scale or scope so marginal costs shift up by $\alpha$.

The representative firm’s profit maximizing problem is:

- Stage 1: invest in traceability technology at cost $F$ or do not invest;
- Stage 2: given investment in stage 1; choose $q$ that maximizes profits given industry output $Q$;

If ($\omega < \Omega$): $\text{MAX } q [a - bQ] q - c(q,F)$;
If ($\omega \geq \Omega$): $\text{MAX } q [a - bQ + \delta] q - c(q,F)$.

3.2. Unregulated Equilibrium in a Closed Economy

The main insight is that no firm has the unilateral incentive to invest in traceability in the absence of regulated mandatory adoption. That is, if ($\omega < \Omega$), then the firm cannot capture any premium regardless of its investment in traceability. As in [25], the inability of consumers to identify products from a particular firm and punish them means they punish all firms in the industry. Hence, if consumers perceive products as too risky, then no firm can earn a premium and so no firm would be willing to choose to invest in traceability. If ($\omega \geq \Omega$), then the firm can capture the premium without investing in traceability and incurring additional costs. Hence, firms have a dominant strategy to avoid investing. This is a classic free-riding problem.

Social Optimum versus the Unregulated Equilibrium

A market failure in this model occurs when unregulated markets fail to achieve the socially optimal level of output and investment in traceability.

Define social welfare (SW) as the sum of consumer and producer surpluses. However, with free entry, producer surplus is always zero and so social surplus is simply equal to consumer surplus.

There are two relevant regimes: there is the unregulated market where no firms invest in traceability, and the regulated market where all firms invest in traceability under mandatory adoption.

In the unregulated market equilibrium, output is at $Q^U$ and prices $P^U$ (see Figure 1) Consumers correctly refrain from paying a premium. Consumer surplus is the grey area bounded by the demand without premium and the market price $P^U$. In the regulated equilibrium, where all firms invest, output is $Q^R$ with prices $P^R$. Note that $Q^R$ can be smaller or larger than $Q^U$ in general. Consumer surplus is the grey spotted area bounded by the demand with premium and the market price $P^R$. 
Sub-Case 1 (non-market failure): Let $\delta < \alpha$ (which implies $Q^R < Q^U$). With regulation, all firms must invest in traceability and will have higher marginal costs. Consumers correctly assess that the industry is reducing food risk enough and so are willing to pay a premium. The premium, though, is less than the additional marginal costs to the firms. This induces some firms to exit the market and reduces aggregate output. Consumers face a lower industry supply and the rise in the equilibrium price is higher than the quality premium. Consumer welfare falls as the net benefit from the higher quality is outweighed by the additional costs of adoption. Producer surplus is unaffected as net profits, in equilibrium, are zero. Regulation does not alter this. This implies that the unregulated market without traceability is superior to the regulated mandatory adoption. Hence, leaving the market unregulated is the optimal policy as there is no market failure.

Sub-Case 2 (market failure): Let $\delta > \alpha$ with low fixed costs $F$. That is, assume the premium is large relative to additional marginal costs and the fixed cost of investment is not too high. With regulation, all firms must invest in traceability. Consumers will correctly assess that food is safer and will pay the premium. Equilibrium output occurs where $P + \delta = cq + \alpha$. If $\delta > \alpha$ we have $Q^R > Q^U$. Consumers pay a higher price than in the unregulated case but the rise in price is smaller than the premium. Consumer surplus rises as the net benefit from the higher quality outweighs the additional costs to firms of the regulations.

The firm’s first-order conditions imply $[a-bQ^U] = cq$ if no investment and $[a-bQ^R] + \delta = cq + \alpha$ if there is investment. For a given level of total industry output $[a-bQ^R]$, a firm makes positive operating profits with the investment if $[a-bQ^R] + \delta > cq + \alpha$. Let $P = [a-bQ^U] = cq$ (i.e., a firm that does not employ traceability and is earning zero profits at the market output in the absence of the premium). Then, the firm employing traceability earns a positive profit if $\delta > \alpha$. That is, the premium has to be high enough to justify the additional marginal costs to the firm. In stage 1, the firm will invest in traceability if $F < (\delta - \alpha)q$. That is, if operating profits from capturing the price premium exceeds the cost of implementing traceability. This implies that $\delta$ must be larger, by some extent, than $\alpha$ if traceability is to be viable. Free entry ensures that operating profits cover only the additional fixed costs of traceability. There is more output but the market prices just offset the additional costs of supplying the market.

If the fixed cost of implementing traceability is large, then firms will exit the industry if facing regulations. This shifts the supply curve down. The net effect is a rise in prices higher than the premium justifies. Hence, as long as both $F$ and $\alpha$ are low relative to the premium, the net rise in market price is smaller than the premium.

Subcase 2 implies mandatory traceability regulations would raise consumer welfare relative to the unregulated equilibrium. Firms are no worse off yet consumers are better off. The unregulated market without traceability would then constitute a market failure.

3.3. Traceability and Rules of Origin in a Small Open Economy

This section extends the model above to analyze the effects of country-of-origin rules when we open to trade in a small open economy. The model assumes that, absent...
traceability, consumers do not value domestic goods above or below foreign-made goods. The only difference in valuation arises from domestic traceability and whether consumers can identify foreign-made goods via COOL regulations.

Results are derived using a graphical approach for two reasons. First, graphical representations are a legitimate analytical approach (see, for example, [41,42]). Second, the basic intuition of trade models is often easier to convey to non-trade specialists.

For the remainder of the paper, assume that the perceived benefits of traceability dominate the additional costs (as in subcase 2 above). This provides an economic rationale for domestic regulation. Further, assume that country-of-origin labelling, when implemented, is effective as it allows consumers to identify the food safety risk where imported goods have a greater contamination risk if foreign firms do not adopt traceability.

The first result is that, in the absence of country-of-origin labels and in the presence of differential risk, free trade need not maximize domestic consumer welfare. This is not surprising since the lack of information on risk, and the inability to assess risk on a firm-by-firm basis, leads to a form of market failure. Nonetheless, free trade may still be Pareto improving in that consumer welfare can still rise. The issue comes down to whether the traditional gains from trade are more than offset by increases in consumer risks. The model then considers some alternative policy responses.

For simplicity, assume that national regulations differ in terms of traceability such that imported products, absent traceability, have a greater safety risk than domestic products. Assume further that consumers are not able to identify this increased risk without country-of-origin labels.

This risk asymmetry is similar to a negative consumption externality. With a negative consumption externality (such as with second-hand smoke or congestion from driving), consumption provides private benefits to the individual but imposes costs on others. The private marginal valuation of goods is higher than the social marginal valuation so leads to market failure. In this model, in the absence of country-of-origin labels, the private valuation of imported and domestic products is based on perceived exposure to risk where perceived exposure can differ from actual exposure. Consumers would, if fully informed, value regulated domestic products more given domestic traceability regulations. This implies the private marginal benefit of domestic products would be above the private marginal benefit of imports but consumers cannot individually make that identification without labels.

The model makes explicit the issue of industry reputation. In the international context and without country-of-origin labelling, the market share of imported products matters. If imports are large enough that the fraction of imports forces \( \omega < \Omega \), then domestic consumers will refuse to pay any premium for any goods. If imports are small, then \( \omega \geq \Omega \), and all firms receive a premium, even importing firms. The model considers both broad cases.

### 3.3.1. Free Trade CASE 1: \( (\omega < \Omega) \)

Free Trade with Domestic Traceability but without COOL

Consider the case where imports, which are of higher risk, are large in the sense that they form a large share of domestic sales (see Figure 2). With imports, we have \( \omega < \Omega \) since foreign firms do not adopt traceability. Consumers know all domestic goods are low risk due to domestic traceability so would be willing to pay a premium. Consumers, though, are no longer willing to pay the premium since, by assumption, they know that foreign goods are higher risk but cannot distinguish between domestic and foreign goods without country-of-origin labels.
In the free trade equilibrium, total purchases are where domestic demand (without the premium) meets world price (at $Q^W$). Domestic supply is where marginal costs, inclusive of the additional abatement costs $\alpha$, meets world price (at $Q_S$). The difference is imported.

Consumer surplus in autarchy is the willingness to pay for the low-risk domestic goods' lesser expenditures and is equal to area $(1 + 2 + 3 + 4)$. With free trade, consumption of domestically produced goods falls and yields a surplus of area $(1 + 2 + 5)$ since domestically produced goods now must sell at the lower world price. This is the surplus from the low-risk goods purchased domestically but for which the consumers are no longer paying a premium. Imports yield additional net benefits of $(3 + 6 + 7)$. Net surplus in free trade is $(1 + 2 + 3 + 5 + 6 + 7)$.

Now, compare consumer surplus in free trade relative to autarchy. Welfare changes by a net $(5 + 6 + 7 - 4)$ which, a priori, is ambiguous. Domestic consumers in free trade are buying more goods but know they are receiving lower quality on average. As long as the world price is low relative to autarchy prices, the traditional gains from trade (area 7) will dominate the increase in risk (loss of area 4) associated with imports.

Suppose the importing country wanted a policy response given that imported goods are not traceable. First, note that there is no reason to eliminate domestic traceability regulations just because of the higher risk imports. The world price determines the domestic market price. Eliminating domestic regulation will not alter this even though it crowds out some imports. Consumer surplus would fall by $(1)$ constituting a net loss.

Second, suppose that imports of the higher risk foreign product were simply banned. Then, welfare could rise but only when the differential risk was large or if free trade benefits were small. If we assume that free trade is better than autarchy, banning imports lowers welfare despite eliminating the higher risk imports. The lost gains from trade may not justify the ban.

Free Trade with Domestic Traceability and with COOL

Consider next mandatory country-of-origin labelling which would allow consumers to differentiate between imports and domestic products and hence identify underlying risk differences. See Figure 3. By assumption, consumers are willing to pay a premium for domestic goods but not foreign goods. Country-of-origin labelling allows consumers to make the informed choice and should satisfy the WTO requirement as not being intended as a trade distortion. In this model, the intent of the policy is to identify legitimate differences in unobservable consumer health risks.
Second, suppose that imports of the higher risk foreign product were simply banned. Now, they pay the premia on domestically produced goods. Hence, mandatory country-of-origin labelling can lower consumer welfare despite the ability to accurately discriminate amongst different risky goods.

What about restricting imports with a quota (or equivalently, an import tax) but with no labelling requirements? Like any import quota, domestic prices rise above the world price, reducing domestic consumption and raising local production. It would raise domestic prices for both domestic and imported goods since, by assumption, consumers could not differentiate between imported and domestic goods. Imports fall. We can set the quota at the level that replicates domestic production under country-of-origin rules (see Figure 3). Consumer surplus would fall by (area $2 + 3 + 4 + 5$) while risks fall (1). Importing firms would reap quota rents (area 4). There is no surprise that, as with any trade barrier, net social welfare can rise or fall ($1 + (2 + 3 + 5)$). As modelled, we have the traditional deadweight losses from the quota ($3 + 5$), a reduction in food risk (1), and a dissipation of surplus (2) by firms. As above, net welfare change is ambiguous. Note that, at least in this scenario, labelling is less damaging than direct import restrictions since mandatory labelling only affects local production, not total consumption.
Free Trade with Foreign Traceability

Now suppose the foreign country adopts the same traceability requirements as home (see Figure 4). We assume foreign costs of implementation (α) are no higher than home’s costs, hence, are smaller than the increase in the willingness to pay for quality (δ). As in home, by assumption, the rise in benefits to foreign producers exceeds the rise in costs and so foreign producers would also gain from this policy.

The impact, from home’s perspective, is to eliminate the quality difference between imports and domestic goods, thereby making country-of-origin labels moot. It would push up domestic prices due to higher foreign costs which would drive up the world price. Home producers will respond with higher output. Consumers will shift up demand since they are now assured that all goods are low risk. Imports may rise or fall depending on elasticities of local supply and demand.

Consumers lose surplus (area 5 + 6 + 7) due to higher prices but gain from safety improvements, as imports have traceability (1 + 2 + 3 + 4). The net welfare gain is (1 + 2 + 3 + 4 − (5 + 6 + 7)) which is ambiguous in general. Consumers gain due to lower risk but pay more for domestic goods. By assumption though, lower risk dominates costs (1 + 2 + 3 − (6 + 7) > 0. This also implies that home producers benefit more if foreign producers adopt the same traceability standards than if home imposes country-of-origin rules. With rules of origin, they gain (1−6) but with global adoption have an additional gain of (2 + 3 + 4 − (7)) > 0. This follows, since the rise in foreign costs is smaller than the rise in private benefit. Hence, as long as foreign traceability costs are not too high, it is in both countries’ interest to adopt the same traceability standards. It also makes country-of-origin rules moot.

3.3.2. Free Trade CASE 2: (ω ≥ Ω)

Now consider when imports are “small” in the sense that, at the exogenous world price, the level of imports is small relative to domestic sales so that ω ≥ Ω. Hence, regardless of whether imports employ traceability, they are priced as if they did, but only if consumers cannot identify the higher risk imports through country-of-origin labels.

Free Trade with Foreign Traceability

First, assume that foreign producers impose traceability regulations consistent with home’s regulations. For the home country, opening to imports under free trade raises consumer welfare. This is the standard free trade case for imports when goods are undifferentiated. In Figure 5, autarchy consumer surplus is (1 + 2 + 3 + 4) and rises by
(5 + 6 + 7 + 8). Consumers receive more of the safer product at lower prices. Country-of-origin rules are moot.

Figure 5. Free trade with and without foreign traceability ($\omega \geq \Omega$).

Free Trade with Country-of-Origin Labelling

Now, suppose foreign producers did not impose traceability but home still imposed country-of-origin labelling in response. With country-of-origin labelling, consumers know that imported products are riskier and can discriminate based on the labels. The world price would fall reflecting the lower foreign costs of production. Consumers would recognize the higher risk associated with imports and purchase imports based on their lower private valuation. They no longer are willing to pay a premium for the imported goods. Domestic sales do not change since consumers use the country-of-origin to discriminate. The “damage” from the rise in risk from imported goods (lost surplus 4 + 8), by assumption, is larger than the benefit of lower prices (area 10) and so consumers are worse off. Hence, global adoption of traceability is preferred to simply having country-of-origin rules.

Free Trade without Country-of-Origin Labelling

Now, suppose home did not have country-of-origin rules at all. In this case, despite the import of higher risk foreign goods, consumers still judge the average quality to be high enough that they judge all goods as low-risk and so consume with their higher private valuation. Since foreign producers do not have traceability, the world price is lower so imports crowd out some domestic sales. Consumption rises given the lowered price. This setup generates a dead-weight loss of area (11) since consumers are “paying for quality” that is not forthcoming in imported goods. Note that this analysis is an analog to a standard consumption externality in a small open economy (see [42] for an example). With a consumption externality, we obtain excess consumption, which is exacerbated by cheap imports. For example, imported fuel may have high sulfur content while local fuel does not. Consumers do not account for this and so impose additional environmental costs on others. This would correspond to willingness to pay less expenditures in exactly the same manner as when lower food risk is not forthcoming. In this model, the “damages” are imposed by consumers on themselves since they are not receiving the quality (e.g., lower risk from food) that they think they are receiving and paying for. This lack of useful information leads to a market failure from trade.

Note that consumers benefit from lower prices paid for local production when they cannot discriminate. Hence, it is no longer clear that country-of-origin rules are beneficial
given foreign producers do not impose traceability. There is a trade-off between lower domestic prices and increased safety risks associated with imports.

4. Discussion and Conclusions

The model is constructed to illustrate that traceability regulation is only socially desirable if the benefits to consumers, measured by their willingness to pay a premium, exceeds the marginal and fixed costs of adoption of traceability. If the perceived benefit by consumers is low (small \( \delta \)) or the implementation costs high (\( F, \alpha \)), then regulation, though necessary to generate adoption, is unwise. This can easily be the case. For instance, [43] argue that, with respect to the US mandatory COOL regulations, “(m)arket behavior suggests that the costs of country-of-origin labels for beef and lamb are greater than the benefits” (p. 30).

The desire for country-of-origin labelling often emerges from the fear that local producers will lose competitiveness and outsource their production to countries with lower safety standards. This then places consumers at heightened risk from less safe, imported foods. Traceability regulations are considered to be one way to mitigate this risk.

We model consumer impacts of imposing country-of-origin labels in conjunction with traceability regulations in a simple trade model. Our model shows that information asymmetry can lead to a market failure since consumers may be willing to pay for additional quality (say from reductions in contamination risk) but cannot unilaterally identify these product qualities. They require labelling to make informed decisions. Our analysis confirms that opening to free trade when foreign producers have higher food safety risks can lower consumer welfare, though it need not. This is a standard result in the international trade literature when free trade exacerbates market failures, as in the case of externalities [41,42]. In our model, the failure of foreign firms to adopt traceability in conjunction with an inability of consumers to distinguish imported from local goods can raise food safety risks which offset the benefits of access to lower priced import goods.

Country-of-origin labels can help solve a market failure problem and raise domestic consumer welfare since consumers would be able to identify differential risk from foods. However, country-of-origin labels allow the domestic industry to charge higher prices, which may offset any benefits of decreased risk as imports fall.

We show that the best solution to potential risk differentials is the adoption of equivalent traceability rules by the exporting country. Then, the true private marginal benefit of imports and domestic products would be the same, free trade unambiguously raises domestic welfare, and there would be no need for country-of-origin labelling at all. Further, by assumption, foreign producers would also presumably benefit from adopting traceability since their consumers would benefit as well. Hence, if it were the case that traceability is a good idea at home, it should not be too hard to convince foreign producers to adopt it as well. If traceability is a bad idea at home, it offers no support for country-of-origin rules, and is a bad idea to impose traceability on imports as well.

Though country-of-origin labelling may raise consumer welfare, it is a third-best solution to the problem of differential risk. It is, as opponents of these policies contend, an indirect trade barrier, though not as restrictive as direct trade barriers. It is no surprise then that country-of-origin labelling would almost certainly trigger WTO scrutiny (as it did with Mexico and Canada challenging US COOL rules). In all policies we look at, domestic employment rises from higher domestic prices either because firms can charge a premium or because import prices rise. Domestic firms and workers would support and lobby for these country-of-origin labelling rules or enforced traceability. However, domestic firms are more likely to prefer direct trade barriers to country-of-origin labels; trade barriers ensure higher domestic prices whereas labelling depends on consumers’ willingness to recognize and value the “higher quality” home product. If consumers refuse to pay, then labelling is ineffective. Domestic firms receive the least benefit from foreign adoption of home traceability standards since the rise in market price is likely smaller than with direct import barriers.
In practice, such trade-related rules have to be implemented in accordance with WTO rules so that they will not interfere unduly with free trade. Even if the policy is truly focused on consumer safety, they need to be implemented in such a way that they will have the least negative effect on trade. We considered only country-of-origin rules. However, alternative policies need to be evaluated as they may be less trade distorting. For instance, international liability laws that permit consumer groups to seek compensation in the event of a safety violation may be more effective than country-of-origin rules that treat all imported goods as the same. It would also be more WTO compliant.

The paper argues that global adoption of traceability is the best option. That implies then that countries need accreditation and certification processes that recognize equivalencies. Otherwise, the inability to garner acceptance of national traceability rules itself becomes a trade barrier. Two common approaches are national treatment and mutual recognition. With national treatment, importers would need to meet domestic traceability rules. That means that they would need to adopt largely identical traceability processes. This can be difficult, particularly if domestic needs differ across countries. With mutual recognition, countries formally recognize that, if products meet foreign regulations, then they, de facto, meet domestic regulations and can be imported without further restrictions. Mutual recognition is the more trade-facilitating approach as it allows countries to adopt different approaches that can achieve similar ends.

It is likely the case that some developing countries may be forced out of international markets, as they will not be able to absorb costs imposed by traceability regulations. Country-of-origin rules exacerbate the problem if consumers fail to recognize equivalent foreign traceability regulations.

The Codex general standard [44] requires country-of-origin labelling only “in cases where its omission would mislead or deceive consumers” (p. 9). If importers have equivalent traceability, then country-of-origin labelling would contravene the Codex and likely face challenges through the WTO. One could argue that Canada’s adoption of traceability in beef operations is precisely because it would avoid US labelling demands.

Author Contributions: Conceptualization, methodology, analysis, writing—original draft preparation, and visualization are equally shared by J.B. and A.I.U. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data sharing not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References
1. Canadian Food Inspection Agency. Fact Sheet: Traceability Proposed Safe Food for Canadians Regulations. 2018. Available online: http://www.inspection.gc.ca/DAM/DAM-aboutcfia-sujetacia/STAGING/texte/regs_safe_fd_rgtlms_fct_sht_trcblty_1484321824323_eng.pdf (accessed on 22 January 2018).
2. Srivastava, L. Parliamentary Research Branch; Country of Origin Labeling; Economic Division, Library of Parliament: Ottawa, Canada, 2003; p. 2.
3. Umberger, W.J.; Feuz, D.M.; Calkins, C.R.; Sitz, B.M. Country of Origin Label of beef products: U.S. Consumers’ Perceptions. J. Food Distrib. Res. 2003, 34, 103–116.
4. Loureiro, M.L.; Umberger, W.J. Estimating Consumer Willingness to Pay for Country-of-Origin Labeling. J. Agric. Resour. Econ. 2003, 28, 287–301.
5. Sterns, J.; House, L.; VanSickle, J.; Wysocki, A. COOL and Consumers’ Willingness to Pay in the Fresh Produce Industry—Some Initial Impressions from the Field. In Proceedings of the Southern Agricultural Economics Association Annual Meeting, Tulsa, OK, USA, 14–18 February 2004.
6. Hobbs, J.E. Traceability and Country of Origin Labeling. In Proceedings of the Farm Policy Developments and Policy Tensions under NAFTA, Policy Disputes Information Consortium, Montreal, QC, Canada, 23–26 April 2003.
7. Dickinson, D.L.; Bailey, D. Meat Traceability: Are US Consumers Willing to Pay for it? J. Agric. Resour. Econ. 2002, 27, 348–364.
31. Hobbs, J.E. Developing Supply Chains for Nutraceuticals and Functional Foods: Opportunities and Challenges. Paper Presented at the INAF/CREA Laval University. 2001. Available online: http://www4.agr.gc.ca/resources/prod/doc/misb/fb-ba/nutra/pdf/ffn-afn_e.pdf (accessed on 25 January 2018).

32. European Commission, Agriculture and Rural Development. EU Agricultural Product Quality Policy. Available online: https://ec.europa.eu/agriculture/quality_en (accessed on 22 January 2018).

33. Hughes, J. Coffee and Chocolate—Can We Help Developing Country Farmers through Geographical Indications? 2010. Available online: http://ssrn.com/abstract=1684370 or http://dx.doi.org/10.2139/ssrn.1684370 (accessed on 22 January 2018).

34. Awada, L.; Yiannaka, A. Consumer Purchasing Decisions and Welfare under Country-of-Origin Labeling Regulation. In Proceedings of the 98th EAAE Seminar, Marketing Dynamics within the Global Trading System: New Perspectives, Chania, Greece, 29 June 29–2 July 2006.

35. US DOC (Department of Commerce). WTO Agreement on Rules of Origin. 2018. Available online: http://tcc.export.gov/Trade_Agreements/Exporters_Guides/List_All_Guides/exp_005553.asp (accessed on 23 January 2018).

36. WTO (World Trade Organization). Technical Information on Rules of Origin. Available online: http://www.wto.org/english/tratop_e/roi_e/roi_info_e.htm (accessed on 23 January 2018).

37. GATT. General Agreement on Tariffs and Trade, Article III:4 (30 October 1947). Available online: https://www.wto.org/english/res_e/booksp_e/gatt_ai_e/art3_e.pdf (accessed on 15 January 2018).

38. Rieger, J.; Kuhlgatz, C.; Anders, S. Food Scandals, Media Attention and Habit Persistence among Desensitised Meat Consumers. Food Policy 2016, 64, 82–92. [CrossRef]

39. McQuade, T.; Salant, S.W.; Winfree, J. Markets with untraceable goods of unknown quality: Beyond the small-country case. J. Int. Econ. 2016, 100, 112–119. [CrossRef]

40. Winfree, J. Partial Adherence to Voluntary Quality Standards for Experience Goods. J. Agric. Food Ind. Organ. 2016, 14, 81–89. [CrossRef]

41. Kendall, L.; Gaisford, J. Trade Creation and Trade Diversion; Analyzing the Impact of Regional Trade Agreements. In Handbook on International Trade Policy; Kerr, W., Gaisford, J., Eds.; Edward Elgar Publishing: Cheltenham, UK, 2007; pp. 120–130.

42. Krutilla, K. Partial equilibrium models of trade and the environment. In Handbook of Environmental and Resource Economics; Van den Bergh, J.C.J.M., Ed.; Edward Elgar Publishing Ltd.: Cheltenham, UK, 1999; Chapter 27; pp. 404–415.

43. Golan, E.; Kuchler, F.; Mitchell, L. Economics of Food Labeling, Economic Research Service; Agricultural Economic Report No. 793; Economic Research Services, U.S. Department of Agriculture: Washington, DC, USA, 2000.

44. Codex. Country of Origin and Food Labeling. Joint FAO/WHO Food Standards, Codex Alimentarius Commission. 2001, p. 9. Available online: http://www.fao.org/tempref/docrep/fao/005/y2770e/y2770e00.pdf (accessed on 30 January 2018).