Quantitative Study to Define the Relevant Market in the Passenger Car Sector[1]

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Final Report

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Executive summary

Purpose of the study

The new competition rules applicable to distribution of passenger cars in the EU contain a number of innovations and, notably, the application of a distinct regime depending on the market shares held by the companies concerned[2]. Whether different restraints of competition are covered by the rules may depend on the market shares held by the manufacturer or supplier and, thus, on how markets in the passenger car sector are defined. Yet the Regulation, which applies to all motor vehicles and servicing alike, does not define the various product and geographic markets that are relevant for its application ("relevant markets"). Nor do previous Commission decisions of application of EC competition rules set out precedent in respect of the passenger car sector. The approach the Commission follows to define the relevant market for the purposes of EC competition law is set out in its 1997 notice on this subject ("the Notice")[3]. This study provides a definition of the relevant markets concerning passenger cars, following the criteria and approach set out in the Notice.

Methodology

In line with the Notice, the study focuses the analysis on competitive constraints arising from demand substitution between different categories of cars and geographic areas within the EU. The definition of the relevant geographic market is based on evidence on international price differentials and trade barriers as documented in previously published studies or Reports, including from the Commission. The definition of the relevant product market is based on an econometric analysis of the demand for new cars, using a database for five EU countries over 1970-1999. The countries concerned, Germany, France, Italy, the UK and Belgium, cover roughly 75% of car sales in the EU.

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2 Commission Regulation (EC) N°1400/2002 of 31 July 2002.

Passenger cars are classified into different segments over that period following common classifications, verified to be consistent with objective characteristics (e.g. price, horsepower, width) and taking into account the model range of each brand. Six segments are distinguished: subcompact, compact, intermediate, standard/luxury, sports and minivans. Although the terminology differs, these segments more or less replicate classifications available in the market and used, notably, by the Commission in its car price report[4], according to the following table of equivalence:

Table. Classification of segments, different sources

Segment	Example	L'Argus 1990	L'Argus 2000	E.C. Report 1999
subcompacts	Ford Fiesta	B	B1+B2	A+B
		(petites urbaines et polyvalentes)		
compacts	VW Golf	M1	M1	C
		(familiales compactes)		
intermediate	Peugeot 406	M2	M2	D
		(familiales)		
Standard/luxury	Audi A6	H	H1+H2	E+F
		(haut et très haut de gamme)		
sports	Mercedes SLK	coupés	coupés	G
minivans	Renault Espace	n.a.	monospace	G

Each of these segments is taken as a "candidate" product market in each country. The study then rigorously and empirically analyses whether demand substitution exerts an effective competitive constraint on each segment by implementing the so-called SSNIP-test ("small but significant non-transitory increase in prices") so as to define relevant markets, in accordance with the Notice. More explicitly, the study verifies whether price increases of 5% and 10% for all models within each candidate market, which entail a shift in demand towards other segments, would be profitable. For each candidate market, if the answer is yes, the segment is held to be a relevant product

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[3] Commission Notice on the definition of the relevant market for the purposes of Community competition law, OJ C372 of 9.12.1997, p.5.

[4] The classification has less segments than the one used by the Commission in its car price report: the segment of subcompact cars and the segment for standard/luxury include each within a single candidate product market two segments which the Commission classifies as separate (i.e. A+B and E+F, respectively).

market. If the answer is no, the segment is not held to be a relevant product market and the models included in it should be re-attributed to other segments.

Results

In the situation prevailing today competitive conditions differ considerably across Member States. The evidence on international price differentials trade barriers indicates that geographic markets for car retailing should be accordingly defined as national markets. Within each of the five relevant geographic markets analysed, the table below shows the SSNIP-tests, i.e. the estimated profit effects of, respectively, a joint 5% and 10% price increase by all products of each candidate product market. These results are driven by the estimated own- and cross-price elasticities of cars from different segments.

SSNIP-tests: Profit increases per segment (in percentage)*

	Belgium	France	Germany	Italy	U.K.
	Price increase by 5 percent				
Subcompact	8.74	6.75	8.47	4.11	9.55
Compact	5.19	4.65	4.52	5.44	6.49
Intermediate	5.42	3.38	4.58	5.21	6.41
Standard/luxury	15.19	13.41	12.59	10.15	16.15
Sports	4.34	3.96	3.37	3.98	4.62
Minivan	0.36	0.24	0.32	0.26	0.27
	Price increase by 10 percent				
Subcompact	16.82	12.92	16.2	7.73	18.1
Compact	9.69	8.58	8.38	9.83	11.72
Intermediate	9.81	6.00	8.17	9.02	11.19
Standard/luxury	26.3	23.09	21.92	16.36	27.36
Sports	7.09	6.58	5.44	6.19	7.2
Minivan	0.20	-0.21	0.11	-0.19	-0.21

(*) Based on flexible nested logit estimates, when wholesale and retail prices coincide, see table 6, main report. The table reads as follows: e.g. an increase of 10% of prices of intermediate cars increases profits by 9.81% in Belgium, by 6.00% in France etc.

The results show that joint price increases of 5% and 10% for each segment would be profitable because the resulting higher profit margins significantly outweigh volumes lost due to a shift of demand to other segments. Only for the minivan segment do price increases of 10% lead to slight profit declines in some Member States. As a consequence, all but one of the segments identified as candidate product markets are held to be distinct relevant product markets. A safe approach leads thus to excluding

minivans as a distinct product market. In some countries, strong consumer preferences for domestic brands are found, which translate into low substitutability within each product market between domestic cars and foreign cars and which would justify even narrower delineations of the product market. A product market definition which includes in all cases domestic and foreign brands alike in the same product market is thus conservative and safe.

These results are relatively insensitive to changes in the precise delineation of the segments, i.e. when some models are assigned to different segments. More importantly, the results are also insensitive to the level of trade at which the test is carried out, i.e. wholesaling or retail. Indeed, a methodology is proposed and implemented to extend the SSNIP-test to account for the fact that the manufacturers' wholesale-level demand is a derived demand and may therefore differ from the retail-level demand. The results remain robust under this extension. In sum, the results and policy conclusions would thus not be greatly altered if slightly different classifications of car models into different segments would be followed. Similarly, an analysis of the relevant market at the wholesale level does not yield significantly different results from an analysis at the final retail level of transaction.

Conclusions

The study therefore concludes that, in each geographic market analysed, i.e. a Member State, five distinct product markets are to be distinguished: subcompact (corresponding to Commission segments A and B), compact (segment C), intermediate (segment D), standard/luxury (corresponding to Commission segments E and F), sports (part of the Commission segment G). Each of these product markets in each of the Member States analysed thus constitute relevant markets.

The extent to which this conclusion would apply to other Member States as such, or whether the same analysis would yield slightly different results is beyond the scope of this study. The general message, however, is that a meaningful competitive assessment of the passenger car sector cannot rely on the assumption that there is a sole relevant market in which all cars compete throughout the EU on equal basis. The level of competition on car retailing has to be assessed at a lower and more detailed level of aggregation.

1 Introduction

The new competition rules applicable to distribution of passenger cars in the EU contain a number of innovations and, notably, the application of a distinct regime depending on the market shares held by the companies concerned[5]. Whether different restraints of competition are covered by the rules may depend on the market shares held by the manufacturer or supplier and, thus, on how markets in the passenger car sector are defined. Yet the Regulation, which applies to all motor vehicles and servicing alike, does not define the various product and geographic markets that are relevant for its application ("relevant markets"). Nor do previous Commission decisions of application of EC competition rules set out precedent in respect of the passenger car sector. This report aims to define the relevant markets concerning passenger cars in the European Union. The study follows the principles, concepts and methodology set out in the *Commission Notice (97/C, 372/03) on the definition of the relevant market for the purposes of Community competition law* (Official Journal of the European Communities C/372 of 9.12.1997, p.5).

The study first provides qualitative elements to be taken into account when defining the relevant geographic market(s) under the existing policy regime. Given the geographic market definition, the study then provides an econometric analysis of the demand for new passenger cars. The parameter estimates of the demand model are used to define the relevant product market(s) based on a rigorous implementation of the SSNIP-test.

The outline of the study is as follows. In section 2 I summarize the basic principles of market definition according to Commission Notice 97/C, and I explain how I implement them here to define the market(s) of passenger cars. In section 4 I consider the relevant geographic market(s), based on previous car market studies. Section 4 and 5 consider the relevant product market(s): section 4 develops and estimates the model for the demand of new passenger cars, while section 5 uses the parameter

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[5] Commission Regulation (EC) N°1400/2002 of 31 July 2002.

estimates of the model to apply the product market definition test. Section 6 concludes.

2 Defining the Relevant Market

2.1 Competitive constraints

According to the Commission Notice, the main purpose of defining the relevant market is to identify in a systematic way the competitive constraints that the undertakings involved face. There are three sources of competitive constraints: demand substitution, supply substitutability and potential competition. First, as stated in the Notice, demand substitutability constitutes the most immediate and effective disciplinary force on the suppliers, in particular in relation to their pricing decisions. It therefore should be taken into account in the market definition stage.

Second, the competitive constraints arising from supply substitutability are less immediate and require an analysis of additional factors. More specifically, "when supply substitutability would imply the need to adjust significantly existing tangible and intangible assets, additional investments, strategic decisions or time delays, it will not be considered at the stage of market definition" (para 23). Given the large investment costs and time delay that is typically involved when developing and marketing new models of passenger cars, I do not take into account supply substitutability in the market definition stage.

Third, potential competition is also a less immediate disciplinary force on the suppliers. According to the principles of the Commission Notice, it is not to be taken into account in the market definition stage but rather at the assessment stage of competition policy analysis.

Conclusion. *My analysis of the relevant market definition focuses on competitive constraints arising from demand substitutability.*

2.2 Demand substitution

Conceptually, market definition based on an analysis of demand substitutability will proceed as follows, consistent with the Commission Notice:

(i) Take a candidate market, i.e. a set of products that are believed to be the relevant market.

(ii) Consider a hypothetical "SSNIP", i.e. a Small but Significant, Non-transitory Increase in the Prices of these products, say in the range of 5-10 percent.

The reference price level when considering a SSNIP is the prevailing market price, unless the prevailing price has been determined in the absence of competition, as might especially be the case in investigations of abuses of dominant positions.[6] While my application may also entail some products with little existing competition, I nevertheless take a conservative approach and use the prevailing price as the reference level.

(iii) Compute the change in these products' joint profits as caused by the SSNIP.

(iv) If the joint profits increase, then the candidate market can in fact be treated as the relevant market.

The intuition for (iv) is that the joint profits will increase if the set of included products are sufficiently close substitutes among themselves and sufficiently distant substitutes for the other non-included products. In this sense, the SSNIP-test is a way to account for demand substitutability in a transparent and systematic way.

Conclusion. *My analysis of demand substitution is based on the SSNIP-test.*

2.3 Product versus Geographic Market

The Commission Notice provides various types of evidence that may be used to apply the principles of the SSNIP-test. Which method is preferable depends on data availability and institutional knowledge of the industry.

To define the relevant geographic market(s) I make use of previously published studies that (i) document international price differentials and the extent of parallel trade, and (ii) provide institutional analyses of possible barriers to cross-border trade to end-consumers, intermediaries, independent resellers and authorized dealers.

To define the relevant product market(s), I base my analysis on the first category of evidence listed by the Commission: evidence of substitution in the past. More specifically, I have at my disposal a detailed database of most models sold in 5 European countries, constituting a large part of the market in the European Union, over the period 1970-1999. I follow an econometric approach, which essentially consists of estimating own- and cross-price elasticities for the various cars. From my estimates it is possible to assess the effects of hypothetical SSNIPs on profits in order to arrive at a definition of the relevant market.

One advantage of my econometric approach to defining the relevant product market is that I can rigorously link my analysis to the SSNIP-test. Another advantage is that there is no need to consider the views of the customers and competitors. So I can assess the product market based on revealed preferences (past behaviour) rather than on stated preferences.

Conclusion. *The definition of the relevant geographic market is based on evidence on international price differentials and trade barriers as documented in previously published studies. The definition of the relevant product market is based on an econometric analysis of the demand for new cars, using a database for five European countries over 1970-1999.*

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[6] Using the prevailing market price as the reference price level might give rise to the "Cellophane fallacy" in such cases.

3 The relevant geographic market

To assess the relevant geographic market I follow two different approaches. A first approach looks at historical evidence such as international price differentials, market shares and parallel imports. A second approach looks at institutional information documenting obstacles to cross-border trade.

3.1 Historical evidence

A first approach to assess the relevant geographic market is to look at the extent of international price differentials and the importance of parallel imports. A large extent of international price dispersion and a low degree of parallel imports indicate that there are large unexploited arbitrage opportunities to consumers (or intermediaries), and thus presumably obstacles to cross-border trade.

There exists a large and ongoing literature documenting international price dispersion in the European car market. A general consensus seems to have emerged that international price differentials are substantial and continue to exist. For a recent and detailed overview I refer to Degryse and Verboven (2000). They find that international price differentials for cars with identical specifications are important even if one adjusts the prices for various factors, such as discounts and other financial benefits, a right-hand drive surcharge, taxes and exchange rates. Table 1 summarizes some of their findings for three measures of pre-tax international price dispersion, with and without the adjustments.

Table 1. Unadjusted and adjusted price dispersion in the European Union, 1999-2000

	Average price dispersion	Change in average price dispersion due to adjustment for:				Residual average price dispersion
		Dealer margin	Right-hand drive	Taxes	Exchange rates	
Range 1	38.8	-0.4	-4.7	-7.7	-5.7	20.7
Range 2	19.5	-0.5	-0.7	-2.8	-1.1	14
Coefficient of variation	9.7	-0.1	-0.8	-1.5	-1.1	6.1

* Source and detailed explanation: Degryse and Verboven (2000). Based on pre-tax common currency prices. “Range 1” refers to the (average) price differential between the most expensive and the cheapest country. “Range 2” refers to the (average) price differential between the second most expensive and the second cheapest country. “Coefficient of variation” is the (average) standard deviation divided by the mean.

The adjustment for the gross dealer margin serves to account for the maximum leeway dealers have to offer discounts and other financial benefits to their customers without making losses. The adjustment for the right-hand drive accounts for the surcharge on right-hand drive cars sold outside the U.K. The adjustments for taxes and exchange rates account for the fact that price differentials may arise because of incomplete exchange rate and tax pass-through. In fact, to obtain an indicator of unexploited arbitrage opportunities and cross-border trade obstacles from the perspective of consumers or their intermediaries, it is sufficient to adjust prices for margins and right-hand drive surcharges. The tax and exchange rate adjustments are only relevant if one is interested in the counterfactual policy question of how price differentials would become if taxes were harmonized and exchange rates were stabilized to their long-term values (as they now are for the Euro countries). But from the perspective of measuring unexploited arbitrage opportunities under the current situation they are not relevant.

Evidence on parallel imports is more limited and presumably also less reliable (often based on surveys or figures from official importers). Yet the available evidence indicates that the extent of parallel imports is small, in most cases less than 1 percent of total sales and generally not greater than 4 percent, see for example the study by BEUC (1992) and its preceding studies in the 80s, and the summary in Goldberg and Verboven (2001) and the references therein.

Finally, the evidence on the sales composition within each country shows that market shares vary widely from country to country. The market share of domestic firms is typically considerably larger than the market share of foreign firms, although there has been a trend towards a decline of the home bias over the years.

3.2 Obstacles to cross-border trade

A second, more direct approach assesses the relevant geographic market by reviewing the various institutional factors that determine cross-border trade obstacles. Various studies provide such analyses. I refer to the reports by the European Commission (2000), the U.K. Competition Commission (2000), Goldberg and Verboven (2001),

and the detailed references therein. Following the literature, one may identify four potential obstacles to cross-border trade in the European car market:

(i) the differing national systems of type approval;

(ii) the requirement of national registration;

(iii) transportation and administration costs

(iv) the selective and exclusive distribution system.

The first obstacle can no longer be viewed to have a considerable impact, since the harmonized type approval system has been achieved in 1995. The main remaining exception is, of course, the right-hand drive regulation in the U.K. The second obstacle had the effect of allowing countries to enforce their own national import quota constraints against Asian countries. This can therefore also no longer be considered as a serious obstacle to cross-border trade. The third obstacle may still be viewed as a source of market segmentation, and has been documented in various studies, e.g. BEUC (1992). It is beyond the scope of the current study to provide a detailed assessment on whether these obstacles have been reduced substantially over the past years. To address this question, it is necessary to measure the importance of transportation and administration costs as a fraction of the purchase price of the product.

The fourth obstacle to cross-border trade is the selective and exclusive distribution system. This obstacle remains relevant as long as manufacturers can impose it to their dealers. I provide a brief discussion on the essential sources of the obstacles caused by the distribution system. First, because of selectivity independent resellers cannot engage in cross-border arbitrage, by purchasing cars in bulk in one country to resell it in another. Second, because of exclusivity authorized dealers cannot actively engage in cross-border arbitrage, by opening foreign outlets or by doing targeted advertising (although passive selling in other territories is in principle possible). In sum, while the distribution system in principle protects the rights of end-consumers (or intermediaries with a written authorization) to take advantage of price differentials, it restricts the possibilities for arbitrage activities by independent resellers (due to selectivity) and by authorized dealers (due to exclusivity).

In fact, the distribution system also restricts the arbitrage possibilities for end-consumers or their intermediaries. This follows from the practice of sales targets,

which manufacturers can impose to their dealer. Put briefly, the sales target usually implies that manufacturers provide limited supply to their dealers once the sales target has been reached; see e.g. Competition Commission (2000) or European Commission (2000) for a discussion. The result of this is that a dealer tends to prefer to sell to local consumers, to whom they are likely to also provide after-sales services. Foreign consumers therefore may in practice face larger delivery lags than domestic consumers, as has also been documented by BEUC (1992) and other studies.

4 The demand for new passenger cars

This section analyses the demand for new passenger cars so as to obtain estimates of the products' own- and cross-price elasticities. These elasticities are the essential ingredient to implement the substitution-based SSNIP-test in section 5.

I begin with an informal discussion of the econometric demand model in subsection 4.1; technical details are provided in the Appendix. The model divides the markets in segments according to marketing classifications, and further subdivides the segments in subsegments according to country of origin. In subsection 4.2, I discuss my dataset, used to estimate the demand model. I outline the criteria used to classify the car market in segments and subsegments in subsection 4.3. Finally, in subsection 4.4, I present the parameter estimates and the implications for the substitution patterns, i.e. own- and cross-price elasticities.

4.1 The econometric model

Based on the discussion of the relevant geographic market, my starting point is that the European car market is segmented into its various national markets. To model demand within each national market I formulate a version of the nested logit model: the two-level nested logit. This model will enable me to estimate the products' own- and cross-price elasticities and lies at the basis for defining the relevant product market(s) in close connection with the principles of the SSNIP-test.

The two-level nested logit model partitions the car market into various product segments according to marketing classifications. Specifically, I classify the market

into six segments: subcompacts, compacts, intermediates, standard/luxury, sports and minivans. Each segment is further partitioned in two subsegments according to country of origin: domestic and foreign cars. The idea is that consumers' may have correlated preferences for all cars belonging to the same segment, because these cars share certain features such as size, performance or prestige. Furthermore, consumers may have even more closely correlated preferences for cars belonging to both the same segment and country of origin, because these cars may share additional features such as style or image. The degree of preference correlation for products in the same subsegments and in the same segments determines the substitution patterns in the car market, specifically the own- and cross-price elasticities for the various cars.

More specifically, the intuition behind the nested logit model can be explained as follows. Call the preference correlation parameters for the subsegments and the segments σ_{hg} and σ_g, where *h* denotes the subsegment (domestic or foreign) and *g* denotes the segment. These (estimable) parameters yield price elasticities that are consistent with demand theory if $1 \geq \sigma_{hg} \geq \sigma_g \geq 0$. Intuitively, the following observations can be made:

(i) If both σ_{hg} and σ_g are close to zero, there is no segment or subsegment preference correlation, and the simple logit model applies. Consumers perceive the products of the same subsegment or the same segment as no closer substitutes than products of different subsegments or segments. In this case, there is no segmentation within the national car markets. Put differently, there is "global" rather than "localized" competition within each national market.

(ii) If both σ_{hg} and σ_g are greater than zero and $\sigma_{hg} = \sigma_g$, there is preference correlation at the segment level. Consumers perceive products in the same segment as closer substitutes than products from different segments. In this case, each national car market is segmented according to the different segments, but there is no additional subsegmentation. Put differently, competition is localized at the level of the segments.

(iii) If σ_{hg} is greater than σ_g and σ_g is greater than zero, there is preference correlation at the segment level, and additional preference correlation at

the subsegment level. Consumers perceive products in the same subsegment as closer substitutes than products in different subsegments of the same segment; they perceive products from different subsegments of the same segment as closer substitutes than products from different segments. In this case, the car market is segmented most strongly at the level of the subsegment, while there is some weaker segmentation at the level of the segment.

(iv) If σ_{hg} is greater than σ_g and σ_g is close to zero, there is preference correlation only at the subsegment level. Consumers perceive products in the same subsegments as closer substitutes than products from other subsegments, no matter whether these other products come from the same segment or not. In this case, the car market is segmented purely at the level of the subsegment.

The preference correlation parameters, and the implied substitution patterns, can be estimated using the nested logit specification, based on historical data for price, sales and product characteristics. I provide more details on the nested logit specification and the estimation approach in the Appendix.

4.2 The data

The data set used to estimate the nested logit model consists of prices, sales and physical characteristics of (essentially) all cars sold in five European markets during 1970-1999. The included countries are Belgium, France, Germany, Italy and the United Kingdom. The total number of observations is about 13,000 so that a bit less than 100 models are available in every market/year. The price data are pre-tax and post-tax list prices corresponding to the base model available in the market, as available in consumer catalogues.[7] Sales are new car registrations for the model range.

[7] It is well known that transaction prices may differ from list prices because of discounts and other financial benefits offered by the dealers to the consumers. In the econometric literature on passenger car demand, a consensus has emerged that list prices are nevertheless informative in obtaining price elasticities if the model is specified in a sufficiently flexible way. The reason is that while deviations from list prices may be country-specific and brand- or even product-specific, they show relatively little

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. The data set is augmented with macro-economic variables including population, exchange rates, GDP and consumer price indices for the various markets over the relevant period. Finally, there is information on dealer discounts and gross dealer margins for a selected number of models/years. A more detailed description of the sources, for the shorter period of 1980-1993, is provided in Goldberg and Verboven (2001).

4.3 The various segments and subsegments

An important issue concerns the actual classification of the cars in different – exhaustive and mutually exclusive – segments. Classifications are available from marketing research. In particular, I make use of the classifications from the European Commission's bi-annual car report (for 75 models since 1993) and from L' Argus de l'Automobile et des Locomotions (for essentially all models since 1990). Table 2 shows the correspondence of the classifications across the different sources.

Table 2. Classification of segments, different sources

Segment	Example	L'Argus 1990	L'Argus 2000	E.C. Report 1999
subcompacts	Ford Fiesta	B	B1+B2	A+B
		(petites urbaines et polyvalentes)		
compacts	VW Golf	M1	M1	C
		(familiales compactes)		
intermediate	Peugeot 406	M2	M2	D
		(familiales)		
standard/luxury	Audi A6	H	H1+H2	E+F
		(haut et très haut de gamme)		
sports	Mercedes SLK	coupés	coupés	G
minivans	Renault Espace	n.a.	monospace	G

variation over time. One can then account for deviations by including market and product effects. Additional measurement error on the price variable is absorbed by instrumenting for price.

Generally speaking, while the labels differ, the various sources assign the majority of cars to the same segments. Nevertheless, there are some differences across sources and even over time for the same source. My point of departure has been the classification of the 1990 issue of L'Argus.[8] I retain the same classification for the available cars in the earlier and later years; for predecessors and successors of the cars sold in 1990, I also assign the same classification. The advantage of this procedure is that segments are not arbitrarily redefined over the years.

To check consistency of the classification, I assessed the physical characteristics of the cars in more detail. Sports cars and minivans are typically classified without ambiguity.[9] To verify the classification of cars from the other segments (subcompact, compact, intermediate, luxury), I analysed their dimensions, performance and price. One procedure would be to rank all the cars according to each of these characteristics, and check whether the higher ranked cars are also assigned to the higher ranked segments. Such an approach would however not be capable of generating a consistent classification that is independent of which characteristic is used to obtain the ranking. If one were to use one characteristic to classify cars, their ranking would generally differ for the other characteristics. To resolve this issue, I rank the cars for each given brand, rather than ranking them over all cars in the market. I then check by brand whether the rankings are consistent with their assigned segments. For example, independent of whether dimension, performance, or price is used as the criterion, one may rank the cars of the Opel brand as follows: Corsa, Astra, Vectra and Omega. Since the segments to which these cars are assigned are ranked in the same order (B, M1, M2 and H), the classification of the Opel cars is therefore consistent.

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[8] The reason is that this was the source I used when constructing the original 1990 database, which was used in Verboven (1996). In further work the database was gradually updated to include earlier and later years.

[9] But this is not to say that the sports cars and minivan segments are not heterogeneous segments.

While this procedure allows one to check whether the classification is consistent, it does leave room for different alternative consistent classifications. For example, while the Honda Civic may be unambiguously ranked below the Honda Accord (i.e. no matter which characteristic is used), there are different consistent classifications. All sources classify the Honda Civic in the compact segment (M1), but they assign the Honda Accord to either the M2 and H1 segment. Rather than advocating one consistent classification over another, my approach has been to take the Argus 1990 classification as the point of departure and check the robustness of the results when alternative consistent classifications are used. Generally speaking, I found that the estimates of the demand parameters, and the implications for the SSNIP-test are insensitive to such alternative consistent classifications. Consequently, while my estimates and analysis below is based on the classification from 1990 issue of L'Argus, the results also apply if one adopts similar classifications (as those from Table 2).

Notice finally that the classification according to L'Argus 1990 is more aggregate than the other classifications. In particular, the B1 and B2 segments and the H1 and H2 segments of the L'Argus 2000 classification are merged. Analogously, the A and B segments and the E and F segments of the Commission's classification are merged. While it may be worthwhile in principle to extend the analysis to the more disaggregate market definitions, this would lead to some difficult classification choices, especially for cars available in the 70s or early 80s. In practice, even if it turns out that the more disaggregate segments constitute relevant markets by themselves, the policy implications may be similar. The reason is that a manufacturer who has a strong market share in one segment (say A in the Commission's classification) is likely to have a similarly strong market share in the neighbouring segments (say the B segments of the Commission's classification).[10]

Table 3 summarizes the characteristics information by market segment, based on the information for the 5 countries in 1999. For example, one can see that the mean horsepower, fuel inefficiency, width and height increase as one moves to higher

[10] Nevertheless, it seems desirable that the Commission retains it more detailed classification, to facilitate future work. It would even seem desirable to classify the Minivan segment in more detailed subsegments, as is done in L'Argus 2000.

segments. Although the standard deviations are relatively small, it is also clear that there are overlaps across segments.

Table 3. Summary statistics, by segment

	Mean	Std. Dev.	Mean	Std. Dev.
	Subcompact (144 obs.)		Compact (110 obs.)	
Horsepower (in kW)	41.73	5.46	60.61	11.39
Fuel inefficiency (litres per 100 km)	7.03	0.59	8.28	0.91
Width (in cm)	160.23	6.32	169.94	2.91
Height (in cm)	143.33	6.17	141.98	4.35
Foreign (1 if foreign)	0.35	0.48	0.36	0.48
Price (Euro)	7277	1435	10515	2420
	Intermediate (118 obs.)		Standard/Luxury (69 obs.)	
Horsepower (in kW)	75.73	14.11	96.93	11.07
Fuel inefficiency (litres per 100 km)	9.19	0.87	10.51	1.05
Width (in cm)	172.99	3.12	176.90	3.49
Height (in cm)	141.37	1.82	141.46	3.34
Foreign (1 if foreign)	0.31	0.46	0.36	0.48
Price (Euro)	13406	3669	18907	3779
	Sports (92 obs.)		Minivan (89 obs.)	
Horsepower (in kW)	99.42	24.42	80.45	19.31
Fuel inefficiency (litres per 100 km)	9.95	1.07	10.68	2.04
Width (in cm)	171.71	5.78	175.01	9.67
Height (in cm)	132.01	6.23	169.08	8.20
Foreign (1 if foreign)	0.33	0.47	0.31	0.47
Price (Euro)	18643	5405	15276	4360

A second issue is to classify the segments in different subsegments. This classification was based on the country of origin. Specifically, I split each of the six segments in two subsegments, depending on whether the cars are domestic or foreign cars. This distinction is not based on the production location of the cars, but rather on the nationality of the firm, since this is more relevant from a demand side perspective. For example, the Volkswagen Polo is treated as a domestic car in Germany, even if this car is produced elsewhere.

4.4 The estimates

The parameter estimates are presented in Table 4. The first two columns present the results from the logit specification, in which all segmentation parameters σ_{hg} and σ_g are set equal to zero. This specification *a priori* rules out any segmentation within the national market, since consumers have no correlated preferences across cars within

the same segment or subsegment; see observation (i) in Subsection 4.1. The third and the fourth column present the results from a restricted specification, in which σ_{hg} is equal across all twelve subsegments, and σ_g is equal across all segments. This is the commonly estimated version of the (two-level) nested logit model. The fifth and sixth column present the results of a more flexible nested logit specification, in which the subsegmentation and segmentation parameters are allowed to vary by segment. To reduce the number of σ to be estimated, I constrained $\sigma_{Dg} = \sigma_{Fg}$ (where D denotes domestic and F denotes foreign), i.e. the degree of heterogeneity within a domestic subsegment is the same as that within its foreign counterpart. To check the robustness of the results, I also considered various alternative specifications. For example, I allowed some of the parameters to vary across countries and over time, e.g. market and year interaction effects. Most parameter estimates were robust across these alternative specifications.

The simple logit specification in Table 4 shows that some of the characteristics parameters have the unexpected sign (e.g. the horsepower coefficient). This no longer appears to be the case for the nested logit specifications. The parameters of the included characteristics are of the expected sign and usually significant. Horsepower, width and height positively affect the consumers' mean valuation, whereas fuel inefficiency (measured as liters per 100 km) has a negative impact. Similarly, price has a significantly negative effect. The foreign firm effect is negative and significant, meaning that the domestic incumbents face a competitive advantage over their foreign competitors in terms of the mean consumer valuation.

Table 4. Parameter estimates for the logit and nested logit models

	Logit		Restricted nested logit		Flexible nested logit	
	Estimate	St. Error	Estimate	St. Error	Estimate	St. Error
Mean valuation parameters						
Constant	-20.209	.980	-12.225	.687	-11.176	.593
Horsepower	-.007	.002	.004	.002	.001	.001
Fuel inefficiency	-.124	.013	-.066	.008	-.050	. 007
Width	.074	.004	.042	.003	.034	.003
Height	.036	.005	.023	.003	.018	.003
Foreign	-.848	.025	-1.048	.047	-.918	.038
Price	-2.320	.231	-2.225	.130	-1.755	.098
Subsegmentation parameters						
Subcompact			.525	.028	.765	.025
Compact			same		.567	.030
Intermediate			same		.538	.033
Standard/luxury			same		.697	.028
Sports			same		.445	.032
Minivan			same		.042	.041
Segmentation parameters						
Subcompact			.318	.030	.298	.035
Compact			same		.379	.041
Intermediate			same		.311	.042
Standard/luxury			same		.450	.035
Sports			same		.143	.042
Minivan			same		.151	.066
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Market dummies	Yes	Yes	Yes	Yes	Yes	Yes
Product dummies	Yes	Yes	Yes	Yes	Yes	Yes

Now consider the segmentation parameters σ. For both the restricted and the unrestricted nested logit specification, the segmentation parameters satisfy the required conditions to obtain price elasticities consistent with demand theory (consistency with random utility maximization), i.e. the condition that $1 \geq \sigma_{hg} \geq \sigma_g \geq 0$ is satisfied for most parameters. The only exception is the subsegmentation parameter of the minivan in the unrestricted specification. This parameter is below the value of the segmentation parameter of the minivans (.04 < .15), but the difference is modest. Both the restricted and the flexible nested logit specification show that consumer preferences are significantly more correlated for cars within the same subsegment (e.g. subsegmentation parameter of .53 in the restricted specification) than for cars within the same segment but a different subsegment (segmentation parameter of .32). 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 (since .32 is significantly different from 0).

The fact that the nested logit specifications yield σ_{hg} that are typically greater than σ_g, which are in turn greater than 0, implies that there is indeed segmentation according to subsegments, and additional (weaker) segmentation according to segments; see observation (iii) in Subsection 4.1. Further insights in the extent of segmentation are obtained from a closer look at the own- and cross-price elasticities as implied by the parameter estimates. Summary statistics are provided in Table 5.

Table 5. Substitution Patterns

	Own elasticity		Cross elasticity with respect to cars from					
			Same subsegment		Same segment		Different segment	
	Logit							
	Average	St. Dev.	Average	St. Dev.	Average	St. Dev.	Average	St. Dev.
Subcompact	.983	.192	.0021	.0029	.0021	.0029	.0021	.0029
Compact	1.417	.329	.0033	.0044	.0033	.0044	.0033	.0044
Intermediate	1.811	.496	.0025	.0033	.0025	.0033	.0025	.0033
Standard/luxury	2.569	.587	.0018	.0028	.0018	.0028	.0018	.0028
Sports	2.516	.740	.0005	.0007	.0005	.0007	.0005	.0007
Minivan	2.068	.608	.0011	.0014	.0011	.0014	.0011	.0014
	Restricted nested logit							
	Average	St. Dev.	Average	St. Dev.	Average	St. Dev.	Average	St. Dev.
Subcompact	1.933	0.382	.056	.078	.018	.023	.002	.003
Compact	2.759	0.646	.108	.160	.033	.043	.003	.004
Intermediate	3.536	0.993	.124	.188	.037	.047	.002	.003
Standard/luxury	4.918	1.273	.273	.395	.079	.113	.002	.003
Sports	4.895	1.487	.187	.205	.058	.068	.000	.001
Minivan	3.990	1.208	.187	.283	.053	.076	.001	.001
	Flexible nested logit							
	Average	St. Dev.	Average	St. Dev.	Average	St. Dev.	Average	St. Dev.
Subcompact	3.023	0.616	.148	.212	.013	.017	.002	.002
Compact	2.383	0.558	.098	.144	.034	.044	.002	.003
Intermediate	2.863	0.806	.105	.161	.029	.036	.002	.002
Standard/luxury	5.956	1.650	.463	.675	.108	.155	.001	.002
Sports	3.313	1.004	.117	.132	.017	.020	.000	.001
Minivan	1.714	0.505	.010	.014	.010	.014	.001	.001

I concentrate the discussion on the nested logit specifications. The average own-price elasticities (presented in absolute value) are more or less in line with previous work.[11] Interesting new findings arise when comparing the average price elasticities for the different segments between the restricted and the flexible nested logit specification. The restricted specification shows that the own-price elasticities are increasing as one moves to higher segments. The increasing pattern follows from the near proportional relationship between the price elasticities and the price level implied by the restricted nested logit. Put differently, in the restricted nested logit the semi-elasticities (elasticities divided by the price) do not show systematic variation across different segments. The flexible nested logit shows that the own-price elasticities no longer move proportionally to price as one moves up to the more expensive segments. As a result, the semi-elasticities tend to be lower for the more expensive models (the exception being the standard segment).

More relevant for my purposes are the estimates of the cross-price elasticities. Note first that the pattern of cross-price elasticities is again increasing across segments for the restricted nested logit, in contrast to the flexible nested logit. Furthermore, looking at the nested logit specifications, one can see that the cross-price elasticities are typically the greatest between cars from the same subsegment. They are smaller between cars from different subsegments within the same segment, and negligible between cars from different segments. These findings of course follow from the obtained estimates of the segmentation parameters, σ_{hg} and σ_g, as discussed above.

5 Applying the market definition test

This section defines the relevant product market(s) using the principles of the SSNIP-test. Section 5.1 discusses the economic principles behind the SSNIP-test. I begin by assuming that the wholesale-level demand coincides with the retail-level demand, so that the SSNIP-test can be directly based on the retail-level demand system, as estimated in section 4. I next account for the fact that the wholesale-level demand is a

[11] Note that for the two nested logit specifications all own-price elasticities exceed one (in absolute value). This is not the case for the logit specification, consistent with previous work.

derived demand and may therefore differ from the retail-level demand. I propose a modified SSNIP-test based on an explicit link between the wholesale-level demand and the estimated retail-level demand. This link is provided by the pass-through relationship between wholesale and retail prices. In section 5.2, I then apply the proposed SSNIP-tests to define the relevant product market(s).

5.1 Economic principles

The SSNIP-test selects a set of products as a candidate relevant market, and then asks whether a joint price increase by 5-10 percent would raise the joint profits of the selected set of products. The test is based on the principle that a joint price increase will be profitable to the manufacturers if there is not too much substitution towards other products left out of the candidate market. On the one hand, the price increase raises the products' markups, which is obviously good for profitability. On the other hand, the price increase induces consumers to substitute towards other products and thus reduces sales, which reduces profitability. If the first effect dominates the second effect, the 5-10 percent price increase is profitable and the set of products can be considered as a relevant antitrust market.

More specifically, call the products for which the price increase is considered the insider products, and the remaining products the outsider products. Consider first the manufacturers' joint profits on the insider products before the price increase, say $\pi_I(w)$. These profits depend on the wholesale prices w, as charged by the manufacturers to the dealers. The wholesale price vector w contains both the insiders' and the outsiders' wholesale price vectors, w^I and w^O, so I sometimes use $w = (w^I, w^O)$. The joint profits before the price increase equal the sum of each insider product j:

$$\pi_I(w) = \sum_{j \in I} (w_j - c_j) s_j(p(w)) L,$$

where I denotes the set of insider products, c_j is the marginal cost of product j, L is the total number of potential consumers, and $s_j(p(w))$ is the market share of product j. For expositional convenience and without loss of generality, the marginal cost c_j is assumed to include both the manufacturers' and the retailers' marginal cost.

It is thus as if the dealers do not bear their own retail cost directly, but rather indirectly through the wholesale price. The market share $s_j(p(w))$ depends on the retail prices p and therefore indirectly on the manufacturers' wholesale prices w, through the pass-through function $p(\cdot)$.

Now consider a percentage increase in the insiders' wholesale prices, w^I. Let this percentage increase be given by λ, think of 5 or 10 percent.[12] Denote the new wholesale price vector by $w^{new} = ((1+\lambda)w^I, w^O)$. The manufacturers' joint profits on the insider profits after the price increase are equal to:

$$\pi_I(w^{new}) = \sum_{i \in I} ((1+\lambda)w_j - c_j)s_j(p(w^{new}))L .$$

On the one hand, the insiders' profit markups increase from $w_j - c_j$ to $(1+\lambda)w_j - c_j$. On the other hand, the raise in the insiders' wholesale prices leads to an increase in the retail prices through the pass-through function, and therefore indirectly reduces the manufacturers' sales. The SSNIP-test simply compares the insiders' profits before and after the price increase and assesses whether the profit change is positive. It therefore accounts for both the increased markups and the reduced sales.

The elements that need to be specified are the wholesale price-cost markups and the demand functions, including a specification of the pass-through functions. I begin by assuming that the wholesale and retail prices coincide, as is commonly assumed when the SSNIP-test is applied. I then propose and extension of the SSNIP-test to allow for the fact that the wholesale and retail prices may differ, implying differing wholesale-level and the retail-level demands.

The exposition concentrates on an intuitive overview. Technical details on the implementation of the SSNIP-test in various steps are provided in the Appendix.

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[12] Since this percentage price increase is a hypothetical experiment, one has the freedom to interpret the time span or the non-transitory character of the price increase. Generally speaking, the price increase may be interpreted over a time span of up to two years, since during this period it is likely that the price change only induces consumer responses and no other changes such as new product development, entry.

5.1.1 Wholesale and retail prices coincide

The common version of the SSNIP-test assumes that wholesale prices and retail prices coincide, i.e. $p = w$.[13] The pass-through of wholesale prices into retail prices is therefore complete. Furthermore, the wholesale markups are equal to the retail markups, and the wholesale-level demands are equal to the retail-level demands. Formally: $w_j - c_j = p_j - c_j$ and $s_j(p(w)) = s_j(p)$. In the context of the European car market, this assumption might be justifiable if one is willing to assume that there is a strong degree of intrabrand competition, i.e. competition between dealers selling the same products. While territorial exclusivity under the current distribution regime forms a potential barrier to such intrabrand competition, the relatively high out-of-territory sales within a country (over 40 percent in the U.K., as indicated by the Competition Commission) suggest that intrabrand competition may be important. (Nevertheless, the same number may be interpreted to be low, given that it refers to out-of-territory sales within a country and given the high mobility of consumers in the urban areas.)

The SSNIP-test can then be implemented if two key ingredients are known for each product j:

(i) the retail-level demand functions $s_j(\cdot)$;

(ii) the current markups $p_j - c_j$.

Knowledge of the retail-level demand system is available since it was estimated in section 4. Knowledge of the current markups may in principle be measured directly by measuring the marginal cost c_j of every product. For example, one could obtain this information from accounting information provided by the manufacturers. It is however necessary to be sure that such information truly reflects the marginal costs and no fixed cost components, and that it includes all opportunity costs of the

[13] It is important to keep in mind that in my exposition the marginal cost c_j includes both manufacturers' and retailers' marginal cost. Therefore, when it is said that the "retail and wholesale prices coincide", the wholesale prices should be interpreted as including the dealers' marginal costs. Equivalently, it means that the dealers' make no economic profits (perfect intrabrand competition) .

manufacturers.[14] Since obtaining such information is a formidable task, I follow an indirect approach to measure markups, in the tradition of recent empirical research in Industrial Organization. I measure markups based on an economic model of pricing behaviour. Intuitively, I assume that each firm chooses its prices non-collusively to maximize the profits of all the products it sells. Based on this assumption, each product's economic price-cost markup can be computed as the ratio of the product's price over its perceived price elasticity of demand. For details on the markup measurement in the context of cars, I refer to Berry, Levinsohn and Pakes (1995).

5.1.2 Wholesale and retail prices differ

In practice, it is possible that the manufacturers' wholesale prices and the dealers' retail prices do not coincide. This will occur to the extent that there is no intrabrand competition between the dealers, e.g. because territorial exclusivity is perfectly enforced. When the wholesale and retail prices do not coincide, the simplifications in subsection 5.1.1 cannot be made. In particular, two problems need to be resolved. First, it is necessary to know the demand functions at the wholesale level. These are not known, but as they are derived demands they may at least be linked to the (estimated) retail-level demand functions.[15] Second, it is necessary to measure the wholesale markups, which are typically not publicly observable.

Both problems may be resolved with a suitable model of the strategic manufacturer-dealer relationship in the absence of intrabrand competition. I briefly outline the intuition below; see the Appendix and Brenkers and Verboven (2002) for more rigorous details. In the spirit of Rey and Stiglitz' (1995) model, manufacturers simultaneously choose their optimal wholesale prices, anticipating that the dealers will respond by optimally choosing their retail prices. Because of a lack of intrabrand

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[14] Opportunity costs can include a wide range of components. For example, in the case of cars, an overcapacity or the expectation of after-sales services and maintenance can be viewed as (negative) determinants of the opportunity cost to be taken into account when selling a new car.

[15] In the context of horizontal mergers, Hosken, O'Brien, Scheffman and Vita (2002) discuss related problems in evaluating mergers at the wholesale level, when the demand system is only known (i.e. estimated) at the retail level.

competition, the pass-through relationship between wholesale prices and retail prices is not necessarily complete as in the previous subsection. The model can nevertheless compute the necessary ingredients for implementing the SSNIP-test:

(i) the wholesale-level demand functions, which are explicitly derived from the (estimated) retail-level demand functions based on the pass-through relationship implied by the model;

(ii) the wholesale markups $w_j - c_j$.

Specifically, the wholesale-level demand functions work as follows in implementing the SSNIP-test. When the insiders' wholesale prices w^I increase by, say, 5 percent, the retail prices p are computed by numerically solving the system of pricing equations that define the retail price (Nash) equilibrium. On the one hand, the insiders' retail prices will typically rise by less than 5 percent, because of incomplete pass-through. On the other hand, the outsiders' retail prices will now respond positively. The new retail prices then determine demand according to the estimated retail-level demand functions.

The wholesale markups $w_j - c_j$ are again not measured directly based on accounting data. Instead, I use the equilibrium conditions from the manufacturer-dealer model to arrive at economic markups that are equal to the ratio of the products' prices over the perceived *adjusted* price elasticities of demand. The adjustment accounts for the fact that the manufacturers are not directly in competition with each other, but only indirectly through the retailers' pricing decisions. For this reason, the adjusted elasticities will be lower and the measured wholesale markups higher than when the wholesale and retail prices coincide.

5.2 Results

The review of previous work in section 3 indicated that the national markets are the relevant geographic markets. Within each national market, I now define the relevant product markets by applying the principles of the SSNIP-test as outlined in subsection 5.1. For each national market I take a set of products and ask whether this set can profitably raise prices. Obviously, one may consider a huge number of possible

product sets as candidate antitrust markets. I limit attention here to the obvious candidates implied by the estimation results of the nested logit model in section 4. Recall from the econometric results that the car market can be viewed as segmented in the six considered segments (subcompact, compact, etc…), with a stronger substitutability between cars of the same segment and a weaker substitutability between cars of different segments. In fact, the results even indicated that there is additional segmentation within each segment according to country of origin (domestic and foreign). These subsegments and segments are therefore the obvious candidate relevant antitrust markets. The SSNIP-test can rigorously confirm whether this is indeed true.

I base my analysis on the flexible nested logit demand system. This was the most general considered specification, and the estimates imply that the more restricted specifications (restricted nested logit and simple logit) are rejected in favour of this alternative.

5.2.1 Wholesale and retail prices coincide

I begin with the common approach, in which the wholesale and retail prices coincide,[16] so that the wholesale-level demand functions are equal to the (estimated) retail-level demand functions. As discussed in subsection 5.1 (see also footnote 13), the interpretation of this approach is that intrabrand competition (competition between dealers of the same brand) is important, so that dealer margins are negligible. The SSNIP-test results for 5 percent and 10 percent price increases in alternative segments are shown in Table 6.

Table 6. Segment's profit increase when wholesale and retail prices coincide (Based on flexible nested logit estimates)

	Belgium	France	Germany	Italy	U.K.
	Price increase by 5 percent				
Subcompact	8.74	6.75	8.47	4.11	9.55
Compact	5.19	4.65	4.52	5.44	6.49
Intermediate	5.42	3.38	4.58	5.21	6.41

[16] Recall the general discussion in section 5.1 and footnote 13 for the interpretation of "wholesale and retail prices coincide".

Standard/luxury	15.19	13.41	12.59	10.15	16.15
Sports	4.34	3.96	3.37	3.98	4.62
Minivan	0.36	0.24	.32	.26	.27
	Price increase by 10 percent				
Subcompact	16.82	12.92	16.2	7.73	18.1
Compact	9.69	8.58	8.38	9.83	11.72
Intermediate	9.81	6.00	8.17	9.02	11.19
Standard/luxury	26.3	23.09	21.92	16.36	27.36
Sports	7.09	6.58	5.44	6.19	7.2
Minivan	.20	-.21	.11	-.19	-.21

To interpret Table 6, consider for example a 5 percent price increase by all subcompact cars in Belgium. The figure in the upper left cell shows that such a price increase would raise the joint profits of the subcompact cars by 8.74 percent. More generally, the top half of the table shows that all segments can profitably increase prices by 5 percent. Apparently, the lost sales following a price increase are sufficiently small compared to the increased margin. In fact, consumer substitution is so small that 10 percent price increases are even more profitable for most segments, as the bottom half of the table shows. The only exception regarding the profitability of a 10 percent price increase is the minivan segment. In France, Italy and the U.K. there appears to be a slight decline in profits. This follows directly from the econometric results, which showed that the minivan segment shows no clear segmentation from the other segments. The interpretation of this, in turn, may be that the minivan segment is fairly heterogeneous, some minivans being closely related to subcompact or compact cars (e.g. Scenic), while others resembling cars from the intermediate or standard segments (e.g. Espace). The general conclusion is that the segments may be viewed to constitute separate relevant markets, with sufficiently small competition from other segments to make 5 and usually even 10 percent price increases jointly profitable.

I also considered even narrower market definitions. First, I considered alternative segment classifications by leaving out some of the cars, e.g. those models that were assigned to a different segment according to the parallel classification schemes (see Table 2 and the discussion in subsection 4.3). Second, I also considered the narrower subsegments (i.e. domestic or foreign within each segment) as candidate relevant markets. The results (not shown) reveal that the relevant markets may often indeed be defined at the subsegment level. There are however several exceptions. The most notable ones occur in Italy: price increases by the domestic segment tend to be

unprofitable. This follows from the fact that the domestic firm (Fiat) already has significant market power, so that further price increases are no longer likely to be profitable.[17] For the sake of simplicity, I therefore chose to focus on the market definition results at the segment level.

Finally, for comparison purposes I also applied SSNIP-tests using the parameter estimates from the simple logit model (first column in Table 4). Recall that this model assumes zero segmentation parameters, i.e. consumer preferences are uncorrelated across cars from the same segments or subsegments, so that competition between cars is imposed to be symmetric. The empirical results clearly rejected the simple logit assumption (see Table 4). The SSNIP-test results based on the simple logit (not shown here) imply that 5-10 percent price increases would no longer generally be profitable at the segment level. The reason is, of course, that the logit model imposes consumers to substitute equally likely to other segments. This illustrates the importance of not using a specification that is rejected by the data in favour of a more flexible one.

5.2.2 Wholesale and retail prices differ

I now consider the alternative approach, in which the wholesale and retail prices do not coincide. The wholesale-level demands now differ from the retail-level demands, but as derived demands they are linked through the strategic relationship between the manufacturers and the retailers. As discussed in subsection 5.1, the interpretation of this approach is that the extent that intrabrand competition is weak. Specifically, the approach accounts for the fact that an increase in the manufacturers' wholesale prices may not be passed through completely in the retail prices. The results for 5 percent and 10 percent price increases in the alternative segments are shown in Table 7.

Table 7. Segment's profit increase when wholesale and retail prices differ (Based on flexible nested logit estimates)

	Belgium	France	Germany	Italy	U.K.
	Price increase by 5 percent				
Subcompact	4.75	2.28	3.84	2.55	4.36

[17] One may interpret this as a Cellophane fallacy. Since Fiat already has strong market power, it can no longer profitably raise its prices.

Compact	2.36	1.88	1.79	2.88	3.39
Intermediate	3.02	1.56	2.36	3.22	3.55
Standard/luxury	9.92	7.96	6.16	6.43	10.05
Sports	2.51	2.08	1.63	2.32	2.40
Minivan	.13	.08	.09	.01	.12
	Price increase by 10 percent				
Subcompact	9.25	4.44	7.44	4.88	8.39
Compact	4.53	3.58	3.43	5.38	6.30
Intermediate	5.64	2.87	4.37	5.79	6.40
Standard/luxury	17.30	13.76	10.75	10.29	17.10
Sports	4.27	3.58	2.74	3.68	3.80
Minivan	.18	0.01	.09	.06	.04

The results are more or less in line with those obtained in the first approach, where wholesale and retail prices coincide. The top half of the table shows that for all segments price increases by 5 percent are jointly profitable. But the effects for minivans are small. Price increases by 10 percent are typically even more profitable, with the same qualification that the effects for minivans are small.

I again also excluded cars that received other classifications, and the results are robust. Similarly, I again considered the subsegments as candidate relevant antitrust markets (not shown). Many subsegments may again be considered as relevant antirust markets, though there are several exceptions in the domestic subsegments. For simplicity, it therefore remains natural to focus on the segments as relevant antitrust markets.

6 Conclusions

This report has studied the relevant antitrust market(s) in five countries of the European passenger car sector. First, the available research from other studies leads to the conclusion that the relevant geographic markets can be reasonably defined at the level of the national countries.

Second, within each national market the relevant product markets may typically defined at the segment level, with the exception of the minivan segment. This conclusion is based on an econometric analysis of the demand for new cars and a rigorous implementation of the SSNIP-test.

The econometric model distinguishes between six different segments: subcompact, compact, intermediate, standard, luxury and minivan. This is slightly more aggregated than the classification of the European Commission's car price report (subcompact segment contains Commission's A+B; standard/luxury contains E+F). The econometric results demonstrate that products from the same segment are closer substitutes than products from different segments; within each segment products of the same origin (domestic or foreign) are even closer substitutes. The results from the demand side are used to implement two versions of the SSNIP-test. The first version applies the traditional SSNIP-test, i.e. it considers a 5-10 percent price increase by the manufacturers without any corrections for the fact that the wholesale-level and retail-level demands may differ. The second version applies a modified SSNIP-test, to account for the fact that the wholesale-level demands may differ from the (estimated) retail-level demands, because of incomplete pass-through of the manufacturers' wholesale prices into the retail prices. Both versions cover a broad economic spectrum, ranging from the extremes of full intrabrand competition to no intrabrand competition between dealers.

Both versions of the SSNIP-test lead to the same conclusion. Most segments may be defined as the relevant product markets within each national market, i.e. 5-10 percent price increases would be jointly profitable in these segments. The only exception is the minivan segment, in which 5-10 percent price increases are not profitable for some countries. For the other segments, it is in fact often possible to apply even narrower product market definitions. First, slightly redefined segments in which some of the cars are dropped (e.g. the ones that do not belong to the segment according to parallel classification schemes) still constitute relevant antitrust markets. Second, many of the subsegments (e.g. foreign cars within a segment) constitute relevant antitrust markets. For simplicity, however, it is reasonable to define the relevant product markets within each country at the segment level, based on the possible classification schemes in Table 2. Cars from the minivan segment, which does not constitute a relevant product market, may be included in their respective "sister" segments (e.g. Scenic in compact; Espace in standard; etc…).

The extent to which the conclusions would apply to other than the consider five Member States as such, or whether the same analysis would yield slightly different results is beyond the scope of this study. Nevertheless, since the SSNIP results are

similar for all countries, one may conjecture that they would also apply to other European countries, if comparable segment classifications are used. The general message, however, is that the results show that a meaningful competitive assessment of the passenger car sector cannot rely on the assumption that there is a sole relevant market in which all cars compete throughout the EU on equal basis. The level of competition on car retailing has to be assessed at a lower and more detailed level.

7 References

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8 Appendix. Technical details

8.1 Demand specification

There are *M* national markets; in each market m there are L_m potential consumers. A consumer *i* located in market *m* can choose between the *J* differentiated products. Assume that cross-border arbitrage costs are prohibitive so that consumers do not consider purchasing a car in another market than where they are located. This assumption allows me to suppress the market subscript *m* for now; I will, however, need to explicitly reintroduce it below. A consumer *i*'s conditional indirect utility from product *j=1,...,J* is given by:

$$u_{ij} = x_j'\beta - \alpha p_j + \xi_j + \varepsilon_{ij} = \delta_j + \varepsilon_{ij} \qquad (1)$$

where δ_j is the mean utility, which is common to all consumers, and ε_{ij} is the (mean zero) individual-specific utility term. The mean utility δ_j depends on x_j, a *K*-dimensional vector of product characteristics, on p_j, the price of product *j*, and on ξ_j, an unobserved product valuation. The observed product characteristics in x_j are horsepower, fuel efficiency, size of the car, etc... The unobserved (to the econometrician) product characteristic ξ_j may include style, image, advertising, etc. Consumers may decide not to purchase any product. In this case they choose the outside good for which the mean part of the indirect utility δ_j is normalized to 0, so that $u_{i0} = \varepsilon_{i0}$.

To model the distribution of the individual-specific utility term ε_{ij} I follow the assumptions of a two-level nested logit model. Assume the national market can be partitioned into *G* different segments. Each segment g can be further partitioned in H_g subsegments. Each subsegment *h* contains J_{hg} products, $\sum_{g=1}^{G}\sum_{h=1}^{H_g} J_{hg}$. According to

the distributional assumptions of the nested logit model consumers may have correlated preferences across all products of the same subsegment, and (no stronger) correlated preferences across all products of the same segment but a different subsegment. The interpretation is that products belonging to the same subsegment or segment share a common set of features, and that consumers have correlated preferences over these features. In the car market, marketing classifications partition the national markets into several according to "market segment" or "class". For example, Goldberg (1995) and Verboven (1996) consider five segments according to "market segment", or "class": subcompact, compact, intermediate, standard and luxury. I merge the standard and luxury segments because the alternative classification schemes differ mainly regarding these two segments. I add two additional segments: "sports" and "minivan". A seventh segment is added and reserved exclusively for the outside good. The idea is that cars from the same market segment share a common set of features such as size and prestige, often as the result of deliberate marketing efforts. Each of the six main market segments is further subdivided in two subsegments according to the country of origin: domestic or foreign. Cars that are also from the same country of origin (domestic or foreign) share additional common features, e.g. the image or style. Since the domestic firms typically have a substantially denser dealer network than the foreign firms, an additional common feature of cars from same origin is the average dealer distance for obtaining after-sales services.

If consumers choose one unit of the product that maximizes utility, the distributional assumptions of the nested logit model yield the following choice probability or market share for each product j, as a function of the J by 1 price vector p:

$$s_j(p) = \frac{\exp(\delta_j/(1-\sigma_{hg}))}{\exp(I_{hg}/(1-\sigma_{hg}))} \frac{\exp(I_{hg}/(1-\sigma_g))}{\exp(I_g/(1-\sigma_g))} \frac{\exp(I_g)}{\exp(I)} \qquad (2)$$

where I_{hg}, I_g and I are called "inclusive values" (see e.g. Greene, 2000) defined by:

$$\begin{aligned} I_{hg} &= (1-\sigma_{hg}) \ln \sum_{j=1}^{J_{hg}} \exp(\delta_j/(1-\sigma_{hg})) \\ I_g &= (1-\sigma_g) \ln \sum_{h=1}^{H_g} \exp(I_{hg}/(1-\sigma_g)) \\ I &= \ln \sum_{g=1}^{G} \exp(I_g) \end{aligned} \quad .$$

The parameters σ_{hg} and σ_g are the nested logit random coefficients associated to the subsegments *h* of *g* and the segments *g*. They measure the degree of correlation of consumer preferences for cars belonging to the same subsegments or segments. The conditions on McFadden's (1978) GEV model imply that the model is consistent with random utility maximization if $1 \geq \sigma_{hg} \geq \sigma_g \geq 0$. In a typical case where $1 > \sigma_{hg} > \sigma_g > 0$, consumer preferences are more strongly correlated across products of the same subsegment than across products of a different subsegment within the same segment; preferences are in turn more correlated across these products than across products from a different segment. As σ_{hg} goes to 1, preferences for products of the same subsegment become perfectly correlated, so these products are perceived as perfect substitutes. If all σ_{hg} go to σ_g, preferences become equally correlated for all products of the same segment. The model then reduces to a one-level nested logit model, where the segments constitute the nests. Similarly, if all σ_g go to 0, preferences for products of the same segment *g* but a different subsegment become uncorrelated and the model again reduces to a one-level nested logit, where the subsegments now constitute the nests. Finally, as all σ_{hg} and σ_g go to 0 preferences for all products become uncorrelated, and the model reduces to a simple logit model.

At the aggregate demand level, the parameters σ_{hg} and σ_g allow me to assess to which extent competition is localized between products from the same subsegment or segment. Note that my specification is more flexible than previous nested logit specifications estimated for the car market. I allow the heterogeneity parameters to differ for different subsegments and segments. Hence, it is possible to assess whether the preferences are more correlated across products from certain (sub)segments than others.

8.2 Estimation

I estimate the nested logit demand system (2) where the mean valuation δ_j is given by (1). The unobserved part of the mean valuation, ξ_j is the error term and enters nonlinearly in (2). Following Berry's (1994) nested logit example, I transform the

demand system to obtain a linear expression for ξ_j; see Verboven (1996) for details on the derivation for the two-level nested logit. Adding a market subscript *m* and a time subscript *t*, the estimating demand equation takes the following form:

$$\ln(s_{jmt} / s_{0mt}) = x'_{jmt}\beta - (\alpha / y_{mt})p_{jmt} + \sigma_{hg} \ln(\bar{s}_{j/hgmt}) + \sigma_g \ln(\bar{s}_{h/gmt}) + \xi_{jmt}$$

where $\ln(\bar{s}_{j/hgmt})$ is the market share of product *j* in its subsegment *h* of *g*, and $\ln(\bar{s}_{h/gmt})$ is the market share of all products of subsegment h in segment g. The price coefficient α is interacted with the inverse of income, y_{mt}. The error ξ_{jmt} includes both product and market/time fixed effects, controlling for unobserved mean product valuations that do not vary over time or across markets, e.g. style or image, and capturing common macro-economic fluctuations over time and across countries.

To estimate the model, the main identification assumption is that the product characteristics entering $x_{jmt}\beta$ are predetermined and thus uncorrelated with the error term ξ_{jmt}. The price p_{jmt} and the market shares $\ln(\bar{s}_{j/hgmt})$ and $\ln(\bar{s}_{h/gmt})$ may however be correlated with the error term, if the manufacturers take into account all the relevant demand factors when setting their prices, including the (to the econometrician) unobserved error terms. Instrumental variables should therefore be used; in my application, I use a fixed effects two-stage least squares estimator, using instruments inspired by Berry, Levinsohn and Pakes (1995). Specifically, I adopt the following list of instruments, making use of the specific structure of the nested logit model: (i) the products' own observed characteristics x_{jmt}; (ii) the number of products, and the sums of characteristics of other products of the same firm belonging to the same subsegment, interacted with a subsegment dummy variable; (iii) the number of products, and the sums of the characteristics of competing products belonging to the same subsegment, interacted with a subsegment dummy variable; (iv) the number of products, and the sums of the characteristics of competing products belonging to the same segment, interacted with a segment dummy variable. Note that I interact the instruments in (ii)-(iv) with subsegment or segment dummy variables, since I allow the differentiation parameters σ_{hg} and σ_g to differ across subsegments and segments.

8.3 The SSNIP-tests

For the sake of completeness, this section briefly formalizes the SSNIP-tests discussed informally in section 5.1. Details on the derivations of the used equilibrium conditions are available in Brenkers and Verboven (2002). Let w be the wholesale price vector, containing both the insiders' and outsiders' wholesale price vectors w^I and w^O, so I sometimes use $w = (w^I, w^O)$. The insiders' joint profits $\pi_I(w)$ before the price increase are given by:

$$\pi_I(w) = \sum_{j \in I} (w_j - c_j) s_j(p(w)) L,$$

where I denotes the set of insider products, c_j is the marginal cost of product j, L is the total number of potential consumers, and $s_j(p(w))$ is the market share of product j. This demand function depends on the retail price vector p and therefore indirectly on the manufacturers' wholesale prices w, through the pass-through functions $p(\cdot)$.

Now consider an increase in the insiders' wholesale prices, w^I, by a percentage λ. Denote the new wholesale price vector by $w^{new} = ((1+\lambda)w^I, w^O)$. The joint profits after the price increase are equal to:

$$\pi_I(w^{new}) = \sum_{i \in I} ((1+\lambda)w_j - c_j) s_j(p(w^{new})) L.$$

The SSNIP-test simply computes the joint profits before and after the price increase and checks whether the change is positive. To make the computations, it is necessary to know the wholesale price-cost markups $w_j - c_j$, the demand function $s_j(\cdot)$ and the pass-through function $p(\cdot)$, which defines the relationship between the retail prices p and the wholesale prices w^I and w^O. The demand function is known from the econometric estimates, and specified by equation (2) in this Appendix (subsection 8.1). The wholesale markups and the pass-through functions are measured based on a model of the wholesalers' and retailers' pricing behaviour.

I consider two approaches, depending on the extent of intrabrand competition between the dealers. Both approaches assume that manufacturers simultaneously choose their wholesale prices to maximize their own profits, anticipating that the dealers then choose their retail prices to maximize their own profits given the wholesale prices

faced by all retailers. The analysis implicitly assumes that the retailers' marginal cost is zero. Yet this is without loss of generality. Think of the retailers' marginal cost being borne by the manufacturers, and then accounted for when setting the wholesale prices to the retailers.

8.3.1 Perfect intrabrand competition – wholesale and retail prices coincide

If there is perfect intrabrand competition, the retail and the wholesale prices coincide, so that:

$$p = w .$$

There is therefore full pass-through in the following sense: an increase in the insiders' wholesale prices leads to the same increase in the insiders' retail prices and has no effect on the outsiders' retail prices. For every candidate relevant market, the SSNIP-test involves the following steps:

Step 1. Compute the wholesale markups $w - c$ before the insiders' price increase.

In matrix notation, use the Nash equilibrium conditions to measure the $J \times 1$ wholesale markup vector by:

$$w - c = p - c = -\left(\theta^F \bullet \left[\nabla_p s(p) \right]' \right)^{-1} s(p) ,$$

where θ^F is the manufacturers' $J \times J$ ownership matrix, with elements equal to 1 if the products belong to the same firm, and 0 otherwise; $s(p)$ is the $J \times 1$ demand vector, $\nabla_p s(p)$ is the $J \times J$ Jacobian of first derivatives, and the operator $\bullet$ performs element by element multiplication of two matrices of the same dimension.

Step 2. Compute the insiders' joint profits $\pi_I(w)$ before the price increase.

Simply substitute the above wholesale markups and the estimated demand functions in $\pi_I(w)$.

Step 3. Take an increase in the insiders' wholesale prices by a percentage λ, and compute the corresponding retail price increases.

The increase in the wholesale price corresponds to a change to $w^{new} = ((1+\lambda)w^I, w^O)$. Because of full pass-through, the new retail price vector p^{new} is straightforward to compute. It simply is $p^{new} = p(w^{new}) = w^{new}$: all insiders' retail prices are multiplied by $1+\lambda$, while the outsiders' retail prices remain unaltered.

Step 4. Compute the new profits $\pi^I(w^{new})$ and check if they exceed $\pi_I(w)$.

8.3.2 No intrabrand competition – wholesale and retail prices differ

If there is no intrabrand competition, the wholesale and retail prices differ. More precisely, the retail prices are determined from the solution to the following $J \times 1$ system of first-order conditions:

$$f(p,w) = p - w + \left(\theta^R \bullet \left[\nabla_p s(p)\right]'\right)^{-1} s(p) = 0,$$

where θ^R is the retailers' $J \times J$ ownership matrix. Numerically solving this system reveals that pass-though may typically be incomplete in the following sense: an increase in the insiders' wholesale prices leads to a smaller increase in the insiders' retail prices, whereas it also increase the outsiders' retail prices.[18] Formally, if the conditions of the implicit function theorem are met, the solution to $f(p,w) = 0$ implicitly defines retail prices as a function of wholesale prices $p = p(w)$. Implicit (and numeric) differentiation of the pass-through function then yields the pass-through matrix $\nabla_p f(p,w)^{-1}$. For every candidate relevant market, the SSNIP-test involves the following steps:

Step 1. Compute the wholesale markups $w - c$ before the insiders' price increase.

In matrix notation, the (subgame perfect) Nash equilibrium conditions now allow one to measure the $J \times 1$ wholesale markup vector $w - c$ by:

[18] Whether pass-through is generally incomplete depends on the functional forms (curvature) of the marginal costs and demands.

$$w - c = -\left(\theta^F \bullet \left[\nabla_p s(p) \left(\nabla_p f(p,w)^{-1} \right)' \right] \right)^{-1} s(p).$$

Step 2. Compute the insiders' joint profits $\pi_I(w)$ before the price increase.

Simply substitute the above wholesale markups and the estimated demand functions in $\pi_I(w)$.

Step 3. Take an increase in the insiders' wholesale prices by a percentage λ, and compute the corresponding retail price increases.

The increase in the wholesale price corresponds to a change to $w^{new} = ((1+\lambda)w^I, w^O)$. Since there is no complete pass-through, the new price vector $p^{new} = p(w^{new})$ cannot be computed as easily as before. Substitute w^{new} in $f(p, w^{new}) = 0$ to numerically solve this system of equations for the new retail price Nash equilibrium p^{new}. This differs from the previous case in that the insiders' retail prices will typically have increased by less than the percentage λ (if pass-through is incomplete), while the outsiders' retail prices will also have increased to some extent.

Step 4. Compute the new profits $\pi_I((1+\lambda)w^I, w^O)$ and check if they exceed $\pi_I(w^I, w^O)$.