LIBERALIZING A DISTRIBUTION SYSTEM: THE EUROPEAN CAR MARKET

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Abstract
We quantify the competitive effects of liberalizing the selective and exclusive distribution system in the European car market, based on a model of oligopoly pricing with differentiated products. We consider 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; and (ii) a possible cumulative effect arising from a strengthening of national intrabrand competition, which would result in reduced double marginalization. We find that the reduction in international price discrimination mainly redistributes consumer gains across countries; it has a positive but modest effect on total welfare. If liberalization also has the cumulative effect of reducing double marginalization, the welfare effects are much higher. Finally, we find that the effects of liberalization on the manufacturers' profits are either small or positive. This finding implies that international price discrimination, and softening competition through a double marginalization mechanism, should not be interpreted as main profit motives for the previous distribution system, but only as unintended side effects. Hence, the industry rationale for maintaining the previous distribution system should be sought in other areas. (JEL: F15, L42)

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 Europe the debate has focused on 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.

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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.

As 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 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 liberalization will promote intrabrand competition, that is, competition between dealers of the same brand. This may occur at the following two levels.

1. 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.
2. Liberalization may possibly also promote national intrabrand competition, that is, 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 competition-softening 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 as 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.

Step 1. We estimate a differentiated products demand model for new cars.

Step 2. We specify oligopoly pricing under the previous selective and exclusive distribution system. We consider two possible pricing scenarios.

> *Pricing scenario 1.* The previous system only limits international intrabrand competition and, hence, enables international price discrimination by the manufacturers. There is full national intrabrand competition, so the retail sector is perfectly competitive as in standard multiproduct pricing models for the car market.

Pricing scenario 2. The previous distribution system also limits national intrabrand competition. Car dealers therefore have market power, giving rise to double marginalization issues. The previous distribution system may thus serve as both a price discrimination and a competition-softening device.

Our two scenarios of pricing may be seen as bounding the possibilities of retailer market power under the previous distribution system.

Step 3. We specify oligopoly pricing after liberalization and quantify the price and welfare changes in the new equilibrium. Liberalization has two possible effects.

(a) It stimulates international intrabrand competition (under both pricing scenarios before liberalization).
(b) It creates national intrabrand competition, at least to the extent that this was effectively limited before liberalization (i.e., pricing scenario 2).

Our analysis indicates that liberalizing the vertical restraints would have the following effects, depending on the pricing scenario.

Scenario 1 (previous distribution system entails national intrabrand competition—standard multiproduct pricing before liberalization). In this scenario, the retail car sector is already competitive in the previous 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 slighty positive and €2.6 billion 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 the main profit motive for the previous distribution system, but only as an (unwanted) side effect.

Scenario 2 (previous distribution system limits national intrabrand competition—multiproduct pricing with double marginalization before liberalization). In this scenario, the retail car sector has market power in the previous distribution system. Liberalization then both reduces the scope for international price discrimination and eliminates the double marginalization and competition-softening 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 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 previous system, if it indeed effectively limited national intrabrand competition and thus created double marginalization, can only be rationalized if there were other important profit motives from the vertical restraints. These 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, as 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 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 multiproduct 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 et al. (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's (1995) theoretical analysis of double marginalization and competition-softening effects under territorial exclusivity. We generalized their model to fit the details of the car market. For other recent empirical papers explicitly modeling the manufacturer–retailer relationship, see Berto Villas-Boas (2002), Manuszak (2002), and Asker (2004).[1]

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.

1. Empirical papers in marketing that model the manufacturer–retailer relationship are Sudhir (2001), Villas-Boas and Zhao (2005), and Besanko, Dubé, and Gupta (2002). 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 was on understanding the sources of international price dispersion, namely, costs versus markups. In contrast, the focus in this paper is on performing policy simulations, that is, 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.

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, for example, 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 sell only 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 advertizing outside their own contract territory. The combination of selectivity and exclusivity may reduce intrabrand competition, namely, competition between dealers selling the same brand, at both the international level and 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. However, selectivity prevents independent resellers from systematically engaging in arbitrage, whereas 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.

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 indeed been limited.

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 noncooperative 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 also succeeded in limiting intrabrand competition within a country. For example, the U.K. Competition Commission quotes the proportion of out-of-territory sales (within a country) as 39%. 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 previous system. This would have the effect of eliminating the double marginalization and competition-softening 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 previous 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, that is, 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, because 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 resulting in 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 for price discrimination in both scenarios and, in addition, eliminates double marginalization in the second scenario.

3.2. Demand

There are M national markets, and 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 purchasing cars in other markets than where they are located. This assumption allows us to suppress the market subscript m for now. The conditional indirect utility of a consumer i from product $j = 1, \ldots, J$ is given by

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

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 δ_j depends on a K-dimensional vector of characteristics x_j, such as horsepower, fuel efficiency, size, and so on. It also depends on characteristics unobserved by the econometrician ξ_j, for example, style, image, or advertising. The individual-specific part of utility depends on price p_j and on a random term ε_{ij}. Specify the price parameter as $\alpha_i = \alpha/y_i$, where y_i is the income of consumer i.[2] Consumers may decide not to purchase any product. In this case they choose the outside good 0, for which the common part of utility δ_j is normalized to 0.

The distribution of the random utility term ε_{ij} follows the assumptions of a two-level nested logit model. Assume that the market can be partitioned into G different groups. Each group g can be further partitioned into 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 ε_{ij} yield the following choice probability of individual i for product j, as a function of the $J \times 1$ price vector p:

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

where I_{ihg}, I_{ig}, and I_i are "inclusive values" for consumer i, defined by

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

2. See also Berry, Levinsohn, and Pakes (2004). If the 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 α with income and income squared, whereas we interact it with the inverse of income.

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, that is,

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

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

The nesting parameters σ_{hg} and σ_g measure the heterogeneity of consumer preferences for cars belonging to the same subgroups or groups. The interpretation is that products of the same subgroup or group share a common set of features, for which consumers may have correlated preferences. 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 that for the outside good) is further divided into two subgroups according to country of origin: domestic or foreign. Cars from the same origin share additional features, for example, the image or style. Another common feature of cars from the same subgroup may be dealer proximity, as domestic firms typically have a substantially denser dealer network than foreign firms.

The model is consistent with random utility maximization if $1 \geq \sigma_{hg} \geq \sigma_g \geq 0$ (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, and preferences are 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 is obtained 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 is obtained if all $\sigma_{hg} = \sigma_g = 0$, that is, 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, for example, Berry (1994) and Berry and Pakes (2001), the nesting parameters σ_{hg} and σ_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. Although 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) as 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, because 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 worth noting that our specification is more flexible than the aggregate nested logit specifications estimated in previous work: Because 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 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 multiproduct 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, and 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 the 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:

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

where L is the total number of potential consumers. Note that we have normalized the retailer's marginal selling cost to zero.[3] The Nash equilibrium in the second stage depends on whether national intrabrand competition is limited or full, that

3. 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 (2002). 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.

is, on whether the retailers' product subsets R_r are mutually exclusive. We specify the actual second stage price equilibrium under both following scenarios. 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, namely,

$$p = p(w), \tag{6}$$

where $p(\cdot)$ is a $J \times 1$ vector of functions, and a typical function $p_j(\cdot)$ describes the retail price of product j 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:

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

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

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

A unit increase in the wholesale price w_j of product j has two effects. First, it raises the manufacturer's margin so that the profits rise proportional to the market share of product j. 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 θ^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

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

The solution $(\overline{p}, \overline{w})$ 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:

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

that is, marginal cost is equal to the wholesale price minus the manufacturers' wholesale markup. To uncover the unobserved wholesale price $\overline{w}$ and the matrix of pass-through rates $\nabla_w p(\overline{w})$, 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—standard multiproduct pricing. 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 framework, full intrabrand competition may be modeled by defining the retailers' product subsets R_r in (5) as mutually nonexclusive, such that at least two retailers r and r' compete to sell the same product j. The retail price equilibrium (6) is then simply $\overline{p} = \overline{w}$ and the pass-through matrix $\nabla_w p(\overline{w})$ reduces to the identity matrix I_J. The marginal cost vector (9) therefore simplifies to the well-known equation

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

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

Scenario 2. Limited national intrabrand competition—multiproduct pricing with double marginalization. In this scenario the distribution system effectively limits national intrabrand competition. This can be modeled by defining the retailers' product subsets R_r in (5) to be mutually exclusive. Oligopoly pricing then generalizes Rey and Stiglitz's (1995) model in which two manufacturers sell their products to two exclusive retailers, leading to the double marginalization and competition-softening 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 $j = 1, \ldots, J$:

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

Define the $J \times J$ matrix θ^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

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

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 $(\overline{p}, \overline{w})$. Furthermore, the matrix of pass-through rates $\nabla_w p(\overline{w})$ evaluated at $(\overline{p}, \overline{w})$ is given by

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

where the second equality follows from the fact that $\nabla_w f(\overline{p}, \overline{w})$ 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

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

that is, 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

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

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 competition-softening effects. This effect is relevant only 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 modeled as a reduction in the consumers' travel costs, leading to a new Nash equilibrium.[4] 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., and so forth. 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.[5]

To formalize oligopoly pricing after liberalization, we reintroduce our subscript notation: there are M national markets, $m = 1, \ldots, M$. 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 τ. Hence, each manufacturer sets its prices subject to the constraint that for each product j and each pair of countries m and n, $p_{jm} - \widehat{mc}_{jm} \leq (1+\tau)(p_{jn} - \widehat{mc}_{jn})$, where $\widehat{mc}_{jm}$ 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 τ, because 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

$$\Pi_{fm}(p_m) = \sum_{m=1}^{M} \sum_{j \in F_{fm}} (p_{jm} - \widehat{mc}_{jm}) s_{jm}(p_m) L_m$$

$$\text{subject to} \quad (1+\tau)(p_{jn} - \widehat{mc}_{jn}) - (p_{jm} - \widehat{mc}_{jm}) \geq 0$$

$$j = 1, \ldots, J, \quad m, n = 1, \ldots, M. \tag{15}$$

4. 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.

5. 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.

Define Lagrange multipliers λ_{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 $m = 1, \ldots, M$ should satisfy the following Kuhn–Tucker conditions, for $m, n = 1, \ldots, M$:

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

$$(1+\tau)(p_{jn} - \widehat{mc}_{jn}) - (p_{jm} - \widehat{mc}_{jm}) \geq 0, \tag{16b}$$

$$\lambda_{jmn} \geq 0, \tag{16c}$$

$$\lambda_{jmn}((1+\tau)(p_{jn} - \widehat{mc}_{jn}) - (p_{jm} - \widehat{mc}_{jm})) = 0. \tag{16d}$$

The first-order conditions (equation (16a)) generalize our previous unconstrained first-order conditions, extended with a set of nonnegative Lagrange multipliers. The complementary slackness conditions (equations (16b), (16c), (16d)) 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 pairs (m, n) and (n, m) are mutually exclusive, so at least $\lambda_{jmn} = 0$ or $\lambda_{jnm} = 0$. Similarly, if the constraint of country pairs (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, thus $\lambda_{jnn'} = \lambda_{jn'n} = 0$. 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 these Kuhn–Tucker conditions are satisfied for all products j.[6] To compute a candidate Nash equilibrium we proceed as follows. For each product j, we impose a set of $K_j \leq M - 1$

6. 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 the 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 performed numerical analysis to verify that the second-order conditions are satisfied in the neighborhood of the equilibrium. We have also intensively experimented with alternative starting values and did not encounter examples of convergence to other equilibria.

active constraints (such that none of them is 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 λ_{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, an example of such a system of equations is worked out in the Appendix, 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 of the Kuhn–Tucker conditions are satisfied, in particular whether (i) no active constraint is unjustified, that is, $\lambda_{jmn} \geq 0$ for all j, m, n; and (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 of 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 of 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 5–10 trials before we obtain a solution that satisfies all of 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, that is, $(p_{jn} - \widehat{mc}_{jn}) - (p_{jm} - \widehat{mc}_{jm}) = 0$ for all j, m, and n.

3.5. Welfare

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

$$\Delta \, \mathrm{CS}_{im} = \frac{I_i(p_m^*)}{\alpha_{im}} - \frac{I_i(\overline{p}_m)}{\alpha_{im}},$$

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 $\Delta\,\mathrm{CS}_m$ 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

$$\Delta\,\mathrm{PS}_m = \sum_{f=1}^{F} \Pi_{fm}(p_m^*) - \sum_{f=1}^{F} \Pi_{fm}(\overline{p}_m).$$

The change in total welfare ΔW_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).

It is assumed that the exogenous variables do not change after liberalization. In particular, the exogenous part of utility in equation (1), that is, $\delta_j = x'_j\beta + \xi_j$, 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 in 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 U.K. 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 each year. The price data are pretax and posttax 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 location, and the market segment ("class"). The data set is augmented with macroeconomic 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

TABLE 1. Summary statistics.

country	All Mean	All St. D.	Bel	Fra	Ger	Ita	U.K.
			Mean				
Sales (units)	19,813	37,720	3,925	23,306	31,003	24,292	19,784
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
Heigth (cm)	140.4	4.6	140.3	140.5	140.5	140.6	140.3
Foreign (0–1)	.81	0.39	0.00	0.75	0.73	0.76	0.77
Price (€)	10,822	7,179	9,943	10,774	10,520	10,856	12,158
Subcompact (0–1)	0.28	0.45	0.28	0.28	0.28	0.31	0.26
Compact (0–1)	0.23	0.42	0.23	0.24	0.23	0.22	0.24
Intermediate (0–1)	0.22	0.41	0.22	0.22	0.22	0.21	0.23
Standard (0–1)	0.19	0.39	0.19	0.19	0.18	0.17	0.19
Luxury (0–1)	0.08	0.27	0.08	0.07	0.09	0.09	0.08

Notes: The number of observations is 11,549. St. D. = standard deviation.

margins for a selected number of models/years.[7] 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.

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 ξ_j is the error term representing unobserved 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 ξ_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 ξ_j involves a slight modification of the contraction mapping suggested by Berry, Levinsohn, and Pakes (1995).[8]

7. Data on dealer discounts and margins are available for selected years from reports of the European Bureau of Consumer Organizations, and from confidential surveys by the European Commission. This is informative as 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.

8. We use the contraction mapping $\delta^{t+1} = \delta^t + (1 - \max\{\sigma_1 \ldots \sigma_G\})(\ln(s) - \ln(s(\delta^t))$. If one does not weight the second term by $(1 - \max\{\sigma_1 \ldots \sigma_G\})$, 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 σ.

- We interact the error term with a set of instruments to obtain a generalized method of moments (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 ξ_j. Although this assumption immediately provides us with K instruments, this is not sufficient to estimate all of the parameters of the model. In addition to the K characteristics parameters β, we also need to estimate the price parameter α. Furthermore, we need to estimate the five group parameters σ_g and the ten subgroup parameters σ_{hg}. To obtain instruments in addition to the characteristics in x_j, supply-side variables are the obvious candidates. As 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 the pricing policy of a firm f for product j does not only depend on the own characteristics x_j of product j. Owing to 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 the use of 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; and (iv) the number of products 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, as we allow the nesting parameters σ_{hg} and σ_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 five countries over 30 years. Adding subscripts to denote the market m and the year t, the error term becomes ξ_{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 ξ_j control for unobserved mean product valuations that do not vary over time or across markets, for example, style or image. Because there are about 350 product fixed effects, we control for them using a within transformation of the model. The market/time-fixed effects ξ_{mt} capture preferences for cars relative to the outside good and can thus be thought of as accounting for macroeconomic fluctuations that affect the decision to purchase a new car.[9] 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, for example, due to unobserved variations in advertising, delivery times, and so forth.

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 σ_{hg} is equal for all ten subgroups and σ_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 and 1985–1999; the second subperiod coincides with the start of the distibution 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 worth noting 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 subsequent discussion. 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

9. Because 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; that is, 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.

TABLE 2. Parameter estimates for the nested logit demand (model with income distribution).

	Restricted		Flexible	
Characteristics parameters				
Horsepower	0.000	(0.002)	0.013	(0.002)
Fuel inefficiency	−0.059	(0.007)	−0.037	(0.007)
Width	0.032	(0.002)	0.032	(0.002)
Height	0.013	(0.003)	0.012	(0.003)
Foreign	−1.028	(0.044)	−0.898	(0.038)
– Price (α)	1.422	(0.440)	4.764	(0.412)
Subgroup segmentation parameters (σ_{hg})				
Subcompact	0.536	(0.028)	0.847	(0.030)
Compact	same		0.647	(0.030)
Intermediate	same		0.538	(0.031)
Standard	same		0.672	(0.030)
Luxury	same		0.167	(0.053)
Group segmentation parameters (σ_g)				
Subcompact	0.411	(0.025)	0.280	(0.032)
Compact	same		0.485	(0.036)
Intermediate	same		0.334	(0.037)
Standard	same		0.543	(0.035)
Luxury	same		−0.052	(0.060)

Notes: The number of observations is 11,549. Standard errors are in parentheses. Fixed effects ξ_j and ξ_{mt} are included. Subgroups are cars from both the same segment and origin (domestic or foreign), whereas 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.

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 ($p < 0.0001$).

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 15-year period. This indicates that the competitive advantage of the domestic incumbents is declining, probably due to the process of European integration (because most foreign firms are E.U. firms or have production facilities in the E.U.).

Now consider the segmentation parameters σ. For both the restricted and the unrestricted specification the restrictions implied by the random utility maximization assumption are satisfied for all parameters, that is, $1 \geq \sigma_{hg} \geq$

$\sigma_g \geq 0$.[10] The restricted specification shows that consumer preferences are significantly more correlated for cars within the same subgroup (0.536) than for cars within the same group but a different subgroup (0.411). 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 for cars of the same segment than for cars of different segments (as 0.411 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 σ_{hg} and σ_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), namely, 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 (σ_{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 segments. For example, preference correlation is 0.847 for domestic subcompact cars, and only 0.167 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 (σ_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 segments (luxuries).

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 that in Goldberg and Verboven 2001) shows that the own-price elasticities increase as one moves to higher segments. For example, the average elasticity in the luxury

10. In the flexible specification, the σ_g for the luxury segment is negative, but it is insignificant.

TABLE 3. Substitution patterns (in 1999).

	Own elasticity	Cross elasticities with respect to car from: Same subgroup	Same group	Different group
Averages for restricted nested logit specification				
All	−3.646	0.247	0.079	0.002
Subcompact	−2.535	0.102	0.031	0.002
Compact	−3.358	0.184	0.056	0.002
Intermediate	−3.995	0.204	0.062	0.002
Standard	−4.633	0.447	0.136	0.002
Luxury	−5.626	0.706	0.254	0.003
Foreign	−3.767	0.187	0.059	0.001
Domestic	−3.428	0.355	0.115	0.003
Averages for flexible nested logit specification				
All	−7.566	0.493	0.104	0.007
Subcompact	−10.900	0.822	0.038	0.005
Compact	−6.113	0.316	0.123	0.008
Intermediate	−5.431	0.220	0.071	0.007
Standard	−8.628	0.799	0.361	0.007
Luxury	−4.537	0.152	−0.011	0.012
Foreign	−7.734	0.364	0.071	0.004
Domestic	−7.263	0.726	0.165	0.011

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.[11] 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

11. 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. Note that the negative cross-price elasticity for the luxury group segmentation parameter is unexpected, but it follows directly from the negative sign of the luxury nesting parameter obtained in Table 2. Because the coefficient does not differ significantly from zero, we used a constrained version of the demand model in the subsequent policy simulations.

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), though 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 summary, the substitution patterns are less dependent on functional form assumptions than on 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: (i) our empirical finding that products in the more expensive segments are perceived as less similar substitutes than products in the inexpensive segments; and (ii) 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 cars is lower on average than the own-price elasticity of foreign cars.

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 noncooperatively, that is, maximizing the sum of the profits of all products in their own portfolio, as reflected by the firms' product ownership matrix θ^F. The first and fourth columns 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 averages 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

TABLE 4. Marginal cost estimates and ϕ (in 1999).

	Full intrabrand competition			Limited intrabrand competition		
	Marginal cost	Lerner index	Implied ϕ	Marginal cost	Lerner index	Implied ϕ
Belgium	10,299	0.16	0.00	9,603	0.16	0.00
France	10,404	0.20	0.08	9,534	0.21	−0.06
Germany	11,192	0.18	0.43	10,155	0.18	0.27
Italy	11,009	0.24	0.29	10,330	0.23	0.20
U.K.	14,499	0.16	0.91	13,588	0.17	0.90

Notes: Marginal costs are expressed in €. All numbers are market averages across car models. Marginal costs and Lerner index are computed assuming noncooperative pricing. The parameter ϕ refers to partial collusion assuming marginal costs are identical across countries, as discussed in the text.

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 summary, 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 could 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. indeed stem from the 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 a 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 with 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 with 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 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 1990s. Goldberg and Verboven (2001) considered the possibility of collusion by modifying the firms' product ownership matrix θ^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 noncooperative pricing model with the model with collusion in the U.K., but they could not empirically distinguish between both possibilities. On this basis (as well as the fact that the U.K. Competition Commission did not find unambiguous results), we do not take a position here whether the marginal costs of selling cars are higher in the U.K. or whether markups are higher due to collusion. Instead, we report and discuss our simulation results based on both a noncooperative 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).[12] 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 θ^F as follows. We replace the zeros (denoting competing products) on each row j in θ^F by a parameter ϕ_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 ϕ_j as a "partial collusion" parameter, capturing deviations from the noncooperative pricing assumption (relative to the country with the lowest prices where the noncooperative outcome is still imposed). A positive ϕ_j (< 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 $\phi_j = 1$, product j is priced fully collusively, that is, as if the effect on the other products' profits is fully taken into account. Conversely, a negative ϕ_j means that the price of a product is set below the multiproduct noncooperative price. On the basis of approach, we find that the pricing in France, Germany, and Italy is slightly less competitive than multiproduct noncooperative pricing, relative to Belgium, with average estimates of ϕ_j in the range 0.08–0.43 under full intrabrand competition and -0.06 to 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.[13] We can now compute the effects from liberalization, under either noncooperative or collusive pricing.

12. As a robustness check, we also followed their approach and obtained similar simulation results.

13. Standard errors are in the range 0.15–0.22. Hence, imposing the assumption that marginal costs are equal across countries, the hypothesis of noncooperative behavior cannot be rejected for most countries and the hypothesis of collusion cannot be rejected for the U.K.

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's (1998) model obtains additional insights on the conditions when this may occur and refers to the situation as "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.[14] 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 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 with the discriminatory prices (nor reverse situations where all prices would decrease). Table 5 provides summary information on the general price level changes by country, 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 noncooperative pricing, liberalization would have the effect of modestly raising the general car price level in most countries except in the U.K., where there would be a price level decline of 1%–2% (see the third and sixth columns of Table 5). The overall price increase (for all five countries) is small, between

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

	Domestic	Foreign	All	Domestic	Foreign	All
	Maximum markup differential $\tau = 12\%$			Maximum markup differential $\tau = 0\%$		
Noncooperative pricing						
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
	Maximum markup differential $\tau = 12\%$			Maximum markup differential $\tau = 0\%$		
Partially collusive pricing (ϕ)						
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

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

14. See also Holmes (1989) and Armstrong and Vickers (2002) for price discrimination analyses under oligopoly.

0.2% and 0.3%. Although the general price levels do not change much, there are fairly substantial relative price changes within each country. This is particularly apparent when breaking down the price changes by domestic and foreign cars (see the first and second and fourth and fifth columns of Table 5). In most countries the price level of domestic cars would drop, whereas the price level of foreign cars would increase. In Germany, the predicted price increase is smaller for domestic cars than for foreign cars. 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). Although 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 noncooperative prices, except in the U.K., where they appear closer to full collusive behavior. Although 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 noncooperative 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. Therefore, it is not surprising that the general price effects are more pronounced under partially collusive pricing.

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 postliberalization equilibrium prices, and the implied producers surplus, consumer surplus, and welfare levels. We found it more informative to present confidence intervals than standard deviations, because 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 noncooperative pricing (a drop of −€36 million, with a 95% confidence interval of −€95 million and +€9 million).

TABLE 6. Welfare changes after liberalization. Scenario 1: Full national intrabrand competition before liberalization.

	Noncooperative pricing				Partially collusive pricing (ϕ)			
	in € million		in %		in € million		in %	
ΔCS								
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)
U.K.	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)
ΔPS								
All	−36	(−95, 9)	−0.2	(−0.4, 0.1)	−584	(−759, −322)	−1.9	(−2.7, −1.0)
ΔW								
All	66	(−8, 97)	0.1	(0.0, 0.1)	2573	(2343, 2686)	2.0	(1.8, 2.1)

Notes: Ninety-five percent confidence intervals are in parentheses. Results are presented for $\tau = 0\%$; similar results are obtained for $\tau = 12\%$. ΔPS refers to changes in manufacturers' profits. Retailer profits are zero under Scenario 1. ΔW refers to changes in total welfare, the sum of consumer surplus, producer (manufacturer) surplus, and tax revenues (VAT).

The drop in manufacturers' producer surplus is somewhat higher under partially collusive pricing (−€584 million, with a confidence interval of −€759 million and −€322 million). 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 possiblility for price discrimination does not necessarily raise profits under oligopoly.[15]

The small effects on manufacturers' producer surplus from liberalization have important policy implications. They show that the possibility for price discrimination under the previous 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 previous 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 previous distribution system should be sought elsewhere. This finding relates to some of Berry, Levinsohn, and Pakes (1999) results on voluntary export restraints (VERs). They also find that the profit effects to Japanese firms from VERs are not very large (so that, again, VERs should not be seen as a main profit motive by the Japanese firms in their application).

The effects of removing price discrimination on consumer surplus and welfare may be summarized as follows. Under noncooperative pricing, consumer surplus would drop by an estimated €231 million or 7.3% in Belgium, by €444 million or 1.7% in Germany, and by €255 million 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 U.K., with an increase of up to €895 million, or 4.4%. The overall change in consumer surplus (sum of five countries) is small, about €0.1 billion. This confirms our earlier finding regarding the general price changes: under noncooperative 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 out, for example by an estimated €1.8 billion in Germany. U.K. consumers would gain substantially, by €7.8 billion. Aggregate consumer surplus across the five countries would

15. In principle, the results may also be driven by the fact that prices are not necessarily strategic complements. In nonlinear product differentiated demand models with multiproduct firms, a rival's price increase may change both the intercept and the slope of demand. The effect may be such that price-sensitive consumers are attracted, possibly making price decreases optimal in response to a rival's price increase, as pointed out by Berry, Levinsohn, and Pakes (1999). On the basis of 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 neighborhood 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.

increase, by an amount of €3 billion (95% confidence interval of €2.6 billion and €3.3 billion). As before, this follows from the fact that the large existing 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 noncooperative pricing (increase of €66 million, with a 95% confidence interval of −€8 million and +€97 million), and they are quite large under partially collusive pricing (increase by €2.6 billion, with a confidence interval of +€2.3 billion and +€2.7 billion).

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/competition-softening mechanism. Table 7 summarizes the computed effects on consumer surplus, manufacturers' producer surplus, and total welfare in the various countries.[16]

At first sight, it appears that the consumer surplus and welfare results differ quite substantially from those 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.[17] Only consumers in Belgium could be worse off (at least under partially collusive pricing). The overall increase in total welfare is between € 9 billion and € 11 billion. 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.

Although 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 in more detail at the effects of liberalization on the manufacturers' producer surplus.[18] This allows us to assess the profit motive for keeping the previous distribution system if the current scenario

16. Because 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 noncooperative and partially collusive pricing, retailers' producer surplus drops by about € 8 billion, whereas tax revenues increase by about € 1.2 billion.

17. Because they do not produce any interesting new insights, we no longer report the results for the predicted price changes, namely, the analogs of Table 5.

18. Note that this does not coincide with total producer surplus, because in the scenario of limited national intrabrand competition retailers also make a profit under the former distribution system.

TABLE 7. Welfare changes after liberalization. Scenario 2: Limited national intrabrand competition before liberalization.

	Noncooperative pricing				Partially collusive pricing (ϕ)			
	in € million		in %		in € million		in %	
ΔCS								
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)
ΔPS								
All	3821	(2846, 5308)	17.3	(15.3,21.2)	637	(−2689, 2929)	2.3	(−9.3, 9.8)
ΔW								
All	9519	(7255,11808)	7.4	(5.8, 8.8)	11620	(9442,13764)	8.6	(7.1, 9.9)

Notes: Ninety-five percent confidence intervals are in parentheses. Results are presented for $\tau = 0\%$; similar results are obtained for $\tau = 12\%$. ΔPS refers to changes in manufacturers' profits only. ΔW refers to changes in total welfare, the sum of consumer surplus; producer (manufacturer + retailer) surplus, and tax revenues (VAT).

is relevant. Recall that under the previous scenario we found the profit motive to be negligible, that is, the possibility to engage in international price discrimination essentially does not contribute by itself to manufacturers' profits. Under the current scenario there are two possible profit motives for the previous distribution system: the possibility to price discriminate plus the double marginalization/competition-softening 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 in 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 under noncooperative pricing and € 0.6 billion under partially collusive pricing. This shows that, taken together, the price discrimination and competition-softening mechanism do not constitute profit motives for the previous distribution system.[19] 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, as 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 the total welfare effects may actually lie much closer to those obtained under the previous scenario.

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 previous 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 per year. If the previous system effectively limits national intrabrand competition, then liberalization may lead to both reduced international price discrimination and to the elimination of the

The changes in retailers' part of producer surplus are not shown explicitly in Table 7, but they enter into the computation of total welfare.

19. In separate computations we also found that the competition-softening 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 interbrand competition (the substitutability between different products) is not sufficiently strong.

competition-softening mechanism. The computed welfare gains become much larger. However, one must also account for potentially large efficiency losses, because the previous 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. However, an issue that has received less attention is that the existing system also provides incentives to individual countries to implement tax discrimination. Although VAT 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.

Appendix

See ⟨http://www.jeea.org⟩.

References

Anderson, Simon P., and André de Palma (1992). "Multiproduct Firms: A Nested Logit Approach." *Journal of Industrial Economics*, 40, 261–276.

Armstrong, Mark, and John Vickers (2002). "Competitive Price Discrimination." *RAND Journal of Economics*, 32, 579–605.

Asker, John (2004). "Diagnosing Foreclosure due to Exclusive Dealing." Working paper, Stern School of Business.

Berry, Steven T. (1994). "Estimating Discrete-choice Models of Product Differentiation." *RAND Journal of Economics*, 25, 242–262.

Berry, Steven T., James Levinsohn, and Ariel Pakes (1995). "Automobile Prices in Market Equilibrium." *Econometrica*, 63, 841–890.

Berry, Steven T., James Levinsohn, and Ariel Pakes (1999). "Voluntary Export Restraints on Automobiles: Evaluating a Trade Policy." *American Economic Review*, 89, 400–430.

Berry, Steven T., James Levinsohn, and Ariel Pakes (2004). "Differentiated Products Demand Systems from a Combination of Micro and Macro Data: The New Car Market." *Journal of Political Economy*, 112, 68–105.

Berry, Steven T., and Ariel Pakes (2001). Additional Information for "Comment on 'Alternative models of demand for automobiles' by Charlotte Wojcik." *Economics Letters*, 74, 43–51.

Berto Villas-Boas, Sofia (2002). "Vertical Contracts between Manufacturers and Retailers: An Empirical Analysis." Working paper, University of California, Berkeley.

Besanko, David, Jean-Pierre Dubé, and Sachin Gupta (2002). "Competitive Price Discrimination Strategies in a Vertical Channel using Aggregate Retail Data." Working paper, University of Chicago.

BEUC (1992). "Parallel Imports for Cars in the EC, BEUC/222/92." Brussels.

Brenkers, Randy, and Frank Verboven (2002). "Liberalizing a Distribution System: The European Car Market." C.E.P.R discussion paper.

Caplin, Andrew, and Barry Nalebuff (1991). "Aggregation and Imperfect Competition: On the Existence of Equilibrium." *Econometrica*, 59, 25–59.

Competition Commission (2000). "New Cars: A Report on the Supply of New Motor Cars within the U.K." London, HSMO.

Corts, Kenneth S. (1998). "Third-Degree Price Discrimination in Oligopoly: All-Out Competition and Strategic Commitment." *RAND Journal of Economics*, 29, 306–323.

Davidson, Russell, Mathias Dewatripont, Victor Ginsburgh, and Martine Labbé (1989). "On the Welfare Effects of Anti-Discrimination Regulations in the EC Car Market." *International Journal of Industrial Organization*, 7, 205–230.

European Commission (2000). "Report on the Evaluation of Regulation (EC) No 1475/95 on the Application of Article 85(3) of the Treaty to Certain Categories of Motor Vehicle Distribution and Servicing Agreements."

Goldberg, Pinelopi K. (1995). "Product Differentiation and Oligopoly in International Markets: The Case of the U.S. Automobile Industry." *Econometrica*, 63, 891–951.

Goldberg, Pinelopi K., and Frank Verboven (2001). "The Evolution of Price Dispersion in the European Car Market." *Review of Economic Studies*, 68, 811–848.

Hausman, Jerry A., Gregory Leonard, and J. Douglas Zona (1994). "Competitive Analysis with Differentiated Products." *Annales d'Economie et de Statistique*, 34, 159–180.

Holmes, Thomas J. (1989). "The Effects of Third-Degree Price Discrimination in Oligopoly." *American Economic Review*, 79, 244–250.

Manuszak, Mark D. (2002). "The Impact of Upstream Mergers on Retail Gasoline Markets." Working paper, Carnegie Mellon University.

McFadden, Daniel L. (1978). "Modeling the Choice of Residential Location." In *Spatial Interaction Theory and Planning Models*, edited by A. Karlqvist, L. Lundqvist, F. Snickars and J. Weibul. North-Holland.

Nevo, Aviv (2000). "Mergers with Differentiated Products: The Case of the Ready-to-Eat Cereal Industry." *RAND Journal of Economics*, 31, 395–421.

Nevo, Aviv (2001). "Measuring Market Power in the Ready-to-Eat Cereal Industry." *Econometrica*, 69(2), 307–342.

PCW (2002). "Global Automotive Review Report."

Petrin, Amil (2002). "Quantifying the Benefits of New Products: The Case of the Minivan." *Journal of Political Economy*, 110, 705–729.

Pinkse, Joris, and Margaret Slade (2004). "Mergers, Brand Competition and the Price of a Pint." *European Economic Review*, 48(3), 617–643.

Rey, Patrick, and Joseph Stiglitz (1995). "The Role of Exclusive Territories in Producers' Competition." *RAND Journal of Economics*, 26(3), 431–451.

Stole, Lars A. (2001). "Price Discrimination in Competitive Environments." Working paper, University of Chicago.
Sudhir, K. (2001). "Structural Analysis of Manufacturer Pricing in the Presence of a Strategic Retailer." *Marketing Science*, 20(3), 244–264.
Thisse, Jacques-Francois, and Xavier Vives (1988). "On the Strategic Choice of Spatial Price Policy." *American Economic Review*, 78, 122–137.
Vives, Xavier (1999). *Oligopoly Pricing: Old Ideas and New Tools*. MIT Press.