Parallel Trade, International Exhaustion and Intellectual Property Rights:  
A Welfare Analysis

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Abstract: This paper analyses the issue of parallel trade (arbitrage) for products protected by intellectual property rights. Many countries have traditionally allowed owners of intellectual property rights to prohibit arbitrage in the face of international price discrimination. In a well known paper Malueg and Schwartz (1994) showed that this policy decreases social welfare when the same markets are served in both regimes, with and without arbitrage. However, their model considered only the setting of prices, and not investment in product development. We show that in a two-stage game where firms choose quality first and then prices this welfare result can be reversed. We also show that these results are highly sensitive to assumptions about the product owner to sell the same product with different quality features and the presence of generic (inferior) substitutes.

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1. Introduction

Parallel trade of goods protected by intellectual property rights is an important but little understood issue in international trade. Parallel trade (sometimes called “grey market” trade) involves the shipment of *bona fide* goods (i.e. not illegal counterfeits) across international borders\(^1\). In a free-trade environment parallel trade prevents monopoly suppliers from engaging in international price discrimination. However, where the good is protected by an intellectual property right, such as a patent or trademark, this right may permit the owner to prohibit international arbitrage.

Examples of parallel trade involving an intellectual property right would be

- The sale of a UK patented anti-ulcer drug by a UK company to distributors in the Greek market, who then decide that it would be more profitable to re-sell the product into the UK market;
- The sale of perfume by a French producer (who owns a trademark in France) to a Russian distributor for sale in Russia who then decides it would be more profitable to re-import the perfume into the French market.

In both cases we suppose the product originated from a country where a patent or trademark was legally registered and the goods had been exported for sale in a foreign territory. In both cases, the price would likely be lower than in the home territory, and therefore wholesalers of the product would have an incentive to engage in international arbitrage.

Historically, national intellectual property law in countries such as the UK and France has given exporters who possess a patent or trademark the right to prohibit such trade. This can be done, for example, simply by marking the goods “not for resale in the UK” or “not for resale in France”. More recently, the European Union has overridden this national law by adopting a policy known as “Community Exhaustion”, meaning that once goods have been placed on the market in the European Union, the holder of the intellectual property right no longer has the right to restrict the further movement of the goods anywhere inside the European Union.

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\(^1\) Thus parallel trade is a form of arbitrage; the term “parallel” trade is used because in many cases the good is shipped back to the country from which it originated: the good is returning whence it came. Parallel trade might equally involve the shipment of goods produced under licence in one country back to the country of the licensor, the key point is that such trade is motivated by international price differences.
term “exhaustion” is used because the rights of the owner of the intellectual property are said to be “exhausted” once the goods have been placed on the market (hence this policy is known as the “first sale doctrine” in the US, where owners of intellectual property have never had the right to prohibit re-importation of bona fide products identical to those sold in the domestic market). In our example, under Community Exhaustion the UK exporter could not prevent the Greek distributor reselling the goods in the UK. However, since Russia is currently outside the EU the owner of the French perfume trademark could prevent re-importation into France.

Parallel trade in products such as pharmaceuticals within the EU is now a significant business activity. For example, one recent study estimated that 20% of branded pharmaceuticals sold in the UK in 2002 were parallel sourced (value about £1.3bn). As one might expect, pharmaceutical companies claim that this is undermining their profitability. As yet the EU policy only extends as far the EU’s borders. However, many developing countries are lobbying for the adoption of a policy of “international exhaustion” to be adopted at the WTO. This would mean that goods placed on the market anywhere in the world could then be resold anywhere else (e.g. French perfume could then be re-imported from Russia). This appears to be motivated by the hope that goods produced under license in developing countries, which are currently prevented from being imported into the licensor’s domestic market by the same intellectual property laws, could be exported and generate large profit for the licensees.

That the potential profits from parallel trade of this kind are significant is not in doubt. Prior to entering the European Union, Sweden operated a system of international exhaustion, permitting importers to source parallel traded goods from anywhere in the world. For example, if Levi jeans could be purchased more cheaply in South America than in Europe, a Swedish importer was free to purchase in South America and resell in Sweden, even if the goods had originally been intended (by Levi Strauss & Co.) for sale in South America. However, on entering the EU Sweden was obliged to respect the rights of any holder of a Community trademark to prevent parallel trade from outside the EU. A study by the Swedish

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2 A number of cases in the European Court of Justice has established this principle, most notably Silhouette v. Hartlauer (Case C-335/96). Silhouette, an Austrian company, that sold spectacles under its trademark sold an outdated batch to a Bulgarian company for resale in the Former Soviet Union. However, the distributor then tried to put them on the market in Austria, and the court upheld Silhouette’s right to prevent this under its trademark.


4 This specific issue arose in the European Court in the case of Davidoff v. A&G Imports and Levi Strauss v. Tesco (Case c-414/99). Tesco, a UK retailer, attempted to circumvent the EU distribution channels of Levi Strauss by buying direct from US wholesalers - the court upheld the right of Levi Strauss under their trademark to prohibit these imports, which represented a form of arbitrage.
Competition Authority (1999) estimated that parallel traded goods in sectors such as motorcycle spare parts, tyres, motorcycles, clothing, footwear, pharmaceuticals, sports equipment and snow scooters were between 10 and 30% cheaper than domestically sourced goods and that the elimination of parallel trade from outside the EU had increased domestic prices by between 0.4 and 5% on average.

This argument raises some interesting economic questions, although there have been surprisingly few papers on the subject. If parallel trade is permitted, why does the producer make low priced goods available in some markets when it knows that they will be parallel traded? One answer is that producers restrict supplies to low priced markets, expecting that the flow of parallel trade will be small. However, if arbitrage undermines profitability in the high price market the producer may choose to offer to sell at a single price across all markets, possibly leaving some markets unserved.

It is clear from this argument that in the short run parallel trade must benefit consumers in high price market but must harm consumers in markets that would have low prices if arbitrage were not possible. The producer’s profit also suffers, suggesting that the welfare trade-offs are difficult to judge. This issue is addressed in Malueg and Schwartz (1994) who develop a model of a single product sold in a continuum of markets, each characterised by the maximum willingness to pay of any consumer in that market (uniformly distributed across markets). They show that aggregate welfare under international exhaustion (arbitrage) is higher than under international price discrimination (no exhaustion of rights) so long as international exhaustion does not imply the closure of any market. However, if the willingness to pay of consumers is sufficiently dispersed between markets then those markets where consumer valuations are very low will be closed and aggregate welfare may fall.

5 However there have been a number of policy oriented reviews - see e.g. Tarr (1985), Szymanski (1999), and Danzon and Towe (2003). Abbot (1998) provides a detailed legal statement of the case for international exhaustion while New Zealand Institute of Economic Research (1999) provides an economic rationale; NERA (1999) provide the case against. The 2002 OECD report provides a useful synthesis. Maskus and Chen (2004) look at parallel trade in relation to vertical price controls and Richardson (2002) makes the simple but important point that prohibiting international exhaustion is not a Nash equilibrium in a game played between governments.

6 In the presence of increasing returns to scale, price uniformity can negatively affect everybody (Hausman and Mackie-Mason, 1988). Also notice how the welfare implications seem quite different depending on the product - for example, both perfume and AIDS treatments will likely be cheaper in poor countries if parallel trade is prohibited, yet in the first case the impact on consumers in poor countries does not seem particularly important, while in the latter case it is vital.

7 Measured by the unweighted aggregate of consumer and producer surplus.
We extend their paper in two ways. First we endogenise the quality of the good sold. Most pharmaceutical companies claim that their R&D spend will fall under a regime of international exhaustion, since this prevents them from recovering their fixed costs efficiently (they liken international price discrimination to a form of Ramsey pricing). We show that, when the producer determines quality endogenously, product quality will fall because of lower investment. This implies that welfare can fall globally under international exhaustion. Second, we model the case where an alternative product exists, which we label a “generic”.

The existence of a generic competitor improves the positive effects of international exhaustion ex post, but worsens the ex ante incentives to invest. We also show that the last result depends on the patent holder being restricted to offer only one product. When the patent holder is allowed to introduce a second lower-quality product, we show that it has an incentive to do so only when the generic product is present. In such a case, the lower-quality variant is introduced to fight the generic, while profits made from the higher-quality good are protected. This implies that while the ex post welfare properties of parallel trade are still improved by the presence of a generic, the ex ante incentives to invest are not affected by it. This is a striking result. In this paper we consider two constraints on monopoly power: the inability to prevent arbitrage (international exhaustion) and the presence of a generic, and in both cases we find that the incentive of the monopolist to supply quality is diminished. However, when we consider these two constraints simultaneously we find that the incentive to supply quality is not reduced relative to benchmark monopoly case as long as the monopolist can offer an inferior version on its own product (a fighting brand).

The paper is set out as follows. In the next section we outline our model assumptions and describe the benchmark case where quality is fixed (as in Malueg and Schwartz). For this case aggregate welfare is higher under international exhaustion (arbitrage) as long as not too many markets are closed. Then in section 3 we show that when quality is endogenous any beneficial effects of arbitrage can be more than offset by the implied reduction in quality of the good in the market, even when all markets are served. In section 4 we consider the effect that the presence of a non-strategic generic alternative (albeit of a lower quality) has on welfare, and we find that although this alternative raises welfare ex post, it does not overturn the result that

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8 With the exception of Rey (2003), to the best of our knowledge there are no papers that look at the dynamic aspects of parallel trade. Rey studies the impact of parallel trade on R&D in a game where governments contribute to finance investments through regulated prices.
arbitrage reduces welfare once the effect on quality is considered. Finally, in section 5 we consider the possibility that the strategic player might introduce more than one quality of product in the face of the non-strategic alternative. Section 6 concludes.

2. Model assumptions and preliminary results

We consider the price and product quality choice of a monopolist selling to (or licensing to) a set of distinct markets. We use a model of vertical product differentiation to represent consumer preferences in each market. When a consumer of type $t$ buys a product of quality $u$ at price $p$, his utility is $tu - p$. $t$ is uniformly distributed between 0 and $T$ with unit density.

There is a continuum of markets characterised by their highest type $T$. $T$ is uniformly distributed over $[1 - x, 1 + x]$ with density $2x$, where $x$ measures demand dispersion: a high value of $x$ implies a large difference between the maximum willingness to pay across markets (as may be the case, for example, if income inequalities between countries are large).

The supply a product with a given quality $u$ involves a fixed cost. The cost is assumed to be convex, and at times we will make use of a quadratic functional form: $C(u) = ku^2/2$. Thus more R&D enables the investing firm to discover “better” products, but the cost per unit of quality is increasing. Once a product has been discovered, its marginal cost of production is not affected by the level of quality. We normalise the marginal cost of production to zero.

We model the problem as a two stage game in which the firm first sets its quality level and then selects the associated price(s). The second stage of the game is essentially the case considered by Malueg and Schwartz.

In the absence of international arbitrage the monopolist sells the same quality $u_d$ at different prices in the various markets. For instance, in market $i$ it sets a price $p_i$. It then sells to all customer types between $t_i = p_i/u_d$ and $T$. The firm sets the price to maximise $\pi_i = (T_i - t_i)p_i$. If arbitrage cannot be avoided the monopolist sells a quality $u_u$ at a price $p$ in every market. If the marginal type $t = p/u_u$ is lower than the lowest possible $T (= 1 - x)$ then all the markets will be served, otherwise the monopolist will serve only those markets with $T$ comprised between $t$ and $1 + x$.

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$^9$ The subscript $d$ stands for price discrimination, while we use a subscript $u$ for price uniformity.
PROPOSITION 1: In the second stage of the game, taking quality as fixed, aggregate consumer surplus will always be higher under international exhaustion (arbitrage), profits will always be lower and aggregate welfare be higher as long as the dispersion of consumer valuations between markets is not too great. If the dispersion of consumer valuations is great enough \((x > x^*)\) then welfare will fall.

Proof: See appendix.

Proposition 1 is simply a restatement of the Malueg and Schwartz results in the context of our modelling assumptions (vertical product differentiation). If arbitrage does not induce any market to close it is always welfare improving, otherwise it depends on the degree of dispersion.

3. Endogenous quality under monopoly

The stage 2 game is incomplete: in practice firms choose to invest on the basis of expected returns and the amount they invest in seeking and acquiring an intellectual property right may depend on whether they expect international exhaustion to apply. This issue is not addressed in the Malueg and Schwartz paper, but is clearly an important issue for research intensive industries such as pharmaceuticals. By solving for the optimal choice of quality in the stage 1 game, contingent on the expected regime at stage 2, we derive the following result.

PROPOSITION 2: At the first stage of the game the selected quality of the product will always be lower under international exhaustion (arbitrage). With a quadratic cost function, consumer surplus will always be higher but profits and aggregate welfare will always be lower.

Proof: See appendix.

Some results are quite intuitive: from the second stage expressions of gross profits and consumer surplus, we first notice that quality enters linearly in all regimes. Since - for a given quality level - gross profits with arbitrage are lower than gross profits without, it also follows that marginal revenues are lower with arbitrage. As a result, the impact of international
arbitrage is to dilute the incentives of the monopolist to invest in quality. The result $u_d > u_u$ would hold for any convex cost function.

The fact that quality is always lower with parallel trade has a negative impact on consumer surplus but this effect never dominates the better ex post allocation among served customers. Of course we are referring to aggregate surplus - customers in some country will always be losers, most notably when they are not served under arbitrage, which happens when $x > \frac{1}{2}$. Overall, the ex ante loss deriving from a lower quality dominates over the ex post consumer gains, and total welfare is always lower under a uniform pricing regime.

More generally, the size of the welfare loss depends on the convexity of the cost function: if it is very convex - so that quality changes are small in the two regimes - then the ex ante analysis would resemble the ex post analysis. On the other hand, if marginal cost is constant or increases at a decreasing rate, then quality differences become magnified and we can construct examples where even consumer surplus is lower with arbitrage.

4. Competition with (non-strategic) generics

Sellers obtain patents or trademarks in order to protect the market power conferred by the originality or distinctiveness of their product. However, substitutes often exist in the form of less attractive alternatives - “own label” brands in supermarkets or generic treatments in pharmaceuticals.10 Competition from generics of this kind places an additional constraint on the behaviour of the monopolist.

Suppose the generic is modelled as a product of quality $u_g$ sold at a price $p_g$. To ensure that the generic product is a competitor ‘from below’ these quantities are treated as parameters (hence the supplier of the generic is non-strategic). In each market $i$, the marginal type is now determined by the presence of the generic $z = p_g / u_g$, while the protected good (i.e. protected by a patent or a trademark) offered by the monopolist is sold to customer types comprised between the highest type $T$ and the indifferent type defined as:

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10 A generic is typically a product that was once protected by a patent which has now expired and can therefore be produced by anyone. Sometimes the generic in its original form may preserve some market power if it acquires some brand identity prior to the expiry of the patent, but in general such transitions are difficult.
\[ \tilde{t}_i = \frac{p_i - p_g}{u_d - u_g}. \]

In the absence of international exhaustion the firm maximises its profit \( \pi_i = (T_i - \tilde{t}_i)p_i \) with respect to \( p_i \) in each market.

If, by contrast, the monopolist cannot discriminate among the various markets (international exhaustion applies) it sells at a common price \( p \) its good of quality \( u_u \). If a market is served by both the protected and the generic product, then the indifferent type in each market is:

\[ \tilde{t} = \frac{p - p_g}{u_u - u_g}. \]

If this indifferent type is lower than the lowest possible \( T (= 1 - x) \) then all the markets will be served, otherwise the monopolist will serve only those markets with \( T \) comprised between \( \tilde{t} \) and \( 1 + x \), while the remaining markets will be served only by the generic. Hence the firm sets \( p \) to maximise:

\[ \Pi_u = \int_{\max\{1-x, \tilde{t}\}}^{1+x} \left( \frac{T - \tilde{t}}{2x} \right) pdT. \]

PROPOSITION 3: When there is no international exhaustion the presence of the generic drives down prices by more in the more lucrative markets. When a generic is present then under either regime (i.e. with or without arbitrage) (a) prices chosen by the monopolist are lower (b) consumption of the protected good is higher and (c) the profit of the monopolist is lower and consumer surplus is higher than the case where there is no generic.

Proof: see appendix.

The fact that the generic exerts a larger effect on price in the lucrative market is an interesting property and suggests that monopolists will have a strong incentive to defend their most valuable markets from generic competition. Part (b) is a property noted by Bae and Choi (2002) in their model of software piracy. The result that sales of the patented good increase
with the generic stems from the fact the monopolist is forced to push its price down. This will be important in section 5 when we consider the possibility of the monopolist offering more than one product.

We can now identify the effect on welfare of the generic in the stage 2 game where quality is taken as given.

**PROPOSITION 4:** *In the stage 2 game, taking quality as fixed, profits fall and consumer surplus increases under international exhaustion. Welfare increases if the dispersion is lower than a fixed threshold $x^{**}$, but decreases otherwise. This threshold value is higher than in the case where there is no generic, $x^{**} > x^{*}$, and the impact of the generic is stronger when the generic is not priced too competitively or the difference in quality is not too great.*

Proof: see appendix.

If dispersion is ‘low’, the welfare analysis mimics the one conducted under pure monopoly: both consumer surplus and welfare increase with parallel trade. The generic good has an impact on the absolute level of welfare in each regime, but not on the difference between regimes. The role of the generic is to increase market shares and to put a downward pressure on the protected good’s price, but its effect is the same with and without discrimination.

If dispersion is ‘high’, the welfare properties still resemble those of pure monopoly: welfare decreases under parallel trade only if the dispersion is sufficiently high. However, the positive effect on consumer surplus and welfare due to parallel trade is now reinforced by the presence of the generic.

To understand why the presence of the generic matters only in the ‘partial’ coverage regime, recall that in the partial coverage regime, the incumbent abandons some of the small markets and concentrates only on the more profitable ones. The more profitable a given market, the greater the impact of the generic on the monopolist’s price (see Proposition 3). In the partial coverage regime, there are relatively more high types since the lower types are not served by the monopolist. Hence, under parallel trade, the monopolist feels the presence of the generic more than without parallel trade when he could respond market-by-market. Ultimately, although some markets are abandoned, those which are served have relatively more people
buying the monopolist’s high-quality good. This positive effect counterbalances the fact that the monopolist withdraws from some markets. In the end, the range of dispersion for which parallel trade increases welfare is shifted to some value $x^{**}$ that lies to the right of $x^*$. 

This result on the threshold value at which the welfare effect of parallel trade goes from positive to negative is of negligible importance if either the quality differences are big or the generic is priced very competitively. In fact, if quality differences are big then the generic is not a very effective threat and the monopolist is almost uncontested. Similarly, if the generic is priced very competitively, the monopolist gives up competing against it and what matters is only the quality differential compared to the generic good. In both cases the threshold value is virtually unchanged compared to the case where there is no generic. By contrast, if quality differences are moderate and the generic is priced not ‘too’ competitively, then the good properties of parallel trade are extended in the ‘partial’ coverage regime by the presence of the generic good. 

In summary, some results are in line with those obtained in section 3, in particular the ex post welfare properties of the ‘full’ coverage regime are robust to the presence of a generic product. We also get additional insights. The generic has a strong impact especially in the ‘partial’ regime as the presence of the generic places greater competitive pressure on the monopolist and on the range of validity of the two regimes. In general, the presence of the generic tends to reinforce the good properties of international arbitrage: it extends the range of demand dispersion compatible with a ‘full’ coverage regime (i.e. the regime when arbitrage has an unambiguous positive impact on welfare) and contrasts the negative impact for high dispersion values in the ‘partial’ coverage regime. 

We now consider the impact of the generic on the stage 1 game.

PROPOSITION 5: In the presence of a generic, at the first stage of the game the selected quality of the product will always be lower under international exhaustion (arbitrage). The reduction in quality due to arbitrage is increased by the presence of a generic. Profits and aggregate welfare will always be lower and consumer surplus will be higher as long as dispersion is not too great. In all regimes, the monopolist reacts by decreasing own quality when the quality of the generic is higher and by increasing own quality when the generic is priced more competitively.
Proof: see appendix.

The main finding is that, for any convex cost function, quality is reduced by international arbitrage also in the presence of a generic product. In fact, the impact is more negative than under pure monopoly and the quality reduction due to parallel trade is magnified. The basic message of this section is that the generic is able to improve the ex post welfare properties of parallel trade (in the partial coverage regime), but worsens the ex ante welfare properties (in all regimes) compared to the absence of a generic. The last result depends on one embedded assumption: the monopolist is restrained to offer only one product.

5. The monopolist offers more than one product

Under what circumstances will the producer be willing to introduce a second product, of lower quality? A second product might be introduced for two main reasons. First, in the presence of arbitrage, a lower-quality variant may become a tool for the monopolist to increase his ability to discriminate between markets, given that price discrimination would be undone by parallel trade. Second, it may be intended to compete with the generic, where the quality of the monopolist’s leading brand has already been fixed. We begin by showing that that it is never optimal in our model to introduce a low quality variant for the purposes of discriminating between markets (when there is no competition form a generic). We then show that a “fighting brand” may be an efficient response to competition from a generic product.

5.1 No competition from a generic

We begin by considering the introduction of a second product when there is no competition from the generic. To model this we assume that once a certain quality \( u \) has been produced at the investment stage, the producer is also able to obtain a lower-quality product of quality \( u_l \) at a zero extra cost, as a by-product of the first innovation, \( u_l \in [u, u] \). This assumption is clearly extreme but it allows us to focus only on the discrimination and competition issues, forgetting about problems associated to costs. This might also be a plausible assumption for the case of a pharmaceutical product where R&D is driven by the search for novel treatments and considerations of product positioning are secondary at the innovative stage.
PROPOSITION 6: Whether there is or is not international exhaustion the unconstrained monopolist is better off by never selling the low-quality product, as it can ensure at least the same profit by selling only the high-quality product.

Proof. Imagine there is no international exhaustion (no arbitrage) and the monopolist decides to offer two products of different quality. In the absence of international arbitrage the firm may try to sell the two products in each market at different prices. Imagine the higher-quality product \( u_d \) is sold at a price \( p_{di} \) and the lower-quality product \( u_l < u_d \) is sold at a price \( p_{li} < p_{di} \) in each market \( i \). The high-quality product is bought by the high end of the market (those customers between \( \tilde{T}_i = (p_{di} - p_{li})/(u_d - u_l) \) and \( T_i \)), while the low-quality product is sold to the low-end (those customers between \( \tilde{L}_i = p_{li}/u_d \) and \( \tilde{T}_i \)). The expression of the profit with 2 products then is:

\[
\pi_i^2 = (T_i - \tilde{T}_i)p_{di} + (\tilde{T}_i - \tilde{L}_i)p_{li}.
\]

On the other hand, if the monopolist decides to offer only 1 product of high-quality in that market it would sell to all customers with \( t \) above \( \tilde{T}_j \) would get:

\[
\pi_i^1 = (T_j - \tilde{T}_j)p_{di}.
\]

Noting that \( \tilde{T}_i - L_i = (L_i - t_{\pi/\sigma})u_j/(u_d - u_j) \) and that \( \tilde{T}_i - t_{\pi/\sigma} = (L_i - t_{\pi/\sigma})u_d/(u_d - u_j) \), it is immediate to show that:

\[
\pi_i^1 - \pi_i^2 = (\tilde{T}_j - L_j)p_{di} - (\tilde{T}_i - t_{\pi/\sigma})p_{li} = \frac{t_{\pi/\sigma} - t_{\pi/\sigma}^*}{u_d - u_l}(p_d u_j - p_l u_d) = \frac{u_d u_l (L_i - t_{\pi/\sigma})^2}{u_d - u_l} > 0.
\]

The same result holds in the case where arbitrage is possible and all markets are served: the monopolist strictly prefers to sell a single product. The proof is omitted as it follows almost exactly the same lines as above and the intuition is the same (all the action comes from the lower tail of the distribution, the high \( t \)'s do not matter as they are always served with the high-quality product). QED
Notice that we have not made use of any first-order condition: when the monopolist is selling two products he will always be better off by increasing the price of the lower-quality variant until no one buys it, i.e. it is optimal to offer only one product. The intuition is that, although by introducing a second product of lower quality can enlarge the market, the availability of such product also induces some customers that were previously buying the high-quality product to purchase the low-quality product at a cheaper price. The reduced revenues from such ‘switching’ customers always prevail over the increased revenues from the expanded bottom end of the market, hence the monopolist should never downgrade its own quality as this confers to overall benefits.

Importantly, the result above carries over to the situation when parallel trade is allowed and the monopolist abandons some markets. With two products, the monopolist sells the quality $u_a$ at a price $p_u$ and the quality $u_l$ at a price $p_l$. The indifferent types are now $	ilde{t} = (p_d - p_l)/(u_d - u_l)$ and $t = p_d/u_d$. By selling two products the monopolist gets:

$$
\Pi^2_a = \int_{\tilde{t}}^{1+x} \frac{(T - \tilde{t})p_u + (\tilde{t} - t)p_l}{2x} dT + \int_{\tilde{t}}^{\frac{T - t}{2x}p_l} dT
$$

while by offering only 1 product sold to those types above $t = p_u/u_d$ it would obtain:

$$
\Pi^1_a = \int_{\tilde{t}}^{1+x} \frac{T - t}{2x} p_u dT.
$$

Computing the integrals and rearranging the difference, one gets:

$$
\Pi^1_a - \Pi^2_a = \frac{u_a u_l (t - t)^2 [2(1 + x) - (\tilde{t} + t + t)]}{4x (u_d - u_l)} > 0.11
$$

We can thus confirm that a second product of lower quality would never be introduced, even in the presence of parallel trade when some markets are not served.
5.2 Competition from a generic

Imagine that the monopolist decides, in the absence of arbitrage and in the presence of a generic, to offer two products of different quality. The higher-quality product $u_d$ is sold at a price $p_{di}$ and the lower-quality product $u_l$ is sold at a price $p_{li} < p_{di}$ in each market $i$. We restrict the analysis to the case of a “poor” generic that still commands a positive market share ($u > u_g$) in order for the following indifferent types to emerge:

$$\bar{t}_i = \frac{p_{di} - p_{li}}{u_d - u_l}$$

$$t_i = \frac{p_{li} - p_g}{u_l - u_g}$$

$$t = \frac{p_g}{u_g}$$

$$\tilde{t}_i \geq t_{\neq i} \geq t$$

so that in a given market $i$, the patented goods are sold to the higher-end of the market. The expression of the profit then is:

$$\pi_i = (T_i - \bar{t}_i)p_{di} + (\bar{t}_i - t_i)p_{li}$$

resulting in:

$$p_{di} = \frac{T_i(u_d - u_g) + p_g}{2}$$

$$p_{li} = \frac{T_i(u_l - u_g) + p_g}{2}$$

$$\tilde{t}_i = T_i / 2$$

$$t = \frac{T_i}{2} - \frac{p_g}{2(u_l - u_g)}$$

$$\pi_i = \frac{[T_i(u_l - u_g) + p_g]^2}{4(u_l - u_g)} + \frac{T_i^2(u_d - u_l)}{4}.$$  

\[11\] The square bracket can be re-written as $(1 + x - \bar{t}) + (1 + x - \bar{t} - t)$, where $\bar{t} < 1 + x$ and $t \leq t = (1 + x)/3$, where the last result comes from Proposition 1 when some markets are not served (this happens when $x > 1/2$).
The first important result that we have found is that the presence of the generic induces the monopolist to use the lower-quality variant. Thus the lower-quality variant is introduced for strategic reasons as entry prompts the monopolist to expand its total output (a ‘fighting brand’; see Johnson and Myatt, 2003) rather than to discriminate more efficiently. This finding also holds with arbitrage.

**PROPOSITION 7:** In the presence of the generic the introduction of a second, low quality product raises both profits and consumer surplus. This holds both with and without international exhaustion.

Proof: see appendix.

That the monopolist is now making higher profits compared to case of competition against a generic using a single brand (proposition 3) is not surprising as the firm has two goods at its disposal and decides to use both. But consumers are also better off: those who still buy the high-quality good or the generic are paying the same price as before, so their welfare is unchanged. Those who decide to switch instead to the lower-quality variant must be better off by revealed preferences. Overall consumer surplus increases. On the other hand, the generic loses market share and profits.

The other interesting implication for our purposes is that - in terms of marginal incentives to conduct R&D - the analysis now resembles very closely the one presented in section 3 when there was no competition from a generic: the patent holder supplies the high-quality good to the same number of customers as under pure monopoly, while the lower-quality variant is used strategically to fight against the presence of the generic good. These results hold under both pricing regimes. By comparing the allocations with and without parallel trade we obtain our final result.

**PROPOSITION 8:** Compared to pure monopoly, the impact of the generic is to improve the welfare properties of parallel trade ex post, without diluting investment incentives ex ante.

Proof: see appendix.
The ex post welfare effects resemble those of the 1-product case: the presence of the generic product improves the good welfare properties of parallel trade in the partial coverage regime. The reason is the same one as before. In the partial coverage regime, the monopolist serves relatively more high types, that is, those types that are particularly sensitive to quality, hence he has to reduce prices considerably to counter the presence of the generic.

Unlike the 1-product case, however, the improved ex post welfare properties of exhaustion are not offset by worse ex ante properties: there is no further incentive to reduce investment in quality compared to pure monopoly once the option to introduce a fighting brand is allowed. The monopolist reacts to the presence of competition by adjusting its portfolio of varieties and is able to 'protect' marginal revenues from the high-quality product. The quality chosen is exactly the same as under pure monopoly since marginal revenues in the different regimes are the same. Compared to pure monopoly, the impact of the generic is then to improve the welfare properties of parallel trade ex post, without diluting investment incentives ex ante.

6. Discussion and conclusions

It is clear that a monopolist, such as the owner of a valuable patent or trademark, will choose to engage in international price discrimination. In this paper we have considered whether social welfare would increase if the monopolist were prevented from doing so. One way to bring this about would be to permit arbitrage. The earlier work of Malueg and Schwartz suggested that arbitrage would increase welfare since the gain in consumer surplus would exceed the value of lost profits. We have extended the analysis to include not just the price setting decision of the monopolist considered by Malueg and Schwartz but also the initial decision to invest in developing a product of a certain quality. This part of the story is critical when we are discussing the supply of goods protected by patents and trademarks - the very reason for granting such intellectual property rights is to encourage investment in supplying high quality products. We have found that in many cases welfare will fall if arbitrage is permitted. The reason for this is that although arbitrage will help high valuation consumers obtain lower prices, it will also diminish the incentive of the monopolist ex ante to invest in supplying a high quality product which will have harmful consequences for the high valuation customers, and overall consumer surplus may even fall.

12 However, notice that the lower-quality variant ‘accommodates’ entry - we can prove it is not optimal to use
Our results are summarised in Table 1. We have analysed both *ex post* welfare (i.e. taking into account only price effects) and *ex ante* welfare (taking into account investments) in four cases. Case A is the benchmark case analysed in Malueg and Schwartz (*ex post*), case B permits competition from a generic when the monopolist is constrained to sell a single product. Case C concerns the situation where there is no competition from the generic but the monopolist can offer two products and case D considers competition from a generic when the monopolist offers two products.

### Table 1: Summary of effects of parallel trade

<table>
<thead>
<tr>
<th>Case</th>
<th>No competition, 1 product</th>
<th>Comp. from generic, 1 product</th>
<th>No competition, 2 products</th>
<th>Comp. from generic, 2 products</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ex post</strong></td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>Lower quality</td>
<td>MS</td>
<td>Better properties than A</td>
<td>As with 1 product.</td>
<td>Better properties than A</td>
</tr>
<tr>
<td>Welfare worsens</td>
<td></td>
<td>Worse properties than A</td>
<td>Identical to A</td>
<td>Same as A</td>
</tr>
</tbody>
</table>

Case A makes the basic point that once investment in quality is considered then international exhaustion can reduce welfare. Case B shows that the presence of the generic both enhances the positive *ex post* welfare properties and the negative *ex ante* properties of international exhaustion. Case C shows that in the absence of competition from a generic product the opportunity to introduce a second quality of product does not produce a different result from case A. This is because it is a dominant strategy for the monopolist to offer a single product even in the presence of arbitrage. Case D is perhaps the most interesting from a theoretical perspective. When a generic is available the monopolist will choose to offer more than one product, because the second product will act as a fighting brand against the generic. The presence of the generic improves the *ex post* welfare properties of international exhaustion because of the competitive effect on price, but will not lead to a further reduction of investment in quality (contrary to case B) because of the presence of the fighting brand.

These results also have significant policy implications. The desirability of international exhaustion is a subject of great controversy. On the face of it parallel trade brings significant benefits to consumers in high valuation markets, but our analysis shows that any consumer benefit must be traded off against the reduction in *ex ante* incentives to invest. However, the disincentive effect may be diluted when the monopolist is able to offer more one than product

---

limit pricing to exclude completely the generic.
variety and generics are present in the market. The nature of the generic in this example is therefore crucial. When dealing with goods protected by trademark generics are quite common, for example unbranded jeans, or coffee, or perfumes with lesser brand names. Moreover, in such cases it is not unusual to see the trademark owner offer branded alternatives that differ significantly in quality. However, in the case of goods protected by patents then during the life of the patent generics that copy the protected good are in fact illegal. When the patent expires the owner attempts to differentiate its brand from generic copies, but in fact the expiry of the patent means that generic copies can exactly mimic the original product. Thus the possibility of a reasonable generic substitute for a good protected by patent is relatively small, unlike the case of branded goods. This might suggest that policy on international exhaustion might optimally differ according to the type of intellectual property right considered.

Another way that one might think about the generic product is to think of it as a constraint on the breadth of the patent granted to a monopolist. When the generic is close in quality terms to the monopolist’s product it is as if the scope of the patent were quite narrow, and when the generic is of significantly inferior quality it is as if the scope of the patent were quite broad. Following this analogy, our analysis suggests that international exhaustion will increase consumer welfare where patents are narrowly defined as long as the patent owner introduces more than one version of the product (this is case D above).

One of the most striking results in this paper is that the monopolist would never choose to introduce a second product absent competition from the generic. When the generic is present the reason for introducing the second product is to protect the market for the principal brand. One might intuitively imagine that introducing a second brand dedicated to low valuation consumers might be a desirable option when arbitrage is possible. That is to say, one could think it would be profitable to restrict countries where a low price is optimal to an inferior brand, so that consumers in countries where a high price is optimal would not then see this inferior version as a substitute, and hence eliminate the negative effects of arbitrage on the monopolist’s profit. However, this is never the case in our model. Intuitively, when the monopolist offers an inferior version there will always be enough low valuation consumers in markets where a high price is optimal to make this strategy unprofitable.
This is in part a consequence of our assumption that the costs of supplying quality are entirely fixed. Hence once the monopolist has sunk its costs in delivering a high quality product, it has nothing to gain by offering the inferior quality. If we allowed that there existed a variable cost of delivering quality, then this result would no longer hold and the monopolist might choose to offer different qualities of the product as a screening device as in the Mussa and Rosen (1978) framework. In the present context, therefore, one might imagine that brand owners selling products where quality has a variable cost (jeans might be an example, if the quality of materials or the process - dyeing, stitching - matters) would sell products of different qualities to limit arbitrage, but that absent a generic, the producer of a pharmaceutical product where most of the costs of quality lie in the original R&D, would not.

The issues discussed in this paper explore the underlying tension that exists between intellectual property rights and the principles of free competition. The paper makes a contribution by extending the analysis to the case where the choice of product quality is endogenous. This is an issue that deserves more attention by economists, not merely because of its theoretical complexities, but because of the significant practical implications for welfare.

References


Appendix

Proof of proposition 1

When price discrimination is possible, then the optimal price and the associated marginal type and profit in each market are respectively:

\[ p_i = T_i u_d / 2 \]
\[ t_d = T_i / 2 \]
\[ \pi_i = T_i^2 u_d / 4 \]

From this we can derive expressions for aggregate profit and consumer surplus:

\[ \Pi_d = \int_{1-x}^{1+x} \frac{\pi_i}{2x} dT = \frac{u_d(3+x^2)}{12} \]

(1)

\[ CS_d = \int_{1-x}^{1+x} \left( \frac{t u_d - p}{2x} \right) dT = \frac{u_d(3+x^2)}{24} \]

When (costless) arbitrage is possible the monopolist sets a single price \( p \) to maximise:

\[ \Pi_u = \int_{\max[1-x,p/u_d]}^{1+x} \frac{T - p / u_d - pdT}{2x} \]

This gives rise to the following solutions under price uniformity:

(2) If \( x \leq 1/2 \)

\[ \begin{cases} p = \frac{u_u}{2} \\ t = 1/2 \\ \Pi_u = \frac{u_u}{4} \\ CS_u = \int_{1-x}^{1+x} \frac{t u_u - p}{2x} dT = \frac{u_u(3+4x^2)}{24} \end{cases} \]

If \( x > 1/2 \)

\[ \begin{cases} p = \frac{u_u(1+x)}{3} \\ t = (1+x)/3 \\ \Pi_u = \frac{u_u(1+x)^3}{27x} \\ CS_u = \int_{1-x}^{1+x} \frac{t u_u - p}{2x} dT = \frac{2u_u(1+x)^3}{81x} \end{cases} \]

Comparing (1) and (2), when quality is not affected by arbitrage \( u_d = u_u = u \), we get:
\[
\begin{align*}
\Delta \Pi &= \Pi_u - \Pi_d = -ux^2 / 12 < 0 \\
\Delta CS &= ux^2 / 8 > 0 \\
\Delta Welfare &= ux^2 / 24 > 0 \\
\end{align*}
\]

The following table summarises the impact of arbitrage ex post (see also the figures drawn for \( u = 1 \)):

<table>
<thead>
<tr>
<th>Number of markets served</th>
<th>Same if ( x &lt; \frac{1}{2} ), smaller if ( x &gt; \frac{1}{2} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer surplus</td>
<td>Higher</td>
</tr>
<tr>
<td>Profits</td>
<td>Lower</td>
</tr>
<tr>
<td>Welfare</td>
<td>Higher if ( x &lt; x^* ), lower if ( x &gt; x^* )</td>
</tr>
</tbody>
</table>

\[
\begin{align*}
\Delta \Pi &= -u[x^2 / 12 - (2x-1)^2(4 + x)/(108x)] < 0 \\
\Delta CS &= u[x^2 / 8 - (2x-1)(16 - x + 46x^2)/(648x)] > 0 \\
\Delta Welfare &= u[\frac{x^2}{24} - \frac{(2x-1)(40 - 43x + 34x^2)}{648x}] > 0 \text{ if } x < x^* = 0.625 \\
\end{align*}
\]
Proof of proposition 2

Using the quadratic cost function we get the following equilibrium values for the quality:

\[
(5) \quad u_d = \frac{3 + x^2}{12k}, \quad u_u = \begin{cases} 
\frac{1}{4k} & \text{if } x \leq 1/2 \\
\frac{(1 + x)^3}{27kx} & \text{if } x > 1/2 
\end{cases}
\]

Plugging these values back into all the previous expressions (1) and (2) we can derive the following implications of allowing international arbitrage when quality is endogenous:

If \( x \leq \frac{1}{2} \):
\[
\begin{align*}
\Delta \Pi &= -x^2(6 + x^2)/(288k) < 0 \\
\Delta CS &= x^2(6 - x^2)/(288k) > 0 \\
\Delta Welfare &= -x^4/(144k) < 0
\end{align*}
\]

If \( x > \frac{1}{2} \):
\[
\begin{align*}
\Delta \Pi &= \frac{(1+x)^6}{1458kx^2} - \frac{(3 + x^2)^2}{288k} < 0 \\
\Delta CS &= \frac{2(1+x)^6}{2187kx^2} - \frac{(3 + x^2)^2}{288k} > 0 \\
\Delta Welfare &= \frac{7(1+x)^6}{4374kx^2} - \frac{(3 + x^2)^2}{144k} < 0
\end{align*}
\]

<table>
<thead>
<tr>
<th>Number of markets served</th>
<th>Same if ( x \leq \frac{1}{2} ), smaller if ( x &gt; \frac{1}{2} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality</td>
<td>Lower</td>
</tr>
<tr>
<td>Consumer surplus</td>
<td>Higher</td>
</tr>
<tr>
<td>Profits</td>
<td>Lower</td>
</tr>
<tr>
<td>Welfare</td>
<td>Lower</td>
</tr>
</tbody>
</table>

![Graphs of CS and Welfare changes](image)
Proof of proposition 3

(i) No international exhaustion (no arbitrage)

We can write equilibrium prices, the marginal type and profits as

\[ p_i = \frac{T_i (u_d - u_g) + p_g}{2} \]

\[ \tilde{t}_i = \frac{T_i}{2} - \frac{p_g}{2(u_d - u_g)} \]

\[ \pi_i = \frac{[T_i (u_d - u_g) + p_g]^2}{4(u_d - u_g)} \]

Notice that the impact on price due to the presence of the generic good is bigger in the more lucrative markets \((\partial p_i / \partial u_g = -T_i / 2)\) - this is the first part of the proposition. To ensure that the generic is ‘effective’ (i.e. it has a positive market share in every market) we need the following condition, which we assume to hold:

(A) \[ p_g < \frac{(u_d - u_g)u_g (1 - x)}{2u_d - u_g} \]

It will be convenient at times to express the previous inequality as a limit on the admissible degree of dispersion:

\[ x \leq x_{\text{max}} = 1 - p_g \frac{2u_d - u_g}{u_g (u_d - u_g)} < 1 \]

Aggregate profits for the patent holder, for the generic and consumer surplus are:

(6) \[ \Pi_d = \int_{1-x}^{1+x} \frac{\pi_i}{2x} dT = \frac{(p_g + u_d - u_g)^2}{4(u_d - u_g)} + \frac{(u_d - u_g)x^2}{12} \]

\[ \Pi_{g,d} = \int_{1-x}^{1+x} \frac{(\tilde{t}_i - p_g / u_g)p_g}{2x} dT = \frac{p_g}{2} \left[ 1 - \frac{p_g (2u_d - u_g)}{u_g (u_d - u_g)} \right] \]
\[ CS_d = \int_{-x}^{+x} \left( \frac{1}{2} \int (tu_d - p_t) dt + \int \frac{(tu_g - p_g)}{8u_g} (u_d - u_g) + \frac{p_g^2 u_d}{8u_g (u_d - u_g)} \right) dx \]

Compared to the case without generic (equation (1)), the monopolist is forced to lower the price and its profits go down. The market is also expanded: more customers buy the patented good and some new customers buy the generic. Hence, for a given level of quality, consumer surplus unambiguously goes up with the presence of the generic.

(ii) With international exhaustion (arbitrage)

Once again the monopoly price, the threshold type and the monopoly profit depend on the critical value of \( x \), the degree of dispersion between markets

\[
\begin{align*}
\Pi_u &= \frac{(p_g + u_d - u_g)^2}{4(u_d - u_g)} \\
\Pi_u &= \frac{(p_g + u_d - u_g)(1 + x)}{3(u_d - u_g)} \\
\end{align*}
\]

Where \( \hat{x} = \frac{1}{2} + \frac{p_g}{2(u_d - u_g)} \).

When there is international exhaustion (arbitrage) we again observe the market expansion effect on the protected product due to the presence of the generic product. Notice how the expressions for the firm’s profit without competition from generics in equations (1) and (2), can be obtained from equations (6), (7) and (8) as both \( u_g \) and \( p_g \) tend to zero. Equation (8) represents the solution when the monopolist drops some markets (‘partial’ coverage).
It is easy to verify that condition (A) always ensures that \( \min[T, T'] > T \), i.e. the generic product always commands a positive market share in both regimes. Equation (7) is valid if \( p_g < (u_u - u_g)u_g / (2u_u - u_g) \), while equation (8) is valid as long as \( p_g < u_g(1 - x) \), which are both satisfied under the more stringent condition (A) (Condition (A) has to be re-written substituting \( u_u \) for \( u_d \) under international exhaustion).

We can also write down the expressions for the profits of the supplier of the generic and for consumer surplus under uniform pricing. Compared to eq. (2) consumer surplus in positively affected by the presence of the generic:

\[
\begin{align*}
\text{If } x \leq \hat{x} & : \quad \Pi_{g, u} = \int_{1-x}^{1-x} \left[ \frac{1}{2x} (T - p_g / u_g) p_g \right] dT = \frac{p_g}{2} \left[ 1 - \frac{p_g (2u_u - u_g)}{(u_u - u_g)u_g} \right] \\
\text{CS}_u &= \int_{1-x}^{1-x} \left[ \frac{1}{2x} \left( tu_u - p \right) dt + \int_{1-x}^{1-x} \left( Tu_g - p_g \right) dt \right] dT = u_u \left( \frac{3 + 4x^2}{24} \right) + \frac{p_g^2 u_u}{8u_g} + \frac{p_g^2}{8u_g (u_u - u_g)}
\end{align*}
\]

\[
\begin{align*}
\text{If } x > \hat{x} & : \quad \Pi_{g, u} = \int_{1-x}^{1-x} \left[ \frac{1}{2x} (T - p_g / u_g) p_g \right] dT = \frac{p_g}{2} \left[ 1 - \frac{p_g (2u_u - u_g)}{(u_u - u_g)u_g} \right] \\
\text{CS}_u &= \int_{1-x}^{1-x} \left[ \frac{1}{2x} \left( tu_u - p \right) dt + \int_{1-x}^{1-x} \left( Tu_g - p_g \right) dt \right] dT + \int_{1-x}^{1-x} \left[ \frac{1}{2x} \left( tu_g - p_g \right) dt \right] dT = u_u \left( \frac{1 + x)^3}{81x} + \frac{69x - 12x^3 + 23x^4 - 4}{162x} + \frac{2 - 23x + 2x^2}{27x} + \frac{2 p_g (1 + x)}{27x(u_u - u_g)} + \frac{p_g^2}{81x(u_u - u_g)^2} \right)
\end{align*}
\]

**Proof of proposition 4**

Fix a given quality level \( u_u = u_d = u \). Denote by \( d \) the quality differential between the patented good and the generic good \( (d = u - u_g) \). Welfare comparisons give:

\[
\begin{align*}
\Delta \Pi &= \Pi_u - \Pi_d = -dx^2/12 < 0 \\
\Delta \Pi_g &= 0 \\
\Delta CS &= dx^2/8 > 0 \\
\Delta \text{Welfare} &= dx^2/24 > 0
\end{align*}
\]
Notice how the previous expressions take the same form as those obtained in Proposition 1 without generic when \( x < 1/2 \) (eq. (3)). When dispersion is ‘high’ the signs of the profit differences are signed as follows:

\[
\frac{\partial \Delta \Pi}{\partial x} = \frac{-2p_g^3 + 6p_g^2d + 6p_g^2d^2(1-x^2) + d^3(2-6x^2 + 5x^3)}{54d^2x^2} < 0, \Delta \Pi \bigg|_{x=x^*} = \frac{-(p_g + d)^2}{48d} < 0 \Rightarrow \Delta \Pi < 0
\]

\[
\frac{\partial \Delta \Pi_g}{\partial x} = \frac{p_g[2(1+x) + p_g][(d(1-x) + p_g)]}{9d^2x^2} > 0, \Delta \Pi_g \bigg|_{x=x^*} = 0 \Rightarrow \Delta \Pi_g > 0
\]

Hence

\[
\begin{cases}
\Delta \Pi < 0; \Delta \Pi_g > 0 \\
\Delta CS = d\left\{\frac{x^2}{8} - \frac{(2x-1)(40 - 43x + 34x^2)}{648x} + \frac{p_g(8 - 11x + 8x^2)}{108x} + \frac{p^2_g(16 - 11x)}{216dx} + \frac{2p^3_g}{81d^2x} > 0 \right. \\
\Delta Welfare = d\left\{\frac{x^2}{24} - \frac{(2x-1)(16 - x + 46^2)}{648x} + \frac{p_g(8 - 11x + 8x^2)}{108x} + \frac{p^2_g(16 - 11x)}{216dx} - \frac{4p^3_g}{81d^2x} > 0 \text{ if } x < x^{**} \\
\end{cases}
\]

Recall that the last expressions make sense as long as \( x < x_{max} \). If dispersion is ‘high’, the expressions for the differences in consumer surplus and in welfare are made of several terms. The first term in each expression is the same as the expression derived in the corresponding case without generics (eq. (4)), while the other terms reflect the impact of the generic and the sum of these latter terms is always positive. If \( d \) is big or if \( p_g = 0 \), then only the first term matters, \( x^* = 1/2 \), and welfare analysis is identical to monopoly. In all other cases, the positive effect on consumer surplus and welfare due to parallel trade is reinforced by the presence of the generic. Welfare decreases only in the ‘partial’ coverage regime if the dispersion of \( x \) is sufficiently high, with \( x^{**} > x^{*} \) as long as this root falls in the range of admissible dispersion implied by Assumption (A). In fact, it is possible to construct examples where welfare increases for any degree of admissible dispersion: a case is depicted in the following figure \((u = 3, u_g = 2, p_g = 0.1, \text{ implying } x_{max} = 0.8)\).
The following table summarises our results for the stage 2 game with a non-strategic generic:

| Number of markets served by the patented product | Same if \( x < \hat{x} \), smaller if \( x > \hat{x} \) (\( \hat{x} > 1/2 \)) |
| Number of markets served by the generic product | Same |
| Consumer surplus | Higher |
| Profits (patented) | Lower |
| Profits (generic) | Same if \( x < \hat{x} \), higher if \( x > \hat{x} \) |
| Welfare | Higher if \( x < \min[\max, x^{**}] \) (\( x^{**} > x^* \)) |

**Proof of proposition 5**

The analysis is more complex since all the expressions for stage 2 gross profit are not linear in \( u \). As a first step note that:

\[
\begin{align*}
\frac{\partial \Pi}{\partial u} & = \frac{(3 + x^2) - p_g^2}{12} \frac{4}{(u - u_g)^2} \\
\frac{\partial \Pi}{\partial u} & = \begin{cases} 
\frac{1}{4} - \frac{p_g^2}{4(u - u_g)^2} & \text{if } x \leq \hat{x} \\
\frac{(1 + x)^3}{27} - \frac{p_g^2[3(u - u_g)(1 + x) + 2p_g]}{27x(u - u_g)^3} & \text{if } x > \hat{x}
\end{cases}
\end{align*}
\]

In other words, the presence of the generic reduces the incentives to invest in quality in all regimes. That the level of marginal revenues is pushed down by the presence of the generic in both regimes is not a surprise. However our main interest is to look at their difference. To answer the question whether the presence of arbitrage affects our earlier result that arbitrage reduces quality relative to the no arbitrage regime, it suffices to show that the difference between marginal revenues with and without arbitrage is negative:
\[
\frac{\partial (\Pi_u - \Pi_d)}{\partial u} = \begin{cases} 
-\frac{x^2}{12} < 0 \text{ if } x \leq \hat{x} \\
\frac{4 - 15x + 12x^2 - 5x^3}{108x} - \frac{p_x^2[3(u-u_g)(4-5x)+8p_x]}{108x(u-u_g)^3} < 0 \text{ if } x > \hat{x} 
\end{cases}
\]

Hence we have proven again that - also in the presence of a generic good - the incentive to produce quality goods is reduced with parallel trade, for any convex cost function.

Under full coverage the analysis is similar to the case without the generic. The difference in marginal incentives is unaffected by the presence of the generic. However, this does not imply that the reduction in quality is the same as under full monopoly. In fact, the difference between marginal revenues is unaffected by the generic only for the same value of \( u \). Notice that, in eq. (11), the extra negative term compared to the absence of generic is bigger the smaller is \( u \). As \( u_u < u_d \), then there is an extra incentive to reduce quality due to the presence of the generic also in the full coverage case.

In the case of partial coverage the first (negative) term is the same one that we derived in the case of pure monopoly. There is also a second term (negative as well: recall that the analysis makes sense as long as \( x < x_{\text{max}} \)). Hence the decrease in quality due to parallel trade is more pronounced under this regime by the presence of the generic product.

In the figure below we report the difference in quality differential with and without generic, i.e. we report \((u_u - u_d)_{\text{generic}} - (u_u - u_d)_{\text{monopoly}}\) for the case of quadratic costs, confirming that the reduction in quality due to parallel trade is more pronounced when a generic product is also available (parameters: \( k = 0.06 \), \( p_g = 0.1 \), \( u_g = 2 \)).
A full welfare analysis depends on the convexity of the cost function. With the quadratic cost function it is possible to obtain closed-form solutions but they are not reported here because they take cumbersome expressions. We report drawings to show the main features. These figures show that the reduced quality worsens the \textit{ex ante} welfare properties of parallel trade (parameters: $k = 0.06, p_g = 0.1, u_g = 2$).

<table>
<thead>
<tr>
<th>Number of markets served by patented product</th>
<th>Same if $x = \hat{x}$, smaller if $x &gt; \hat{x}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of markets served by generic product</td>
<td>Same</td>
</tr>
<tr>
<td>Quality</td>
<td>Lower</td>
</tr>
<tr>
<td>Consumer surplus</td>
<td>See figure below</td>
</tr>
<tr>
<td>Profits (patented)</td>
<td>Lower</td>
</tr>
<tr>
<td>Profits (generic)</td>
<td>See figure below</td>
</tr>
<tr>
<td>Welfare</td>
<td>See figure below</td>
</tr>
</tbody>
</table>

The last part of Proposition 5 comes from the following cross-partial derivatives that drive comparative statics with and without international exhaustion respectively:

\[
\frac{\partial^2 \Pi_d}{\partial u_d \partial p_g} = -\frac{p_x}{2(u_d - u_g)^3} < 0
\]

\[
\frac{\partial^2 \Pi_d}{\partial u_d \partial u_g} = -\frac{p_g^2}{2(u_d - u_g)^3} < 0
\]
\[
\frac{\partial^2 \Pi}{\partial u \partial p_g} = \begin{cases} 
- \frac{p_g}{2(u_g - u_g)^2} < 0 & \text{if } x \leq \hat{x} \\
2p_g \{ p_g + (u_u - u_g)(1 + x) \} - \frac{9x(u_u - u_g)^3}{9x(u_u - u_g)^3} < 0 & \text{if } x > \hat{x} 
\end{cases}
\]

\[
\frac{\partial^2 \Pi}{\partial u_g} = \begin{cases} 
- \frac{p_g^2}{2(u_u - u_g)^3} < 0 & \text{if } x \leq \hat{x} \\
2p_g^2 \{ p_g + (u_u - u_g)(1 + x) \} - \frac{9x(u_u - u_g)^3}{9x(u_u - u_g)^3} < 0 & \text{if } x > \hat{x} 
\end{cases}
\]

Hence the way a monopolist reacts in terms of its own investment to a 'better' generic depends on whether 'better' means having a higher quality \( u_g \) (the monopolist's \( u \) decreases) or a lower price \( p_g \) (\( u \) increases). These two side-results are the main findings in Bae and Choi (2002).

**Proof of proposition 7**

(i) **No international exhaustion**

Aggregate profits and consumer surplus are:

\[
\Pi_d = \int_{1-x}^{1+x} \frac{\pi_e}{2x} dT = \frac{(u_g - u_g) x^2}{12} + \frac{(p_g + u_l - u_g)^2}{4(u_l - u_g)}
\]

\[
\Pi_g = \int_{1-x}^{1+x} \frac{(u_g - u_g) x^2}{2x} dT = \frac{p_g}{2} \left[ 1 - \frac{p_g (2u_l - u_g)}{(u_l - u_g) u_g} \right]
\]

(12)

\[
CS_g = \int_{1-x}^{1+x} \left( \int_{1-x}^{1-x} (u_g + u_l - p_g) dt + \int_{1-x}^{1-x} (u_g - p_l) dt + \int_{1-x}^{1-x} (u_g - p_g) dt \right) dT =
\]

\[
\frac{u_g (3 + x^2)}{24} + \frac{3(u_g - p_g)^2}{8u_g} + \frac{p_g^2 u_g}{8u_g (u_g - u_g)} + \frac{x^2 u_g}{8}
\]

If we compare to the case where there is competition from a generic but the monopolist supplies no second product (equation (6)), we can immediately see that both profits and consumer surplus are higher.

(ii) **With international exhaustion**

When the firm cannot discriminate among the various markets it sells at a common price \( p_d \) the higher-quality product \( u_d \) and the lower-quality product \( u_l \) is sold at a price \( p_l \). These are the indifferent types (we need restrictions to limit our attention only to this case):
\[ \tilde{t} = \frac{p_d - p_t}{u_d - u_t} \]
\[ t = \frac{p_i - p_d}{u_i - u_d} \]
\[ \tilde{t} = \frac{p_i}{u_i} \]
\[ \tilde{t} \geq t \geq t \]

Depending on the dispersion of the willingness-to-pay across markets, the monopolist sets its prices to maximise:

\[ \Pi_u = \int_{\max[1-s, \tilde{t}]}^{1+s} \frac{T - \tilde{t}}{2x} p_u \, dT + \int_{\max[1-s, \tilde{t}]}^{1+s} \frac{t - \tilde{t}}{2x} p_d \, dT + \int_{\max[1-s, \tilde{t}]}^{1+s} \frac{T - t}{2x} p_i \, dT \]

This gives rise to the following solutions, which can be divided into three regions:

\[
\begin{cases}
    p_u = \frac{p_s + u_s - u_d}{2} \\
p_i = \frac{p_s + u_i - u_d}{2}\\n\Pi_u = \frac{(p_s + u_i - u_d)^2}{4(u_i - u_d)} + \frac{u_d - u_i}{4} \\
\end{cases}
\]

If \( x \leq \frac{1}{2} \)
\[ \tilde{t} = 1/2 \]
\[ t = \frac{1}{2} - \frac{p_g}{2(u_i - u_d)} \]
\[ \Pi_u = \frac{(p_s + u_i - u_d)^2}{4(u_i - u_d)} + \frac{u_d - u_i}{4} \]

\[
\begin{cases}
    p_u = \frac{3(p_s - u_d) + 2u_d (1 + x) + u_i (1 - 2x)}{6} \\
p_i = \frac{p_s + u_i - u_d}{2}\\n\Pi_u = \frac{(p_s + u_i - u_d)^2}{4(u_i - u_d)} + \frac{(u_d - u_i)(1 + x)^3}{27x} \\
\end{cases}
\]

If \( \frac{1}{2} < x \leq \tilde{x} \)
\[ \tilde{t} = (1 + x)/3 \]
\[ t = \frac{1}{2} - \frac{p_g}{2(u_i - u_d)} \]
\[ \Pi_u = \frac{(p_s + u_i - u_d)^2}{4(u_i - u_d)} + \frac{(u_d - u_i)(1 + x)^3}{27x} \]
Eq. (13) corresponds to full coverage, eq. (14) to partial coverage of the high-quality good (but full coverage of the low-quality variant) and eq. (15) to partial coverage of both variants. From these we can also derive expressions for aggregate profits and consumer surplus depending on the threshold values for dispersion:

\[
\left\{ \begin{array}{l}
P_u = \frac{p_g + (u_u - u_g)(1+x)}{3} \\
P_l = \frac{p_g + (u_l - u_g)(1+x)}{3} \\
\Pi_u = \frac{[p_g + (u_l - u_g)(1+x)]^3}{27(u_l - u_g)^2 x} + \frac{(u_u - u_l)(1+x)^3}{27x}
\end{array} \right.
\]

where \( \bar{x} = \frac{1}{2} + \frac{p_g}{2(u_l - u_g)}. \)

If \( x > \bar{x} \), \( \bar{t} = (1+x)/3 \)

\[
\left\{ \begin{array}{l}
t = \frac{1+x}{3} - \frac{2p_g}{3(u_l - u_g)} \\
\Pi_u = \frac{[p_g + (u_l - u_g)(1+x)]^3}{27(u_l - u_g)^2 x} + \frac{(u_u - u_l)(1+x)^3}{27x}
\end{array} \right.
\]

If \( x \leq \frac{1}{2} \)

\[
\Pi_{g,u} = \frac{1}{2x} \left[ (t-l)p_g \right]_{l-x}^{x} \int dt = \frac{p_g}{2} \left[ 1 - \frac{p_g(2u_l - u_g)}{2(u_l - u_g)u_g} \right]
\]

\[
CS_u = \frac{1}{2x} \left[ \int (u_u - p_u) dt + \int (u_l - p_l) dt + \int (u_u - p_g) dt \right]_{l-x}^{x} \int dt = \frac{u_u(3+4x^2)}{24} + \frac{3(u_g - p_g)^2}{8u_g} + \frac{p_g^2u_u}{8u_g(u_l - u_g)}
\]

If \( \frac{1}{2} < x \leq \bar{x} \)

\[
\Pi_{g,u} = \frac{1}{2x} \left[ (t-l)p_g \right]_{l-x}^{x} \int dt = \frac{p_g}{2} \left[ 1 - \frac{p_g(2u_l - u_g)}{2(u_l - u_g)u_g} \right]
\]

\[
CS_u = \frac{1}{2x} \left[ \int (u_u - p_u) dt + \int (u_l - p_l) dt + \int (u_u - p_g) dt \right]_{l-x}^{x} \int dt + \int \left[ \frac{1}{2} (u_u - p_u) dt + \frac{1}{2} (u_l - p_l) dt + \frac{1}{2} (u_u - p_g) dt \right]_{l-x}^{x} \int dt = \frac{2u_u(1+x)^3}{81x} + \frac{u_l(2x-1)(16-x+46x^2)}{648x} + \frac{3(u_g - p_g)^2}{8u_g} + \frac{p_g^2u_u}{8u_g(u_l - u_g)}
\]
Comparisons with the expressions for consumer surplus and monopolist’s profits with arbitrage but only one quality (Proposition 3) give the results that the introduction of the lower-quality variant has a positive impact on them.

**Proof of proposition 8**

We first conduct welfare comparisons ex post, for a given quality level \((u_u = u_d = u)\) and with the same low-quality patented good. Denote by \(d\) the quality differential between the high-quality patented good and the generic good \((d = u - u_g)\). When dispersion is ‘low’ all markets are served and it results:

\[
\Pi_{g,a} = \int \frac{(T-t)p_g}{2x} dT + \int \frac{(T-t)p_s}{2x} dT =
\]

\[
p_g \left\{ \frac{7x - 1 - x^2}{x} - \frac{9p_g}{u_g} \frac{2p_g(1 + x)}{x(u_i - u_g)} - \frac{p_g^2}{x(u_i - u_g)^2} \right\}
\]

\[
CS_g = \int \left( \int (tu_u - p_u) dt + \int (tu_l - p_l) dt + \int (tu_g - p_g) dt \right) dx + \int \left( \int (tu_g - p_g) dt \right) dx + \int \left( \int (tu_g - p_g) dt \right) dx
\]

\[
\Delta \Pi = \Pi_{u} - \Pi_{d} = -dx^2 / 12 < 0
\]

\[
\Delta \Pi = 0
\]

\[
\Delta CS = dx^2 / 8 > 0
\]

\[
\text{Welfare} = dx^2 / 24 > 0
\]

\[
\Delta \Pi = -dx^2 / 12 + (u_u - u_i)(2x - 1)^2 (4 + x) / (108x) < 0
\]

\[
\Delta \Pi = 0
\]

\[
\Delta CS = dx^2 / 8 - (u_u - u_i)(2x - 1)(16 - x + 46x^2) / (648x) > 0
\]

\[
\text{Welfare} = dx^2 / 24 - (u_u - u_i)(2x - 1)(40 - 43x + 34x^2) / (648x) > 0
\]
Looking at the corresponding expressions in Proposition 4 (eq. (9) and eq. (10)), it is immediate that the ex post welfare effects resemble those of the 1-product case\(^\text{13}\).

Ex ante, notice how the quality chosen is exactly the same as under pure monopoly with no generic. In fact, comparing marginal revenues in the different regimes in the presence of a generic (these are derived from equations (13), (14) and (15)) with marginal revenue under pure monopoly (equation (2)), they turn out to be identical for a given degree of dispersion\(^\text{14}\).

\[
\Delta \Pi = d\left[\frac{x^2}{12} + \frac{(2x-1)^2(4+x)}{108x} \right] + \frac{p_g(2-5x+2x^2)}{18x} + \frac{p_g^2(4-5x)}{36(u_i-u_g)x} + \frac{p_g^3}{27(u_i-u_g)^2x} \\
\Delta \Pi_g = \frac{(x-u_g)(4x-x)(x-x)(2x-1)}{9x} > 0
\]

(18) \quad If \quad x > \tilde{x} \quad \Delta CS = d\left[\frac{x^2}{8} - \frac{(2x-1)(16-x+46x^2)}{648x} \right] + \frac{p_g(8-11x+8x^2)}{108x} + \frac{p_g^2(16-11x)}{216(u_i-u_g)x} + \frac{2p_g^3}{81(u_i-u_g)^2x} \\
\Delta Welfare = d\left[\frac{x^2}{24} - \frac{(2x-1)(40-43x+34x^2)}{648x} \right] + \frac{p_g(8-11x+8x^2)}{108x} + \frac{p_g^2(19x-8)}{216(u_i-u_g)x} - \frac{4p_g^3}{81(u_i-u_g)^2x}
\]

\(^{13}\) There are some minor differences: there are now three regimes, and the ‘full’ coverage case of both variants happens for a smaller range of the dispersion parameter.

\(^{14}\) We have considered \(u_l\) as exogenous. It is easy to check that all expressions for the monopolist’s profits are decreasing in the lower-quality variant. Hence the patent holder will set the lowest possible one (\(u_g\)). If we allow for \(u\) to be as low as \(u_g\), then we have the result that \(u_l\) is set equal to \(u_g\), and the monopolist sells it at \(p_g\) (minus a small \(\epsilon\)) to exclude the generic.