

TRADEMARK PROTECTION AND PRODUCT DIFFERENTIATION

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ABSTRACT

Trademarks are useful in identifying products and producers, but limit competition from products close in product space. We examine welfare effects of trademark protection in a model of vertical product differentiation. We find that (extended) trademark protection, which restricts imitation, does not always increase welfare. In Bertrand competition, imitation is associated with a decrease in the prices and profits of both firms and is therefore unlikely to occur. In Cournot competition, the short-term welfare effects of trademark protection are positive, but strengthened trademark protection may lead to over-investment in marketing or quality and thereby reduce welfare.

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1. Introduction

A trademark serves the purpose of distinguishing a product from other products and identifies the trademark owner as producer and source. Trademark protection laws prevent other firms than the owner from using the trademark or a similar mark. Without trademark protection, consumers might not know which product it is that the trademark stands for, or who is the producer of that product. If the trademark could not thus be used as a shorthand description of the product, consumers would have to specify products in detail before purchase. Confusion about the source of the product would make it difficult to punish the producer, e.g. by not repeating purchases, if the product is not what consumers are lead to believe. (See Landes & Posner, 1987.) An established trademark can also be used in support of a new product in another market (so-called brand stretching). There are thus very clear informational arguments for protecting trademarks.

However, trademark protection is not unproblematic. The owner of a trademark is granted a form of monopoly power, since marketing of close substitutes becomes limited (see Besen & Raskind, 1991). The existence of a well-established trademark can therefore serve as a barrier to entry for other producers. A desire to limit monopoly power may explain why trademark protection is itself limited in several ways. For example, trademark protection is not offered for any trademark, not for example to generic descriptions in contexts for which they are generic (like “apple” for a fruit or “frozen” for ice-cream). Indeed, trademarks that are so successful that they become generic may lose their status as trademarks (like “aspirin” or “thermos”). In addition, a number of unauthorized uses of trademarks by others than their owners are permitted, in particular referring to them in comparative advertising as long as the comparison is not misleading.¹ (See Phillips, 2002, for a presentation of trademark law in Europe and the US.)

¹ In the EU as well as in the US a clear distinction is made between misleading advertising and comparative advertising. In European Parliament (1984), *comparative advertising* means advertising which identifies a

The actual extent of trademark protection may be increasing—at least that is one possible interpretation of the recent laws concerning trademark dilution (see Bottero, Mangàni & Ricolfi, 2004). Trademark dilution refers to the case when a (low-quality) producer without permission relates to another firm’s (high-quality) product in its marketing. The producer of low quality hereby takes advantage of the goodwill created by the high-quality firm and possibly also dilutes its trademark. There are rules against trademark dilution in the EU as well as in the US.² Note that confusion appears not to be an issue in trademark dilution. This means that owners of famous trademarks may bring an action for dilution even where there is no likelihood of confusion, as for example when firms belong to different markets.³

The proper extent of trademark protection should be a relevant question for research, not least because changes in the extent of trademark protection would have an impact on a large share of the world’s advertising investments.⁴ From a dynamic point of view there is often good reason to protect private investments with public good characteristics, e.g. in R&D, since there is a risk that firms will under-invest in the absence of regulation. The motivation for protecting investments in marketing is however less clear. For example, it is not evident whether or not marketing contributes to welfare or if it just shifts demand between products. If marketing affects preferences, it is far from clear what the “true” consumer

competitor or goods or services offered by a competitor, whereas *misleading advertising* means advertising which deceives or is likely to deceive the persons to whom it is addressed or whom it reaches and therefore is likely to affect their economic behaviour, or which injures or is likely to injure a competitor.

² The European Parliament (1984) has for example stated that: “Comparative advertising shall, as far as the comparison is concerned, be permitted when the following conditions are met: (g) it does not take unfair advantage of the reputation of a trade mark, trade name or other distinguishing marks of a competitor or of the designation of origin of competing products.” (p. 4 ff). Similarly, according to the 1996 Federal Anti Dilution Act of the US: “The owner of a famous mark shall be entitled, subject to the principles of equity and upon such terms as the court deems reasonable, to an injunction against another person’s commercial use in commerce of a mark or trade name, if such use after the mark has become famous causes dilution of the distinctive quality of the mark, and to obtain such other relief as is provided in this subsection.”

³ See the 1996 Federal Anti Dilution Act where misleading and confusing advertising is treated separately from the issue of dilution of famous marks.

⁴ According to one estimate around 60 percent of all advertisements are at least indirectly comparative in the sense that it relates to another firm’s product (see Pechmann & Stewart, 1990).

preferences are.⁵ Finally, it is not obvious that firms will in fact have an incentive to take advantage of other firms' trademarks. These observations motivate a study of trademark protection from an economics perspective. Specifically, our study aims to:

- 1) analyze theoretically firms' incentives to position their products in product space, and
- 2) explore the circumstances under which laws that extend trademark protection are likely to increase welfare.

We take an agnostic position with respect to the relevant welfare measure. That is, the welfare aspects of legislation are discussed both for the case when consumers are fully informed about product characteristics, and when there is confusion. This is done by evaluating welfare effects in terms of both post-advertising tastes and pre-advertising tastes. We consider a one-period purchase decision by consumers, and thus do not study reputation effects of confusion.

In order to discuss these issues we need a framework where investments determine the perceived quality levels, i.e., the degree of vertical product differentiation. Moreover, consumers must be different in the sense that some (presumably poor) prefer low-quality products while others (presumably rich) prefer heavily advertised high-quality products. Our choice of workhorse model is Shaked & Sutton (1982), which is extended to allow for sequential investments in marketing by two firms. In period one, firm *A* chooses between investing in high quality or in low quality. In period two, firm *B* also has the choice between investing in high quality or in low quality. In addition, it may have access to an imitation strategy which, at a low cost, increases the consumers' valuation of firm *B*'s product, possibly at the expense of the perceived quality offered by firm *A*. In the third and final period firms compete in prices or quantities.

⁵ The welfare effects of advertising are complicated by the possibility that advertising affects tastes. This issue is discussed by Dixit & Norman (1978) who argue that there is excessive advertising, even when the point of reference is post-advertising tastes. See also Fischer & McGowan (1979) and Shapiro (1980) for a critique.

The model provides a framework for analyzing different aspects of trademarks and the laws that regulate their use. *Trademark infringement*, e.g. using the same or a similar mark as another trademark owner's, on the same or similar or different goods, makes the products seem more alike to consumers than they would otherwise be. An example is *counterfeiting*, where the identical trademark is used on the same type of good. We model trademark infringement as imitation of the high-quality good, by the producer of lower quality. Clearly, many (or most) cases of imitation are not infringing acts⁶, but we take the view that trademark protection restricts imitation. *Trademark dilution* occurs when the free-riding on another trademark that infringement involves, also has some negative effect on that mark. The way we describe dilution in the model is that it reduces the higher quality, in addition to increasing the lower quality. Dilution is similar to *tarnishment* in the model. *Comparative advertising* is a means by which producers in the same market may specify the differences or similarities between their and their competitors' products. Truthful comparative advertising to some extent substitutes for infringement, in that it conveys the information to consumers that the product is as good as another. In terms of the model, comparative advertising allows the possibility of legal imitation, while infringement is illegal imitation.

Our main findings are the following. The circumstances under which extended trademark protection is welfare-enhancing are quite limited. Under Bertrand competition, imitation, which implies a decrease in the amount of product differentiation, is always associated with a decrease in the prices and profits of both firms. Under Cournot competition, trademark protection will be likely to affect quality levels and also equilibrium investments patterns, but only for intermediate levels of investment costs. When legislation does have an impact, the outcome is dependent on investment decisions, implying that short-term and long-run effects are different. Welfare results are ambiguous.

⁶ As when a producer truthfully states that their product shares some or several characteristics with another, identified by its trademark, while still clearly being a different product.

The paper is organized as follows. First, the model is introduced for our main case when products are sold in the same market and are substitutes. Then we examine incentives under Bertrand and Cournot competition. After a discussion of static welfare effects we characterize the sub-game perfect equilibrium of the investment game. Next, we analyze the welfare implications of trademark protection and legislation extending it. We then turn to the case when the two products are not substitutes but are instead sold in unrelated markets. This case is examined in a separate section. The final section concludes and discusses the policy implications of the results.

2. The Model

Consider a market with two sellers, firm A and firm B , each selling goods with one of two exogenously determined quality levels, high quality (or service) S_A and low quality S_B , at prices P_A and P_B . Each consumer buys maximum one unit of each good and derives utility from the quality level of that good and from consumption of other goods on which the rest of the income is spent. The utility function for an individual with income V is

$$U(V) = \max\{(V - P_A)S_A, (V - P_B)S_B\} . \quad (1)$$

Consumers will only consider buying low quality if its price is lower than that of high quality. For $P_A > P_B$ we can determine the income level V^* such that a consumer is indifferent between buying high or low quality,

$$V^* = \frac{P_A S_A - P_B S_B}{S_A - S_B} . \quad (2)$$

In the utility function a higher income increases the utility of buying high quality more than the utility of buying low quality. Thus consumers with incomes above V^* will purchase one

unit each of high quality. Consumers with incomes below V^* will either purchase one unit of low quality or make no purchase. The decision whether to remain outside the market depends on whether utility is positive or not for the given S_B and P_B . Assume that income levels are uniformly distributed over the interval $[0, b]$. The firms then face demand functions

$$\begin{aligned} Q_A &= b - V^* \\ Q_B &= V^* - P_B. \end{aligned} \tag{3}$$

The structure of demand is shown in *Figure 1*.

The cost structure is simple: the marginal cost of production is zero and the additional cost of supplying high quality is modeled as a fixed cost K . This formulation of the cost structure allows for different interpretations of the concept of quality, or high quality.⁷ Specifically, the perceived high quality may to some extent be due to advertising, in which case the issue arises if pre-advertising tastes or post-advertising tastes are used when evaluating welfare effects.

We assume that trademark law works by restricting imitation (which might be found to constitute trademark infringement) of the higher-quality product, by the producer of low quality.⁸ Imitation has the effect of increasing the (perceived) quality of the low-quality good. At the same time it may but need not reduce (i.e. dilute) the quality of the high-quality good. The timing is that firm A acts first by making a once-and-for-all choice of high or low quality. Firm B then chooses the quality level of its product. The quality level of firm B 's product is determined as a combination of its investment and its choice of imitation. Imitation is only possible when firm A selects high quality and firm B low quality, i.e. we assume that it is only

⁷ A high quality product may be the result of an investment in product development that yields e.g. a new design, which is superior.

⁸ We focus on infringement by the producer of low quality, although this is not the only case possible.

the first mover in terms of quality choice that can be exposed to imitation. Once quality levels are determined firms will set prices or quantities.⁹

3. Incentives and Profit Effects in Bertrand and Cournot Competition

Trademark protection can affect the choices of the players at different stages. For example, by maintaining a distance between the higher and the lower quality level, trademark protection may increase Firm A's incentive to invest. On the other hand, for given investments trademark protection has the potential to reduce welfare since it restricts the level of the lower quality. A welfare analysis of trademark protection must take all such effects into account. To do this we will work backwards and start with the last stage.

In describing the competitive structure at the last stage there is the basic choice between two models, price competition as in the Bertrand model or quantity competition as in the Cournot model. It is known from other policy-oriented studies that this choice can have a critical influence on welfare results. Examples are strategic trade policy (Eaton & Grossman, 1986), information-sharing in oligopoly (Vives, 1990), endogenously determined quality levels (Motta, 1993), and profit effects of horizontal mergers (Deneckere & Davidson, 1985). Thus the welfare effects of trademark protection may depend on whether the strategic variable used by firms is price or quantity. To be able to draw conclusions that are reasonably general, we investigate both cases.

We examine Bertrand competition first. From Expressions (2) and (3) we can derive quantities demanded as functions of prices. We need only consider the case when firm A supplies high quality and firm B low quality since otherwise imitation is not an issue. In this case the profit functions are of the form $\pi_A = P_A \cdot Q_A(P_A, P_B, S_A, S_B) - K$ and

⁹ In Shaked & Sutton (1982) it is shown that the market structure with two firms is endogenous, which means that it would be difficult to extend the number of firms using the present model. The model has the advantage of being analytically tractable.

$\pi_B = P_B \cdot Q_B(P_A, P_B, S_A, S_B)$. To simplify interpretation let z denote the ratio between the quality levels, $z = S_B / S_A$, $0 < z \leq 1$. First-order conditions for profit maximization with respect to own price, together with a Nash equilibrium condition in prices, yields an expression for the profit of the firm producing low quality:

$$\pi_B = \frac{b^2(1-z)}{(4-z)^2} \quad (4)$$

Imitation increases the low quality (and may reduce the high quality) and thereby increases z . It is straightforward to show that π_B is decreasing in z , i.e. imitation reduces profits for the firm that produces low quality. We summarize the result in:

Observation 1: In a market with Bertrand competition there is no incentive for the firm producing low quality to engage in imitation.

The reduced quality differentiation that is the result of imitation has two opposing effects. Firstly, by increasing the lower quality it increases the number of consumers who will buy the low-quality product at given prices. Secondly, by reducing the distance between the two products in the quality dimension, it increases the strength of price competition between the two firms and reduces prices and profits. In Bertrand competition the second effect is the stronger one. This means that trademark infringement is an unlikely phenomenon in markets with price competition.

We next look at Cournot quantity competition. Equilibrium prices as functions of quantities are derived from Expressions (2) and (3), yielding profit functions of the form $\pi_A = Q_A \cdot P_A(Q_A, Q_B, S_A, S_B) - K$ and $\pi_B = Q_B \cdot P_B(Q_A, Q_B, S_A, S_B)$. Using first-order conditions for profit maximization with respect to own quantity for each firm and the Nash equilibrium

condition in quantities, we arrive at expressions for the variable profits (i.e., investment costs not deducted) of the firms producing high and low quality.

$$\pi_A = \frac{b^2(2-z)^2}{(4-z)^2} \equiv \gamma(z) \quad (5)$$

$$\pi_B = \frac{b^2}{(4-z)^2} \equiv \lambda(z) \quad (6)$$

$$\pi = \pi_A + \pi_B = \frac{b^2(5+z^2-4z)}{(4-z)^2} \quad (7)$$

As before, profits do not depend on absolute levels of quality but only on the ratio z . Here π_B is increasing in z , implying that the firm producing low quality has an incentive to imitate and may thus infringe on the high quality trademark. We now turn to a closer investigation of the effects of trademark protection on profits and utility under Cournot competition.

4. Welfare Effects for Given Quality Levels

Imitation refers to any activity that raises the perceived quality of the product produced by firm B , possibly at the expense of the quality produced by firm A , i.e., the case of tarnishment. Hence, in our model the concept of imitation covers illegal activities, such as counterfeiting, trademark dilution, tarnishment, as well as legal ones like comparative advertising. Let the amount of increase in quality for firm B be denoted by I , and let the reduction in high quality be αI , where $0 \leq \alpha \leq 1$. Thus there is dilution or tarnishment when $\alpha > 0$.¹⁰ The process creates two new quality levels, $S_A^I = S_H - \alpha I$ for firm A and $S_B^I = S_L + I$ for firm B , where S_L and S_H denote exogenous pre-imitation quality levels such that $S_H > S_L$. We assume the extent of imitation to be limited so that $S_A^I > S_B^I$ which is equivalent to assuming that

¹⁰ Phillips, 2003 (pages 366-369), urges caution when using these terms, but suggest that they imply a reduction of the reputation of the trademark. This could be interpreted as reduced quality of the higher quality good.

$I < (S_H - S_L)/(1 + \alpha) \equiv \bar{I}$. The case when $I = \bar{I}$ could be thought of as completely successful counterfeiting, when the products become identical to consumers.

It is straightforward to show that $dz/dI > 0$, i.e., imitation reduces the relative quality difference. Using this and differentiating Expressions (5), (6) and (7) with respect to z we derive the profit effects:

$$\frac{\partial \pi_A}{\partial z} \frac{\partial z}{\partial I} = \frac{-4b^2(2-z)}{(4-z)^3} \frac{\partial z}{\partial I} < 0 \quad (8)$$

$$\frac{\partial \pi_B}{\partial z} \frac{\partial z}{\partial I} = \frac{2b^2}{(4-z)^3} \frac{\partial z}{\partial I} > 0 \quad (9)$$

$$\frac{\partial \pi}{\partial z} \frac{\partial z}{\partial I} = \frac{-2b^2(3-2z)}{(4-z)^3} \frac{\partial z}{\partial I} < 0. \quad (10)$$

Observation 2: In a market with Cournot competition, imitation increases the variable profit for the firm producing low quality while reducing the variable profit for the firm producing high quality.

Observation 3: The effect of imitation on total variable profits is negative, i.e. the reduction in the profit of the firm producing high quality is greater than the increase in the profit of the firm producing low quality.

We now turn to investigating the effects of reduced quality differentiation on consumer welfare, measured in terms of consumers' surplus. We look at two cases:

- (i) When the quality levels are correctly identified by consumers and reflect real product characteristics that affect utility. In this case there is no consumer confusion and post-advertising preferences should be used to evaluate welfare.

- (ii) When consumer willingness to pay more for high quality is mainly a result of marketing and both goods are essentially of the same and constant quality. Prices can differ because consumers have to some extent been confused by marketing, and pre-advertising preferences should be used to evaluate welfare. Here we assume both goods to be valued at the original quality level, S_L .¹¹

First note that when high quality is valued at $S_A \neq S_L$, the inverse demand functions facing firms are given by $P_A = b - Q_A - zQ_B$ and $P_B = b - Q_B - Q_A$ respectively. Hence, consumers' surplus in the two markets at equilibrium prices and quantities equal:

$$CS_H^{post} = \frac{b^2(2-z)^2}{2(4-z)^2} \quad (11)$$

$$CS_L^{post} = \frac{b^2}{2(4-z)^2} \quad (12)$$

where superscript *post* refers to post-advertising preferences. This, in turn, implies the following aggregate consumers' surplus

$$CS^{post} \equiv CS_H^{post} + CS_L^{post} = \frac{b^2(5+z^2-4z)}{2(4-z)^2}.$$

Differentiating with respect to I we find the effect of imitation:

$$\frac{dCS_H^{post}}{dI} = \frac{\partial CS_H^{post}}{\partial z} \frac{\partial z}{\partial I} = \frac{-2b^2(2-z)}{(4-z)^3} \frac{\partial z}{\partial I} < 0 \quad (13)$$

¹¹ These two cases represent two extremes: with post-advertising preferences the initial quality difference is genuine and so is the change caused by imitation, while with pre-advertising preferences neither the initial nor the final quality difference is genuine.

$$\frac{dCS_L^{post}}{dI} = \frac{\partial CS_L^{post}}{\partial z} \frac{\partial z}{\partial I} = \frac{b^2}{(4-z)^3} \frac{\partial z}{\partial I} > 0 \quad (14)$$

$$\frac{dCS^{post}}{dI} = \frac{\partial CS^{post}}{\partial z} \frac{\partial z}{\partial I} = \frac{-2b^2(3-2z)}{(4-z)^3} \frac{\partial z}{\partial I} < 0. \quad (15)$$

Hence, imitation decreases consumers' surplus in the market for high-quality goods and increases it in the market for low-quality goods. The net effect is negative since high-income individuals have a higher willingness to pay for product quality.

Next, consider the case that both high and low quality is valued at S_L . This means that consumers' valuation of the high-quality product is independent of z . The inverse demand functions are given by $P_A = b - Q_A - Q_B$ and $P_B = b - Q_B - Q_A$, and consumers' surplus in the two markets evaluated at equilibrium prices and quantities then equal:

$$CS_H^{pre} = \frac{zb^2(2-z)}{2(4-z)^2} \quad (16)$$

$$CS_L^{pre} = \frac{b^2}{2(4-z)^2} \quad (17)$$

where superscript *pre* refers to pre-advertising tastes and Expression (17) is the same as Expression (12). This, in turn, implies the following consumers' surplus

$$CS^{pre} \equiv CS_H^{pre} + CS_L^{pre} = \frac{b^2(1-z^2+2z)}{2(4-z)^2}.$$

Differentiating with respect to I we find the effect of reduced quality differentiation under pre-advertising tastes:

$$\frac{dCS_H^{pre}}{dI} = \frac{\partial CS_H^{pre}}{\partial z} \frac{\partial z}{\partial I} = \frac{b^2(4-3z)}{(4-z)^3} \frac{\partial z}{\partial I} > 0 \quad (18)$$

$$\frac{dCS_L^{pre}}{dI} = \frac{\partial CS_L^{pre}}{\partial z} \frac{\partial z}{\partial I} = \frac{b^2}{(4-z)^3} \frac{\partial z}{\partial I} > 0 \quad (19)$$

$$\frac{dCS^{pre}}{dI} = \frac{\partial CS^{pre}}{\partial z} \frac{\partial z}{\partial I} = \frac{b^2(5-3z)}{(4-z)^3} \frac{\partial z}{\partial I} > 0. \quad (20)$$

Now, imitation increases consumers' surplus in both markets. This is the result of the interaction of several effects. Firstly, the price of low quality increases since its quality level in the eyes of consumers has increased, thus reducing consumers' surplus. Secondly, the price of high quality is reduced and this has a positive effect on consumers' surplus. Finally, V^* increases and thereby the number of consumers who buy low quality, and these pay less than when they bought high quality.

Thus we find that trademark protection, which restricts imitation, increases consumers' surplus only in the case when high quality is valued at post-advertising preferences. The results are summarized below.

Observation 4: (i): When post-advertising preferences are used for welfare evaluation, trademark protection increases consumers' surplus. *(ii):* When pre-advertising preferences are used for welfare evaluation, trademark protection reduces consumers' surplus.

To find total welfare effects we aggregate consumers' surplus and profits. Let us define total welfare W as the sum of consumers' surplus and profits, disregarding investment costs. The total welfare functions are:

$$W^{post} = \frac{3b^2(z^2 - 4z + 5)}{2(4-z)^2} \quad (21)$$

$$W^{pre} = \frac{b^2(z^2 - 6z + 11)}{2(4-z)^2} \quad (22)$$

and differentiating with respect to I we have:

$$\frac{dW^{post}}{dI} = \frac{\partial W^{post}}{\partial z} \frac{\partial z}{\partial I} = \frac{3b^2(2z-3)}{2(4-z)^3} \frac{\partial z}{\partial I} < 0 \quad (23)$$

$$\frac{dW^{pre}}{dI} = \frac{\partial W^{pre}}{\partial z} \frac{\partial z}{\partial I} = \frac{b^2(z-1)}{(4-z)^3} \frac{\partial z}{\partial I} < 0. \quad (24)$$

Observation 5: The static effect of trademark protection is an increase in total welfare.

The result that aggregate welfare is positively affected by trademark protection under post-advertising preferences follows trivially from Observations 3 and 4. Under pre-advertising tastes the effect on profits dominates the effect on consumers' surplus.

5. Investment Strategies in Quantity Competition

We have investigated the effects of reduced quality differentiation on profits and welfare when the investment strategies of the two firms were given, i.e. under the assumption that firm A would always produce high quality and firm B always low quality. However, a purpose of trademark protection may be to signal that investments in marketing will be protected. This suggests that without legal restrictions, firms may invest less in producing and/or marketing high quality products when considering the risk of imitation. For example, if imitation is ruled out it is possible that firm B would also consider investing in high quality. Thus in order to determine the effects of trademark protection laws on investment behavior we need to investigate incentives for investment with and without trademark protection.

The introduction of an initial investment phase makes it necessary to consider the extensive form version of the game, described in *Figure 2*. Firm profits (net of investment costs) are denoted in such a way that subscripts refer to firms (A and B), the first letter of the superscript refers to the strategy of firm A (H for high quality or L for low quality) while the

last letter refers to the strategy of firm B (H for high quality, L for low quality and I for imitation/infringement). Firms may choose any quality level at the investment stage and we denote the quality levels produced under imitation by S_A^I and S_B^I . Specifically, profits are:

$$\begin{aligned}\pi_A^{HI} &= \gamma(S_B^I / S_A^I) - K \\ \pi_B^{HI} &= \lambda(S_B^I / S_A^I) \\ \pi_A^{HL} &= \pi_B^{LH} = \gamma(S_L / S_H) - K \\ \pi_A^{LH} &= \pi_B^{HL} = \lambda(S_L / S_H) \\ \pi_A^{HH} &= \pi_B^{HH} = \gamma(1) - K \\ \pi_A^{LL} &= \pi_B^{LL} = \gamma(1)\end{aligned}$$

where $\gamma(z)$ and $\lambda(z)$ are equivalent to Equations (5) and (6).

The firms' equilibrium strategies are determined by the extent of trademark protection, together with the cost of investing in high quality. To categorize the different cases we define four levels of investment costs, $K_1 < K_2 < K_3 < K_4$ (see the Appendix for details). Moreover, we define a threshold level of infringement or imitation $I' < \bar{I}$ (also in the Appendix).¹² Since firm A is the first mover it will take firm B 's actions into account when determining its investment. We thus start by examining firm B 's optimal investment strategies, given the different possible actions taken by firm A and whether imitation is legal or not.

Consider first the case when firm A produces high quality and its trademark is not protected from imitation. We can then show the following.

Lemma 1. If $S_A = S_H$ and imitation is allowed then S_B^I is an optimal strategy for firm B if the investment cost is large ($K > K_1$). Otherwise, the optimal strategy is S_H .

¹² To be precise, K_3 plays a role only for $I > I'$ and in that case $K_2 < K_3 < K_4$.

Proof: See the Appendix.

Thus if the investment cost is sufficiently low, the fact that firm A has invested in high quality will not prevent firm B from doing so too. In this case it does not make any difference if trademarks are protected or not, since imitation will not occur anyway. For investment costs higher than K_1 firm B will however profit from engaging in product imitation.

Next consider the case when firm A produces high quality but its trademark is protected from imitation. We then have

Lemma 2. If $S_A = S_H$ and imitation is illegal then S_L is an optimal strategy for firm B if the investment cost is large ($K > K_2$). Otherwise, the optimal strategy is S_H .

Proof: See the Appendix.

Thus with investment costs above K_1 but below K_2 , firm B will invest in high quality if it is prevented by trademark protection law from engaging in product imitation.

If firm A instead produces low quality, firm B may invest in high quality without risking exposure to imitation. Here firm B 's incentives are the following

Lemma 3. If $S_A = S_L$ then S_L is an optimal strategy for firm B as long as the investment cost is large ($K > K_4$). Otherwise, the optimal strategy is S_H .

Proof: See the Appendix.

Thus when firm A produces low quality, it is relatively more profitable for firm B to invest in high quality, and firm B will do so unless the investment cost is above K_4 .

Having determined firm B 's optimal strategies as dependent on the actions of firm A and whether imitation is illegal or not, we now determine the equilibrium strategies by

considering firm A's optimal strategies in the investment stage. These are summarized in Propositions 1 and 2 below.

Proposition 1. When imitation is legal equilibrium strategies are

$$\begin{aligned}
K > K_4 & \rightarrow \pi_A^{LL} > \pi_A^{HI} \rightarrow S_A = S_L \text{ and } S_B = S_L \\
K_4 > K > K_1 \text{ and } I < I' & \rightarrow \pi_A^{HI} > \pi_A^{LH} \rightarrow S_A = S_A^I \text{ and } S_B = S_B^I \\
K_4 > K > K_3 > K_1 \text{ and } I > I' & \rightarrow \pi_A^{LH} > \pi_A^{HI} \rightarrow S_A = S_L \text{ and } S_B = S_H \\
K_4 > K_3 > K > K_1 \text{ and } I > I' & \rightarrow \pi_A^{HI} > \pi_A^{LH} \rightarrow S_A = S_A^I \text{ and } S_B = S_B^I \\
K < K_1 & \rightarrow \pi_A^{HH} > \pi_A^{LH} \rightarrow S_A = S_H \text{ and } S_B = S_H
\end{aligned}$$

Proof: This follows from $K_4 > K_2 > K_1$ and $K_4 > K_3 > K_1$ if $I < I'$.

To summarize, if the investment cost of high quality is very low ($K < K_1$) both firms will invest in high quality, and if it is very high ($K > K_4$) none of the firms will do so. For intermediate investment costs firm A will invest in high quality while firm B will instead engage in product imitation, *except* when the investment cost is quite high ($K_3 < K < K_4$) and imitation above the threshold level I' is possible. In that case firm A will abstain from investing in high quality and firm B will do so instead.

If trademark protection prevents all imitation, the optimal strategies of firm A and thus the equilibrium strategies are somewhat different.

Proposition 2. When imitation is illegal equilibrium strategies are

$$\begin{aligned}
K > K_4 & \rightarrow \pi_A^{LL} > \pi_A^{HL} \rightarrow S_A = S_L \text{ and } S_B = S_L \\
K_4 > K > K_2 & \rightarrow \pi_A^{HL} > \pi_A^{LH} \rightarrow S_A = S_H \text{ and } S_B = S_L \\
K < K_2 & \rightarrow \pi_A^{HH} > \pi_A^{LH} \rightarrow S_A = S_H \text{ and } S_B = S_H
\end{aligned}$$

Proof: This follows from $K_4 > K_2$.

The equilibrium investment strategies are summarized in *Table 1*, where the extent of trademark protection (TP) is described in terms of three levels: Weak, Intermediate and Strong, determined by whether all, some, or no imitation is allowed.

Table 1
EQUILIBRIUM QUALITY LEVELS

Imitation legal, $I > I'$: Weak TP	$S_A = S_H$ $S_B = S_H$	$S_A = S_A^I$ $S_B = S_B^I$	$S_A = S_A^I$ $S_B = S_B^I$	$S_A = S_L$ $S_B = S_H$	$S_A = S_L$ $S_B = S_L$
Imitation legal, $I < I'$: Intermediate TP	$S_A = S_H$ $S_B = S_H$	$S_A = S_A^I$ $S_B = S_B^I$	$S_A = S_A^I$ $S_B = S_B^I$		$S_A = S_L$ $S_B = S_L$
Imitation illegal: Strong TP	$S_A = S_H$ $S_B = S_H$	$S_A = S_H$ $S_B = S_H$	$S_A = S_H$ $S_B = S_L$		$S_A = S_L$ $S_B = S_L$
		K_1	K_2	K_3	K_4

The first row shows quality investment when imitation is unrestricted, in the second row imitation up to but not beyond the level I' is legal, and in the third row imitation is illegal. The effect on equilibrium strategies of strengthening trademark protection is essentially that the conditions under which it is profitable for both firms to invest in high quality are extended: when $K_2 > K > K_1$, both firms invest in high quality if imitation is illegal, but only firm A if they are not. In this sense trademark protection increases investments in quality and this may increase welfare. On the other hand, investment costs also have to be taken into account.

The investment effects of trademark protection imply that it also leads to dynamic welfare effects. We now turn to a closer investigation of these.

6. Dynamic Welfare Effects of Trademark Protection

To determine the welfare effects of trademark protection we consider the impact on profits and consumers' surplus for those cases where trademark protection will change either the investment decisions or the production and pricing decisions of one or both firms. As in Section 4 above, we will check if it makes a difference whether quality is evaluated using post-advertising or pre-advertising consumer preferences.

It is obvious from *Table 1* that trademark protection affects investment patterns only for intermediate levels of investment costs. There are three cases. When $K \in [K_1, K_2]$, both firms invest in high quality under strong trademark protection, while otherwise firm *A* invests in high quality and firm *B* chooses the imitation strategy. Let us denote this case by *Case 1*. For $K \in [K_2, K_3]$, firm *A* invests in high quality and firm *B* supplies low quality, and unless there is strong trademark protection firm *B* chooses the imitation strategy. Thus investments are not affected by trademark protection, only quality levels. Let us denote this case by *Case 2*. Finally, in *Case 3* when $K \in [K_3, K_4]$, firm *A* alone will invest high quality under strong trademark protection, while under weak trademark protection the reverse relation holds. Under intermediate trademark protection firm *A* invests and firm *B* imitates.

In *Case 1* aggregate investment costs are affected by trademark protection laws and investment costs must be incorporated in the definition of profits. The results are summarized in *Table 2*. Subscripts *WTP*, *ITP* and *STP* refer to weak, intermediate and strong trademark protection. Aggregate profit net of investment costs is denoted by π , and *TS* refers to total welfare net of investment costs. For details, see the Appendix.

Table 2**WELFARE EFFECTS OF TRADEMARK PROTECTION***Case 1: $K \in [K_1, K_2]$*

Post-advertising tastes	Pre-advertising tastes
$CS_{WTP}^{post} = CS_{ITP}^{post} > CS_{STP}^{post}$	$CS_{WTP}^{pre} = CS_{ITP}^{pre} < CS_{STP}^{pre}$
$\pi_{WTP} = \pi_{ITP} > \pi_{STP}$	$\pi_{WTP} = \pi_{ITP} > \pi_{STP}$
$TS_{WTP}^{post} = TS_{ITP}^{post} > TS_{STP}^{post}$	$TS_{WTP}^{pre} = TS_{ITP}^{pre} > TS_{STP}^{pre}$

In *Case 1*, strong trademark protection reduces quality differentiation since it implies that both firms invest in high quality. This reduces consumers' surplus in the market for high-quality goods and increases it in the market for low-quality goods. The net effect is negative for post-advertising tastes and positive for pre-advertising tastes, see Expressions (15) and (20). In terms of aggregate profits, imitation is favorable for firms since it reduces total investment costs. For post-advertising tastes the consumers' surplus effect and the profit effect have the same sign, and for pre-advertising tastes the profit effect dominates. Note that in *Case 1* the welfare effect of trademark protection is completely reversed compared with the static case with exogenously determined quality levels. Here, strong trademark protection leads to over-investment in quality.

The *Case 2* welfare results are summarized in *Table 3*. For details, see the Appendix.

Table 3**WELFARE EFFECTS OF TRADEMARK PROTECTION***Case 2: $K \in [K_2, K_3]$*

Post-advertising tastes	Pre-advertising tastes
$CS_{WTP}^{post} = CS_{ITP}^{post} < CS_{STP}^{post}$	$CS_{WTP}^{pre} = CS_{ITP}^{pre} > CS_{STP}^{pre}$
$\pi_{WTP} = \pi_{ITP} < \pi_{STP}$	$\pi_{WTP} = \pi_{ITP} < \pi_{STP}$
$TS_{WTP}^{post} = TS_{ITP}^{post} < TS_{STP}^{post}$	$TS_{WTP}^{pre} = TS_{ITP}^{pre} < TS_{STP}^{pre}$

In *Case 2*, trademark protection increases quality differentiation. This increases consumers' surplus in the market for high-quality good and reduces it in the market for low-quality goods. The net effect is positive for post-advertising tastes and negative for pre-advertising tastes (Expressions (15) and (20)). Moreover, we know from Expression (10) that aggregate variable profits increase in the degree of quality differentiation. The overall welfare effects are obvious in the left column, while in the right column the effect on profits dominates.

Table 4 summarizes the welfare results for *Case 3* (with details in the Appendix):

Table 4

WELFARE EFFECTS OF TRADEMARK PROTECTION

Case 3: $K \in [K_3, K_4]$

Post-advertising tastes	Pre-advertising tastes
$CS_{ITP}^{post} < CS_{STP}^{post} = CS_{WTP}^{post}$	$CS_{ITP}^{pre} > CS_{STP}^{pre} = CS_{WTP}^{pre}$
$\pi_{ITP} < \pi_{STP} = \pi_{WTP}$	$\pi_{ITP} < \pi_{STP} = \pi_{WTP}$
$TS_{ITP}^{post} < TS_{STP}^{post} = TS_{WTP}^{post}$	$TS_{ITP}^{pre} < TS_{STP}^{pre} = TS_{WTP}^{pre}$

In *Case 3*, only one firm invests in high quality production, firm *A* under strong and firm *B* under weak trademark protection. In terms of welfare, weak and strong trademark protection are therefore identical, while with intermediate trademark protection some imitation occurs with similar welfare effects as in *Case 2*. We thus have

Observation 6: For investment costs $K \in [K_1, K_2]$, trademark protection increases investment in quality and reduces welfare as well as quality differentiation (*Case 1*). For $K \in [K_2, K_3]$ (*Case 2*) trademark protection implies increased quality differentiation and higher welfare. For $K \in [K_3, K_4]$ (*Case 3*) quality differentiation and welfare is highest for intermediate trademark protection. All aggregate welfare results are independent of the point of reference; pre-advertising tastes or post-advertising tastes.

In all results so far only relative quality turns out to matter. Thus, for example, an increase in S_B reduces aggregate consumers' surplus under post-advertising preferences. For alternative welfare measures, such as utility, absolute quality levels would matter, but at the expense of a loss of comparability between profits and consumer welfare. In addition, in our framework the level of trademark protection affects the results since it determines the likelihood of different scenarios. Specifically, both I and α affect the threshold levels for investment costs that determine equilibrium investment patterns and, in turn, the likelihood of the three cases. Using the fact that $I \in [0, \bar{I}]$, it can easily be shown that

$$\begin{array}{ll} \frac{\partial K_1}{\partial \alpha} < 0 & \frac{\partial K_1}{\partial I} < 0 \\ \frac{\partial K_2}{\partial \alpha} = 0 & \frac{\partial K_2}{\partial I} = 0 \\ \frac{\partial K_3}{\partial \alpha} < 0 & \frac{\partial K_3}{\partial I} < 0 \\ \frac{\partial K_4}{\partial \alpha} = 0 & \frac{\partial K_4}{\partial I} = 0. \end{array}$$

This leads to our last observation

Observation 7: (i): The *Case 1* scenario is more likely the more efficient the imitation strategy is, i.e., the higher I and α are. (ii): The *Case 2* scenario is less likely the more efficient the imitation strategy is, i.e., the higher I and α are. (iii) The *Case 3* scenario is more likely the more efficient the imitation strategy is, i.e., the higher I and α are.

The intuition for the first result is simply that the more efficient the imitation strategy is, the more attractive it is for firm B to use it. The second and third results follow since it is less attractive for firm A to invest in high quality when the imitation strategy is more efficient for firm B .

7. Unrelated markets – An Extension

In the base model of trademark protection we have allowed for competition between firms. Sometimes however strong trademarks are granted protection from free-riding also when products are unrelated from the consumers' perspective, i.e., the case when firm demands are unrelated in the sense that cross-price elasticities are zero. This is often true in the context of trademark dilution. It can however be shown that the main results are essentially robust to limiting the focus to unrelated demand. In this section we will merely account for the qualitative results. A full proof is of course available from the authors on request.

Let there be two monopolistic sellers, firm A and firm B , each selling goods with one of two exogenously determined quality levels, high quality (or service) S_A and low quality S_B . Since unrelated demand is not consistent with the previous model specification we look at the simplest possible model that is. Specifically, we assume that demand is linear and that quality differences are captured by the intercepts so that demand is $P_A = S_A - Q_A$ and $P_B = S_B - Q_B$ respectively, where S_A and S_B are defined as before. Again, the marginal cost of production is zero and the additional cost of supplying high quality is modeled as a fixed cost K . Also, timing is the same as in the base model.

Due to the monopoly assumption the choice of strategic variable (price or quantity) does not affect the results. Equilibrium prices as functions of quantities are derived from the profit functions $\pi_A = Q_A(S_A - Q_A)$ and $\pi_B = Q_B(S_B - Q_B)$. Using first-order conditions for profit maximization with respect to own quantity for each firm, we arrive at expressions for the variable profits (i.e., investment costs not deducted):

$$\pi_A = \frac{S_A^2}{4} \quad \text{and} \quad \pi_B = \frac{S_B^2}{4}.$$

The extensive form version of the game remains unchanged and is described in *Figure 2*. Equilibrium strategies are determined by whether trademarks are protected, together with the cost of investing in high quality. To categorize the different cases three levels of investment costs, $\hat{K}_1 < \hat{K}_2 < \hat{K}_3$ can be derived, defined by $\pi_B^{HI} = \pi_B^{HH}$, $\pi_A^{HI} = \pi_A^{LH}$, and $\pi_B^{LL} = \pi_B^{LH}$.¹³

The equilibrium strategies under Weak and Strong trademark protection, i.e. whether imitation is legal or illegal, are summarized in *Table 5*. Again, the effect on equilibrium strategies of making imitation or dilution illegal is essentially that it extends the conditions under which it is profitable for both firms to invest in high quality: when $\hat{K}_3 > K > \hat{K}_1$, both firms invest in high quality if trademarks are protected, while otherwise only one of the firms does so. In this sense trademark protection increases investments in quality and this may increase welfare. On the other hand, investment costs also have to be taken into account.

It is interesting to note that imitation/dilution only occurs in equilibrium when it is relatively harmless, i.e., when α is small (*Case 5*). On the other hand, legal restrictions affect the equilibrium outcome also when imitation/dilution is not observed (*Case 4*).

¹³ To be precise, \hat{K}_2 plays a role only for specific parameter values that imply $\hat{K}_1 < \hat{K}_2 < \hat{K}_3$.

Table 5

EQUILIBRIUM QUALITY LEVELS WITH UNRELATED DEMAND

Weak TP, $\hat{K}_2 < \hat{K}_1$	$S_A = S_H$	$S_A = S_L$		$S_A = S_L$
	$S_B = S_H$	$S_B = S_H$		$S_B = S_L$
Strong TP, $\hat{K}_2 < \hat{K}_1$	$S_A = S_H$	$S_A = S_H$		$S_A = S_L$
	$S_B = S_H$	$S_B = S_H$		$S_B = S_L$
		\hat{K}_1		\hat{K}_3
Weak TP, $\hat{K}_2 > \hat{K}_1$	$S_A = S_H$	$S_A = S_A^I$	$S_A = S_L$	$S_A = S_L$
	$S_B = S_H$	$S_B = S_B^I$	$S_B = S_H$	$S_B = S_L$
Strong TP, $\hat{K}_2 > \hat{K}_1$	$S_A = S_H$	$S_A = S_H$	$S_A = S_H$	$S_A = S_L$
	$S_B = S_H$	$S_B = S_H$	$S_B = S_H$	$S_B = S_L$
		\hat{K}_1	\hat{K}_2	\hat{K}_3

We now consider aggregate welfare for those cases where the extent of trademark protection will change either the investment decisions or the production and pricing decisions of one or both firms. As before, we will check if it makes a difference whether quality is evaluated using post-advertising or pre-advertising consumer preferences.

It is obvious from *Table 5* that investment patterns are only affected for intermediate levels of investment costs. There are two cases. When $K \in \left[\hat{K}_1, \hat{K}_3 \right]$ (for $\hat{K}_2 < \hat{K}_1$) and when $K \in \left[\hat{K}_2, \hat{K}_3 \right]$ (for $\hat{K}_2 > \hat{K}_1$), both firms invest in high quality under trademark protection, while otherwise firm *A* invests in low quality and firm *B* invests in high. Let us denote this case by *Case 4*. The other case is when $K \in \left[\hat{K}_1, \hat{K}_2 \right]$ (for $\hat{K}_2 > \hat{K}_1$). Here, both firms invest in high quality if trademarks are protected, while otherwise firm *A* invests is high quality while firm *B* chooses the imitation or dilution strategy. Let us denote this case by *Case*

5. Basically, this situation can only arise when α is small. Otherwise, the threat of trademark infringement will prevent firm *A* from investing in high quality in the first place.

The aggregate welfare effects (measured as above) are shown in *Table 6*.

Table 6

WELFARE EFFECTS OF TRADEMARK PROTECTION (UNRELATED DEMAND)

Case 4: $S_A = S_L$ and $S_B = S_H$ under Weak trademark protection

Post-advertising tastes	Pre-advertising tastes
Trademark protection increases welfare	Trademark protection decreases welfare

Case 5: $S_A = S_A^I$ and $S_B = S_B^I$ under Weak trademark protection

Post-advertising tastes	Pre-advertising tastes
Mixed results	Trademark protection decreases welfare

Under pre-advertising tastes, imitation or trademark dilution reduces investments in quality, and these are not valued by consumers ex post. Moreover, prices in one or both markets are reduced. Hence, aggregate welfare is higher without trademark protection. Under post-advertising preferences results are mixed. If α is large (*Case 4*), the negative effects of imitation/trademark dilution dominate since the drop in average quality is large, and monopolistic firms have weak incentives to over-investment in quality for strategic reasons. For smaller values of α (*Case 5*), i.e. in particular when there is imitation but not dilution, imitation reduces aggregate investment costs while the effect on average quality is moderate. Hence, imitation may very well increase aggregate welfare. To sum up, theory provides no clear-cut policy advice even in the case of unrelated demand.

8. Conclusions and Policy Implications

An important motivation for this study was to explore the circumstances under which trademark protection laws, and extended trademark protection, are likely to increase welfare. The overall results for welfare effects are ambiguous to say the least. One general conclusion that *can* however be drawn is that a justification on the grounds that welfare-enhancing investments in marketing need to be protected, is questionable.

If legislation is unlikely to affect investment patterns, implying that a static framework of analysis is appropriate, trademark protection does seem to be beneficial in terms of aggregate welfare. Under Bertrand competition such legislation does not affect firm behavior, but under Cournot competition welfare is higher if imitation is not an option for firms. The reason is partly that imitation puts an upward pressure on the price of low-quality products, which has the consequence that the poorest consumers are excluded from the market. In addition, imitation reduces rich consumers' willingness to pay for high quality.

In a dynamic setting, results are less clear-cut. With a total welfare standard, trademark protection is beneficial to society only if investment costs are relatively high (*Case 2* and *Case 3*). In these cases total investments in quality are unaffected by the policy chosen, but trademark protection puts a downward pressure on the price of the low-quality product which increases aggregate demand. It also increases the willingness to pay for high quality. For lower levels of investment costs (*Case 1*) the policy affects investment, and if imitation is not allowed firms will tend to *over*-invest in product quality, which reduces welfare.

These results hold independently of whether consumers are confused or not, i.e., regardless of whether pre-advertising preferences or post-advertising preferences are used for the welfare evaluation. More narrowly defined welfare measures, such as the consumer welfare standard or the producer welfare standard, also yield ambiguous results. However, if pre-advertising preferences are used for welfare evaluation, increased trademark protection

tends to reduce consumer surplus. This suggests that the argument for extended trademark protection is generally weaker if quality is mainly due to marketing, and there is some confusion as to what constitutes a genuine quality difference. In this situation it could be argued that legal imitation, perhaps supported by truthful comparative advertising, is more likely to increase consumer welfare.

We also find that it is more likely that increased trademark protection reduces welfare when imitation leads to tarnishment of the high quality.¹⁴ This somewhat surprising result depends on the investment effects of trademark protection, since in markets where tarnishment is a real possibility, the range of investment costs for which firm *B* prefers imitation to investment in high quality is extended, and this mitigates the problem of over-investment in marketing.

In general, the qualitative results are also independent of whether products are assumed to be substitutes (the main model) or unrelated and sold in separate markets (the more likely case for dilution). Hence, our study suggests that economic theory does not provide a basis for clear-cut policy advice. Instead, the main conclusion is perhaps that the positive *and* the negative effects of trademark protection laws are important, and it is therefore not at all clear that extended trademark protection would lead to welfare gains.

¹⁴ *Case 1* then becomes more likely.

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Appendix:

Definition of investment costs:

K_1, K_2, K_3, K_4 are defined by $\pi_B^{HI} = \pi_B^{HH}$, $\pi_B^{HH} = \pi_B^{HL}$, $\pi_A^{HI} = \pi_A^{LH}$ and $\pi_A^{LL} = \pi_A^{HL}$.

$$K_1 \equiv \frac{b^2(S_H - S_L - I(\alpha + 1))(7S_H - S_L - I(7\alpha + 1))}{9(4S_H - S_L - I(4\alpha + 1))^2}$$

$$K_2 \equiv \frac{b^2(S_H - S_L)(7S_H - S_L)}{9(4S_H - S_L)^2}$$

$$K_3 \equiv \frac{b^2 X_1 X_2}{(4S_H - S_L)^2 (4S_H - S_L - I(4\alpha + 1))^2}$$

$$K_4 \equiv \frac{4b^2(S_H - S_L)(5S_H - 2S_L)}{9(4S_H - S_L)^2}$$

where

$$X_1 \equiv 2\alpha(2S_H - S_L) + I(3S_H - S_L) - (S_H - S_L)(4S_H - S_L)$$

$$X_2 \equiv 2\alpha(6S_H - S_L) + I(5S_H - S_L) - (3S_H - S_L)(4S_H - S_L).$$

For $0 \leq z \leq 1$ and $I \in [0, \bar{I}]$ we have that $K_1 < K_2 < K_4$ and $K_2 < K_3$.

A threshold level of imitation:

$$I' \equiv \frac{(4S_H - S_L)[X_3 + 43S_H^2 - S_L(26S_H - S_L)]}{X_4 + 115S_H^2 - 44S_H S_L + S_L^2}$$

where

$$X_3 \equiv 2\alpha(14S_H^2 + 2S_H S_L - 7S_L^2) - 6(\alpha S_L + S_H)\sqrt{29S_H^2 - 28S_H S_L + 8S_L^2}$$

$$X_4 \equiv 4\alpha^2(28S_H^2 + 40S_H S_L - 23S_L^2) + 4\alpha(86S_H^2 - 16S_H S_L - 7S_L^2).$$

$I > I'$ implies $K_3 < K_4$. For $I \leq I'$, K_3 is not relevant for investment or imitation decisions

since when $K > K_4$ the highest attainable profit is $\pi_A^{LL} = \pi_B^{LL}$.

Proofs of

Lemma 1: Since $K_4 > K_2 > K_1$ it follows that

$$\begin{aligned}
K > K_2 &\rightarrow \pi_B^{HI} > \pi_B^{HL} > \pi_B^{HH} \rightarrow S_B = S_B^I \\
K_2 > K > K_1 &\rightarrow \pi_B^{HI} > \pi_B^{HH} > \pi_B^{HL} \rightarrow S_B = S_B^I \\
K_2 > K_1 > K &\rightarrow \pi_B^{HH} > \pi_B^{HI} > \pi_B^{HL} \rightarrow S_B = S_H
\end{aligned}$$

Lemma 2: Since $K_4 > K_2 > K_1$ it follows that

$$\begin{aligned}
K > K_2 &\rightarrow \pi_B^{HL} > \pi_B^{HH} \rightarrow S_B = S_L \\
K_2 > K &\rightarrow \pi_B^{HH} > \pi_B^{HL} \rightarrow S_B = S_H
\end{aligned}$$

Lemma 3: Since $K_4 > K_2 > K_1$ it follows that

$$\begin{aligned}
K > K_4 &\rightarrow \pi_B^{LL} > \pi_B^{LH} \rightarrow S_B = S_L \\
K_4 > K &\rightarrow \pi_B^{LH} > \pi_B^{LL} \rightarrow S_B = S_H
\end{aligned}$$

Tables 2, 3 and 4:

In *Table 2* the results for consumers' surplus follow from Observation 4 since trademark protection implies that $z = 1$, i.e. z increases. When calculating differences in net profits, investment costs have to be included. Define $\psi \equiv \pi_A^{HI} + \pi_B^{HI} - 2\pi_A^{HH}$. By Observation 3, the function ψ is decreasing in I . Moreover $\psi(\bar{I}) = K$. Thus $\psi > 0$ for $0 < K_1 < K_2$. For post-advertising preferences the aggregate welfare result follows directly since effects on consumers' surplus and profits have the same sign. For pre-advertising preferences we define the function $\chi \equiv TS_{WTP}^{pre} - TS_{STP}^{pre}$ (or equivalently, $\chi \equiv TS_{ITP}^{pre} - TS_{STP}^{pre}$). It can be shown that χ is decreasing in I , and $\chi(\bar{I}) = K$. Thus for $0 < K_1 < K_2$ we have that $\chi > 0$. The results in *Tables 3* and *4* follow directly from Observations 3, 4 and 5.

Figure 1: Demand structure

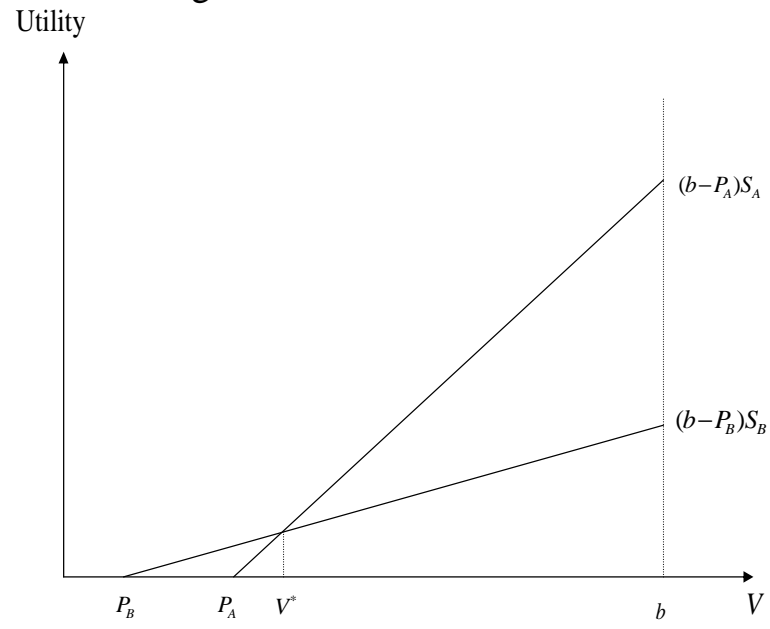


Figure 2: Structure of the game

