

Trade-inducing Quality Standards for Used Durables*

Sofronis Clerides
University of Cyprus and CEPR

Costas Hadjiyiannis
University of Cyprus

PRELIMINARY AND INCOMPLETE DRAFT

August 9, 2004

Abstract

Most countries enforce automobile safety and emission standards. These standards are broadly similar with respect to new automobiles, but quality requirements for used cars can vary substantially across countries. The durable nature of automobiles implies that the different treatment of used cars will impact trade flows in both new and used car markets. Motivated by this observation, we construct a theoretical framework to study the effects of such asymmetric policies on trade flows, profits and consumer welfare under various assumptions on trade barriers. We find that countries with automobile industries have an incentive to raise used car standards to reduce the durable good problem faced by their producers. This leads to the export of used cars to other countries. At the same time consumer surplus is reduced in the exporting country and increased in the importing country.

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

JEL Classification: F1, L1.

*We are grateful to Nadia Soboleva for many thoughtful comments. Participants at seminars at the University of Cyprus and the 2004 Conference on Research in Economic Theory and Econometrics also provided helpful feedback. We are responsible for all errors.

Correspondence: Department of Economics, University of Cyprus, P.O.Box 20537, CY-1678 Nicosia, Cyprus. Clerides: s.clerides@ucy.ac.cy; +357-22892450. Hadjiyiannis: costash@ucy.ac.cy; +357-22892440.

1 Introduction

Most countries enforce automobile safety and emission standards. These standards are broadly similar with respect to new automobiles, but quality requirements for used cars can vary substantially across countries. For example, it is well-known that Japan has very stringent regulations requiring cars to go through a rigorous and costly quality certification process at regular intervals, starting at the age of three. The enforcement of such high quality standards lowers the value of used cars relative to otherwise identical countries that adopt lower standards. A trade opportunity thus arises, whereby countries with high quality standards will export used cars to countries with low quality standards. It has indeed been documented that Japan is a major exporter of used automobiles, with exports worth \$2.7 billion.¹

Motivated by this observation, we construct a theoretical framework to study the impact of asymmetric quality standards on trade flows, profits and consumer welfare. This framework allows us to address a number of interesting questions. 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 countries that produce the durable more likely to require high quality standards? Many countries either prohibit or severely restrict the importation of used automobiles, often on environmental and safety grounds. Can this behavior be rationalized?

In our model we allow durable goods to live for two periods. Consumers have the choice of buying either a new or a used durable, or they can spend 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 but new goods are not, the imposition of quality standards in the exporting country benefit 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

¹*The Wall Street Journal* (Eastern Edition), January 8, 2004. See Clerides (2003) for a related case study that estimates welfare gains from the used car trade in the importing 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, unless there are negative externalities associated with used goods. In the absence of such externalities, the importing country's consumers benefit from the efforts of exporters to favor their producers.

2 Literature review

There is an extensive literature dealing with several aspects of durable goods markets. Waldman (2003) offers a detailed review of the industrial organization aspects of this literature. He reviews the work on optimal durability, on the time inconsistency faced by producers of durable goods, on the impact of adverse selection on durable goods markets and on the timing of new product introductions.

This paper is concerned with the interaction of durable goods markets and international trade. The literature on this interaction is rather limited. A number of papers examine the case where used durables have increased labor requirements and because of different factor prices trade in goods of different vintages is generated. Smith (1976) using such a model examines the pattern of international trade in used machines and analyzes the gains from trade. In a similar framework Bond (1983) models depreciation as an increase in downtime increasing the labor requirements as machines age and tests 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. 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.

3 A market for durables

For better exposition, 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 trading 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. We assume that the test does not improve the quality of the vehicle.

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 in every period in the steady state. 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 is the same as demand for new goods.

Demand. Our demand framework is based on the well-known vertical differentiation model introduced by Shaked and Sutton (1982). 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 other 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 the price received by sellers of the used durable is exactly the same as the price paid by buyers. That is, there are no transaction costs and 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 essentially 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, $v_h = \{v \mid U_n = U_u\}$. From equations (2) and (3):

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

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

$$v_l = \frac{p_u + T}{ks}. \quad (6)$$

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

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

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

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

$$b > v_h > v_l > a. \quad (9)$$

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

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

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:

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

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

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

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

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

$$p_u^* = \frac{kM - T}{1 + k\delta}. \quad (14)$$

We illustrate the equilibrium with a simple numerical example. We set $\delta = 1$, $s = 1$, $b = 1$, $a = 0$, $k = 0.8$, $M = 0.5$, $N = 1$ and $T = 0$. The equilibrium prices implied by those parameters are $p_n^* = 0.572$ and $p_u^* = 0.222$ and the equilibrium quantity sold $Q_n^* = Q_u^* = 0.361$. We depict the equilibrium in Figure 1. The demand for new goods is drawn for $p_u = 0.222$ and the demand for used goods is drawn for $p_n = 0.572$. The monopolist equates marginal revenue to marginal cost leading to $p_n = 0.572$ and $Q_n = 0.361$. Market clearing requires that the supply of used goods on the market is $Q_u = 0.361$ which leads to $p_u = 0.222$.

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 because the two goods are substitutes, hence a drop in demand for used goods increases demand for new goods. This is apparent in the demand function in (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 $T = 0.15$ in order to illustrate the impact of quality certification on the equilibrium. Note that we depict demand *at equilibrium prices*.

In Table 1 we compare the utility of consumers with and without quality certification for

Table 1: Consumer Surplus with no trade in used goods

Interval	$T = 0$	$T > 0$	$U^0 - U^T$
$[v_h, b]$	New	New	> 0
$[v_h^0, v_h]$	New	Used	> 0
$[v_l, v_h^0]$	Used	Used	> 0
$[v_l^0, v_l]$	Used	0	≥ 0
$[a, v_l^0]$	0	0	0
TOTAL			> 0

used goods. Variables with the superscript 0 refer to the case $T = 0$ and variables without a superscript refer to the case $T > 0$. The table shows that 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. Consumers with preference parameters in the interval $[v_h, b]$ 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 $[v_l, v_h^0]$ buy used goods under both scenarios but the cost of used goods $p_u + T$ increases when quality certification is required. Consumers in the interval $[v_h^0, v_h]$ are forced to buy used instead of new goods and consumers in the interval $[v_l^0, v_l]$ are forced to exit the market when certification is required.

Finally, the profits of the monopolist are given by:

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

Differentiating this expression yields:

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

From equation (9) it can be shown that the existence of the used market requires $(M - bs(1+k\delta) + T\delta) < 0$ and therefore $\frac{d\Pi}{dT} < 0$. Thus quality certification hurts both consumers and producers. Therefore, a welfare maximizing government would never require quality certification in this case.

4 Trade in new and used durables

We now introduce a second country into the picture. The two countries are identical in every aspect 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 of Exportia are denoted by the superscript E and of Importia by I. We assume that the goal of the government in Exportia 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.² Automobile manufacturers can sustain price differentials using various methods such as specialized models and authorized dealerships. We assume that used goods are freely traded between the two countries resulting in the equalization of their price. However, buyers of used goods have to go through the quality certification procedure in the country they reside. The monopolist's first order conditions are not affected, since by assumption he can price discriminate between the two markets and are given by

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

Market clearing no longer requires 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, it requires that the total quantity of new goods sold is equal to the total quantity of used goods sold. Therefore, the market clearing condition is given by

$$Q_n^E + Q_n^I = Q_u^E + Q_u^I. \quad (18)$$

Solving equations (17) and (18) we get the following prices:

$$p_n^E = \frac{(-T^I(\delta + 1) - T^E(\delta - 2k\delta - 1) - M(-2k - 4k\delta - 2) - bs(2k - 2k\delta + 2k^2\delta - 2))}{4(k\delta + 1)}, \quad (19)$$

$$p_n^I = \frac{(T^E(-\delta - 1) + M(2k + 4k\delta + 2) + T^I(2k\delta - \delta + 1) + bs(2k\delta - 2k - 2k^2\delta + 2))}{4(k\delta + 1)}, \text{ and} \quad (20)$$

$$p_u = \frac{(2Mk - T^E - T^I)}{2(k\delta + 1)}. \quad (21)$$

²See, for example, Verboven (1996).

Table 2: Consumer Surplus in Exportia with Trade in used goods

Interval	$T = 0$	$T > 0$	$U^0 - U^T$
$[v_h^{T=0}, b]$	New	New	> 0
$[v_h, v_h^{T=0}]$	Used	New	> 0
$[v_l, v_h]$	Used	Used	> 0
$[v_l^{T=0}, v_l]$	Used	0	≥ 0
$[a, v_l^{T=0}]$	0	0	0
TOTAL			> 0

4.1 Welfare implications of quality certification

We first consider consumers in Exportia and compare their utility with and without quality certification. Table 2 summarizes the results.

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. Consumers with preference parameters in the interval $[v_h^{T=0}, b]$ buy new goods in both scenarios 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 (19) $\frac{dp_n}{dT^E} > 0$ and from equation (21) $\frac{dp_u}{dT^E} < 0$. 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 $[v_h, v_h^{T=0}]$ to switch from used to new goods in the presence of quality certification. Consumers in the interval $[v_l, v_h]$ 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 expensive for consumers in $[v_l^{T=0}, v_l]$ forcing them out of the market.

The consumer welfare effects in Importia when Importia decides to impose quality certification are the same as those in Table 2. Since the government of Importia maximizes consumer welfare it will set $T^I = 0$. However, it is also necessary to examine the consumer welfare effects in Importia from the imposition of quality certification in Exportia. The results are summarized in Table 3.

From equations (20) and (21) 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 $[v_l, v_l^{T=0}]$ 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 $[v_l^{T=0}, v_h^{T=0}]$ who buy used goods under both scenarios also increases. Consumers in the interval $[v_h^{T=0}, v_h]$ shift from the new to the used market because the reduction in the cost of used goods

Table 3: Consumer Welfare effects in Importia from quality certification in Exportia

Interval	$T = 0$	$T > 0$	$U^T - U^0$
$[v_h, b]$	New	New	> 0
$[v_h^{T=0}, v_h]$	New	Used	> 0
$[v_l^{T=0}, v_h^{T=0}]$	Used	Used	> 0
$[v_l, v_l^{T=0}]$	0	Used	≥ 0
$[a, v_l]$	0	0	0
TOTAL			> 0

is larger than the reduction in the cost of new goods. Finally, since the cost of new goods is reduced, consumers in the interval $[v_h, b]$ who buy new goods under both scenarios also benefit.

The profits of the monopolist are given by

$$\begin{aligned} \Pi = & \frac{N(T^I(\delta+1) + 2M(1-k) + T^E(\delta - 2k\delta - 1) + 2bs(k-1)(k\delta+1))^2}{16(b-a)(k\delta+1)^2(1-k)s} + \\ & \frac{N(2M(k-1) - T^E(1+\delta) + T^I(2k\delta - \delta + 1) - 2bs(k-1)(k\delta+1))^2}{16(b-a)(k\delta+1)^2(1-k)s} \end{aligned} \quad (22)$$

The impact of quality certification in Exportia on profits is, therefore, given by

$$\begin{aligned} \Delta\Pi = \Pi^T - \Pi^0 = & \frac{NT^{E2}(2k\delta^2 - \delta^2 - 2k\delta - 2k^2\delta^2 - 1) +}{8(b-a)(k\delta+1)^2(k-1)s} \\ & \frac{NT^E(2(2k\delta - \delta + 1)(\delta+1)T^I + (-4)(k-1)^2\delta M + 4(k\delta+1)(k-1)^2s\delta b)}{8(b-a)(k\delta+1)^2(k-1)s} \end{aligned} \quad (23)$$

Equation (23) shows that profits increase with quality certification if s is small and k is large. A small s and a large k imply that the difference in quality between new and used goods, $s(1-k)$, is small. That makes used goods better substitutes for new goods and intensifies the durable goods problem faced by the monopolist. In that case, if the government of Exportia puts a large enough weight on the profits of the monopolist, the increase in profits will outweigh the loss in consumer welfare and it will set $T^E > 0$. Intuitively, quality certification in Exportia increases the cost of buying a used good in that country. That leads to an outflow of used goods from Exportia to Importia reducing the quantity of substitutes for new goods in Exportia. This reduces the durable goods problem faced by the monopolist leading to a higher price for new goods in that country. Note that the cost of both new and used goods increase in Exportia making all consumers in that country worse off. The inflow of used goods in Importia reduces the cost of buying one. This decrease in the price of the substitute for new goods increases

the durable goods problem faced by the monopolist in Importia lowering the cost of new goods as well. Therefore, all consumers in Importia benefit. If the durable goods problem is big the monopolist gains by relaxing it in his home country and increasing it in the other country. To understand how this works one needs to consider each country separately. From equation (7) note that in Exportia T^E affects the quantity of new goods sold directly and indirectly. The indirect effect is through the impact on used and new prices and directly because it is directly added to the cost of buying a used good. However, in Importia the quantity of new goods sold is only affected indirectly through the prices of new and used goods. Therefore, the quantity sold in Exportia is more elastic than that in Importia and thus the increase in profits in Exportia outweighs the loss in profits in Importia. Therefore, total sales of the monopolist increase with the imposition of quality certification.

The model, therefore, 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. Countries that just import durable goods have no incentive to increase the cost of buying used goods, unless their use is associated with some negative externality. In the absence of such externalities, their consumers benefit from the efforts of exporters to favor their producers.

5 Trade and Welfare

The only difference between the single country case in section (3) and section (4) is the existence of trade in used goods. In this section we analyze the impact of trade on welfare by comparing consumer and producer welfare with and without trade in used goods keeping quality certification requirements constant. 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), (19), (20) and (21) we get that the difference in the cost of new goods, $p_n + \delta p_u$, with and without trade is given by

$$(p_n^{trade} + \delta p_u^{trade}) - (p_n^{notrade} + \delta p_u^{notrade}) = \frac{1}{4} (k\delta + 1)^{-1} (T^{other} - T^{own}) (\delta - 1), \quad (24)$$

where T^{own} is a country's own cost of quality certification and T^{other} is the other country's cost. From equation (24) note that trade reduces the cost of new goods in the country with the low quality certification and increases it for the other country. Similarly the difference in the cost of used goods is given by

$$(p_u^{trade} + T^{own}) - (p_u^{notrade} + T^{own}) = \frac{1}{2} (k\delta + 1)^{-1} (T^{own} - T^{other}). \quad (25)$$

Therefore, the cost of used goods also decreases for the country with low quality certification and increases for the other country. High certification requirements increase the cost of buying 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 cost of used goods decreases in the former and increases in the latter. This change in the cost of used goods increases the competition faced by new goods in the low certification country and decreases the competition in the high certification country. The monopolist can therefore, 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.

In section (4) we reached the conclusion that Exportia is going to impose stricter quality certification procedures. This leads to an increase in the cost of all goods with trade and, therefore, consumers lose from trade. Trade is beneficial for consumers in Importia since the lower certification requirements lower the cost of all goods. On the other hand, from equations (15) and (22) it can be shown that the profits of the monopolist increase with trade if s is small and k is large. The intuition is similar to the intuition for imposition of

quality certification. The case of trade with no quality certification is similar to the case of no trade. In that case, because of symmetry there would be no trade. The only difference is that profits with trade and no certification requirements would be lower than those without trade and certification requirements because certification requirements decrease profits in the absence of trade (see equation (16)). In section (4) we have shown that, under some conditions, profits increase with quality certification in the presence of trade. Therefore, profits with quality certification and trade exceed those without certification and trade which in turn exceed those with certification and no trade. Thus trade increases profits for small s and large k .

Alternatively, one could take the approach that governments play a two-stage game in which they first decide whether to allow trade in used goods or not and then the level of quality certification. In that case, section (4) provides the solution to the second stage of the game. In the absence of trade both countries require no quality certification while with trade Exportia requires quality certification and Importia no quality certification. Given these results one could analyze the decision in the first stage by comparing the welfare with trade and quality certification requirements by Exportia only, to the welfare with no trade and no quality certification. In that case, using equations (24) and (25) we can show that consumers in Exportia lose and consumers in Importia gain from trade. Finally, following the reasoning in the previous paragraph it can be shown that profits increase if s is small and k is large. Thus, if profits are important

enough for Exportia the equilibrium outcome of this two-stage game would be that trade would be allowed and quality certification would be required by Exportia.

6 Quality Upgrade

In this section we examine the case where the quality standards imposed by the government require a quality upgrade. Let Exportia require that used goods are of quality Es . 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. This assumption implies that Importia has no incentive to impose such a quality upgrade. The government of Importia is only interested in maximizing consumer welfare and quality upgrades cost more than they are worth. Following the same methodology as above we derive the following equilibrium prices in Exportia in the absence of trade in used goods

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

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

Comparing equations (26) and (27) to the case with no quality standards observe that quality standards decrease the price of used goods, P_u , and increase the cost of used goods, $P_u + \gamma(k - E)$. If the per unit cost of the upgrade is high enough quality standards also decrease the price of new goods P_n . In other words, 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 and are given by table 1.

The equilibrium prices with trade in used goods but no trade in new goods are given by

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

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

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

From equations (28) and (29) we get that the price of new goods is higher in the country with the high quality standards.³ In addition, it is easy to show that the imposition of quality standards in Exportia increases the price of new goods in Exportia and decreases the price of new goods in Importia if the cost of the upgrade is relatively high. Finally, from equation (30) note that the imposition of quality standards increases the cost of used goods in Exportia, $P_u + \gamma(E - k)$, and decreases the cost of used goods in Importia. Again, the qualitative results are the same as in the quality certification case.

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. Therefore, tables 2 and 3 show the changes in consumer welfare in Exportia and Importia as a result of the imposition of quality standards in Exportia.

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 large 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 large. 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 competition. If the per unit cost

³This assumes that $\gamma > b$ which is a sufficient condition for the cost of the upgrade to exceed its benefit.

of the upgrade is large the former outweighs the latter and all the results go through.

We illustrate the equilibrium with a quality upgrade in Figures 4 and 5. Figure 4 represents the one country case where trade in used goods is not allowed (analogous to Figure 2). Figure 5 depicts the situation with trade in used goods (analogous to Figure 3). In this numerical example we set $\delta = 0.8$, $s = 5$, $b = 1$, $a = 0$, $k = 0.8$, $M = 2$, $N = 1$, $E = 0.85$ and $\gamma = 3.75$. In the single country case the imposition of a quality standard that costs 39% of the new good price reduces profits by 41%. In the presence of trade in used goods the same quality upgrade increases the price of new goods in Exportia by 3%, decreases the price of new goods in Importia by 11%, increases the cost of used goods in Exportia by 66% and decreases the cost of used goods in Importia by 30%. As a result profits increase by 14%. In Figures 4 and 5 note that a quality upgrade shifts the demand curves in the same direction as in the quality certification case. However, at the same time it changes the slope of these curves. 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.

7 Conclusion

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

Our framework highlights a motive for the imposition of quality certification 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. Profits increase because the trade in used goods generated relaxes the durable goods problem faced by producers in their home market. Therefore, if these countries, for political economy reasons, value profits enough they have an incentive to impose strict quality certification procedures. 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.

Finally, we find that trade in used goods benefits consumers in importing countries and producers in exporting countries. Consumers in exporting countries end up worse off with trade.

We are currently working on extending this basic model by allowing production in both countries and thus introducing competition in the market. This case is particularly relevant because one of the justifications of used good import prohibition is the protection of domestic industry.

References

- Bond, E. W., 1983, "Trade in Used Equipment with Heterogeneous Firms," *The Journal of Political Economy*, 91, 688–705.
- Clerides, S. K., 2003, "Gains from Trade in Used Goods: Evidence from Automobiles," University of Cyprus mimeo.
- Driskill, R. A., and A. W. Horowitz, 1996, "Durability and Strategic Trade. Are There Rents to Be Captured?," *Journal of International Economics*, 41, 179–194.
- Goering, G. E., and M. K. Pippenger, 2000, "International Trade and Commercial Policy for Durable Goods," *Review of International Economics*, 8, 275–294.
- Shaked, A., and J. Sutton, 1982, "Relaxing Price Competition Through Product Differentiation," *Review of Economic Studies*, 49, 3–13.
- Smith, M. A. M., 1976, "International Trade Theory in Vintage Models," *Review of Economic Studies*, 43, 99–113.
- Verboven, F., 1996, "International Price Discrimination in the European Car Market," *Rand Journal of Economics*, 27, 240–268.
- Waldman, M., 2003, "Durable Goods Theory for Real World Markets," *Journal of Economic Perspectives*, 17, 131–154.

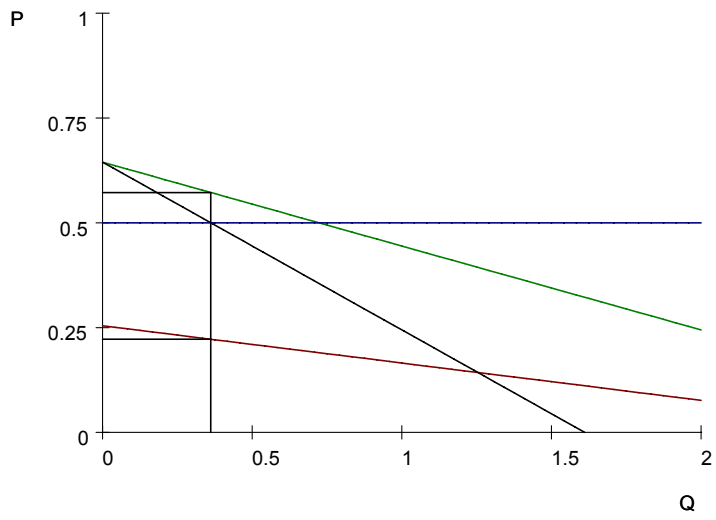


Figure 1: Single country with no quality certification

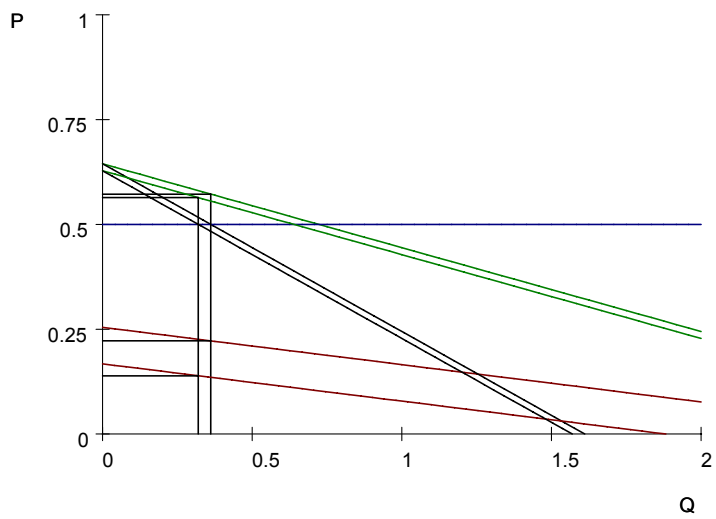


Figure 2: Single country with quality certification

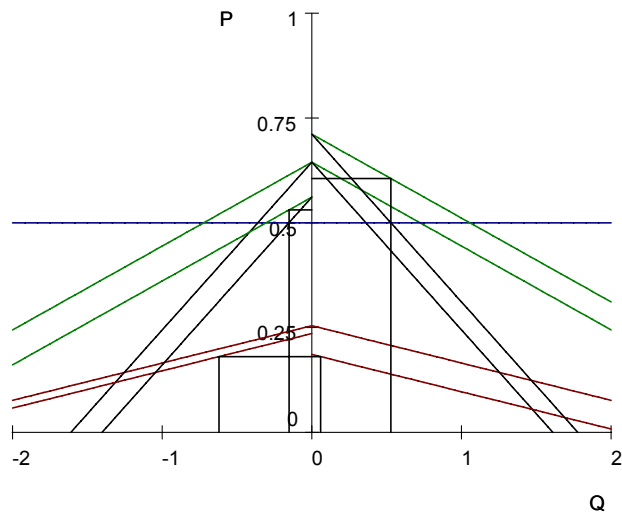


Figure 3: Quality certification and trade

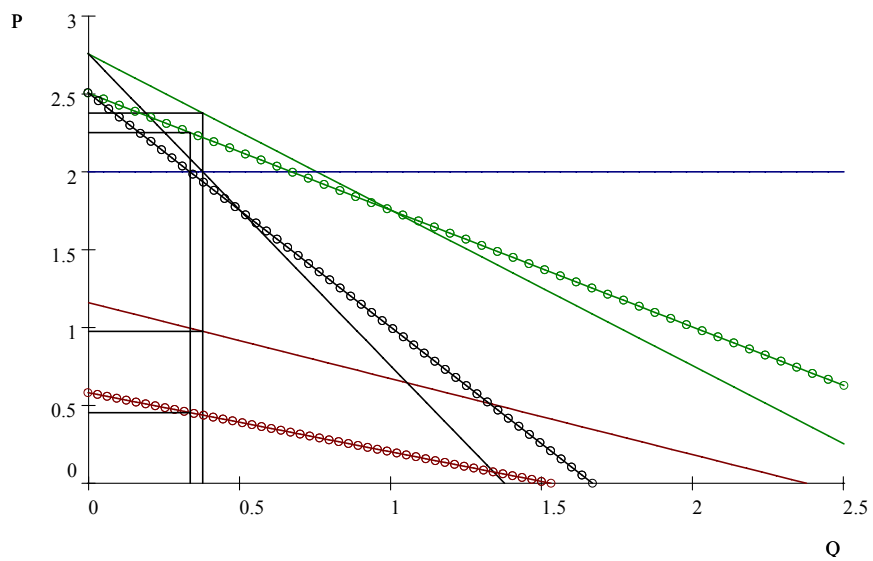


Figure 4: Single country with quality upgrade

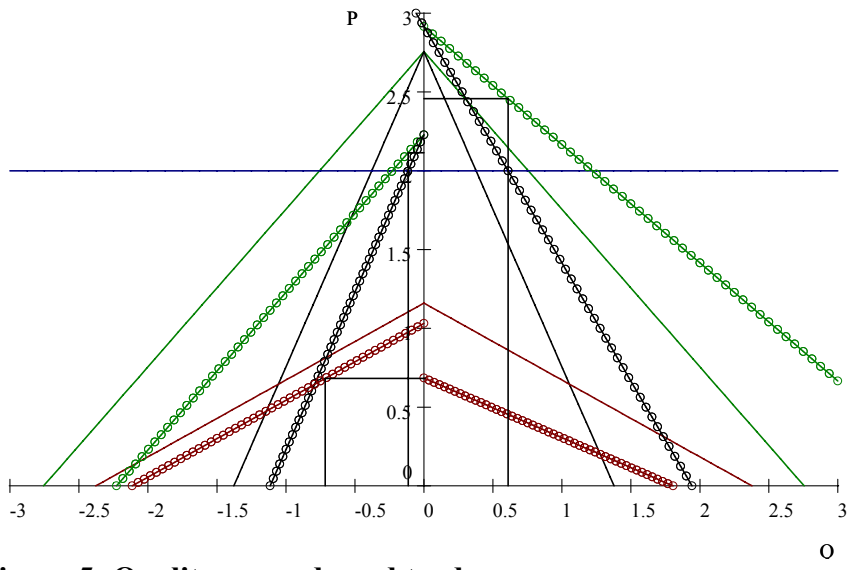


Figure 5: Quality upgrade and trade