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Strategic Delays of Delivery, Market Separation and Demand Discrimination

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Abstract
We show that an adequate choice of delays to deliver a durable good allows a monopolist to soften the intrabrand price competition between his two retailers on two different markets, when consumers suffer a switching cost to buy on the market where they are not located. To prevent each retailer from selling on both markets, the upstream producer increases the delay of delivery on the market where the willingness to pay is the lowest. It therefore separates the markets across time, by orientating consumers to the appropriate downstream retailer. Consumers pay their highest valuation, and a price differential higher than the switching cost persists in equilibrium. We discuss the application of our findings to the European car market.

Keywords:
durable good, switching cost, discrimination, intrabrand competition, European car market

JEL Classification: L22, L12, L40

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1 Introduction

The European car distribution system has been scrutinized by the European Commission for thirty years. After a first period during which manufacturers and retailers had to submit their contracts to the Commission in order to get an individual exemption from the application of article 81(1) (previously 85(1)) of the Treaty of Rome, the distribution of cars has been covered by a sector-specific block exemption since July 1, 1985. There was a first revision of the block-exemption in 1995, then a second in 2002 that changed drastically the legal framework of car distribution in the EU. In addition to the regulation of distribution agreements, the Commission is publishing since 1993 a report on car prices within the EU every six months. In the Commission's view, the report "has created greater price transparency on recommended retail prices and induced consumers to acquire cars in another Member State where prices are lower" (Commission of the European Communities (2000)). However consumers willing to take advantage of price differentials within the single market by purchasing their car from foreign dealers often experienced difficulties in doing so. While some dealers declare not to be interested in such sales, dealers who are willing to sell "quote delivery times which are much longer than their normal delivery times" (CEC (2000)). The Commission was informed of many such cases of discrimination against foreign customers as compared with domestic buyers, which is a violation of the Treaty. These complaints from consumers lead the Commission to initiate several investigations between 1995 and 1999 to verify whether measures had been taken by manufacturers vis a vis dealers "with the aim of restricting or preventing sales to customers from other Member States in a way which was contrary to Regulations 123/85 and 1475/95" (CEC (2000)). The 2002 Regulation is clearly influenced by practices the Commission discovered during these investigations. It sets a series of rules to prevent discrimination against customers from other parts of the single market in terms of availability, prices and delays. Following the Regulation, dealers must be able to supply customers from any part of the single market under the same conditions. Any clause that aims at preventing or discouraging dealers from selling to foreign customers is forbidden. However, the Regulation does not oblige manufacturers to serve dealers everywhere within the EU with the same delay. Typically, delivery delays may differ from one country to the other for several reasons, from genuine ones (logistic organization, distance between the market and the plant,...) to strategic ones. In this paper, we show that manufacturers may use delays of delivery to implement a profitable fragmentation of the single market, in order to prevent parallel trade between low price and high price countries while maintaining a substantial price differential between the two countries. We show that this practice may be welfare reducing[1]

More specifically, our model studies the interaction between the producer of a durable good located in one market (the "national" market), two retailers, one located on the national market, the other one on a different but contiguous market (the "foreign" market), and two price-taking consumers, one on each market. Consumers have a switching cost to buy the good "abroad", that is on the market other than the one on which they are located. They differ according to their willingness to pay for one unit of the good: it is higher on the national market than on the foreign market. The producer offers a menu of franchise contracts that are identical with respect to the wholesale price, but differ regarding the delays of deliveries of the product and the fixed fees.[2] The existence of different franchise contracts can be thought as "show room" versus "official dealer" franchise contracts: official dealers own inventories of the finished product, allowing consumers to use the good immediately after purchasing, while "show rooms" have to ask for the good at the time it is purchased by consumers, inducing a delay. Retailers accept one (or none) of the contracts and set prices. With immediate delivery in both countries, the price differential is limited by the level of switching costs, due to the possibility of arbitrage by consumers. If the willingness to pay of local and foreign consumers differ by more than the switching cost, that is if markets are not naturally separated, the manufacturer faces a trade-off between either extracting the entire willingness to pay of local consumers but renouncing to supply the foreign market or supplying both markets but leaving rents to local consumers. By delaying delivery in the foreign country, the manufacturer is able to extract the entire willingness to pay both of the national and the foreign consumers. Price differential in equilibrium ultimately exceeds the switching cost, as well as the difference between consumers willingness to pay without delays: the delay imposed on the foreign market reduces the intertemporal foreign consumer's benefit and in turn increases the difference in valuations. Even if price differential is increased, it is not possible for the national and high willingness-to-pay consumer to buy on the foreign market because at the foreign price and delay, he is earning a strictly negative payoff.

Our findings contrast with previous work on price discrimination in the European car mar-

[1]As usual price discrimination by a monopoly is not always welfare reducing. One of the objectives that the Treaty assigns to European competition policy is however the creation of a single market, and thus the elimination of any barrier to cross-border trade flows within the EU. From that point of view price discrimination that results from market separation is "bad".

[2]Allowing for differing wholesale prices would raise supplementary issues that are not central to this paper, while leaving the main results unchanged.

ket. Kirman and Schueller [1990] show that differences in prices may be explained by imperfect competition between producers, but also by differences in tax rate. They consider a model of oligopolistic competition where on each market there is a dominant producer except on one specific market where there is no national producer. They show that in markets where the dominant producer has high costs, the prices of all the products are higher. In markets where the tax rate is high, the pre-tax prices are lower. Finally in the market where there is no dominant producer, prices are lower. Verboven [1996] estimated a model to explain price differences between new cars within the European Community: he shows that three factors are particularly interesting, namely the existence of a local market power (national producers in France, Germany, United Kingdom and Italy, benefit from a lower price elasticity than others), binding import quotas constraints (in France and Italy against Japanese cars), and collusion (which cannot be rejected in Germany and United Kingdom).

Our study is related to previous works on intertemporal price discrimination for durable goods (see e.g. Stockey [1979],Bagnoli, Salant, and Swierzbinski [1989], Anderson and Ginsburgh [1994], Kühn and Padilla [1996] and Kühn [1998]). None of those papers are however analyzing the impact of retailers competition on the strategy of a monopolistic producer, in presence of a transportation cost between markets. As shown by our study, these specificities are at the core of the car distribution system in Europe. Delaying the delivery of a durable good can be interpreted as lowering the quality of the good: our paper is therefore related to the literature on vertical differentiation in oligopolistic competition. Departing from Gabszewicz and Thisse [1979], [1980], and Shaked and Sutton [1982], non integrated retailers would not choose to differentiate themselves with respect to delays since short delays of delivery are not more costly to implement than long delays, or would not differentiate as much as the upstream monopolist would like them to if short delays were more costly to produce than long ones.

Our paper is organized as follows: in the second section we present the model, and in the third section we deal with the existence of an equilibrium. In the fourth section we analyze the benchmark case, where there are no delays in the delivery, to prove that discrimination cannot occur. In section 5 we determine the producer's optimal delays choices in the delivery. Finally the last section discusses our results and concludes.

2 The model

Let a producer P_N of an homogenous, indivisible and durable good be able to sell it through two retailers, R_N on the domestic or national market N and R_F on a foreign market F. On each market there is only one price-taking consumer buying one unit of the durable good, C_N on the domestic market and C_F on the foreign market.

To market the good retailer R_N chooses a retail price $p_N \in \mathbb{R}^+$, and retailer R_F chooses a retail price $p_F \in \mathbb{R}^+$, given the franchise contract $\mathcal{FC}$ signed with the producer. A mixed strategy for retailer R_N (respectively R_F) is a probability measure σ_N (respectively σ_F) on a support $\mathrm{Supp}(\sigma_N) \subseteq \mathbb{R}^+$ (respectively $\mathrm{Supp}(\sigma_F) \subseteq \mathbb{R}^+$). As usual a mixed strategy σ_x may be any type of distribution, continuous or discrete, on $\mathrm{Supp}(\sigma_x)$. Let Σ denote the set of mixed strategies from which each retailer can choose. Retailers R_N and R_F do not suffer any cost to market the good, apart those specified in the franchise contract.

A franchise contract $\mathcal{FC}$ is offered at the beginning of the game by producer P_N. It consists in a wholesale price $w \in \mathbb{R}^+$ charged by the producer P_N for any unit sold by the retailer, a fixed fee $T \in \mathbb{R}^+$ paid by the retailer to the producer, and a date at which the producer delivers the good, $\tau \in \mathbb{N}$. We assume that P_N can offer two different contracts $\mathcal{FC}_N$ and $\mathcal{FC}_F$ on which retailers self-select. We restrict our attention to contracts having the same wholesale price to avoid arbitrage by retailers, but differing with respect to fixed fees and delays of delivery,

$$\mathcal{FC}_N = (w, T_N, \tau_N) \quad \text{and} \quad \mathcal{FC}_F = (w, T_F, \tau_F) \tag{1}$$

Contracts are therefore observable, and P_N proposes the contracts via a take-it-or-leave-it offer. Finally producer P_N does not suffer any cost to produce the good.

Each consumer chooses the retailer he wants to buy from, depending on the pairs (p_x, τ_x) observed on each market. Let v_x be the constant instantaneous flow of benefit generated by the consumption of the durable good for $x = N, F$. For the sake of tractability we assume that $v_N > v_F = 1$. Moreover the good does not depreciate, consumers are infinitely living and obtain a 0 benefit if they do not buy the good. Finally we assume that buying on one's foreign market (i.e. C_N buying from R_F or C_F buying from R_N) induces an additional switching cost $\epsilon \geq 0$ for the consumer. Let $\delta < 1$ be the discount factor identical for all consumers. If he buys the good from retailer R_y, the net benefit for consumer C_x for $x, y = N, F$ is then,

$$u_x(p_y, \tau_y) = \sum_{t=\tau_y}^{+\infty} \delta^t v_x - p_y - \epsilon \cdot \mathbb{I}_{x \neq y}$$

where we assume that the good is paid on order, $\mathbb{I}_{x \neq y}$ being equal to one when $x \neq y$ and 0 else[3]. We assume that the difference between the valuations is high enough,

$$\frac{v_N - 1}{1 - \delta} \geq \epsilon \tag{2}$$

in order for the problem to be significant: if the switching cost ϵ exceeds the difference between the valuations for the good, the markets are naturally separated and manufacturer P_N does not need to introduce delays of delivery to restore exclusive territories.

Some simplifications give immediately that

- $u_N(p_N, \tau_N) = \frac{\delta^{\tau_N}}{1-\delta} v_N - p_N$ if C_N buys the good from R_N,
- $u_N(p_F, \tau_F) = \frac{\delta^{\tau_F}}{1-\delta} v_N - p_F - \epsilon$ if C_N buys the good from R_F,
- $u_F(p_N, \tau_N) = \frac{\delta^{\tau_N}}{1-\delta} - p_N - \epsilon$ if C_F buys the good from R_N,
- $u_F(p_F, \tau_F) = \frac{\delta^{\tau_F}}{1-\delta} - p_F$ if he buys the good from R_F.

When choosing its supplier, each consumer simply compares the net benefits in both cases. We assume that when a consumer is indifferent between both retailers, he chooses to buy the good in his own country. Moreover when he is indifferent between buying or not, each consumer chooses to buy. These natural assumptions guarantee the upper semi-continuity of the industry profit. In this setting, each consumer buys either from R_F or from R_N, depending on the prices (p_N, p_F) and the delays (τ_N, τ_F). Let $d_x(p_N, p_F, \tau_N, \tau_F)$ be the individual demand for $x = N, F$, we obtain

$$d_x(p_N, p_F, \tau_N, \tau_F) = \begin{cases} 1 \quad \text{to} \quad R_x & \text{if} \quad u_x(p_x, \tau_x) \geq u_x(p_y, \tau_y), \quad u_x(p_x, \tau_x) \geq 0 \\ 1 \quad \text{to} \quad R_y & \text{if} \quad u_x(p_x, \tau_x) < u_x(p_y, \tau_y), \quad u_x(p_y, \tau_y) \geq 0 \\ 0 & \text{if} \quad \max\{u_x(p_x, \tau_x), u_x(p_y, \tau_y)\} < 0 \end{cases} \tag{3}$$

We assume that the two retailers R_N and R_F and the producer P_N have the same discount factor equal to 1. Retailers's payoffs are therefore

$$\Pi_N(\sigma_N, \sigma_F) = \int_{Supp(\sigma_N)} \int_{Supp(\sigma_F)} (p_N - w) \times D^N(p_N, p_F, \tau_N, \tau_F) d\sigma_N \, d\sigma_F - T_N \tag{4}$$

$$\Pi_F(\sigma_N, \sigma_F) = \int_{Supp(\sigma_N)} \int_{Supp(\sigma_F)} (p_F - w) \times D^F(p_N, p_F, \tau_N, \tau_F) d\sigma_N \, d\sigma_F - T_F \tag{5}$$

[3]This assumption is not restrictive: we could instead assume that the good is paid at delivery. When deciding to buy or not, consumers would still compare two intertemporal net satisfactions, the one drawn from delayed consumption being lower than the one drawn from an immediate delivery.

where $D^y(p_N, p_F, \tau_N, \tau_F)$ is the aggregated demand addressed to the retailer R^y, for $y = N, F$. Producer P_N's payoff is

$$\Pi_P(w, \tau_N, \tau_F, T_N, T_F) = w \times (D^N(\tau_N, \tau_F) + D^F(\tau_N, \tau_F)) + T_N + T_F \tag{6}$$

where $D^y(\tau_N, \tau_F)$ denotes the quantity asked to retailer R_y at the equilibrium of the price competition sub-game for a given pair of delivery dates (τ_N, τ_F), and for $y = N, F$.

3 Existence of an equilibrium in the retail competition sub-game

First let us characterize the total demands received by retailers as a function of delays and prices. Consumer C_N buys from retailer R_N if his net benefit is higher than the benefit obtained from buying to R_F. Moreover he buys from any retailer if the benefit he earns is positive or equal to 0. These incentive compatibility and individual rationality constraints can be re-written as

$$\begin{cases} u_N(p_N, \tau_N) \geq u_N(p_F, \tau_F) & \Leftrightarrow \quad p_N \leq p_F + \epsilon + \frac{\delta^{\tau_N} - \delta^{\tau_F}}{1-\delta} v_N \\ u_N(p_N, \tau_N) \geq 0 & \Leftrightarrow \quad p_N \leq \frac{\delta^{\tau_N}}{1-\delta} v_N \\ u_N(p_F, \tau_F) \geq 0 & \Leftrightarrow \quad p_F + \epsilon \leq \frac{\delta^{\tau_F}}{1-\delta} v_N \end{cases} \tag{7}$$

Similarly consumer C_F buys from retailer R_F if the net benefit he obtains from consuming is positive and higher than the benefit of buying to retailer R_N,

$$\begin{cases} u_F(p_F, \tau_F) \geq u_F(p_N, \tau_N) & \Leftrightarrow \quad p_N \geq p_F - \epsilon + \frac{\delta^{\tau_N} - \delta^{\tau_F}}{1-\delta} \\ u_F(p_N, \tau_N) \geq 0 & \Leftrightarrow \quad p_N + \epsilon \leq \frac{\delta^{\tau_N}}{1-\delta} \\ u_F(p_F, \tau_F)) \geq 0 & \Leftrightarrow \quad p_F \leq \frac{\delta^{\tau_F}}{1-\delta} \end{cases} \tag{8}$$

When aggregating the individual demands to establish the demand addressed to each retailer, there are three different cases depending on the delays on each market. Moreover those three cases will lead to discontinuous demands and therefore to discontinuous retailers' payoffs. Before describing fully the demand system and its consequences on the existence of an equilibrium to the retail competition sub-game, let us come back briefly on the reason for which this discontinuity exists.

We have assumed that there were only two price-taking consumers differing by their willingness to pay v_N and $v_F = 1$, suffering a switching cost ϵ to buy "abroad". If ϵ were equal to 0, then we would be in the standard Bertrand case: the maximal demand of two units would be driven to the retailer charging the lowest price, shared in case of retail prices being equal. When ϵ is strictly positive, it exists a region for the retail prices in which the two retailers sell exactly one unit, but prices do not need to be equal anymore. This enlarges the region in which both retailers sell one unit compared to the case in which there is no switching cost. One way to suppress this "diagonal" discontinuity in the payoffs would be to introduce many consumers differentiated with respect to their switching costs ϵ. This solution increases the number of regions in the demand system to consider, solving the existence problem by continuifying the payoffs, but has the drawback to lead to never ending discussions on the parameters of the model. We opted for the discontinuous version of the payoffs, since the result we want to establish can be found in a more elegant way in a discontinuous but computationally tractable setting[4]. We can now describe the three cases for the demand system.

Case 1 If the delays are such that $\delta^{\tau_F}\frac{v_N}{1-\delta} - \epsilon \geq \delta^{\tau_F}\frac{1}{1-\delta}$ and $(\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta} + \epsilon > (\delta^{\tau_N} - \delta^{\tau_F})\frac{1}{1-\delta} - \epsilon$ then the pair of aggregated demands $(D^N(p_N, p_F, \tau_N, \tau_F), D^F(p_N, p_F, \tau_N, \tau_F))$ addressed to retailers is

$(0,0)$ if $p_N > \delta^{\tau_N}\frac{v_N}{1-\delta}$ and $p_F > \delta^{\tau_F}\frac{v_N}{1-\delta} - \epsilon$
$(1,0)$ if $\delta^{\tau_N}\frac{v_N}{1-\delta} \geq p_N \geq \delta^{\tau_N}\frac{v_N}{1-\delta} - \epsilon, p_F > \delta^{\tau_F}\frac{1}{1-\delta}$, and $p_N \leq p_F + \epsilon + (\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta}$
$(0,1)$ if $\delta^{\tau_F}\frac{v_N}{1-\delta} - \epsilon \geq p_F \geq \delta^{\tau_F}\frac{1}{1-\delta}$, and $p_N \geq p_F + \epsilon + (\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta}$
$(1,1)$ if $p_N \leq p_F + \epsilon + (\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta}, p_N \geq p_F - \epsilon + (\delta^{\tau_N} - \delta^{\tau_F})\frac{1}{1-\delta}$, and $p_F \leq \delta^{\tau_F}\frac{1}{1-\delta}$
$(2,0)$ if $p_N < p_F - \epsilon + (\delta^{\tau_N} - \delta^{\tau_F})\frac{1}{1-\delta}$ and $p_N \leq \delta^{\tau_N}\frac{v_N}{1-\delta} - \epsilon$
$(0,2)$ if $p_N > p_F + \epsilon + (\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta}$ and $p_F \leq \delta^{\tau_F}\frac{1}{1-\delta}$

This case is depicted in figure 1 from appendix B.

Case 2 If the delays are such that $\delta^{\tau_F}\frac{v_N}{1-\delta} - \epsilon < \delta^{\tau_F}\frac{1}{1-\delta}$ and $(\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta} + \epsilon > (\delta^{\tau_N} - \delta^{\tau_F})\frac{1}{1-\delta} - \epsilon$ then the pair of aggregated demands $(D^N(p_N, p_F, \tau_N, \tau_F), D^F(p_N, p_F, \tau_N, \tau_F))$ addressed

[4] The "vertical" discontinuities resulting from prices exceeding willingness to pay can be smoothed by introducing many consumers differentiated with respect to their willingness to pay.

to retailers is

$$
\begin{array}{ll}
(0,0) & \text{if } p_N > \delta^{\tau_N}\frac{v_N}{1-\delta} \text{ and } p_F > \delta^{\tau_F}\frac{v_N}{1-\delta} \\
(1,0) & \text{if } \delta^{\tau_N}\frac{v_N}{1-\delta} \geq p_N \geq \delta^{\tau_N}\frac{1}{1-\delta} - \epsilon, \text{ and } p_F > \delta^{\tau_F}\frac{1}{1-\delta} \\
(0,1) & \text{if } \delta^{\tau_F}\frac{v_N}{1-\delta} - \epsilon \leq p_F \geq \delta^{\tau_F}\frac{1}{1-\delta}, \text{ and } p_N \geq \delta^{\tau_N}\frac{v_N}{1-\delta} \\
(1,1) & \text{if } p_N \leq p_F + \epsilon + (\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta}, p_N \geq p_F - \epsilon + (\delta^{\tau_N} - \delta^{\tau_F})\frac{1}{1-\delta}, \\
 & p_F \leq \delta^{\tau_F}\frac{1}{1-\delta}, \text{ and } p_N \leq \delta^{\tau_N}\frac{v_N}{1-\delta} \\
(2,0) & \text{if } p_N < p_F - \epsilon + (\delta^{\tau_N} - \delta^{\tau_F})\frac{1}{1-\delta} \text{ and } p_N \leq \delta^{\tau_N}\frac{1}{1-\delta} - \epsilon \\
(0,2) & \text{if if } p_N > p_F + \epsilon + (\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta} \text{ and } p_F \leq \delta^{\tau_F}\frac{v_N}{1-\delta} - \epsilon
\end{array}
$$

This case is depicted in figure 2 from appendix B.

Case 3 If the delays are such that $\delta^{\tau_F}\frac{v_N}{1-\delta} - \epsilon \geq \delta^{\tau_F}\frac{1}{1-\delta}$ and $(\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta} + \epsilon \leq (\delta^{\tau_N} - \delta^{\tau_F})\frac{1}{1-\delta} - \epsilon$ then the pair of aggregated demands $(D^N(p_N, p_F, \tau_N, \tau_F), D^F(p_N, p_F, \tau_N, \tau_F))$ addressed to retailers is

$$
\begin{array}{ll}
(0,0) & \text{if } p_N > \delta^{\tau_N}\frac{v_N}{1-\delta} \text{ and } p_F > \delta^{\tau_F}\frac{v_N}{1-\delta} - \epsilon \\
(1,0) & \text{if } p_N \leq \delta^{\tau_N}\frac{v_N}{1-\delta}, p_N \geq \delta^{\tau_N}\frac{1}{1-\delta} - \epsilon \text{ and } p_N \leq p_F + \epsilon + (\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta} \\
(0,1) & \text{if } p_N > \delta^{\tau_N}\frac{1}{1-\delta} - \epsilon, p_F \leq \delta^{\tau_F}\frac{v_N}{1-\delta} - \epsilon, p_F \geq \delta^{\tau_F}\frac{1}{1-\delta} \\
 & \text{and } p_N > p_F + \epsilon + (\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta} \\
(1,1) & \text{if } p_N \leq \delta^{\tau_N}\frac{1}{1-\delta} - \epsilon, p_N \geq p_F + \epsilon + (\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta}, \\
 & \text{and } p_N \leq p_F - \epsilon + (\delta^{\tau_N} - \delta^{\tau_F})\frac{1}{1-\delta} \\
(2,0) & \text{if } p_N > \delta^{\tau_N}\frac{1}{1-\delta} - \epsilon \text{ and } p_N < p_F + \epsilon + (\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta} \\
(0,2) & \text{if } p_F \leq \delta^{\tau_F}\frac{1}{1-\delta} \text{ and } p_N > p_F - \epsilon + (\delta^{\tau_N} - \delta^{\tau_F})\frac{1}{1-\delta}
\end{array}
$$

This case is depicted in figure 3 from appendix B.

Let us define $\Gamma(\mathcal{FC}_N, \mathcal{FC}_F)$ the retail price competition sub-game for a given pair of franchise contracts. Retailers' payoffs are not continuous with respect to prices (p_N, p_F). Neither are they quasi-concave. Solving this type of games is generally a difficult exercise, since one has to determine Nash equilibria in mixed strategy. However we do not need to know the equilibrium for each franchise contract: in equilibrium the contracts offered by the producer induce a Nash equilibrium in pure strategy in the retail price competition sub-game. Obtaining an upper bound on the expected profits of the retailers is then sufficient to solve the full game, by eliminating the sub-game with Nash equilibrium in mixed strategies by a dominance argument. This is what is done in lemmas 1, 2, 3, 4 below. Let us show before that our game possesses a Nash equilibrium.

Let us define a Nash equilibrium in mixed strategy in $\Gamma(\mathcal{FC}_N, \mathcal{FC}_F)$ as a pair (σ_N^*, σ_F^*) such that

$$\begin{cases} \Pi_N(\sigma_N^*, \sigma_F^*) \geq \int_{Supp(\sigma_F^*)} \Pi_N(p_N, p_F) d\sigma_F^* - T_N \quad \text{for any } p_N \in \mathbb{R}^+ \\ \\ \Pi_F(\sigma_N^*, \sigma_F^*) \geq \int_{Supp(\sigma_N^*)} \Pi_F(p_N, p_F) d\sigma_N^* - T_F \quad \text{for any } p_F \in \mathbb{R}^+ \end{cases} \tag{9}$$

We prove the existence of a Nash equilibrium in mixed strategy in every retail competition subgame $\Gamma(\mathcal{FC}_N, \mathcal{FC}_F)$ following the methodology developed by Reny (1999). We apply Reny's framework in two steps: first (proposition 1 below), we prove that the mixed extension of the game is better reply secure for any $(\mathcal{FC}_N, \mathcal{FC}_F)$. Then it directly follows (corollary 1 below) that the game possess a Nash equilibrium in mixed strategy.

Better reply security in the context of pure strategies corresponds to the following property (Reny (1999), p. 1032-1033): for every non equilibrium pair of prices $(\widehat{p}_N, \widehat{p}_F)$ and every pair of profits associated $(\widehat{\Pi}_N, \widehat{\Pi}_F)$, such that $\lim_{(p_N, p_F) \to (\widehat{p}_N, \widehat{p}_F)} \Pi_x(p_N, p_F) = \widehat{\Pi}_x$ for every $x = N, F$, some player can secure a payoff strictly above $\widehat{\Pi}_x$ at $(\widehat{p}_N, \widehat{p}_F)$. A player x can secure a payoff strictly above $\widehat{\Pi}_x$ at $(\widehat{p}_N, \widehat{p}_F)$ if it exists $\overline{p}_x$ such that $\Pi_x(\overline{p}_x, p_{-x}) > \widehat{\Pi}_x$ for p_{-x} in an open neighbourhood of $\widehat{p}_{-x}$. This property is obviously satisfied by the standard Cournot game: for every pair of quantities different from the Cournot-Nash equilibrium, at least one player is not on his best response function. This player can obtain a payoff strictly better by playing a best response to the opponent's choice, even when the opponent modifies slightly its action. The same analysis can be done in the standard Bertrand game with identical and constant marginal costs: for every pair of prices different from the marginal costs, at least one player can increase its profit by playing a price on its best response. Moreover the profit functions in the classic Bertrand game are quasi-concave. Therefore Reny (1999) theorem 3.1, can be applied to guarantee the existence of a Nash equilibrium in pure strategy[5].

Even if the game $\Gamma(\mathcal{FC}_N, \mathcal{FC}_F)$ is extremely close to the standard Bertrand game, the profit functions are not quasi-concave. Therefore Reny's existence result for Nash equilibria in pure strategy cannot be used. The reader may check in figure 1 that at the wholesale price w there is no pure strategy Nash equilibrium. For example $(p_F, p_N) = (w, w + \epsilon + (\delta^{\tau_N} - \delta^{\tau_F}) \frac{v_N}{1-\delta})$ cannot be a Nash equilibrium: R_F is better off increasing its price. For any pair of prices higher,

[5] Obviously Reny's machinery is not needed since the pure strategy Nash equilibrium of this game can be computed.

R_F is better undercutting R_N. Those two forces are going in opposite directions, leading to the non existence of a pure strategy Nash equilibrium. We use instead Reny's corollary 5.2, that guarantees the existence of a Nash equilibrium in mixed strategy. To do it, we need to verify that the mixed extension of the game is better reply secure. We follow Reny (1999) methodology by proving that the industry profit is upper semi-continuous and that the mixed extension of the game is payoff secure. Those two properties imply that the game is better reply secure. Let us establish the formal result.

Proposition 1 *The mixed extension of the retail competition sub-game $\Gamma(\mathcal{FC}_N, \mathcal{FC}_F)$ is better reply secure for any pair of delays (τ_N, τ_F), for any wholesale price w, and for any fixed fees (T_N, T_F).*

Proof: See appendix A.‖

Corollary 1 *The retail competition sub-game $\Gamma(\mathcal{FC}_N, \mathcal{FC}_F)$ has a mixed strategy Nash equilibrium for any pair of delays (τ_N, τ_F), for every wholesale price w and for any fixed fees (T_N, T_F).*

Proof : See appendix A.‖

We may now turn to the characterization of some special cases that will help us to show that the delays in the delivery may be used by a producer to separate two markets and increase his profits.

4 The benchmark case : no delays in delivery

To show that introducing delays of delivery may be a matter of strategy for producer P_N, let us first consider the situation where there are no delays at all. In that case, if the difference between the consumers gross benefits is sufficiently large compared to the switching cost ϵ, both retailers are in direct competition. Under the assumption (2), the aggregated demands $D^N(p_N, p_F)$ and $D^F(p_N, p_F)$ addressed to each retailer are a particular case of figure 1 for $\tau_N = \tau_F = 0$. Depending on the wholesale price chosen by the upstream monopolist, the retailers payoffs are given in the following lemma.

Lemma 1 *If the difference between the consumers gross benefits is large enough, i.e. if (2) holds, the retailers payoffs for any wholesale price are given (or bounded) by*

- $(\Pi_N(p_N^*, p_F^*), \Pi_F^*(p_N^*, p_F^*)) = (0,0)$ *if* $w > \frac{v_N}{1-\delta}$

- $(\Pi_N(p_N^*, p_F^*), \Pi_F^*(p_N^*, p_F^*)) = (\frac{v_N}{1-\delta} - w, 0)$ *if* $w \in [\frac{v_N}{1-\delta} - \epsilon; \frac{v_N}{1-\delta}]$

- $(\Pi_N(p_N^*, p_F^*), \Pi_F^*(p_N^*, p_F^*)) = (\epsilon, 0)$ *if* $w \in [\frac{1}{1-\delta}; \frac{v_N}{1-\delta} - \epsilon]$

- $(\Pi_N(\sigma_N^*, \sigma_F^*), \Pi_F(\sigma_N^*, \sigma_F^*)) < (\frac{1}{1-\delta} + \epsilon - w, \frac{1}{1-\delta} - w)$ *if* $w \in [0; \frac{1}{1-\delta}]$

Proof : See appendix A.$\|$

From this last result, it is immediate that the upstream producer finds profitable to offer a contract with a wholesale price w between $\frac{v_N}{1-\delta} - \epsilon$ and $\frac{v_N}{1-\delta}$, and a fixed fee $T = \frac{v_N}{1-\delta} - w$. This contract is accepted by retailer R_N only, since it is indifferent between retailing the good or not while retailer R_F is better off refusing the contract to avoid losses. Another profitable contract is w between $\frac{1}{1-\delta}$ and $\frac{v_N}{1-\delta} - \epsilon$, in that case $T = 0$. Any other contracts with lower wholesale prices lead to strictly lower profits for the upstream monopolist: he does not offer them. Amongst the profitable contracts, one is of a particular interest: $w = \frac{1}{1-\delta}$ and $T = 0$. In that case the retailers are selling 2 units (1 each), retailer R_N realizes a profit $\epsilon > 0$ that cannot be recovered through the fee by the upstream producer, consumer C_N gets a positive utility $\frac{v_N}{1-\delta} - \frac{1}{1-\delta} - \epsilon > 0$. Retailer R_F earns nothing, and consumer C_F has a 0 satisfaction. The producer's trade-off is therefore the following: when offering the first contract, $(w, \frac{v_N}{1-\delta} - w)$, the producer's profit is equal to $\frac{v_N}{1-\delta}$. This profit has to be compared to the profit obtained with the contract $(\frac{1}{1-\delta}, 0)$, which is equal to $\frac{2}{1-\delta}$ since the producer is supplying two units. The comparison is obvious. Therefore we have proved

Proposition 2 *In absence of delays in the delivery, producer P_N is unable to price discriminate the demand.*

- *If $v_N > 2$, P_N may offer any contract $(w^*, T^*) = (w, \frac{v_N}{1-\delta} - w)$ for $w \in]\frac{v_N}{1-\delta} - \epsilon, \frac{v_N}{1-\delta}]$. Only R_N accepts to retail the good and only C_N obtains it, at a price $p_N^* = \frac{v_N}{1-\delta}$. The social welfare is constituted by the producer's profit only, $SW = \frac{v_N}{1-\delta}$.*

- *If $v_N \in [1; 2]$, P_N offers the contract $(w^*, T^*) = (\frac{1}{1-\delta}, 0)$. Both retailers accept it, and both consumers obtain the good from their local retailer at prices $p_N^* = \frac{1}{1-\delta} + \epsilon$ and $p_F^* = \frac{1}{1-\delta}$. Producer P_N's profit is equal to $\frac{2}{1-\delta}$, retailer R_F's profit is equal to 0, retailer R_N's profit is equal to ϵ and consumer's surplus is equal to $\frac{v_N}{1-\delta} - \frac{1}{1-\delta} - \epsilon$. The social welfare is $SW = \frac{v_N}{1-\delta} + \frac{1}{1-\delta}$.*

Note that as a direct consequence of the demand system, there is no distortion on the Social Welfare when the willingness to pay on the producer's national market is low enough, $v_N < 2$. However the producer cannot extract all the surplus, and has to leave some profit to its national retailer. This last result comes from the fact that the producer cannot oblige the retailer R_N to accept a contract in which he is paying the same wholesale than R_F while having to pay a higher fixed fee. R_F would simply accept the contract, buy 2 units of the good and sell 1 to R_N directly. Introducing delays in the delivery of the durable good allows to extract a larger part of the consumers surplus, and is profitable for the producer even if the social welfare turns out to be lower.

5 Separating the markets by delaying the deliveries

Let us start by establishing the profits earned by retailers depending on the delay of delivery of the durable good.

Lemma 2 *If the delays (τ_N, τ_F) are such that $\delta^{\tau_F}\frac{v_N-1}{1-\delta} \geq \epsilon$ and $(\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N-1}{1-\delta} > -2\epsilon$, and moreover if $\delta^{\tau_N}\frac{1}{1-\delta} - \frac{1}{2}(\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta} - \frac{3}{2}\epsilon \in [\delta^{\tau_F}\frac{1}{1-\delta}, \delta^{\tau_N}\frac{1}{1-\delta} - \epsilon]$, the expected profits obtained by retailers in equilibrium are given (or bounded) by*

- $(\Pi_N(p_N^*, p_F^*), \Pi_F^*(p_N^*, p_F^*)) = (0, 0)$ *if* $w > \delta^{\tau_N}\frac{v_N}{1-\delta}$
- $(\Pi_N(p_N^*, p_F^*), \Pi_F^*(p_N^*, p_F^*)) = (\delta^{\tau_N}\frac{v_N}{1-\delta} - w, 0)$ *if* $w \in [\delta^{\tau_F}\frac{v_N}{1-\delta} - \epsilon; \delta^{\tau_N}\frac{v_N}{1-\delta}]$
- $(\Pi_N(p_N^*, p_F^*), \Pi_F^*(p_N^*, p_F^*)) = (\epsilon + (\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta}, 0)$ *if* $w \in [\delta^{\tau_N}\frac{1}{1-\delta} - \epsilon; \delta^{\tau_F}\frac{v_N}{1-\delta} - \epsilon]$
- $(\Pi_N(p_N^*, p_F^*), \Pi_F^*(p_N^*, p_F^*)) = (\epsilon + (\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta}, 0)$ *if* $w \in [\delta^{\tau_N}\frac{1}{1-\delta} - \frac{1}{2}(\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta} - \frac{3}{2}\epsilon, \delta^{\tau_N}\frac{1}{1-\delta} - \epsilon]$
- $(\Pi_N(p_N^*, p_F^*), \Pi_F^*(p_N^*, p_F^*)) = (2\ (\delta^{\tau_N}\frac{1}{1-\delta} - \epsilon - w), 0)$ *if* $w \in [\delta^{\tau_F}\frac{1}{1-\delta}, \delta^{\tau_N}\frac{1}{1-\delta} - \frac{1}{2}(\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta} - \frac{3}{2}\epsilon]$
- $(\Pi_N(\sigma_N^*, \sigma_F^*), \Pi_F(\sigma_N^*, \sigma_F^*)) < (\delta^{\tau_N}\frac{v_N}{1-\delta} - w, \delta^{\tau_F}\frac{v_N}{1-\delta} - \epsilon - w)$ *if* $w \in [0; \delta^{\tau_F}\frac{1}{1-\delta}]$

Else if $\delta^{\tau_N}\frac{1}{1-\delta} - \frac{1}{2}(\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta} - \frac{3}{2}\epsilon > \delta^{\tau_N}\frac{1}{1-\delta} - \epsilon$, R_N serves C_N and C_F when $w \in [\delta^{\tau_F}\frac{1}{1-\delta}, \delta^{\tau_N}\frac{1}{1-\delta} - \epsilon]$, and if $\delta^{\tau_N}\frac{1}{1-\delta} - \frac{1}{2}(\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta} - \frac{3}{2}\epsilon < \delta^{\tau_F}\frac{1}{1-\delta}$ then R_N serves only C_N when $w \in [\delta^{\tau_F}\frac{1}{1-\delta}, \delta^{\tau_N}\frac{1}{1-\delta} - \epsilon]$.

Proof: See appendix A.$\|$

In another configuration of the parameters,

Lemma 3 *If the delays* (τ_N, τ_F) *are such that* $\delta^{\tau_F}\frac{v_N-1}{1-\delta} < \epsilon$ *and* $(\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N-1}{1-\delta} > -2\epsilon$ *the expected profits obtained by retailers in equilibrium are given (or bounded) by*

- $(\Pi_N(p_N^*, p_F^*), \Pi_F^*(p_N^*, p_F^*)) = (0,0)$ *if* $w > \delta^{\tau_N}\frac{v_N}{1-\delta}$

- $(\Pi_N(p_N^*, p_F^*), \Pi_F^*(p_N^*, p_F^*)) = (\delta^{\tau_N}\frac{v_N}{1-\delta} - w, 0)$ *if* $w \in [\delta^{\tau_F}\frac{1}{1-\delta}; \delta^{\tau_N}\frac{v_N}{1-\delta}]$

- $(\Pi_N(p_N^*, p_F^*), \Pi_F^*(p_N^*, p_F^*)) = (\delta^{\tau_N}\frac{v_N}{1-\delta} - w, \delta^{\tau_F}\frac{1}{1-\delta} - w)$ *if* $w \in [\delta^{\tau_F}\frac{v_N}{1-\delta} - \epsilon; \delta^{\tau_F}\frac{1}{1-\delta}]$

- $(\Pi_N(\sigma_N^*, \sigma_F^*), \Pi_F(\sigma_N^*, \sigma_F^*)) < (\delta^{\tau_N}\frac{v_N}{1-\delta} - w, \delta^{\tau_F}\frac{1}{1-\delta} - w)$ *if* $w \in [0; \delta^{\tau_F}\frac{v_N}{1-\delta} - \epsilon]$

Proof: See appendix A.$\|$

Note that there is a region in which the two retailers are selling the good to their local consumer, at the highest prices possible.

Lemma 4 *If the delays* (τ_N, τ_F) *are such that* $\delta^{\tau_F}\frac{v_N-1}{1-\delta} \geq \epsilon$ *and* $(\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N-1}{1-\delta} \leq -2\epsilon$ *the expected profits obtained by retailers in equilibrium are given (or bounded) by*

- $(\Pi_N(p_N^*, p_F^*), \Pi_F^*(p_N^*, p_F^*)) = (0,0)$ *if* $w > \delta^{\tau_N}\frac{v_N}{1-\delta}$

- $(\Pi_N(p_N^*, p_F^*), \Pi_F^*(p_N^*, p_F^*)) = (\delta^{\tau_N}\frac{v_N}{1-\delta} - w, 0)$ *if* $w \in [\delta^{\tau_N}\frac{1}{1-\delta} - \epsilon; \delta^{\tau_N}\frac{v_N}{1-\delta}]$

- $(\Pi_N(p_N^*, p_F^*), \Pi_F^*(p_N^*, p_F^*)) = (\delta^{\tau_N}\frac{v_N}{1-\delta} - w, 0)$ *if* $w \in [2\delta^{\tau_N}\frac{1}{1-\delta} - \delta^{\tau_N}\frac{v_N}{1-\delta} - 2\epsilon; \delta^{\tau_N}\frac{1}{1-\delta} - \epsilon]$

- $(\Pi_N(p_N^*, p_F^*), \Pi_F^*(p_N^*, p_F^*)) = (2(\delta^{\tau_N}\frac{1}{1-\delta} - \epsilon - w), 0)$ *if* $w \in [\delta^{\tau_F}\frac{v_N}{1-\delta} - \epsilon, 2\delta^{\tau_N}\frac{1}{1-\delta} - \delta^{\tau_N}\frac{v_N}{1-\delta} - 2\epsilon]$

- $(\Pi_N(p_N^*, p_F^*), \Pi_F^*(p_N^*, p_F^*)) = (\epsilon + (\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta}, 0)$ *if* $w \in [\delta^{\tau_N}\frac{1}{1-\delta} - \frac{3}{2}\epsilon - \frac{1}{2}(\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta}, \delta^{\tau_F}\frac{v_N}{1-\delta} - \epsilon]$

- $(\Pi_N(p_N^*, p_F^*), \Pi_F^*(p_N^*, p_F^*)) = (2(\delta^{\tau_N}\frac{1}{1-\delta} - \epsilon - w), 0)$ *if* $w \in [\delta^{\tau_N}\frac{1}{1-\delta} - 2\epsilon - (\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta}, \delta^{\tau_N}\frac{1}{1-\delta} - \frac{3}{2}\epsilon - \frac{1}{2}(\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta}]$

- $(\Pi_N(\sigma_N^*, \sigma_F^*), \Pi_F(\sigma_N^*, \sigma_F^*)) < (\delta^{\tau_N}\frac{v_N}{1-\delta} - w, \delta^{\tau_F}\frac{v_N}{1-\delta} - \epsilon - w)$ *if* $w \in [0; \delta^{\tau_N}\frac{1}{1-\delta} - 2\epsilon - (\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta}]$

if $\delta^{\tau_N}\frac{1}{1-\delta} - \frac{3}{2}\epsilon - \frac{1}{2}(\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta} \in [\delta^{\tau_N}\frac{1}{1-\delta} - 2\epsilon - (\delta^{\tau_N} - \delta^{\tau_F})\frac{v_N}{1-\delta}, \delta^{\tau_F}\frac{v_N}{1-\delta} - \epsilon]$ *and* $2\delta^{\tau_N}\frac{1}{1-\delta} - \delta^{\tau_N}\frac{v_N}{1-\delta} - 2\epsilon \in [\delta^{\tau_F}\frac{v_N}{1-\delta} - \epsilon, \delta^{\tau_N}\frac{1}{1-\delta} - \epsilon]$. *Else some expressions disappear from the profit function in an obvious manner.*

Proof: See appendix A.$\|$

Before analyzing the choice of delay made by the upstream monopolist, let us characterize the main difference between a delay in the delivery and a genuine quality parameter by showing that the two retailers never differentiate with respect to delays. Whenever he increases the delay at which he is able to deliver the good, a retailer decreases the profit he is able to realize when serving his local consumer, and lowers the attractiveness of his product compared to his opponent. He is not able to attract the consumer from the other region any more. This strategy is obviously dominated for any wholesale price w. Therefore $\tau_N^* = \tau_F^* = 0$. Consider first the case $\frac{v_N-1}{1-\delta} > 2\epsilon$. In that case only lemmas 2 and 3 are relevant for the analysis. More precisely only the condition $\delta^{\tau_F}\frac{v_N-1}{1-\delta} \geq \epsilon$ matters for the profit. First note that choosing a delay low enough is always dominant: for a given wholesale price, τ_N is always such that $\delta^{\tau_N}\frac{v_N}{1-\delta} > w$, and τ_F is always such that $\delta^{\tau_F}\frac{1}{1-\delta} > w$. The profit of retailer R_N is in expectation lower than $\delta^{\tau_N}\frac{v_N}{1-\delta} - w$, which is maximal when $\tau_N^* = 0$ no matter the delay chosen by retailer R_F. On the other hand the profit of retailer R_F increases when τ_F goes to 0, to be equal to $\delta^{\tau_F}\frac{v_N}{1-\delta} - \epsilon - w$ for τ_F low enough, such that $\delta^{\tau_F}\frac{v_N-1}{1-\delta} \geq \epsilon$. The dominant strategy is again for R_F to choose $\tau_F^* = 0$. In the case where $\frac{v_N-1}{1-\delta} \leq 2\epsilon$, the dominant strategy is again for retailer R_N to choose $\tau_N^* = 0$: retailer R_F also chooses $\tau_F^* = 0$ in that case. We then have proved

Proposition 3 *If retailers R_N and R_F were able to commit to delays of delivery, respectively τ_N and τ_F, they would never choose to differentiate. The equilibrium in which delays are chosen non cooperatively by retailers R_N and R_F is*

$$\tau_N^* = \tau_F^* = 0$$

for any wholesale price w and franchise fees T_N and T_F.

If there were a cost of delivering the good earlier (i.e. if the cost of "producing a good of high quality" were higher than the cost of "producing a good of low quality"), then there would still be an externality exerted by one retailer on the other that the producer would find profitable to internalize. The upstream monopolist would be better off choosing the delays.

Consider now a situation in which the delay τ_N is set to 0 on market N, and is positive on market F, $\tau_F > 0$. In that case only lemmas 2 and 3 are relevant for the payoffs of the upstream producer P_N. Indeed substituting $\tau_N = 0$ in the conditions governing the demand systems, we obtain for lemma 2 the conditions $\delta^{\tau_F} \frac{\upsilon_N - 1}{1-\delta} \geq \epsilon$ and $(1 - \delta^{\tau_F}) \frac{\upsilon_N - 1}{1-\delta} > -2\epsilon$, and for lemma 3 the conditions $\delta^{\tau_F} \frac{\upsilon_N - 1}{1-\delta} < \epsilon$ and $(1 - \delta^{\tau_F}) \frac{\upsilon_N - 1}{1-\delta} > -2\epsilon$. Obviously $(1 - \delta^{\tau_F}) \frac{\upsilon_N - 1}{1-\delta} > 0$ and therefore lemma 4 is not possible. The following proposition shows the contracts offered by P_N in equilibrium.

Proposition 4 *Producer P_N is able to discriminate the demand by optimizing τ_F and offering two franchise contracts on which retailers self-select. He chooses*

$$\tau_F^* = Ent\{\ln(\frac{\epsilon(1-\delta)}{\upsilon_N - 1})/\ln\delta\} + 1 \quad \textit{and} \quad w^* \in [\frac{\delta^{\tau_F^*}}{1-\delta}\upsilon_N - \epsilon; \frac{\delta^{\tau_F^*}}{1-\delta}]$$

where $Ent\{z\}$ denotes the entire part of $z \in \mathbb{R}$. The two franchise contracts offered are

$$\mathcal{C}_N = (w^*, \frac{\upsilon_N}{1-\delta} - w^*, 0) \quad \textit{and} \quad \mathcal{C}_F = (w^*, \delta^{\tau_F^*}\frac{1}{1-\delta} - w^*, \tau_F^*)$$

The franchise fee T_N^* is higher for contract $\mathcal{C}_N$ than the franchise fee T_F^* for contract $\mathcal{C}_F$: retailer R_N chooses $\mathcal{C}_N$ and retailer R_F chooses $\mathcal{C}_F$.

Proof : Start in the situation where the difference between the gross benefits from consuming is large enough, i.e. $\frac{\upsilon_N - 1}{1-\delta} > \epsilon$. In that case the demands are given as in figure 2. We know that the price competition sub-game ends in a situation where the producer either looses a market or looses a large amount of profit. What happens if $\tau_N = 0$ and τ_F increases ? The demands are for a while given as in figure 3, but when τ_F is high enough, the demands are given as in figure 4. Indeed the benefit earned by C_N when he buys the good to R_F decreases at a higher rate than the benefit earned by C_F when he buys to R_F. The condition to be in "figure 4 configuration" when $\tau_N = 0$ is

$$\frac{\delta^{\tau_F}}{1-\delta}\upsilon_N - \epsilon < \frac{\delta^{\tau_F}}{1-\delta} \quad \text{and} \quad \frac{1-\delta^{\tau_F}}{1-\delta}\upsilon_N + \epsilon > \frac{1-\delta^{\tau_F}}{1-\delta} - \epsilon$$

The second condition is always true. The first condition resumes to

$$\delta^{\tau_F}\frac{\upsilon_N - 1}{1-\delta} < \epsilon \quad \Leftrightarrow \quad \delta^{\tau_F} < \frac{\epsilon(1-\delta)}{\upsilon_N - 1}$$

which gives

$$\tau_F > \ln(\frac{\epsilon(1-\delta)}{\upsilon_N - 1})/\ln\delta > 0$$

Choosing a wholesale price $w \in [\frac{\delta^{\tau_F}}{1-\delta}v_N - \epsilon; \frac{\delta^{\tau_F}}{1-\delta}]$ induces a pure strategy equilibrium given by

$$(p_N^*, p_F^*) = (\frac{1}{1-\delta}v_N, \frac{\delta^{\tau_F}}{1-\delta})$$

and this equilibrium will be more profitable for P_N. Clearly the consumers are doing a 0 benefit in that case, and the producer will be able to obtain all the profit in the game through the fees.

Since the utility of C_F diminishes with τ_F, P_N chooses the first delay such that he may separate the markets, τ_F solution of

$$\frac{\delta^{\tau_F}}{1-\delta}v_N - \epsilon = \frac{\delta^{\tau_F}}{1-\delta}$$

and he charges $w = \delta^{\tau_F}\frac{1}{1-\delta}$. Each retailer accepts the contract that has been designed for him.||

Is it possible for P_N to do better than this equilibrium ? Again if he increases the delay of delivery on market N keeping delay τ_F at the value computed in proposition 4, it lowers the difference between the two market and makes it more and more profitable for consumer C_N to buy abroad. Therefore it reduces the efficiency of his strategy. Moreover C_N's benefit decreases. There is less to extract from the market, and producer P_N will prefer to delay the delivery on market F only. Figure 4 presents the intuition of the result. By delaying the delivery on market R_F, P_N manages to sell the good at the highest price to consumer C_F on this market, $\frac{\delta^{\tau_F}}{1-\delta}$, while making sure that at this price consumer C_N buys on his national market even if he is charged his entire valuation $\frac{v_N}{1-\delta}$.

Let us do some comparative statics on the delay τ_F^* imposed on the foreign market: obviously if buyers are infinitely patient, i.e. if their discount rates tend to 1 by smaller values, the delay applied on the foreign market τ_F^* increases up to infinity. Provided that δ is strictly lower than 1, then the delay is decreasing with the switching cost ϵ: the higher is the natural barrier to parallel trade, the lower the delay will be on the foreign market. Finally the largest is the difference between the willingness to pay, $v_N - 1$, the higher is the delay: restricting parallel trade requires a higher delay when the natural difference in (maximal) prices is high.

Another interesting remark concerns the difference between the retail prices. From the proof of proposition 4, and since prices are paid immediately, this difference is equal to

$$\Delta p^* = p_N^* - p_F^* = \frac{v_N - \delta^{\tau_F}}{1-\delta}$$

Using the expression of the delay in equilibrium (forgetting the fact that it has to be an integer), we can roughly bound this price difference from below. Since $\delta^{\tau_F} < \frac{\epsilon(1-\delta)}{v_N-1}$, it comes

$$\Delta p^* > \frac{v_N}{1-\delta} - \frac{\epsilon}{v_N - 1}$$

Let us consider the right-hand side of this last equation, and let us compare it to the switching cost ϵ.

$$\frac{v_N}{1-\delta} - \frac{\epsilon}{v_N - 1} > \epsilon \Leftrightarrow v_N(v_N - 1) - \epsilon(1-\delta) > \epsilon(1-\delta)(v_N - 1)$$

which after some obvious simplifications is equivalent to

$$\frac{v_N - 1}{1-\delta} > \epsilon$$

This assumption is exactly the one under which our model is constructed. Therefore the difference between the retail prices exceeds the switching cost, $\Delta p^* > \epsilon$. Delaying the delivery prevents consumers's arbitrage between the two markets, and allows retailers to exert fully their local monopoly power. Note that since $\delta^{\tau_F} < 1$, the price differential in equilibrium also exceeds the difference between the valuations, $\frac{v_N - 1}{1-\delta}$. The use of delays increases the price differential up to a level higher than the natural difference between valuations.

Finally and before characterizing the Social Welfare that results from the existence of delays, one has to make sure that this strategy does not give P_N a profit lower than the profit obtained by selling the good immediately to the two consumers, that is realizing a profit equal to $\frac{2}{1-\delta}$. The profit obtained in proposition 4 is equal to $\frac{v_N}{1-\delta} + \frac{\delta^{\tau_F^*}}{1-\delta}$: P_N chooses to offer different franchise contracts to his retailers if $\delta^{\tau_F^*} > 2 - v_N$. Since to be able to discriminate the delay on market F has to be such that $\delta^{\tau_F^*} < \frac{\epsilon(1-\delta)}{v_N - 1}$, it suffices to establish conditions such that $2 - v_N < \frac{\epsilon(1-\delta)}{v_N - 1}$ to have the solution of proposition 4 has an equilibrium of the game. It is equivalent to search for v_N such that $-v_N^2 + 3v_N - 2 - \epsilon(1-\delta) < 0$. We have $\Delta = 1 - 4\epsilon(1-\delta)$: if this value is negative, that is if $\epsilon(1-\delta) > \frac{1}{4}$ then any v_N is such that the delayed delivery is chosen. In that case we can establish the following corollary that compares Social Welfare. The other cases can be derived easily.

Corollary 2 *By price discriminating through the delays, producer P_N obtains the entire Social Welfare: its profit is equal to $\frac{v_N}{1-\delta} + \delta^{\tau_F^*}\frac{1}{1-\delta}$, retailers's profits are equal to 0 and consumers's surplus is equal to 0.*

- *When $v_N \in]1,2]$, the Social Welfare is lower with delays than without: the low willingness to pay consumer C_F gets a lower utility from buying the good later.*

- *When $v_N > 2$, the Social Welfare is higher with delays than without: the low willingness to pay consumer C_F obtains the good.*

Remark that if v_N is too close to 1, then there is no point in delaying the delivery of the good. The producer is better off serving all consumers immediately. However there is a non empty set of parameters such that even if $v_N < 2$ producer P_N finds profitable to serve C_N first. The delayed delivery used by the manufacturer hurts the foreign buyer while it extracts the whole surplus of the national buyer. Instead of leaving a rent to the national buyer, the producer reduces the benefit he earns on the foreign buyer to be able to increase the price on the national market and take back all the profit through the fixed fee.

6 Discussion

We have shown that a producer may use his retail network to discriminate consumers demand by imposing delays in the delivery of a durable good. The consumer with the highest willingness to pay obtains the good earlier than the other, and pays his entire valuation for it. The consumer with the lowest willingness to pay is delivered with a delay. This delay is decreasing with the cost of switching from one market to the other, and increasing with the difference between the willingness to pay: the lower the switching cost is, the more costly it is to reduce intrabrand competition by delaying the delivery of the good. Similarly the larger the difference between consumers' valuations, the higher is the incentive of high valuations consumers to switch from their market to the other: the delay has to increase on this market. For some parameter values, we show that the strategy of delaying the delivery lowers the Social Welfare. Our result is a noticeable exception to the Coase conjecture: because of consumers switching cost between the two markets, selling the good later at a lower price on one market - the one where consumers have the lowest willingness to pay - is possible. It can therefore be connected to Kühn [1998], who shows that differences in quality and production costs between a durable and a non-durable good may be used to discriminate the demand, and to Kühn and Padilla [1996], who show that the Coase conjecture does not hold when a durable good monopolist sells non durable goods that are demand-related to the durable.

Even if it is a vertical parameter, retailers do not differentiate according to the delay of delivery, contrary to the results established for a quality (Gabszewicz, Thisse (1979), (1980), Shaked and Sutton (1982)). The main reason is the following: when increasing the delay at which he is able to deliver the durable good, a retailer exerts a positive externality to its opponent without increasing its benefit from differentiating itself. Its opponent can indeed charge higher prices without fearing to loose consumers now unwilling to wait any longer to buy on the other market. Consumers buying from him are ready to pay a lower amount for the good, since they will enjoy the service of the durable good on a shorter period. Each retailer able to do it would choose no delay at all. However retailers turn out to be the producer's tool to discriminate consumers. The practice we point out here neither excludes nor is included in classic vertical differentiation, but can be seen as another tool to help a monopolist with a retail network to increase its profit.

In order to discriminate efficiently (i.e. without letting the revenues decrease too much because of time), the producer has to charge a wholesale price higher than his marginal cost. If we were to consider a model closer to the structure of the Car manufacturing and retailing industry, we should obviously consider many consumers with differences in tastes and in willingness to pay, but also introduce competition at the manufacturing and retailing levels.

If there were many consumers, for example with individual valuations distributed on a line with a linear or quadratic transportation cost, the producer would then have an incentive to let double-marginalization occur in the retail competition sub-game. Retailers would sell less, and the discrimination strategy through delays of delivery would have an additional cost, since less consumers would be able to buy the good. This effect can be counter-balanced by an increase in the delay. The trade-off between discrimination and market coverage would then appear without cancelling the profitability of the delay strategy. In the context of competition between producers, with new retailers on each market, increasing the delay may be dangerous since the retailer may loose consumers on the market where the delay is long. However this effect depends drastically on the differentiation between the two producers: if the goods they are producing are close substitutes (i.e. if the retailers are close on the Hotelling line), clearly increasing the delays will hurt a producer with a third effect, an increased competition made by his competitor if he has chosen short delays on his market. If on the contrary the goods are differentiated enough (i.e. if the retailers are far one from the other on the Hotelling line), increasing the delay will not decrease the demand addressed to the retailer by a large amount, and then an incentive to discriminate through this method will reappear.

Finally some remarks on the Competition Policy consequences of our findings on the European car market. We have shown that even if consumers are perfectly informed about prices, the possibility of different delays combined with the existence of a switching cost lead to market separation. This rises two questions: first, how to progress towards unifying the market, that is, reduce the price dispersion within the European Union? Second, it is optimal to do so? Unifying the market can be achieved by either forcing firms to offer identical delays between countries, or by reducing the switching cost between countries. The first solution seems difficult to implement due to the extreme sophistication of manufacturers logistic organization (see CEC (2000)). The second solution seems more promising since part of the switching costs are administrative costs that can be lowered[6]. Reducing the price dispersion, clearly one of the European Antitrust Policy objectives, may not be welfare improving: manufacturers may react by reducing the coverage of the market. From this point of view, following Klemperer [1995], lowering the switching costs is more likely to be welfare improving, and can be part of or complementary to an active Competition Policy.

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Appendices

A. Proofs

Proof of proposition 1. To show that the mixed extension of $\Gamma(\mathcal{FC}_N, \mathcal{FC}_F)$ is better reply secure for any pair of franchise contracts, it is sufficient to show that the property is true for any pair of delays (τ_N, τ_F) and for every wholesale price w. From Reny (1999), corollary 5.2 p. 1044, it suffices to check that $\Gamma(\mathcal{FC}_N, \mathcal{FC}_F)$ is payoff secure and reciprocally upper semicontinuous: those two properties imply the better reply security.

Let us start by showing the reciprocal upper semicontinuity. We can apply Reny (1999) proposition 5.1, p. 1044, that shows that if the sum of the payoffs is upper semicontinuous, then the mixed extension of $\Gamma(\mathcal{FC}_N, \mathcal{FC}_F)$ is reciprocal upper semicontinuous. To check that the sum of the payoffs is upper semicontinuous, we need to check that[7] for any sequence $\{p_N^n, p_F^n\} \subseteq \mathbb{R}^+ \times \mathbb{R}^+$ such that $\{p_N^n, p_F^n\}$ converges to (p_N, p_F), then $\limsup_{n\to+\infty}(\Pi_N(p_N^n, p_F^n) + \Pi_F(p_N^n, p_F^n)) \leq \Pi_N(p_N, p_F) + \Pi_F(p_N, p_F)$. Let us consider the 3 sub-games resulting from demands in cases 1, 2 and 3. First remark that since $\delta < 1$, the sum of the payoffs is always finite. Therefore the supremum of the sum of the payoffs exists and we can compute its limit. The sum of the payoffs is obviously continuous along the diagonals $p_N = p_F + \epsilon$ and $p_N = p_F - \epsilon$, and inside each region. Therefore it is also upper semicontinuous along the diagonals. It remains to check that the property is true along the horizontal and vertical discontinuities. Consider the demand system depicted in case 1. When the pair of prices belongs to the set $\{(p_N, p_F) \in \mathbb{R}^+ \times \mathbb{R}^+ / p_N > \delta^{\tau_N} \frac{1}{1-\delta} - \epsilon, p_F > \delta^{\tau_N} \frac{1}{1-\delta}\}$ then consumer C_F does not buy the good at all. The total demand is brutally shifted downward by 1 unit. Under the assumption that consumers indifferent between buying or not are buying the good, then at the pair of prices were the discontinuity occurs, the limit of sum of the payoffs for any sequence converging to the discontinuity is always lower or equal to the value of the sum of the payoffs at the discontinuity itself. This is exactly what upper semicontinuity requires. When the pair of prices belongs to the set $\{(p_N, p_F) \in \mathbb{R}^+ \times \mathbb{R}^+ / p_N > \delta^{\tau_N} \frac{v_N}{1-\delta}, p_F > \delta^{\tau_N} \frac{v_N}{1-\delta} - \epsilon\}$, the same reasoning can be applied: no one is buying the good, meaning that total demand is shifted downward by 1 unit. However consumer C_N indifferent between buying or not chooses to buy, implying that the limit of the sum of the payoffs is always lower or equal to the value of the sum of the payoffs at the discontinuity itself. The same argument can be applied to demand systems depicted in cases 2 and 3.

[7] Definition 2 given in Dasgupta and Maskin (1986)

Let us turn to the payoff security of the mixed extension of $\Gamma(\mathcal{FC}_N, \mathcal{FC}_F)$. Let us define a distance on Σ by $d(\sigma, \sigma')$ for any pair of probability measures (σ, σ'), and for $\eta > 0$ and $\sigma' \in \Sigma$, let $\mathcal{B}(\sigma', \eta)$ denote an open ball of radius η around σ', i.e. $\mathcal{B}(\sigma', \eta) = \{\sigma \in \Sigma \ / d(\sigma, \sigma') < \eta\}$. The mixed extension of $\Gamma(\tau_N, \tau_F, w)$ is payoff secure if (Reny (1999) p. 1033)

$$\begin{aligned}
&\forall\ (\sigma_N, \sigma_F) \in \Sigma \times \Sigma,\ \forall\ \alpha > 0, \\
&\exists\ \overline{\sigma}_N,\ \eta > 0,\ \Pi_N(\overline{\sigma}_N, \sigma'_F) \geq \Pi_N(\sigma_N, \sigma_F) - \alpha,\ \forall\ \sigma'_F \in \mathcal{B}(\sigma_F, \eta) \\
&\text{and } \exists\ \overline{\sigma}_F,\ \eta > 0,\ \Pi_F(\sigma'_N, \overline{\sigma}_F) \geq \Pi_F(\sigma_N, \sigma_F) - \alpha,\ \forall\ \sigma'_N \in \mathcal{B}(\sigma_N, \eta)
\end{aligned}$$

Payoff security can be interpreted in the following way: for any pair of mixed strategies, each agent has another strategy $\overline{\sigma}_x$ that gives him a payoff always higher than a given level slightly lower than what he was obtaining by playing σ_x (i.e. $\Pi_x(\sigma_x, \sigma_{-x}) - \alpha$) for any small perturbation in its opponent's strategy. To put it differently players are able to be almost as well off at $\overline{\sigma}_x$ than at σ_x even if the opponent is slightly modifying its strategy.

Consider R_N's profit function and take $\eta > 0$. A typical difference that could appear between σ_F and σ'_F is that σ'_F assigns a probability η to a low price $\underline{p}_F$ that was not used in σ_F, while still using the same support. Then $\int_{\mathrm{Supp}(\sigma_F)} d\sigma'_F = 1 - \eta$. Cases in which R_F charges high prices more often will lead to an increase in R_N's profit. Sticking to the same strategy will give him strictly more than in the situation where R_F plays σ_F. The property is therefore true in the case where R_F charges higher prices more often.

Consider directly the case in which σ'_F assigns a weight strictly lower than σ_F to any price or any interval of prices on $\mathrm{Supp}(\sigma_F)$. Is it possible to find a strategy $\overline{\sigma}_N$ that leaves R_N with a profit as close as possible to $\Pi_N(\sigma_N, \sigma_F)$? R_N's profit when he plays σ_N and R_F plays σ'_F is equal to

$$\int_{\mathrm{Supp}(\sigma_N)} \int_{\mathrm{Supp}(\sigma_F)} \Pi_N(p_N, p_F)\ d\sigma_N d\sigma'_F$$

$$+\eta\ \int_{\mathrm{Supp}(\sigma_N)} \Pi_N(p_N, \underline{p}_F)\ d\sigma_N \leq \int_{\mathrm{Supp}(\sigma_N)} \int_{\mathrm{Supp}(\sigma_F)} \Pi_N(p_N, p_F)\ d\sigma_N d\sigma_F$$

Since R_N's profits are piecewise linear and independent of p_F, the only thing that matters for R_N are the prices he is charging with positive probabilities and the probability to get a positive demand which depends on the supports of the two mixed strategies. He can always play a strategy $\overline{\sigma}_N$ that reallocates the probability weights on its prices by taking $\xi \in [0, 1]$ from the upper part of $\mathrm{Supp}(\sigma_N)$ i.e. such that $\int_{\overline{p}_N(\overline{\sigma}_N)}^{\overline{p}_N(\sigma_N)} d\sigma_N = \xi$ and redistributing it to the lower part of $\mathrm{Supp}(\sigma_N)$, possibly charging new values out of $\mathrm{Supp}(\sigma_N)$, and lower than the lower bound of $\mathrm{Supp}(\sigma_N)$. The loss on the term in η in its profit function will be small (η is already small), while the gain on the first part of the profit is clearly bigger. To put it differently R_N lowers the risk of having no demand at all, while still being able to obtain a profit as close as he wants from his initial payoff by increasing the probability of selling 1 unit or 2 units. Since payoffs functions are piecewise continuous, this "quantity" effect can outweigh the "price" effect of putting more probability weights on low prices. Therefore for any small perturbation of his opponent's strategy, R_N can find a strategy close enough in terms of profit to the one he was previously using. The same argument can be applied on R_F's payoffs. Therefore the mixed extension of the original game is payoff secure.

Proof of corollary 1. From proposition 1 we know that the mixed extension of the game $\Gamma(\tau_N, \tau_F, w)$ is better reply secure for any pair of delays and any wholesale price. Moreover firms sets of strategies are compact: it exists a pair of finite prices $(\overline{p}_F, \overline{p}_N)$ such that retailer R_x will never charge more than $\overline{p}_x$ for any price p_{-x} set by its opponent. Since retailers can charge any price $p_x \in [0, \overline{p}_x]$ the game is compact and metric. Therefore we can apply Reny (1999), corollary 5.2, p. 1044: the game $\Gamma(\mathcal{FC}_N, \mathcal{FC}_F)$ possesses a mixed strategy Nash equilibrium.

Proof of lemma 1. If the wholesale w is higher than the maximal willingness to pay $\frac{v_N}{1-\delta}$, then obviously retailers cannot sell and their variable profits (i.e. excluding the fixed fees) are equal to 0. If w is lower than the maximal willingness to pay but higher than $\frac{v_N}{1-\delta} - \epsilon$, retailer R_F can neither sell to its local consumer C_F nor attract its foreign consumer C_N while realizing a non negative profit. R_F does not earn any profit. Retailer R_N does not face any competition in that case, and it sets its price at the maximal level to extract consumer C_N surplus, $p_N^* = \frac{v_N}{1-\delta}$. Its variable profit is $\Pi_N(p_N^*, p_F^*) = \frac{v_N}{1-\delta} - w$. Finally when w is such that $w \in [\frac{1}{1-\delta}, \frac{v_N}{1-\delta} - \epsilon]$, retailers are in competition. If R_N sets its price at the maximal willingness to pay of its local consumer C_N, R_F is able to propose a price slightly lower than $\frac{v_N}{1-\delta} - \epsilon$ and attract C_N. C_F is still unable to buy the good as long as $w > \frac{1}{1-\delta}$. Therefore charging the highest willingness to pay is no more possible. In fact any pair of prices (p_N, p_F) such that retailer R_F is able to undercut R_N and realize a positive profit cannot be an equilibrium. The unique equilibrium in pure strategies is $(p_N^*, p_F^*) = (w + \epsilon, w)$, consumer C_N buys from R_N and consumer C_F does not buy unless $w = \frac{1}{1-\delta}$, in which case he buys from R_F. Consider finally the case in which $w \leq \frac{1}{1-\delta}$: the equilibrium exists in mixed strategy. We need to prove that the upper bounds $(\overline{\overline{p}}_N, \overline{\overline{p}}_F)$ on the support of each firm's strategy cannot be higher or equal to $(\frac{1}{1-\delta} + \epsilon, \frac{1}{1-\delta})$. Let us assume that $(\overline{\overline{p}}_N, \overline{\overline{p}}_F) = (\frac{1}{1-\delta} + \epsilon, \frac{1}{1-\delta})$. In that case retailer R_F could slightly reduce its upper price to get almost the same profit when selling only to its national consumer, while selling the good to the two consumers with a strictly positive probability. The expected profit from using an upper price slightly lower than $\frac{1}{1-\delta}$ is strictly higher than the certain profit from selling at $\frac{1}{1-\delta}$, therefore this price cannot be part of the support of the equilibrium strategy. May an upper price $\overline{\overline{p}}_N = \frac{1}{1-\delta} + \epsilon$ be part of the equilibrium strategy? Neither, since retailer R_N is doing a profit equal to 0 in that case. He is better off reducing the upper bound to realize a positive profit. Therefore $(\overline{\overline{p}}_N, \overline{\overline{p}}_F) = (\frac{1}{1-\delta} + \epsilon, \frac{1}{1-\delta})$ cannot be part of an equilibrium strategy. Ruling out upper bounds strictly higher than this pair is immediate, since those prices are strictly dominated in pure strategies for retailer R_F. Therefore the expected profits of retailers are respectively lower than $\frac{1}{1-\delta} + \epsilon - w$ and $\frac{1}{1-\delta} - w$.

Proof of lemma 2. Obviously when the wholesale price is higher than $\delta^{\tau_N} \frac{v_N}{1-\delta}$ the retailers cannot sell the good. When w is in between $\delta^{\tau_F} \frac{v_N}{1-\delta} - \epsilon$ and $\delta^{\tau_N} \frac{v_N}{1-\delta}$, retailer R_F never finds profitable to sell the good. Retailer R_N charges consumer C_N the highest price possible, $p_N^* = \delta^{\tau_N} \frac{v_N}{1-\delta}$.

When $w \in [\delta^{\tau_N} \frac{1}{1-\delta} - \epsilon, \delta^{\tau_F} \frac{v_N}{1-\delta} - \epsilon]$, then retailer R_N cannot charge more than $w + \epsilon + (\delta^{\tau_N} - \delta^{\tau_F}) \frac{v_N}{1-\delta}$. Indeed any price higher would induce an undercutting by R_F. The equilibrium in pure strategies is $(w + \epsilon + (\delta^{\tau_N} - \delta^{\tau_F}) \frac{v_N}{1-\delta}, w)$ and only consumer C_N obtains the good.

When $w \in [\delta^{\tau_F} \frac{1}{1-\delta}, \delta^{\tau_N} \frac{1}{1-\delta} - \epsilon]$, then retailer R_N can either sell to consumer C_N only, at a price $w + \epsilon + (\delta^{\tau_N} - \delta^{\tau_F}) \frac{v_N}{1-\delta}$, or can sell to C_N and C_F at price $\delta^{\tau_N} \frac{1}{1-\delta} - \epsilon$. R_F sets $p_F = w$. Let us compare the variable profits. $\Pi_N(w + \epsilon + (\delta^{\tau_N} - \delta^{\tau_F}) \frac{v_N}{1-\delta}, w) = \epsilon + (\delta^{\tau_N} - \delta^{\tau_F}) \frac{v_N}{1-\delta}$ and $\Pi_N(\delta^{\tau_N} \frac{1}{1-\delta} - \epsilon, w) = 2\ (\delta^{\tau_N} \frac{1}{1-\delta} - \epsilon - w)$. We obtain immediately that $\Pi_N(w + \epsilon + (\delta^{\tau_N} - \delta^{\tau_F}) \frac{v_N}{1-\delta}, w) > \Pi_N(\delta^{\tau_N} \frac{1}{1-\delta} - \epsilon, w)$ if $w > \delta^{\tau_N} \frac{1}{1-\delta} - \frac{1}{2}(\delta^{\tau_N} - \delta^{\tau_F}) \frac{v_N}{1-\delta} - \frac{3}{2}\epsilon$.

When $w \in [0, \delta^{\tau_F} \frac{1}{1-\delta}]$, the game does not possess a pure strategy Nash equilibrium. We know that it has a mixed strategy Nash equilibrium. Let us characterize the property of the support of any mixed equilibrium. First the upper bound on the support of R_F's equilibrium mixed strategy cannot be higher than $\delta^{\tau_F} \frac{v_N}{1-\delta} - \epsilon$: using the fact that R_F has to be indifferent between any pure strategy used in the mixed one, the expected profit of retailer R_F would be equal to 0, which is dominated. For the same reason, R_N cannot use prices higher than $\delta^{\tau_N} \frac{v_N}{1-\delta}$ in its mixed strategy. Therefore since the expectation is an interior operator, the retailers expected payoffs have to be strictly lower than $(\delta^{\tau_N} \frac{v_N}{1-\delta} - w, \delta^{\tau_F} \frac{v_N}{1-\delta} - \epsilon - w)$.

Proof of lemma 3. The first 3 expressions are obvious to derive using figure 2. Let us focus on the last case. When $w \in [0; \delta^{\tau_F} \frac{v_N}{1-\delta} - \epsilon]$ the equilibrium has to be found in mixed strategies. Remark that R_N never uses prices higher than $\delta^{\tau_N} \frac{v_N}{1-\delta}$ in the support of its equilibrium mixed strategy. Indeed it would do an expected profit equal to 0, which is obviously dominated. For the same reason remark that R_F cannot use prices higher than $\delta^{\tau_F} \frac{1}{1-\delta}$. Therefore since putting all the probability weights on those values cannot be an equilibrium, the expected profits have to be lower than $(\delta^{\tau_N} \frac{v_N}{1-\delta} - w, \delta^{\tau_F} \frac{1}{1-\delta} - w)$.

Proof of lemma 4. When $w > \delta^{\tau_N} \frac{v_N}{1-\delta}$, no retailer sells the good.

When $w \in [\delta^{\tau_N} \frac{1}{1-\delta} - \epsilon, \delta^{\tau_N} \frac{v_N}{1-\delta}]$, R_N charges $p_N^* = \delta^{\tau_N} \frac{v_N}{1-\delta}$ and sells the good to C_N.

When $w \in [\delta^{\tau_F} \frac{v_N}{1-\delta} - \epsilon, \delta^{\tau_N} \frac{1}{1-\delta} - \epsilon]$, R_N can either sell only to C_N at $p_N^* = \delta^{\tau_N} \frac{v_N}{1-\delta}$, or sell to C_N and C_F at price $p_N^* = \delta^{\tau_N} \frac{1}{1-\delta} - \epsilon$. Comparing the profits gives that R_N sells to C_N only if $\delta^{\tau_N} \frac{v_N}{1-\delta} - w > 2\ (\delta^{\tau_N} \frac{1}{1-\delta} - \epsilon - w)$, i.e. $w \geq 2\delta^{\tau_N} \frac{1}{1-\delta} - 2\epsilon - \delta^{\tau_N} \frac{v_N}{1-\delta}$.

When $w \in [\delta^{\tau_N} \frac{1}{1-\delta} - 2\epsilon - (\delta^{\tau_N} - \delta^{\tau_F}) \frac{v_N}{1-\delta}, \delta^{\tau_F} \frac{v_N}{1-\delta} - \epsilon]$, R_N can either sell to C_N at price $w + \epsilon + (\delta^{\tau_N} - \delta^{\tau_F}) \frac{v_N}{1-\delta}$, or sell to C_N and C_F at price $p_N^* = \delta^{\tau_N} \frac{1}{1-\delta} - \epsilon$. Selling to C_N only is more profitable if $\epsilon + (\delta^{\tau_N} - \delta^{\tau_F}) \frac{v_N}{1-\delta} > 2\ (\delta^{\tau_N} \frac{1}{1-\delta} - \epsilon - w)$ i.e. if $w > \delta^{\tau_N} \frac{1}{1-\delta} - \frac{3}{2}\epsilon - \frac{1}{2}(\delta^{\tau_N} - \delta^{\tau_F}) \frac{v_N}{1-\delta}$. If this value is higher than $\delta^{\tau_F} \frac{v_N}{1-\delta} - \epsilon$, then retailer R_N is always better off selling to both consumers. If $\delta^{\tau_N} \frac{1}{1-\delta} - \frac{3}{2}\epsilon - \frac{1}{2}(\delta^{\tau_N} - \delta^{\tau_F}) \frac{v_N}{1-\delta} \leq \delta^{\tau_N} \frac{1}{1-\delta} - 2\epsilon - (\delta^{\tau_N} - \delta^{\tau_F}) \frac{v_N}{1-\delta}$ then for those values of w, R_N prefers to sell to C_N only.

When $w \in [0, \delta^{\tau_N} \frac{1}{1-\delta} - 2\epsilon - (\delta^{\tau_N} - \delta^{\tau_F}) \frac{v_N}{1-\delta}]$, the equilibrium exists in mixed strategies. Again the upper bounds of the supports are $\delta^{\tau_N} \frac{v_N}{1-\delta}$ for R_N and $\delta^{\tau_F} \frac{v_N}{1-\delta} - \epsilon$ for R_F.

B. Figures

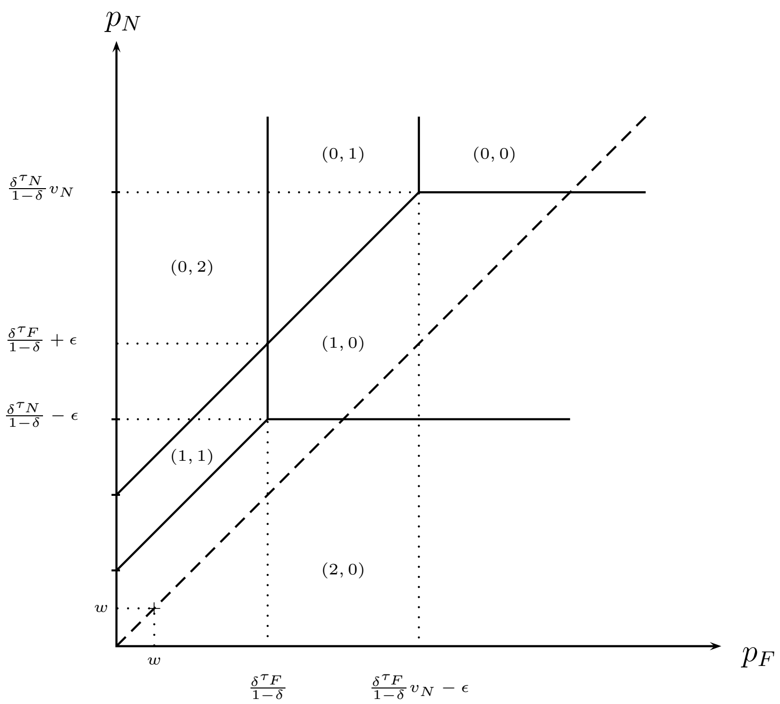

Figure 1: Demands (D^N, D^F) when $\delta^{\tau_F}\frac{v_N-1}{1-\delta} \geq \epsilon$ and $(\delta^{\tau_N}-\delta^{\tau_F})\frac{v_N-1}{1-\delta} > -2\epsilon$ (Case 1)

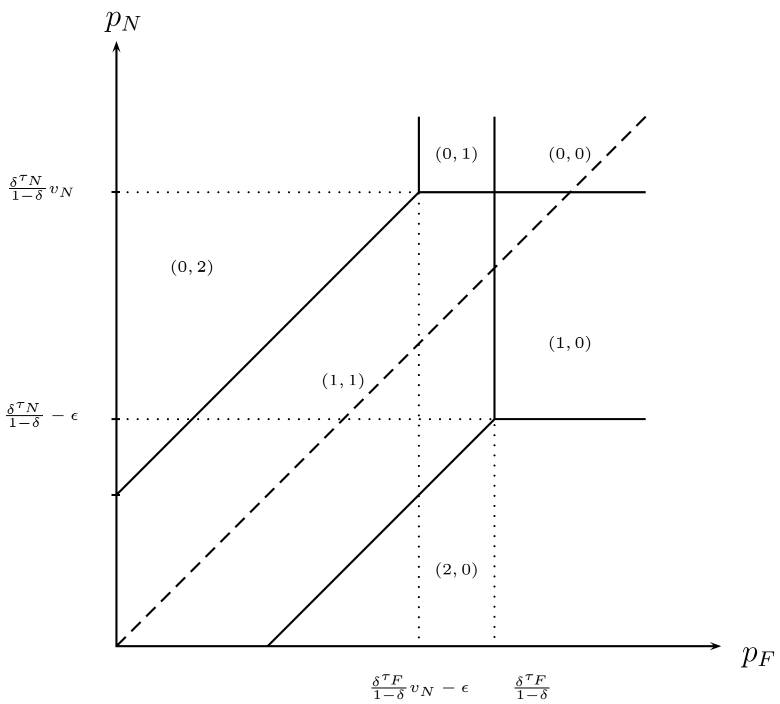

Figure 2: Demands (D^N, D^F) when $\delta^{\tau_F} \frac{v_N - 1}{1-\delta} < \epsilon$ and $(\delta^{\tau_N} - \delta^{\tau_F}) \frac{v_N - 1}{1-\delta} > -2\epsilon$ (Case 2)

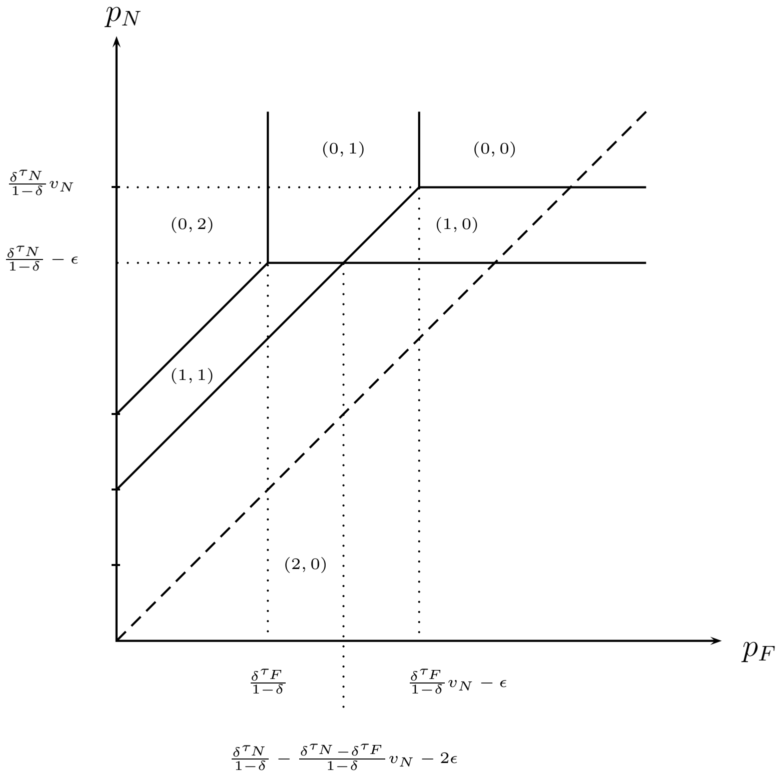

Figure 3: Demands (D^N, D^F) when $\delta^{\tau_F} \frac{v_N - 1}{1-\delta} \geq \epsilon$ and $(\delta^{\tau_N} - \delta^{\tau_F}) \frac{v_N - 1}{1-\delta} \leq -2\epsilon$ (Case 3)

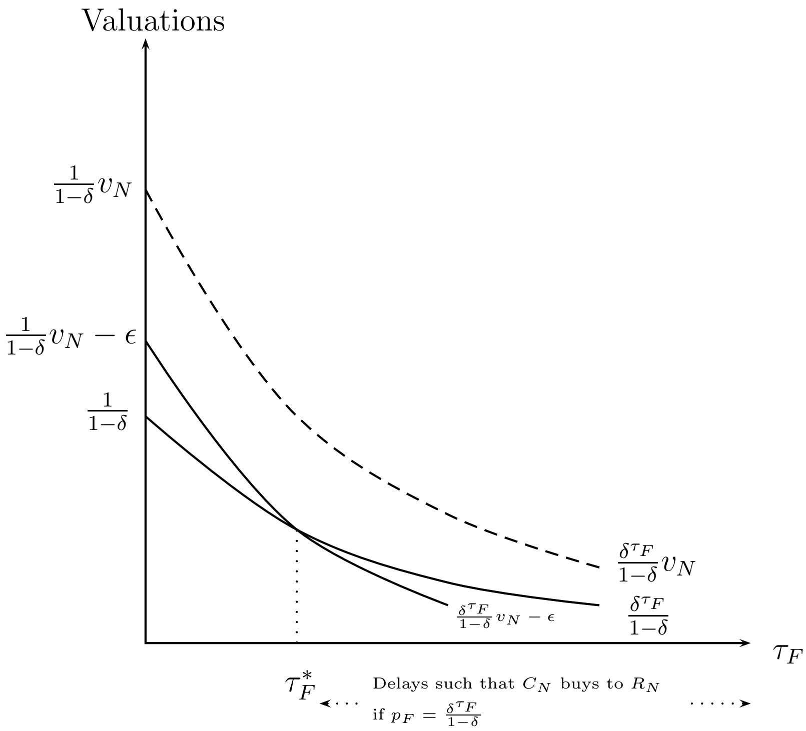

Figure 4: Consumers's valuations when the delay τ_F increases