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ABSTRACT

Exclusive dealing as a barrier to entry? Evidence from automobiles*

Exclusive dealing contracts between manufacturers and retailers force new entrants to set up their own costly dealer networks to enter the market. We ask whether such contracts may act as an entry barrier, and provide an empirical analysis of the European car market. We first estimate a demand model with product and spatial differentiation, and quantify the role of a dense distribution network in explaining the car manufacturers' market shares. We then perform policy counterfactuals to assess the profit incentives and entry-deterring effects of exclusive dealing. We find that there are no individual incentives to maintain exclusive dealing, but there can be a collective incentive by the industry as a whole, even absent efficiencies. Furthermore, a ban on exclusive dealing would shift market shares from the larger European firms to the smaller entrants. More importantly, consumers would gain substantially, mainly because of the increased spatial availability and less so because of intensified price competition. Our findings suggest that the European Commission's recent decision to facilitate exclusive dealing in the car market may not have been warranted.

JEL Classification: L14, L42 and L62
Keywords: automotive industry, exclusive dealing, foreclosure and vertical restraints

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1 Introduction

Exclusive dealing has attracted a lot of attention from researchers and competition authorities alike. The early view considered exclusive dealing to be an anticompetitive barrier to entry, since it forces new entrants to set up their own costly distribution networks. The Chicago school (Bork, 1978; Posner, 1976) challenged this view. It stressed that the incumbent must pay the retailer to accept exclusivity, so that an exclusive deal does not turn out in their joint interest in the absence of efficiencies. The post-Chicago literature, in turn, identified conditions under which an incumbent and a retailer may have a joint incentive to contract on exclusive dealing as a way to foreclose entry. The main insight is that such contracts imply externalities on other firms not accounted for by the Chicago school.

In this paper, we contribute to the growing debate on whether exclusive dealing may act as a barrier to entry. We first provide a framework to empirically analyze the incentives and effects of exclusive dealing. We then apply it to the European car market, which has a long history of industry regulations towards vertical restraints. Since its first Motor Vehicle Block Exemption in 1985, the European Commission accepted that manufacturers could impose exclusive dealing on their retailers. As a result, exclusive dealing has become prevalent in most European countries, with exclusivity ranging between 70% and 90% of the car dealers.

We begin our analysis with a simple conceptual framework. We assume that incumbents can convince their retailers to accept exclusivity, consistent with some recent post-Chicago theories. We instead focus on the largely ignored question whether the incumbent has an incentive to keep out an entrant in the first place. The theoretical literature has typically taken this for granted, by assuming that entry reduces the incumbent's and entrant's joint profits. In practice, however, this is not so obvious. While entry leads to intensified competition, it may also increase demand through two channels. First, when an individual incumbent allows an entrant on its distribution network, this leads to business stealing from other incumbents. As a result, no incumbent may have a unilateral incentive for exclusive dealing to deter entry. Second, when a group of incumbents allows entry on their distribution networks, there is no more business stealing from each other, but demand may still increase because of product differentiation (or "business stealing from the outside good"). Hence, incumbents may not even have a collective incentive for exclusive dealing as a mechanism to foreclose entrants. In sum, when entry raises total demand (because of business stealing and/or product differentiation), entrants may be able to sufficiently compensate incumbents for *not* signing exclusive contracts with their retailers.

This framework serves as a guide for our empirical analysis of exclusive dealing as an entry barrier in the European car market. We collected a rich data set on car sales per model at the level of local towns in Belgium, and we combined this with data on dealer locations. Our empirical analysis consists of two steps. In a first step, we estimate a rich demand model with both product and spatial differentiation.[1] The model enables us to quantify how much consumers value brands and how much they value dealer proximity (for buying a car, but especially for obtaining convenient after-sales services).[2] We find that dealer proximity is an important determinant of automobile demand. This gives a first indication that exclusive dealing may serve as an entry barrier.

In a second step, we combine the demand model with a model of oligopoly pricing to perform a counterfactual analysis of exclusive dealing. We focus on the effects of a shift from exclusive dealing to multi-branding agreements between European incumbents and more recent entrants. Consistent with competition policy approaches, we consider both the internal profit incentives and the external effects of such a shift.

Regarding the internal profit incentives, we find that European incumbents have strong unilateral incentives to shift to multi-branding with recent entrants. This enables them to steal business from other competitors. At the same time, however, incumbents have no collective incentive to shift to multi-branding with entrants. Although this creates a small amount of market expansion (business stealing from the outside good), this is outweighted by losses from intensified competition. In sum, there are no unilateral but possibly collective incentives to maintain exclusive dealing, even absent efficiencies. These findings may rationalize the industry's efforts to organize exclusive dealing under an industry block exemption regulation, as this provides a collective incentive infrastructure for all incumbent firms.

Regarding the external effects, we find that a collective shift to multi-branding would raise the entrants' market share from 27% to 32%, at the expense of European incumbents. More importantly, consumers would gain substantially from the removal of exclusive contracts, namely €867 per household, a sizeable fraction of the average price of a sold car. These consumer gains are for 90% due to increased spatial availability and only for 10% due to lower prices. Finally, total welfare also increases, by an amount similar to the consumer gains. Overall, these results imply that the current distribution system, where firms collectively maintain exclusive dealing, does not necessarily have an immediate efficiency rationale and

[1] To incorporate product differentiation, we follow Berry et al. (1995) and Nevo (2001), and adopt a random coefficients logit model, accounting for both observed and unobserved heterogeneity for the valuation of product characteristics. Furthermore, we add spatial differentiation as in Davis (2006) and Ishii (2008). For the car market in the San Diego area, Albuquerque and Bronnenberg (2010) also introduced both product and spatial differentiation, but in a simpler nested logit framework.

[2] There is still a strong link with sales services in Europe. A survey conducted by Lademann and Partner (2001) found that "*The high value placed on after-sales servicing* [...] *shows that, when a new car is being purchased, the buying phase is already overshadowed by the expectations placed on the utilisation phase. Therefore after-sales servicing is already of utmost importance at the time of purchase.*" Shortly after the purchase, brand loyalty is about 90%.

can imply large losses to consumers and welfare. These findings suggest that the European Commission's recent decision to facilitate exclusive dealing in the car market may not have been warranted.

There is a large theoretical literature on exclusive dealing. Most of this work has focused on the challenge raised by the Chicago school that an incumbent is not able to pay a sufficient amount to the retailer to accept exclusivity, unless there are efficiencies. One example of such a post-Chicago theory is the theory of Aghion and Bolton (1987). They show that an incumbent and a retailer can at least partially exclude an efficient entrant if the contract includes liquidated damages (serving as an entry cost for the entrant). Another theory of exclusive dealing starts from the assumption that an entrant needs more than one retailer to cover its fixed entry costs (Rasmusen et al., 1991; Segal and Whinston, 2000). Although retailers would prefer upstream competition, no single retailer has an incentive to refuse an exclusive dealing contract when all other retailers sign. The incumbent can take advantage of the retailers' coordination failure and cheaply exclude the entrant from the market. More recent work has shown that the circumstances under which an incumbent can exploit the retailers' coordination failure are surprisingly subtle.[3] Our paper simply assumes that incumbents can convince retailers to sign an exclusive dealing contract. We instead focus on the possibility that an entrant can convince an incumbent *not* to sign an exclusive dealing contract and allow entry on its distribution network. This provides interesting insights and suggests that more theoretical work could focus in this direction.

Despite the variety of theories, empirical evidence on exclusive dealing remains very scarce, especially on the entry deterring motive. A small experimental literature has studied the role of specific game-theoretic assumptions behind exclusive dealing as an entry barrier. Consistent with the theory, these studies confirm that the outcome depends crucially on the set-up of the game, including communication and discrimination (Landeo and Spier, 2009), sequentiality and secrecy (Boone et al., 2009) and the number of buyers (Smith, 2010).

Empirical evidence outside of the laboratory is even scarcer. Since directly estimating the effect of exclusive dealing on entry is very difficult, all previous empirical studies have used an indirect approach. Sass (2005) finds that exclusive dealing is more prevalent in smaller markets, while foreclosure theory suggests they opposite. Similarly, Asker (2004) finds that rivals do not have higher costs when they must compete with firms who sell under exclusive dealing agreements. This also goes against the raising-rivals'-cost prediction of

[3] Fumagalli and Motta (2006) show that the coordination problem may disappear when the retailers are not final consumers, but instead compete with each other. One single deviant retailer may then be able to serve the whole market by buying more cheaply from the entrant, enabling the entrant to cover its fixed costs. However, Simpson and Wickelgren (2007) reverse the results when there is contract breach. The incumbent is then able to prevent entry when retailers compete, but not when they are final consumers.

foreclosure. One study suggests exclusive dealing contracts may be used to foreclose. Ater (2010) finds that exclusive dealing reduces sales, and concludes that this is inconsistent with efficiencies, so that exclusive dealing must be used for anti-competitive reasons. We take this literature a step further. By estimating a rich demand model with both product and spatial differentiation, we can first assess the anti-competitive profit incentives for exclusive dealing, and subsequently evaluate the impact on consumers and welfare.

Our work does not only contribute to the academic literature, but also to the policy debate on vertical restraints, competition policy and non-tariff trade barriers. Policy makers in both the U.S. and in Europe have repeatedly expressed concerns that the reduction of government-imposed trade barriers (such as tariffs) may induce private companies to set up anti-competitive practices as a protection against foreign manufacturers.[4] In this respect, our findings suggest that exclusive dealing in the European car market has only served as a mild entry barrier against Asian competitors, but with large consequences on consumers' domestic welfare.

The remainder of this paper is organized as follows. Section 2 discusses the relevant regulations in the European car market. Section 3 provides a conceptual framework for thinking of the internal profit incentives for exclusive dealing. Section 4 develops the model of demand and pricing, and the counterfactuals to assess the effects of a shift from exclusive dealing to multi-branding. Section 5 describes the data and estimation issues and section 6 shows the empirical results and counterfactual analyses. Finally, section 7 provides extensions and sensitivity analysis: we consider the role of substitution to the outside good, and we allow for the possibility that a shift to multi-branding induces firms to coordinate pricing decisions, as in Bernheim and Whinston (1998) and Rey and Vergé (2010). Section 8 concludes.

2 Vertical restraints in the European car market

Car manufacturers have exercised control on their dealership networks through a wide range of vertical restraints. We first give a broad overview of the most relevant price and non-price restraints in the European car market. We then discuss the evolution in the European Commission's policy towards the three main non-price restraints, with a focus on exclusive

[4] For example, the following quote comes from two former European Commissioners for trade and competition policy: "[...] *the incentive for firms to engage in anti-competitive behavior impeding market access (such as [...] vertical restraints) increases with the reduction of tariffs and other barriers*", see Brittan and Van Miert (1996). Similarly, the U.S. Federal trade Commission's Assistant Director of the International Antitrust Division has stated that: "[...] *as government barriers to market integration disappear, we can expect that private anticompetitive practices will assume increased importance. And vertical restrictions will be an important and complicated issue for competition enforcers*", see Valentine (1997).

dealing. Finally, we present preliminary evidence on exclusive dealing and its relationship with market shares.

Price and non-price restraints European car manufacturers apply several types of price restraints. First, they apply non-linear wholesale pricing policies in the form of bonuses to their dealers if they meet certain sales targets. Second, they publish recommended retail prices (or list prices) to their dealers and advertise these to consumers through price catalogues. Recommended retail prices are evidently not equivalent to resale price maintenance (RPM), since car dealers can still apply discounts to the recommended retail prices. In practice, however, the distinction between both is often very small.[5] Based on both considerations, we will assume throughout the paper that manufacturers control retail prices either directly or indirectly, so there are no double marginalization effects.

In addition to these price restraints, manufacturers apply three main non-price restraints: selective distribution, exclusive distribution and exclusive dealing. Selective distribution enables manufacturers to impose various quantitative and qualitative criteria on their dealers, such as a maximum number of dealers through the country, and minimum standards on showrooms, staff training and advertising. Exclusive distribution (or exclusive territories) allows manufacturers to appoint a designated territory to each dealer. Finally, exclusive dealing (or single-branding) restricts the dealer to sell competing brands, or only allows a maximum number of sales of competing brands. This third vertical agreement is the focus of our paper.

Evolution in policy towards non-price restraints Before 1985 vertical restraints were allowed as individual exemptions under Article 81 of the EC Treaty. This was a costly process, and the arguments motivating the exemptions were typically the same across cases. Since 1985, the European Commission has therefore followed a policy of granting block exemptions applicable to the whole car sector. This eliminated the need to file for individual exemptions, and automatically allowed manufacturers to impose the vertical restraints as long as they remained within the "safe harbor" market share thresholds of the block exemption.

Table 1 summarizes the three main episodes of block exemptions. In 1985 the Commission introduced its first Motor Vehicle Block Exemption, renewed in 1992 with minor changes. It allowed manufacturers to apply both selective and exclusive distribution, and

[5] Discounts to recommended retail prices tend to be quite uniform and show little variation over time, as discussed in Degryse and Verboven (2001) based on a survey conducted through the European Commission. Furthermore, several manufacturers such as Volkswagen and DaimlerChrysler have been convicted for imposing RPM, as reviewed in Verboven (2008).

impose exclusive dealing up to 80% of the dealers' sales. In practice, the distribution system was rather rigid and led to a standardized system in which all firms essentially adopted the same vertical restraints. In 2002 a major reform took place, which became stricter towards manufacturers while at the same time promoting more diversity in the distribution agreements across firms. Manufacturers could adopt either selective or exclusive distribution, but no longer both at the same time. Exclusive dealing was still allowed, but only up to 30% of the dealers' sales (compared with 80% before). So in principle, between 2002 and 2010, European dealers could sell up to three different brands, each brand asking for exclusive dealing up to 30% of the dealers' sales. The Motor Vehicle Block Exemption was at that time considerably more strict than the General Vertical Block Exemption that applied to other industries. In June 2010 the Commission again revised the regulation. It deemed that the level of competition was sufficient in the market of new car distribution, so it scaled the Motor Vehicle Block Exemption back towards the levels of the General Vertical Block Exemption. In June 2013 the car sector should completely fall under the general block exemption rules towards vertical restraints. In particular, this means that manufacturers can again impose exclusive dealing up to 80% of the dealers' sales.[6]

This brief history of block exemptions shows an interesting evolution in the European Commission's thinking about vertical restraints. Until 2002, the Commission was largely preoccupied with its objective of the realization of a common market. It feared that a system of selective and exclusive distribution would give manufacturers too much control over new car sales, and would prevent parallel imports between European countries when international price differences become large. The Commission therefore took several initiatives to promote parallel imports and it periodically monitored the evolution of international price differences. Our own and other research has documented how selective and exclusive distribution can influence international price differentials and European integration in general (Goldberg and Verboven, 2001; Brenkers and Verboven, 2006).

Since 2002 the Commission has clearly shifted its focus to the competition policy objective, perhaps because it considers that the common market objective has made sufficient progress. First, it has taken measures to loosen the link between the car manufacturers' sales and after-sales networks, to reduce the risk of foreclosure of independent spare part manufacturers. Second, it showed concern with the practice of exclusive dealing, since it entails the risk of foreclosure of new entrants. The latter motivates our analysis of exclusive dealing as an entry barrier.

[6]The 2010 regulation only became more strict towards manufacturers with respect to after-sales repair and maintenance services, since the Commission considered competition to be less intense in these markets.

Table 1: History of the European Motor Vehicle Block Exemption Regulation

	selective distribution	exclusive distribution	exclusive dealing
1985-2002	AND	AND	up to 80%
2002-2010	OR	OR	up to 30%
2010-2013	OR	OR	up to 80%

Note: The table reports the regulation regarding selective and exclusive distribution and exclusive dealing throughout the three major reforms of the European Motor Vehicle Block Exemption Regulation.

Exclusive dealing in practice Even though multi-brand dealerships were actively encouraged between 2002 and 2010, exclusive dealing still remained prevalent in most European countries. The European Commission acknowledged this as well in their press release accompanying the new block exemption on May 27th 2010, where they state: *"The old rules have had little impact on favouring multi-dealerships [...]."* (DG competition, 2010). While in the U.S. only 57% of the dealers are exclusive to one brand, this amounts to 70% in Europe (Wade, 2005).

Our empirical application considers the case of Belgium, for which we were able to construct a rich data set. This application is interesting for several reasons. First, because of its highly urbanized structure exclusive dealing is even more prevalent in Belgium than in other countries, with 95% of the dealers selling one single brand. Second, the Belgian car market is the largest among countries that do not have a domestic producer.[7] This leads to a fairly unconcentrated market share with a strong market presence of most main European manufacturers. As we discuss below, this makes it particularly relevant to distinguish between unilateral exclusive dealing incentives (by a single incumbent) and collective incentives (by multiple incumbents).

Figure 1 presents preliminary evidence on the relationship between market shares and the number of dealers for the 38 different brands. This is based on our detailed data set, which we describe in more detail in section 5) Figure 1 shows there is a strong correlation between market shares and the number of dealers (86%). While this suggests the importance of large distribution networks, it does not imply a causal relationship since manufacturers of intrinsically more popular brands may also open more dealerships. To address this in more detail, we will estimate a spatial demand model at the level of the zip code, and control for brand fixed effects. This model will confirm the importance of dealer proximity, and serve

[7] The market is evidently smaller than that of the six large European countries with domestic producers (France, Germany, Italy, Spain and the U.K.). But it is larger than more populated countries such as the Netherlands (high taxes) or Poland (lower income/capita).

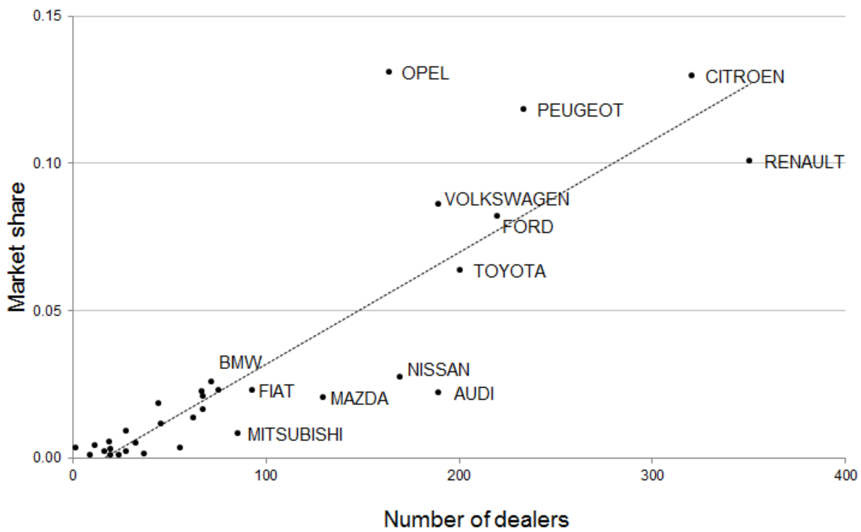

Figure 1: Market shares and the size of the distribution network

Note: The figure plots the market shares and the number of dealers of each of the 33 brands in our data set.

as the basis for assessing the incentives and effects of exclusive dealing.

3 Profit incentives for exclusive dealing

We begin with a simple framework to discuss the incumbent firms' profit incentives to engage in either exclusive dealing or multi-branding. Previous theoretical research has focused on the question whether an incumbent firm can compensate its retailers sufficiently to make them sign an exclusive contract and keep an entrant out of the market.[8] Here, we simply assume the incumbent can indeed induce its retailers to sign. For example, this may work by exploiting a lack of coordination between retailers (as in Rasmusen et al. (1991)), or even more simply by granting territorial exclusivity to the dealer in exchange for accepting to sell only one brand.

Instead of the question whether the retailer can be induced to sign an exclusive dealing contract, we focus on the equally important question whether the incumbent has an incentive to keep out the entrant the first place. The theoretical literature has typically taken this for granted. In practice, however, this is not so obvious since the entrant may want to

[8] Aghion and Bolton (1987), Rasmusen et al. (1991) and Segal and Whinston (2000) provide models where the incumbent and the retailer have a joint interest to sign exclusivity. The debate is not settled, as evident from the recent extensions when there is downstream competition, analyzed by Fumagalli and Motta (2006) and Simpson and Wickelgren (2007).

compensate the incumbent for *not* signing an exclusive contract with its retailers.

We first consider the case of one incumbent and one entrant. This introduces the basic incentives for exclusive dealing. Next, we consider the case of two incumbents and one entrant. This enables us to distinguish between the unilateral and the collective incentives for exclusive dealing by multiple incumbents.

3.1 One incumbent, one entrant

Consider a market with one incumbent firm I and one potential entrant E. Assume that I sells through its own (vertically integrated) downstream retailer, and E can only enter if it also obtains access to I's retailer. We ask whether I has an incentive to use exclusive dealing to foreclose E, or whether instead E can convince I not to use exclusive dealing.

If I imposes exclusive dealing, it forecloses entry by E and obtains the monopoly profits π_I^M, and E obtains zero. If instead I allows multi-branding, then I and E obtain the duopoly profits π_I^D and π_E^D. To achieve multi-branding, E is willing to compensate I by an amount up to π_E^D. At the same time, I requires a minimum compensation equal to its loss when going from monopoly to duopoly, $\pi_I^M - \pi_I^D$. Hence, the entrant cannot convince the incumbent to accept multi-branding if and only if $\pi_E^D < \pi_I^M - \pi_I^D$, or equivalently if and only if

$$\pi_I^D + \pi_E^D < \pi_I^M,$$

i.e. industry profits are smaller under duopoly than under monopoly. This is the typical assumption in the literature and it is satisfied when the incumbent and the entrant sell homogeneous products and are equally efficient. In practice, however, industry profits may be higher under duopoly, for example if the entrant is more efficient or if it adds sufficient product differentiation to the market. Under these circumstances, E can convince I not to sign an exclusive dealing contract with its dealer and instead would accept a multi-branding arrangement with E.

3.2 Two incumbents, one entrant

Now consider a market with two incumbent firms I and U and one potential entrant E. Both I and U sell through their own downstream retailer, and E can only enter if it obtains access to either I's or U's retailer (and E is indifferent between obtaining access through either retailer). We now distinguish between the incumbents' unilateral and collective incentives to use exclusive dealing to foreclose entry.

If both incumbents I and U impose exclusive dealing, they foreclose entry and can obtain duopoly profits of π_I^D and π_U^D, respectively, whereas E obtains zero. If instead either I or U allows multi-branding with E, then E becomes a viable competitor and I, U and E obtain the triopoly profits π_I^T, π_U^T and π_E^T. To achieve multi-branding, the entrant is willing to compensate one of the incumbents by an amount up to π_E^T. Incumbent I requires a compensation for going to triopoly of at least $\pi_I^D - \pi_I^T$, and incumbent U requires a compensation of at least $\pi_U^D - \pi_U^T$. The outcome depends on whether the incumbents can make a collective or only a unilateral exclusive dealing agreement.

Collective exclusive dealing agreements If the incumbents can make a collective agreement, the entrant must pay the minimum required compensation to both incumbents, i.e. pay a total of at least $\pi_I^D - \pi_I^T + \pi_U^D - \pi_U^T$. Since E is willing to pay at most π_E^T, the incumbents have a collective incentive for exclusive dealing if $\pi_E^T < \pi_I^D - \pi_I^T + \pi_U^D - \pi_U^T$, or

$$\pi_I^T + \pi_U^T + \pi_E^T < \pi_I^D + \pi_U^D.$$

The incumbents thus have a collective incentive to foreclose entry through exclusive dealing if industry profits are greater under duopoly than under triopoly. In practice, this will be the case if the entrant is not substantially more efficient or if it does not add sufficient product differentiation, i.e. if there is limited "business stealing" from the outside good.

Unilateral exclusive dealing agreements In contrast, if the incumbents cannot make a collective exclusive dealing agreement, the entrant must only convince either I or U to accept multi-branding, and pay at least $\min\left\{\pi_I^D - \pi_I^T, \pi_U^D - \pi_U^T\right\}$. Since E is willing to pay at most π_E^T, the incumbents have a unilateral incentive for exclusive dealing if $\pi_E^T < \min\left\{\pi_I^D - \pi_I^T, \pi_U^D - \pi_U^T\right\}$, or

$$\pi_I^T + \pi_E^T < \pi_I^D \text{ and } \pi_U^T + \pi_E^T < \pi_U^D.$$

The incumbents thus have a unilateral incentive to foreclose entry through exclusive dealing if each incumbent's duopoly profits is greater is greater than the sum of each incumbent's and the entrant's triopoly profits. The unilateral incentives for exclusive dealing are clearly smaller than the collective incentives. In both cases, the incumbents are concerned that multi-branding creates a third competitor. But with unilateral agreements, the incumbents take into account that they can steal potentially substantial business from the other incumbent. With a collective exclusive dealing agreement, there is no business stealing from each other, only from the "outside good".

To summarize, depending on the incumbents' and the entrant's payoffs under duopoly and triopoly, we have the following possibilities:

(i) no unilateral, nor collective incentives for exclusive dealing if the entrant can compensate both incumbents for their loss in profit when going from duopoly to triopoly, i.e. if

$$\pi_I^D - \pi_I^T + \pi_U^D - \pi_U^T < \pi_E^T$$

(ii) no unilateral, but collective incentives for exclusive dealing if the entrant can compensate one of the incumbents for his loss in profit, but not both incumbents, i.e. if

$$\min\left\{\pi_I^D - \pi_I^T, \pi_U^D - \pi_U^T\right\} < \pi_E^T < \pi_I^D - \pi_I^T + \pi_U^D - \pi_U^T$$

(iii) both unilateral and collective incentives for exclusive dealing if the entrant cannot compensate any of the incumbents for their loss in profit, i.e. if

$$\pi_E^T < \min\left\{\pi_I^D - \pi_I^T, \pi_U^D - \pi_U^T\right\}.$$

Our empirical framework will consider a much richer set-up to account for the particular characteristics of the car market. There may be both brand differentiation and spatial differentiation between competitors, and "entrants" may already be in the market but with only a limited spatial presence. The basic economic intuition behind the profit incentives remains however the same. On the one hand, incumbents have an incentive to engage in exclusive dealing to soften competition and limit the spatial presence of small firms. On the other hand, incumbents may be tempted to accept multi-branding, especially unilaterally, since this enables them to steal business from competitors or from the "outside good".

4 The model

Keeping in mind the stylized example of the previous section, we now present a rich equilibrium model of the demand and supply of new cars. First, the demand side incorporates both product and spatial differentiation. We formulate a random coefficients logit model, in which consumers value both car characteristics and dealer proximity. Second, the supply side considers multi-product price-setting manufacturers. Each manufacturer has a network of exclusive dealers and determines prices to maximize profits. Finally, we discuss how a change from exclusive dealing to multi-branding may affect equilibrium profits, consumer surplus and welfare.

4.1 Demand

We observe a number of local markets (towns) $t = 1, ..., T$, each with $i = 1, ..., I_t$ consumers, so the total number of consumers across local markets is $M = \sum_{t=1}^{T} I_t$. The indirect utility of a consumer i in market t from buying a car model $j = 1, ..., J$ is given by

$$\begin{aligned} u_{ijt} &= x_j \beta_i + \alpha_i p_j + \gamma_i d_{ijt} + \xi_j + \epsilon_{ijt} \\ &= V_{ijt} + \epsilon_{ijt}. \end{aligned} \tag{1}$$

Here, x_j is a $1 \times K$ vector of observable car characteristics, p_j is the price of product j, d_{ijt} is the geographic distance between consumer i and the nearest dealer of model j, and ξ_j is an unobserved product characteristic (unobserved to the researcher). The parameters β_i (a $K \times 1$ vector), α_i and γ_i are random coefficients, capturing individual-specific tastes for the car characteristics, price, and distance to the nearest dealer. They are thus of central importance to describe the extent of product differentiation and spatial differentiation in the car market. With the exception of Albuquerque and Bronnenberg (2010), most other empirical work on car demand has focused on product differentiation and neglected spatial differentiation and the role of dealer proximity ($\gamma_i = 0$). For our purposes, the role of dealer proximity is particularly relevant, since we will assess the effects of a move from exclusive dealing to multi-branding by changing the distances that consumers need to travel to obtain certain products. Finally, ϵ_{ijt} is an individual-specific taste parameter for product j, modeled as a zero mean i.i.d. random variable with a Type 1 extreme-value distribution (the logit error term).

The individual-specific taste parameters β_i, α_i and γ_i may vary across consumers because of both observed and unobserved heterogeneity. Following Nevo (2001), we specify the $(K+2) \times 1$ taste parameter vector as follows:

$$\begin{pmatrix} \alpha_i \\ \beta_i \\ \gamma_i \end{pmatrix} = \begin{pmatrix} \alpha \\ \beta \\ \gamma \end{pmatrix} + \Pi D_i + \Sigma \nu_i,$$

where D_i is an $H \times 1$ vector of observed demographic variables taken from the empirical distribution, and ν_i is a $(K+2) \times 1$ vector of unobserved standard normal consumer valuations, $\nu_i \sim N(0, I_{K+2})$, independent from the distribution of D_i. The parameter vector $(\alpha, \beta, \gamma)'$ is a $(K+2) \times 1$ vector, capturing the mean valuations for the product characteristics, Π is a $(K+2) \times H$ matrix describing how the valuations for the product characteristics vary with consumer demographics, and Σ is a $(K+2) \times (K+2)$ scaling matrix capturing unobserved heterogeneity in the valuations for the product characteristics. To reduce the number of parameters to be estimated, we restrict several parameters in the matrix Π to zero and we assume that Σ is diagonal, i.e. set the covariances in Σ to zero.

Instead of purchasing one of the car models j, consumers may also decide not to purchase a car, in which case they consume the "outside good". We specify $u_{i0t} = \epsilon_{i0t}$, i.e. we normalize the mean and individual-specific valuations to zero, since they are not identified from the constant terms.

Assuming that consumers choose the car model that maximizes utility, the probability that individual i in market t chooses car model j, conditional on the draws for D_i and ν_i, is given by

$$\Pr{}_{ijt}(\nu_i, D_i) = \frac{\exp(V_{ijt}(\nu_i, D_i))}{1 + \sum_{k=1}^{J} \exp(V_{ikt}(\nu_i, D_i))}. \tag{2}$$

To obtain the unconditional probability or aggregate market share of car model j in market t, we need to integrate the conditional logit probability over the density of D_i and ν_i:

$$\Pr{}_{jt} = \int \Pr{}_{ijt}(\nu, D) f(\nu, D) d\nu dD, \tag{3}$$

where $f(\nu, D)$ is the joint density function of ν and D the demographic variable vector and the random draws.

We can now derive total demand for each model j across all local markets $t = 1, ..., T$. It is useful to express demand as a function of car prices and the geographic dealer network. Let $\mathbf{p}$ be the $J \times 1$ price vector, with elements p_j. Furthermore, let $\mathbf{d}$ be a $J \times M$ distance matrix, with elements d_{ijt}. The distance matrix $\mathbf{d}$ thus describes the distances that all consumers need to travel to the nearest dealer of each product j. Rewriting $\Pr_{jt}$ as $\Pr_{jt}(\mathbf{p}, \mathbf{d})$, we can express total demand for each model j across all local markets $t = 1, ..., T$ as:

$$q_j(\mathbf{p}, \mathbf{d}) = \textstyle\sum_{t=1}^{T} \Pr_{jt}(\mathbf{p}, \mathbf{d}) I_t.$$

Hence, total demand for each model j is a function of the price vector $\mathbf{p}$ and the distance matrix $\mathbf{d}$. As we discuss in the next subsection 4.2, prices are determined according to multi-product Bertrand pricing. Furthermore, as we discuss in subsection 4.3, the distance matrix is taken as given, but we will consider counterfactuals where the distance matrix changes when firms would open up their exclusive distribution networks.

4.2 Oligopoly pricing

As discussed in section 2, car manufacturers may influence retail prices in various ways, by setting wholesale prices, franchise fees, sales targets and dealer bonuses, etc. Based on this, we follow a simplified approach and assume each manufacturer sets retail prices to maximize total upstream and downstream profits over all its products, taking as given the retail prices set by the other firms. This is the multi-product pricing Bertrand pricing assumption, common in much of the car market literature. It is as if manufacturers and dealers implement the vertically integrated solution. As shown by Rey and Vergé (2010), this equilibrium may also result from "interlocking relationships" between manufacturers and dealers when firms using non-linear pricing schemes. Bonnet and Dubois (2010) obtain recent empirical evidence consistent with this assumption.[9]

More formally, we observe F car manufacturers, each producing a subset $\mathcal{F}_f$ of the J different car models and selling it through the existing dealer network $\mathbf{d}$. Manufacturer f's total profits π_f over all its products $j \in \mathcal{F}_f$ are given by

$$\pi_f = \sum_{j \in \mathcal{F}_f} (p_j - c_j) q_j(\mathbf{p}, \mathbf{d}), \tag{4}$$

where c_j is the constant marginal cost of producing and selling product j. Each manufacturer sets the prices of all its products to maximize profits, taking as given the prices set by the other firms. Assuming existence of a pure-strategy Nash equilibrium, the necessary first-order conditions are

$$q_j(\mathbf{p}, \mathbf{d}) + \sum_{k \in \mathcal{F}_f} (p_k - c_k) \frac{\partial q_k(\mathbf{p}, \mathbf{d})}{\partial p_j} = 0, \qquad \text{for all } j = 1, ..., J. \tag{5}$$

We write the Nash equilibrium solution to this system as $\mathbf{p} = \mathbf{p}^*(\mathbf{d})$.

To write the first-order conditions in matrix form, define θ^F as the manufacturers' product ownership matrix, where a typical element θ^F_{jk} is equal to 1 if products j and k are produced by the same manufacturer, and 0 otherwise. Let $\mathbf{q}(\mathbf{p})$ be the $J \times 1$ market share vector, and $\bigtriangledown_p \mathbf{s}(\mathbf{p}(\mathbf{d}), \mathbf{d}) \equiv \frac{\partial q(\mathbf{p}(\mathbf{d}),\mathbf{d})}{\partial \mathbf{p}'}$ be the corresponding $J \times J$ Jacobian matrix of first derivatives. Using the operator $\odot$ to denote the Hadamar product, or element-by-element multiplication,

[9] Bonnet and Dubois (2010) consider a various possible equilibria based on Rey and Vergé (2010) model of vertical interlocking relationships. See also Villas-Boas (2007) for an analysis of alternative models of vertical relations. On the European car market, Brenkers and Verboven (2006) find that a linear wholesale pricing model with double marginalization is not plausible.

we can write the first-order conditions as

$$\mathbf{q}(\mathbf{p},\mathbf{d}) + \left(\theta^F \odot \nabla_p' \mathbf{q}(\mathbf{p},\mathbf{d})\right)(\mathbf{p}-\mathbf{c}) = 0. \tag{6}$$

As is well-known, one can use the first-order conditions (6) to retrieve the current marginal costs $\widehat{\mathbf{c}}$ as the difference between the current prices and the equilibrium profit margins

$$\widehat{\mathbf{c}} = \mathbf{p} - \left(-\left(\theta^F \odot \nabla_p' \mathbf{q}(\mathbf{p},\mathbf{d})\right)\right)^{-1} \mathbf{q}(\mathbf{p},\mathbf{d}). \tag{7}$$

One can subsequently use the uncovered marginal costs to perform policy counterfactuals on (6), i.e. consider the effects of exogenous changes on equilibrium prices, profits and welfare. We now describe the type of counterfactuals we conduct.

4.3 From exclusive dealing to multi-branding

Our main goal is to assess the profit incentives and the welfare effects of a move from exclusive dealing to multi-branding. Such a move essentially consists of a change in the spatial availability of the products that become available at multi-brand dealerships. More formally, we define a move from exclusive dealing to multi-branding as a change in the distance matrix $\mathbf{d}$ (which consists of the nearest distances of all consumers to all products). Define the current system of exclusive dealing by the distance matrix $\mathbf{d}^0$ and a new distribution system with multi-branding arrangements by a new distance matrix $\mathbf{d}^1$.

To illustrate, consider Figure 4.3, showing the location of a single consumer i and three single-product firms I, U and E, who initially apply exclusive dealing. Think of I and U as large incumbents, located close to consumer i, and E as a small entrant, located at a high distance. Suppose that the large firm I opens up its dealer network to the small entrant E, but not vice versa, and the other large firm U remains outside the agreement. Figure 4.3 shows how consumer i's travel distance to E would change, while its travel distances to I and U would stay the same. Multi-branding, as we consider it, is then a shift from the 3×1 distance matrix $\mathbf{d}^0 = \{d_{iI}^0, d_{iU}^0, d_{iE}^0\}$ to $\mathbf{d}^1 = \{d_{iI}^1, d_{iU}^1, d_{iE}^1\}$.

More generally, a move from exclusive dealing ($\mathbf{d}^0$) to multi-branding ($\mathbf{d}^1$) thus involves a change of the travel distances for all consumers whose nearest dealer of a particular product has changed. This increased spatial availability has both direct effects and indirect effects through the change in the Nash equilibrium price vector $\mathbf{p}^*(\mathbf{d})$. We consider the effects on demand, profits and welfare in turn.

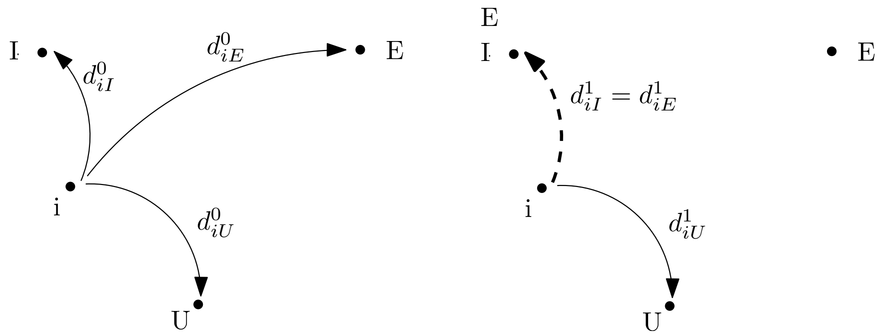

Figure 2: Entrant E makes use of incumbent I.s dealerships under multibranding

Note: The figure illustrates a move from exclusive dealing to multibranding. The panel on the left shows the situation under exclusive dealing, when I, E and U each have their own dealer. The distances that the consumer must travel are given by distance matrix $d^0 = \{d^0_{iI}, d^0_{iU}, d^0_{iE}\}$. The panel on the right shows the situation under multibranding, when E can sell its goods at I's dealer. The distance matrix is now given by $d^1 = \{d^1_{iI}, d^1_{iU}, d^1_{iE}\}$, where $d^1_{iI} = d^1_{iE}$.

Demand effects The total demand effects of multi-branding are

$$\begin{aligned} \Delta \mathbf{q} &= \mathbf{q}\left(\mathbf{p}^*\left(\mathbf{d}^1\right), \mathbf{d}^1\right) - \mathbf{q}\left(\mathbf{p}^*\left(\mathbf{d}^0\right), \mathbf{d}^0\right) \\ &= \underbrace{\mathbf{q}\left(\mathbf{p}^*\left(\mathbf{d}^0\right), \mathbf{d}^1\right) - \mathbf{q}\left(\mathbf{p}^*\left(\mathbf{d}^0\right), \mathbf{d}^0\right)}_{\text{direct demand effect}} + \underbrace{\mathbf{q}\left(\mathbf{p}^*\left(\mathbf{d}^1\right), \mathbf{d}^1\right) - \mathbf{q}\left(\mathbf{p}^*\left(\mathbf{d}^0\right), \mathbf{d}^1\right)}_{\text{indirect demand effect}} \\ &= \Delta \mathbf{q}|_{p^0} + \Delta \mathbf{q}|_{d^1}. \end{aligned}$$

The second and third equalities decompose the total demand effect into a direct demand effect $\Delta \mathbf{q}|_{p^0}$ (holding prices at current equilibrium) and an indirect demand effect (allowing for a new Nash equilibrium).

Consider our example where I opens up its network to E, but not vice versa. The direct effect is to reduce the demand for I and increase the demand for E (and also reduce the demand for U). The indirect demand effect stems from intensified competition and a decrease in prices (because of reduced spatial differentiation). The total demand effect of a shift to multi-branding is therefore ambiguous, though it appears reasonable to expect that the direct effect dominates, hence a net reduction in the demand for I and a net increase in the demand for E.

Profit incentives Consider for simplicity single-product firms. In our empirical analysis, we will take into account that firms are multi-product firms. The effects of multi-branding on the profits of product j are

$$\begin{aligned}\Delta\pi_j &= \left(p_j^1 - c_j\right) q_j\left(\mathbf{p}^*\left(\mathbf{d}^1\right), \mathbf{d}^1\right) - \left(p_j^0 - c_j\right) q_j\left(\mathbf{p}^*\left(\mathbf{d}^0\right), \mathbf{d}^0\right) \\ &= \underbrace{q_j^1\left(p_j^1 - p_j^0\right)}_{\text{competition effect}} + \underbrace{\left(p_j^0 - c_j\right)\left(q_j\left(\mathbf{p}^*\left(\mathbf{d}^0\right), \mathbf{d}^1\right) - q_j\left(\mathbf{p}^*\left(\mathbf{d}^0\right), \mathbf{d}^0\right)\right)}_{\text{(total) demand effect}} \\ &\equiv q_j^1 \Delta p_j + \left(p_j^0 - c_j\right)\Delta q_j.\end{aligned}$$

This decomposes the total profit effect into a competition effect and a (total) demand effect.

In our example where I opens its network to E, the joint profit effect of multi-branding for I and E is

$$\Delta\pi_I + \Delta\pi_E = \underbrace{q_I^1 \Delta p_I + q_E^1 \Delta p_E}_{\text{competition effect}} + \underbrace{\left(p_I^0 - c_I\right)\Delta q_I + \left(p_E^0 - c_E\right)\Delta q_E}_{\text{demand effect}}.$$

To obtain economic intuition on the signs of these effects, consider a symmetric situation, where I and E have identical marginal costs ($c_I = c_E$) and set identical prices in equilibrium ($p_I^k = p_E^k$, $k = 0, 1$), but do not necessarily obtain the same demands. We then obtain

$$\Delta\pi_I + \Delta\pi_E = \underbrace{\left(q_I^1 + q_E^1\right)\Delta p_I}_{\text{competition effect}} + \underbrace{\left(p_I^0 - c_I\right)\left(\Delta q_I + \Delta q_E\right)}_{\text{demand effect}}.$$

Regarding the competition effect, one may expect that prices go down because of the decreased spatial differentiation between firms I and E when I allows E on its network. This is especially the case if consumers are very sensitive regarding distance (weak spatial differentiation) and/or if consumers perceive I and E as close substitutes products (weak brand differentiation).

Regarding the demand effect, one may typically expect that $\Delta q_I < 0$, $\Delta q_E > 0$ and $\Delta q_I + \Delta q_E > 0$: when I opens it network to E, there is a shift in demand from I to E, but the joint demand of I and E may be expected to increase (at the expense of U). Only in the extreme case where the joint demand for I and E is perfectly inelastic with respect to distance, the joint demand for I and E remains unaffected.

The overall profit effect of a shift from exclusive dealing to multi-branding is therefore ambiguous. The standard anti-competitive profit incentive for exclusive dealing only holds if the competition effect dominates the demand effect.

Welfare effects Following Williams (1977) and Small and Rosen (1981), in the logit model the consumer surplus of an individual i in market t (up to a certain constant) is given by

$$CS_{it}\left(\nu_i, D_i\right) = \frac{1}{\alpha_i} \ln \Big(\sum_{j=1}^{J} \exp\left(V_{ijt}\left(\nu_i, D_i\right)\right).$$

Total consumer surplus is obtained by integrating over the density of D_i and ν_i, and summing across markets t:

$$CS = \textstyle\sum_{t=1}^{T} \displaystyle\int CS_{it}\left(\nu_i, D_i\right) f(\nu, D) d\nu dD.$$

Write CS explicitly as a function of $\mathbf{p}$ and $\mathbf{d}$, i.e. $CS(\mathbf{p}, \mathbf{d})$, to decompose the effects of multi-branding on i' s consumer surplus into

$$\begin{aligned} \Delta CS &= CS\left(\mathbf{p}^*\left(\mathbf{d}^0\right), \mathbf{d}^1\right) - CS\left(\mathbf{p}^*\left(\mathbf{d}^0\right), \mathbf{d}^0\right) + CS\left(\mathbf{p}^*\left(\mathbf{d}^1\right), \mathbf{d}^1\right) - CS\left(\mathbf{p}^*\left(\mathbf{d}^0\right), \mathbf{d}^1\right) \\ &= \Delta CS|_{p^0} + \Delta CS|_{d^1} \end{aligned}$$

The first part is the increased consumer surplus because of increased availability, the second part is the change in consumer surplus because of the implied change in prices.

Producer surplus is simply the sum of all firm's profits

$$PS(\mathbf{p}(\mathbf{d}), \mathbf{d}) = \sum_{f=1}^{F} \pi_f\left(\mathbf{p}^*(\mathbf{d}), \mathbf{d}\right),$$

after substituting (4). Similar to consumer surplus, the effects of multi-branding on producer surplus can then be decomposed into

$$\begin{aligned} \Delta PS &= PS\left(\mathbf{p}^*\left(\mathbf{d}^0\right), \mathbf{d}^1\right) - PS\left(\mathbf{p}^*\left(\mathbf{d}^0\right), \mathbf{d}^0\right) + PS\left(\mathbf{p}^*\left(\mathbf{d}^1\right), \mathbf{d}^1\right) - PS\left(\mathbf{p}^*\left(\mathbf{d}^0\right), \mathbf{d}^1\right) \\ &= \Delta PS|_{p^0} + \Delta PS|_{d^1}, \end{aligned}$$

i.e. a profit effect because of increased availability, and a profit effect because of the change in competition. Finally, we can compute the effects of multi-branding on total welfare, the sum of consumer and producer surplus.

5 Data and estimation

We first discuss how we construct our data set from a combination of various sources. We then describe how we use the data set to estimate our spatial demand model with differentiated products.

5.1 Data

Our data set covers the car market in Belgium at a highly disaggregate level. After the five large countries France, Germany, Italy, Spain and the U.K., Belgium is the sixth largest car market in the European Union (larger than the more populated but high car tax country the Netherlands, and larger than the low income countries Poland and Romania). In contrast with the five large countries, there are no domestic brands. This results in a relatively unconcentrated market structure with many European incumbents of similar size.

We combine the following data sets. The main data set consists of car sales by model, zip code and sex. We combine this with three auxiliary data sets: dealer locations and dealer characteristics; car characteristics by model; and household characteristics by statistical sector within each zip code.

Car sales data The data on car sales come from Febiac, the Belgian automobile federation. The data cover car sales during the year 2004 for each model, by zip code and purchaser type. The zip code is the postal code, which refers to a town or a group of at most 2–3 towns. The purchaser type may be one of three groups (in addition to a negligible rest category): men, women and corporations. Since corporations often buy their fleet centrally and have different relationships with the car dealers, we exclude car sales to private companies. We thus end up with car sales data per model, broken down by zip code and sex.

Dealer data The dealer data were assembled by Arvato Spectron in 2005. They consist of 3,329 dealer observations with information on their address and brands sold. We use this information to assign the dealers' geographic (x, y) coordinates and compute the distances between consumers and the nearest dealer per brand.

Car characteristics The data on car characteristics come from JATO. We have data by model and by variant on several product characteristics, including: price, horsepower, maximum speed, acceleration, fuel consumption, length, width, and availability of standard or optional equipment (airbag, climate control, ABS, etc.) Since many of these variables are correlated, we only include four: price, horsepower, length and fuel consumption. Price is the list price, and therefore uniform across markets, just as the other car characteristics. We do not observe dealer discounts, but the evidence (discussed in section 2) suggests that discounts tend to be relatively uniform across consumers, vary little over time, and mainly differ by brand (for which we control using fixed effects) or for corporations (which we exclude from our analysis).

While the characteristics data are available at the model and variant level, we only observe sales at the model level. We therefore construct a baseline version of each model. This is the lowest priced variant, excluding the 25% lowest selling models.

Consumer demographics Finally, we observe consumer demographics by statistical sector within each zip code, obtained from ADSEI (Belgian institute of statistics). This information includes personal income, household size, age of head of household, and degree of urbanization. One may expect that the distribution of these consumer demographics affects car sales, observed at the zip code level. We therefore match the information on consumer demographics to car sales at the zip code level, following Nevo (2001), as discussed in the previous section. Since we observe car sales by sex, this procedure is not needed for this consumer characteristic.

Summary statistics Table 2 summarizes the variables in our data set. The top panel shows summary statistics on car sales. We observe sales of 225 models, in 1,139 zip codes and for 2 consumer types (men and women), amounting to a total of 512,550 observations. Since the data is at such a disaggregate level, there are many models/zip codes/consumer types with zero sales. In fact, average sales per model/zip code/consumer type are equal to 0.5, and the median of sales is zero. Average sales are much higher for European incumbents (1.3) than for other firms (Asian and smaller niche producers, 0.2).

The second panel summarizes information on the calculated travel distances for consumers to the nearest dealer of each brand. The average travel distance is 12.1 km. This seems fairly large, but it follows from the fact that there are many brands with few dealers across the country. Indeed, the average travel distance to dealers of incumbent brands is only 5.7 km, while the average travel distance to other brands is 14 km. For example, consumers need to travel on average 3 km to the nearest Renault or Citroën dealer, and on average 20 km to a Subaru dealer.

The third panel shows summary statistics on the included model characteristics. The average car has a price equal to 0.9 times GDP/capita, but varies from 0.4 for the 10% quartile to 1.5 for the 90% quartile. The other car characteristics, horsepower, fuel consumption and length show similar variation across models.

Finally, the bottom panel summarizes the information on consumer demographics, by zip code. The average zip code (town) has 9,100 inhabitants, about half of which are men. Average GDP/capita is around €25,000, and the average household contains 2.5 members.

Table 2: Summary statistics

Variable	Mean	Std. Dev.	10%.	Median	90%	# Obs.
			Car sales			
Sales - all brands	0.5	1.8	0	0	1	512,550
Sales - incumbents	1.3	3.4	0	0	4	113900
Sales - others	0.2	0.9	0	0	1	398650
			Dealer distance			
Distance (km) - all brands	12.1	14.0	2.3	8.2	25.0	512,550
Distance (km) - incumbents	5.7	4.6	1.3	4.7	11	113,900
Distance (km) - others	14	15.1	2.8	9.7	28.5	398,650
			Model characteristics			
Price (/GDP per cap)	0.9	0.6	0.4	0.8	1.5	225
Horsepower (in kW)	87.9	37.9	47.0	80.0	128.0	225
Fuel consumption (liter/km)	7.0	2.0	4.8	6.5	9.7	225
Length (in cm)	428.4	45.4	366.6	435.0	481.0	225
			Market demographics			
Population(10^3)	9.1	12.0	0.7	5.4	21.8	1,139
Men(10^3)	4.5	5.9	0.3	2.7	10.6	1,139
Women(10^3)	4.7	6.2	0.3	2.7	11.3	1,139
Mean income(10^3)	25.0	4.1	20.0	24.6	30.4	1,139
Household size	2.5	0.2	2.3	2.5	2.7	1,139
Urbanization	5.5	3.3	2.0	5.0	11.0	1,139

Note: The table reports means and standard deviations of the main variables, as well as the 10h, 50th and 90th percentiles. The total number of observations is 512,550: 225 models x 1,139 zip codes x 2 consumer types (men and women), covering Belgium in 2004.

5.2 Estimation

We now discuss how we estimate the demand model with product and spatial differentiation. The estimated demand parameters are subsequently used to uncover markups and marginal costs, based on our equilibrium pricing model. This, in turn, enables us to conduct our counterfactuals on the incentives and effects of exclusive dealing agreements.

Maximum likelihood estimation We estimate the demand parameters using simulated maximum likelihood. In section 4, we first derived the conditional choice probability of individual i in market t for choosing model model j, i.e. $\Pr_{ijt}(D_i, \nu_i)$, as given by (2). We integrated this over the density of unobserved consumer characteristics D_i and ν_i, to obtain the unconditional choice probability $\Pr_{jt}$, as given by (3). We now generalize this to also account for observed consumer heterogeneity, since we observe sales not just by model j and market t, but also by sex s.

The conditional choice probability that individual i of sex s in market t chooses model j can be written as

$$\Pr{}_{isjt}(D_i, \nu_i) = \frac{\exp(V_{isjt}(\nu_i, D_i))}{1 + \sum_{k=1}^{J} \exp(V_{iskt}(\nu_i, D_i))},$$

and the unconditional probability is again the integral over unobserved consumer characteristics D_i and ν_i.

$$\Pr{}_{sjt} = \int \Pr{}_{isjt}(\nu, D) f(\nu, D) d\nu dD.$$

We approximate this integral by taking draws from the empirical distribution for D_i and Halton draws from the normal distribution for ν_i.

Let θ be the vector of demand parameters to be estimated. We can then construct the simulated log likelihood function as the logarithm of the product of all the individual simulated likelihoods:

$$\log L(\theta) = \sum_s \sum_j \sum_t n_{sjt} \log \Pr{}_{sjt}(data, \theta),$$

where n_{sjt} is the number of individuals of sex s choosing model j in zip code t, or simply the observed car sales by sex, model and zip code.

The likelihood function also contains the probabilities $\Pr{}_{s0t}$ that an individual chooses the outside good 0, i.e. take public transportation or use an old car. We therefore need a measure of the number of consumers that choose the outside good, n_{s0t}. This amounts to specifying the total number of potential consumers of sex s in market t, I_{st}, from which we then simply compute $n_{s0t} = I_{st} - \sum_{j=1}^{J} n_{sjt}$. Following other work on the car market, we specify the number of potential consumers I_{st} as proportional to total population, POP_{st}. Since cars are durable goods, we assume that individuals make a purchasing decision every seven years. Furthermore, we exclude the non-active population from the potential market. The number of potential consumers of sex s in market t then becomes $I_{st} = POP_{st}/37$. This is in line with other literature, and we also performed a sensitivity analysis with respect to other factors of proportionality, which gave similar results.

Price endogeneity Our utility specification in (1) does not only include observed car characteristics x_j and p_j, but also characteristics unobserved to the researcher, ξ_j, such as brand image, quality, design, etc. Both consumers and manufacturers may take these unobserved characteristics into account in their purchasing and pricing decisions. This creates a well-known potential endogeneity problem for the price variable. We considered two approaches to account for this.

A first approach is the control function approach of Petrin and Train (2010). In a first stage we perform a linear regression of prices on the observed exogenous product characteristics x_j and additional instruments z_j

$$p_j = E[p_j|x_j, z_j] + \mu_j.$$

Following Berry et al. (1995), Petrin and Train (2010), Albuquerque and Bronnenberg (2010), the instruments z_j include the sum of each exogenous characteristic across all car models of other firms and the sum of each characteristic across other car models of the same firm. In the second stage, we estimate our demand model using maximum likelihood, after replacing ξ_j by $\beta^* \widehat{\mu}_j$ in the utility specification of (1), where $\widehat{\mu}_j$ are the residuals from the first stage regression, and β^* is an additional parameter to be estimated. Petrin and Train (2010) show that the control function approach is consistent under monopoly pricing and marginal cost pricing in a discrete choice setting. Under oligopoly pricing however, the unobservable product product characteristic enters the pricing equation in a nonseparable manner, therefore $\widehat{\mu}_j$ may not fully condition out the dependence of prices on the unobservable product characteristic ξ_j. Any remaining dependence may still bias the estimated price elasticity to some extent.

An alternative approach is to immediately proceed with maximum likelihood, but include a full set of car model fixed effects to control for the unobserved car characteristics ξ_j. As discussed in Nevo (2000), the mean utility parameters associated with x_j and p_j (β and α) are then no longer identified, but one can follow Chamberlain (1982) and in a second stage conduct a linear instrumental variable regression of the estimated fixed effects on x_j and p_j (and adjust the standard errors appropriately).

We implemented both approaches in a simplified setting without random coefficients and obtained similar results (with a slightly lower absolute value for the price parameter under the fixed effects approach). This suggests that in our dataset the control function method works quite well in eliminating the bias from the endogenous price variable. Furthermore, the maximum likelihood method with a full set of model fixed effects is substantially slower, because of the large number of these fixed effects. Estimation would evidently become even slower in the complete model with random coefficients to account for unobserved consumer heterogeneity.[10] Since the results in the simplified setting are similar using both methods, we estimate our rich specification based on a combination of both methods. We include a set of dummy variables for country of origin effects, and implement a control function approach

[10]When estimating 225 model dummies in 2x1139 markets, we need to use matrices of dimension 225x512550. For a small subset of 2x100 markets, thus employing matrices of dimension 225x45,000, maximum likelihood estimation of the 225 model dummies took over 6 hours in the model without random coefficients.

to account for remaining unobserved model characteristics.

6 Empirical results and implications for exclusive dealing

We first discuss the estimated demand parameters. We then combine these parameters with our equilibrium pricing model to perform policy counterfactuals on the effects of a move from exclusive dealing to multi-branding.

6.1 Empirical results of demand model

Specification We considered a variety of different specifications for our spatial demand model: with or without consumer demographics to account for observed heterogeneity (Π); and with or without random coefficients to account for unobserved heterogeneity (Σ). Table 3 presents the empirical results for the complete model, including consumer demographics and random coefficients to account for unobserved consumer heterogeneity. Several tables in Appendix shows the results of the parallel models that do not account for observed and/or unobserved heterogeneity.

The vector of car characteristics x_j consists of a constant and the variables horsepower, length, and fuel consumption. The vector of consumer demographics D_i consists of the variables female, income, household size and urbanization. Finally, the distance vector d_{ijt} includes both distance (in km) and distance squared, to account for a possibly declining impact of distance on utility.

To account for unobserved consumer heterogeneity we restrict the random coefficients matrix Σ to the diagonal elements. To account for observed consumer heterogeneity (in the second specification), we can in principle interact all consumer demographics D_i with price p_j and the other car characteristics x_j through the parameter matrix Π. Since we observe sales by sex, it was indeed possible to interact the variable female with all car characteristics (including the constant). For the other demographics, however, we only observe the empirical distribution across consumers, so it was more difficult to precisely estimate all interaction parameters. We therefore interact the other demographics only with the constant and a limited number of other car characteristics.

We first discuss the estimated mean valuations for price p_j and the other car characteristics x_j (first column of Table 3), and then discuss the observed and unobserved consumer heterogeneity regarding the valuation of these characteristics (next columns). Finally, we discuss the consumers' valuations for distance to the nearest dealer d_{ij}.

Table 3: Results of the random coefficients logit model with observed and unobserved consumer heterogeneity

	Means	Std. Dev.	Interactions with Demographics			
	(β's)	(σ's)	Female	Income	Hh size	Urbanization
Constant	-1.79	2.21	-1.11	7.03	-0.42	-0.19
	(0.13)	(0.04)	(0.06)	(0.14)	(0.05)	(0.00)
Price	-7.27	0.05	-0.43	8.27	-	-
	(0.04)	(0.03)	(0.03)	(0.11)		
Length	0.45	0.00	-0.35	-	0.36	-
	(0.03)	(0.00)	(0.01)		(0.01)	
Fuel consumption	-5.67	0.27	-0.29	-	-	0.02
	(0.04)	(0.03)	(0.03)			(0.00)
Horsepower	5.44	0.17	-1.16	-	-	-
	(0.03)	(0.04)	(0.04)			
distance	-0.57	0.33	-0.16	-	-	-
	(0.00)	(0.01)	(0.01)			
distance^2	0.00	0.00	0.01	-	-	-
	(0.00)	(0.00)	(0.00)			
$\widehat{\mu}$	3.72		-	-	-	-
	(0.02)					
Origin dummies	yes					

Note: The table shows parameter estimates and standard errors (in parentheses) of the mean effects (β's) in the first column. Column 2 shows estimates of the random coefficients (σ's), while columns 3-6 show estimates of the interactions between product characteristics and consumer demographics. Compared with the summary statistics in Table 2, the variables are scaled as follows: horsepower/100, fuel consumption/10, length/100, distance/10 and income/100.

Mean valuations for the car characteristics Price has a significant and negative impact on consumers' mean utility. The implied average own-price elasticity across car models is equal to -4.7. This corresponds to a mean price cost–margin of 30% (median of 26%), which is broadly in line with other estimates, e.g. Berry, Levinsohn and Pakes (1995) or Goldberg and Verboven (2001). Horsepower and length have a significantly positive impact on mean utility. Fuel consumption (liter per 100 km) has a negative effect, meaning that consumers on average care a lot about fuel efficiency.

Note that the residual $\widehat{\mu}$ of the first stage price regression has a significant positive coefficient, indicating that the control function method captures the endogeneity of the price variable quite well. As expected, when we estimate the model without the control function, the price coefficient is estimated much closer to zero, as shown in Appendix. The average own-price elasticity also drops considerably to -1.8, compared with -4.7 when we accounted for price endogeneity.[11]

Observed and unobserved consumer heterogeneity There is considerable heterogeneity in the valuation of the car characteristics across consumers. We begin with the role of observed consumer heterogeneity (Π). Women show a substantially different purchasing behavior than men. They are more sensitive to price and especially to fuel costs, and they tend to care less about horsepower. In contrast with men, they only have a weak preference for larger cars: the valuation parameter of length is 0.45 for men, and only 0.10 (=0.45–0.35) for women. This may reflect the tradition of multi-car households to register the family car under the man's name. Finally, the constant suggests that women are substantially less likely to purchase a car (and instead choose the outside good). This may capture the frequent practice of single-car households to register their car under the men's name.

As mentioned earlier, we do not have direct sales information on the other demographics, and only observe the distribution of these demographics by zip code. We therefore consider a more limited number of interactions for the other demographics. High income households are more likely to buy a car, and tend to be less price sensitive. Larger households have a stronger valuation for car size (length) and for the outside good. Urban households are less likely to buy a car, as they have better access to public transportation. Urban households are also slightly less concerned about fuel efficiency, possibly because they tend to have a lower annual mileage than households in rural areas.

Now consider unobserved consumer heterogeneity, as captured by the random coefficients (Σ). They are precisely estimated and quantitatively important compared to the mean valuations (β). For example, the mean (-5.67) and standard deviation (0.27) for the valuation of fuel consumption imply that 95% of consumers have a valuation for fuel consumption in the interval [–5.14,–6.20]. It is interesting to note that the random coefficients on the constant, price and fuel consumption are significantly lower than in the model where we do not account for observed heterogeneity (see table in Appendix). Consumer demographics therefore capture a significant part of consumer heterogeneity. Nevertheless, there is still an important part of unobserved heterogeneity left.

The economically most relevant random coefficient turns out to be the one associated with the constant. This parameter reflects consumer heterogeneity regarding the valuation

[11] As discussed above, as an alternative to the control function approach, we also included a full set of car model fixed effects, and estimated the price coefficient and other mean utility parameters in a second stage. This procedure gave similar results, though we only implemented it on a simplified model because it is computationally much more complex because of the large number of car model fixed effects.

of the inside goods relative to the outside good. It thus allows substitution between inside goods to be stronger than substitution towards the outside good. Our estimates show that the random coefficient on the constant is more than twice as large as the mean, indicating strong substitution between inside goods relative to the outside good.[12] To confirm this finding, we also estimated a nested logit model where the first nest includes all inside goods, and the second nest includes the outside good. The nesting parameter of this model has a similar interpretation as the standard deviation for the constant. This results in a highly significant nesting parameter of 0.33, implying very similar results on the substitutability of the inside goods versus the outside good (results not shown).

In sum, these findings indicate the importance of accounting for both observed and unobserved consumer heterogeneity, in particular regarding the valuation of the outside good. Accounting for consumer heterogeneity implies more flexible substitution patterns. The cross-price elasticities among the inside goods are on average almost three times larger (1.3) than the cross-price elasticities between the inside goods and the outside good (0.5).[13] These flexible substitution patterns will be important in our counterfactuals. As we discuss below, a simple logit without consumer heterogeneity would predict too much substitution between inside goods and the outside good, and thus lead to unrealistic effects of introducing multi-brand dealers.

Distance to dealers In addition to car characteristics, consumers value dealer proximity: distance has a strong and highly significant, negative effect on consumer utility. Women value dealer proximity even more than men. There is substantial unobserved heterogeneity, since the standard deviations for the distance coefficient is about half of the mean. Note that the magnitudes of the estimated mean distance coefficients are of a similar order of magnitude as Albuquerque and Bronnenberg (2010)'s results for the car market in the San Diego area (in a model that does not allow for consumer heterogeneity regarding the valuation of distance).[14]

The distance coefficients imply that consumers are more likely to purchase a given brand if they are closely located to the brand. This has several possible interpretations. It may reflect direct travel costs associated with the search and purchase of a new car, or a higher brand awareness when a dealer of a particular brand is located nearby. Probably more

[12] Furthermore, in the model without the random coefficients (see table in Appendix) most remaining parameters remain similar. The only exception is the constant, which is much higher and thus appears to take over the omitted random coefficient on the constant.

[13] A figure in Appendix provides more information on the distribution of the own- and cross price elasticities.

[14] Albuquerque and Bronnenberg (2010)'s coefficient ranges between -0.7 for the logit model and -0.2 for the nested logit model (when transformed from 100 miles to 10km). We obtain measures between -0.4 and -0.6 across our 4 specifications.

importantly, it may also reflect travel costs for expected after-sales services, because there are still strong links between the sales and after-sales network in the European car market (e.g. Lademann and Partner (2001)).[15]

Regardless the interpretation, the strong significance of the distance coefficients highlights the importance of a dense dealer network to establish market share. To gain further insights in this, Table 4 computes a distance elasticity matrix. Each cell shows the predicted percentage change of a brand's market share when the distances to dealers of a given brand are decreased by 10%. The elements on the diagonal show the effect of the change in dealer distances on the brand's own market share. We find that a brand's market share would on average increase by 2% if its dealers are 10% closer to consumers. For example, Opel would experience a market share increase of 2.2% (or an increase by 0.2 percentage points from 9.1% to 9.3%). The off-diagonal elements of the matrix represent the effects on the other brands' market shares when a dealer's distance decreases by 10%. The table shows that Opel would mainly gain at the expense of its competitors, rather than from attracting new consumers (outside good). This follows from the high significance of the estimated random coefficient on the constant and will be important when we consider the policy counterfactuals on a shift to multi-branding.

In sum, these findings on the importance of dense dealer networks are a first indication that exclusive dealing may serve as an entry barrier. We will explore this in much more detail in our counterfactuals in the next subsection.

Table 4: Distance elasticity matrix using full demand model

	Opel	Citroën	Toyota	Honda	Outside good
Opel	2.2	-0.3	-0.3	-0.3	-0.1
Citroën	-0.2	1.6	-0.2	-0.2	-0.1
Toyota	0.0	0.0	2.2	0.0	0.0
Honda	0.0	0.0	0.0	2.4	0.0

Note: The table reports the percentage change in market shares for Opel, Citroën, Toyota, Honda and the outside good (columns), when dealers of Opel, Citroën, Toyota and Honda are located 10% closer to consumers (rows).

[15] According to Lademann and Partner (2001), a large fraction of consumers make use of maintenance and repair services at the dealer where they purchased their car. The car manufacturers actively promote the link between sales and after-sales services, for example through a warranty system at authorized dealers. In recent years, the European Commission has attempted to loosen the link, but apparently with mixed success.

6.2 Incentives and effects of exclusive dealing

We use the estimated demand system and equilibrium conditions to uncover the manufacturers' current marginal costs, as given by (7). We then perform policy counterfactuals to assess the effects of a shift from exclusive dealing to multi-branding. As discussed in section 4, a shift to multi-branding can be modeled as a shift in the distance matrix from $\mathbf{d}^0$ to $\mathbf{d}^1$. It may have direct effects on profits and welfare, and indirect effects through a change in the equilibrium price vector defined by (6).

Following our framework set out in section 3, we consider both unilateral and collective multi-branding agreements between incumbents and entrants. Our data set contains 33 brands, which we divide in 11 European incumbents and 22 entrants. The European incumbent mass manufacturers that we consider are large with respect to sales and density of the dealer network. They are Opel, Citroën, Peugeot, Renault, Volkswagen, Ford, BMW, Seat, Fiat, Audi and Mercedes.[16] The other 22 brands are Asian, Eastern European and smaller Western European brands. In each multi-branding agreement we pair one of the 11 European incumbents with two of the 22 entrants, so that dealers sell at most three brands. This is consistent with the second reform of the Block Exemption Regulation's between 2002-2010, when dealers could in principle sell up to three brands (see section 2). More specifically, we pair each of the incumbents with 1 Asian and 1 non-Asian brand in decreasing order of sales.[17] We also considered numerous other possible combinations of agreements, and these lead to similar conclusions.

For simplicity, we consider "one-way access", i.e. the incumbents accept the entrants on their existing network, but not vice versa. We assume that entrants keep their existing dealerships, but results are robust with respect to this assumption. Allowing two-way access would imply that the incumbents also obtain new dealerships: this would go against most of the theoretical literature on exclusive dealing as an entry barrier, and is also likely to infringe current exclusive territory agreements (since the incumbents already have many dealerships, all with exclusive territories). We thus end up with 11 hypothetical unilateral agreements, and one collective agreement where all 11 agreements are made simultaneously.[18]

We first consider the internal profit incentives, and focus on comparing unilateral with collective agreements. We subsequently consider the external effects on market shares, consumer surplus and welfare, focusing only on the collective agreement.

[16] Opel (G.M.) and Ford are multi-national firms under U.S. ownership. We treat them here as incumbents because of their long market presence through local production facilities targeted mainly for European markets.

[17] Since there are only 10 Asian brands, we do not pair Mercedes with an Asian, but instead with 2 other luxury brands.

[18] Table A-6 in Appendix lists all the agreements in detail.

6.2.1 Internal profit incentives

Table 5 shows the effects of hypothetical multi-branding agreements on the manufacturers' profits. Unilateral agreements are in the left panel, collective agreements are in the right panel. The results are based on the demand parameters of the full model with both observed and unobserved consumer heterogeneity.

Unilateral agreements According to Table 5, each unilateral multi-branding agreement would substantially raise the firms' combined profits. For example, an agreement between Opel, Toyota and Skoda lowers Opel's profits by 0.7%, but substantially raises Toyota's and Skoda's profits by 17%, implying a combined profit increase for the three brands of 3.5%.

To explain this, recall our conceptual framework for the profit incentives for exclusive dealing in section 3. There are essentially two opposing effects of a multi-branding agreement. On the one hand, it intensifies competition and thus reduces profits; this is the typical effect stressed in the theoretical literature. But on the other hand, multi-branding raises the spatial availability and thus steals business from competitors and the outside good. With unilateral agreements, there is a lot of business stealing from competitors, so that the availability effect dominates the competition effects.

Since all unilateral multi-branding agreements in Table 5 raise the firms' combined profits, it is quite safe to conclude that there are no unilateral anti-competitive profit incentives to maintain exclusive dealing arrangements in the absence of efficiencies. Hence, the profit incentives should be sought elsewhere. Perhaps there is a collective anti-competitive profit incentive. We turn to this possibility next.

Collective agreements The situation is indeed quite different when we consider the manufacturers' collective incentives, i.e. when we compare profits assuming that all twelve manufacturers simultaneously shift to multi-branding. The combined profits of each incumbent–entrant pair now no longer necessarily increase. There is only a strong profit increase for 2 out of the 11 agreements. The other 9 multi-branding agreements are barely profitable, or even induce a strong profit reduction when collectively moving from exclusive dealing to multi-branding. The total combined profit effects of a collective shift from exclusive dealing to multi-branding are negative, but small, i.e. -0.2%.

The intuition again follows from the two opposing effects of a shift to multi-branding: the negative effect from intensified competition and the positive effect from increased spatial availability. From the manufacturers' collective perspective, the availability effect is much less important. Since all firms are now in multi-branding agreements, there is only potential business stealing from the outside good. But this business stealing from the outside good

Table 5: Internal profit incentives for exclusive dealing (in €mil.) using full demand model

	(1) Current profit (€ mil.)	(2) Unilateral agreement % Δ Incumb.	% Δ Other 2	% Δ Both	(3) Collective agreement % Δ Incumb.	% Δ Other 2	% Δ Both
Opel & 2	217	-0.7	17.0	3.5	-7.1	9.1	-3.2
Citroën & 2	268	-0.7	18.8	2.8	-7.1	10.8	-3.9
Peugeot & 2	180	-1.2	30.1	6.9	-7.0	22.0	0.4
Renault & 2	200	-0.8	19.2	4.1	-7.4	11.2	-2.8
VW & 2	145	-0.9	24.5	6.2	-7.2	16.5	-0.6
Ford & 2	137	-1.3	68.1	8.8	-7.3	57.7	2.2
BMW & 2	39	-0.2	14.1	5.5	-6.9	6.2	-1.7
Seat & 2	81	-1.9	44.6	26.1	-7.0	37.1	19.6
Fiat & 2	43	-0.7	34.8	16.2	-7.0	26.0	8.7
Audi & 2	45	-0.3	66.7	6.9	-7.2	54.9	-0.5
Mercedes & 2	24	0.0	53.0	1.8	-6.8	42.6	-5.1
Total	1,378	-0.9	28.8	6.6	-7.1	20.6	-0.2

Note: The table reports for each of the 11 agreements between 1 incumbent and 2 entrants: (1) the current joint profit of the 3 parties; (2) the percentage change in profits made by the incumbent and 2 entrants in a unilateral agreement; (3) and the percentage change in profits when all agreements are made collectively. Precise definitions of the agreements are provided in the.

turns out to be fairly limited, since our demand model showed that consumers tend to view the inside goods as quite close substitutes relative to the outside good (strong observed and unobserved heterogeneity regarding the constant).[19]

In sum, these counterfactuals show that the car manufacturers do not have unilateral anti-competitive incentives to engage in exclusive dealing absent efficiencies, since they would lose too much sales to competitors and limit competition only to a limited degree. However, from a collective perspective, manufacturers can have anti-competitive profit incentives for exclusive dealing (even absent efficiencies), since they only lose sales relative to the outside good and can restrict competition more substantially.

[19] This is different in our simplified logit model where we do not account for consumer heterogeneity, as reported in the Appendix. In this case, there is much more substitution from the outside good so that even collective multi-branding is quite profitable.

6.2.2 External effects of exclusive dealing on the market

We can now consider the external effects of exclusive dealing. Given that firms do not have a unilateral, but possibly a collective anti-competitive incentive, we limit attention to the external effects from a collective multi-branding agreement. More specifically, Table 6 shows the effects of a collective multi-branding agreement (or a ban on exclusive dealing) on market shares, total profits, consumer surplus and total welfare. To gain economic intuition, we present a decomposition into the direct availability effect of multi-branding, holding prices constant, and the indirect competition effects, through changes in the equilibrium prices (as discussed in section 4).

Market shares would shift from the European incumbents in favor of the entrants after a collective ban on exclusive dealing. The European incumbents would loose 5.3 percentage points of market share, and the entrants would gain the same amount when they can access the incumbents' dealer networks. Holding prices constant, the European incumbents would loose 5.5% points of market share, because the Asian entrants are now located closer to consumers. But the incumbents gain back 0.2 percentage points as a result of the changed prices. Intuitively, multi-branding intensifies price competition, and especially by the incumbents whose market power has decreased. Similarly, the market share gain of the entrants is largely due to their increased distribution network and slightly reduced by the price effect.

Consumers would gain from a collective ban on exclusive dealing. Consumer surplus will rise by €3.8 billion. This amounts to €867 per household, which is a sizeable fraction of the average price of a sold car. The biggest part of this increase (€781 per household) is due to increased spatial availability: the larger number of dealerships means that consumers incur lower travel costs associated with sales and after-sales services. A smaller part of the consumer surplus increase (€87 per household) is due to the reduced prices stemming from the increased competition after a ban on exclusive dealing. On balance, most of the consumer gains from multi-branding are due to increased spatial availability (90%), and only a small part is due to increased competition (10%). Industry profits do not change that much, so that the total welfare increase from multi-branding largely coincides with the gains to consumers (+€3.8 billion).

6.2.3 Summary

We can summarize these findings as follows. Absent efficiency considerations, a ban on exclusive dealing would have a quite substantial positive effect on consumer surplus and total welfare. The consumer gains of about €3.8 billion or €867 per household are for 90% due to increased spatial availability of brands, and only for 10% due to the benefits from

Table 6: Welfare effects of a ban on exclusive dealing using full demand model

	Current	Total change	Change at ct prices	Change due to prices
	Market shares (%)			
Outside good	24%	-0.8	-0.7	-0.1
Inside goods	76%	+0.8	+0.7	+0.1
Incumbents	73%	-5.3	-5.5	+0.2
Entrants	27%	+5.3	+5.5	-0.2
Total	100%	+0.0	+0.0	+0.0
	Profits (€ million)			
Incumbents	1,031	-74	-69	-5
Entrants	346	+71	+74	-3
Total	1,378	-3	5	-8
	Consumer surplus (€ million)			
Total		+3817	+3436	+381
Per hh (euro)		+867	+781	+87
	Welfare (€ million)			
Total		+3814	+3441	+373

Note: The table reports the effects of a collective shift to multi-branding on the market shares, profits, consumer surplus and total welfare. The effects are split into a change at constant prices (only spatial availability effect) and a change due to changed prices

increased price competition. Firms clearly have no unilateral incentives for maintaining exclusive dealing, but they can have collective incentives to adopt exclusive dealing, even in the absence of efficiencies. In sum, the current distribution system, where firms collectively maintain exclusive dealing, does not necessarily have an efficiency rationale (such as the provision of services) and can imply large losses to consumers and welfare.

7 Extensions

To gain further intuition on the incentives and effects of exclusive dealing we now consider several extensions of the base model of section 6. First, we ask how the results change under alternative demand specifications, in particular if consumers cannot substitute to the outside good. Second, we ask what happens when a multi-branding agreement operates as a common agency mechanism to raise prices of the firms in the agreement (as in a merger).

7.1 The role of the outside good in alternative demand models

According to our base model, firms have a strong unilateral incentive to make multi-branding agreements, but they can have a collective incentive to maintain exclusive dealing. Intuitively, multi-branding does not only intensify price competition, but it also raises demand because of increased spatial availability. With a unilateral multi-branding agreement the demand effect is large because there is business stealing from both the competitors and from the outside good. With a collective multi-branding agreement the demand effect is much lower, since there is only business stealing from the outside good. Hence, a collective multi-branding agreement may not be profitable, if substitution to the outside good is small relative to the intensified price competition.

This discussion shows that the substitution possibilities towards the outside good are central to understand the collective incentives for exclusive dealing that we estimated. This is why we specified a rich demand model, and in particular allowed for both observed and unobserved heterogeneity regarding the valuation of the outside good (the intercept). Nevertheless, it is still possible that the demand model overestimates substitution from the outside good after a multi-branding agreement. If so, then the profit gains from multi-branding would be overestimated. In this section we therefore ask how do the results change (i) when specifying simplified models with less heterogeneity regarding the outside good valuation, and (ii) when specifying a model where consumers cannot substitute to the outside good (and hence can only substitute to other firms).

Table 7 shows a summary of the results from this sensitivity analysis. The first four rows address the first question. They show how a collective multi-brand agreement affects the share of the outside good, profits and consumer surplus under four demand specifications: the simple logit without consumer heterogeneity ($\Pi = \Sigma = 0$), the logit with only observed heterogeneity through the demographic variables (Π only), the logit with only unobserved heterogeneity through the random coefficients (Σ only) and the logit with both observed and unobserved heterogeneity (both Π and Σ, our base model above).[20] Both simple logit and the logit with only observed heterogeneity overestimate substitution from the outside good after a multi-brand agreement. Hence, these models find that multi-branding increases total profits, hence no collective incentive for exclusive dealing. In contrast, the logit with unobserved heterogeneity implies limited substitution from the outside good. As a result, this model predicts that multi-branding reduces total profits, or a collective incentive for exclusive dealing (even higher than in the base model with both observed and unobserved heterogeneity).

[20] The Appendix presents more complete results (demand parameters and counterfactuals) for these models, as well as for the model without an outside good discussed further below.

The last row shows the results from an alternative demand model with both observed and unobserved heterogeneity, but without substitution possibilities towards the outside good. This model thus assumes that consumers always buy one car, regardless of prices or spatial availability, in line with assumptions in some theoretical work, e.g. Besanko and Perry (1994). By construction, in this model multi-branding attracts no demand from the outside good. This in turn implies that the multi-branding agreement now reduces profits by a larger amount: by -1.4% as compared with -0.2% in the base model where we allowed substitution to the outside good. Hence, if we abstract from substitution to the outside good, the collective incentives for exclusive dealing become stronger, but they are not overwhelming. The reason is that multi-branding on the one hand does not attract demand from the outside good (by construction), but on the other hand it also does not intensify competition by that much (as shown in Appendix where we present the welfare effects including the price effects).

Table 7: Summary of profit incentives and external effects under alternative demand models

Demand	Δs_0 (% points)	$\Delta\pi$ (mill. €)	(%)	ΔCS (€ / hh)
simple logit ($\Pi = \Sigma = 0$)	-1.1	+11	+0.8	+641
logit + Π	-1.2	+9	+0.7	+774
logit + Σ	-0.4	-7	-0.5	+740
logit + Π + Σ	-0.8	-3	-0.2	+867
logit + Π + Σ; no outside good	0	-25	-1.4	+1105

Note: The table reports the effects of a collective shift to multi-branding on the market share of the outside good (Δs_0), total profits ($\Delta\pi$) and consumer surplus (ΔCS). Results are for four alternative demand models: logit without heterogeneity ($\Pi = \Sigma = 0$), with only observed heterogeneity (Π), with only unobserved heterogeneity (Σ), with both observed and unobserved heterogeneity (the full model), and the full model but assuming there is no outside good.

7.2 Change in price-setting behavior

Our base model assumed that multi-brand agreements do not influence pricing behavior: firms continue to behave as multi-product price-setting firms, accounting for other products of the firm, but competing with products from rival firms. However, Bernheim and Whinston (1998) showed that two competing upstream firms may alter their behavior when they sell their products through a common agent (i.e. a multi-brand dealer): they can use the common agent to coordinate on the monopoly outcome. Rey and Vergé (2010) extend this framework to have interlocking relationships between two upstream firms and two downstream retailers.

Under RPM, there are multiple equilibria for wholesale and retail price schedules. In one equilibrium, retail prices are the Bertrand prices (and wholesale prices are such that variable retail margins are zero). This was the equilibrium we considered in our base model, and for which Bonnet and Dubois (2010) found empirical support in another context. In another equilibrium, retail prices are equal to the joint-profit maximizing monopoly prices (and wholesale prices are equal to marginal costs). This equilibrium is similar to Bernheim and Whinston's common agency model with one retailer.

In the spirit of this common agency literature, we modify our base model and assume that firms in a multi-brand agreement set retail prices to maximize their joint profits. These are not the monopoly prices as in the above papers, since we do not consider a single common agent selling all products. Instead, these are the prices of multi-product price-setting firms taking into account the products of all brands in the multi-brand agreement, both the ones already owned before the agreement and the ones that they gain in the multi-brand agreement. Hence, we consider multi-brand agreements that are equivalent to a full merger between the firms in the considered multi-brand agreement. For example, a multi-brand agreement between Opel and Toyota does not only imply that Toyota gets access on Opel's network (as in the base model), but also that Opel and Toyota set their prices as a single firm. Concretely, as in section 5 we still assume that multi-branding changes the distance matrix from $\mathbf{d}^0$ to $\mathbf{d}^1$, but we now also assume that multi-branding changes the firms' ownership matrix as in a merger simulation.

Table 8 shows the profit incentives of a collective shift to multi-branding (parallel to the right panel of Table 5). All agreements now become profitable, because multi-branding eliminates competition between the involved firms. As a result, total profits of all firms would increase by 6.3% after a collective shift to multi-branding (as opposed to a drop by -0.2% if multi-branding would not eliminate competition). In sum, if multi-branding induces the involved firms to coordinate their pricing decisions, it becomes very difficult to rationalize exclusive dealing, even from a collective perspective: large efficiencies are required.

Table 9 shows the external effects of a collective shift to multi-branding when firms in the agreement set prices cooperatively. The changes at constant prices evidently remain the same as in the base model, shown in Table 6. The differences stem from the new, more cooperative price equilibrium assumed here. First, the shift in market share from the incumbents to the entrants becomes much smaller (-3.4% instead of -5.3% in the base model). This is because under coordinated pricing the entrants raise their prices by more than the incumbents, allowing the latter to gain back part of the lost market share after opening access to their dealership network. Second, the increase in profits under multi-branding mainly comes from the higher prices (+€80 million), and only slightly comes from the higher demand due

Table 8: Internal profit incentives for exclusive dealing (in €mil.) under change in price-setting behavior

	(1) Current profit (€ mil.)	(2) Collective agreement % Δ Incumb.	% Δ Other 2	% Δ Both
Opel & 2	217	-0.4	17.0	3.8
Citroën & 2	268	-1.8	14.8	1.1
Peugeot & 2	180	-1.8	25.8	5.3
Renault & 2	200	-0.5	18.9	4.4
VW & 2	145	-1.1	23.1	5.7
Ford & 2	137	-0.1	69.4	10.0
BMW & 2	39	0.6	14.8	6.2
Seat & 2	81	-0.9	45.0	26.7
Fiat & 2	43	0.3	36.0	17.3
Audi & 2	45	-1.0	63.8	5.9
Mercedes & 2	24	0.8	55.1	2.6
Total	1,378	-0.9	27.6	6.3

Note: The table reports for each of the 11 agreements between 1 incumbent and 2 entrants under Common Agency: (1) the current joint profit of the 3 parties; (2) the percentage change in profits made by the incumbent and 2 entrants in a unilateral agreement; (3) and the percentage change in profits when all agreements take place simultaneously.

to increased spatial availability (+€6 million). Third, while we found large consumer gains from a collective shift to multi-branding (+€867 per household), consumers are now actually hurt, albeit by a small amount (-€22 per household): the gains from increased spatial variety (+€781) are more than outweighed by the losses from the increased prices (-€803).

To summarize, if multi-branding would result in an equilibrium where the involved firms coordinate their pricing decisions, firms have a strong profit incentive to shift to multi-branding, while consumers are essentially unaffected (since their gains from more availability are compensated by their losses from higher prices. Since firms in practice apparently prefer exclusive dealing over multi-branding, this means that there must be large efficiency gains so that a ban on exclusive dealing would likely harm welfare under this scenario.

Table 9: Welfare effects of a ban on exclusive dealing under change in price-setting behavior

	Current	Total change	Change at ct prices	Change due to prices
	Market shares (%)			
Outside good	24%	0.0	-0.7	0.7
Inside goods	76%	+0.0	+0.7	-0.7
Incumbents	73%	-3.4	-5.5	2.1
Entrants	27%	+3.4	+5.5	-2.1
Total	100%	+0.0	+0.0	0.0
	Profits (€ million)			
Incumbents	1,031	-9	-68	59
Entrants	346	+95	+74	21
Total	1,378	86	6	80
	Consumer surplus (€ million)			
Total		-95	+3436	-3531
Per hh (euro)		-22	+781	-803
	Welfare (€ million)			
Total		-9	+3442	-3451

Note: The table reports the effects of a shift to multi-branding on the market shares, profits, consumer surplus and total welfare under Common Agency, ignoring efficiency gains. The effects are split into a change at constant prices (only spatial availability effect) and a change due to changed prices

8 Conclusion

Exclusive dealing contracts between manufacturers and retailers force new entrants to set up their own dealer networks to enter the market. If consumers care a lot about dealer proximity, then new entrants must set up dense networks to enter the market and obtain critical mass. Exclusive dealing may then act as a barrier to entry and foreclose new competitors. We develop a framework to understand the internal profit incentives and external effects of exclusive dealing, and apply it to the European car market. The empirical results from our demand model show, among other things, that consumers indeed put a high value on dealer proximity, presumably because of strong links with after-sales services. Counterfactuals show that manufacturers have a strong unilateral incentive to shift from exclusive dealing to multi-branding. However, the industry as a whole can have a collective incentive to maintain exclusive dealing, even in the absence of efficiencies. A ban on exclusive dealing would shift market shares from the larger European firms to the smaller entrants. But more importantly, consumers would gain substantially, mainly because of the increased spatial availability and less so because of intensified price competition. Our findings suggest that the European

Commission's recent decision to facilitate exclusive dealing in the car market may not have been warranted.

Our analysis is based on a number of assumptions that may be generalized in future research. First, as in most of the car market literature we assumed a standard pricing equilibrium, where it is as if the upstream and downstream firm are vertically integrated. This equilibrium is consistent with the various price- and non-price restraints in the car market, and with some empirical evidence in another context (Bonnet and Dubois (2010)). Further work could consider other pricing equilibria, but this would best require additional data such as wholesale prices or information on sales targets and bonuses at the dealer level, which is difficult to obtain for the car market.

Second, we considered simple policy counterfactuals, where alternative manufacturers shift from exclusive dealing to multi-branding. An extensive sensitivity analysis confirmed that the results remain similar for other collective multi-branding agreements. It would be interesting to endogenize the entry decisions to uncover fixed entry costs and compute new equilibria after a ban on exclusive dealing. Estimating such a model implies important new challenges: it does not only require modeling both the manufacturers' decisions to allow more retailers on their networks (taking account of territorial exclusivity), it also involves modeling the retailers' decisions to enter and accept exclusive dealing, for which there is no unified theory yet as we reviewed in the introduction.[21] Also, computing a new entry equilibrium after a ban on exclusive dealing is challenging, not only because of the great number of possible dealer locations, but also since the equilibrium depends on the specific assumptions and is not necessarily unique. These questions are nevertheless interesting to explore in future research.

[21] This would follow an emerging literature on estimating fixed costs from models of demand and entry. In a simplified setting, Berry and Waldfogel (1999) estimate a demand model together with a free entry model, while Ferrari et al. (2010) estimate a demand model simultaneously with a monopoly model with restricted entry. Ishii (2008) is an example of a more complicated model of spatial demand and entry, following Pakes et al.'s (2011) moment inequalities approach.

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Appendix

Table A-1: Results of the logit model without consumer heterogeneity and without controlling for price endogeneity

	Means	Std. Dev.	Interactions with Demographics			
	(β's)	(σ's)	Female	Income	Hh size	Urbanization
Constant	-2.76					
	(0.02)					
Price	-1.94					
	(0.01)					
Length	0.87					
	(0.01)					
Fuel consumption	-5.41					
	(0.02)					
Horsepower	0.71					
	(0.02)					
distance	-0.48					
	(0.00)					
distance^2	0.03					
	(0.00)					
Origin dummies	yes					

Note: The table shows parameter estimates and standard errors (in parentheses) of the mean effects (β's) in the first column, when we do not control for endogeneity in price. We find estimates for price and horsepower that are much closer to zero compared to the estimates including the control function approach in the next table. Column 2-6 are empty since we don't account for any observed or unobserved heterogeneity among consumers in the simple logit specification.

Table A-2: Results of the logit model without consumer heterogeneity

	Means (β's)	Std. Dev. (σ's)	Interactions with Demographics: Female	Income	Hh size	Urbanization
Constant	-4.89					
	(0.02)					
Price	-5.38					
	(0.02)					
Length	1.14					
	(0.01)					
Fuel consumption	-5.66					
	(0.02)					
Horsepower	5.33					
	(0.03)					
distance	-0.48					
	(0.00)					
distance^2	0.03					
	(0.00)					
$\widehat{\mu}$	3.95					
	(0.02)					
Origin dummies	yes					

Note: The table shows parameter estimates and standard errors (in parentheses) of the mean effects (β's) in the first column. Column 2-6 are empty since we don't account for any observed or unobserved heterogeneity among consumers in the simple logit specification.

Table A-3: Results of the logit model with only observed consumer heterogeneity

	Means	Std. Dev.	Interactions with Demographics			
	(β's)	(σ's)	Female	Income	Hh size	Urbanization
Constant	-1.05		0.77	5.7608	-1.56	-0.13
	(0.12)		(0.04)	(0.06)	(0.05)	(0.00)
Price	-6.52		-0.44	3.94		
	(0.04)		(0.03)	(0.11)		
Length	0.02		-0.58		0.56	
	(0.03)		(0.01)		(0.01)	
Fuel consumption	-5.89		-0.11			0.03
	(0.04)		(0.03)			(0.00)
Horsepower	5.86		-0.69			
	(0.03)		(0.04)			
distance	-0.54		-0.20			
	(0.00)		(0.01)			
distance^2	0.04		0.01			
	(0.00)		(0.00)			
$\widehat{\mu}$	4.04					
	(0.02)					
Origin dummies	yes					

Note: The table shows parameter estimates and standard errors (in parentheses) of the mean effects (β's) in the first column. Columns 3-6 show estimates of the interactions between product characteristics and consumer demographics. Column 2 is empty since we don't account for unobserved heterogeneity among consumers in this simplified model.

Table A-4: Results of the random coefficients logit model with only unobserved consumer heterogeneity

	Means	Std. Dev.	Interactions with Demographics			
	(β's)	(σ's)	Female	Income	Hh size	Urbanization
Constant	-2.17	4.45				
	(0.03)	(0.02)				
Price	-5.76	0.30				
	(0.02)	(0.02)				
Length	1.24	0.02				
	(0.01)	(0.00)				
Fuel consumption	-6.66	2.99				
	(0.02)	(0.02)				
Horsepower	5.65	0.23				
	(0.03)	(0.02)				
distance	-0.57	0.31				
	(0.00)	(0.01)				
distance^2	0.01	0.00				
	(0.00)	(0.00)				
$\widehat{\mu}$	4.16					
	(0.02)					
Origin dummies	yes					

Note: The table shows parameter estimates and standard errors (in parentheses) of the mean effects (β's) in the first column. Column 2 shows estimates of the random coefficients (σ's). Columns 3-6 are empty since we don't account for observable consumer heterogeneity through consumer demographics in this simplified model.

Table A-5: Results of the full random coefficients logit model when excluding the outside good

	Means (β's)	Std. Dev. (σ's)	Sex	Interactions with Demographics: Income	Hh size	Urbanization
Price	-7.65	0.12	-0.19	7.98		
	(0.04)	(0.08)	(0.04)	(0.11)		
Length	0.88	0.00	-0.42		0.23	
	(0.03)	(0.13)	(0.01)		(0.01)	
Fuel consumption	-5.49	2.18	-0.27			-0.03
	(0.04)	(0.04)	(0.03)			(0.00)
Horsepower	5.76	0.00	-1.34			
	(0.03)	(0.16)	(0.04)			
distance	-0.61	-0.37				
	(0.00)	(0.01)				
distance^2	0.00	0.00				
	(0.00)	(0.00)				
$\widehat{\mu}$	3.95					
	(0.02)					
Origin dummies	yes					

Note: The table shows parameter estimates and standard errors (in parentheses), when excluding the outside good, of the mean effects (β's) in the first column. Column 2 shows estimates of the random coefficients (σ's), while columns 3-6 show estimates of the interactions between product characteristics and consumer demographics.

Table A-6: List of agreements used in counterfactual simulations of multibranding

	Incumbent (European)	Entrant 1 (Asian)	Entrant 2 (non-Asian)
Agreement 1	Opel	Toyota	Skoda
Agreement 2	Citroën	Nissan	Volvo
Agreement 3	Peugeot	Hyundai	Alfa Romeo
Agreement 4	Renault	Mazda	Saab
Agreement 5	Volkswagen	Suzuki	Lancia
Agreement 6	Ford	Honda	Rover
Agreement 7	BMW	Mitsubishi	Land Rover
Agreement 8	Seat	Kia	Smart
Agreement 9	Fiat	Daihatsu	MG
Agreement 10	Audi	Subaru	Jeep
Agreement 11	Mercedes*	Jaguar	Porsche

Note: The table reports the 11 multi-branding agreements used in the counterfactual simulations. Each European incumbent is paired with 1 Asian entrant and 1 non-Asian entrant in a decreasing order of sales. Since there are only 10 Asian brands, we do not pair Mercedes with an Asian, but instead pair it with 2 other luxury brands.

Table A-7: Internal profit incentives for exclusive dealing (in €mil.), when there is no substitution to the outside good

	(1) Current profit (€ mil.)	(2) Collective agreement % Δ Incumb.	% Δ Other 2	% Δ Both
Opel & 2	271	-8.4	8.1	-4.5
Citroen & 2	347	-8.2	9.8	-5.3
Peugot & 2	222	-8.2	20.7	-0.8
Renault & 2	250	-8.7	10.2	-4.1
VW & 2	178	-8.5	15.4	-1.7
Ford & 2	172	-8.6	56.6	0.2
BMW & 2	44	-8.1	5.7	-2.4
Seat & 2	104	-8.2	36.4	19.1
Fiat & 2	54	-8.4	26.0	7.4
Audi & 2	53	-8.4	55.9	-1.2
Mercedes & 2	26	-8.0	44.1	-6.1
Total	1,694	-8.4	19.7	-1.4

Note: The table reports for each of the 11 agreements between 1 incumbent and 2 entrants, when keeping the outside good constant: (1) the current joint profit of the 3 parties; (2) the percentage change in profits when all agreements are made collectively.

Table A-8: Welfare effects of a ban on exclusive dealing, when there is no substitution to the outside good

	Current	Total change	Change at cte prices	Change due to prices
			Market shares (%)	
Outside good	0%	0.0	0.0	0.0
Inside goods	100%	+0.0	+0.0	0.0
Incumbents	73%	-5.3	-5.6	0.3
Entrants	27%	+5.3	+5.6	-0.3
Total	100%	+0.0	+0.0	0.0
Incumbents	1,294.7	-109	-100	-9
Entrants	425.5	+84	+89	-5
Total	1,720.2	-25	-11	-14
Total		+4864	+4288	+576
Per hh (euro)		+442	+390	+52
Total		+4839	+4277	+562

Note: The table reports the effects of a shift to multi-branding on the market shares, profits, consumer surplus and total welfare, when keeping the outside good constant. The effects are split into a change at constant prices (only spatial availability effect) and a change due to changed prices.

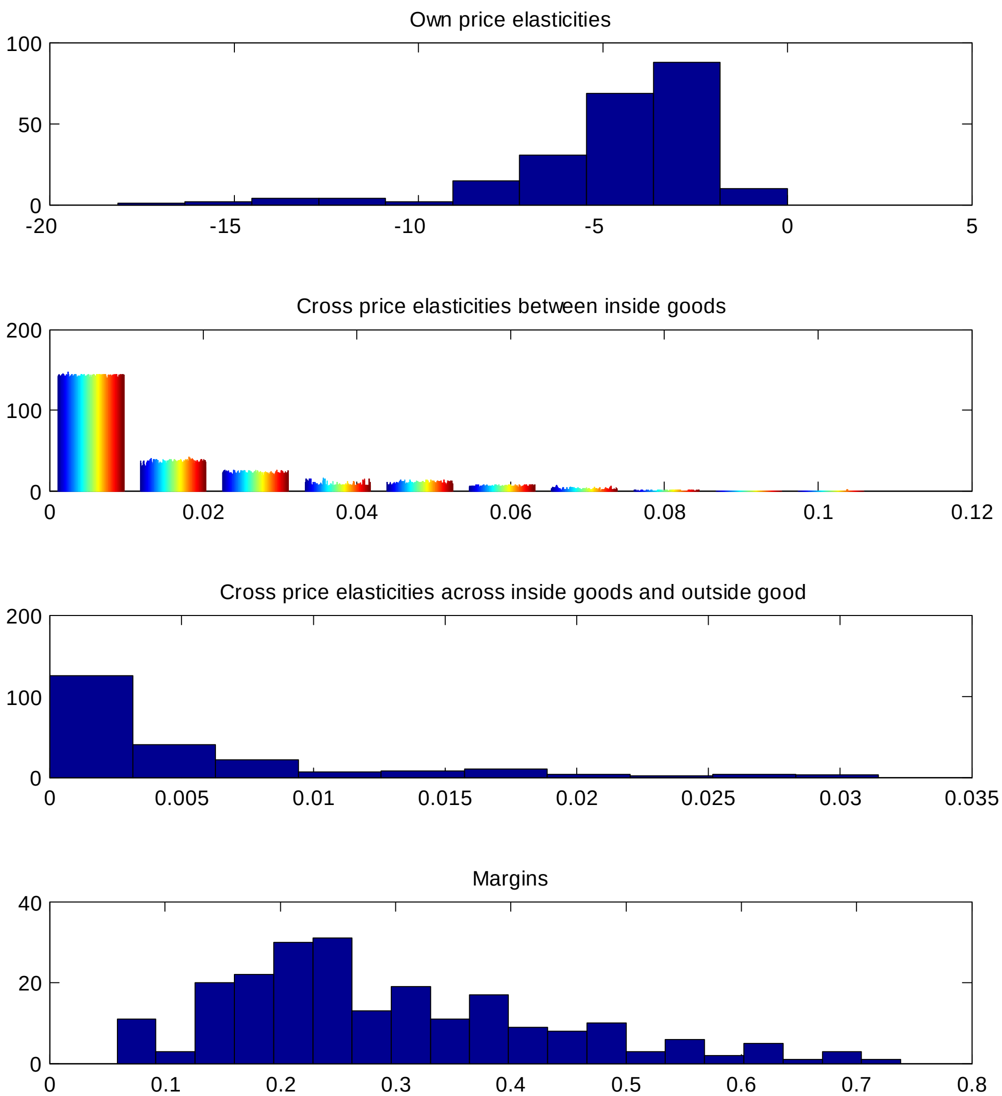

Figure A-1: Price elasticities and margins in the random coefficients logit model with demographics