Trade-Inducing Quality Standards for Used Durables*

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Abstract

We construct a theoretical framework to study the impact of asymmetric quality standards on used durable goods on trade flows, profits and consumer welfare. We show that asymmetry in quality standards generates trade in used goods from high to low standard countries while at the same time reducing trade in new goods. The industry in the exporting country benefits from this change while consumers lose out. Consumers in the importing country are the biggest beneficiaries, but domestic industry is hurt. These results suggest that quality standards on used goods are a powerful policy tool whose use should be monitored by the WTO.

Keywords: quality standards, durable goods, used durables, trade in used goods.

JEL Classification: F1, L1.

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1 Introduction

Most countries enforce automobile safety and emission standards. New vehicles must meet certain specifications in order to be allowed on the market, while used cars are required to pass periodic tests of roadworthiness. While quality requirements for new vehicles are broadly similar across countries, they can vary substantially when it comes to used vehicles. For example, Japan is known to have very stringent testing procedures for used cars. New cars in Japan are sold with a *shaken*, a fitness certificate that is valid for three years. In order for the shaken to be renewed, the vehicle must go through a rigorous quality certification process that is both expensive and time-consuming. The pecuniary cost of this procedure is reported to average around a thousand dollars, although some reports put it even higher.[1] Once renewed the shaken is good for two years, at which point the whole process must be repeated and the renewal cost must be incurred again. Although many other countries have motor vehicle inspection procedures, nowhere that we are aware of is the cost nearly as high.

High quality standards for used durable goods increase the cost of holding on to them and induce consumers to upgrade their holdings frequently. Indeed, most Japanese consumers replace their vehicles after only three or five years. This creates a large supply of used cars with a very low value on the Japanese market. Automobiles of the same quality have a much higher value in other countries where the cost of holding on to a used vehicle is much lower. A trade opportunity thus arises, whereby countries with high quality standards will export used cars to countries with low quality standards. Japan exports $2.7 billion worth of used automobiles annually, compared to just $0.7 billion for the US.[2] Given that the US car fleet is roughly four times that of Japan, the proportion of the used car fleet that is exported every year is 16 times higher in Japan that in the US.[3]

Quality standards have been prescribed as a way to address problems created by informational asymmetries and by externalities. Informational asymmetries arise when prospective buyers are unable to assess a good's quality prior to purchase. Leland (1979) provides the classic theoretical justification for minimum quality standards by showing that their imposition may be

[1] This is only the inspection cost; expenses for any major repairs would be in addition to that. Useful descriptions of the test can be found at `http://www.qualityimports.biz/`, `http://uktoyotaestimasite.tripod.com/Japanese_Market.htm`, `http://www.asapmotors.com/services/shaken.htm`, `http://www.japanese-imports.co.uk/market.asp` and `http://cars.micklay.com/content/blogcategory/84/56/`.

[2] The figure for Japan's used car exports is a 2002 estimate reported in *The Wall Street Journal* (Eastern Edition), January 8, 2004. US exports are for 2001, as reported in the United States International Trade Commission online database, DataWeb (http://dataweb.usitc.gov).

[3] This calculation assumes that the average value of used cars originating from each country is approximately the same. Figures for vehicles in use (54 million for Japan and 222 million for the US) are from the United Nations Common Database.

welfare improving in the presence of asymmetric information. Externalities typically relate to environmental or safety concerns. For example, Motta and Thisse (1999) show that minimum quality standards can be used as an environmental policy tool as they force firms to produce goods that are more environmentally friendly.

The literature above suggests that different countries would impose different quality standards if they differ in the degree of information asymmetries, the environmental or safety costs they face, or their preferences towards safety and the environment. For example, Japan may impose high standards for used vehicles because it places an unusually high value on safety and a clean environment. One can make the argument that the marginal social cost of a vehicle in Tokyo is high because of congestion and lack of parking space. While this may go some way towards explaining differences in observed quality standards, it seems unlikely to be the whole story. The pollution or safety risk from a three-year old car is not very different from a brand new car. An alternative explanation can be put forward that is based on political economy considerations. High quality standards that lead to frequent replacement of vehicles are likely to benefit the automobile industry, while the rigorous inspection process should be a boon to the service sector. Hence the imposition of high quality standards may be motivated by a desire to boost domestic industry rather than (or at least in addition to) the need to protect the environment.

In order to explore this possibility we construct a theoretical framework that incorporates durable good production and quality standards in an international trade environment. The framework allows us to assess the impact of asymmetric quality standards on trade flows, profits and consumer welfare. A number of interesting questions can then be addressed. How does the imposition of quality standards for used goods affect trade flows of both used and new goods? What is the impact on producers and consumers in each country? Are durable good producing countries more likely to require high quality standards than non-producers? Do imports of used durables hurt domestic industry?

Durable goods in our model live for two periods. Consumers have the choice of buying either a new or a used durable, or of spending all their income on nondurables. The durable is produced by a monopolist firm which is allowed to sell the good, but not to lease it. The government has the option of requiring used goods to adhere to costly quality standards. Our analysis focuses on the steady state of this economy. We first describe the equilibrium in the context of a single country. We then introduce a second country, which is not a producer of durables, and analyze the effects of international trade in the new equilibrium.

Because of durability, trade in used goods will impact trade flows in the new good market

also. The model shows that, when used goods are freely traded, the imposition of quality standards in the exporting country benefits its producers at the expense of its consumers. Thus the exporting country has an incentive to impose such standards if it wants to win favor with its producers. This is because the increased cost of purchasing a used good pushes consumers towards new goods and leaves used goods to be exported to the country with lower standards. The latter country benefits because prices of both new and used goods are lower. It has no producers and thus no incentive to impose quality standards.

Intuitively, the benefit to producers arises because the imposition of quality standards mitigates the competition they face from their own products. This is a well-known problem that has been studied extensively in the industrial organization literature.[4] The crux of the issue is that new durable goods have to compete in the marketplace with the used incarnations of the durables that were sold in previous periods. Firms try to reduce the problem with practices that limit the scope of the second-hand market, such as leasing instead of selling or making the product less durable ("planned obsolescence"). The imposition of minimum standards by the government serves the same purpose by increasing the cost of owning used goods.

Our welfare calculations do not take into account any benefits from reduced pollution, congestion, and accident risk. It could very well be that the welfare gains from internalizing these externalities are greater than the losses consumers suffer because of increased prices. This is an open empirical question that is beyond the scope of this paper. Similarly, we do not claim that minimum quality standards must necessarily be interpreted as indirect subsidization of industry. Our point here is that industry subsidization is one possible motive for imposing minimum standards.

In section 4 we use the same theoretical framework to address a different issue with important policy implications. What is the impact of free trade in used goods on welfare, for a given set of quality standards? This is relevant to situations where the quality standards were imposed for other reasons, such as externalities, and governments have to decide on trade policy. We find that free trade hurts consumers in countries with high quality standards and benefits producers everywhere and consumers in countries with low standards.

We also, examine the impact of quality standards in the presence of international competition in production. In this case, quality standards are even more beneficial for exporters when competition is more intense in their export market compared to their home market. In addition,

[4]See Waldman (2003) for a detailed review of issues like optimal durability, the time inconsistency problem faced by producers of durable goods, the impact of adverse selection on durable goods markets and the timing of new product introductions.

importing countries have an incentive to impose quality standards of their own or restrict trade in used goods to protect domestic industry. Finally, we consider more general quality standards that require a costly quality upgrade of used goods and show that the qualitative results are the same as those with quality certification.

2 Quality certification in a market for durables

We start by laying out the details of our model in the context of a single country. Once the market structure is clear, we will introduce a second country and look at the world equilibrium under different trade scenarios.

Supply. We consider a durable good that lives for two periods. In the first period of its life the good is considered "new" and its quality is denoted by s. In the second period the good becomes "used" and its quality drops to ks, where $k \in [0, 1]$ represents the proportion of its original value retained by the good. The good is produced by an infinitely-lived monopolist who can produce any quantity at constant marginal cost M. The firm can only sell the good; that is, we rule out leasing. Because the good lives for exactly two periods, in each period there are two qualities available, the new version and the used version. The government requires used goods to go through a quality certification process which costs T per unit. In this section we assume that the test does not improve the quality of the vehicle. Section 6 examines the case where the quality is upgraded.

Our analysis will focus on the steady state of this economy. Given that all periods are identical, equilibrium prices p_n and p_u of new and used durables will be the same across time. Since all durables live for exactly two periods, the number of new and used durables in the market will always be equal; that is,

$$Q_n = Q_u, \tag{1}$$

where Q_n and Q_u are the quantities of new and used goods sold respectively. This market clearing condition, along with the first order condition from the firm's optimization problem, will determine the equilibrium in the market: given the new good's price, the price of used goods must be such that demand for used goods equals demand for new goods.

Demand. Our demand framework is based on the well-known vertical differentiation model introduced by Mussa and Rosen (1978). There is a constant density N consumers who are infinitely lived. Consumers are identical in all respects except in their willingness to pay for quality. Every period each consumer receives income y, which he has to allocate between the

durable good and a composite nondurable good. The consumer faces a simple choice between three alternatives: buying a new durable, buying a used durable, and buying no durable. Consumers who choose the latter option will spend all their income on the nondurable good and obtain utility equal to their income. Consumers who purchase the new good pay a price p_n for the good. At the end of the period they can recover p_u by selling the depreciated durable. Purchasers of used goods pay p_u plus the certification cost T and receive nothing at the end of the period because the good becomes obsolete. The utilities from purchasing a new, used, or no durable are given below:

$$U_n = y - (p_n - \delta p_u) + vs, \tag{2}$$

$$U_u = y - (p_u + T) + vks, \tag{3}$$

$$U_0 = y. \tag{4}$$

The parameter v is the willingness to pay for quality and it varies across consumers. Note also that we assume that end-of-period income is discounted by a factor δ. We have implicitly assumed that there are no transaction costs; in other words, the price received by sellers of the used durable is exactly the same as the price paid by buyers. The assumption of perfect and complete information means that there is no "lemon" problem. This ensures that all used goods will be sold in the second-hand market, as required by the market-clearing condition (1).

Given the structure of the model, consumers are effectively divided into three groups: those who consume new durables in every period, those who consume used durables, and those who consume only nondurables. Let v_h be the quality preference parameter of the consumer who is indifferent between buying a new and a used good; that is, $v_h = \{v \,|\, U_n = U_u\}$. From equations (2) and (3):

$$v_h = \frac{(p_n - \delta p_u) - (p_u + T)}{(1-k)s}. \tag{5}$$

Similarly, let v_l be the quality preference parameter of the consumer who is indifferent between buying a used good and buying nothing: $v_l = \{v \,|\, U_u = U_0\}$. ¿From equations (3) and (4):

$$v_l = \frac{p_u + T}{ks} \tag{6}$$

We assume that v is uniformly distributed over the interval $[a, b]$, so it has density $f(v) = 1/(b-a)$. Consumers with preference parameters $v \in [v_h, b]$ will buy a new good, those with $v \in [v_l, v_h]$ will buy a used good and those with $v \in [a, v_l]$ will buy nothing. Let

$\lambda = N/(b-a)$. The demand functions for new and used goods are

$$D_n(p_n, p_u) = \lambda\,(b - v_h) = \lambda\left[b - \frac{(p_n - \delta p_u) - (p_u + T)}{(1-k)s}\right] \tag{7}$$

$$D_u(p_n, p_u) = \lambda\,(v_h - v_l) = \lambda\left[\frac{k(p_n - \delta p_u) - (p_u + T)}{(1-k)ks}\right]. \tag{8}$$

Note that for all markets to exist in equilibrium and for all used goods to be traded the following ordering must hold:

$$b > v_h > v_l > a. \tag{9}$$

Given that leasing is not permitted, the good is out of the firm's control once it is sold and it can be traded in the open market. The firm's only choice variable is the price p_n, which it chooses in order to maximize the present discounted value of future profits. The firm's static profit function is

$$\Pi = \lambda \cdot D_n(p_n, p_u) \cdot (p_n - M). \tag{10}$$

Through the demand functions, this profit function takes into account the fact that every period the firm faces competition from its own products, the used goods that it had sold in the previous period. As there is no other link between successive periods, maximization of future profits is equivalent to maximizing (10) every period. The first order condition of this problem is given by:

$$p_n = \frac{1}{2}(M + T + bs(1-k) + p_u(1+\delta)). \tag{11}$$

The market clearing condition (1) implies a different relationship between p_n and p_u:

$$p_n = \frac{1}{2k}[bks(1-k) + (1 + k + 2k\delta)p_u + (1+k)T]. \tag{12}$$

Solving equations (11) and (12) yields the following equilibrium prices:

$$p_n^\star = \frac{(1 + k + 2k\delta)M + bs(1-k)(1+k\delta) - \delta(1-k)T}{2(1+k\delta)} \tag{13}$$

$$p_u^\star = \frac{kM - T}{1 + k\delta}. \tag{14}$$

We illustrate the equilibrium with a simple numerical example. We set $\delta = 0.8$, $s = 5$, $b = 1$, $a = 0$, $k = 0.8$, $M = 3.5$, $N = 1$ and $T = 0$. The equilibrium prices implied by those parameters are $p_n^\star = 3.787$ and $p_u^\star = 1.707$ and the equilibrium quantity sold $Q_n^\star = Q_u^\star = 0.287$. We depict the equilibrium in Figure 1. The top panel of the figure depicts the market for new goods and the bottom panel the market for used goods. The monopolist equates marginal revenue to marginal

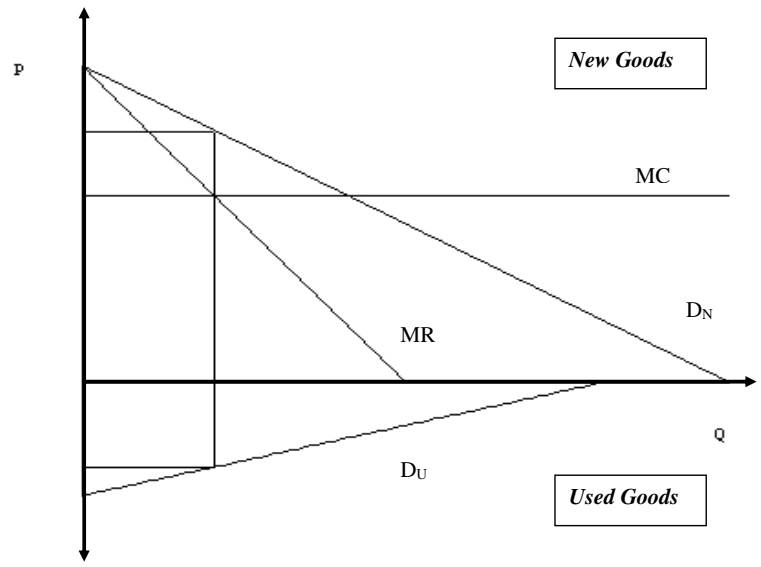

Figure 1: A market for durables with no quality certification

cost leading to $p_n = 3.787$ and $Q_n = 0.287$. Market clearing requires that the quantity of new goods must be the same as the quantity of used goods and from the bottom panel we get that at $Q_u = 0.287$ the price of used goods is $p_u = 1.707$. The demand curves are drawn at equilibrium prices for the other good; that is, the demand for new goods is drawn for $p_u = 1.707$ and the demand for used goods is drawn for $p_n = 3.787$.

Effects of quality certification. Consider first the effect on prices. It is easy to see in equations (13) and (14) that the derivatives of both prices with respect to T are negative. That is, both prices drop when quality certification is required. The drop in the price of used goods is expected because the additional cost T lowers demand for them. The fact that the price of the new good also drops might seem counterintuitive at first. One might expect that a drop in demand for used goods would increase demand for new goods because the two are substitutes. This is apparent in the demand equation (7). This increase in demand, however, is conditional on p_u. But p_u drops substantially when T is increased, and the rise in the overall cost $p_u + T$ of a used good is fairly small. Its positive effect on the demand for new goods is overwhelmed by the income effect that the drop in p_u imparts on buyers of new goods. This effect reduces the degree of substitutability between the two goods, and results in lower prices for new goods when T is imposed. In Figure 2 we revisit our numerical example with $T = 0.7$ in order to illustrate the impact of quality certification on the equilibrium. The solid lines depict the equilibrium without

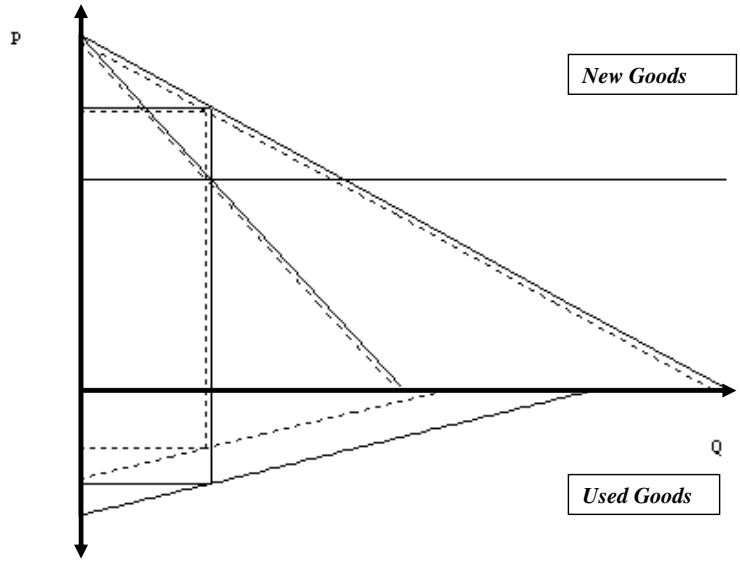

Figure 2: A market for durables with quality certification

quality certification and the dashed lines the equilibrium with quality certification. Note that once again we depict demand *at equilibrium prices*. The first column in Table 1 shows the percentage changes in prices and profits due to the introduction of the quality certification fee. The cost of quality certification is 18.7% of the price of the new good. The imposition of the quality standard decreases the price of new goods by 0.9% and increases the cost $p_u + T$ of used goods by 16%.

In Figure 3 we compare the quantity of new and used goods sold before and after the imposition of the quality certification fee. The diagram depicts choices made by consumers according to their willingness to pay for quality. $v_h(0)$ refers to the consumer who is indifferent between buying a new and a used good and $v_l(0)$ to the consumer who is indifferent between used goods and buying nothing without certification costs. $v_h(T > 0)$ and $v_l(T > 0)$ refer to the corresponding marginal consumers when there is a positive certification cost. In the absence of trade, quality certification for used goods reduces the welfare of all consumers, except those who choose not to buy in either scenario who are indifferent. Consumers with preference parameters in the interval $[v_h(T > 0), b]$ buy new goods under both scenarios but the cost of the new good, $p_n - \delta p_u$, increases when quality certification is required. Similarly, consumers with parameters in $[v_l(T > 0), v_h(0)]$ buy used goods under both scenarios but the cost of used goods $p_u + T$ increases when quality certification is required. In the example in Table 1 the overall cost of new

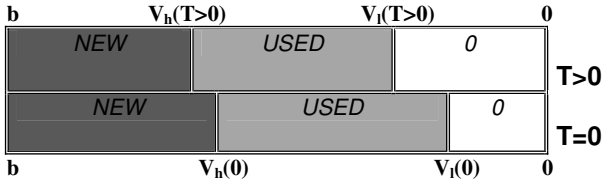

Figure 3: Quantities sold in the single country case

goods increases by 12.7% and used goods by 16%. Consumers in the interval $[v_h(0), v_h(T > 0)]$ are forced to switch from new to used, while consumers in the interval $[v_l(0), v_l(T > 0)]$ are forced to exit the market when certification is required.

The effects of certification on the monopolist's profits are easy to assess. The profit equation is given by:

$$\Pi = \frac{N}{b-a}\frac{1}{4}(k\delta+1)^{-2}s^{-1}(1-k)(bs(1+k\delta)-M-T\delta)^2 \tag{15}$$

Differentiating this expression with respect to T yields:

$$\frac{d\Pi}{dT} = \frac{N}{b-a}\frac{1}{2}(k\delta+1)^{-2}s^{-1}(M-bs(1+k\delta)+T\delta)(1-k)\delta \tag{16}$$

The sign of this derivative depends on the sign of the expression $M-bs(1+k\delta)+T\delta$. It is easy to show that the existence condition in (9) requires this expression to be negative, therefore $\frac{d\Pi}{dT} < 0$. Profits decrease in T because both price and quantity sold decrease. In the example in Table 1 profits decrease by 22.4%. Since quality certification hurts both consumers and producers, a welfare maximizing government in a closed economy will require it only if there are significant externalities that need to be corrected.

The fact that consumers are hurt is not surprising because quality certification in our model is just a tax on used goods. On the other hand, the finding that the producer also loses out was not obvious ex ante – at least not to us. A producer normally benefits from a tax on a product that is a substitute to his own. Here, however, production of the two goods is inextricably linked in a very particular way. Not only do quantities of the two goods have to be equal, we also have the consumers of one good (the new good) being the 'producers' of the other (the used good). A tax on used goods lowers their consumption and hurts both their consumers and their producers. The loss incurred by producers of used goods lowers their demand for new goods to the detriment of the new good's producer.

3 Quality certification with trade

Before we proceed to our model we note that we are not the first ones to consider trade in used goods. Sen (1962) was the first to point out the potential benefits from international trade in used goods. His insight was that used machinery requires higher labor inputs for maintenance than new machinery. In the presence of different factor prices across countries, this will generate international trade in goods of different vintages: used machines will flow from countries with high labor costs to countries with low labor costs. Smith (1976) models this explicitly and analyzes the pattern of international trade in used machines and the gains from trade. In a similar framework Bond (1983) models depreciation as an increase in downtime which increases labor requirements as machines age and derives a measure of comparative advantage that explains trade patterns. He illustrates the predictions using data from the truck tractor market.

Goering and Pippenger (2000) analyze the interaction between the durability of a product and trade barriers. They argue that in effect a durable good is a way to import more services without paying tariffs. Finally, Driskill and Horowitz (1996) examine the optimal policies when two duopolists from different countries compete in the durable good market of a third country. They find that the optimal policy for is a tax on domestic production for duopolists that sell their product and a subsidy for duopolists that lease their product.

We take a different approach from all these papers and examine trade that is purely generated by differences in quality standards. We do that by introducing a second country into the model of section 2. The two countries are identical in every respect except one: the new country does not produce the durable good. We will refer to the country that produces and exports the durable good as Exportia; we will call the country that imports the good Importia. Variables relating to each country will be denoted respectively by superscripts E and I. We assume that the goal of Exportia's government is to maximize the weighted sum of consumer welfare and producer profits in this industry. The weights are determined by political economy considerations. Since there is no production in Importia, the government there simply maximizes consumer welfare.

We maintain the assumption that the monopolist can price discriminate between markets. It is well documented that there are substantial price variations in the prices of new cars across countries, even within the European Union.[5] Automobile manufacturers can sustain price differentials using various methods such as specialized models and authorized dealerships.[6] We

[5] See, for example, Verboven (1996).

[6] We have also solved the model under the assumption of complete free trade (and therefore price equalization) in both new and used goods. The qualitative implications are the same.

assume that used goods are freely traded between the two countries resulting in equalization of their price. Of course, the total cost of a used good differs across countries because buyers have to pay the certification fee in their country of residence.

The assumption of segmented new good markets implies that the monopolist's first order conditions are the same as before:

$$p_n^j = \frac{1}{2}(M + T^j + bs(1-k) + p_u(1+\delta)), \qquad j = \{E, I\}. \tag{17}$$

The principal difference is in the market clearing condition. It is no longer required that all new goods are sold in the used market of the same country but that all new goods in both countries are sold in the used good market of either country. In other words, market clearing requires that the total quantity of new goods is equal to the total quantity of used goods:

$$Q_n^E + Q_n^I = Q_u^E + Q_u^I. \tag{18}$$

Equilibrium prices p_n^E and p_n^I can be obtained by solving equations (17) and (18). The resulting expressions are reported in the appendix. Note that if the two countries impose the same quality certification fee (that is $T^E = T^I$) then they become identical, equilibrium prices in both countries are the same (as given by equations (13) and (14)) and there is no trade between them.

Suppose that Exportia has higher certification requirements than Importia. How will that affect trade flows and welfare? To keep things simple, we will assume that Importia has no requirements; that is, it sets $T^I = 0$. Later on in this section we show that this is the equilibrium choice of Importia. We know from the previous section that certification requirements lower the price of used goods. This means that used goods will be cheaper in Exportia than in Importia. This can not be sustained in the presence of free trade. An international market for used goods will arise whereby Exportia will be exporting used goods to Importia until prices in the two countries are equalized. Exportian consumers will purchase more new than used goods, while Importians will do the opposite.

We depict the free trade equilibrium in Figure 4. As before, solid lines and dashed lines represent the equilibria without and with quality certification respectively. The right hand side of the graph shows the new and used markets in Exportia and the left hand side the corresponding markets in Importia. Note how market clearing no longer requires equal consumption of new and used goods in each country; graphically, the points of consumption do not have to lie on the same vertical line. Instead, the new market clearing condition requires that the horizontal

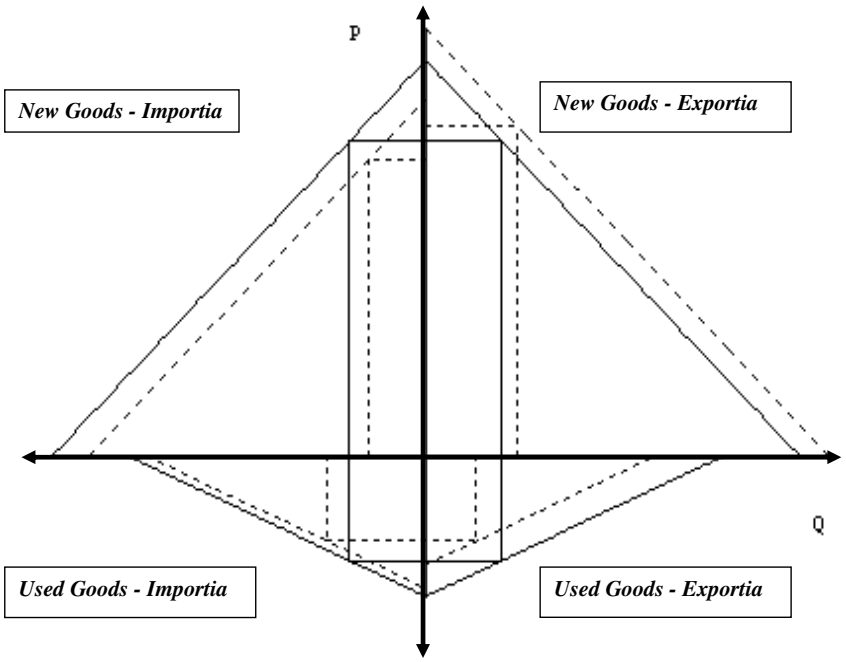

Figure 4: Equilibrium with quality certification and free trade in used goods

distance between the vertical dashed lines is the same in the top and bottom portions of the graph.

The demand for used goods from Importia raises their price in Exportia relative to the no trade case and mitigates the income effect suffered by Exportian new good consumers. As a result, demand for new goods in Exportia rises and their price and sales both rise. The opposite happens in Importia. Here the used good price drops because of the influx of cheap used goods from Exportia. This lowers the demand for new goods, resulting in lower prices and sales for them.

The reallocation of sales due to quality certification is depicted succinctly in Figure 5. For each country, we show consumer choices in two cases: when Exportia has no certification requirement ($T^E = 0$, bottom half of each panel) and when Exportia imposes a certification requirement ($T^E > 0$, top half of each panel). In both cases Importia has no requirement ($T^I = 0$). Just as in the no trade case, quality certification for used goods reduces the welfare of all consumers, except those who choose not to buy in either scenario who remain indifferent. Consider consumers in Exportia and compare their utility with and without quality certification. Consumers with preference parameters in the interval $[v_h(0), b]$ buy new goods in both scenarios

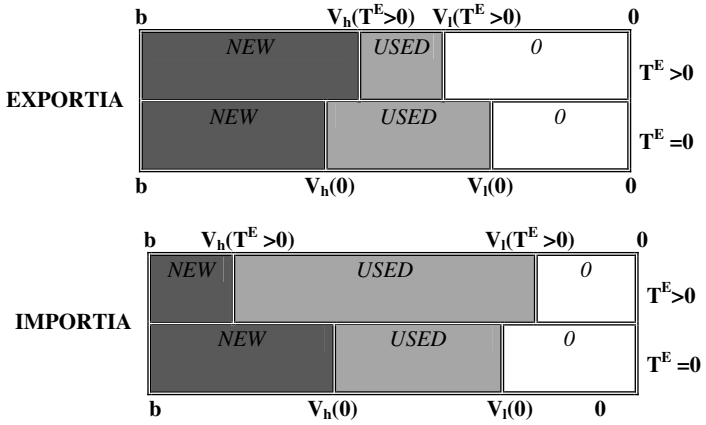

Figure 5: Quantities sold in Exportia and Importia with free trade in used goods

but their welfare is reduced because quality certification increases $p_n - \delta p_u$, the net cost of new goods. To see that note that from equation (22) $\frac{dp_n}{dT^E} > 0$ and from equation (24) $\frac{dp_u}{dT^E} < 0$. As expected, buyers of used goods do not pay the full cost of quality certification and part of it is paid by the sellers. The increase in the cost of used goods, $p_u + T^E$, is much bigger than the increase in the cost of new goods and forces consumers in the interval $[v_h(T^E > 0), v_h(0)]$ to switch from used to new goods in the presence of quality certification. Consumers in the interval $[v_l(T^E > 0), v_h(T^E > 0)]$ buy used goods in both scenarios and, therefore, the increase in the cost of used goods with quality certification leaves them worse off. Finally, quality certification makes the cost of used goods too high for consumers in $[v_l(0), v_l(T^E > 0)]$ forcing them out of the market.

The bottom panel of Figure 5 shows the quantities sold in Importia with and without quality certification in Exportia. From equations (23) and (24) note that quality certification in Exportia decreases the price of both new and used goods in Importia. As a result, the cost of used goods, p_u, decreases allowing consumers in the interval $[v_l(T^E > 0), v_l(0)]$ to enter the market and buy used goods, increasing their welfare. The reduced cost of used goods means that the welfare of consumers in the interval $[v_l(0), v_h(T^E > 0)]$ who buy used goods under both scenarios also increases. Consumers in the interval $[v_h(0), v_h(T^E > 0)]$ shift from the new to the used market because the reduction in the cost of used goods is larger than the reduction in the cost of new goods. Finally, since the cost of new goods is reduced, consumers in the interval $[v_h(T^E > 0), b]$ who buy new goods under both scenarios also benefit.

To make the results more concrete we extend our numerical example from the previous section to the free trade case. All parameters take the same values as before. The only difference between

the two countries is that Importia does not impose a quality certification fee while Exportia sets $T^E = 0.7$. The impact of quality certification is demonstrated in the second column of Table 1. The price of new goods in Exportia increases by 4.2%. The total cost of owning a new good increases by more (13.6%) because of the decrease in the value of the good in its used incarnation. The cost of owning a used good increases by 28.5%, mostly due to the certification fee. In Importia the price of new goods decreases by 5% and the cost of owning a new good by 0.9%. The price of used goods in Importia drop significantly by 28.5%.

The effect on firm profits could go either way because the price of new goods rises while sales drop. It can be shown that profits will increase with quality certification if $s(1-k)$ is small.[7] In that case the difference in quality between new and used goods is small, which makes used goods good substitutes for new goods. Quality certification increases the cost of owning a used good and makes them less appealing to consumers. This reduces the durable goods problem faced by the monopolist leading to a higher price for new goods in that country. By contrast, the inflow of used goods in Importia reduces their price, worsens the durable goods problem faced by the monopolist in Importia and lowers the cost of new goods.

If the durable goods problem is big the monopolist gains by relaxing it in his home country and increasing it in the other country. The reason this is beneficial to the monopolist is that it raises the average price of the product in exchange for a reduction in sales. Recall that after the imposition of quality certification the monopolist sells most of his products in Exportia at the higher price which raises the average price of his production. It can be shown that total sales are reduced but if the durable goods problem is severe enough profits increase. The second column of Table 1 shows that for this example the imposition of quality certification increased total profits by 25.7%.

Summing up, the model predicts that countries producing durable goods have a bigger incentive to increase the cost of owning a used good in the presence of free trade in used goods. That benefits their producers at the expense of consumers and constitutes an indirect subsidy to the industry. The fact that WTO rules do not allow the use of more direct tools such as subsidies or trade restrictions, but allows exceptions for the protection of the environment and health, provides an explanation of why this indirect tool might be used.[8] Most governments justify the use of quality standards and restrictions in the importation of used automobiles on environmental and safety grounds. Pelletiere and Reinert (2002) cite several examples of countries justifying such measures on those grounds to the World Trade Organization (WTO). The potential use of quality standards as an indirect subsidy to domestic industry suggests that the

[7] The relevant expression is given in equation (25) in the appendix.

[8] Article XX of GATT refers to these exceptions.

WTO should examine these more carefully. The fact that Japanese automobile manufacturers have on occasion lobbied for tougher quality standards on used cars provides circumstantial evidence supporting this idea. Another group lobbying for tougher quality standards is the service sector. Enforcement of the shaken has created a huge service industry that was valued at $30 billion in 1991.[9]

On the other hand, durable good importing countries have no incentive to increase the cost of buying used goods, unless their use is associated with some negative externality. The presence of such externalities might justify such policies as the literature on minimum quality standards suggests (e.g. Leland (1979), Motta and Thisse (1999)). In the absence of such externalities, their consumers benefit from the efforts of exporters to favor their producers.

4 Gains from trade

The aim of sections 2 and 3 was to determine whether governments may have an incentive to use quality standards for used durables as an indirect industry subsidy. The framework we developed for that purpose can be used to answer a different question with important policy implications. What are the effects of introducing trade in used goods in a world where asymmetric quality standards are already in place due to other considerations such as environmental and safety externalities? Many countries have in place severe restrictions on the importation of used goods. Can this be justified on economic grounds?

There are a few papers that examine this issue in the context of international trade in the automobile market. Grubel (1980) using informal arguments demonstrates the potential welfare gains from free trade in used cars for developing countries. Recently, Clerides (2003) utilized a partial liberalization in the imports of used cars in Cyprus to put a number to these claims. He found welfare gains of the order of several hundred dollars per purchaser. Finally, Pelletiere and Reinert (2002) examine used car import restrictions in several Latin American countries and conclude that the existence of domestic production is an important predictor of significant import restrictions in used cars.

The impact of trade on consumer welfare is easy to see once its impact on the cost of new and used goods is examined. From equations (13), (14), (22), (23) and (24) we get that the

[9]The Economist (US edition) December 21, 1991.

difference in the cost of new goods, $p_n + \delta p_u$, and used goods with and without trade is given by

$$(p_n^{trade} + \delta p_u^{trade}) - (p_n^{notrade} + \delta p_u^{notrade}) = \frac{1}{4}(k\delta + 1)^{-1}(T^{other} - T^{own})(\delta - 1) \tag{19}$$

$$(p_u^{trade} + T^{own}) - (p_u^{notrade} + T^{own}) = \frac{1}{2}(k\delta + 1)^{-1}(T^{own} - T^{other}) \tag{20}$$

where T^{own} is a country's own cost of quality certification and T^{other} is the other country's cost. From equations (19) and (20) note that trade reduces the cost of both new and used goods in the country with the low quality certification and increases it for the other country.

High certification requirements increase the cost of owning a used good and in the presence of trade lead to the export of used goods to the other country. This increases the quantity of used goods in the country with the low T and decreases the quantity in the other country. As a result, the competition faced by new goods is increased in the low certification country and decreased in the high certification country. Therefore, the monopolist can charge higher prices in the high certification country (where competition is low) and lower prices in the low certification country (where competition is high). Thus trade in used goods decreases the cost of new goods in the country with low certification costs and increases the cost of new goods in the other country. The increase in the price of new goods in the high certification country allows sellers of used goods to demand a higher price since the substitute (new goods) is more expensive. The reverse happens in the low certification country.

Therefore, trade benefits consumers in the low certification country and hurts consumers in the high certification country. It might seem strange at first to suggest that trade reduces consumer welfare but closer examination reveals the intuition behind this result. This is really an application of the theory of second best. In the presence of market failures free trade is not an optimal policy. It this case the key feature of the model that drives the result is the lack of competition on the production side. More competition would restrict the ability of producers to increase prices and thus keep the cost of both new and used goods down.

On the other hand, using equation (25) it can be shown that the profits of the monopolist increase with trade if $s(1-k)$ is small. Here we are comparing profits with quality certification and no trade to profits with quality certification and trade. To do that let us compare first the profits with trade and quality certification to those with trade but without quality certification. From section 3 we know that the former exceed the latter if $s(1-k)$ is small. Now recall that because of symmetry there would be no trade in the absence of differences in quality certification. Therefore, profits with trade and no quality certification are the same as those with without trade and no quality certification. Finally, compare profits without trade and no quality certification

to those without trade but with quality certification. ¿From section 2 the former exceed the latter. Therefore,

$$\Pi(tr, qc) > \Pi(tr, noqc) = \Pi(notr, noqc) > \Pi(notr, qc) \tag{21}$$

where tr stands for trade and qc for quality certification. These comparisons show that trade increases profits if quality certification requirements are kept constant.

Summing up, Importia benefits from trade and would thus follow a free trade policy in used goods. Exportia on the other hand would ban trade in used goods if consumers matter more than producers. If, however, producers matter more than consumers free trade would be adopted in Exportia too.

An interesting implication arises if consumption of used goods is associated with negative environmental externalities (which presumably was the motivation behind the introduction of quality certification in the first place). If both countries adopt free trade policies, pollution would be exported from Exportia to Importia. This would be a version of the pollution haven effect that has been the subject of intense debate in recent years. The main difference is that in our model pollution is associated with consumption, while most of the literature has focused on pollution generated by production.[10]

5 International production

Many countries that restrict imports of used vehicles do so in order to protect domestic manufacturers. The presumption is that imports of used vehicles will reduce demand for domestically produced vehicles and thwart efforts to develop a domestic industry. Frazer (2004) provides evidence that the export of used-clothing donations in Africa has hurt the local clothing industry.

In order to address this issue we augment our model with the addition of a local producer in Importia. We assume that this producer sells a non-durable substitute good that lives only one period and is not exported to Exportia. The Exportian producer only faces competition from the Importian producer in the Importian market; he remains a monopolist in his home market. Competition is, therefore, more intense in the export market. This situation resembles the trade flows of automobiles between Japan and Russia. Japan exports both new and used cars to Russia but Russian exports to Japan are almost non-existent. We further assume that the new goods produced in Exportia are the best available quality in the market, followed by the

[10]See Copeland and Taylor (2004) for a review of the literature on trade and the environment.

used cars made in Exportia. The lowest available quality is the goods produced in Importia.[11]

The system consists of the two profit maximization conditions of the producer in Exportia, one profit maximization condition of the producer in Importia and the market clearing condition of equation (18). The solution of this system of four equations gives us the four prices of the model (the two prices for each of the two markets of new goods produced in Exportia, the price of the used goods and the price of the good produced in Importia). Proposition 1 summarizes the impact of quality certification on prices and quantities sold.

Proposition 1. *Quality certification in Exportia in the presence of free trade in used goods leads to:*

i. an increase in the price and the quantity of new goods in Exportia

ii. a decrease in the price and the quantity of new goods produced in Exportia and exported to Importia

iii. an increase in the cost and a decrease in the quantity of used goods in Exportia

iv. a decrease in the price and an increase the quantity of used goods in Importia and

v. a decrease in the price and the quantity of new goods produced and consumed in Importia.

Therefore, prices and quantities move in the same direction as in the previous section. Trade flows are also in the same direction (i.e. used goods are exported from Exportia to Importia). As a result the consumer welfare impact of quality certification is also the same with consumers in Exportia paying the price and consumers in Importia benefiting from the efforts of Exportia to benefit its producers. Finally, total profits increase for the producer in Exportia (if $s(1-k)$ is small) and decrease for the producer in Importia. As opposed to previous sections, in this case Importia might be better off imposing quality standards of its own or restricting trade in used goods. That depends on the relative importance of consumers and producers in the political economy considerations of the government and the degree of substitutability of domestic production and foreign production. Higher substitutability increases the likelihood that quality standards in Importia will benefit domestic producers.

The key difference between this case and that in section 3 is that the producer in Importia splits the decrease in profits in the Importian market with the producer in Exportia. The benefits

[11] Anyone who has driven a Russian made car will have no problem with this quality ranking. The authors of this paper will happily vouch for the quality of exported used Japanese vehicles; between them, they own four of them. For some additional evidence see "Japan's Used Cars Find New Lives On Russian Roads" (James Brooke, *New York Times*, Feb. 12, 2003).

of quality certification in the market of Exportia accrue solely to the producer in Exportia. Therefore, the overall benefit of the producer of Exportia from the same quality certification is larger. This logic holds more generally: the more market power producers have in their domestic markets relative to foreign markets, the more they gain from quality certification requirements.

The third column of Table 1 shows the impact of quality standards in this scenario using the same parameter values. The same quality certification raises new goods prices and overall cost in Exportia by 4.7% and 13.7% respectively. It also increases the cost of used goods in Exportia by 31.1%. Finally, it reduces the price of new goods produced in Exportia and consumed in Importia by 4.7% and the price of used goods by 12%. The profits of the producer in Exportia increase by 70% which is higher than the 25.7% gain of section 3. The profits of the producer in Importia decrease by 36.8%.[12]

6 Quality upgrade

One important simplifying feature of our theoretical framework is the assumption that quality certification requirements do not raise quality. In this section we show that relaxing this assumption does not change the nature of the results, although it does impose some additional conditions in order for them to hold.

Let Exportia require that the quality of used goods is upgraded from ks to Es to be allowed on the market. The cost of the quality upgrade is given by $\gamma s(E-k)$, where γ is the cost per unit of quality upgrade. We also assume that the cost of this upgrade is higher than its benefit to consumers. Otherwise, consumers would upgrade the quality of the goods even in the absence of quality standards. In the absence of externalities Importia has no incentive to impose such standards since they cost more to consumers than they are worth. Following the same methodology as above we derive the following proposition from the price equations shown in the appendix.

Proposition 2. *A quality upgrade in Exportia in the absence of free trade in used goods leads to:*

i. a decrease in the price and the overall cost of new goods

ii. a decrease in the price and an increase in the overall cost of used goods

iii. a decrease in the quantity of new goods sold quantity of used goods in Exportia

[12] We assumed that the marginal cost of production in Importia is 0.5

if the cost of the upgrade is high enough.

Proposition 2 shows that the qualitative results with the quality upgrade are the same as those with quality certification. Since prices move in the same direction the consumer welfare effects are also qualitatively the same.

Similarly, proposition 3 below shows that the qualitative results also go through when there is free trade in used goods.

Proposition 3. *A quality upgrade in Exportia in the presence of free trade in used goods leads to:*

i. an increase in the price, the cost and the quantity of new goods in Exportia

ii. a decrease in the price and the quantity of new goods produced in Exportia and exported to Importia

iii. an increase in the cost and a decrease in the quantity of used goods in Exportia

iv. a decrease in the price and an increase the quantity of used goods in Importia and

v. a decrease in the price and the quantity of new goods produced and consumed in Importia.

if the cost of the upgrade is high enough.

Since prices move in the same direction as in the quality certification case trade also flows in the same direction. In other words, quality standards lead to the export of used goods from Exportia to Importia. The qualitative effects of quality standards on consumer welfare are also the same.

Finally, it can be shown that producer profits increase with the imposition of quality standards if the per unit cost of the upgrade, γ, is high enough. Therefore, the government of Exportia can favor its producers at the expense of its consumers by imposing quality standards that require a quality upgrade of used goods. At the same time the consumers of Importia benefit from the efforts of Exportia to favor its producer.

In general the qualitative results of quality certification and quality upgrade are the same. The only caveat is that with quality upgrade the cost of the upgrade must be high. Recall that profits increase because competition from used goods is relaxed in Exportia by exporting used goods to Importia. With quality upgrade the export of used goods relaxes competition on one hand but on the other hand it makes used goods better substitutes for new goods intensifying

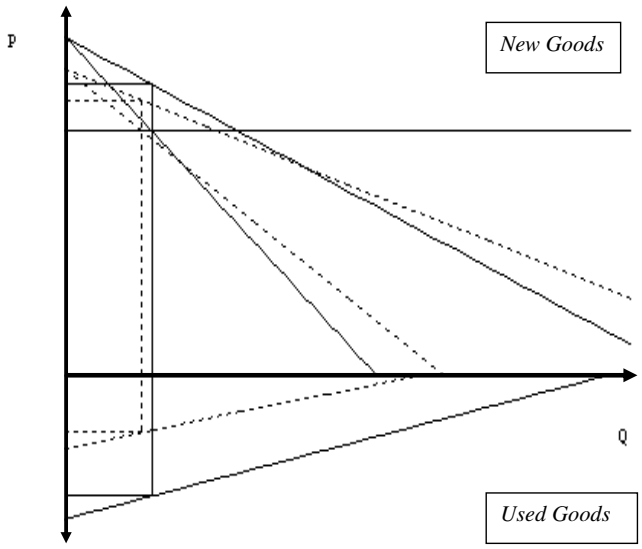

Figure 6: A market for durables with quality upgrade

competition. If the per unit cost of the upgrade is high, the former outweighs the latter and all the results go through.

We illustrate the equilibrium with a quality upgrade in Figures 6 and 7. Figure 6 represents the one country case where trade in used goods is not allowed (analogous to Figure 2). Figure 7 depicts the situation with trade in used goods (analogous to Figure 4). Note that a quality upgrade shifts the demand curves in the same direction as in the quality certification case but it changes the slope of these curves, at the same time. This last effect is the increase in demand elasticity of new goods because of the availability of better substitutes. From these figures it is easy to see that if the change of the slope is small relative to the displacement of the curve the prices change in the same direction as in the quality certification case. If the change in the slope is large then some prices might move in the opposite direction. This is the reason that with a quality upgrade we need the extra condition that the cost of the upgrade is high.

Finally, the last column of Table 1 shows the results using the same parameters as before for a quality upgrade that costs exactly the same as the quality certification used in the other columns. A quality upgrade that costs 18.1% of the new good price increases the price of new goods in Exportia by 1.8% and their overall cost by 9.5%. The price of new goods decreases in Importia by 4.8% and their overall cost by 0.8%. The cost of used goods increases by 29.2% in Exportia and decreases the by 11.8% in Importia. As a result profits increase by 2.8%.

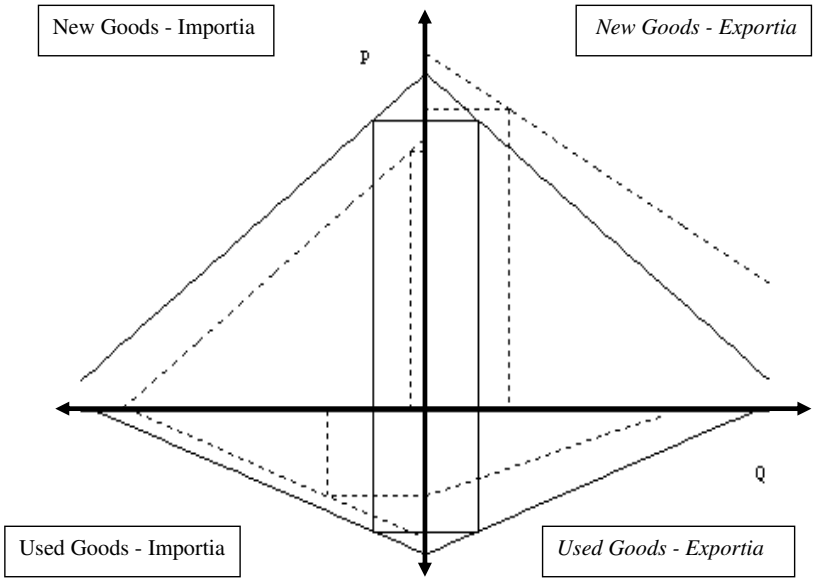

Figure 7: Equilibrium with free trade in used goods and quality upgrade

7 Conclusion

The purpose of this paper was to construct a theoretical framework to examine the impact of asymmetric quality standards on used goods on the trade flows, profits and consumer welfare in durable goods markets. We find that costly quality standards generate trade in used goods from the high to the low quality standard country. This trade in used goods reduces the exports of new goods to the low standard country.

Our framework highlights a motive for the imposition of quality standards unexplored by the literature so far. We find that stricter quality standards in countries that export durable goods favor producers at the expense of consumers and thus constitute an indirect subsidy. Profits increase because the trade in used goods generated relaxes the durable goods problem faced by producers in their home market. Therefore, if for political economy reasons these countries value profits enough they have an incentive to impose strict quality standards. On the other hand, importing countries have no incentive to impose quality standards and their consumers benefit from the efforts of exporters to favor their producers.

The gains of producers in exporting countries in their home market are moderated by losses

in export markets. This is because the outflow of used goods relaxes the durable good problem in the home market but makes it more severe in export markets. Therefore, if domestic markets are more important for some reason than export markets the benefits from imposing quality standards on used goods are increased. We demonstrate that this is indeed true when competition in export markets is more intense than that in the home market.

Using the same framework we also examine the welfare implications of trade in used goods in the presence of quality standards. We find that trade in used goods benefits consumers in countries with lower standards and hurts consumers in countries with higher standards. Producers in exporting countries also benefit from free trade in used goods.

Our results show that it is possible that quality standards on used goods may be motivated by the desire of some governments to favor their producers. The appeal to environmental and safety externalities makes it possible for them to justify these policies to the WTO. However, whether these considerations are more important for the countries that impose such policies than the negative externalities that might be associated with used goods is an empirical issue that remains open for investigation.

Appendix

Prices with quality certification and trade in used goods:

$$p_n^E = \frac{-T^I(\delta+1) - T^E(\delta - 2k\delta - 1) - M(-2k - 4k\delta - 2) - bs(2k - 2k\delta + 2k^2\delta - 2)}{4(k\delta+1)} \quad (22)$$

$$p_n^I = \frac{T^E(-\delta - 1) + M(2k + 4k\delta + 2) + T^I(2k\delta - \delta + 1) + bs(2k\delta - 2k - 2k^2\delta + 2)}{4(k\delta+1)} \quad (23)$$

$$p_u = \frac{2Mk - T^E - T^I}{2(k\delta+1)} \quad (24)$$

Change in profit due to quality certification in Exportia:

$$\begin{aligned} \Delta\Pi &= \Pi^T - \Pi^0 = \frac{NT^{E2}(2k\delta^2 - \delta^2 - 2k\delta - 2k^2\delta^2 - 1)}{8(b-a)(k\delta+1)^2(k-1)s} \\ &+ \frac{NT^E(2(2k\delta - \delta + 1)(\delta+1)T^I + (-4)(k-1)^2\delta M + 4(k\delta+1)(k-1)^2 s\delta b))}{8(b-a)(k\delta+1)^2(k-1)s} \end{aligned} \quad (25)$$

Prices with quality upgrade and no trade in used goods:

$$P_u^* = (E\delta+1)^{-1}(ME+s\gamma(k-E)) \tag{26}$$

$$P_n^* = \frac{1}{2}\left[\frac{M(E+2E\delta+1)+(E-k)(E-1)s\delta\gamma}{E\delta+1}-(E-1)sb\right] \tag{27}$$

Prices with quality upgrade and free trade in used goods:

$$P_n^E = \frac{-(k\delta-E-kE\delta-k^2\delta)(E-k)(E-1)\gamma s}{2(k^2-E-2kE\delta-k+E^2+kE^2\delta+k^2E\delta)}-\frac{1}{2}bs(E-1)+ \frac{M(k^2-E-2kE-4kE\delta-k+E^2+kE^2+k^2E+2kE^2\delta+2k^2E\delta)}{2k^2-2E-4kE\delta-2k+2E^2+2kE^2\delta+2k^2E\delta} \tag{28}$$

$$P_n^I = \frac{M(k^2-E-2kE-4kE\delta-k+E^2+kE^2+k^2E+2kE^2\delta+2k^2E\delta)}{2(k^2-E-2kE\delta-k+E^2+kE^2\delta+k^2E\delta)}- \frac{(\delta+1)(E-k)k(k-1)\gamma s}{2(k^2-E-2kE\delta-k+E^2+kE^2\delta+k^2E\delta)}-\frac{1}{2}bs(k-1) \tag{29}$$

$$P_u = \frac{MkE(k+E-2)-k\gamma(s(k-1)(E-k))}{(k^2-E-2kE\delta-k+E^2+kE^2\delta+k^2E\delta)}. \tag{30}$$

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Table 1: Impact of quality certification

Variable	No trade No competition (section 2)	Trade No competition (section 3)	Trade with competition (section 5)	Quality upgrade (section 6)
Cost of certification/upgrade as % of new price	18.66	17.75	18.03	18.16
%Δ new price Exportia	-0.90	4.17	4.69	1.81
%Δ cost of new good Exportia	12.69	13.58	13.70	9.49
%Δ new price Importia		-5.07	-4.75	-4.79
%Δ cost of new good Importia		-0.88	-0.81	-0.83
%Δ price of used good	-25.00	-12.50	-12.07	-11.80
%Δ cost of used good Exportia	16.00	28.50	31.14	29.20
%Δ cost of used good Importia		-12.50	-12.07	-11.80
%Δ Profits	-22.41	25.72	69.78	2.78

Parameters: $\delta = 0.8$, $s = 5$, $b = 1$, $a = 0$, $k = 0.8$, $M = 3.5$, $N = 1$, $I = k$, $E = 0.84$, $\gamma = 3.5$, $q = 3$, $C = 0.5$, $T^I = 0$, $T = 0.7$.