

# Liberalizing a Distribution System: the European Car Market\*

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## Abstract

We quantify the competitive effects of removing vertical restraints, based on the recent proposals to liberalize the selective and exclusive distribution system in the European car market. We first estimate a differentiated products demand system for new cars and specify a model of oligopoly pricing under the former distribution regime. We then evaluate two possible competitive effects from liberalization: (i) the creation of international intrabrand competition (cross-border trade), which will result in a reduction of international price discrimination; (ii) a possible cumulative effect arising from a strengthening of national intrabrand competition, which would result in reduced double marginalization.

We find that a reduction in international price discrimination mainly redistributes consumer gains across countries; it has a positive but modest effect on total welfare. If liberalization has the cumulative effect of reducing double marginalization, then the welfare effects are much higher. In addition, we find that the effects of liberalization on the manufacturers' profits are either small or positive. This finding implies that the possibility to engage in international price discrimination, and to soften manufacturers' competition by creating a double marginalization mechanism, should not be interpreted as main profit motives for the former distribution system, but only as unintended side effects. Hence, the industry rationale for maintaining the former distribution system should be sought in other areas. Our approach may also be useful to assess the competitive effects of vertical restraints in other applications.

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# 1 Introduction

Vertical agreements between firms have been the subject of a long and intense debate in competition policy. In both the U.S. and in Europe the debate has focused around the relative importance of their anticompetitive effects and their efficiency gains. In Europe, an important additional concern has typically been the extent to which the vertical restraints are compatible with the common market and achieve the goals of economic integration. Despite this additional concern, it seems fair to say that the E.U. has followed a more lenient approach than the U.S. This is reflected in the relatively large number of individual and block exemptions granted for vertical restraints in Europe.

The selective and exclusive distribution system for the European car market is a well-known example of a block exemption. It has been in place since 1985 and institutionalized a series of previously granted individual exemptions to the whole industry. The system allows car manufacturers to select authorized dealers through qualitative and quantitative criteria, and to assign them territorial exclusivity. The industry has defended the system based on efficiency considerations, such as the need to provide sufficient incentives for sales and after-sales services. At the same time, consumer organizations have pointed out the potential anticompetitive effects from the system and the conflict with the European integration objectives. In particular, the distribution system has been held responsible for the limited cross-border arbitrage opportunities to consumers, resulting in large and persistent international price differentials.

Since the block exemption expired in September 2002, the European Commission prepared a detailed investigation into the benefits and the costs of alternative distribution systems. The result is a new Regulation with more flexibility. It allows the manufacturers to impose either selectivity or territorial exclusivity on their dealers, but no longer the combination of both. The idea is that such a liberalization will promote intrabrand competition, i.e. competition between dealers of the same brand. This may occur at two levels:

- First, liberalization promotes international intrabrand competition. By removing selectivity or exclusivity, dealers can either open their own outlets abroad, or sell cars to (unauthorized) parallel importers. This will facilitate cross-border trade and reduce the feasibility to engage in international price discrimination.
- Second, liberalization may possibly also promote national intrabrand competition, i.e. intrabrand competition within a country. This would reduce or eliminate retailer market power, and hence the implied double marginalization problems, which can sometimes serve as a softening competition device between the manufacturers.

The purpose of this paper is to quantify these possible competitive effects from the liberalization proposals. An empirical analysis is necessary since the theoretical literature on price discrimination and double marginalization issues has shown that there are no general results in oligopoly. To accomplish this, we proceed in several steps. In a first step, we estimate a differentiated products demand model for new cars. In the second step, we specify oligopoly pricing under the former selective and exclusive distribution system. We consider two possible pricing scenarios. In the first scenario, the former system only limits international intrabrand competition, and hence it enables international price discrimination by the manufacturers. In this scenario, there is full national intrabrand competition, so that the retail sector is perfectly competitive as in standard pricing models for the car market. In the second scenario, the former distribution system also limits national intrabrand competition. Car dealers therefore have market power, giving rise to double marginalization issues. In this scenario, the former distribution system may thus serve as both a price discrimination and a softening competition device. Our two scenarios of pricing may be seen as bounding the possibilities about retailer market power under the former distribution system. In a third step, we specify oligopoly pricing after liberalization and quantify the price and welfare changes in the new equilibrium. Liberalization has two possible effects. First, it stimulates international intrabrand competition (under both pricing scenarios before liberalization). Second, it creates national intrabrand competition, at least to the extent that this was effectively limited before liberalization (i.e. the second scenario). Our analysis indicates that liberalizing the vertical restraints would have the following effects:

*Scenario 1: former distribution system entails national intrabrand competition*

In this scenario, the retail car sector is already competitive in the former distribution system. Liberalization then only has the effect of reducing the scope for international price discrimination. We estimate consumer surplus and total welfare to increase by an amount between slightly positive and 2.6 billion Euro per year, depending on whether there are differences in conduct across countries (i.e. collusion in the U.K.). There is also a substantial redistribution of gains to U.K. consumers. Industry profits however decrease by a negligible or relatively small amount. From this, we infer that the possibility to engage in international price discrimination should not be viewed as a main profit motive for the former distribution system, but only as (unwanted) side effects.

*Scenario 2: former distribution system limits national intrabrand competition*

In this scenario, the retail car sector has market power in the former distribution system. Liberalization then reduces both the scope for international price

discrimination, and eliminates the double marginalization and softening competition device. The estimated consumer and welfare gains are now much larger. In particular, total welfare would increase by about 7-8%, the equivalent of an amount of between 9-11 billion Euro per year. At the same time, however, the manufacturing sector would experience a quite substantial profit increase from liberalization in this scenario. This implies that the former system, if it indeed effectively limited national intrabrand competition and thus created double marginalization, can only be rationalized if there were important other profit motives from the vertical restraints. Such other profit motives could be efficiencies, such as public good aspects in providing after-sales services. The net welfare gains from liberalization would then be lower, since they would be accompanied by a reduction in these efficiencies.

Competition policy has shown an increasing interest in empirical oligopoly models to quantify competitive effects. This trend has so far been limited to the analysis of horizontal mergers; see e.g. Hausman, Leonard and Zona (1994), Nevo (2000), and Pinkse and Slade (2004). Our analysis shows that empirical oligopoly models can also assist in other areas of antitrust, such as vertical restraints, provided that the assumptions on oligopoly behavior are appropriately modified. The horizontal merger literature typically considers the equilibrium effects of changing the product ownership matrix in a multi-product price setting oligopoly. Our oligopoly model looks at the equilibrium effects of increased international and national intrabrand competition due to the removal of selectivity or territorial exclusivity. First, we model international intrabrand competition by imposing a set of inequality constraints on all products' cross-country markup differentials after liberalization. See Davidson, Dewatripont, Ginsburgh and Labbé (1989) for a simplified theoretical framework with price constraints; and Stole (2001) for a general overview of the ambiguous effects of third-degree price discrimination in oligopoly. Second, we model national intrabrand competition, and the possible absence thereof before liberalization, by explicitly specifying the strategic interaction between the manufacturers and retailers (amounting to the standard competitive retail sector pricing model in scenario 1, but a pricing model with retail market power in scenario 2). This approach was inspired by Rey and Stiglitz' (1995) theoretical analysis of double marginalization and softening competition effects under territorial exclusivity. We generalized their model to fit the details of the car market. For recent other empirical papers explicitly modelling the manufacturer-retailer relationship, see Berto Villas-Boas (2002), Manuszak

(2002), and Asker (2004).<sup>1,2</sup>

The outline of the rest of the paper is as follows. In section 2 we discuss the role of selectivity and exclusivity in reducing international and national intrabrand competition. Based on this discussion, we specify the model in section 3. Section 4 presents the parameter estimates based on a large data set for the car market before liberalization. Section 5 discusses the expected effects of the liberalization on prices, profits and welfare. Conclusions and extensions follow in section 6.

## 2 The distribution system and reform proposals

We begin with a review of the essential features of the selective and exclusive distribution system for cars, and the recently proposed liberalization measures. The Appendix provides considerably more detail. Selectivity means that each manufacturer can choose its dealers, based on qualitative or quantitative criteria, e.g. the requirement to provide after-sales services. To protect the selective relationship, the manufacturer can prohibit its dealers from selling cars to independent resellers. Dealers must thus only sell to end-consumers, or to intermediaries with a written consumer authorization. Territorial exclusivity refers to the manufacturers' right to appoint only one dealer in a geographically limited territory. Dealers can therefore not maintain branches or engage in targeted advertising outside their own contract territory. The combination of selectivity and exclusivity may reduce intrabrand competition, i.e. competition between dealers selling the same brand, both at the international level or at the national level.

### **International intrabrand competition: price discrimination**

When selectivity and exclusivity are combined, cross-border arbitrage possibilities are limited. The rights of end-consumers to purchase cars abroad are in principle protected. But selectivity prevents independent resellers to systematically engage in arbitrage, while exclusivity prevents the authorized dealers from setting up foreign branches to take advantage of price differentials. The result is a lack of international intrabrand competition, enabling the manufacturers to engage in international price discrimination.

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<sup>1</sup>Empirical papers in marketing that model the manufacturer-retailer relationship are Sudhir (2001), Villas-Boas and Zhao (2001), and Besanko, Dubé and Gupta (2002).

<sup>2</sup>Another related paper is Goldberg and Verboven (2001). Using a similar data set (for a shorter period) and a simplified model (simpler demand framework, and a competitive retail sector), their focus is on understanding the *sources* of international price dispersion, i.e. costs versus markups. In contrast, the focus in this paper is on performing policy simulations, i.e. to understand the *consequences* in terms of profits and welfare, when price discrimination (and possibly double marginalization) is no longer feasible due to a liberalization of the distribution system.

The lack of international intrabrand competition has been documented extensively in empirical work. For example, BEUC (1992) and Goldberg and Verboven (2001) report evidence of very limited parallel imports, in the range of only 0–2% of total sales. The same sources also show that international price differentials have been large and persistent during the corresponding period, implying that the possibilities for cross-border trade have been limited indeed.

### **National intrabrand competition: double marginalization and softening competition**

Selectivity and exclusivity may have an additional potential effect on intrabrand competition within a country. As analyzed by Rey and Stiglitz (1995), a limited degree of intrabrand competition creates a double marginalization effect, which tends to soften competition between the manufacturers. As a result, equilibrium prices will increase and profits may be higher than under non-cooperative Bertrand pricing. Selectivity and exclusivity may thus serve as a mechanism to soften competition between manufacturers.

In practice, there is no clear empirical evidence on whether the distribution system effectively succeeded in limiting intrabrand competition also within a country. For example, the U.K. Competition Commission quotes the number of 39% as the proportion of out-of-territory sales (within a country). It interprets this as a small number because of the high degree of urbanization and commuting. The industry, in contrast, could interpret this number as an indication that national intrabrand competition is high.

### **The 2002 proposals for liberalization**

The Commission's proposed liberalization essentially consists of a more flexible system, where manufacturers may choose to adopt either selectivity or exclusivity, but no longer the combination of both. This has the following possible effects. First, it stimulates international intrabrand competition, either by independent resellers (if exclusivity is chosen) or by the foreign branches of authorized dealers (if selectivity is chosen). This reduces the feasibility of international price discrimination. Second, it also stimulates national intrabrand competition, at least to the extent that this was effectively limited under the former system. This would have the effect of eliminating the double marginalization and softening competition effects.

## 3 The model

### 3.1 Overview

We proceed in three steps. The first step specifies the demand for new cars. The second step models oligopoly pricing before liberalization. We distinguish between two scenarios, based on the above discussion on the impact of the selective and exclusive distribution system on intrabrand competition. Consistent with prior evidence, both scenarios assume that the system has limited international intrabrand competition, i.e. it has been responsible for limited cross-border trade, enabling manufacturers to engage in international price discrimination. The scenarios differ in their assumptions about national intrabrand competition, since there is no clear prior evidence on this. In the first scenario, there is full national intrabrand competition, resulting in no dealer market power, as in traditional models of car pricing. In the second scenario, there is limited national intrabrand competition, hence there is dealer market power and double marginalization.

The third step of our analysis specifies oligopoly pricing after liberalization. Due to the removal of either selectivity or exclusivity, there is improved international intrabrand competition and full national intrabrand competition. Hence, liberalization reduces the possibility to price discriminate in both scenarios, and in addition eliminates double marginalization in the second scenario.

### 3.2 Demand

There are  $M$  national markets, in each market  $m$  there are  $L_m$  potential consumers (measured by population). A consumer  $i$  located in market  $m$  can choose among the  $J$  available differentiated products. Consistent with the discussion of the previous section, cross-border arbitrage costs are prohibitive so that consumers do not consider to purchase a car in another market than where they are located. This assumption allows us to suppress the market subscript  $m$  for now. A consumer  $i$ 's conditional indirect utility from product  $j = 1, \dots, J$  is given by:

$$u_{ij} = x_j' \beta + \xi_j - \alpha_i p_j + \varepsilon_{ij}. \quad (1)$$

Utility thus consists of a common part  $\delta_j \equiv x_j' \beta + \xi_j$  and an individual-specific part  $-\alpha_i p_j + \varepsilon_{ij}$ . The common part  $\delta_j$  depends on a  $K$ -dimensional vector of characteristics  $x_j$ , such as horsepower, fuel efficiency, size, etc... It also depends on characteristics unobserved by the econometrician  $\xi_j$ , e.g. style, image or advertising. The individual-specific part of utility depends on price  $p_j$  and on a random term  $\varepsilon_{ij}$ . Specify the price parameter as  $\alpha_i = \alpha/y_i$ ,

where  $y_i$  is income of consumer  $i$ .<sup>3</sup> Consumers may decide not to purchase any product. In this case they choose the outside good 0, for which the common part of utility  $\delta_j$  is normalized to 0.

The distribution of the random utility term  $\varepsilon_{ij}$  follows the assumptions of a two-level nested logit model. Assume the market can be partitioned into  $G$  different groups. Each group  $g$  can be further partitioned in  $H_g$  subgroups. Each subgroup  $h$  contains  $J_{hg}$  products, so that  $\sum_{g=1}^G \sum_{h=1}^{H_g} J_{hg} = J$ . If consumers choose one unit of the product that maximizes random utility, the nested logit distributional assumptions on the random utility term  $\varepsilon_{ij}$  yield the following choice probability of individual  $i$  for product  $j$ , as a function of the  $J \times 1$  price vector  $p$ :

$$s_{ij}(p) = \frac{\exp((\delta_j - \alpha_i p_j)/(1 - \sigma_{hg})) \exp(I_{ihg}/(1 - \sigma_g)) \exp(I_{ig})}{\exp(I_{ihg}/(1 - \sigma_{hg})) \exp(I_{ig}/(1 - \sigma_g)) \exp(I_i)}, \quad (2)$$

where  $I_{ihg}$ ,  $I_{ig}$ , and  $I_i$ , are “inclusive values” for consumer  $i$ , defined by:

$$\begin{aligned} I_{ihg} &\equiv (1 - \sigma_{hg}) \ln \sum_{j=1}^{J_{hg}} \exp((\delta_j - \alpha_i p_j)/(1 - \sigma_{hg})) \\ I_{ig} &\equiv (1 - \sigma_g) \ln \sum_{h=1}^{H_g} \exp(I_{ihg}/(1 - \sigma_g)) \\ I_i &\equiv \ln \sum_{g=1}^G \exp(I_{ig}). \end{aligned} \quad (3)$$

The predicted aggregate market share for product  $j$  is obtained by averaging the choice probabilities  $s_{ij}(p)$  over the number of individuals  $N$ , as drawn from the empirical distribution of income  $y_i$ , i.e.

$$s_j(p) = \sum_{i=1}^N s_{ij}(p)/N, \quad (4)$$

so that the predicted sales for product  $j$  are equal to  $s_j(p)L$ .

The nesting parameters  $\sigma_{hg}$  and  $\sigma_g$  measure the heterogeneity of consumer preferences for cars belonging to the same subgroups or groups. The interpretation is that products of

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<sup>3</sup>See also Berry, Levinsohn and Pakes (2004). If price is small relative to (capitalized) income, our specification approximates Berry, Levinsohn and Pakes’ (1995) Cobb Douglass specification, in which price enters conditional indirect utility through the term  $\alpha \ln(y - p_j)$ . Nevo (2001) interacts  $\alpha$  with income and income squared, whereas we interact it with the inverse of income.

the same subgroup or group share a common set of features, for which consumers may have correlated preferences. More specifically, we define five groups according to their market segment: subcompact, compact, intermediate, standard and luxury. A sixth group is added and reserved exclusively for the outside good. Cars from the same market segment share features such as size and prestige. Each group (except the one for the outside good) is further divided in two subgroups, according to country of origin: domestic or foreign. Cars from the same origin share additional features, e.g. the image or style. Another common feature of cars from the same subgroup may be dealer proximity, since the domestic firms typically have a substantially more dense dealer network than the foreign firms.

The model is consistent with random utility maximization if  $1 \geq \sigma_{hg} \geq \sigma_g \geq 0$ ; see McFadden (1978). In a typical case where  $1 > \sigma_{hg} > \sigma_g > 0$ , consumer preferences are more strongly correlated across products of the same subgroup than across products of a different subgroup within the same group; preferences are in turn more correlated across these products than across products from a different group. In an extreme case,  $\sigma_{hg} = 1$  so that products within the subgroup  $hg$  are perceived as perfect substitutes. The special case of a one-level nested logit model obtains if all  $\sigma_{hg} = \sigma_g$  (the groups constitute the nests), or if all  $\sigma_g = 0$  (the subgroups constitute the nests). The simple logit model obtains if all  $\sigma_{hg} = \sigma_g = 0$ , i.e. when preferences are uncorrelated for products of the same groups or subgroups.

The nested logit model is a special case of the random coefficients model estimated by Berry, Levinsohn and Pakes (1995), Nevo (2001), Petrin (2002) and others. As discussed in e.g. Berry (1994) and Berry and Pakes (2001), the nesting parameters  $\sigma_{hg}$  and  $\sigma_g$  can be interpreted as random coefficients on discrete dummy variables for the subgroups and groups, rather than on continuously measured variables such as performance or size in the general case. While this is potentially restrictive, our model does allow for preference heterogeneity on one of the continuous variables which is particularly important for the substitution patterns, i.e. the price variable, since we interact the price parameter with income, as drawn from the empirical distribution. Furthermore, the group dummy variables may at least partially proxy for the omitted continuous variables, since cars from the same group tend to have similar performance, size, and other characteristics, often as the result of deliberate marketing efforts. In this respect, it is also noteworthy to point out that our specification is more flexible than the aggregate nested logit specifications estimated in previous work: since we allow the nesting parameters to differ across subgroups and groups, consumer heterogeneity may be larger for cars of certain (sub)groups than others. As we will show below, this has important implications for the pattern of price elasticities across the different market segments.

### 3.3 Oligopoly pricing before liberalization

Before liberalization, there is no international intrabrand competition (no cross-border trade), as already reflected in the demand specification. In contrast, national intrabrand competition may be either limited or full. To incorporate the possibility that the selective and exclusive distribution system limits national intrabrand competition, we explicitly model the manufacturer–retailer relationship.

There are  $F$  multi-product manufacturing firms. Each firm  $f$  sells a subset  $F_f$  of the  $J$  products. These subsets  $F_f$  are mutually exclusive, so each product is sold by only one firm. Each firm sells its products through a retailer, rather than directly to consumers. There are  $R$  retailers, each retailer  $r$  sells a subset  $R_r$  of the products. Under limited national intrabrand competition, these subsets are mutually exclusive. Under full intrabrand competition, these subsets are not mutually exclusive: each product  $j$  is sold by at least two retailers. There are two stages. In the first stage each firm  $f$  simultaneously chooses the wholesale price  $w_j$  for every product  $j \in F_f$ . In the second stage, each retailer  $r$  simultaneously chooses the retail price  $p_j$  for every product  $j \in R_r$ , given the wholesale prices charged by the firms in first stage. The equilibrium is solved by backward induction.

In the second stage, each retailer  $r$  simultaneously chooses its prices and obtains the following profits as a function of the  $J \times 1$  price vector  $p$ :

$$\Pi_r(p) = \sum_{j \in R_r} (p_j - w_j) s_j(p) L \quad (5)$$

where  $L$  is the total number of potential consumers. Note that we have normalized the retailer’s marginal selling cost to zero.<sup>4</sup> The Nash equilibrium in the second stage depends on whether national intrabrand competition is limited or full, i.e. on whether the retailers’ product subsets  $R_r$  are mutually exclusive or not. We will specify the actual second stage price equilibrium under both scenarios below. At a general level, we can write the  $J \times 1$  second-stage Nash equilibrium retail price vector  $p$  as a function of the  $J \times 1$  first-stage wholesale price vector  $w$ , i.e.

$$p = p(w) \quad (6)$$

where  $p(\cdot)$  is a  $J \times 1$  vector of functions, and a typical function  $p_j(\cdot)$  describes product  $j$ ’s

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<sup>4</sup>This is without loss of generality and simplifies the notation. Alternatively, we could have started by separately distinguishing between the retailer’s and manufacturer’s marginal cost, as in related vertical pricing models of Sudhir (2001) or Villas-Boas (2004). But in the end, this alternative notation can only uncover the *sum* of the manufacturer’s and retailer’s marginal cost, making it equivalent to our simplified notation.

retail price as a function of the wholesale price vector  $w$ . Let  $\nabla_w p(w) \equiv \partial p(w)/\partial w'$  be the  $J \times J$  Jacobian matrix of first derivatives. A typical element  $(j, k)$  of this matrix contains the effect of an increase in the wholesale price  $w_k$  on the retail price  $p_j$ . In other words,  $\nabla_w p(w)$  is the matrix of pass-through rates.

In the first stage, each manufacturer  $f$  simultaneously chooses its wholesale prices to maximize its own profits, taking into account the retailers' pricing responses in the second stage through the pass-through function  $p(\cdot)$ . Each manufacturer  $f$  obtains the following profits as a function of the wholesale price vector  $w$ :

$$\Pi_f(w) = \sum_{j \in F_f} (w_j - mc_j) s_j(p(w)) L \quad (7)$$

where  $mc_j$  is the marginal cost of product  $j$ . Since the retailer's marginal cost has been normalized to zero,  $mc_j$  ought to be interpreted as including both the manufacturer's and the retailer's marginal cost. The profit-maximizing wholesale price of each product  $j = 1, \dots, J$  then satisfies the following first-order condition:

$$s_j(p(w)) + \sum_{k \in F_f} (w_k - mc_k) \left( \frac{\partial s_k(p)}{\partial p_1} \frac{\partial p_1(w)}{\partial w_j} + \dots + \frac{\partial s_k(p)}{\partial p_J} \frac{\partial p_J(w)}{\partial w_j} \right) = 0.$$

A unit increase in product  $j$ 's wholesale price  $w_j$  has two effects. First, it raises the manufacturer's margin so that the profits raise proportional to product  $j$ 's market share. Second, it induces positive price responses by its own and the competing retailers, which indirectly reduces sales.

To write this system of  $J$  first-order conditions in vector notation, define the  $J \times J$  matrix  $\theta^F$  as the manufacturing firms' product ownership matrix with a typical element  $\theta^F(j, k)$  equal to 1 if products  $j$  and  $k$  are produced by the same firm, and 0 otherwise. Let  $s(p)$  be the  $J \times 1$  market share vector, and  $\nabla_p s(p) \equiv \partial s(p)/\partial p'$  be the corresponding  $J \times J$  Jacobian matrix of first derivatives. Let  $mc$  be the  $J \times 1$  marginal cost vector. Using the operator  $\odot$  to denote the Hadamar product, or element-by-element multiplication of two matrices of the same dimension, we have:

$$s(p(w)) + (\theta^F \odot [\nabla_p s(p) \nabla_w p(w)]') (w - mc) = 0. \quad (8)$$

The solution  $(\bar{p}, \bar{w})$  to the second stage system (6) and the first stage system (8) constitutes the subgame perfect equilibrium, which we assume to exist. Inverting the system (8) at this solution, we obtain the following solution for the marginal cost vector:

$$mc = \bar{w} + (\theta^F \odot [\nabla_p s(\bar{p}) \nabla_w p(\bar{w})]')^{-1} s(\bar{p}), \quad (9)$$

i.e. marginal cost is equal to the wholesale price minus the manufacturers' wholesale markup. To uncover the unobserved wholesale price  $\bar{w}$  and the matrix of pass-through rates  $\nabla_w p(\bar{w})$ , we now complete the model and specify the second-stage equilibrium retail price vector (6) under full and limited intrabrand competition.

### Scenario 1: full national intrabrand competition

In this scenario the distribution system does not successfully limit national intrabrand competition. There is perfect retail competition in the second stage, driving down retail prices to wholesale prices, so that the standard model of multiproduct pricing with differentiated products applies. In our above framework, full intrabrand competition may be modelled by defining the retailers' product subsets  $R_r$  in (5) as mutually non-exclusive, such that at least two retailers  $r$  and  $r'$  compete to sell the same product  $j$ . The retail price equilibrium (6) is then simply  $\bar{p} = \bar{w}$ , and the pass-through matrix  $\nabla_w p(\bar{w})$  reduces to the identity matrix  $I_J$ . The marginal cost vector (9) therefore simplifies to the well-known equation:

$$\begin{aligned} mc &= \bar{p} + (\theta^F \odot [\nabla_p s(\bar{p})]')^{-1} s(\bar{p}) \\ &\equiv \widehat{mc}^F. \end{aligned} \quad (10)$$

The marginal cost vector  $\widehat{mc}^F$  under full intrabrand competition is then simply measured by the observed equilibrium price vector  $\bar{p}$  minus the familiar wholesale margin vector  $-(\theta^F \odot [\nabla_p s(\bar{p})]')^{-1} s(\bar{p})$ .

### Scenario 2: limited national intrabrand competition

In this scenario the distribution system effectively limits national intrabrand competition. This can be modelled by defining the retailers' product subsets  $R_r$  in (5) to be mutually exclusive. Oligopoly pricing then generalizes Rey and Stiglitz' (1995) model in which two manufacturers sell their products to two exclusive retailers, leading to the double marginalization and softening competition effects. When each exclusive retailer chooses its retail prices to maximize its own retail profit (5), the following first-order conditions should be satisfied for each product  $j = 1, \dots, J$ :

$$s_j(p) + \sum_{k \in R_r} (p_k - w_k) \frac{\partial s_k(p)}{\partial p_j} = 0.$$

Define the  $J \times J$  matrix  $\theta^R$  as the retailers' product ownership matrix with a typical element  $\theta^R(j, k)$  equal to 1 if products  $j$  and  $k$  are sold by the same retailer, and equal to 0 otherwise. The above system can then be written in vector notation and inverted to obtain:

$$f(p, w) \equiv p - w + (\theta^R \odot [\nabla_p s(p)]')^{-1} s(p) = 0. \quad (11)$$

Assuming the conditions of the implicit function theorem are satisfied, the system  $f(p, w) = 0$  implicitly defines the functions  $p(\cdot)$  of the second-stage Nash equilibrium retail price vector at the equilibrium solution  $(\bar{p}, \bar{w})$ . Furthermore, the matrix of pass-through rates  $\nabla_w p(\bar{w})$  evaluated at  $(\bar{p}, \bar{w})$  is given by:

$$\nabla_w p(\bar{w}) = - [\nabla_p f(\bar{p}, \bar{w})]^{-1} \nabla_w f(\bar{p}, \bar{w}) = [\nabla_p f(\bar{p}, \bar{w})]^{-1}, \quad (12)$$

where the second equality follows from the fact that  $\nabla_w f(\bar{p}, \bar{w})$  equals minus the identity matrix.

Rearranging (11), we can write the (to us) unobserved equilibrium wholesale price vector as a function of the observed equilibrium retail price vector:

$$\bar{w} = \bar{p} + (\theta^R \odot [\nabla_p s(\bar{p})]')^{-1} s(\bar{p}), \quad (13)$$

i.e. the wholesale price vector equals the retail price vector minus the retail margin vector. After substituting out (12) and (13), the marginal cost vector (9) becomes:

$$\begin{aligned} mc &= \bar{p} + (\theta^R \odot [\nabla_p s(\bar{p})]')^{-1} s(\bar{p}) + \left( \theta^F \odot [\nabla_p s(\bar{p}) (\nabla_p f(\bar{p}, \bar{w})^{-1})]' \right)^{-1} s(\bar{p}) \\ &\equiv \widehat{mc}^N. \end{aligned} \quad (14)$$

Intuitively, the marginal cost vector under no intrabrand competition is measured by the observed equilibrium retail price vector minus the equilibrium retail margin vector minus the equilibrium wholesale margin vector.

### 3.4 Oligopoly pricing after liberalization

The liberalization of the distribution system affects competition in two possible ways. First, it creates national intrabrand competition, thereby eliminating any possible existing double marginalization and softening competition effects. This effect is only relevant under our second scenario of limited national intrabrand competition before liberalization.

Second, liberalization creates international intrabrand competition and therefore reduces

the scope for international price discrimination. This effect is relevant under both scenarios. There are several ways to model the reduced possibilities for international price discrimination. One approach would be to allow consumers to choose between cars from all countries, at an additional travel cost when the car is purchased abroad. Liberalization could then be modelled as a reduction in the consumers' travel costs, leading to a new Nash equilibrium.<sup>5</sup> We chose an alternative approach and model the creation of international intrabrand competition by extending the oligopoly model to include constraints on maximum international price differentials. These constraints may be interpreted as capturing arbitrage interventions by either the independent resellers or by the authorized dealers' foreign branches. Such arbitrage interventions would take place whenever the price differentials exceed cross-border trade costs, such as transportation, administration and delay costs. In practice, however, it is important to account for the fact that our measured products are not completely identical across countries. Products may differ because of specification differences, such as horsepower, better optional equipment, the right-hand drive regulation in the U.K., etc... Arbitrage interventions will therefore only take place when the price differentials exceed the cross-border trade costs *after* adjusting for any differences in the marginal costs. For this reason, it is appropriate to introduce the constraints on international markup differentials, rather than on international price differentials.<sup>6</sup>

To formalize oligopoly pricing after liberalization, we reintroduce our subscript notation: there are  $M$  national markets,  $m = 1, \dots, M$ . Because there is full national intrabrand competition after liberalization, the manufacturers' wholesale prices coincide with the retail prices. Furthermore, arbitrage interventions would take place when the international markup differences exceed a certain percentage  $\tau$ . Hence, each manufacturer sets its prices subject to the constraint that for each product  $j$  and each pair of countries  $m$  and  $n$ ,  $p_{jm} - \widehat{m}c_{jm} \leq (1 + \tau)(p_{jn} - \widehat{m}c_{jn})$ , where  $\widehat{m}c_{jm}$  is the marginal cost of product  $j$  in market  $m$ , measured by either (10) or (14). In the policy simulations we consider alternative values of  $\tau$ , as our measure of the extent to which international intrabrand competition has improved after liberalization. Each firm  $f$  maximizes its total profits across all markets, subject to the set of cross-country markup constraints:

$$\Pi_{f_m}(p_m) = \sum_{m=1}^M \sum_{j \in F_{f_m}} (p_{jm} - \widehat{m}c_{jm}) s_{jm}(p_m) L_m \quad (15)$$

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<sup>5</sup>In fact, a demand model with consumer cross-border travel costs could in principle be estimated. Intuitively, travel costs would be high when the relative sales of a given car model for two countries show little variation despite large fluctuations in price differentials, conditional on other factors.

<sup>6</sup>Formally, this assumes that an arbitraging dealer can adjust its cars to the same specifications as those in the importing country, at a cost equal to the difference in marginal costs between the two countries.

$$\text{subject to } (1 + \tau)(p_{jn} - \widehat{m}c_{jn}) - (p_{jm} - \widehat{m}c_{jm}) \geq 0 \\ j = 1, \dots, J, \quad m, n = 1, \dots, M.$$

Define Lagrange multipliers  $\lambda_{jmn}$  associated with the constraints of each product  $j$  and each pair of countries  $m$  and  $n$ . The constrained profit-maximizing prices of product  $j$  in markets  $m = 1, \dots, M$  should satisfy the following Kuhn-Tucker conditions:

$$\left( s_{jm}(p_m) + \sum_{k \in F_{jm}} (p_{km} - \widehat{m}c_{km}) \frac{\partial s_{km}(p_m)}{\partial p_{jm}} \right) L_m - \sum_{n=1}^M \lambda_{jmn} + (1 + \tau) \sum_{n=1}^M \lambda_{jnm} = 0, \quad (16)$$

$$(1 + \tau)(p_{jn} - \widehat{m}c_{jn}) - (p_{jm} - \widehat{m}c_{jm}) \geq 0, \quad \lambda_{jmn} \geq 0, \\ \lambda_{jmn} ((1 + \tau)(p_{jn} - \widehat{m}c_{jn}) - (p_{jm} - \widehat{m}c_{jm})) = 0,$$

$$m, n = 1, \dots, M.$$

The first-order conditions (in the first row of (16)) generalize our previous unconstrained first-order conditions, extended with a set of nonnegative Lagrange multipliers. The complementary slackness conditions (in the second and third row) state that for each pair of countries  $m$  and  $n$  the constraint is either binding (“active”), or nonbinding in which case  $\lambda_{jmn} = 0$ . Although there is a large number of country pair combinations, several constraints can be immediately eliminated. The constraints are obviously nonbinding for  $m = n$ , so that  $\lambda_{jmm} = 0$  for all  $m$ . The constraints of country pair  $(m, n)$  and  $(n, m)$  are mutually exclusive, so at least  $\lambda_{jmn} = 0$  or  $\lambda_{jnm} = 0$ . Similarly, if the constraint of country pair  $(m, n)$  and  $(m, n')$  are both binding, then  $p_{jn} = p_{jn'}$  so that the constraints of both country pairs  $(n, n')$  and  $(n', n)$  must be nonbinding, so  $\lambda_{jnn'} = \lambda_{jn'n} = 0$ . By eliminating these possibilities, one can easily verify that each product  $j$  has at most  $M - 1$  active constraints, hence  $\lambda_{jmn} > 0$  for at most  $M - 1$  country pairs.

A Nash equilibrium is a  $JM \times 1$  price vector  $p^*$  such that the Kuhn-Tucker conditions (16) are satisfied for all products  $j$ .<sup>7</sup> To compute a candidate Nash equilibrium we proceed as

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<sup>7</sup>We assume that an interior Nash equilibrium exists. Caplin and Nalebuff (1991) provide conditions for existence in a model with single-product price-setting firms and with product differentiation that covers our nested logit setting. Vives (1999) discusses existence and uniqueness of supermodular price games. Our oligopoly model has two complications. First, there are multiproduct firms. No general results are available, but Anderson and de Palma (1992) show existence and uniqueness of the multiproduct firm equilibrium in a symmetric nested logit model. Second, there are (linear) price constraints (after liberalization). Davidson et al. (1989) obtain a unique equilibrium in a symmetric model with linear demand. In addition to these theoretical results, we also did numerical analysis to verify that the second-order conditions are satisfied in the neighbourhood of the equilibrium. We have also intensively experimented with alternative starting

follows. For each product  $j$ , we impose a set of  $K_j \leq M - 1$  active constraints (such that none of them are mutually exclusive or inconsistent otherwise). In addition, for each product  $j$  we impose the  $M$  first-order conditions with respect to prices, setting the Lagrange multipliers of the nonactive constraints equal to zero. We simplify these  $M$  first-order conditions to a reduced system of  $M - K_j$  equations by substituting out the  $K_j$  nonzero  $\lambda_{jmn}$ . For each product  $j$ , we thus impose  $K_j$  active constraints and  $M - K_j$  other equations as obtained from the first-order conditions. The candidate Nash equilibrium is the solution to this system of equations over all products  $j$ . To gain some intuition, the Appendix works out an example of such a system of equations, in which only the constraint of one product  $j$  for one country pair  $(1, 2)$  is binding (so  $K_j = 1$  for product  $j$  and  $K_j = 0$  otherwise).

Once the solution of a candidate Nash equilibrium is obtained, we check whether all the Kuhn-Tucker conditions are satisfied, in particular whether (i) no active constraint is unjustified, i.e.  $\lambda_{jmn} \geq 0$  for all  $j, m, n$ , and whether (ii) no inactive constraint is violated. If all the conditions are satisfied, we use the solution as our constrained Nash equilibrium. If not, then we consider a new candidate Nash equilibrium, by relaxing one or more of the active constraints and/or imposing one or more new constraints, until a solution is found that satisfies all the Kuhn-Tucker conditions. This is a process of trial and error, common in constrained optimization problems. In practice, we proceed as follows. We begin by imposing all the constraints that are violated under the old (observed) equilibrium, and compute the candidate constrained Nash equilibrium. We then check whether new constraints need to be imposed and whether some constraints need to be relaxed, and, if so, we compute a new candidate Nash equilibrium. We usually need about 5 to 10 trials before we obtain a solution that satisfies all the Kuhn-Tucker conditions. Note that, if we set  $\tau = 0$ , the problem is drastically simplified. In this case, the problem reduces to a simple constrained maximization problem with equality constraints only, i.e.  $(p_{jn} - \widehat{m}c_{jn}) - (p_{jm} - \widehat{m}c_{jm}) = 0$  for all  $j, m$  and  $n$ .

### 3.5 Welfare

To compare the computed equilibrium prices  $p^*$  after liberalization with the observed equilibrium prices  $\bar{p}$  before liberalization, we compute the changes in the various welfare components, in particular consumer surplus and producer surplus. Consumer  $i$ 's surplus is the expected value of the maximum of the utilities (1). Using the nested logit distributional assumptions, the change in consumer surplus for individual  $i$  in market  $m$  is equal to:

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values, and did not encounter examples of convergence to other equilibria.

$$\Delta CS_{im} = \frac{I_i(p_m^*)}{\alpha_{im}} - \frac{I_i(\bar{p}_m)}{\alpha_{im}},$$

where  $I_i$  is the inclusive value defined by (3), now written as a function of the price vectors before or after liberalization. Total consumer surplus  $\Delta CS_m$  is obtained by averaging this over the drawn individuals. For comparison purposes, we also compute the changes in the price indices, using either the pre-liberalization or the post-liberalization market shares as weights. The change in manufacturers' producer surplus is simply given by

$$\Delta PS_m = \sum_{f=1}^F \Pi_{fm}(p_m^*) - \sum_{f=1}^F \Pi_{fm}(\bar{p}_m).$$

The change in total welfare  $\Delta W_m$  is the sum of total consumer surplus, manufacturers' producer surplus, retailers' producer surplus (only applicable in the second scenario) and tax revenues (VAT only).

The exogenous variables are assumed not to change after liberalization. In particular, the exogenous part of utility in (1), i.e.  $\delta_j = x'_j \beta + \xi_j$ , and marginal cost,  $\widehat{mc}_j$  remain unchanged for all products  $j$ . Our focus is thus entirely on a quantification of the allocative effects of liberalizing the distribution system. A more complete analysis would also incorporate the efficiency effects, which may enter through changes utility, marginal costs or fixed costs.

## 4 Data and estimation

### 4.1 The data

The data set consists of prices, sales and physical characteristics of (essentially) all car models sold in five European markets during 1970-1999. The included countries are Belgium, France, Germany, Italy and the United Kingdom. There are about 350 different car models during this period, although many of them are successors of old models. Examples are the Fiat Uno, VW Golf, Toyota Corolla, Peugeot 405, and BMW 5-series. The total number of observations is 11,549, implying that on average about 80 models are sold in every market/year. The price data are pre-tax and post-tax list prices corresponding to the base model available in the market, as published in consumer catalogues. Sales are new car registrations for the model range. Physical characteristics (also from consumer catalogues) include dimensions (weight, length, width, height), engine characteristics (horsepower, displacement) and performance measures (speed, acceleration and fuel efficiency). The data set also includes variables to identify the model, the brand, the firm, the country of origin/production loca-

tion, and the market segment (“class”). The data set is augmented with macro-economic variables including population, exchange rates, GDP and consumer price indices for the various markets over the relevant period. Finally, there is information on dealer discounts and gross dealer margins for a selected number of models/years.<sup>8</sup> A more detailed description of the data set and the sources, for the shorter period of 1980-1993, is provided in Goldberg and Verboven (2001). Table 1 provides summary statistics on the main variables, with the means also broken down by market.

**Table 1. Summary statistics**

country	All		Bel	Fra	Ger	Ita	UK
	Mean	St. D.					
sales (units)	19813	37720	3925	23306	31003	24292	19784
horsepower (kW)	57.2	23.9	56.5	56.7	57.4	57.2	58.4
fuel inefficiency (liter/100 km)	8.2	1.7	8.2	8.1	8.2	8.1	8.2
width (cm)	164.4	9.6	164.2	164.3	164.6	164.1	164.8
height (cm)	140.4	4.6	140.3	140.5	140.5	140.6	140.3
foreign (0-1)	.81	.39	.00	.75	.73	.76	.77
price (Euro)	10822	7179	9943	10774	10520	10856	12158
subcompact (0-1)	.28	.45	.28	.28	.28	.31	.26
compact (0-1)	.23	.42	.23	.24	.23	.22	.24
intermediate (0-1)	.22	.41	.22	.22	.22	.21	.23
standard (0-1)	.19	.39	.19	.19	.18	.17	.19
luxury (0-1)	.08	.27	.08	.07	.09	.09	.08

\* The number of observations is 11549.

## 4.2 Demand estimation and identification

### Estimation

We estimate the parameters of the nested logit demand system (4), where the individual choice probabilities are given by (2). The demand system contains the common valuation terms  $\delta_j = x'_j\beta + \xi_j$  for each product  $j$ , where  $\xi_j$  is the error term representing unobserved

<sup>8</sup>Data on dealer discounts and margins are available for selected years from reports of the European Bureau of Consumer Organizations, and from surveys by the European Commission. This is informative since it shows that percentage discounts may show systematic variation across markets and car models, but do not vary much over time. This motivates using list prices to estimate the demand parameters, provided that appropriate car model and market fixed effects are included in the specification.

product characteristics. Following Berry (1994) and Berry, Levinsohn and Pakes (1995) we proceed as follows.

- We set observed sales equal to predicted sales and solve the error term  $\xi_j$  as a function of the parameters and the data. In our nested logit model an analytic solution is not available, because consumers are heterogeneous regarding the price parameter  $\alpha_i = \alpha/y_i$ . The numerical solution for  $\xi_j$  involves a slight modification of the contraction mapping suggested by Berry, Levinsohn and Pakes (1995).<sup>9</sup>
- We interact the error term with a set of instruments to obtain a GMM estimator.

## Identification

To construct the set of instruments, the main identification assumption is that the product characteristics entering the  $K$ -dimensional vector  $x_j$  are predetermined and thus uncorrelated with the error term  $\xi_j$ . While this assumption immediately provides us  $K$  instruments, this is not sufficient to estimate all parameters of the model. In addition to the  $K$  characteristics parameters  $\beta$ , we also need to estimate the price parameter  $\alpha$ . Furthermore, we need to estimate the five group parameters  $\sigma_g$  and the ten subgroup parameters  $\sigma_{hg}$ . To obtain instruments in addition to the characteristics in  $x_j$ , supply side variables are the obvious candidates. Since cost shifters are not readily available at the product level, we follow Berry, Levinsohn and Pakes (1995) and use “markup shifters” as additional instruments.

Their starting point is that a firm  $f$ 's pricing policy for product  $j$  does not only depend on product  $j$ 's own characteristics  $x_j$ . Because of oligopolistic interdependence, it also depends on the characteristics of the other products owned by firm  $f$  and on the characteristics of the competing products (measuring their closeness in the product space). Berry, Levinsohn and Pakes propose to use functions of the competitors' characteristics as instruments, and discuss the general problem of how to choose approximately efficient instruments. In the spirit of their results, we adopted the following list of instruments, making use of the specific structure of the nested logit model: (i) the products' own observed characteristics  $x_j$ ; (ii) the number of products, and the sums of characteristics of other products of the same firm belonging to the same subgroup, interacted with the set of subgroup dummy variables; (iii) the number of products, and the sums of the characteristics of competing products belonging to the same subgroup, interacted with the set of subgroup dummy variables; (iv) the number of products,

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<sup>9</sup>We use the contraction mapping  $\delta^{t+1} = \delta^t + (1 - \max\{\sigma_1 \dots \sigma_G\})(\ln(s) - \ln(s(\delta^t)))$ . If one does not weigh the second term by  $(1 - \max\{\sigma_1 \dots \sigma_G\})$ , the procedure may not lead to convergence in a nested logit model. This follows from the fact that the unweighted function may not satisfy the derivative properties of Assumption 1 in Berry, Levinsohn and Pakes (1995) for some values of  $\sigma$ .

and the sums of the characteristics of competing products belonging to the same group, interacted with the set of group dummy variables. Note that we interact the “oligopolistic interdependence” instruments in (ii)-(iv) with the set of subgroup or group dummy variables, since we allow the nesting parameters  $\sigma_{hg}$  and  $\sigma_g$  to differ across subgroups and groups. F-tests from a first-stage regression show that the instruments are jointly significant.

## Panel features

We estimate the demand model based on our panel data set of 5 countries over 30 years. Adding subscripts to denote the market  $m$  and the year  $t$ , the error term becomes  $\xi_{jmt}$ . We specify this error term as a two-way error components model, such that  $\xi_{jmt} = \xi_j + \xi_{mt} + u_{jmt}$ . The product fixed effects  $\xi_j$  control for unobserved mean product valuations that do not vary over time or across markets, e.g. style or image. Since there are about 350 product fixed effects, we control for them using a within transformation of the model. The market/time fixed effects  $\xi_{mt}$  capture preferences for cars relative to the outside good, and can thus be thought of as accounting for macro-economic fluctuations that affect the decision to purchase a new car.<sup>10</sup> We estimate these market/time fixed effects using 150 dummy variables. Finally, the error term  $u_{jmt}$  captures the remaining unobserved product valuations varying across products, markets and time, e.g. due to unobserved variations in advertising, delivery times, etc.

## 4.3 Demand estimates

The parameter estimates are presented in Table 2. For comparison purposes, the first column presents the results from a restricted specification in which  $\sigma_{hg}$  is equal for all ten subgroups and  $\sigma_g$  is equal across all five groups. This is the common version of the nested logit model. The second column presents the results of a more flexible specification, in which the subgroup segmentation parameters are allowed to vary by segment. To check the sensitivity of the results, we also considered various alternative specifications. For example, we estimated a restricted specification in which  $\xi_{mt} = \xi_m + \xi_t$ . We also allowed some of the parameters to vary across countries, and we estimated the model for two separate subperiods: 1970-1984

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<sup>10</sup>Since we use a full set of market/time fixed effects, the parameter estimates do not change when different assumptions are made about the size of the outside good (i.e. the potential number of consumers  $L_m$  minus total sales). The size of the outside good does, however, potentially affect the subsequent policy simulations. To assess this, we experimented with different assumptions on the potential number of consumers  $L_m$ , i.e. we took both the total population and the population divided by 4 (a proxy for the number of households). The policy simulations are very similar even for such large changes (differences less than 5%). This follows from the fact that we find significant segmentation parameters.

and 1985-1999; the second subperiod coincides with the start of the distribution system. Most parameter estimates were robust across specifications.

In a previous version of the paper, we estimated the same demand model but without accounting for consumer heterogeneity on the price parameter. That model could be estimated using a much simpler linear instrumental variable estimator. It is noteworthy to point out that most of the parameter estimates were of roughly the same order of magnitude. However, the implied own- and cross-price elasticity estimates differ in several respects. We will come back to the most important differences in our discussion below. For a complete discussion of the results without accounting for heterogeneity on the price parameter, we refer to Brenkers and Verboven (2002).

Table 2 shows that the parameters of most characteristics are of the expected sign and significant. Width and height positively affect the consumers' mean utility. Fuel inefficiency (measured as liters per 100 km, hence the inverse of the U.S. measure of "miles per gallon") has the expected negative impact on utility. Price also has a significantly negative effect. Horsepower has an insignificant effect in the restricted specification, but a significant and positive effect in the flexible specification. The joint significance of the fixed effects could not be rejected at a very high significance level ( $P$ -value less than .0001).

The foreign firm effect is negative and significant. The domestic incumbents thus face a competitive advantage over their foreign competitors in terms of the mean consumer valuation (e.g. Peugeot/Citroën and Renault in France; Volkswagen, etc. in Germany; Fiat in Italy). We also considered two extensions to look at whether the foreign firm effect has changed over time. A first specification added a foreign firm effect interacted with a post-1984 dummy variable; a second specification added a foreign firm effect interacted with a time trend. Both specifications show that the importance of the foreign firm effect has declined substantially, by some 40% over a fifteen year period. This indicates that the competitive advantage of the domestic incumbents is declining, probably due to the process of European integration (as most foreign firms are E.U. firms, or have production facilities in the E.U.).

Now consider the segmentation parameters  $\sigma$ . For both the restricted and the unrestricted specification the restrictions implied by the random utility maximization assumption are satisfied for all parameters, i.e.  $1 \geq \sigma_{hg} \geq \sigma_g \geq 0$ .<sup>11</sup> The restricted specification shows that consumer preferences are significantly more correlated for cars within the same subgroup (parameter of .536), than for cars within the same group but a different subgroup (parameter of .411). Put differently, consumers have more homogeneous valuations regarding cars that come from both the same origin (domestic or foreign) and the same segment than regarding cars that only come from the same segment. Furthermore, preferences are more correlated

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<sup>11</sup>In the flexible specification, the  $\sigma_g$  for the luxury segment is negative, but it is insignificant.

for cars of the same segment than for cars of different segments (since .411 is significantly different from 0). These results are roughly in line with previous estimates for the European car market, in particular by Goldberg and Verboven (2001).

The flexible specification allows the segmentation parameters  $\sigma_{hg}$  and  $\sigma_g$  to vary by subgroup and group. To reduce the number of parameters to be estimated, we constrained  $\sigma_{Dg} = \sigma_{Fg}$  (where  $D$  denotes domestic and  $F$  denotes foreign), i.e. the degree of heterogeneity within a domestic subgroup is the same as that within a foreign subgroup of a given group  $g$ . This specification reveals several interesting new insights. Consider first the parameters for the subgroups ( $\sigma_{hg}$ ), defined by cars of both the same origin and segment. The estimates show that consumers have more homogeneous preferences for cars from the smaller segments than for cars from the larger ones. For example, preference correlation is .847 for domestic subcompact cars, and only .167 for domestic luxury cars. This finding appears to be consistent with our *a priori* guess that the degree of differentiation increases as one moves up to the more expensive segments. The only exception to this pattern is the standard segment, for which the segmentation parameter is close to that of the compact segment.

Considering the parameters from the groups ( $\sigma_g$ ), one can see that  $\sigma_{hg} > \sigma_g$  in all cases: consumers thus perceive cars from the same origin as significantly closer substitutes than cars from a different origin. Put differently, for each segment we find significant additional segmentation between domestic and foreign cars. This pattern appears to be more striking in the smaller segments (subcompacts) than in the more expensive ones (luxuries).

**Table 2. Parameter estimates for the nested logit demand\***  
(model with income distribution)

	restricted		flexible	
<i>Characteristics parameters</i>				
horsepower	.000	(.002)	.013	(.002)
fuel inefficiency	-.059	(.007)	-.037	(.007)
width	.032	(.002)	.032	(.002)
height	.013	(.003)	.012	(.003)
foreign	-1.028	(.044)	-.898	(.038)
– price ( $\alpha$ )	1.422	(.440)	4.764	(.412)
<i>Subgroup segmentation parameters (<math>\sigma_{hg}</math>)</i>				
subcompact	.536	(.028)	.847	(.030)
compact	same		.647	(.030)
intermediate	same		.538	(.031)
standard	same		.672	(.030)
luxury	same		.167	(.053)
<i>Group segmentation parameters (<math>\sigma_g</math>)</i>				
subcompact	.411	(.025)	.280	(.032)
compact	same		.485	(.036)
intermediate	same		.334	(.037)
standard	same		.543	(.035)
luxury	same		-.052	(.060)

\* The number of observations is 11549. Standard errors are in parentheses. Fixed effects  $\xi_j$  and  $\xi_{mt}$  are included. Subgroups are cars from both the same segment and origin (domestic or foreign), while groups are cars from the same segment regardless of the origin. For all car models, the own-price effects were greater than the sum of the cross-price effects.

It is instructive to look at the price elasticities implied by the estimates, and see how they differ between the restricted and the flexible nested logit specifications. Table 3 provides a summary, showing the average own- and cross-price elasticities by segment. The average elasticities for the whole market are in line with previous work, for example Berry, Levinsohn and Pakes (1995) or Goldberg and Verboven’s (2001) findings. Interesting new findings arise when comparing the price elasticities for the different segments between the restricted and the flexible specification. The restricted specification (similar to the one in Goldberg and Verboven, 2001) shows that the own-price elasticities are increasing as one moves to higher segments. For example, the average elasticity in the luxury segment is more than twice the

average elasticity in the subcompact segment. This increasing pattern directly follows from the assumptions of the restricted nested logit model in which the segmentation parameters do not vary by segment. The flexible nested logit specification shows that the pattern is reversed in our application: the own-price elasticities now tend to be declining as one moves up to the more expensive segments. For example, compare the average own-price elasticity of 10.9 in the subcompact segment with the average of 4.5 in the luxury segment. The reason for the reversed pattern stems in part from our earlier empirical finding that consumers perceive products in the inexpensive segments as more homogeneous than products in the more expensive segments.<sup>12</sup> It is interesting to compare the pattern of price elasticities with that obtained in Berry, Levinsohn and Pakes (1995). Recall that our flexible nested logit model essentially differs in that we do not have random coefficients on continuously measured variables (except price), but on a set of discrete segment dummies. They also find a declining pattern, reporting price elasticities in the range of 6–6.5 for car models in the subcompact and compact segments, and in the range of 3–4 for cars in the luxury segments. This is comparable to the declining pattern obtained here (ranging from 10.9 to 4.5), although our absolute numbers are somewhat higher.

To further understand the pattern of price elasticities across segments, it is also instructive to make a comparison with our previously estimated model with a common price parameter (no income distribution), as reported in Brenkers and Verboven (2002). In the restricted nested logit version there was an even sharper increasing pattern of price elasticities; in fact, the relationship between the price elasticities and price levels was nearly proportional. In the flexible nested logit version with a common price parameter, the pattern was more or less flat.

In sum, the substitution patterns are less dependent on functional form assumptions than in more commonly estimated aggregate nested logit models. Notably, the declining pattern of price elasticities across segments in our flexible nested logit model with a heterogeneous price parameter can be attributed to two features:

- our empirical finding that products in the more expensive segments are perceived as less close substitutes than products in the inexpensive segments;
- and the fact that consumers do not have a common price parameter.

Finally, Table 3 also summarizes the price elasticities by origin, domestic or foreign. Both the restricted and the flexible specifications show that the own-price elasticity of domestic

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<sup>12</sup>Note that similar remarks can also be made regarding the pattern of cross-price elasticities across different segments. In fact, the restricted nested logit specification shows an even sharper rising pattern for the cross-price elasticities between cars of the same subgroup or group.

cars is lower on average than the own-price elasticity of foreign cars.

**Table 3. Substitution patterns (in 1999)**

	Own elasticity	Cross elasticities with respect to car from		
		same subgroup	same group	different group
<i>Averages for restricted nested logit specification</i>				
all	-3.646	.247	.079	.002
subcompact	-2.535	.102	.031	.002
compact	-3.358	.184	.056	.002
intermediate	-3.995	.204	.062	.002
standard	-4.633	.447	.136	.002
luxury	-5.626	.706	.254	.003
foreign	-3.767	.187	.059	.001
domestic	-3.428	.355	.115	.003
<i>Averages for flexible nested logit specification</i>				
all	-7.566	.493	.104	.007
subcompact	-10.900	.822	.038	.005
compact	-6.113	.316	.123	.008
intermediate	-5.431	.220	.071	.007
standard	-8.628	.799	.361	.007
luxury	-4.537	.152	-.011	.012
foreign	-7.734	.364	.071	.004
domestic	-7.263	.726	.165	.011

#### 4.4 Marginal costs

Based on the demand estimates and the specification of oligopoly pricing before liberalization it is possible to recover the marginal costs (i.e. the *sum* of manufacturer and retailer marginal cost). Recall that we consider two alternative pricing scenarios: one with full national intrabrand competition and one with limited national intrabrand competition. In both scenarios the manufacturing firms behave non-cooperatively, i.e. maximizing the sum of the profits of all products in their own portfolio, as reflected by the firms' product ownership matrix  $\theta^F$ . The first and fourth column of Table 4 show the 1999 averages of the marginal costs implied by the two pricing models (flexible demand specification). The estimates generally appear plausible and in line with previous estimates obtained in the literature.

The implied manufacturers' Lerner indices are on average between 16% and 24%, with the highest averages in Italy and France (where the domestic producers are strongest). These

average are comparable to those obtained by Berry, Levinsohn and Pakes (1995), with an average of 24% implied by their Table VIII; they are lower than the average of 38% reported in Goldberg (1995). It is also of some interest to compare the numbers with average gross margins available from accounting sources. The U.K. Competition Commission report refers to average gross profit margins in the range of 10-12%. On the other hand, the 2002 PCW Global Automotive Review Report finds that gross profit margins are on average 21.2%, which is close to our estimates. (The cited U.S. studies also report estimates from accounting sources in the 20% range). In sum, our estimates are of the same order of magnitude, though perhaps at the higher end of the range of estimates available from accounting sources. This can be due to the fact that gross profit margins based on accounting data may inherently still contain some fixed cost components. Finally, note that the pattern of Lerner indices across segments (not shown) is consistent with the pattern of price elasticities discussed earlier. Percentage margins tend to be higher for the luxury segments than for the subcompact or compact segments.

Comparing these averages across countries, there are sometimes substantial differences. In particular, the marginal cost of cars sold in the U.K. appears substantially higher than the marginal cost of cars in the other countries. This finding is similar to Goldberg and Verboven (2001), who analyzed it in detail. One explanation is that the high observed prices in the U.K. stem indeed from higher higher marginal costs of selling cars in the U.K. This could be due to the presence of unmeasured extra optional equipment on U.K. cars, such as radio or insurance. Furthermore, the importance of local distribution costs, which may amount to up to 35% of the price of a car, may explain the higher marginal costs during periods when the local exchange rate is overvalued. In fact, in 1999 the pound had appreciated by about 30% compared to 1997, without an accompanying reduction in relative factor prices. Distribution costs, as measured in a common currency, were therefore (temporarily) higher in the U.K. than elsewhere. Despite these explanations, the estimated marginal costs in the U.K. appear rather high compared to the other countries, as also pointed out by Goldberg and Verboven.

An alternative possibility is that the higher U.K. prices are not due to higher marginal costs of selling cars in the U.K., but due to higher markups stemming from collusive behavior. This possibility cannot be ruled out *a priori* in light of the repeated investigations by the U.K. Competition Commission during the 1990's. Goldberg and Verboven (2001) considered the possibility of collusion by modifying the firms' product ownership matrix  $\theta^F$  for the U.K. market, such that firms behave as maximizing the sum of profits over all products of the same subsegment. They compared the non-cooperative pricing model with the model with collusion in the U.K., but they could not empirically distinguish between both possibilities.

Based on this (as well as the fact that the U.K. Competition Commission did not find unambiguous results), we do not take a position here as to whether marginal costs of selling cars are higher in the U.K., or whether markups are higher due to collusion. Instead, we will report and discuss our simulation results based on both a non-cooperative and a collusive model of pricing, realizing that the truth may lie somewhere in the middle.

We use a somewhat different approach to account for possible collusive behavior than Goldberg and Verboven (2001).<sup>13</sup> Rather than redefining the U.K. product ownership matrix as if all firms of the same segment are a single firm, we adopt the following procedure. For every country except the country with the lowest average price level (Belgium) we modify  $\theta^F$  as follows. We replace the zeros (denoting competing products) on each row  $j$  in  $\theta^F$  by a parameter  $\phi_j$ , which is chosen in such a way that the marginal cost for product  $j$  equals the marginal cost for the same product  $j$  in Belgium. One may interpret  $\phi_j$  as a “partial collusion” parameter, capturing deviations from the non-cooperative pricing assumption (relative to the country with the lowest prices where the non-cooperative outcome is still imposed). A positive  $\phi_j$  (less than 1) means that the price of product  $j$  is determined with a partial account for the effect on competing products (not in the firm’s own portfolio), hence the price is set in a partially collusive way. In the extreme case where  $\phi_j$  is equal to 1, product  $j$  is priced fully collusively, i.e. as if the effect on the other products’ profits is fully taken into account. Conversely, a negative  $\phi_j$  means that the price of a product is set below the multi-product non-cooperative price. Based on this approach, we find that the pricing in France, Germany and Italy is slightly less competitive than multi-product non-cooperative pricing, relative to Belgium, with average estimates of  $\phi_j$  in the range of 0.08–0.43 under full intrabrand competition and -0.06–0.27 under limited intrabrand competition; see Table 4. In the U.K. pricing appears to be quite collusive, with an average partial collusion parameter estimate of around 0.9.<sup>14</sup> We can now compute the effects from liberalization, under either non-cooperative or collusive pricing.

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<sup>13</sup>As a robustness check, we also followed their approach and obtained similar simulation results.

<sup>14</sup>Standard errors are in the range of 0.15–0.22. Hence, *imposing* the assumption that marginal costs are equal across countries, the hypothesis of non-cooperative behavior cannot be rejected for most countries, and the hypothesis of collusion cannot be rejected for the U.K.

**Table 4. Marginal cost estimates and  $\phi$  (in 1999)**

	Full intrabrand competition			Limited intrabrand competition		
	marg. cost	Lerner index	implied $\phi$	marg. cost	Lerner index	implied $\phi$
Belgium	10299	0.16	0.00	9603	0.16	0.00
France	10404	0.20	0.08	9534	0.21	-0.06
Germany	11192	0.18	0.43	10155	0.18	0.27
Italy	11009	0.24	0.29	10330	0.23	0.20
U.K.	14499	0.16	0.91	13588	0.17	0.90

Note: Marginal costs are expressed in Euro. All numbers are market-averages across car models. Marginal costs and Lerner index are computed assuming non-cooperative pricing. The parameter  $\phi$  refers to partial collusion assuming marginal costs are identical across countries, as discussed in the text.

## 5 The effects of liberalization

We begin the analysis by assuming that full national intrabrand competition already exists before liberalization (scenario 1). As discussed, this possibility cannot be ruled out. Moreover, it allows us to first focus purely on the effects of increased international intrabrand competition after liberalization, and the corresponding reduction in international price discrimination. This is a question of independent interest. Next, we extend the analysis by considering the possibility that there was only limited national intrabrand competition before liberalization (scenario 2). This enables us to evaluate the cumulative effect from reducing both international price discrimination and double marginalization effects after liberalization.

Our simulation analysis amounts to numerically computing the new Nash equilibrium after imposing constraints on international markup differentials, based on the estimated demand parameters and the uncovered marginal costs (flexible nested logit specification). To capture the effects of intermediate and strong increased cross-border trade, we consider constraints on markup differentials of respectively 12% and 0%. The 12% number is obviously arbitrary, meant to capture any remaining cross-border trade costs. We extensively experimented with alternative percentage constraints on markup differentials, but there are no essential new insights from reporting these results as well.

## 5.1 Full national intrabrand competition before liberalization

Under full national intrabrand competition before liberalization, the impact of liberalization amounts to a reduction in the degree of international price discrimination. Recent theoretical work has shown that it is difficult to draw general conclusions regarding the price, profit and welfare effects of eliminating third-degree price discrimination in an oligopolistic setting; for a survey, see Stole (2001). Under monopoly, the elimination of price discrimination would typically lead to a uniform price in between the discriminatory prices, to reduced profits and to ambiguous welfare effects. Things are quite different under oligopoly. The elimination of price discrimination may sometimes lead to a uniform price that is above all the discriminatory prices. This was shown by Thisse and Vives (1988) in a location model; Corts' (1998) obtains additional insights on the conditions when this may occur and refers to the situation as one of "all-out competition". The implication is that in oligopoly profits may be higher under uniform pricing than under discriminatory pricing. Essentially, when given the possibility to discriminate, firms have additional instruments to compete and steal business from each other, so that they may arrive in a prisoners' dilemma situation and have reduced profits.<sup>15</sup> The welfare effects from eliminating price discrimination are correspondingly even more difficult to predict *ex ante* than under monopoly. An empirical analysis is thus necessary to evaluate the effects from reducing or eliminating price discrimination.

### Price effects

First consider the price effects from introducing a 12% or a 0% constraint on international markup differentials. For each car, we find that there is at least one country where the price would fall and at least one country where the price would rise after liberalization. Hence, there are no situations of "all-out competition" where all prices increase compared to the discriminatory prices (nor reverse situations where all prices would decrease). Table 5 provides summary information on the general price level changes by country, and further broken down by domestic and foreign cars. The price levels refer to weighted price indices, where the weights are the market shares before liberalization.

Under non-cooperative pricing, liberalization would have the effect of modestly raising the general car price level in most countries except in the United Kingdom, where there would be a price level decline of 1–2% (see the third and sixth column of Table 5). The overall price increase (for all five countries) is small, between 0.2–0.3%. While the general price levels do not change much, there are fairly substantial relative price changes within each country. This can especially be seen from breaking down the price changes by domestic

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<sup>15</sup>See also Holmes (1989) and Armstrong and Vickers (2001) for price discrimination analyses under oligopoly.

and foreign cars, see the first and second, and fourth and fifth column of Table 5. In most countries the price level of domestic cars would drop while the price level of foreign cars would increase. In Germany, the predicted price increase is smaller for domestic cars than for foreign cars; and in the U.K. the predicted price decrease is larger for domestic cars than for foreign cars. We also broke down the price changes by market segment (not shown). While the price changes are somewhat stronger in the lower-end segments, there do not appear to be striking differences across segments.

Now consider the price level changes under partially collusive pricing. Recall that we found that in most countries prices are close to non-cooperative prices, except in the U.K. where they appear closer to full collusive behavior. While the general price changes show a similar qualitative pattern as before, the magnitudes are now more pronounced. Liberalization would raise the price level by about 4–16% in all countries except the U.K. In the U.K. the price level would drop by about 15–18%. The intuition for these stronger findings follows directly from the different pricing assumptions and the implied marginal costs and markups before liberalization. Under non-cooperative pricing, the systematic country-level international price differentials are partly driven by cost differences; markup differences only play an important role for differences between domestic and foreign cars. Under partially collusive pricing, systematic country-level price differences are (by construction) purely driven by markup differences instead of cost differences. It is therefore not surprising that the general price effects are more pronounced under partially collusive pricing.

**Table 5. Percentage price changes after liberalization**  
(full national intrabrand competition before liberalization)

	domestic	foreign	all	domestic	foreign	all
Non-cooperative pricing						
	Max. markup differential $\tau = 12\%$			Max. markup differential $\tau = 0\%$		
Belgium	–	–	4.1	–	–	4.7
France	-1.3	1.8	0.1	-2.6	3.1	-0.1
Germany	0.3	1.3	0.6	0.5	2.8	1.1
Italy	-2.5	1.3	0.1	-2.9	3.2	1.3
U.K.	-2.2	-0.3	-1.0	-4.4	-1.1	-2.3
All	-0.4	0.8	0.2	-0.8	1.6	0.3
Partially collusive pricing ( $\phi$ )						
	Max. markup differential $\tau = 12\%$			Max. markup differential $\tau = 0\%$		
Belgium	–	–	15.8	–	–	14.7
France	5.3	10.4	7.6	6.5	13.0	9.4
Germany	4.1	1.8	3.5	5.1	2.5	4.4
Italy	7.0	4.0	4.9	12.4	4.5	7.0
U.K.	-14.6	-15.4	-15.1	-17.7	-18.7	-18.3
All	2.4	-2.3	0.3	3.0	-2.7	0.5

Note: Results are percentage changes of price indices. Price indices are weighted average price levels using the sales before liberalization as weights.

### Profit and welfare effects

Table 6 summarizes the effects from removing price discrimination on producer surplus, consumer surplus, and total welfare. We present both the effects as computed from the point estimates of our parameters, and 95% confidence intervals as obtained using parametric bootstrapping. To compute the confidence intervals, we took 40 draws of the parameter vector, assuming it has a multivariate normal distribution with a covariance matrix equal to our estimated one. For these draws, we numerically compute the post-liberalization equilibrium prices, and the implied producers surplus, consumer surplus and welfare levels. We found it more informative to present confidence intervals than standard deviations, since the confidence intervals are sometimes asymmetric around the mean. To keep the table readable, we only present the results for  $\tau = 0\%$ ; we obtained similar numbers for  $\tau = 12\%$ .

The effects of removing price discrimination on the manufacturers' producer surplus are negative but insignificant under non-cooperative pricing (drop of -36 million Euro, with a 95% confidence interval of -95 and +9 million Euro). The drop in manufacturers' producer surplus is somewhat higher under partially collusive pricing (-584 million Euro, with a confi-

dence interval of -759 and -322 million Euro). Nevertheless, these numbers are quite small in percentage terms (points estimates of -0.2% and -1.9% respectively). These findings are consistent with the above discussed theoretical insights that the possibility to price discriminate does not necessarily raise profits under oligopoly.<sup>16</sup>

The small effects on manufacturers' producer surplus from liberalization have important policy implications. They show that the possibility to price discriminate under the former distribution system did not by itself contribute to an important extent to the manufacturers' profits. Hence, in contrast to what is often suggested in the policy debate, it is not appropriate to view the former system as a mechanism with the deliberate intention to make price discrimination feasible. Instead, the feasibility of price discrimination should be seen as a – possibly unwanted – side effect, and the main profit motives for the former distribution system should be sought elsewhere. This finding relates to Berry, Levinsohn and Pakes' (1999) results on voluntary export restraints (VER's). They also find that the profit effects from VER's are not very large (so that VER's should also not be seen as a main profit motive by the industry in their application).

The effects of removing price discrimination on consumer surplus and welfare may be summarized as follows. Under non-cooperative pricing, consumer surplus would drop by an estimated 231 million Euro or 7.3% in Belgium, by 444 million Euro or 1.7% in Germany, and by 255 million Euro, or 1.9% in Italy. In France, consumer surplus would increase by a small amount. The main increase in consumer surplus is realized in the United Kingdom, with an increase by up to 895 million Euro, or 4.4%. The overall change in consumer surplus (sum of five countries) is small, about 0.1 billion Euro. This confirms our earlier finding regarding the general price changes: under non-cooperative pricing, the effects on consumers are relatively modest, but the main winners are generally the U.K. consumers at the expense of consumers in most other countries. Under partially collusive pricing similar findings are obtained, but the magnitudes of the effects are considerably more important. Consumers from all countries except the U.K. would lose, for example by an estimated 1.8 billion Euro in Germany. U.K. consumers would gain substantially, by 7.8 billion Euro. Aggregate consumer surplus across the five countries would increase, by an amount of 3 billion Euro (95% confidence interval of 2.6 and 3.3 billion Euro). As before, this follows from the fact that the large existing

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<sup>16</sup>In principle, the results may also be driven by the fact that prices are not necessarily strategic complements. In non-linear product differentiated demand models with multi-product firms, a rival's price increase may change both the intercept and the slope of demand. The effect may be such that especially price sensitive consumers are attracted, possibly making price decreases optimal in response to a rival's price increase, as pointed out by Berry, Levinsohn, Pakes (1999). Based on numerical analysis of the second-order cross-price effects on profits, we found that most product pairs are strategic complements rather than strategic substitutes in the neighbourhood of our pre- and post-liberalization equilibrium. Hence, we attribute our findings mainly as being consistent with the results from the oligopoly price discrimination literature.

international price differentials between the U.K. and the rest of Europe are now entirely attributed to markup differences.

Finally, because of the small producer surplus effects, the effects from liberalization on total welfare are comparable to the consumer surplus effects. They are negligible under non-cooperative pricing (increase of 66 million Euro, with a 95% confidence interval of -8 and +97 million Euro), and they are quite large under partially collusive pricing (increase by 2.6 billion Euro, with a confidence interval of +2.3 and +2.7 billion Euro).

**Table 6. Welfare changes after liberalization**

Scenario 1. Full national intrabrand competition before liberalization

	Non-cooperative pricing				Partially collusive pricing ( $\phi$ )			
	in million Euro		in percentage		in million Euro		in percentage	
$\Delta CS$								
Bel	-231	[-235,-183]	-7.3	[-7.4,-5.8]	-648	[-671, -624]	-20.3	[-20.7,-19.8]
Fra	170	[ 81, 205]	1.1	[ 0.5, 1.3]	-1682	[-1756,-1631]	-10.8	[-11.0,-10.5]
Ger	-444	[-477,-348]	-1.7	[-1.9,-1.4]	-1797	[-1903,-1758]	-7.0	[-7.4, -7.0]
Ita	-255	[-302,-197]	-1.9	[-2.2,-1.5]	-615	[-736, -514]	-4.5	[-5.3, -3.8]
UK	895	[ 670,1059]	4.4	[ 3.3, 5.2]	7785	[ 7657, 7843]	38.0	[ 36.8, 38.6]
All	135	[ 70, 165]	0.2	[ 0.1, 0.2]	3043	[ 2605, 3299]	3.9	[ 3.3, 4.3]
$\Delta PS$								
All	-36	[-95, 9]	-0.2	[-0.4, 0.1]	-584	[-759, -322]	-1.9	[-2.7, -1.0]
$\Delta W$								
All	66	[-8, 97]	0.1	[ 0.0, 0.1]	2573	[ 2343, 2686]	2.0	[ 1.8, 2.1]

Note: 95% confidence intervals are in parentheses. Results are presented for  $\tau = 0\%$ ; similar results obtain for  $\tau = 12\%$ . Percentage changes are in parentheses.  $\Delta PS$  refers to changes in manufacturers' profits. Retailer profits are zero under scenario 1.  $\Delta W$  refers to changes in total welfare, the sum of consumer surplus, producer (manufacturer) surplus, and tax revenues (VAT).

## 5.2 Limited national intrabrand competition before liberalization

Under limited national intrabrand competition before liberalization, the liberalization proposals will have the *combined effect* of increasing both national and international intrabrand competition. Hence, the liberalization would lead to both a reduction in international price discrimination and to an elimination of the double marginalization/softening competition mechanism. Table 7 summarizes the computed effects on consumer surplus, manufacturers'

producer surplus and total welfare in the various countries.<sup>17</sup>

At first sight, it appears that the consumer surplus and welfare results differ quite substantially from the ones obtained under the previous scenario of full national intrabrand competition before liberalization. Consumer surplus now increases by a large amount, about 16-22% at the European level.<sup>18</sup> Only consumers in Belgium could be worse off (at least under partially collusive pricing). The overall increase in total welfare is between 9 and 11 billion Euro. The intuition for these findings is that liberalization now has the combined effect of both reducing international price discrimination and eliminating the double marginalization effects.

While the results differ quite substantially from our findings under the previous scenario in section 5.1, this does not mean our policy implications become inconclusive. To explain this, we look into more detail at the effects of liberalization on the manufacturers' producer surplus.<sup>19</sup> This allows us to assess the profit motive for keeping the former distribution system if the current scenario is relevant. Recall that under the previous scenario we found the profit motive to be negligible, i.e. the possibility to engage in international price discriminate does essentially not contribute by itself to manufacturers' profits. Under the current scenario there are two possible profit motives for the former distribution system: the possibility to price discriminate plus the double marginalization/softening competition effect, as identified by Rey and Stiglitz (1995) and summarized in section 3.2. If both of these profit motives turn out to be absent, then the distribution system must have been present for other reasons, for example efficiencies such as public good aspects in providing after sales services.

The second to last row on Table 7 shows the changes in the manufacturers' producer surplus. We find that their profits would actually increase from liberalization, by about 3.8 billion Euro under non-cooperative pricing and 0.6 billion Euro under partially collusive pricing. This shows that, taken together, the price discrimination and softening competition mechanism do not constitute profit motives for the former distribution system.<sup>20</sup> To the

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<sup>17</sup>Since it is not our main interest, we do not separately report the two remaining components of retailers' producer surplus changes and tax revenue (VAT) changes. Under both non-cooperative and partially collusive pricing, retailers' producer surplus drops by about 8 billion Euro, whereas tax revenues increase by about 1.2 billion Euro.

<sup>18</sup>Since they do not produce any interesting new insights, we no longer report the results for the predicted price changes, i.e. the analogues of our previous Table 5.

<sup>19</sup>Note that this does not coincide with total producer surplus, since in the scenario of limited national intrabrand competition retailers also make a profit under the former distribution system. The changes in retailers' part of producer surplus are not shown explicitly on Table 8, but they enter in the computation of total welfare.

<sup>20</sup>In separate computations we also found that the softening competition effect does not by itself constitute a profit motive. Hence, the possibility that double marginalization may raise profits, as shown by Rey and Stiglitz (1995), does not turn out to be empirically relevant in our application. This is because the estimated degree of *inter*brand competition (the substitutability between different products) is not sufficiently strong.

contrary, to the extent that this scenario is relevant, they should be viewed as side effects that are unwanted by the manufacturers. Consequently, if one is to argue that the second scenario is more relevant than the first, one has to be consistent and accept the presence of possibly large efficiencies, since the firms would otherwise not have cooperated to obtain the system in the first place. Hence, liberalization would also involve large efficiency losses in this scenario, so that the total welfare effects may actually lie much closer to the ones obtained under the previous scenario.

**Table 7. Welfare changes after liberalization**  
(limited national intrabrand competition before liberalization)

	Non-cooperative pricing				Partially collusive pricing			
	in million Euro		in percentages		in million Euro		in percentages	
$\Delta CS$								
Bel	146	[ 101, 248]	4.6	[ 3.2, 7.7]	-143	[ -179, -91]	-4.5	[-5.5,-2.9]
Fra	2393	[ 1727, 2714]	15.3	[11.1,17.2]	314	[ 67, 565]	2.0	[ 0.4, 3.6]
Ger	4973	[ 3623, 5817]	19.5	[14.2,22.6]	3055	[ 2565, 3567]	12.0	[ 9.9,13.9]
Ita	1431	[ 1321, 2279]	10.5	[ 9.6,16.7]	2823	[ 1903, 4672]	20.7	[13.6,34.5]
UK	3351	[ 2335, 3977]	16.3	[11.4,19.3]	11425	[11022,11837]	55.7	[52.7,57.8]
All	12295	[9962,14319]	15.7	[12.7,18.1]	17474	[15517,20000]	22.3	[19.3,25.7]
$\Delta PS$								
All	3821	[ 2846, 5308]	17.3	[15.3,21.2]	637	[-2689, 2929]	2.3	[-9.3, 9.8]
$\Delta W$								
All	9519	[7255,11808]	7.4	[ 5.8, 8.8]	11620	[ 9442,13764]	8.6	[ 7.1, 9.9]

Note: 95% confidence intervals are in parentheses. Results are presented for  $\tau = 0\%$ ; similar results obtain for  $\tau = 12\%$ . Percentage changes are in parentheses.  $\Delta PS$  refers to changes in manufacturers' profits only.  $\Delta W$  refers to changes in total welfare, the sum of consumer surplus; producer (manufacturer + retailer) surplus, and tax revenues (VAT).

## 6 Conclusions and extensions

Our analysis has investigated how the liberalization of vertical restraints may affect consumer surplus, manufacturers' producer surplus and total welfare. Our main findings may be summarized as follows. If the former system already entails sufficient national intrabrand competition, then liberalization mainly improves international intrabrand competition, and so leads to a reduction in international price discrimination. Total welfare may increase by an amount between slightly positive and 3.0 billion Euro per year. If the former system effec-

tively limits national intrabrand competition, then liberalization may lead to both reduced international price discrimination and to the elimination of the softening competition mechanism. The computed welfare gains become much larger. However, one must also account for potentially large efficiency losses, since the former system would be hard to rationalize without efficiencies from the manufacturers' point of view.

The analysis may be extended in several ways. First, one might account for the fact that industry restructuring may take place in response to liberalization. Assuming that firms incur fixed costs, they may no longer be able to recover those after liberalization. One might investigate what the effects would be when liberalization measures trigger mergers or other horizontal agreements. Second, it would be interesting to analyze the effects in high tax countries in more detail. We have focused here on the incentives for international price discrimination induced by the existing system. Yet an issue that has received less attention is that the existing system also provides incentives to individual countries to implement tax discrimination. While V.A.T. is similar between countries, other taxes are far from being harmonized across Europe. Some countries apply registration and other taxes amounting to over 100% of the purchase price. These are countries that typically do not have much local production (e.g. Denmark, Greece). It is clear that the incentives for tax discrimination by governments may be seriously reduced when the distribution system is liberalized. Firms currently charge lower markups in the high tax countries to stimulate demand, but they would no longer be willing to do so in an integrated market as it would attract too many foreign consumers. Hence markups would increase in the high tax countries, which would lead to lower demand and tax revenues. This would in turn induce local governments to bring their taxes more in line with those of other European countries, implying possible further welfare effects.

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## 8 Appendix.

### 8.1 The selective and exclusive distribution system

This part of the appendix provides a detailed discussion on the essential features of selectivity and exclusivity, to demonstrate their impact on national and international intrabrand competition.

Until 1985 the relationships between the car manufacturers and their dealers were regulated through individual exemption decisions by the European Commission. In 1985, the Commission decided to adopt a block exemption regulation, Regulation 123/85, applicable to the whole industry. The block exemption allowed for two main restrictions in distribution: selectivity and territorial exclusivity. In addition, non-compete clauses (or “exclusive dealing” arrangements) and other restrictions were allowed. In 1995, the Commission adopted a new block exemption, Regulation 1475/95, expiring in September 2002. The basic principles remained unchanged, though some of the restrictions were relaxed to stimulate competition. We summarize the main properties of the distribution system as it exists since 1995. For further details, including a comparison between the 1985 and 1995 system, we refer to the European Commission (2000) and the U.K. Competition Commission (2000).

#### Selectivity and exclusivity

Selective and exclusive distribution agreements have in common that they restrict the number of authorized distributors and the possibilities of resale.<sup>21</sup> The difference lies in how these restrictions work, see Table A.1 for a summary. Selectivity means that each manufacturer can set qualitative and quantitative criteria on its distributors. Qualitative criteria are, for

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<sup>21</sup>See the Commission Notice in O.J. 2000/C 291/01 of 13.10.2000 on Guidelines on Vertical Restraints, paragraph (184).

example, minimum standards as regards training of staff, advertising and storage, and most notably, the obligation to provide after-sales repair and maintenance services. Quantitative criteria allow the manufacturer to restrict the total number of dealers and to impose annual sales targets. To protect the selectivity of the distribution system, the manufacturer can prohibit its dealers to sell cars to independent resellers. Dealers may thus only sell to end-consumers, to intermediaries with a written authorization from consumers, or to other dealers within the manufacturer’s network.

Territorial exclusivity refers to the manufacturers’ right to appoint only one dealer in a geographically limited territory. The appointed dealers must not maintain branches outside their own contract territory, i.e. a “location clause” is permitted. Dealers have to concentrate their marketing efforts on their own territory and are restricted from an active sales policy in other territories. While they can advertize in media that cover a wider area than their own territory, personalized advertising campaigns outside their territory are forbidden.

We focus on the two main potential anti-competitive effects from the selective and exclusive distribution system. Both effects concern a reduction of intrabrand competition, i.e. competition between dealers selling the same brand. First, the system may restrict international intrabrand competition, i.e. opportunities for cross-border trade, and thus lie at the basis of large international price differentials. Second, the system has the potential of reducing national intrabrand competition and thereby creating a softening competition mechanism among the manufacturers.

**Table A1. Selective versus exclusive distribution**

Distribution	Restriction imposed on	
	authorized distributors	possibilities of resale
Selective	qualitative and quantitative criteria	no sales to independent reseller
Exclusive	geographic territory	no active selling in other territory

**Effects on international intrabrand competition: price discrimination**

When selectivity and territorial exclusivity are not combined, the opportunities for international intrabrand competition, or cross-border trade, are not seriously affected. Suppose there is selectivity without exclusivity. While the selected dealers are then restricted from selling to independent resellers, they can set up their own branches abroad to take advantage of existing price differentials. Furthermore, the dealers can engage in active cross-border sales policies such as personalized advertising. Conversely, suppose there is exclusivity without selectivity. Although the exclusive dealers cannot set up their own branches abroad, they

can sell to independent resellers who may exploit the price differentials. Hence when selectivity and exclusivity are not combined, international price differentials are constrained by the arbitrage activities of either the foreign branches of the selected dealers or the independent resellers.

In contrast, when selectivity and exclusivity are both adopted together, the possibilities for cross-border trade become limited. It can then only take place directly by end-consumers, by intermediaries with a written authorization from consumers, or by dealers within the manufacturer's network. An "availability clause" aims to guarantee the cross-border supply. It states that dealers should be able to obtain cars with foreign specifications from their manufacturers (e.g. right-hand drive cars for the U.K. market). In practice, however, the system of quantitative sales targets (including the associated bonus schemes) severely limits the cross-border supply and thus the possibilities for arbitrage. Most manufacturers link the allocation of new cars to their dealers to the agreed sales targets. As a result, the dealers cannot supply any amount they want; they are constrained by the sales targets. They are thus inclined to first serve their local customers to whom they can also offer after-sales services. Supply is further limited because the dealers must sell the whole model range. This means that dealers can in practice only get sufficient numbers of an attractive model if they also take a number of less attractive models. The conclusion is that the system does not hamper the availability of cars to customers within the dealers' territory, but may lead to long delivery lags (or excessive surcharges) for other customers.

To which extent do end-consumers, intermediaries and other dealers face other restrictions, in addition to the limited cross-border supply?

(i) The rights of end-consumers to purchase a car abroad are in principle best protected. A 1985 Commission Notice formally states that consumers who purchase their car abroad must not face excessive delivery lags or refusals to carry out warranty works.<sup>22</sup> The benefits from the distribution system may be withdrawn if international price differentials exceed 12% for more than a year, or exceed 18% for a shorter period. In practice, foreign consumers have in fact often faced long delivery lags or have had to pay higher prices than domestic consumers, see BEUC (1992) and its previous studies for anecdotal evidence. Furthermore, international price differentials have regularly exceeded the thresholds without initiating a formal investigation by the Commission.

(ii) The rights of intermediaries with a written authorization from end-consumers

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<sup>22</sup>Warranty works could be refused when the car has been purchased from non-authorized, independent resellers. See the Commission Notice in O.J. 1985/C17/03 of 18.1.1985 on the rights of consumers and the tolerance levels for price differentials.

are formally restricted by a 1991 Notice.<sup>23</sup> To ensure that they do not act like independent resellers, they must avoid carrying a common name; they must not use supermarkets as outlets; and they must quote their prices only as “best estimates”. Furthermore, intermediaries and dealers may not establish privileged relationships with each other, in the form of favorable conditions or sales amounts exceeding 10% of the dealers sales.

(iii) The dealers who want to purchase from other dealers of their network also face additional restrictions. The sales targets are not only responsible for the limited cross-border supply as discussed above. The U.K. Competition Commission (2000) reports an interesting additional effect. Many manufacturers seem to determine whether the sales targets are met by counting only the cars that the dealers obtain directly from the manufacturers, and not the cars they obtain from foreign dealers. Dealers will therefore have a great difficulty in meeting their sales target if most of their sales to local customers are sourced from foreign dealers rather than from the manufacturer. Note that a similar effect would arise if the manufacturer would exclude the sales sourced from foreign dealers when determining the bonus payments, but this is a black practice according to the regulation.

In summary, this discussion makes clear that the selective and exclusive distribution system contains several restrictions that limits international intrabrand competition, or cross-border trade. Further support for this conclusion comes from the large international price differentials together with the low extent of parallel imports (in the range of 0–2% of total sales), as previously documented by e.g. BEUC (1992) and Goldberg and Verboven (2001).

### **Effects on national intrabrand competition: double marginalization and softening competition**

Selectivity and exclusivity may have an additional anti-competitive effect, relating to intrabrand competition within a country. As analyzed by Rey and Stiglitz (1995), a limited degree of national intrabrand competition creates a double marginalization effect, which serves to reduce the degree of competition between the manufacturers (interbrand competition). As a result, both the dealers’ retail prices and the manufacturers’ wholesale prices may be higher than the noncooperative Bertrand prices, and manufacturers may succeed in obtaining larger profits, a form of softening competition between the manufacturers.

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<sup>23</sup>See the Commission Notice in O.J. 1991/C 329 of 18.12.1991 on the obligations of intermediaries.

Does the existing system effectively reduce the extent of intrabrand competition within a country, and thus potentially work as a softening competition mechanism? It is not obvious that this is the case. As discussed above, dealers can engage in non-personalized advertising campaigns outside the territory. The U.K. Competition Commission (2000) quotes the number of 39% as the proportion of out-of-territory sales. Based on the fact that most of the population lives in urban areas and commutes to different areas, the Competition Commission interprets this to be a small proportion, and concludes that intrabrand competition is relatively weak; see 2.117 and 2.322 in Competition Commission (2000). Nevertheless, the proportion suggests that consumers do purchase in other territories, so that intrabrand competition is potentially present to at least some extent.

### **Other features of the distribution system**

The manufacturers can also place additional restrictions to their dealers, apart from selectivity and territorial exclusivity. In particular, they are allowed to adopt non-compete clauses, or “exclusive dealing” arrangements. This limits the dealers’ possibilities to sell cars from different manufacturers. Multiple brands can only be sold if this is done under separate management, in the form of a distinct legal entity and in separate showrooms to avoid confusion between brands. In practice, most dealers sell only one brand; exceptions occur in the rural areas of the Nordic countries.

The manufacturers should allow access to their dealer network by independent spare part producers. The dealers thus have the right to use spare parts from these suppliers, provided that they are of “matching quality”.

Although the selectivity imposes dealers to provide after sales services, independent repairers may also be active. They should have access to the necessary technical information so as to provide maintenance and repair services. Repairs that fall under the warranty are to be carried out by the authorized dealers.

### **The 2002 proposals for liberalization**

In light of the expiration of the existing distribution system in September 2002, the Commission has proposed a revised system. On the one hand, the new system is potentially more liberal than the existing system; on the other hand, it gives the manufacturers more choice. The main proposal is to allow the manufacturers to impose either selectivity or exclusivity on their dealers, but no longer a combination of both. Note that this is effectively a stricter than the general exemption granted to vertical restraints. This is because of the Commission’s fear of cumulative effects, i.e. the competitive effects when a large group of firms adopts the vertical restraints simultaneously. More specifically, if manufacturers adopt a selective

agreement, their dealers can open foreign outlets, since they are no longer subject to a location clause.<sup>24</sup> If manufacturers adopt an exclusive agreement, dealers have the right to sell to independent resellers, who do not need a written authorization from consumers.<sup>25</sup> Furthermore, some of the conditions of selectivity and exclusivity are weakened. For example, the intermediaries who can trade under selectivity provided they have a written consumer authorization, are no longer restricted to purchase at most 10% of a dealer's total sales. Similarly, manufacturers can no longer impose sales targets (and bonus schemes) based on a territory that is smaller than the E.U. This should prevent the risk of a limited supply to dealers selling intensively abroad.

Other proposals are to facilitate the dealers' possibilities to sell cars from different manufacturers, and to reduce the link between new car sales and after-sales services. Although all of these proposals may affect the nature of competition in the market, we choose to focus on the main proposal, relating to selectivity and territorial exclusivity. Our focus also reflects the Commission's own interests. Before publishing its reform proposals, the Commission had requested a comparative study (carried out by Andersen) to evaluate the effects from five alternative distribution systems, each being a different combination of selectivity and exclusivity.

## 8.2 Constrained Nash equilibrium

This part of the appendix illustrates the computation of a constrained candidate Nash equilibrium. Suppose all constraints are nonbinding, except product  $j$ 's constraint for country pair (1, 2), for which:

$$(1 + \tau)(p_{j2} - \widehat{m}c_{j2}) - (p_{j1} - \widehat{m}c_{j1}) = 0. \quad (17)$$

In this case, the only nonzero Lagrange multiplier is  $\lambda_{j12}$ . Hence the first-order conditions with respect to price reduce to the standard unconstrained first-order conditions:

$$s_{j'm'}(p_{m'}) + \sum_{k \in F_{f m'}} (p_{km'} - \widehat{m}c_{km'}) \frac{\partial s_{km'}(p_{m'})}{\partial p_{j'm'}} = 0, \quad (18)$$

for all  $j' \neq j$ , or for  $j' = j$  and  $m' \neq 1, 2$ , while they reduce to:

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<sup>24</sup>The abolishment of the location clause is subject to a transition period until 1 October 2005. Furthermore, it only applies to passenger cars, and not to trucks, buses and coaches.

<sup>25</sup>One might argue that the possibility to sell to independent resellers undermines the principle of territorial exclusivity. However, the independent resellers retain a substantial competitive disadvantage against the authorized exclusive dealers, who have faster access to supply, etc ...

$$\begin{aligned} \left( s_{j1}(p_1) + \sum_{k \in F_{f1}} (p_{k1} - \widehat{m}c_{k1}) \frac{\partial s_{k1}(p_1)}{\partial p_{j1}} \right) L_1 &= \lambda_{j12}, \\ \left( s_{j2}(p_2) + \sum_{k \in F_{f2}} (p_{k2} - \widehat{m}c_{k2}) \frac{\partial s_{k2}(p_2)}{\partial p_{j2}} \right) L_2 &= -(1 + \tau)\lambda_{j12}, \end{aligned} \quad (19)$$

for product  $j$  in markets 1 and 2. This can be interpreted as follows. Since  $\lambda_{j12} \geq 0$  (and assuming a concave profit function), the first equality implies that product  $j$ 's price in market 1 is below its unconstrained optimum; the second equality implies that product  $j$ 's price in market 2 is above its unconstrained optimum. Notice the importance of the market sizes  $L_1$  and  $L_2$ . When  $L_1$  is large relative to  $L_2$ , the price in market 1 will be close to (but still below) the unconstrained optimum in market 1, whereas the price in market 2 will be far from (and above) the unconstrained optimum in market 2. The reverse conclusion holds when  $L_1$  is small relative to  $L_2$ .

To compute the candidate Nash equilibrium, substitute  $\lambda_{j12}$  out of (19) to obtain:

$$\begin{aligned} \left( s_{j1}(p_1) + \sum_{k \in F_{f1}} (p_{k1} - \widehat{m}c_{k1}) \frac{\partial s_{k1}(p_1)}{\partial p_{j1}} \right) L_1 + \\ \left( s_{j2}(p_2) + \sum_{k \in F_{f2}} (p_{k2} - \widehat{m}c_{k2}) \frac{\partial s_{k2}(p_2)}{\partial p_{j2}} \right) \frac{1}{1 + \tau} L_2 = 0 \end{aligned} \quad (20)$$

The candidate Nash equilibrium is given by the solution  $p^*$  to the system of equations given by (17)-(18)-(20). It remains to verify whether at the solution to this system (i) no active constraint is unjustified, i.e.:

$$\lambda_{j12} = \left( s_{j1}(p_1^*) + \sum_{k \in F_{f1}} (p_{k1}^* - \widehat{m}c_{k1}) \frac{\partial s_{k1}(p_1^*)}{\partial p_{j1}^*} \right) L_1 \geq 0,$$

and whether (ii) no inactive constraint is violated, i.e.  $(1 + \tau)(p_{j'n}^* - \widehat{m}c_{j'n}) - (p_{j'm'}^* - \widehat{m}c_{j'm'}) > 0$  for all  $j' \neq j$ , or for  $j' = j$  and  $m' \neq 1, 2$ .

This example immediately generalizes to cases in which at most one constraint is binding for several products. When two or more constraints per product are binding, there are two or more nonzero Lagrange multipliers per product. These multipliers may be substituted

out in an analogous way as in the above example.